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COGNITIVE SYNTHESIS AND THE COMPREHENSION
OF WRITTEN LANGUAGE

by



Ross Oliver Martin Latham

A THESIS

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ABSTRACT

This study was an analysis of an aspect of the reading process. The major purpose was to establish the role of the integration and synthesis of language elements in the comprehension of written language.

Three basic research questions were addressed: (1) What is the relationship between a reader's ability to select an appropriate synthesizing strategy for a visual-verbal task and written language comprehension? (2) What is the relationship between level of performance in effecting the synthesis of discrete elements in the visual-verbal task and written language comprehension? (3) Is grammar involved in the synthesis and understanding of written language?

Bousfield's (1953) test of recall was modified to classify and evaluate Ss' synthesizing strategies on a visual-verbal task.

Subjects' knowledge of verbal concepts, as an important component in their comprehension of written language, was evaluated with the vocabulary section of a standardized reading test.

To investigate the three research questions, an IBM 1500 Instructional System was programmed to present five passages, in five different formats, on the System's CRT screens. The formats were: (1) "normal;" (2) two-word chunks; (3) small grammatical chunks; (4) large grammatical

chunks; and, (5) long, non-meaningful chunks.

Five testing procedures were employed. These were constructed using: (1) the cloze procedure; (2) facet design; and, (3) the application of linguistic algorithms.

Ss were assigned to one of four experimental groups. To reduce the number of Ss required and the time for data collection, the four independent variables described above were used as the basis of a Greco-Latin Square research design. Although four independent variables were manipulated, the variable of interest was format. No conclusions were drawn regarding the factors of groups, tests, and passages.

The data generated by the test of recall and the standardized reading test provided for the stratification of the sample needed for the testing of the experimental hypotheses.

To control the creation of the chunks used in the grammatical formats, two linguistic algorithms were developed.

It was concluded that, for the restricted sample of college students investigated, the accomplishment of the reading act, i.e., the identification of an acceptable meaning for written language, is substantially dependent upon skill in selecting an appropriate language synthesizing strategy and a high standard of performance in effecting that strategy.

It was further concluded that a high level of performance in these two components will not ensure the

accomplishment of reading. Evidence was collected in this study which suggests that the ability to use grammatical structure as an agent for the synthesis of the elements of written language is also required.

It is clear from the findings of this study that a listener is not called upon to make as extensive a contribution of grammatical knowledge as a reader. This is because, in general, written language does not signal the vital grammatical information that is conveyed by stress, pitch, juncture, and gestural signs used continuously in spoken language. Further research is required to establish which teaching procedures will most efficiently render this knowledge available to readers for use in the reading act.

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CHAPTER 1

INTRODUCTION AND STATEMENT OF PROBLEM

The function of language is communication. Thus, it has two aspects--production and perception. On the output, or production side, language may be spoken or written. On the input, or reception side, it may be heard or read. The study to be reported here is concerned with the perception of language. It is aimed at the investigation of aspects of the comprehension of written language. Specifically, it evaluates the impact of various word-chunking strategies upon the comprehension of written language by undergraduate university students.

Language is a system for the coding and transmission of information. The basic units of the oral aspect of the coding system may be phonemes or distinctive acoustic features. The basic unit of the written aspect of the system may be graphemes or distinctive visual features, i.e., distinctive geometric forms. One reason that coding can be said to occur, is that these basic units appear to be susceptible to synthesis into higher level units or chunks. One such unit is the syllable. Another is the word, while yet another higher level unit, is the phrase.

The phrase may be comprised of one or more words. These words cohere to form a discrete entity because of some unifying element. In a number of studies (North and Jenkins, 1951; Cromer, 1970; Carver, 1970) this unifying

element has been described as "meaningfulness." This term, however, does not provide a precise or consistent description of the synthesizing agent. It is possible that this is due to the lack of a fully developed theory of semantics.

Some reading instructional programs place an early and continuing emphasis upon the recognition of separate words. Such an approach would suggest, perhaps, that the word is the most important unit of language processing. Evidence from studies in speech perception, however, (Ladefoged, 1959; Ladefoged and Broadbent, 1960; Miller and Isard, 1963; Marks and Miller, 1964; Fodor and Bever, 1965; and others) suggests that the perception and apprehension of higher order units of more than one word are probably fundamental to language comprehension. If individual words are the units "referred" for the higher cognitive assessment that is necessary for adequate comprehension, the listener/reader would have to make a perceptual-cognitive decision with every word. Such a word by word processing of language input would be linear and sequential. Although some readers seem to process written language in this way, it is hypothesized that the low level of their comprehension is due, at least in part, to their failure to give due consideration to certain groups of words as groups.

Miller (1962a) contends that some sort of structuring operates in speech processing. He suggests (1962b) that the hearer probably segments the "ongoing flow of sound" into groups which have some semantic reality or

representation. Miller's suggestion is supported by the findings of Pollack and Pickett (1964). They discovered the fact that a hearer decodes an average of four or five syllables per second. This rate of decoding persists for relatively sustained periods of time. That comprehension is associated with this rate of processing is evidence of a perceptual strategy based upon higher level units than the single word. This claim is further supported by the fact that words can be spoken at the rate of two or three per second. Thus, it is extremely likely that strings of spoken words are organized by the listener into cohesive groups.

In spoken language, the listener is assisted in this organization by the pattern of production employed by the speaker. The speaker provides signals which help the listener to group or chunk appropriate words. These signals are conveyed by variations in pitch, stress, intonation, juncture, and gestural signs, plus situational knowledge mutual to speaker and listener. The motivation for this organization of output is the comprehension of input.

When the language input is via the visual modality the reader needs to structure or organize that input for himself in order to associate an acceptable meaning with it. In this case, however, many of the structuring signals, normally contributed by the speaker, are absent. Clearly, then, the reader has less data to assist him in achieving comprehension than does the listener.

It is proposed that one basic strategy in the

comprehension of written discourse is the synthesizing of words into units. The creation of these units enhances the reader's potential for identifying meaning. One reason for this is the manner in which such a strategy tends to offset the "bottleneck" imposed upon the processing of visual information by short term memory. Short term memory is capable of simultaneously holding and processing only four or five separate entities. This applies whether such entities are individual words or "chunks" comprised of several words each. Thus, the reader, by providing non-visual information in the form of syntactic, semantic, and experiential knowledge, for the purpose of the meaningful grouping of individual words, renders written language comprehension dependent on fewer decision-making events (F. Smith, 1971, 1973). Fewer perceptual-cognitive decisions mean the potential for a more rapid rate at which the human brain assimilates written-language-transmitted messages.

Viewed in this way, comprehending connected strings of written words involves a succession of decision-making postponements. Decisions are suppressed until the word elements in the visual array can be synthesized into a cohesive entity. This cohesion is provided by the interaction of syntactic and semantic factors jointly interacting with situational and experiential influences provided by both the writer and the reader. An essential aspect of the language processing strategy proposed here, is that it depends upon the simultaneous consideration of several words.

As a result of this simultaneous focussing of attention upon more than one word, meaningful units are created by synthesis based on syntactic, semantic, and other considerations.

In summary, then, a theoretical tenet which is fundamental to the investigation to be reported here, is that the understanding of written language is closely related to the reader's ability to form and process closely-knit word groups or language segments.

An additional proposal is that the identification of verbal concepts and their synthesis into language segments proceed at the same time. This dual activity is a form of the parallel processing outlined by Neisser (1967). Decisions about segments are made as the result of the simultaneous consideration of one or more words which perform syntactic or lexical functions or both.

It is also hypothesized that this synthesizing process does not stop with the formation of meaningful segments. Rather, it is a hierarchical process by means of which lower level units are synthesized into higher level units. With the help of this process of repeated synthesis the meanings of sentences are reconstituted. The motivation for the formation of these higher level units is the establishment of the functional relationships in sentences. That is, the selection of coherent word groups and the identification of their function in the sentences as subject, verb, object, or modifier, etc., and the recognition of the semantic information that is encoded by such grammatical

functions.

Thus, it is claimed that an important component in the understanding of written sentences is an appreciation of the information conveyed by grammatical entities and the functional relationships that obtain between them. It is further claimed that this apprehension of functional relationships is also dependent upon a form of simultaneous synthesis. That is, this simultaneous synthesis stems from the simultaneous consideration of the grammatical entities that are potentially inter-relatable.

Any written sentence makes use of verbal concepts, a surface structure or syntax, and a graphological form in which those verbal concepts and structure are represented. These, together, are a representation of the underlying meaning of a sentence. As such, they provide only the raw data for the perceptual-cognitive processing that ultimately leads to the recognition of sentence meaning. This act of processing which implicitly reconstructs underlying sentence meaning is the act of written language comprehension. Since the purpose of written language is to convey information, the processing that results in its comprehension may be looked upon as a highly skilled act of information processing.

If the proposals regarding the act of comprehension which have been advanced here can be substantiated with empirical evidence, they hold important implications for the construction of instructional reading materials, the compi-

lation of reading programs, and the preparation and in-service training of teachers.

The Purpose of the Study

The general purpose of this study was to investigate the role of the information processing strategy of simultaneous synthesis in the understanding of written language. Supporting general purposes were to establish the relationship between the ability to select an appropriate information processing strategy for a specific, verbal, recall task and the comprehension of written materials, and the relationship between the level of performance in effecting simultaneous synthesis in the recall task and the comprehension of written language. The study involved theoretical discussions of the importance of language synthesis in language processing, the role of grammar in language processing, reading as a constructive process, grammar and reading, and chunking and reading. The formulation of a theoretical position based on these discussions was followed by the collection and analysis of data relating to information processing strategies and reading, and simultaneous synthesis and reading.

Definition of Terms

The normal format (FP)

The normal format (FP--full presentation) describes the form in which printed materials are usually encountered

in a book, a newspaper, or a magazine. The use of the CRT (Cathode Ray Tube) screens of the IBM 1500 Instructional System meant that the length of lines in this format was restricted to 38 characters including spaces between words and all punctuation marks. In terms of the number of letters, this is about equal to the width of an average newspaper column. Again, because of the restrictions imposed by the CRT screens, only 11 lines of a passage could be displayed during a single exposure using this format. Thus, the complete display of each passage required two full screens and a portion of the third.

The two-word format (TW)

This format is comprised of chunks made up of groups of two words occurring consecutively in a printed text.

The lowest major constituent format (LMC)

The LMC format is made up of chunks generated with the Lowest Major Constituent algorithm (also defined in this section).

The higher major constituent format (HMC)

This format is comprised of chunks produced with the Higher Major Constituent algorithm (also defined in this section).

The bizarre long format (BL)

This format is made up of word-groups based on HMC chunks. After the HMCs have been identified in a passage

their boundaries are consistently moved two words to the right. The result, in almost every instance, is a unit of disrupted meaning, i.e., a non-grammatical chunk.

The lowest major constituent algorithm

LMCs may be formed from all labelled nodes in a surface structure tree except lexical nodes. They are found by locating those nodes which are immediately above the lexical nodes and deciding whether or not there are sister nodes to the lexical nodes. If there are no sister nodes to a specific lexical node then the node immediately above the lexical node, i.e., its dominating node, is an LMC. If there are sister nodes to a specific lexical node, then the LMC associated with that node is the node which immediately dominates all sisters of the lexical node in question.^{1 2}

The higher major constituent algorithm

HMCs may be formed only after the LMCs for a sentence have been established. They are located by finding those nodes which are immediately above the LMCs and deciding whether or not there are sister nodes to the LMCs. If there are no sister nodes to a specific LMC then the LMC becomes an HMC. If there are sister nodes to a specific LMC then

¹ These algorithms were produced in consultation with Dr. G.D. Prideaux of the Department of Linguistics, University of Alberta, 1970.

² See: Chapters 6 and 8, for a fuller explanation of these algorithms and examples of their application to various sentences.

the HMC associated with that LMC is the node which immediately dominates all sisters of the LMC in question. This algorithm is iterated three times or until a surface structure sentence is completely reconstituted if this occurs prior to the third iteration. Thus, the HMC of interest in the present study, is that which is produced by three applications of this algorithm.^{1 2}

Simultaneous synthesis

This term refers to a basic form of integrative activity of the cerebral cortex by which different aspects of the outside world may be reflected. It involves the integration of successive stimuli arriving in the brain into simultaneous groups. The synthesis of separate and successive elements into simultaneous groups may take place during perception or during the performance of complex intellectual operations. One writer describes perceptual, mnemonic,³ and intellectual levels of simultaneous synthesis (Luria, 1966a).

Successive synthesis

This term also refers to a basic form of integrative activity of the cerebral cortex by which different aspects

¹These algorithms were produced in consultation with Dr. G. D. Prideaux of the Department of Linguistics, University of Alberta, 1970.

²See: Chapters 6 and 8, for a fuller explanation of these algorithms and examples of their application to various sentences.

³of or relating to memory (Gove and Webster, 1966).

of the outside world may be reflected. It involves the integration of individual stimuli arriving consecutively in the brain into temporally organized, successive series. Again, the synthesis of separate elements into a successive series may take place during perception or during the performance of complex intellectual activities. Successive synthesis is also described for perceptual, mnestic, or intellectual levels (Luria, 1966a).

Cloze test (CL)

This is the test produced by the application of the cloze procedure involving the deletion of every fifth word.

Vocabulary test (VOC)

The vocabulary subtest of the Cooperative English Test of Reading Comprehension.

Level of comprehension test (LC)

The Level of Comprehension subtest of the Cooperative English Test of Reading Comprehension.

Facet design posttest (FDP)

This term describes the test compiled according to facet design and applied as a posttest.

Linguistic algorithm posttest (LAP)

This is the test based on linguistic algorithms and administered as a posttest.

Linguistic algorithm pretest-posttest (LAPP)

This is the test based on linguistic algorithms and administered as both a pretest and a posttest.

Clustering

This term describes the tendency to recall randomly displayed words in conceptual categories.

Chunk

In this study the term "chunk" is used to describe a group of words. Such a group may or may not be cohesive.

Ratio of repetition (RR)

This refers to the percentage of words recalled that are in clusters (Gonzales and Cofer, 1959, p.296).

Ratio of serial repetition (RSR)

This term refers to the percentage of words that are recalled in the serial order of their presentation.

The "good" group

This term describes 150 readers in the total sample of 325 undergraduate students who produced a Level of Comprehension (LC) scaled score of 160 or more.

The "poor" group

This group was comprised of 150 readers from the total sample of 325 undergraduate students who produced an LC scaled score of 160 or less.

The First Large Good group (FLG)

The 50 Ss from the "good" group who were matched with Ss from the "poor" group on the basis of equal Vocabulary subtest (VOC) and RR scores.

The Second Large Good group (SLG)

The 50 Ss from the "good" group who were matched with Ss from the "poor" group on the basis of equal VOC scores but RR scores 20 to 30 percentage points higher than those of the corresponding "poor" readers.

The First Small Good group (FSG)

Twenty five Ss were identified from among the 150 "good" readers who could each be matched with an RSR¹ "poor" reader on the basis of equal VOC scores. These 25 Ss were assigned to the FSG group.

The Second Small Good group (SSG)

This group of 25 Ss was made up of those who remained in the "good" group after the other three subgroups had been selected. They did not match readers from the "poor" group on any variable. Their scores on the experimental tests, however, were compared with those achieved by the Ss in the Deficit group.²

¹See: definition of RSR group below.

²See: definition of Deficit group below.

The First Large Difference group (FLD)

This group was comprised of the 50 Ss in the "poor" group who could be individually matched with members of the "good" group on the basis of equal VOC and RR scores.

The Second Large Difference group (SLD)

The 50 Ss in this group were matched with individual members of the "good" group on the basis of having equal VOC scores but RR scores 20 to 30 percentage points lower than the corresponding member of the "good" group.

The ratio of serial repetition group (RSR)

Of the 631 volunteers who completed the pencil and paper tests, including the test of clustering in recall, 29 Ss indicated that they had attempted to recall the 60 words in the list by reproducing them in the precise order of their display. It was concluded that these Ss had used an inappropriate information processing strategy for this task. Twenty-five of these Ss were randomly selected and assigned to the RSR group.

The Deficit group

From the original group of Ss who had completed the pencil and paper tests, 51 were identified who had produced substantially lower LC, VOC, and RR scores than the other Ss in the entire group of volunteers. Twenty-five of these Ss were randomly selected and assigned to the Deficit group.

Derivation of Hypotheses

Chapter 5 provides a detailed discussion of the hypotheses that were investigated. The present section outlines how the broad purposes of the study were translated into the general research questions from which the hypotheses were formulated.

The study was planned to achieve the following specific purposes:

1. To determine the relationship between the ability of college readers to select an appropriate information processing strategy for a specific task and their comprehension of written materials;
2. To investigate units of written language processing employed by college readers;
3. To compare the standard of comprehension, using reading materials displayed by various formats, of college readers classified and grouped according to their performance on a task calling for simultaneous synthesis.

In order to satisfy these purposes they were reformulated into general research questions to permit the subsequent generation of specific hypotheses. Thus, the present study was designed to provide empirical information relative to five general questions.

1. Is the ability to select an appropriate information processing strategy for the completion of a specific verbal task, related to reading performance?

2. Can units of written language processing be identified for college readers?
3. Does the type of chunk used in a format for presenting reading materials to college readers affect their comprehension of those materials?
4. With college readers, what are the specific comparative effects of presenting written materials by means of formats based on different chunk-types?
5. On reading materials displayed by means of various formats, how do the comprehension scores of "good" and "poor" college readers compare?

Overview of the Design of the Study

The sample evaluated in this investigation consisted of 325 undergraduate university students engaged in formal course work at the University of Alberta. Knowledge of vocabulary was assessed with the Vocabulary subtest of the Cooperative English Test of Reading Comprehension. A standardized measure of the comprehension of written language was obtained with the Level of Comprehension subtest of the same reading test. The ability to select an appropriate information processing strategy was decided on the results secured from a modified version of Bousfield's (1953) test of clustering in recall. The synthesizing strategies of Ss in dealing with written language were identified on the basis of their reactions to prose selections displayed by means of different formats, each comprised of a different type of

chunk. The completely discrete presentation of each chunk in the various formats was accomplished by programming the IBM 1500 Instructional System with the Minnesota Fortran Pack (see: Chapter 9).

Comprehension of the written materials presented by means of different formats was evaluated with three test types combined to create five testing situations. The three test types were compiled by the cloze procedure based on the deletion of every fifth word, the use of facet design, and the application of linguistic algorithms.

Five different passages were used as the reading materials. These were prepared for presentation to experimental Ss in five different formats. The five different test situations were constructed on each of the passages. To avoid the creation of a biased version of the cloze test on any passage, five forms were prepared for each passage. This ensured the ultimate deletion of every word. The Ss were assigned to one of five groups. The five levels of the four factors of groups, passages, formats, and tests were organized into a research design based on a Greco-Latin Square (Winer, 1971).

The research design described above was fully balanced and produced 25 cells each of which contained a unique combination of the four independent variables. This same basic design was preserved when smaller, specialized groups were created using the classifying variables of Vocabulary subtest scores, Level of Comprehension subtest

scores, and the scores generated by the test of clustering in recall. Analysis of variance, according to a number of different plans, and a posteriori multiple comparisons of means, were the chief statistical techniques used for data analysis.

Significance of the Study

It is widely acknowledged that large numbers of students in the upper elementary through high school grades comprehend written language so poorly that they assimilate very little of the information that is presented to them in that form. That this is a situation for the serious consideration of all reading teachers and researchers, is emphasized by the large proportion of instruction that is dependent upon the student's successful interaction with written materials.

The motivation for the research project which is reported here, was the specific comprehension deficiency represented by the reader who possesses efficient word identification and vocabulary skills but still does not understand what he reads. It appears that readers in this category do not read meaningful word groups but, rather a series of individual words. For such readers the information conveyed by a string of words is no more than a collection of separate word meanings, rather than groups of words providing contextually unified conceptions. Clearly, an aspect of the reading process, fundamental to understanding,

has not been acquired by readers of this type.

This study is considered to derive significance from the fact that it has attempted an explanation of the importance of language synthesis in the reading act. The investigation made use of college level readers on the assumption that these Ss would be proficient readers. The purpose behind the use of readers of this level was the hope that the act of comprehension, as accomplished by the proficient reader, would be in a "purer" form, and thus, the analysis would not be contaminated by other factors brought to the reading situation by readers still at the stage of acquiring reading skill. It was hoped, too, that the analysis of the comprehension of mature readers would provide valuable insights into the functioning of less than adequate readers and readers at all stages of development.

A further significant aspect of this study is the fact that the impact of the independent variable of "format" upon the dependent variable of comprehension was assessed according to five different procedures. Thus, the results and findings that are presented and analyzed, are generalizable to a quite wide spectrum of reading test situations.

It is significant too, that the findings of this study point clearly to the advantages that should accrue as a result of the use of different formats for the presentation of reading materials to readers representing a range of different reading abilities.

Finally, while this study is similar to others that

have been conducted on the basis of the chunked presentation of reading materials, it is unique in that it has attempted to examine the functioning of the process of language synthesis that renders such chunks meaningful. This examination is considered to be significant because it has involved, at least indirectly, the assessment of the extent to which comprehension of written language requires the use of a reader's internalized and implicit knowledge of the grammar of his language.

Limitations of the Study

The factors discussed below should be noted as limitations upon the generalizability of the findings reported in this study.

1. The Ss who took part in the study were volunteers from one department within a single faculty, or a university of 18,000 students. It cannot be considered that these students are truly representative of the students within that university, faculty of department, and clearly, they cannot be considered to represent college readers in general.
2. Reading for approximately one hour from a CRT screen is certainly reading of some sort. The degree to which this physical reading situation was the same as a "more normal" reading situation, however, is unknown. The chapter which deals with the pilot study addresses this question in somewhat more detail.

3. While the use of the IBM 1500 Instructional System provided the perfect situation for the completely separate presentation of discrete chunks, it did carry with it the penalty of specific constraints. Perhaps the most severe of these was the fact that Ss could not "refer back" in a text in search of a particular answer. It is not known, therefore, to what extent the results collected are purely a function of readers' memories.
4. The mechanics of experiments based on chunking are not as straight forward as those in many other areas of research. In particular, it is difficult to make a clear separation between the dependent and the independent variables. Several different procedures have been adopted in various studies to induce Ss to chunk sequences in particular ways. While any one of the available procedures can be used as an attempt to induce Ss to use a particular synthesizing scheme, systematic variation in one of these procedures cannot be considered a truly independent variable.

In the present study, of the four independent variables which were under experimenter manipulation, the variable of particular interest was that of "formats." That is, the variation in the type of chunk used to present reading materials. This independent variable cannot be considered the independent variable. The independent variable is the

variation in chunking which Ss did adopt. If the adopted scheme of particular Ss did not conform to the scheme which the experimenter attempted to induce, then the experimental variation was irrelevant to the study. The real difficulty, and, therefore, the damaging limitation, is that there is almost no way of knowing what scheme was adopted by any one S or group of Ss.

Plan of the Investigation

The investigation is reported according to the plan set out below.

Chapter 2 contains a theoretical discussion of the role played by language synthesis in language processing. The discussion deals with the application to language of the information processing strategies of simultaneous and successive syntheses (Luria, 1966a, 1966b).

The theoretical discussion in Chapter 3 deals with the importance of grammar in language processing. Sentence plans, and to a lesser extent, discourse plans and the functions they perform in the productive and receptive aspects of language, are discussed.

Chapter 4 deals with the empirical and theoretical work that has been concerned with reading as a constructive process, the relationship between grammar and reading, and the impact of chunked presentations upon reading performance.

From the analysis of relevant empirical research and

theories presented in Chapters 2, 3, and 4, the specific theoretical position that was adopted in this study is outlined in Chapter 5. This chapter also presents the hypotheses that were designed to provide tests of this theoretical position.

Chapter 6 is devoted to the description of the experimental design while Chapters 7 and 8 deal with the pilot study and the construction of the experimental instruments.

The use of the IBM 1500 Instructional System for the collection of the experimental data is set out in Chapter 9.

Chapter 10 reports the findings relating to the total sample and the five experimental groups into which the sample was divided. Chapter 11 also presents findings. It deals with the analysis of results with specific reference to the hypotheses presented in Chapter 5.

The last chapter, Chapter 12, reports the main findings and conclusions and the implications that can be drawn from these.

CHAPTER 2

REVIEW OF RELATED LITERATURE: LANGUAGE

SYNTHESIS AND LANGUAGE PROCESSING

Introduction

The acts of natural language production begin with the focussing of attention upon a general impression within the field of consciousness (Wundt, 1912, see: Blumenthal 1970). From this general impression, attention then isolates a specific aspect while still retaining a sense of its relation or belonging to the general impression. Thus, the function of attention is to perform a dual operation. This dual operation of attention results in the structuring of cognitive content. On the one hand, cognitive content is organized and analyzed into features or constituents. On the other hand, these features are organized to preserve certain relationships to one another. The outcome of this is the production of language at two levels. The first level is that of the sentence, or in some situations, the sentence fragment. The second level is that of connected discourse. The sentence, which is comprised of constituents, is characterized by relational structure. The discourse is marked by serial connectedness which is represented in its coherent and developing nature.

Miller, Galanter, and Pribram (1960) and Luria (1966b) have provided the most parsimonious descriptions of the operations of these phenomena. Miller et al. account

for the expansion of a general impression into a grammatical sentence according to a grammar plan.¹ Luria suggests that an argument, topic, or narrative is developed into continuous prose on the basis of a discourse plan.

The process of analyzing for production occurs without the disturbance of the essential synthetic quality of either the general impression from which the sentence grows or the argument, topic, or narrative from which the discourse is developed. There is, however, an essential difference between the sentence level of language production and the discourse level of language production. The sentence is characterized by a unity or simultaneity that establishes a vital, simultaneous relationship between the syntactic structures of subject, verb, object, and modifier, etc., and the semantic information encoded by them within the sentence. The discourse is characterized by two types of unity. The first type of unity establishes a serial connectedness between the underlying sentences of which the discourse is comprised. The second type of unity is marked by the simultaneity that is captured in the main idea of the discourse.

The application of grammatical relationships such as AGENT, OBJECT, BENEFACTIVE, etc., which are encoded by such grammatical relationships, to the various aspects of general

¹Since the production of both sentences and discourses is controlled, in large measure, by grammatical criteria, it is proposed, henceforth to substitute the term "sentence plan" for the "grammar plan" of Miller et al.

impressions, is fundamental in the preparation of thought for expression in the sentences of the language. These grammatical relationships influence the direction of the analysis which results in production, but, at the same time, they also preserve the sense of sentence unity. The application of situational factors such as "field of discourse" (what the discourse is about), the "mode" of language (spoken or written, extempore or prepared), the "tenor" (the total set of social relations in a communication situation), and the various linguistic devices that are employed as "cohesive ties," preserve the essential unity of a discourse (Hasan, 1968). These linguistic, cohesive ties may be grammatical, lexical, or phonological. For example, the repetition of items, and the use of near synonyms, is one type of lexical cohesion. Meter and various other phonological aspects of verse form, such as rhyme, are important cohesive factors in poetry, although phonological cohesion is not limited to verse; this is one of the very important functions of everyday speech. The grammatical aspect of cohesion that ties the sentences of a discourse together has not been, as yet, susceptible to the same generalized, relational-structure description that can be applied to individual sentences. The most common vehicle of grammatical inter-sentence cohesion is "anaphora" which means, referring back in the text (Hasan, 1968). Significant in the present context is the fact that this type of cohesion refers to a serially established integration in which the

preservation of logical sequence is of vital importance (Lashley, 1951).

As Wundt points out, the aim of the whole process of analyzing the general impression prior to the production of the individual sentences and the total discourse, is to enable the listener to use the ultimate end of the analysis, that is, the speech sounds, as cues, for organizing and creating his own cognition.

This analysis of the production of the sentences of spoken language applies also to the production of written language. In Vygotsky's (1962) terms, "written speech" stems from "internal speech" in the same way as "oral speech" does, except that a greater degree of premeditation is generally effected before overt production takes place in written form.

The Wundt approach to the study of language comprehension or reception, is also useful. Whether comprehension stems from listening or reading, the focussing of attention upon a general impression within the field of consciousness, is a basic aspect of the process. The listener or reader must recombine the auditory or visual signals to arrive at the sentence-level, general impression and the argument, topic, or narrative, at the discourse level, from which the language message was developed. This phenomenon can be usefully described as analysis-for-reception, though the analysis in this case is achieved by means of synthesis (Neisser, 1967; Norman, 1968). In the terms of the more

recent transformational grammarians, the apprehension of meaning involves the identification of the underlying meaning of the individual sentences of the written or spoken communication (Katz and Postal, 1964; Chomsky, 1965; Fillmore, 1968; McCawley, 1968) and the underlying meaning of the integrated sentences of the spoken or written discourse (Grimes and Glock, 1970).

It should be noted that although the basic transformational notion of an underlying representation is fundamental in this discussion, no attempt has been made to adopt, exclusively, the Chomsky position (Katz and Postal, 1964; Chomsky, 1965) in which the underlying representation is syntactic, and in which semantics perform an interpretive function. The treatment is intended to be sufficiently general to include the McCawley (1968), Lakoff (1968) position, in which the underlying representation is semantic.

It is the purpose of this chapter to propose that this reconstruction of underlying meaning involves, as basic components, two types of synthesizing activities. The first of these may be termed the "communication of relations," operating chiefly at the sentence level, and the second, "the communication of events," operating mainly at the discourse level. Both syntheses are basic to the position adopted by Luria (1966a, 1966b) on the question of information processing. These syntheses, he describes as "simultaneous synthesis" and "successive synthesis," respectively. In this chapter these concepts will be

described and the central role in the comprehension of language, and especially written language, which is posited for them, will be outlined.

Language Synthesis

The view of language synthesis to be discussed here is one aspect of a more general theory of information processing which Luria (1966a, 1966b) has developed as a result of his observations of patients with cortical lesions in different brain locations. In this model, Luria suggests two major methods of such cognitive functioning. As pointed out above, he describes these as "simultaneous synthesis" and "successive synthesis." The terms were first coined by Sechenov (1878) in his discussion of the "elements of thought."

Simultaneous Synthesis

Luria (1966a) describes three levels of simultaneous synthesis. From the combined results of neurosurgical and psychological investigations, he has concluded that these are all associated with activity of the occipital and occipitoparietal cortical divisions. The first of these levels of synthesis results in sensory synthesis such as tactile, visual, or olfactory perception. The second level described by Luria is concerned with the more complex mnemonic (memory) processes which form the basis for the symbolic forms of activity, such as speech activity, which require

simultaneous synthesis for their execution. The third level of simultaneous synthesis is closely connected with the second level except that it involves a greater degree of complexity and, therefore, depends on a higher level of intellectual activity. The ability to comprehend mathematical and logical-grammatical relationships is dependent upon this level of simultaneous synthesis.

Luria (1966a, 1966b) has proposed that although an adequate understanding of separate words may be possessed by an individual, this does not ensure satisfactory comprehension of complex logical-grammatical constructions. The term "logical-grammatical" is used by Luria to describe the types of expressions that are created when spatial prepositions like, "below," "above," "before," "behind," and so on, and the adverbial phrases, "to the back of," "to the left of," etc., are used to place sentence entities in a specific relationship. He also includes expressions of comparative relationships, time relationships incorporating a spatial component, e.g., "spring before summer," and "winter before fall," verbs expressing an action transacted from one object to another, e.g., "to take to someone," and "to take from someone." The definition is further extended to include grammatical constructions in which there is an unfamiliar, inverted position of elements so that the order of the words is opposite to the order of the action they describe. These include expressions making use of the passive voice. A difficult type of construction which possesses greater

generality in most languages, than those listed to date, is the complex construction in which elements bearing certain relationships to each other are some distance apart, i.e., they are separated by other words or phrases, so that the distant elements have to be synthesized before the meaning of the construction becomes clear. This last class of constructions includes examples in which a system of connections is expressed by means of certain grammatical devices which may come into conflict with the order of the actions directly indicated from the order of the words in the sentence. Luria (1966a, p.384) uses the example, "Point to the comb with the pencil." When the task called for by this sentence is performed, the sentence order of the words must not be followed. As Luria claims, this is the manner in which inverted constructions, in general, are understood.

Although he does not make specific reference to such relationships, it is clear that Luria's logical-grammatical relationships are drawn from the total class of sentence grammatical relationships and the semantic relationships which are encoded by them. It is proposed, therefore, that Luria's logical-grammatical relationships are drawn from the general class of sentence functional relationships.

The comprehension of these logical-grammatical constructions is a highly complex and incompletely understood process. This type of comprehension calls for the "coordination of details into a common whole" or the "fitting together of details into a single formula (Head, pp.257-262,

1926)." This cognitive functioning is that of logical operations in which a relational structure is controlled by the logic of grammar in interaction with the meaning of content-bearing lexical items. Luria differentiates the ability to discern and perform such operations from a knowledge of concepts. Head (1926) observes that the difficulty of these constructions is not a function of their length but, rather, of the inability of the language processor to carry out an appropriate synthesizing of the component elements.

Luria's interest in the disturbances of language function which stem from localized brain lesions leads him to discuss only those logical-grammatical constructions which readily reflect language dysfunction. It is clear, however, that the principle of simultaneous synthesis possesses greater generality in the comprehension of language. For the understanding of all constructions that involve grammatical relationships, a special form of language synthesis is required in which the consecutive scrutiny of individual elements transforms those elements into a simultaneously perceived set of functional relationships.

Luria's (1966a, 1966b) analysis of simultaneous synthesis and language processing deals almost exclusively with logical-grammatical constructions which, while making use of relatively few elements, reflect a high level of complexity. These constructions are used to reduce the

demands placed upon mnestic processes. Luria does this because his purpose is to avoid sources of contamination which may obscure important information about the pathological condition he is attempting to investigate. It is very likely, however, that the same basic processes of simultaneous syntheses are required at much lower levels of language processing. This is especially so when the communication is presented in the form of written language which is divested of much of the synthesizing information conveyed by pitch, stress, juncture, intonation, and gesticulation which normally accompanies spoken language.

An essential component in the process of identifying meaning with the individual sentences of written discourse, is the discernment of grammatical relationships such as subject of, object of, modifier of, verb of, and so on, and the semantic relationships for which they provide a representation. These functional relationships can only be apprehended, however, if the individual elements comprising these entities to be related can first be synthesized as noun group, verb group, modifier group, and so on. In the mature, fluent reader, it is contended that this level of simultaneous synthesis is effected in the completely automatic manner described by Ausubel (1967, 1968). He claims that the skilled reader perceives directly both the denotative meanings of words in a sentence and their syntactic functions. The individual words are seen immediately as part of a grammatical context so that their "meanings emerge

as an immediate, perceptual content of awareness," i.e., automatically. This does not mean that the propositional meaning of a passage is yielded in the same way. The directly perceived denotative and syntactic meanings have to be related to relevant ideas in existing cognitive structure (Ausubel, p.70, 1968).

The syntactic functions referred to by Ausubel, and of interest in the present context, permit the fluent, mature reader to automatically identify the subject, verb, etc., of a sentence. For instance, in the sentence, "The great, grey green, greasy, Limpopo River rolls gently, in ever-widening sweeps, towards the distant sea." the reader, by a process of automatic, simultaneous synthesis, must identify the subject, "river," cumulatively modified, the verbal element, "rolls gently," and the two verb-modifying constituents, "in ever-widening sweeps," and "towards the distant sea". Thus the sentence is immediately reduced to its essential relational elements with a form something like, "River flows how where."

That this process is efficiently carried out in speech from a relatively early age has been widely documented. Several studies reviewed in Chapter 3 below, however, indicate that, even with readers who have achieved college entrance, the carry-over of this simultaneous synthesizing strategy from spoken language, may not be fully accomplished in a substantial number of cases. As already pointed out, a contributing reason for the failure to transfer this specific

language processing skill from one language mode to the other is that many of the synthesizing cues, present in spoken language, have to be provided by the reader himself when he is confronted with written language. One aspect of this research project was concerned with identifying and investigating such readers.

Successive Synthesis

As with simultaneous synthesis, Luria identifies three levels of successive synthesis. Again, these are the sensorimotor level, the mnestic level, and the mnestic-intellectual level (Luria, 1966b). As a result of his work in localized lesions of the brain, Luria has discovered that successive synthesis is controlled by the fronto-temporal regions of the brain.

As examples of the sensorimotor level of performance in the mature language user, Luria lists the articulation of whole words consisting of organized series of sounds. Apart from the efficient performance of the articulatory apparatus itself, the production of series of sounds, in the correct order, depends upon sensorimotor, successive synthesis. The same phenomenon is in operation in the writing of sequences of sounds, sound combinations, and whole words. That is, the smooth performance of serial forms of activity, like the successive series of sounds in speech and the series of letters in cursive writing, require successive synthesis at a sensorimotor level.

The mnestic level of successive synthesis is required for the following of a verbal instruction that calls for the drawing of a series of three elements in a nominated order. Luria (1966b) uses the example of a circle, a cross, and a minus sign, which have to be drawn in precisely that order. The difference between this level of performance and the purely motor level reflected in the mechanical production of cursive writing is that the order of the verbal instructions for the task has to be retained.

The mnestic level of successive synthesis is called upon in the movements of the speech organs required for the production of a sentence. Successive synthesis is also required for the successful perception of the speech sounds and words in a spoken sentence. Much the same process is involved in the retention of the rhythm and melody of a piece of music as opposed to the recognition of the level of pitch of a specific musical sound. The production and perception of a code, such as the morse code, relies heavily upon the mnestic level of successive synthesis.

At the sensorimotor and mnestic levels of successive synthesis, the essential abilities are reflected in the retention of a series of words as a single "kinetic melody." This refers to the retention of the order of a series of words rather than the absolute retention of the words without any specific serialization.

The manifestation of successive synthesis is not confined to the serial organization of processes as

reflected in the ability to reproduce a series consisting of isolated elements. Successive synthesis at a sensorimotor-mnemonic level is required for the learning of poetry by heart. Poetry is essentially a successive, spoken melody in which words are arranged in a single rhythmic and melodic verbal structure (Luria, 1966b).

The discussion of successive synthesis, to this point, has dealt with the relatively simple sensorimotor and mnemonic processes. Successive synthesis at a higher level, is believed by Luria (1966a, 1966b) to be also involved in the more complex levels of organization of mental processes reflected in the course of thinking as it is related to linguistic processes. In the discussion of simultaneous synthesis it was suggested that this type of thinking has, as important components, the systems of the logical-grammatical code and of verbal concepts. It also has another aspect of great importance. Luria (1966b) describes this as the "dynamic aspect" of thinking as it relates to the linguistic process (p.114). This aspect of thinking is a necessary element for the successful transition from a topic, through a discourse plan, to expression in the form of a successive chain of events, propositions, or arguments that conform to that general plan. And conversely, it is required for the successful transition from connected discourse, written or spoken, with its successive chain of events, propositions, or arguments, to the general plan from which the discourse originally grew. Luria asserts that this

requires an extremely complex form of successive synthesis and that this is a basic component in the dynamics of thinking which involves linguistic processes. A deficiency in this facet of information processing, then, may be revealed in an inability to make the transition from a condensed idea into expanded or discursive "speech" or the transition from expanded "speech" into thought, that is, an inability to identify the connected meaning of a discourse.

Thus, successive synthesis at the highest level is required to ensure the smooth development of thought and to ensure that this evolves spontaneously. These cognitive processes, in the mature adult, rest upon highly automatized logical schemes. Such schemes permit the rapid production or discernment of relationships such as, cause-effect, sequence, part-whole, dependency hierarchies, and so on, where these relationships extend beyond the sentence level of production or reception. The ease with which the normal, mature adult can call forth appropriate logical schemes has led psychologists to speak of appropriate "logical feelings," e.g., a feeling of "but," a feeling of "if," etc. (Luria, 1966b). The importance to the reading act of such indicators of logical schemes in a text has previously been investigated by Robertson (1966).

Thus, comprehension of a discourse depends upon recognizing grammatical constructions and relationships; firstly at the sentence level (simultaneous synthesis), and secondly, at the discourse level (both simultaneous and

successive synthesis). For the fluent, mature reader, it is proposed that this recognition is automatic. As discussed in the Introduction to this chapter, sequential connectedness at the discourse level is also established with situational aids such as the field, the mode, and the tenor of the discourse. The familiarity of a reader with the field of a discourse will depend upon the dimensions of his past experiences. The establishment of the higher level, propositional meaning of a discourse, will also be extensively dependent upon the existence of relevant ideas in the present cognitive structure of the reader (Ausubel, 1968). The growth of this cognitive structure will also stem from the new concepts that are developed at the level of propositional thinking by the novel relationships in which existing concepts are placed in response to the demands of new discourse material.

Sentence Meaning

The two levels of sentences

The notion that sentences have two levels is not new. Wundt proposed this as long ago as 1900 (see: Bever, Kirk, and Lackner, 1969; Blumenthal, 1970). He stated that the sentence is both a simultaneous and a sequential structure. From the spoken language point of view, it is a simultaneous structure despite its sequential production, because, at each moment of its production, it is present in consciousness as a totality. It is sequential because the speech manifestation

of it changes from moment to moment as individual constituents move into the focus of attention and then out again one after the other. Wundt, however, dismissed the claim that the sentence is a chain of words or even a chain of concepts. He accounted for this frequently held, incorrect notion, by explaining that the sentence is produced as a dissection of a totality present as a whole in consciousness. To think of this as nothing more than a linking process, he claimed, is to treat the outer form as the inner mental totality. This is plainly in error, as the outer form is the result of the dissection or analysis necessary for production. Because of its temporal-sequential mode of presentation in spoken language, and its spatial-sequential mode of presentation in written language, the physical configuration of the sentence is not a faithful picture of the simultaneous, psychological processes underlying it. It is this end product which shows, by its nature, that the psychological factors determining a grammatical utterance are themselves distinct from the utterance. That is to say, the sentence, as an inner psychological construction, must have a simultaneous nature in addition to its sequential physical manifestation.

From the foregoing, it can be seen that at least one aspect of what has to be understood for the comprehension of written materials is the correct identification of the underlying functional relationships of sentences. This is well exemplified in Chomsky's (1965) often-quoted examples:

- (1) John is easy to please.

(2) John is eager to please.

It is essential for the reader to understand that in (1) John is the one who is pleased and that the agent of the pleasure afforded John is not specified, and that in (2) John is the agent of the pleasure and the person who is pleased is unspecified. This relational information is necessary for the understanding of a sentence. A reader must be able to identify the sentence entities of AGENT, VERB, OBJECT, BENEFACTIVE, etc., (Lakoff and Ross, 1968; Prideaux, 1972).

Underlying meaning of sentences

Perhaps the most important fact about the sentences of human languages is that all sentences have both an underlying meaning and a surface structure. The underlying representation provides the meaning of a sentence while the surface structure gives the form of the sentence as it is used in communication. Thus, the underlying representation is an abstract object. It is a representation that is assumed on the basis of the meaning which stems from the lexical items of a sentence considered in the syntactic framework in which they are found. A surface structure is closer to physical reality in that it concretely specifies the syntactic structure necessary for spoken or written communication (Jacobs and Rosenbaum, 1968).

The underlying meaning of sentences and simultaneous synthesis

The theory proposed in this study is that the apprehension of sentence meaning relies heavily on an information

processing strategy of the type described by Luria (1966a, 1966b) as "simultaneous synthesis." The process depends upon the simultaneous interaction of synthesized, grammatical entities with an implicit "knowledge" of grammar. This "knowledge" of grammar includes a component that serves the same function as the transformational component of transformational-generative theory. It establishes the functional relationships operating within sentences. The simultaneous interaction of these functional relationships, with the content-bearing, individual lexical items in sentences, permits the identification of the meanings underlying sentences.

Discourse Meaning

On the whole, generative-transformational grammarians have concerned themselves but little with structures larger than the sentence. A possible exception is that they have addressed the troublesome problem of sentence compounding. Clearly, however, there are higher level structures in discourse than the sentence. Pike (1964) and Becker (1965) for example, have searched for structures that are characteristic of connected language that consists of more than one sentence (Wardhaugh, 1969).

The reason for the preoccupation of linguists with the sentence as the basic unit of organization in syntactic description is not difficult to appreciate. The structure of the sentence has seemed to exhibit a kind of closure

which allows it to be investigated in relative, if not complete independence. Nobody would deny, however, that systematic constraints do exist across sentence boundaries (see: Levin, Grossman, Kaplan, and Yang, 1971). If language is to be looked at from a semantic perspective, and in the examination of the reading act this would seem to be essential, the role of intersentential constraints must be more closely examined than they are under other views of language. This is so because a number of the limitations which cross sentence boundaries are clearly semantic in nature. No adequate theory of language structure can ignore across sentence constraints and relationships. It is certain, then, that the structure of paragraphs or discourses is of basic importance (Chafe, 1970).

The tight structure of high quality prose is not found only in sentences, but just as much in the sequencing of sentences within a passage. Indeed, there is probably more difference between good English and mediocre English in the matter of sentence transitions than in any features of the sentences considered separately. Many readers have trouble with language of this type. It seems desirable, therefore, that remedial efforts should take into account the impact of this source of difficulty. Such specific remediation can hardly be attempted until the scope of grammar has been extended to include the grammatical

features of sentence connection and discourse structure (Gleason, 1965).

It is obvious that sets of random sentences can be distinguished from sets of related sentences (Wardhaugh, 1969). It is equally clear that this relatedness does not stem from any significant parallelism of the grammatical structure of the sentences in such a set. Evidence of this is that the relatedness or cohesion is immediately lost when the order of the sentences in the set is reorganized. As already pointed out in the introduction to this chapter, "textuality" (Hasan, 1968) or discourse coherence, has two basic sources: the situational and the linguistic. The importance of the three situational aspects of field, mode, and tenor, proposed by Hasan, is not underrated, but there appear to be immense difficulties that will inhibit attempts to characterize them in any formal and systemized way. Naturally, the internal and external aspects of discourse cohesion are not wholly separable, and certainly the reader or listener does not separate them when making his own unconscious judgments about a specimen of language. Internally, relations within the language are being described i.e., patterns of syntax and semantics are being employed. Externally an attempt is made to relate what is stated about language and social environment. Discourse cohesion is an intricate interaction between its internal and external features. Linguistics is

concerned with both these aspects. The internal patterns of language are significant, among other things, because they embody, and impose structure on, the writer's or speaker's experience of his environment; and conversely the linguistic patterns permit the identification of the features of the environment that are relevant to, and thus enter into, the "context of situation" of linguistic behavior. An adequate description of the grammatical aspect of discourse cohesion, as a separate, analyzable entity, would also be extremely difficult to formalize and present systematically.

A major effort has been directed at the systematic description of the aspect of grammatical cohesion that has been classified as anaphoric reference (Hasan, 1968). As Hasan clearly demonstrates, anaphora contributes extensively to the serial connectedness of the meaning of discourse. In view of this, it is clear that for a reader to identify the meaning of a discourse he must be sensitive to the inter-sentence relationships that are signalled by anaphora.

Some grammatical features of discourse

Although they have been examined much less systematically, there are other grammatical discourse features that aid the reader in apprehending the sequential integration that is an essential aspect of discourse comprehension. Some relationships have to do with determiner sequences such as "a" followed by "the." For instance,

English determiners are used quite differently in opening sentences from the way they are used in the other sentences of the same discourse. Other relationships are signalled with deictics such as "this" and "that." As previously stated, one of the most extensive systems that indicates discourse connectedness, is that of anaphora which makes use of such meaningful sequences as "Bill - he" and "Joan - she." This system includes verbal elements making use of substitution and ellipses, as in, "You have been told to go to bed. Now do so," and, "I believe he doesn't like his new employer much." "No, but he does the job."

Meaningful connection within a discourse is frequently indicated by sequencing words such as, "first," "second," "then," "after," and so on. Words like, "but," "therefore," and "however," mark the relationship of contrast. The consistent use of a specific tense ties sentences together in an important way. "Finally," "and," "besides" provide continuity and order. Word sets with internal, semantic relationships, e.g., "yacht," "sales," "rigging," "crew," "skipper," and so on, provide collocations that are strong clues to meaningfulness that stems from relationships that cross sentence boundaries.

All of these devices are used in spoken language. Many of them are surface structure phenomena (see: C. Smith, 1971). In written language, however, they are used far more deliberately and in a much more strictly controlled manner. It is essential that the reader learn

to recognize the importance of the different distribution of such language signalling devices. He must learn to react to the different demands of interpretation and understanding that this different distribution involves. This becomes an even more urgent need when the prose becomes elaborate by making use of extensive parallelisms, intricate word patternings, and balanced sentences (Wardhaugh, 1969).

The underlying meaning of discourse

Grimes and Glock (1970) comment that discourse studies still seem to be looked on more or less in the way that Dr. Johnson described the preaching of women: "like a dog walking on its hind legs, it is not done well; but you are surprised that it is done at all." It has already been mentioned that undoubtedly the reason for this is the current preoccupation with sentence grammars. From the brief summary of some discourse phenomena that has been provided above, it is clear that another part of the reluctance to work at the discourse level is its awesome potential for variation and complexity.

No attempt will be made here to fully outline any specific approach to the question of discourse underlying meaning. The use of the term, however, is well-motivated (see Chafe, 1967, 1968; Fillmore, 1968; Gleason, 1968; Halliday, 1967; Labov and Waletzky, 1967; Langendoen, 1969; Schwarcz, 1967). The notion of a connected, underlying

meaning coexisting with the surface sentences of a discourse is important in the theory used in this study, so the essential points of the position of Grimes and Glock (1970) which is congenial to this theoretical stance, will be presented. This does not mean, however, that any of the other theories that are in the process of development would not serve that theoretical position equally well.

Grimes and Glock assume that a semantic underlying representation, which relates to a grammatical surface structure, provides a basis for the study of discourse. Various types of discourse, therefore, are characterized by a typical surface organization. Grimes and Glock cite the surface organization of the narrative pattern of the Saramaccan language which is marked by the omission of information in some places. To account for this organization they assume an underlying relation among events, event settings, the narrative setting, the identification of participants in the events, collateral information, and background information. In this approach to discourse, the sentence is treated as part of the surface grammar and not as part of the underlying representation. Grimes and Glock suggest that the mapping relation between semantics and grammar has various ways of packaging information into chunks of limited size. These chunks, which in the model of Grimes and Glock, are the sentences, have their own sets of internal relationships. Nothing in this, denies

the validity of sentence grammar within that domain. From the point of view of producing the discourse in a sequential, linear form (an important feature of most types of discourse), sentences permit both the encoder and the decoder to physically or mentally "relax" and take a "breath" fairly often. The occurrence of sentences also keeps complexity within bounds.

The essence of the theory is that the underlying semantics requires a treatment other than a structural one. Grimes and Glock propose that such information can best be described in terms of logical predicates and their arguments. The Saramaccan travel narrative as analyzed by Grimes and Glock, for example, consists of a sequence of predicates that denote a sequence of events in time. The narrative is not just a linear sequence of events. The events are grouped into clusters. This grouping is what is expressed on the surface by the mechanism of paragraphing. When the predicate model is applied to the Saramaccan travel narrative this paragraphing corresponds to a sequence of predicates, each of which has event predicates as its arguments. The predicates that perform the grouping, form event clusters of their arguments. Within each event cluster there is a single setting.

Although covered in far more detail and with more supporting evidence than has been reported here, the essence of this theory is that the underlying meaning of

discourse is semantic, as opposed to syntactic, in nature, and consists of the arguments of logical predication.

The underlying meaning of discourse and successive synthesis

The theory of the discourse aspect of language which is implicit in the discussion of Grimes and Glock on the Saramaccan travel narrative, is particularly amenable to being matched with Luria's (1966a, 1966b) psychological model of information processing. It has previously been proposed that the information processing strategy of simultaneous synthesis is appropriate for the apprehension of the underlying meaning of individual sentences. This is in accord with the model of Grimes and Glock in that, although they propose that sentences are the surface level manifestation of discourse underlying representation, they also state that sentence grammars, e.g., transformational-generative grammar, remain appropriate for that domain. That is, the internal relations of individual sentences can still be generated according to a grammatical model based on a sentence grammar.

The information processing strategy of successive synthesis is appropriate for the apprehension of the underlying meaning of discourse. This strategy is concerned with discerning successive "events" rather than simultaneous relations. Broadly interpreted, "events" are semantic in nature--they convey "information," and are successive in occurrence. The information thus conveyed

will most likely include information obtained as a result of the communication of relations, but that information will have resulted from a separate though concurrent, cognitive act--simultaneous synthesis, which has been shown to occur in a separate area of the brain (Luria, 1966a, 1966b). "Events," of course, may be the successive events in a narrative, the consecutive points in an exposition, or the propositions in a logical argument.

The underlying representation of discourse, conceptualized in the Grimes/Glock manner, may be described in similar terms. It is concerned with communicating "events." That is, information sequentially organized into a cohesive unit which develops according to the logical predicates of arguments.

Summary

The fluent, mature reader and the skilled listener employ information processing strategies in order to identify the meaning of connected discourse. Luria's (1966a, 1966b) model, which he developed following extensive observations of the effects of cortical lesions in different brain locations, suggests two major methods of information processing: simultaneous and successive syntheses. In simultaneous synthesis, stimuli must be perceived simultaneously for a decision to be arrived at or for information to be correctly processed. In successive synthesis, stimuli must be perceived as a sequence in order to make a decision

or to correctly decode the information that is being processed. The two strategies for processing information are available to language-users according to the demands of the task and their past learning and experience.

This chapter has discussed the place of language synthesis in the reception of spoken or written discourse. In Chapter 3 the dependence of language synthesis on grammar will be examined in greater detail.

CHAPTER 3

REVIEW OF RELATED LITERATURE:

THE ROLE OF GRAMMAR IN LANGUAGE PROCESSING

Introduction

From the previous chapter it is clear that there is a relationship between language synthesis and grammar. The purpose of this chapter is to examine the importance of grammar to this relationship. Because of the paucity of linguistically-based research in the area of language at the discourse level, and the fact that grammars are essentially sentence-based, this examination will deal only with the relationship between grammar and simultaneous synthesis of language. For both of these the sentence, at present, represents the most important unit of analysis.

In Chapter 2 it was indicated that at least two levels of simultaneous synthesis are of importance in the perception of sentences. The first results in the recognition of grammatical entities like noun group and verb group. The second permits the language perceiver to identify the functional relationships amongst these entities, within sentences, i.e., to ascribe to such segments, the description of AGENT, VERB, OBJECT, PATIENT, BENEFACTIVE, and so on.

Both levels of simultaneous synthesis complement the sentence plan¹ concept proposed by Miller, Galanter, and

¹ Referred to by Miller et al. as a grammar plan.

Pribram (1960). On the one hand, the sentence plan generates cohesive sentence segments like noun phrase, main verb, prepositional phrase, etc., while on the other, it relates these segments to each other according to a linguistic pattern.

The ability to produce sentences following a finite set of such plans, requires syntactic competence. Likewise, in the comprehension of sentences, syntactic competence is called upon if the sentences are to be perceived in terms of the sentence plans which were employed in generating them.

Sentence segments like noun phrase and main verb are the chief elements upon which sentence plans operate. They are grammatical categories and include the individual lexical items of sentences. Syntactic competence is required for the perception of such language units. Their importance in the perception of sentences suggests that they may represent a "natural" unit for language processing. In view of this, the research in spoken and written language which examines the existence of a natural unit of language is reported in this chapter.

The demonstration of syntactic competence also involves the ability to discern, simultaneously, the functional relationships between the language segments within a sentence. The operation of this level of simultaneous synthesis is necessary so that the language perceiver hears or sees the sentence as an entity possessing functional unity. The research on syntactic competence, summarized in this

chapter (See: Farnham-Diggory, 1967; Denner, 1970), suggests that the ability to process incoming oral language in this way does not ensure that written language will necessarily be perceived with the same success.

This chapter will show, then, that the basis for simultaneous synthesis within the sentences of incoming language, is the sentence plan. This sentence plan motivates simultaneous synthesis at the level of grammatical constituents and also at the level of functional relationships.

Sentence Plans

The competent use of language involves the ability to utilize sentence plans of the type proposed by Miller, Galanter, and Pribram (1960). In their discussion of such plans these researchers chiefly address the question of speech production. It is clear, however, that the paradigm outlined is sufficiently general to apply to both the spoken and written modes of language encoding and decoding.

Language Production Plans

The basic tenet of the theory is that a sentence is manipulated as a unit which, on the production side, is developed according to a plan.

Rules of formation

The actual way in which humans produce sentences is not known. The theory of Miller et al. is a hypothetical

description of the production act. This description characterizes language output by means of a set of hierarchical rules. Because they describe ways in which sentences may be formed they can usefully be thought of as, rules of formation. One rule that could operate in a sentence plan is that a sentence is comprised of a noun phrase and a verb phrase. That is,

$$S \rightarrow NP + VP,$$

where sentence is symbolized by S, noun phrase by NP, verb phrase by VP, and "comprised" by \rightarrow . This means that the symbol S can be rewritten as NP + VP in the characterized derivation of the eventual utterance. Likewise, the noun phrase can be expanded to a determiner plus noun by a rule of the sort

$$NP \rightarrow D + Noun,$$

and the verb phrase to a verb and a noun phrase by a rule like

$$VP \rightarrow Verb + NP,$$

and so on, until the level of individual lexical items is produced.

Rules of transformation

The plan, to this point, can be seen to consist solely of "rewrite" rules. Clearly, to handle all the sentences possible in any language, an extremely large number of such rules would be required. To deal with this problem, Miller et al. suggest that the sentence plans should incorporate "rearrangement" rules in addition to

rewrite rules. These rules of transformation are more complicated than the rewrite rules because they are concerned with the analysis of the strings to which they apply and the precise description of the structural change which they effect in a sentence (in proposing such rules Miller et al. have drawn on the work of Chomsky, 1957). Transformational rules form an important part of the theory because of the immense economies they effect in the statement of the grammar. Thus, Miller et al. propose plans which involve rules of formation and transformation. An example of a rule of transformation is that which converts active constructions to passive constructions. Another example is the transformation which combines two sentences into one by joining them with a suitable connective. This transformation permits the building of long, complex, and compound sentences.

Semantic considerations

The sentence plans¹ proposed by Miller et al. do not explain how a speaker selects the content of his utterances. It is obvious, however, that syntax must interact with semantics in the production of sentences. To date, however, a semantic theory, as explanatory and adequate as Chomsky's theory of syntax (1957, 1965) has not been forthcoming. In

¹Again, it should be noted that the sentence plans outlined by Miller et al. do not represent an attempt to describe how humans actually construct sentences. Nobody knows this. What is known is that descriptive systems such as that of Miller et al. seem to provide a set of "boundary conditions" in that a speaker of English is somehow constrained by the "rules of English" in terms of output.

the meantime, the nature of the interaction between syntax and semantics must remain a matter of conjecture.

The Generality of Sentence Plans

Miller et al. claim that the performance of any skilled act requires a plan. Thus, the perception of a sentence requires a plan. The contention, here, is that sentence perception and production make use of much the same grammar plans. In both cases, it is possible that the plan corresponds with the way in which the sentence would be "parsed." The essential difference lies in the opposite directions followed in the implementation of the plan. That is to say, at least one aspect of the production of a sentence involves the breaking down of ideas, concepts, or feelings into the constituent parts of language. Such parts may be identifiable distinctive features, discrete phonemes, individual words, or phrases. Each has to be produced in such a way that the overall, integrated nature of the sentence is enhanced rather than obscured. On the other hand, an important facet of the perception of a sentence requires the amalgamation of language constituents in order to reconstitute the original unit of thought.

Thus, the sentence plan could be central to both skilled acts, i.e., to sentence production and perception. The structure of the plan could be the set of rules of formation and transformation. On the production side, the object that the sentence plan operates upon is tested for

its "sentencehood," i.e., its grammaticality. Initially, this reduces to a question of whether the object has a noun phrase and a verb phrase. As Miller et al. state "the test of whether it has a noun phrase fails and so sends the system off to generate one (p.156)." In this way, the system is cycled until all the tests, subtests and sub-subtests are satisfied and the system returns to the main test, which now passes, and the motor plan is complete. The motor plan in speech involves comparisons of the uttered sounds and felt movements with the auditory and proprioceptive images of what they should be. The final operational phase of the spoken sentence plan involves the movements of the speech musculature. The motor plan in writing involves comparisons of the written symbols and felt movements with the visual and proprioceptive images of what they should be. The final operational phase of the written sentence plan involves the movements of the musculature concerned with writing.

Language Perception Plans

The theory of Miller et al. can be readily extended to the listening aspect of language perception. In this case the sentence plan would operate upon the language entities of which the sentence is comprised. They could be tested for the way in which they can be amalgamated into the lower level units of the sentence. The potential, functional relationships amongst these units could then be tested and thus, ultimately, a reconstruction of the underlying sentence

meaning effected.

Rules of formation

In this way, it is plausible to suggest that the sentence plan, for the mature listener, would operate on the lexical items of the sentence. Thus, one of the rules applied early in the sentence plan could be that a determiner followed by a noun forms a noun phrase. That is,

$$D + \text{Noun} \rightarrow \text{NP.}$$

In this way, the lexical items of determiner and noun would be synthesized and perceived as the single entity--noun phrase. Other reconstituting rules, suitable for application in the plan, could be

$$\text{Verb} + \text{NP} \rightarrow \text{VP}$$

$$\text{NP} + \text{VP} \rightarrow \text{S}$$

Rules of this sort would permit the plan to commence at the level of individual lexical items and to complete its function with the apprehension of an underlying meaning represented by the complete sentence. Of course, the prior application of the rules of lower level plans to distinctive acoustic features and phonemes would produce the individual lexical items.

Rules of transformation

As with sentence production, the number of "rules of formation" required to permit the reconstitution of all sentences would be very large indeed. Again, valuable economies in the sentence plans would be effected by the inclusion

of rules of transformation. These would operate in conjunction with the rules of formation and, thus, assist the language perceiver to gain access to the meaning underlying a sentence. Given that the passive construction has the same semantic value as the active construction, the rules of formation and those of transformation would permit the listener to arrive at congruent underlying meanings for each of these constructions. Likewise, the inclusion of the transformational rule which combines two sentences in the sentence plan would permit the listener to recognize the two separate sentences that were originally in the production history of the sentence.¹

Semantic considerations

The interaction of syntax and semantics in sentence plans is no better understood in the perception of sentences than it is in their production. The content of perceived utterances, however, is already present and therefore is inextricably interwoven with the sentence syntax used to present them. In fact, it is clear from the units produced by sentence parsing, that syntactic units also encode semantic information. It seems likely, therefore, that "event-based" discourse plans have an important influence upon the

¹It is again emphasized that the above proposals are not intended to describe how the actual processes of sentence perception work. The plans and rules are intended as a descriptive system that seems to provide a set of "boundary conditions" in that a listener to English sentences is somehow constrained by the "rules of English" in terms of input.

formulation of the sentence plans according to which individual sentences are generated. This proposal runs counter to the generative syntax model of Chomsky (1965) and more closely approximates the position of the generative semanticists (e.g., McCawley, 1968).

The Perception of Written Language

The points already raised in the discussion of the listening aspect of language perception are all pertinent to the analysis of the perception of written language by the mature reader. Clearly, the communality stemming from the language element essential to most conventional communication, ensures that listening and reading make use of the same sentence plans composed of variations of the same rules of formation and transformation. Perhaps the only truly significant difference between the two modes of decoding lies in the degree of control which the reader has over the rate of signal emission. The listener does not have this same control.

Syntactic Competence¹

It has been suggested above that the sentence plans

¹It should be noted that the term "competence" is used throughout this discussion to describe a level of "performance" that stems from an implicit knowledge of the language. That is, the term refers to a degree of performance that reflects a knowledge of how to use the language rather than a knowledge of how the language works.

This use of the term "competence" should be distinguished

which have been proposed as part of a descriptive theory of language reception would be common to both the listening and reading aspects of such language activity. It is well known, however, that some children who speak and listen efficiently have difficulty deriving appropriate meanings from samples of written language, despite the fact that they have no difficulty identifying or recognizing the individual written words. This suggests that the use of sentence plans in the decoding of written language requires a higher level of syntactic competence than is required for the decoding of spoken language. The studies of Farnham-Diggory (1967) and Denner (1970), conducted to address a somewhat broader question, provide tentative support for this contention.

The work of Farnham-Diggory suggests a method for evaluating the extent of a pre-school child's ability to perceive a short sentence as a functional unity. The testing method consists of a hierarchy of four tasks. The first task, which is enactive in nature, establishes whether the child knows the meanings of certain simple verbs, nouns, and prepositions. These are tested by asking him to follow simple commands like "jump high," "walk around the teacher,"

from that of Chomsky: "...the technical term 'competence' refers to the ability of the idealized speaker-hearer to associate sounds and meanings strictly in accordance with the rules of his language. The grammar of a language, as a model for idealized competence, establishes a certain relation between sound and meaning--between phonetic and semantic representations. ...To discover this grammar is the primary goal of the linguistic investigation of a particular language (Chomsky, 1967, p.398)."

and "put the block on the floor." The second task is conducted with pictographs. These are used to assess whether the child understands that pictures can represent things. This understanding is tested by having the child associate the same verbs, nouns, and prepositions with appropriate pictures. The third task is logographic in nature. It is a test of a child's representational competence (Sigel, 1968). In this task he has to associate the same words with abstract, graphic forms. The child's ability is assessed by the skill with which he can adjust to the fact that graphic symbols which stand for things and actions in the world, need not resemble them in form. The final task calls upon the child to synthesize separate logographs. Several logographs are placed on a line in the same way that words are placed to form a sentence. The child first reads the sentence and then performs what the sentence commands.

Farnham-Diggory found that young children (three to six years of age) are unable to integrate or synthesize the independent logographic meanings into a unit or sentence. Such children attempted to perform the sentence meaning by performing the separate logograph meanings one at a time. Although these children could "read" the sentence as a higher order unit, i.e., sequentially translate each of the logographs of which the sentence was composed, their behavior indicated that the sentence did not function as a unit for them. The conclusion Farnham-Diggory draws from these results is that the inability to integrate and subordinate

individual word meanings to the meaning of a higher order unit reveals a lack of syntactic competence. The absence of entities which operate like some function words in these logographs raises some interesting questions with regard to the conclusions drawn. Farnham-Diggory, however, does not examine these questions.

Denner (1970) used exactly the same tasks and procedures to evaluate the theoretical notion that representational and syntactic competence are essential in learning how to read. Denner's experimental sample was comprised of four groups, (1) first-grade problem readers; (2) first-grade average readers; (3) problem readers from grades three to five; and (4) a random selection of Head-Start children participating in a typical summer program. Both the younger problem readers and non-readers, who were able to grasp the meanings of logographs, found it very difficult to translate a string of logographic symbols into a unified act. As with Farnham-Diggory's Ss these children attempted to act the meaning of each logographic unit instead of translating the sentence meaning into an integrated action. The Head-Start pre-school Ss and the older problem readers also approached this task in the same way. Both groups of children reacted as if the sentence meaning were a product of individual word meanings. On the other hand, the average readers seemed to realize that words derive their meanings from sentence context. Denner's conclusion from these results is that Head-Start children commence the first grade with an

atomistic, mechanical conception of reading. This places emphasis on the relationship of individual graphic forms to the context of perception and action. Even as late as fifth grade, Denner found that problem readers still fail to subordinate the perceptual-motor meaning to the larger linguistic reality of the word-group or sentence.

Denner cautions that this conclusion should not be interpreted to mean that problem readers cannot communicate their ideas in sentence forms. The children who comprised the sample in his study were found to speak fluently and with appropriate word-groupings. Rather, the deficiency seems to be in an appreciation of written language. This is evidenced chiefly in a failure to understand the rules that govern the relationship of words to other words in written sentences, i.e., syntax, which is independent of the relevance and reference of such words to external reality. Denner suggests that his findings may indicate that some problem readers may be trapped in an oral tradition which is opposed to the impersonal abstractions of printed language. This hypothesis is consistent with that of Bernstein (1960)-- that lower-class spoken language is so distant from formal written language that it serves to inhibit reading. In this way, the attempt to map oral syntax onto the written form is frustrated by the mismatch between the two forms of syntax.

In the reading of a connected string of words which is represented in a conventional language orthography, the syntactic competence referred to in the studies of Farnham-

Diggory and Denner, is necessary if the reader is to recognize the semantic information that is conveyed by the syntactic functions of such words. From a psychological point of view, syntax primarily serves the transactional function of bringing ideas (i.e., images and concepts), expressed in the symbolism of language, into relationship with each other, in a dependable fashion. The purpose of establishing this relationship is the generating and understanding of new ideas (Ausubel, 1968). Clearly, if the function of syntax can be described in this way, only an adequate understanding of syntax, i.e., a satisfactory level of syntactic competence, will ensure that the reader will be able to understand the ideas that are expressed in written language.

Typically, therefore, a given word in a sentence conveys a distinctive denotative meaning (and various connotative meanings for different individuals). Furthermore, its particular syntactic function in the sentence provides additional semantic information that contributes to the understanding of sentence meaning (Ausubel, 1968). Generally, it is necessary for a reader to know the syntactic function of a word before he can apprehend its denotative meaning. This is certainly the case with words that have more than one meaning and can function as both nouns and verbs or as nouns and adjectives.

The Natural Unit of Language Processing

The preceding section on syntactic competence, especially that portion dealing with the studies of Farnham-Diggory and Denner, suggests that, on the perception side, successful language processing requires the integration of relatively discrete elements to form a synthesis or language unit. The two pieces of research referred to emphasize that this is particularly so with the decoding of written language which does not make available the same devices employed in spoken language for indicating which language elements should be integrated into larger units by the listener. It is suggested that syntactic competence is, in large measure, the ability to apply the information processing strategy that produces these reconstituted units, i.e., simultaneous synthesis. The ultimate result is the amalgamation of basic importance--the sentence, i.e., the underlying sentence which represents the essential meaning of a connected word string.

What are the language units that form the logical building blocks in this process of reconstitution? The visual perceptions that are involved in the decoding of printed language are already organized to a degree. This organization produces units which the reader recognizes as words. There is little agreement, however, about how these units should be defined or about their adequacy as precise descriptors of basic language units. In addition, there is a vast difference in the discriminability of these units in

spoken language when compared with their discriminability in written language. Spectrograms of the stream of speech indicate that oral language is not produced in discrete words, nor, always in clearly separated sentences. From this, it seems likely that neither the word nor the sentence is a "natural" unit for the processing of spoken language. In contrast, however, the written form of language does make constant use of the readily discriminable units of the word and the sentence. It is improbable, though, that single words are the basic units of meaning that the reader uses to reconstruct the underlying sentence meanings. Words only rarely carry significant meaning without due consideration being afforded the context in which they are found.

Written language is without many of the meaning-bearing signals with which the speaker assists the listener in the construction of underlying sentence meaning. Intonation, stress, inflection, pauses, and gestural signs are generally available to aid the listener in his attempts to understand what he hears. The aural comprehension of language is very much bound up with the reconstitution of meaningful language units and the reconstitution of these units into higher level units. The research reviewed below suggests how intonation, stress, inflection, pauses, and so on, assist in the identification of the syntacto-semantic units of speech. Thus, whatever the units of written language processing are, they probably have their basis in oral language, the ability to process which is acquired much

earlier than the ability to process written language.

The Processing of Auditory Language

The following review will highlight the fact that the listener receives many more clues to the meaningful units of the language to which he is listening than does the reader. That is to say, the lower level simultaneous synthesis required for the recognition of basic grammatical entities like noun group, verb group, etc., is aided in a substantial way by the suprasegmental aspect of the linguistic system which operates in oral language. Jones (1968) provides six classifications of factors that have been suggested by various researchers, as markers of meaningful speech units. These are

1. Intonation contours and stress;
2. Pauses;
3. Separability of parts;
4. Frequency of occurrence;
5. Coding efficiency;
6. Ease of learning or retention.

Intonation and Stress

Although Halliday (1963) maintains that there is no simple relationship between phonological units and grammatical units and that we do not know a great deal about the information conveyed by English intonation, he cites two grammatical units as frequently co-occurring with the tone

group. These he describes as the clause and the group or phrase.

Lieberman (1967) proposes that intonation has a central role in assisting the listener carry out the syntactic analysis that he believes precedes the assigning of a correct semantic interpretation to a sentence. That is, the intonation provided by the speaker furnishes the cues that assist the listener in segmenting the speech stream into linguistic units that are suitable for syntactic analysis. Lieberman, however, does not describe these linguistic units. He simply asserts that the primary function of intonation is linguistic in that it provides the acoustic cues which permit the listener to segment speech into blocks for syntactic processing. Thus, intonation can provide different meanings for utterances that have the same words by segmenting or chunking the words into different blocks or chunks which direct the listener's recognition routines toward one underlying meaning rather than another.

Ebeling (1960) also emphasizes the fact that it is intonation that marks a group of words, or even a single word, as a linguistic unit. Another writer (Stene, 1954) sees the "sense group" as the unit in spoken language, and, because of its semantic unity, its recognition does not require the assistance of pauses. Recognition is assisted, however, by intonation or language stress patterns. Stene's position requires the support of an adequate theory of semantics. Such a theory has not yet been proposed.

Fries (1952) sees intonation patterns as the signaling system of English structure. Thus, it is intonation which indicates sentence units. Fries does not hold, however, that intonation is a very decisive indicator of units smaller than the sentence. Pike (1945), on the other hand, believes that intonation contours mark phrases.

Goodman (1963) discovered that children who read aloud with "natural" intonation show a tendency to retain more information from a story than readers who are not able to read in such a way. That is, when a natural intonation is used in the oral rendering of a piece of written discourse, Goodman believes that the flow of language is being chunked or segmented in the way most likely to lead to comprehension and successful storage. Goodman does not describe this process of segmentation or how it may vary from reader to reader

Pauses

Goldman-Eisler (1958, 1964) has investigated two sorts of pauses in speech. The first of these, she asserts, defines the boundaries of syntactic or phrase units. The second type of pause is found to precede a sudden increase in information and is necessary to facilitate the assimilation of the increased information load. Lounsbury (1954) looked at pauses in terms of transition probabilities. He found that hesitations of speech occurred as reflections of low probability transitions at the semantic level in the

sense of Johnson (1965). That is, hesitations occurred when an unexpected word followed another word. The transition from the first word to the second word was inhibited by their unaccustomed juxtaposition. Both of these studies were concerned with the production rather than the perception of speech.

The findings of MacLay and Osgood (1959) support those of Goldman-Eisler. They discovered the existence of hesitation pauses where a specific word caused a marked increase in information load. These were additional to those defining syntactic units. At the encoding level they found evidence of two types of units--lexical and grammatical, i.e., words and tightly knit phrase units. In the report of their study they comment that while pauses mark the existence of encoding units in speech, the same units are not necessarily the units used in listening or decoding written language.

Separability of Parts

A good deal of research in speech perception has been aimed at demonstrating that the boundaries of sentence constituents or parts form the boundaries of units that listeners perceive. As such they resist fractionation or separation. Although the means of deriving the constituents forming the experimental sentences used in these research projects are clearly explained, no derivational algorithm or set of algorithms, applicable to all English sentences,

is reported in any of them. Replicability and generalizability of the findings are thus placed in some doubt.

The studies referred to can be broadly classified as the "click migration experiments" and the "probe-latency experiments." The click experiments were based on a demonstration originally provided by Ladefoged (1959) and on subsequent, joint work by Ladefoged and Broadbent (1960). The procedure used in these studies was to superimpose a brief click on a tape-recorded sentence. After listening to the complete sentence, the subject was asked to identify the exact point, i.e., word or part of a word, where he thought the click occurred. Ladefoged discovered that individuals often erred by hundreds of milliseconds or several phonemes in their subjective placement of the click. From this he drew the conclusion that his experimental subjects processed or heard the sentences in rather large chunks that were quite resistant to interruption. Ladefoged could make no definitive statement about "language-processing" because his procedure established no more than that the subject had heard the sentence. He did state, however, that chunks of several words, which resist separation, might be a feature of the way in which listeners, in general, process sentences.

Based on these findings, and making use of similar techniques, Fodor and Bever (1965), Garrett, Bever, and Fodor (1966), Fodor and Garrett (1967), Fodor, Garrett, and Bever (1968), and Bever, Lackner, and Kirk (1969), conducted

a series of experiments which were designed to test the hypothesis that the subjective migration of clicks followed a predictable pattern which was derived from certain notions in linguistics. The original hypothesis of Fodor and Bever, and of the research subsequently conducted with minor variations, was that the clicks would be displaced subjectively by listeners to points in the sentences that coincided with the major grammatical breaks of the sentences. The results showed a statistically significant tendency of Ss to locate clicks at such major grammatical breaks. The conclusion drawn from these results is that the boundaries of sentence constituents act as perceptual as well as linguistic boundaries. This conclusion has since been supported by a great deal of data collected with a wide variety of experimental procedures (as reported by Neisser, 1967; Miller and Izard, 1963; Marks and Miller, 1964; and others). Interesting counter evidence, casting some doubt on the validity of the experimental procedures used, has however, now been provided by Ladefoged (1967) and Reber and Anderson (1970).

Another technique which has been used to test for the separability of parts is the probe-latency technique (Suci, Ammon, and Gamlin, 1967). In the study carried out by Suci et al. the subjects heard simple sentences, each followed immediately by one of the first four content words in the sentence. The experimental task was to respond to the "probe" word, as quickly as possible, with the word that had come right after it in the sentence. Thus, if the subject heard:

The big boy likes red apples--boy, the correct response was likes. Response latencies tended to be lower (at a statistically significant level) within phrases than across major phrase boundaries. This finding is consistent with the hypothesis that a listener perceives a sentence in units that match the syntactic units contained in that sentence.

Using different materials and changed experimental conditions, Ammon replicated these results (1968, 1969, and 1970), and discovered that the phenomenon held for both children and adults. From the 1969 study Ammon also concludes that phrases function as cohesive units in the processing of a sentence but that the configuration of these phrases, and the precise syntactic data they convey, is not retained in its surface form by the processor for very long. The information conveyed by the surface configuration of the sentence is rapidly recoded to permit assimilation within existing cognitive structure.

Gamlin (1969) reports the findings of other researchers (Suci, 1967; Ammon, 1967) and claims that they lend support to the notion that phrase structure is crucial, at least in the initial stages of sentence decoding. Subsequent studies by Gamlin (1970a, 1970b) again substantiate the claim that the initial perception of sentences is in terms of syntax. An additional finding of interest is that only listeners of low comprehension ability appear to be bound by the syntactic organization or structure in which they initially perceive the sentence. Listeners of high

comprehension ability indicate that they more readily free themselves from syntactic constraints and respond to the semantic component in the sentence.

The studies reported in this section support the hypothesis that the major phrases of a sentence are the units in which the sentence is initially perceived. That such perceptual units resist fractionation, at least during the early moments of decoding, is also supported. That is, major phrases in sentences are essential to perception but this importance lessens as the decoding act becomes more dependent on higher level cognitive activity. This ability to have cognition overrule the dictates of phrase-structure bound perception, is stronger in subjects of high listening comprehension ability than in subjects with lower listening comprehension.

Frequency of Occurrence

The frequency of occurrence of words has been shown to be an important determiner of how readily they are perceived (Pierce, 1963; Rubinstein and Aborn, 1960). Less work has been done, however, with frequency as a factor in the formation of larger groups. Yngve (1956) describes a sentence as a structure comprised of morphemes that occur frequently in all sentences with various open positions into which infrequent morphemes and new words fit. The frequently occurring morphemes and their combinations are role markers for infrequent ones and Yngve sees them as being important

for stating syntactic patterns. He attempted to use "gap analysis" to discover these patterns. Essentially, gap analysis is a count of the number of words intervening between two occurrences of a word, or between two words, and the summing of such counts. Although Yngve analyzed only a very small corpus of words, in fact, six, the findings are very interesting. The word "the," for example, most often occurs in a phrase of two or three words; "and" repeats most often after fifteen gaps suggesting that it is generally associated with larger syntactic groups like co-ordinate clauses. The combination of words, "of--the" is most frequent at zero gap, showing that they are often part of a very close-knit group. From another point of view, Yngve's work may be another demonstration of the importance of the role filled by the closed set of function words in the apprehension of sentence meaning.

Coding Efficiency

The term "codability" has been used by a number of investigators to refer to the ease with which words can be formed into groups. Thus, the degree of codability influences the ease with which word strings are likely to be broken into chunks or segments. Codability is listed as a factor in language-unit perception by Suci (1963). Miller (1962a) adopts the same position. He believes that codability, and therefore coherence, is affected by the type of grammatical context in which word strings are found.

Grammatical constraint, for instance, improves intelligibility by assisting in the perception of phrases because it makes use of knowledge already in the possession of the language perceiver.

Ease of Learning or Retention

In addition to the frequency of occurrence of certain words, language units have also been defined in terms of the ease with which they are learned or retained. Glanzer (1962) found that function words are hard to learn when they are presented as separate entities but are easily learned if they are put into a meaningful group. In comparison, content words are easier than function words when they are presented in isolation. From these findings Glanzer concludes that an utterance is made up of a series of units or chunks. Some of these may be comprised of single content words while others are sets of words that have function words embedded in them. Chunks are never comprised of function words in isolation.

The Processing of Written Language

The research concerning the processing of auditory language reviewed above has obvious application when the processing of written language is considered. There is, however, substantive variation between the two language forms. Written language is not spoken language in graphic form. Perhaps the relationship between the two language

forms can best be expressed as one of systematic paraphrase. That is, both forms of presentation can be used to convey the same meaning, though either one may be superior to the other for expressing the concepts of specific topics. A fundamental difference between written and spoken language lies in the degree of control over the rate of message-reception which the language-receiver possesses in each mode and the transitory nature of one compared with the other. In addition, the information load per unit of language, for example, per sentence, tends to be substantially higher for written language than for spoken language.

Johnson (1965) designed a study to investigate the extent to which Ss use their knowledge of the grammar of the language to break a written sentence into sub-units as they attempt to learn it. As with many studies in this area, the criterion variable was not the level of comprehension of the sentences achieved by the Ss but, rather, the ability to learn the sentences and successfully reproduce them in a specific manner. Thus the degree to which learning was guided by phrases was assessed by the way in which Ss performed the criterion task using the same integrated response units. The hypothesis tested was the possibility that phrase structure rules may represent a formally stated analogue of the psychological rules used for decoding, storing, then encoding written language. Johnson's investigation was based on the supposition that the language processor possesses item pools which consist of response sequences

that have been integrated, or learned as sequences, for example, grammatical phrases. Thus, these can be sampled (synthesized) from the input side as relatively simple response units for the output mode in new learning situations. In the case where grammatical phrases are amongst the entities in the item pool, a clear dependence exists, for comprehension, learning, and output, upon the processor's internalized grammar of the language and his ability to apply an appropriate synthesizing strategy to create them when he is confronted with written language.

Johnson concluded that some Ss do approach written language in terms of pre-integrated units, and that these units are predictable from the linguistic structure of the material. Therefore, to the degree that Johnson's results can be generalized to a larger corpus of sentences (he used sixteen only), phrase-structure rules seem to be psychologically real. A deficiency here, of course, lies in the fact that no satisfactory set of phrase-structure rules has been devised for dealing directly with the surface sentences listeners and readers receive. Immediate constituent analysis (Wells, 1947), which has been proposed by a number of investigators, leaves too many items unsatisfactorily categorized.

In addition to the number of phrase-structure based responses, Johnson collected data on the probability of word-to-word transition errors. That is, given a correct word in a S's responses, Johnson computed the probability of

the correct emission of the word immediately following it. As predicted, he found that intraphrase probabilities of transition errors were significantly lower than inter-phrase probabilities of transition errors.

The Research on Language Processing

The preceding summary of language research reveals that a variety of procedures have been used to study sentence processing. One set of studies used sentence recall as the experimental task. The dependent variable in these sentence memorizing situations was latencies or trials to correct recall, or errors in recall attempts.

Another set of studies attempted to disrupt the natural processing of language. Two strategies were used. The first had the Ss recall a word from within a sentence that had been read to them. The response was elicited with the stimulus of a related word in the same sentence, e.g., the word which immediately preceded the target word. The second strategy had Ss locate an extraneous stimulus, e.g., a click, in relation to the words in a sentence which had been played to them on a tape-recorder.

An important point about these studies is that language processing was assumed to have occurred if the sentence, or part of it, could be successfully recalled by the Ss. These approaches would seem to be predicated on the assumption that sentence learning is really language processing. This assumption, however, has rarely been questioned

or examined. The term "language processing" is used in the present study in the sense of language comprehension, i.e., the identification of meaning.

It has already been emphasized that reading is one aspect of language processing. Thus, the ability to manipulate language is as basic to the skill of reading as it is to any of the other three aspects of language behavior. This is not a claim, however, that written discourse is simply "talk" written down. It is an assertion rather, that a knowledge of the grammar of the language is one of the common components needed for reading, listening, writing, and speaking.

Summary

This chapter has suggested that the mature listener or reader possesses language plans which control the language syntheses that are important components in the successful identification of the meaning of language. Although it is obvious that language plans are several in type and operate at a number of different levels of language processing, the two types of concern in the context of the present discussion are sentence plans and discourse plans. No attempt has been made in this chapter to enlarge upon the comments made in Chapter 2 on discourse plans because of the lack of linguistic research or theory in the area. In that chapter, however, sufficient of the research of Luria (1966a, 1966b) was reported to support the claim that the serially connected

events in a narrative, the successive points in an exposition, or the propositions in a logical argument, are integrated into one cohesive unit with the aid of successive and simultaneous synthesis.

Sentence plans control simultaneous synthesis of language at two levels. The first level of synthesis results in the creation of groups of lexical items that represent grammatical constituents such as noun phrases, prepositional phrases, etc. This grammatical basis for word grouping produces language segments, at one level, which seem to have much in common with the natural unit of language processing frequently investigated in research of spoken and written language. This research provides support for the claim of psychological reality of language segments like these.

The second level of simultaneous synthesis controlled by sentence plans permits the language perceiver to establish the functional relationships in the underlying sentences of a discourse. Synthesis effected at this level reflects the internal simultaneity of these underlying sentences. That is to say, groups of words in one sentence are simultaneously identified as the AGENT, VERB, OBJECT, PATIENT, BENEFACTIVE, and so on, within the sentence.

The ability to make use of sentence plans in the comprehension of language requires syntactic competence. The fact that listeners demonstrate this syntactic competence does not ensure that the same level of syntactic competence is available to them as readers attempting to decode written

language. It is likely that for young readers this type of difficulty stems from the dramatic reduction in the occurrence of synthesizing signals in written language when compared with spoken language.

In this chapter, an attempt has been made to show the extent to which the perception of the sentences of a language is dependent upon the perceiver's tacit knowledge of the grammar of that language. It remains now to demonstrate the importance of grammar in the specific language process of reading. This topic is treated in Chapter 4.

CHAPTER 4

REVIEW OF RELATED LITERATURE: LANGUAGE

KNOWLEDGE AND READING: GRAMMAR AND READING:

READING AS A CONSTRUCTIVE PROCESS: CHUNKING AND READING

Introduction

The role played by grammar in the syntheses essential for successful, receptive language processing was outlined in Chapter 3. Since reading is an aspect of language processing it is clear that grammar will be of basic importance here too.

The reading act, as performed by the mature reader, is essentially a constructive act to which the reader must make a substantial contribution. This contribution consists not only of the word-based skills which the reader takes to the reading situation, e.g., his word recognition ability, his knowledge of concepts, and so on, but also the facility he has in using the grammar of his language. This implicit knowledge may be thought of as the "reader's grammar." It is this "knowledge" which guides his synthesis of words into cohesive groups. It also dictates the way in which he will see the relationships which operate between these groups within sentences.

The reader also makes a contribution at the word level of written discourse. With the help of a type of figural analysis the reader separates the individual words from the other words in a string. In doing this the mature

reader makes use of preattentive processes which employ his tacit knowledge of letter sequences in the language. These refer to a global, wholistic, non-detailed level of operations that serve to construct and segregate figural units and direct further processing. Thus, the mature reader contributes analysis at two levels. The less sophisticated of the two, based on preattentive processes, chunks the figural units that are words. The second level of analysis, operating under "focal attention," chunks groups of words and interrelates these groups. It is a constructive, synthetic activity and depends upon the simultaneous language synthesis referred to in Chapter 2. Analysis-by-synthesis provides an apt description of this latter process.

The role of grammar in the perception of written language by mature readers has been investigated by means of a variety of experimental procedures. The results of these studies support the claim that a reader's grammar is a vital component in his attempt to associate meaning with written sentences.

It has been shown in Chapter 3 that a different level of grammatical competence is required for reading from that required for listening. The research of Cromer (1970) indicates that even amongst college level readers, who are supposedly competent in comprehending spoken language, there are those who possess a high level of ability in vocabulary but perform at a significantly lower level in the comprehension of written language. A plausible explanation would

appear to be that these readers have not been successful in transferring their grammatical competence in listening to the interpretation of incoming, written language messages.

The importance to comprehension of "reading in phrases" has long been known to teachers. This knowledge, however, has been intuitive, i.e., teachers have been guided only by their intuitive "feel" for the language in showing children the phrases by means of which they want them to read. The research in the area reflects a similar picture in that no consistent paradigm has been employed by the various researchers in breaking texts into meaningful phrases.

Language Knowledge¹ and Reading

The term "language knowledge" encompasses a knowledge of verbal concepts as well as a knowledge of grammar with its system and structure. In this section these aspects of language knowledge are discussed.

Knowledge of Concepts

In order to comprehend written materials a reader must be able to identify words and associate suitable meanings with them.

Specific and generic meaning

Individual readers differ in their ability to react

¹Knowledge, as used in this context, refers to the reader's

to written words. Interpretation of words vary in that words may be thought of in their general or specific senses. The writer and the reader communicate only if they are capable of assigning some common meaning to words. Common meaning has two sources: (a) the communality of experience enjoyed by writer and author; and (b) the ability of both writer and reader to make generic response to their experience. Naturally, not all words refer to class concepts. The function words in any language, for instance, do not refer to classes of things. With repeated experience a person will achieve a generic meaning for various content words. He abstracts and forms concepts. Usually he learns to associate these concepts with spoken symbols and subsequently with printed symbols. In some cases the association of a concept with a printed symbol is achieved without the intervening establishment of association between the concept and the spoken symbol. Thus, eventually, a reader identifies a specific word within a category or a class of objects. When perception has achieved an abstract level, that is, when a reader associates a concept with a word, perception has become a kind of summing up of a number of sensory experiences. When the reader can demonstrate this capability he has the potential to bring sufficient meaning to the knowledge of how to use the language rather than any knowledge he may possess that the language functions in specific ways.

reading situation to obtain, from the printed page, an approximation of the experience the writer is trying to convey. In this way, the reader may attain an understanding of the writer's experience. It is at this point that accurate communication, by way of reading, can take place. Thus, a large store of verbal concepts is necessary for the understanding of continuous, written discourse. It is claimed that the accomplished, adult reader has such a store of concepts.

"Knowledge" of Grammar

Given an adequate knowledge of concepts the reader possesses the potential for associating meaning with the printed page. This potential meaning of a sentence is not realized as the result of a simple combinatorial process. The reader does not identify the meaning of a sentence by summing or fusing the individual meanings of its parts considered in a linear order. Such a process would be entirely passive.¹ It would not allow for the multiple meanings that words have and the fact that decisions must be made about precise meanings in specific contexts. This decision making is of fundamental importance in the apprehension of meaning. The process is largely dependent on the system and structure of language.

¹See: "Reading as a Constructive Process" which is treated at a later point in this chapter.

System and structure

• Goodman (1967) believes that the reader's deeply internalized knowledge of the system of the language he speaks, strongly influences his language perceptions. This tacit knowledge of a language concerns its organized and uniform nature. By the time children begin learning to read, such language knowledge is firmly established in their minds. As shown in Chapter 3, there is research evidence to support the contention that listeners organize their aural perceptions of language on the basis of its system and structure. Goodman asserts that children must come to the point where they can also organize their visual, language perceptions on the same basis.

The recognition of the system and structure of written language involves more than the recognition of the superficial patterns of sentences. The reader must also be able to project an underlying meaning for each sentence, though, the fact that this meaning is at a deeper level than the surface configuration of the sentence, need not be a conscious realization of the reader. The surface structures of sentences are not unimportant, however. The surface representations of sentences provide the substance from which underlying forms are reconstructed. Although the surface structures of sentences have an important role to play in assisting readers discern the meanings underlying them, it is at the underlying level that sentences must be interpreted (Wardhaugh, 1969). This is not to say that the meanings of

sentences are not also dependent upon the lexical items contained in them. Without system and structure or grammatical form, however, sentences have no underlying forms, and the lexical items are without meaning. Thus, a sentence cannot be adequately described as simply a fusion, of whatever sort, of the lexical items contained in it.

Wardhaugh (1969) describes the important distinction between understanding what is involved in the comprehension of a sentence, and understanding a sentence. To accomplish the former, the total linguistic content of the sentence must be considered and understood. To realize the latter, it is necessary only to be a native speaker of the language in which the sentence is expressed. The distinction involves the difference between "knowing about" (i.e., in this case, understanding comprehension) and "knowing" (comprehending).

Being a native speaker of a language means possessing the knowledge that certain words group together and that these groups can inter-relate in a variety of ways, and thus, produce specific underlying meanings. It does not involve knowing why certain words can be integrated into groups or why particular relationships can obtain between such groups so that certain meanings are generated.

The internalized knowledge of the grammar of his language is necessary for the native speaker to become also a comprehender of written materials. Thus, the accomplished reader displays a high degree of grammatical competence in

his perception of written language.

Grammar and Reading: Empirical Evidence

Considerable research evidence has been compiled which suggests that a knowledge of the grammar of a language affects the perception of the written form of that language.

The Mature Reader's Use of Grammar

Kolers (1969) has not only found that Ss (college students) identify words better than individual letters but that sentences are not always perceived word by word. He also found that Ss read passages aloud, without rehearsal, using the correct stress and intonation. His deduction from this is that some preliminary grammatical analysis must be associated with the successful reading act. Again with college students, Kolers demonstrated that when Ss read texts that have been geometrically transformed, e.g., by inversion or mirror-imaging, the types of errors they make indicate that they are not just naming words. They are also giving consideration to grammatical relationships which they have perceived by the simultaneous consideration of the grammatical groups they have formed within individual sentences. The errors analyzed in Kolers study were consistent with the grammatical structure of the sentences which the Ss were reading. Error correction was highest when grammatical deviations were involved. Thus, Kolers concludes, mature readers at least, appear to be sensitive to the functional

relationships of the sentences they read as well as to the words of which they are comprised.

In a similar study, conducted earlier by Morton (1964), the experimenter had students read specially prepared texts, orally. These passages represented varying degrees of approximation to English. They were generated with a statistical information model making use of word probabilities. In this experiment the errors were once again in the direction of restoring greater grammatical consistency to the distorted sentences.

Eye camera evidence

With the help of eye-camera photography Mehler, Bever, and Carey (1967) found that the visual scanning patterns of college students, in reading familiar materials, are affected by the surface phrase-structure of sentences. These investigators claim that the observed relationships between eye-movements and phrase-structure, suggest that syntactic information is used in the perception of written language. Insufficient evidence is presented in the report of the study of Mehler et al., to indicate that the Ss were indeed processing, i.e., attempting to comprehend, the sentences used in the experiment. This would have been difficult to establish anyway, as the sentences used in the experiment were already familiar to the Ss who took part in the project.

The Eye-Voice Span

As has often been observed, the difficulty in the studying of the reading act lies principally in the private nature of the process. It is probably impossible to externalize and observe the process without disturbing it to some degree. To investigate some outcomes or correlates of the process is not the same as studying the process itself. A number of researchers have adopted the "Eye-Voice Span" technique as the most reasonable compromise between externalizing the process and observing its correlates.

The Eye-Voice Span (EVS) has a substantial history in reading research which goes back as far as Quantz (1897) who found that the EVS is longest at the beginning of a line. The EVS can only be observed in oral reading. It is the distance, measured in words, that the eye is ahead of the voice. Two general procedures are adopted in studying the EVS. The first consists of the recording of eye movements while the subject is reading aloud. The second, which is the simpler of the two, involves the removal of the text at some point and the S is asked to go on naming the words as far as he is able, beyond the point at which he no longer saw the text.

One researcher (Buswell, 1920) suggested that the EVS allowed the mind to understand a large meaning unit before the voice was called upon to express it. Buswell proposed the hypothesis that the EVS takes in units of meaning based on phrases or sentences. He produced no substantive evidence to support the hypothesis. Anderson's

research (1937) led him to suggest that the reader's eye movements are controlled by the content of the reading material. From this he inferred that the reader progresses by phrases rather than word by word. More recently Schlesinger (1969) asserted that the distance the eyes are ahead of the voice represents a decoding unit. From his study he predicted that the "units of reading" could be described in terms of syntactic structure. He thus hypothesized that, when the text was removed, Ss would name words ahead to the end of a group of words that could exist alone as a unit. Schlesinger produced data that support his hypothesis. That is, he found that readers do call words to the end of units that are both syntactic and semantic wholes.

Levin and Kaplin (1970) replicated Schlesinger's findings and discovered also that a reader's propensity to name words to the end of a phrase, following text removal, is not affected by the size of phrases. Additionally, they discovered that when Ss inserted words in the EVS that were not in the original text, such words usually completed phrases.

Levin and Kaplan claim that their data support the hypothesis that Ss read in phrase units. Although they do not define phrase units, it is clear that such units, however defined, will vary in length. Thus, Levin and Kaplan assert that readers have an "elastic span which stretches or shrinks to phrase boundaries (p.124)."

This study also revealed that fast or good readers

named words to the end of phrase boundaries more frequently than the slow or poor readers did. The finding suggested to Levin and Kaplan that good readers process more in terms of units or phrases than poor readers do (cf. Cromer, 1970). It also suggested that they are more adaptable to changes in sentence structure, as reflected in changes in phrase size, than poor readers are. It further suggested that slow readers, much like beginning readers, probably read more in terms of individual words rather than phrases (again, cf. Cromer, 1970), indicating that they have not learned to apply the information processing strategy of simultaneous synthesis.

With these EVS studies, as with much of the work on language processing already reported, there is no test, and, therefore, no evidence, that the word naming going on, results in the identification of meaning. As previously pointed out, for the present writer, reading that does not include the identification of meaning, is not reading at all.

Reading and Transformational Grammar

The model of the reading process developed by Brown (1970) is intended to relate the reading act to recent research in psycholinguistics. This model suggests that the text is scanned by the reader with considerable semantic and syntactic expectancy. The text is passed through a type of "word-filter expectancy device" which quickly recognizes units consisting of a word or words. These are stored in

Short Term Memory (STM). The function of the word filter is to provide an initial segmentation of the word-string (this may be thought of as the first step in the lower level of the simultaneous synthesis of language--see Chapter 2). This is followed by a check of the punctuation of the text to see if a complete structural fit can be obtained. Thus, the word-filter expectancy device and the "punctuation assessor" work in combination. The output is a set of clues with which the reader attempts to reconstruct the underlying meaning of each sentence in the passage. Brown's model assumes that these clues are insufficient for the reader to do this. Control then passes to a "heuristic analyzer." The heuristic analyzer searches the string in STM for additional clues that will suggest the deep structure from which the surface sequence under consideration can be generated. The function of the heuristic analyzer, in short, is to modify and supplement the findings of the word-filter expectancy device and the punctuation assessor. The over-riding function of the heuristic analyzer is aimed at the reconstruction of the meaning underlying the sentence.

Brown's model proposes that the analyzer achieves this reconstruction of underlying sentence meaning by identifying the logical subject and the main verb as the basic units of predication in the underlying structure. This is done with the assistance of such clues as structural constraints and commitments in the word order of the unfolding sentence. Special attention is paid to the verb as Brown

believes that the verb plays the major role in determining deep structure configurations. The same position is adopted by Fodor and Garrett (1967) and Fodor, Garrett, and Bever (1968). The essential feature of the argument is that the major constraints in the deep structure stem from the verb in the form of the selectional restrictions it places on the remaining constituents of the sentence. In addition to using lexical selection rules, the analysis unit reconstructs the transformational history of the sentence with the help of which the surface configuration of the original sentence was produced. It does this in an attempt to recover the deep structure phrase marker of the sentence perceived as a simultaneous, functional unit. In sentence production, Brown asserts that the deep structure phrase marker is generated by the rewrite rules which are part of the syntactic component of the grammar of the language. The creation of the surface sentence results from the operation of the transformational component upon this deep structure phrase marker.

These are the major features of the model. Together with other minor strategies that make use of various surface representation clues, deep structure hypotheses are generated until one, satisfactory to the reader, is finally found. In essence, and substantially oversimplified, Brown's model depicts a process in which the reader undertakes the initial segmentation of the surface sentence. This segmentation brings the reader to the reconstruction of

the abstract deep structure of the sentence, and, therefore, to the identification of its meaning.

Although Chomsky (1965) proposed his transformational, generative grammar "as a system of processes and rules that apply in a certain order to relate sound and meaning, we are not entitled to take this as a description of the successive acts of a performance model . . . in fact, it would be quite absurd to do so . . . The grammatical rules . . . do not constitute a model for the production of sentences . . . (1967, p.399)." Brown asserts that his model of the reading act has been inspired by recent psycholinguistic research. The model, however, depends less on the findings of empirical research in psycholinguistics than it does on Chomsky's original linguistic grammar. Clearly, a great deal more reliably conducted, empirical research will be required before Chomsky's competence model can be directly applied as an explanation of the perception of written sentences in reading as Brown has. The model also lacks consideration of discourse phenomena which, clearly, have a vital impact on a reader's attempts to identify meaning.

Reading as a Constructive Process

Ryan and Semmel (1969) suggest that language processing strategies are used by the reader in the perception of printed material. For them, reading is a constructive process¹ to which the reader makes a significant contribution.

¹The term constructive is not used to describe a purely

These strategies are based upon three areas of knowledge. One concerns the reader's knowledge of verbal concepts. Another concerns the knowledge of the system and structure of language. The third refers to the reader's knowledge of the situation captured in the reading event. All of these areas of knowledge draw on the reader's experiential background. The child's knowledge of the language develops in interaction with a language oriented environment. The possibility of his familiarity with situations presented in print is dependent upon the breadth and richness of his past experiences. Of course, these too, develop in a substantial way, from the reader's interaction with his environment.

Preattentive Processes

Neisser (1967, 1969) treats attention as the allocation of resources. Attention is the allocation of analyzing mechanisms to a restricted region of the stimulus field. Neisser proposes two systems of processes involving two levels of analysis. These are preattentive processes and focal attention. Both are strategies employed by the reader in the reading act.

The preattentive processes are preliminary in that they are crude, global, wholistic operations which serve to

linear or additive process. The constructive process referred to is dynamic and multi-directional such that the reader may operate progressively, retrogressively and integratively, i.e., the construction makes use of both simultaneous and successive syntheses.

construct figural units and direct subsequent processing. They produce what Hebb (1949) terms "primitive unity." The preattentive processes thus produce the figural units that other mechanisms will later interpret. In his list of activities which are frequently under the control of the preattentive processes Neisser includes walking and driving. For the mature reader, these processes perform certain of the preliminary aspects of the act of reading, e.g., initially chunking the figural unit of a word. Assuming that the skilled reading act does not involve attention to details such as identifying each letter, the use of partial cues and fragmentary features is almost certainly a preattentive activity (Schiffman, 1971).

The preattentive processes permit the perceiver to allot most of his cognitive resources to a suitably chosen part of the field. This is necessary because the processes of focal attention cannot operate on the whole field simultaneously. It is possible for them to function only after the preliminary, preattentive operations have already constructed and segregated the units involved. In the present theory a basic tenet is that, with the fluent, adult reader, the recognition of most words is achieved "automatically" by means of preattentive processes.

The problem of specifying the operation of the selection of the entities to which focal attention will be directed is largely resolved with the postulation that the initial analysis of the signal is performed automatically.

In this way, the primary analysis is carried out in the sensory register without any sophisticated cognitive processes. An incoming signal is considered to have been "interpreted" when its physical characteristics have been "matched" with those of some representation stored in memory, i.e., Long Term Store (LTS). This representation then, functions as the guide to information stored about the meaning of the signal. Meaning, at the individual word level, includes the syntactic function of the specific word. In fact the instant recognition of the meaning of such a representation is frequently dependent upon the same availability of the syntactic information about that representation (Ausubel, 1968).

Norman (1968, 1969) also provides support for the claim of automation for the perceptual recognition of words. The automation of this interpretation process, he asserts, depends upon the initial access to storage (i.e., of stored physical representation) being based entirely on the sensory features of the signal.

Selection and Focal Attention

The preattentive processes are not built for accuracy--that is the domain of focal attention. When responses occur without attentive construction they will be characterized by certain approximateness. The preattentive processes show a dependence on global, nonspecific attributes rather than on details. Their function is to form the

objects which are dealt with by focussed attention. Reading is a prime example of the way in which the preattentive processes function. Advanced readers make use only of partial clues (Neisser, 1967). A problem which remains, however, is how the selection process decides on the objects for focal attention.

After sensory inputs have activated their representation in storage (LTS) and various possible appropriate meanings (also from LTS) have been associated with those representations, they are held in Short Term Memory (STM) and are operated upon by further cognitive processes. These additional cognitive processes effect the selection of inputs for focal attention. In addition to the physical form of the inputs, Norman (1968) has suggested that selection is determined by grammatical and meaningful cues, as well as the expectations generated by the situation. Thus, the analysis of previous signals in terms of the linguistic system and expectations, sets up a class of events deemed to be pertinent to the ongoing analysis. The establishment of pertinence results from cognitive processes rather than sensory ones. Printed symbols may be decoded into morphemes or words as the result of the activation of the stimulus analyzing mechanisms, but the integration of these basic units into more meaningful structures is not performed in the absence of selection involving the higher cognitive processes which draw upon the various types of knowledge possessed by the reader (Norman, 1968). Norman's position is sympathetic

to that of Luria (1966a, 1966b) with regard to the application of simultaneous and successive syntheses.

Analysis-by-Synthesis

The selection analysis proposed by Norman (1968) and Neisser (1967) has much in common with the analysis-by-synthesis model outlined by Halle and Stevens (1959, 1962). A fundamental aspect of this model is that with the identification of parts, for instance, of individual words, their synthesis into a higher level unit becomes possible. Thus, a prior analysis to identify the elements is required for synthesis (Neisser, 1967). The integrative process becomes a type of silent calculation in which the language processor formulates an hypothesis about the original message. To this he applies certain criteria to discover what the input would be like if the hypothesis were the correct one.

Visual synthesis, like its auditory counterpart, can produce units of various sizes. The synthesis of these units develops according to rules--graphological, graphemic, syntactic, and semantic rules. The contention, in the context of the present study, is that the syntactic and semantic rules known by the reader, play major roles in the skilled reading act. Neisser claims that it is the employment of these rules that renders analysis-by-synthesis so much more attractive than rival theories. He quotes Stevens (1960) on the value of rules in this theory:

...rules for generating spectral patterns, rather than the entire catalogue of patterns themselves, are stored,

with a resulting large saving in storage capacity. Furthermore, if a proper strategy is devised for selecting the order in which patterns are synthesized for comparison with the input, then the number of patterns which must be generated and compared may be of orders of magnitude less than the total number of patterns that could be generated by the rules (p.53).

The final point made by Stevens is vital if analysis-by-synthesis is to be a convincing explanation of how selection and attention result in high level word-groupings in reading. Without a strategy which selects the order in which patterns are synthesized the idea of analysis-by-synthesis is reduced to the most crude type of trial and error. Stevens (1960) emphasizes that the success of the theory depends upon "a preliminary analysis of the signal" which is a kind of processing specifically not analysis-by-synthesis. The crucial point here is that there must be mechanisms that select the portions of the input that are worth synthesizing. These mechanisms, clearly, are of the same type as the preattentive processes alluded to by Wundt (1897, 1900; see: Bever, Lackner, and Kirk, 1969) and specifically described by Neisser (1967) and Norman (1968).

Stevens' (1960) emphasis of the importance of rules and a strategy of rule application in analysis-by-synthesis, clearly indicates the close affinity between this approach to the explanation of language synthesis and that of Luria (1966a, 1966b). Stevens also emphasizes that the reader, like the listener, uses "data from previous spectra," i.e., he makes extensive use of context and expectation. The way in which readers make use of contextual information presents

an important supporting argument for analysis-by-synthesis. In interaction with the internalized sentence and discourse plans of the reader, the context of the material being read, and the situations dealt with in the printed text, hypotheses are formulated for testing against input.

For Neisser (1967) there is an important difference between the rapid reading of words without attending to specific letters and the rapid reading of sentences without attending to specific words. The end-product of both word-recognition and letter-recognition is a name or label, i.e., a structured verbal pattern in inner or outer speech. The method of recognition, at least for a cognitive system capable of constructing individual letters visually, and of verbalizing their names, is substantially the same in both cases.

In rapid reading, however, the end-product of the cognitive activity, is not an item of verbal behavior. is, rather, an underlying meaning, i.e., a "continuing silent stream of thought (p.136)." In viewing reading¹ as a kind of analysis-by-synthesis, Neisser sees an analysis of word sequences that results in a synthesis that permits the apprehension of meaning (cf. the simultaneous synthesis of Luria, 1966a, 1966b).

¹Neisser uses the term "reading for meaning." The present writer holds the belief, however, that there can be no reading without the identification of meaning. The additional words, "for meaning," in Neisser's term are, therefore, considered to be redundant.

Neisser's position is in agreement with that subsequently adopted by Smith (1971, 1973), who argues that in fluent reading, meaning is reconstructed without the identification of individual words. New synthesized groups of words are continuously taken into account to construct new thought processes (Neisser, p.136). Because the synthesis referred to by Neisser occurs at the word group level, it involves the reader's consideration of the structural and systematic aspects of the language of written discourse. In this way, one level of simultaneous synthesis produces coherent word groups. Another level of simultaneous synthesis relates these groups to each other to establish the functional relationships within a sentence (Luria, 1966a, 1966b). Thus, it can be seen that the individual word meanings in a sentence, summed in a simple linear fashion will not produce a single cognitive construct. Rather, they produce a series of cognitive constructs that, considered additively, do not produce the same cognate as the series of words considered in their linguistic structure.

Chunking and Reading

The fact that language is incapable of carrying meaning without system and structure has been repeatedly demonstrated. This system and structure is represented, chiefly, in phrases and relatively large word sequences. It is rarely carried by letters and individual words. Although an individual function word frequently signals the occurrence

of a specific structure, it does not delineate that structure. Because of this, Goodman (1967) claims that an essential strategy in successful reading (i.e., fluent reading) is the perception of "phrases and large sequences rather than letters and/or words (p.542)."

Up to this point, considerable theoretical and empirical evidence has been presented which indicates that language processing involves the processor in dealing with groups of words which he synthesizes into a meaningful unit. If meaningful verbal material tends to be coded into chunks or segments by the language processor, e.g., the reader, then the prior organization of reading material into meaningful word groupings for the reader, should optimize the efficiency of reading. Some research has examined this question. This research is reported below.

The Identification of Meaning and the Organization of Reading Output

Major versus minor segments

Graf and Torrey (1966) conducted a study in which they found the comprehension of paragraphs is higher for material which is broken into major segments by immediate constituent analysis. The researchers do not define a major segment nor do they explain what procedures were adopted to deal with the items in the sentence which defy classification under immediate constituent analysis, e.g., most connectives and sentence-openers like, "presently," "suddenly," "now," and so on. In any case, the generalizability of the findings

appears to be open to question. The readers were not reading at their normal rate, but at a faster rate, under the control of the experimenter. In addition, the Ss' performances were not compared with their achievements on conventionally presented reading materials, but reading materials which had been broken into minor chunks (undefined) also on the basis of immediate constituent analysis.

Meaning units

North and Jenkins (1951) found that a format composed of segments created on the basis of "meaning units" increased comprehension scores and reading speeds. Their conclusion was that the segmentation of words into "thought" units supplements punctuation and grammatical cues, and, therefore, facilitates reading. This is an interesting conclusion but it is not open to further testing because no definition of "meaning unit" was provided. Without such a definition, the segmentation of other texts in exactly the same way, is not possible.

Klare, Nichols, and Shuford (1957) carried out a similar study making use of a time limit. Since the time limit amounted to permitting a reading speed of fifty words per minute, the use of the term "time limit" seems to be without warrant. The results obtained by Klare et al. failed to confirm those of North and Jenkins. Coleman and Kim (1961) found a difference in comprehension results in favour of materials that had been segmented on the basis of "meaningful units." Again, no definition of "meaningful

units" is provided. The difference found, however, did not reach statistical significance. Coleman and Hahn (1966) showed that a vertical format comprised of one word per line failed to improve the readability of the materials read.

The difference-deficit model

Cromer (1970) conducted a study making use of sixty-four male college freshmen and sophomores. His research was carried out within the four dimensional conceptual framework originally proposed by Wiener and Cromer (1967) to provide a theoretical explanation of reading difficulty. In brief, the model describes four causes which, singly or in combination, account for reading difficulty. These are: (a) a defect which is a nonfunction or dysfunction such as a sensory impairment without the removal or correction of which the individual cannot learn to read; (b) a deficit which describes the absence of some ability or function which must be added if acceptable reading is to occur; (c) a disruption which describes the presence of an atypical or interfering function which must be removed before adequate learning can occur; and (d) a difference which is a mismatch between the individual's typical mode of responding and the pattern of responding necessary for adequate reading to occur.

Cromer's (1970) study was chiefly concerned with the "difference" aspect of this model although some attention is given to Ss suffering from a specific deficit. The "difference" postulated in this case was in the manner in which mature readers organize their input of reading material

into meaningful units. It was assumed that the "different" readers have the skill to read aloud and pronounce individual words correctly but do not organize the material they are reading in a meaningful way. They organize reading input in a word-by-word fashion rather than into meaningful units such as phrases and thus, lose that portion of the meaning of continuous, written discourse which is carried by the interaction of words in context. This means that although they are confronted by the same materials and, therefore, recognize the same words as readers not hampered by the "difference," they are virtually taking in different information with the inevitable result of a poorer standard of comprehension. A second assumption made by Cromer is that "different" readers can organize input into meaningful units but for some reason they persist in reading word-by-word.

On the basis of these two assumptions Cromer hypothesized that if reading material for the "difference" group is preorganized into meaningful word groupings their comprehension will be facilitated. Conversely, if meaningful organization is impeded by a word-at-a-time mode of presentation their comprehension will not be affected. The second half of this hypothesis is based upon the assumption that the word-by-word presentation parallels the typical pattern of responding of readers in the "difference" group.

The meaningful word groupings used by Cromer were determined by a criterion based on punctuation, structure,

and the meaning of the material. Lefevre's (1964) criteria were used as the primary basis for the creation of meaningful word-groups. Lefevre contends that the significant elements in sentences are grammatical and syntactical structures, i.e., noun and verb groups and clusters. Although Cromer is much more precise than most researchers in his specifications for these meaningful units, he is, nevertheless, vague to the point of making replication a difficult undertaking.

As hypothesized by Cromer, it was demonstrated that for poor readers, classified as belonging to the "difference" group, comprehension is improved by presenting them with reading materials preorganized into meaningful word groupings instead of having them read materials presented in a normal format. Also, as hypothesized, the comprehension of the "difference" group poor readers, did not suffer a significant decrement when the mode of presentation was a word-at-a-time. This supports the contention that this type of poor reader typically uses a word-by-word method of taking in reading matter.

Cromer feels that two important conclusions are implied: (a) if a reader does not learn to take in materials in terms of meaningful linguistic structures or, if he has overlearned a word-by-word method of reading, his comprehension of what he is reading will not be at the optimum level for him; and, (b) some readers who have not learned to deal with the intake of reading materials in terms of meaningful

units can be encouraged to do so by an artificial method of presentation.

Cromer classified another category of readers as the "deficit" group. These readers had performed poorly on both the vocabulary and level of comprehension subtests of a standardized reading test. It was discovered that none of the modes of presentation used by Cromer produced a significant improvement in the comprehension of these readers. Cromer concluded from this evidence that readers in the "deficit" group did not possess the concepts necessary for college level reading.

Comparison of various formats

Based on the research of Fodor and Bever (1965), Mehler, Bever, Carey (1967), Epstein (1967), and Anglin and Miller (1968), Carver (1970) conducted a study which also tested the hypothesis that the preorganization of reading material into meaningful word groupings would improve the efficiency of reading.

Carver's research consisted of three separate studies. The purpose of the first was to compare five different experimental formats (word groupings) with a conventional format to discover which of the five should be again compared with a conventional format in the subsequent, main study.

The passages used in the investigation were taken from the Nelson-Denny Reading Test (1960), Form B. Each passage was typed in six different formats. Format A was

the conventional format. Formats B - F involved some form of segmentation or chunking.

In discussing the manner in which the reading materials were chunked, Carver states:

There are no firm rules for chunking reading material and the rules used are seldom given in the research reports. An immediate constituent analysis could be used to chunk material, but even this technique may involve somewhat arbitrary decisions when a complex sentence is being analyzed. The chunking of materials by immediate constituent analysis would probably not be a practical procedure due to the time required to prepare the material by this procedure (p.289).

In spite of these comments, Carver made use of the guidelines for breaking sentences into groups of meaningfully related words as set out by Klare and others (1957). These guidelines suggest that in forming the groupings, (a) modifiers should be placed with the words they modify; (b) clauses and phrases should be separated from the rest of the sentence; (c) segments should never be broken due to lack of space at the right hand margin, and (d) existing punctuation should be used to determine boundaries between chunks. By using these guidelines Carver discovered that chunks of a quite arbitrary length resulted. He therefore investigated three different chunk lengths: long, medium, and short. Carver does not explain how the consistent application of the same guidelines to the same word string produced chunks of three different lengths. In fact, there is some doubt as to which guidelines were actually used: those of Klare et al., the dimensional guides of long, medium, and short, or a combination of both.

The long chunks were presented to Ss in a format made up of one chunk per line. The medium and short chunks were presented in two formats: one with a line devoted to each chunk and one with two chunks per line. With the latter format, chunks were separated by two spaces rather than the customary one space used between words. Once again, Carver fails to explain the confounding effect stemming from the presentation of chunks in two different ways, viz., one per line and two per line, separated by a barely perceptible, larger-than-usual, typographic spacing.

The aim of the first study was to compare the six formats for speed of reading and comprehension scores, and to obtain a preference ranking for the formats.

Carver found that his experimental Ss read the conventional format fastest. They achieved a mean comprehension score on this format that was comparable with the mean comprehension scores secured on the other formats. Of the five experimental formats, the researcher found no single format superior because the highest comprehension scores tended to go with the slowest reading times, and the fastest reading times tended to go with the lowest comprehension scores. Format D, the medium length chunk, using one chunk per line, was afforded a clear preference over the other experimental formats by the Ss. The conclusion drawn from these results was that none of the formats would improve the efficiency of reading.

In spite of the results already obtained from Study

1, a further study, Study 2, was designed to compare the conventional format, A, with the previously preferred, chunked format, D. The purpose of Study 2 was to discover which format resulted in the most efficient reading. The data obtained led Carver to suggest that a chunked format cannot be read more efficiently than a conventional format.

Study 3 was a slightly more refined edition of Study 2. From its results Carver concluded that there was no evidence to suggest that there is an interaction between readers of varying ability and the facilitating effects of chunking. Moreover, he claimed that the chunking of reading material does not appear to increase the reading rate or reading comprehension of a mature reader who reads either quickly or slowly, or who reads either accurately or inaccurately .

Carver summarized the conclusions from his three studies as follows:

These results suggest that the spatial separation of reading material (e.g., textbooks) into meaningfully related groups of words will probably not improve the reading efficiency of mature readers, reading at their normal rate, no matter what method is used to separate the material (p.296).

From the studies reviewed, it can be seen that no firm conclusion can be drawn with regard to the impact on comprehension of the use of segmented or chunked reading materials.

Summary

An attempt has been made in this chapter to show

that the reader must make a substantial contribution to the reading act. It appears that there are at least two important ways in which this contribution is made. One of these concerns the implicit knowledge of language at both the letter sequence level and the syntactic level which the reader brings to the reading situation. Another component which the reader contributes to the reading process is the store of meanings and concepts he brings to the printed page. While this contribution is clearly an interaction of these components, the emphasis in this discussion has been placed upon the importance of a knowledge of the system and structure of language.

In the mature, fluent reader, a process of figural synthesis, operating at the level of preattentive processes, separates the individual words of sentences upon which the higher cognitive processes operate. Selection of the input for focal attention is determined by the interaction of syntactic, semantic, and situational cues. For the selection to be effected faithfully the reader must be able to contribute a knowledge of the language and an appreciation of situational influences. Finally, by means of a process of analysis-by-synthesis, the reader makes a contribution by generating hypotheses about what meaning the printed message conveys and tests these against the unfolding linguistic pattern and situation of the sentence or discourse.

In spite of the essentially private nature of the

process, an impressive amount of empirical research has been conducted in the investigation of close correlates of the reading act. The evidence stemming from this research provides support for the suggestion that grammar plays a vital role in the reading process.

The transformational-generative model of grammar has been shown, by a number of researchers, to be of value in assessing the difficulty of certain sentence constructions for readers. Although less research data have been collected with regard to the transformational model as an explanation of specific aspects of the reading process, it has been used to construct reading models such as that proposed by Brown (1970).

It has been shown that "phrases" and "phrasing" have been of interest to researchers in the area of reading. Although significant results have been produced, the usefulness of these results has been restricted by the failure of the researchers to clearly describe the grammatical underpinnings of their work. This study represents an attempt to overcome some of the deficiencies noted in this approach to reading research.

The next chapter, Chapter 5, is devoted to a summary presentation of the theoretical framework of the study and the experimental hypotheses that have been generated from the theory.

CHAPTER 5

THEORY AND HYPOTHESES

Introduction

This chapter has two purposes. The first is to outline the theory upon which this study was based. The second is to show how the research hypotheses were generated from the theory.

The Theory

This theory is not intended to provide a definitive description of the "total" reading process. The aim is to outline a testable explication of an aspect of the cognitive functioning by means of which the "accomplished, adult reader"¹ identifies the meaning of written language.

"Knowledge" of Grammar

An understanding of a large number of words is not sufficient to ensure that a reader will identify an acceptable meaning for a specific sample of written language. The meanings of written sentences are not realized by simply summing the meanings of the individual words that comprise them. To construct a meaning for written language the

¹Undergraduate university student, otherwise termed "college reader," "efficient, adult reader," and other similar self-explanatory terms.

reader must be able to appreciate the impact of grammatical and situational contexts upon specific words and groups of words.

In order to correctly interpret the situational aspect of written language, a reader must have enjoyed appropriate direct or vicarious experience. Although it is clear that this is of vital importance in meaning identification, this study does not include a specific attempt to evaluate the degree of importance of this component.

Any attempt to understand written language must involve a close examination of the precise grammatical context of sentences. The act of comprehension, however, requires more than the recognition of the superficial pattern or surface structures of sentences. The reader must also be able to project an underlying meaning for the sentences although this may not be at a conscious level. This is not to say that the surface forms of sentences are unimportant. Surface configurations provide the substance from which underlying forms are reconstructed. Surface structures, thus, have an important role to play in assisting readers discern the meanings that underlie them. But as Wardhaugh (1969) emphasizes, it is at the underlying level that sentences must be interpreted. It follows, therefore, that readers must be able to apprehend this underlying representation.

Recent linguistic thought has been considerably concerned with the interaction between syntax and semantics.

The aim has been to demonstrate how the relationship between syntax and semantics can be characterized within a set of grammatical rules. Although this purpose appears to be far from accomplishment, it is clear that a speaker's implicit semantic knowledge of his language is at least as well systematized as his syntactic knowledge of it. The fact that a set of rules has not yet been formulated does not lessen the strong possibility that there are facts about English semantics that speakers of English have internalized and can call upon in interpreting words found in new combinations (Wardhaugh, 1969).

The accomplished, adult reader will have systematized such a body of semantic knowledge which, in interaction with his syntactic knowledge, he can apply to the perception of spoken language. The possession of this syntactosemantic knowledge constitutes the reader's knowledge of grammar. It is hypothesized that the reader draws extensively upon this knowledge in his attempts to reconstruct the underlying meanings of sentences.

Grammar Plans

In the previous section it was pointed out that the reader's "knowledge" of grammar, in both its syntactic and semantic aspects, is employed in the comprehension of continuous written discourse. On the basis of the work of Miller, Galanter, and Pribram (1960) and Luria (1966a, 1966b), it is suggested that "grammar plans" are employed by the

speaker/writer for the generation of written language. These plans are applied at the sentence and discourse levels of production, respectively, and they are evolved on the basis of interacting syntactic, semantic, and situational aspects.

Sentence plans

It is a basic tenet of the theory proposed here that the sentence plans used in the construction of written sentences are reconstructed by the reader in his attempts to identify the ideas upon which the written sentences are based. Thus, the grammatical entities (i.e., meaningful word groups) within a sentence must be discerned and the manner in which they relate to each other as AGENT, OBJECT, BENEFACTIVE, and so on, appreciated. Decisions about these two aspects of sentence perception call for syntactic, semantic, and situational knowledge. It is clear, then, that to achieve the comprehension of the sentences of written language the accomplished, adult reader will possess facility in synthesizing individual words to form the grammatical word groups used in the production plan for the sentence. Likewise, he will have the ability to discern the inter-relationships between such word groups which are required in the sentence production plan.

Discourse plans

The production of a discourse makes use of a discourse plan (Luria, 1966a, 1966b). Luria describes the

dynamic aspect of the thinking required for linguistic processes as effecting the transition from a topic through a discourse plan to expression in the form of a successive chain of events, points, or propositions that conform to that plan. Luria also claims that the understanding of a discourse involves the reconstruction of the plan by means of which the topic was developed into a discourse. Thus, it is proposed that the comprehension of written language, at the discourse level, involves the synthesis of the individual entities that together comprise the topic to which the discourse is addressed.

While this proposal forms an integral part of the theoretical stance adopted in this piece of research, the study was not designed to generate data that will permit its evaluation.

Language Synthesis

The central feature of this theory is that comprehension of written language is essentially a synthesizing activity. Individual words representing verbal concepts and signalling syntactic functions, semantic constraints, and/or situational information, are synthesized to form meaningful word groups. These word groups are inter-related to establish the functional relationships within sentences. Sentences are synthesized to reconstruct coherent discourse. For the comprehension of written language, the two information processing strategies of simultaneous and successive

syntheses, described by Luria (1966a, 1966b), encompass the synthesizing activities referred to here.

Simultaneous synthesis

In simultaneous synthesis, stimuli must be perceived simultaneously for a decision to be arrived at or for information to be correctly processed. The present theory proposes that the simultaneous synthesis of language occurs within sentences: (a) in the recognition of meaningful word groups such as noun phrase, verbal element, verb modifier, preposition phrase, and so on; (b) in the identification of the functional relationships which obtain between such word groups; and, (c) to the apprehension of the main ideas or ideas of a discourse.

With the skilled, college reader, this theory proposes that, in general, both levels of simultaneous synthesis are effected in the automatic manner outlined by Ausubel (1967, 1968). These processes are efficiently carried out in speech from an early age. The transfer of their application from spoken language to written language, however, is not always automatic or accomplished without some difficulty. Written language lacks the stress, pitch, juncture, intonation, and gestural signs which are generally available to assist the listener in deciding which words should be synthesized into single units, and, to a lesser extent, how these units should relate to each other. Until the chunking of written language, and the inter-relating of the entities formed by chunking, are carried out with equal

facility as the same operations in spoken language, it is hypothesized that the comprehension of written language will be impeded.

Units of written language processing

For the accomplished, adult reader, it is hypothesized that there are minimum units towards which the lower level of simultaneous synthesis is directed. These units are lower major constituents or word groups extremely similar to them. The derivation of LMCs is fully described in a subsequent chapter. The emphasis placed upon these units here, is not intended to suggest that some mature readers may not use a larger unit. The assertion is, however, that larger units employed by individual readers will be based upon LMCs. That is, such units would commence where one LMC commences and would terminate where another terminates.

Functional relationships within sentences

Making use of language units (e.g., LMCs) such as those proposed in the previous section, it is hypothesized that the efficient, adult reader further employs simultaneous synthesis to reconstitute higher level units. The motivation for this process of reconstitution achieved by means of simultaneous synthesis, is the apprehension of the functional relationships within sentences.

Successive synthesis

In successive synthesis, stimuli must be perceived

as a sequence in order to make a decision or to comprehend the information that is being processed. As explained in Chapter 2, successive and simultaneous syntheses are involved in the more complex levels of the organization of mental processes reflected in the course of the cognitive activity that underlies linguistic processes. Luria (1966b) suggests that this cognitive activity depends upon three components. These are: verbal concepts, the logical-grammatical code, and the dynamic aspect of thinking that underlies linguistic processes. The last component effects the transition from a connected discourse, comprised of a successive chain of events, propositions, or points, through the discourse plan to the topic from which the discourse originally grew. Successive synthesis is probably the basic element in the dynamic quality of the aspect of cognition associated with the use of language. A deficiency in this aspect of information processing may be revealed in an inability to identify the connected meaning of a written discourse.

As already stated, this study is not intended to generate data that are pertinent to the assessment of this proposal regarding successive synthesis and the role it may play in comprehension at the discourse level.

Summary

Three types of "knowledge" are basic to the comprehension of written materials by accomplished, adult readers. These are: a knowledge of verbal concepts, a knowledge of

grammar that subsumes syntactic and semantic competence at both the sentence and discourse levels, and a knowledge of the situations that are captured in written materials. The meanings that emerge from the integration of these three types of knowledge are achieved with the assistance of two information processing strategies depending upon cognitive synthesis. These are simultaneous synthesis, operating at two levels within the sentence to reveal the meaning of that linguistic unit, and successive and simultaneous synthesis together integrating the sequenced "events" of a discourse to disclose the topic and supporting general impressions upon which it is based.

Derivation of Hypotheses

On the basis of the theoretical positioned outlined in this chapter a study was planned for the purposes set out in Chapter 1. These were:

1. To determine the relationships between the ability of college readers to select an appropriate information processing strategy for a specific task and their comprehension of written materials;
2. To investigate the possible existence of units of written language processing employed by college readers;
3. To compare the comprehension performance, on reading materials displayed by various formats, of college readers classified according to performance on a task calling for simultaneous synthesis.

Research Questions

Again, as explained in Chapter 1, the present study

was designed to provide empirical information relative to five general questions, viz.:

1. Is the ability to select an appropriate information processing strategy for the completion of a specific verbal task, related to reading performance?
2. Is it possible to identify units used for written language processing by college readers?
3. Does the type of chunk used in a format for presenting reading materials to college readers affect their comprehension of those materials?
4. With college readers, what are the specific comparative effects of presenting written materials by means of formats based on different chunk-types?
5. On reading materials displayed by means of various formats, how do the comprehension scores of "good" and "poor" college readers compare?

In order to evaluate each of these research questions, hypotheses were developed in the manner described below.

Research Question 1

Is the ability to select an appropriate information processing strategy for the completion of a specific verbal task, related to reading performance?

Although Luria associates the impairment or inappropriate use of information processing strategies with specific pathological conditions of the cortex, it is hypothesized that the inappropriate use of a strategy may not require a brain lesion to cause its occurrence. Failure to apply successive or simultaneous synthesis in specific tasks may result from arrested development, inadequate training, or general mental deficiency. The factor analytic study of Das (1972) suggests that one difference between

normal and retarded children is that they use different approaches for the processing of information.

It is suggested that the inability to select an appropriate information processing strategy may provide a parsimonious explanation of the variation in the quality of task performance in average and above average Ss. As has been detailed in an earlier chapter, the clinical work of Luria indicates the dependence of productive and receptive language functions upon both strategies of simultaneous and successive synthesis. It is proposed that the appropriate application of simultaneous and successive synthesis is available for the production and perception of speech in the majority of the adult population. Clearly, it is available in most children, at varying levels of performance, from quite early ages. Doubt is expressed, however, that the same skill is automatically, or necessarily, transferred to the production and perception of written language. It is hypothesized that mature adults who can otherwise demonstrate the ability to select the appropriate strategy, may reveal a failure to generalize this skill to the reading situation. This section of the present study was designed to assess the relationship between the ability of college Ss to employ an appropriate synthesizing strategy in a word-based task and their performance in comprehending written materials.

Hypothesis 1A

The correlation between Level of Comprehension subtest scores and the RR scores of the test of clustering in recall will be positive and significant.

Hypothesis 1B

All Ss who achieve "good" RR scores on the test of clustering in recall will also produce "good" Level of Comprehension subtest converted scores.

Hypothesis 1C

Ss who employ successive synthesis in the test of clustering in recall will be below the sample average in their performance on the Level of Comprehension subtest.

Research Question 2

Is it possible to identify units used for written language processing by college readers?

In Chapter 3 a considerable body of empirical evidence was summarized which attests to the likely existence of basic units of language processing. While it is recognized that the processing of spoken or written language is essentially a private affair which resists direct observation, evidence of Ss' performances on close correlates suggests that such units do exist. As stated elsewhere, this does not preclude a variation in the dimensions of such units from S to S. It is asserted, however, that efficient, adult readers commence the process of sentence reconstitution with similar basic units. Individual differences may stem from the variation in the extent to which reconstitution may be continued before a decision about unity is made and the reconstitution process recommenced. It is further contended that basic units are grammatical in nature in that they possess both syntactic and semantic unity. The lowest major constituent algorithm, described in Chapter 8, produces

such a unit.

Extant research in this area has produced inconclusive findings largely because precise procedures for generating the basic units of language processing have not been provided. The extent to which experimenter intuition has been relied upon has rendered experimental replication a difficult task.

Hypotheses 2

For college readers, written materials will be comprehended at equivalent levels when they are displayed by:

- 2A. the FP and TW formats;¹
- 2B. the FP and LMC formats;
- 2C. the FP and BL formats.

Research Question 3

Does the type of chunk used in a format for presenting reading materials to college students affect their comprehension of those materials?

The research reported in Chapter 4 does not provide a clear indication of the impact, on the comprehension of readers, of the display of reading materials by means of various types of word groups. The purpose of this section was to evaluate the impact of precisely defined formats on the attempts of college readers to identify the meaning of written language.

The hypotheses that were based on Research Question 3 are considered to provide tests of the validity of the

¹See Chapter 1 for definitions of formats.

claim of grammatical motivation for each of the levels of simultaneous synthesis that have been postulated for receptive, written language processing.

Hypothesis 3

Reading materials will be comprehended at equivalent levels when they are presented by:

- 3A. formats comprised of long chunks and the FP format;
- 3B. formats comprised of short chunks and the FP format;
- 3C. formats comprised of bizarre chunks and the FP format;
- 3D. formats comprised of grammar-based chunks and the FP format;
- 3E. formats comprised of long chunks and formats comprised of short chunks;
- 3F. formats comprised of grammar-based chunks and formats comprised of bizarre chunks.

Research Question 4.

With college readers, what are the specific comparative effects of presenting written materials by means of formats based on different chunk types?

The research question addressed in this section of the study is designed to extend the scope of Cromer's (1970) investigation. On the evidence of Cattell (1885) and Erdmann and Dodge (1898), that a mature reader can identify two unconnected words from a single tachistoscopic exposure, it was assumed that even "poor" college readers probably attend to two words at a time. A two-word chunk was, therefore, used as the basis of the format which it was proposed would discourage meaning-getting language processing. The

degree to which grammatical processing would be disrupted by longer bizarre chunks was investigated by using the BL format described in Chapter 6. Cromer's description of the "meaningful, linguistic structures" he employed in his study leaves some doubt as to the precise nature of the units employed. Two grammatical algorithms were, therefore, formulated which would generate small and large grammatical chunks respectively and which could be applied to any passage of connected, written discourse.

Using the four formats referred to above and a "normal" presentation, it was possible to assess the impact of five different formats on "good" and "poor" college readers.

Hypotheses 4

Reading materials will be comprehended at equivalent levels when they are presented by:

- 4A. the TW and LMC formats;
- 4B. the TW and HMC formats;
- 4C. the TW and BL formats;
- 4D. the LMC and HMC formats;
- 4E. the LMC and BL formats;
- 4F. the HMC and BL formats.

Research Question 5

On reading materials displayed by means of various formats, how do the comprehension scores of "good" and "poor" college readers compare?

Again, this section of the present study was planned to extend the work of Cromer. A significantly larger sample

was employed and "good" readers were matched with "poor" readers on the Vocabulary subtest scores from the standardized reading test and the RR scores achieved on the test of clustering in recall. The aim in making use of the RR scores was to permit the drawing of conclusions about the importance, in the comprehension of written materials, of the information processing strategy of simultaneous synthesis.

Four different matchings were used:

1. "Good" readers were matched with "poor" readers having equal scores (within 4 points for each individual matching) on Vocabulary and RR scores. These groups were designated as "First Large Good group" and the "First Large Difference group," respectively. The term "difference" was employed to maintain consistency with the nomenclature of the Cromer study. This "difference" group had adequate vocabulary and language skills but still experienced difficulty in comprehending written materials. Plainly they were doing something "different" in their attempts to process written materials.
2. "Good" readers were matched with "poor" readers having equal scores on Vocabulary but RR scores between 20 and 30 percentage points lower than the "good" readers. These groups were designated as the "Second Large Good group" and the "Second Large Difference group," respectively.
3. "Good" readers were matched with "poor" readers who had equal Vocabulary subtest scores but who registered RSR scores higher than or equal to their RR scores. That is, apparently, these "poor" readers had attempted to employ the information processing strategy of successive synthesis, rather than that of simultaneous synthesis, to complete the test of clustering in recall. These groups were designated the "First Small Good group" and the "RSR group."
4. "Good" readers were matched with "poor" readers who had lower Vocabulary subtest scores and very low RR scores not compensated for by a high RSR score. These groups were called the "Second Small

Good group" and the "Deficit group." The term "deficit" was employed because it was considered that these Ss read poorly owing to a deficiency in vocabulary skills.

Hypotheses 5

"Good" and "poor" college readers will comprehend reading materials at equivalent levels when they are displayed by:

- 5A. the FP format;
- 5B. the TW format;
- 5C. the LMC format;
- 5D. the HMC format;
- 5E. the BL format.

CHAPTER 6

THE EXPERIMENTAL DESIGN

Introduction

This chapter describes the design of the study. It includes a description of the target population and the sample, and a brief account of the test instruments administered. A more thorough analysis of the construction of the experimental testing instruments is provided in Chapter 8. The procedure followed for the collection of the data for the main study is outlined and the statistical treatment of the data is also set out.

The Design of the Study

The broad aim of this study was to demonstrate that success in reading, for college level students, is not solely a function of knowledge of vocabulary. Specifically, this study was an attempt to demonstrate that, for college readers, the use of an appropriate information processing strategy is of vital importance if meaning is to be associated with written language. In addition, the influence of quality of performance in this appropriate processing strategy, on reading level, was investigated.

The design used to evaluate these postulates was a five level Greco-Latin Square with repeated measures on one factor (Winer, 1971). The four factors making up the four dimensions of the design were: five groups of Ss on whom the

repeated measures were obtained; five different texts or passages of connected, written discourse, five different test types; and, five different presentation types or formats. This design was employed because of the economical use of Ss and time which it permitted. Notwithstanding the use of four factors in the design, one factor only, that of formats, was investigated in the analysis of data.

Five passages and five groups were used as factors so that a fully balanced design could be created. The five different test procedures were employed for the same reason and for the additional reason that the variation in test-type made it possible to generalize the impact of format manipulation over a range of test situations. The Greco-Latin Square design was not employed in order that the "main effects" of groups, passages, and tests could be evaluated. For this reason the findings which are presented in Chapter 11 do not include the detailed discussion of these factors.

The design is shown in Figure 6.1 Figure 6.2 shows the unique combination of group, passage, format, and test which occurred in each of the 25 cells of the design. Since the factor of interest in the study was format, Figure 6.3 has been constructed to show the different ways in which each format was combined with the five levels of the other three factors.

In addition to the data that were secured by the administration of the five experimental tests, the vocabulary level and comprehension performances of each S were obtained

with the use of a standardized reading test. For each S, a measure of his use of clustering in the recall of randomly arranged associates was obtained by the administration of a technique similar to that outlined by Bousfield (1953).

Sample

The target population in this study was intended to be the 3972 students registered in the undergraduate Bachelor of Education program at the University of Alberta in September of 1971. The fact that the data from the experimental tests were collected by means of the IBM 1500 Instructional System meant, however, that these tests could

	I	II	III	IV	V
1	A α	B λ	C θ	D β	E δ
2	B β	C δ	D α	E λ	A θ
3	C λ	D θ	E β	A δ	B α
4	D δ	E α	A λ	B α	C β
5	E θ	A β	B δ	C θ	D λ

Fig. 6.1 -- The standard form of the Greco-Latin Square which was the basis of the experimental design in this study. Arabic Numerals represent the different passages. Roman Numerals represent the five experimental groups. Upper case Latin letters designate the experimental formats. Lower case Greek letters stand for the experimental tests.

	Group I	Group II	Group III	Group IV	Group V
Passage 1	Normal Cloze	TW FDPP	LMC LAPP	HMC FDP	BL LAP
Passage 2	TW FDP	LMC LAP	HMC Cloze	BL FDPP	Normal LAPP
Passage 3	LMC FDPP	HMC LAPP	BL FDP	Normal LAP	TW Cloze
Passage 4	HMC LAP	BL Cloze	Normal FDPP	TW LAPP	LMC FDP
Passage 5	BL LAPP	Normal FDP	TW LAP	LMC Cloze	HMC FDPP

Fig. 6.2 -- The twenty-five unique combinations of GROUP, PASSAGE, FORMAT, and TEST created by the use of the form of the Greco-Latin Square diagrammed in Figure 6.1.

Combinations of Groups, Passages, and Tests									
Format	Combination 1	Combination 2	Combination 3	Combination 4	Combination 5				
	GroupPassageTest	GroupPassageTest	GroupPassageTest	GroupPassageTest	GroupPassageTest				
FP Format	1 Cloze	5 FDP	4 FDPP	1V LAP	V 2 LAPP				
TW Format	1 FDP	1 FDPP	5 LAP	1V LAP	V 3 Cloze				
LMC Format	1 FDPP	2 LAP	1 LAPP	1V Cloze	V 4 TW				
HMC Format	1 LAP	3 LAPP	2 Cloze	1V FDP	V 5 FDPP				
BL Format	1 LAPP	4 Cloze	3 FDP	1V FDPP	V 1 LAP				

Fig. 6.3 -- The five combinations of Groups, Passages, and Tests associated with each of the five formats.

not be administered during scheduled class times as had originally been intended. Under these circumstances, it was necessary to abandon the aim of randomly drawing individuals or classes from this entire population. Instead volunteers were asked to indicate their willingness to participate in the project. They were given an opportunity to volunteer during the normal University of Alberta Registration Week conducted in September, 1971. A total of 631 students, registered with the Department of Elementary Education, volunteered to become Ss in the study.

The Target Population

This reduced the apparent population to 631 student volunteers who were prepared to take part in an experimental project designed to investigate selected aspects of college level reading. It was thought that these students represented all levels of the Bachelor of Education program from freshmen through seniors. As explained in the section devoted to the experimental sample, the target population was ultimately reduced to 609 Ss registered in the Department of Elementary Education.

The Experimental Sample

All 631 Ss completed the "pencil and paper" section of the testing program. This aspect of data collection consisted of the Level of Comprehension and Vocabulary subtests of the Cooperative English Test of Reading Comprehension

(Educational Testing Service, 1960) and a modified version of the Bousfield test of clustering in recall.¹ Following the administration of the pencil and paper tests, 15 Ss whose first language was not English, were withdrawn from the group. At this point, it was also discovered that three graduate students and four students from other faculties, had crept into the experiment. These Ss were deleted from the target population.

The response protocols of the remaining 609 Ss were examined. From this examination it was discovered that 29 Ss had apparently attempted to recall words in the adapted Bousfield test in the precise order of their administration. This seemed to indicate the use, by these Ss, of the information processing strategy of successive synthesis as opposed to the more appropriate strategy of simultaneous synthesis. Twenty-five of these Ss were randomly selected for inclusion in the sample.

Of the remaining 580 Ss, 51 were found to have recorded Vocabulary and Level of Comprehension subtest scores, and RR clustering in recall scores that were substantially below the scores of the other subjects in the group. Twenty-five of these "deficit" Ss were randomly selected from the group of 51. Of the Ss left, 325 were randomly selected to make the experimental sample up to an N of 375.

¹See: Chapter 8.

The Experimental Groups

These 375 Ss consisted of 324 female students and 51 males. Because of the heavy demand for computer time from a variety of other sources, it was not possible to schedule the computer-based tests in any consistent way. In order to avoid the disruption of the individual schedules of students, 325 of the Ss were haphazardly (as opposed to randomly) assigned to 25 groups which were scheduled for computer times convenient to the Ss. The 25 Ss who used serial recall for the test of clustering in recall were each permitted to join one of these 25 groups. The same procedure was followed with the Ss who had secured the low VOC, LC, and RR scores. This procedure produced groups with an "n" of 15. During the computer-based collection of data, experimental mortality was quite high. Seven Ss, of the 15 scheduled in one group, failed to attend. The full number of 15 Ss was secured on two only of the 25 testing occasions. The "drop-out" rate, however, was generally either one or two Ss per group session. Because of the rather extensive "make-up" testing program that would have been necessary to build all 25 groups up to the originally planned 15, it was decided to use a cell size of 13 Ss. The special precautions taken to ensure the attendance of the Ss who had used serial recall for the test of clustering in recall or had achieved the low VOC, LC, and RR scores, resulted in none of these Ss dropping out. Five groups required special sessions in order to achieve the "n" of 13. The Ss for

these sessions were randomly drawn from the original sample of those who had completed the pencil and paper tests but who had not been selected to participate in the computerized tests and/or had not used serial recall for the test of clustering in recall or achieved low overall scores. These were assigned haphazardly to the groups which were short of the proposed cell number of 13 Ss. Where 14 or 15 Ss had attended and taken part in the computer-based tests, the extras, above the required number of 13, were randomly withdrawn from each group. In carrying out this cell number adjustment, the "serial recall" Ss and the "low LC score" Ss were set aside to prevent them being withdrawn from the sample.

The final experimental sample, then, consisted of 325 Ss who had been haphazardly assigned to one of 25 groups with each group representing a separate testing session. These 25 groups were then randomly assigned to each of five groups. In this way, five large groups, each comprised of 65 Ss and five subgroups, each made up of 13 Ss, were created. With repeated measures being taken on the individual Ss in each group, these groups and subgroups were ultimately used to build the cells of the 5 x 5 Greco-Latin Square. The severe limitations which these methods of sample selection placed on the generalizability of the conclusions, have previously been discussed under the heading "Limitations of the Study."¹

¹See: Chapter 1.

The matching procedure that was used for the comparison of subgroups required for the evaluation of some of the research hypothesis was outlined in Chapter 1 in the section dealing with definitions. These data are summarized in Figure 6.4 below.

Good Group n = 150			Poor Group n = 150	
		Sample Total = 325*		
Good Subgroups	n	How Matched	Poor Subgroups	n
First Large Good Group (FLG)	50	Equal VOC and RRscores	First Large Difference Group (FLD)	50
Second Large Good Group (SLG)	50	Equal VOC but lower RR scores	Second Large Difference Group (SLD)	50
First Small Good Group (FSG)	25	Equal VOC but use of inappropriate recall strategy by "poor" subgroup.	Serial Recall Group (RSR)	25
Second Small Good Group (SSG)	25	No matching scores	Deficit Group (Deficit)	25
Total	150		Total	150

* Twenty-five Ss did not fit clearly into the classifications delineated above. They were omitted, therefore, from this section of the analysis.

Fig. 6.4 -- A summary of the matching of Ss that was effected to permit the evaluation of some of the research hypotheses.

Characteristics of experimental groups

The sampling procedures outlined above produced a sample which included very few male Ss. It was not possible, therefore, to evaluate the importance of sex differences in the results.

Because of these unscientific methods of sampling, it was decided to compare the five groups for similarity on several important characteristics. Using the level of comprehension scores obtained with the standardized reading test, the hypothesis of similar means was checked using a one-way analysis of variance. On this variable, the analysis indicated that there was no significant difference between any of the groups ($F = 0.44$, $df = 4/320$, n.s.). Again, no significant difference between the groups was found on the variable of vocabulary ($F = 1.48$, $df = 4/320$, n.s.). On the basis of this evidence, it was assumed that these groups were substantially similar in their reading ability. The hypothesis of similarity of means, therefore, was considered to be upheld.

In this study, two of the scores obtained on the Bousfield test of clustering in recall were used as classification variables. These were the Ratio of Repetition score (RR), and the Ratio of Serial Repetition (RSR). These terms are discussed in greater detail below. Because of the importance of these scores to the study, it was decided to check the similarity of the groups on each of these variables too. The outcome of these analyses also indicated that the

five groups were not significantly different on these two variables (RR: $F = 0.11$, $df = 4/320$, n.s.; RSR: $F = 0.00$, $df = 4/320$, n.s.). Thus, the hypothesis of similarity of means was upheld.

Instruments Used in the Collection of Data

This section provides an overview of instruments that were employed in this study for the collection and generation of data. The construction of the instruments created specifically for this study is described in Chapter 8.

The Experimental Passages

From an original population of 30 prose passages, each of approximately 200 words in length, five were selected to comprise the experimental passages or texts. In making the selection, an attempt was made to obtain texts that showed some variation in subject matter and level of difficulty, but, which, at the same time, were complete episodes, descriptions, or pieces of exposition. The criteria for selection were based on the findings of the pilot study. These findings are reported more fully in Chapter 7. They clearly indicated that difficult passages dealing with topics drawn from astronomy, genetics, psychology, religion, and biochemistry were too specialized to suit the purposes of this study. The Ss who took part in the pilot study registered a strong aversion to all passages of this type. In addition, the pilot study indicated that semi-technical

subjects such as these, placed readers with a specialized knowledge in a much stronger position than readers who did not possess such knowledge. The subjective reactions of the pilot study Ss suggested that the passages should cover a variety of non-technical topics and should make use of different styles of writing. These Ss also felt that some variation in readability levels would be preferable to the consistently difficult passages used in the pilot study. The balanced nature of the research design employed meant that it was feasible to implement the required changes that stemmed from the pilot study.

The five texts selected were adapted from the following selections: (a) "Atomic Energy in War and Peace," by Hawley and Leifson (1952); (b) "Seeing Life," by Arnold Bennett (1965); (c) "Wallace," by Rovere (1965); (d) "What Dare I Think," by Julian Huxley (1952); and, (e) "What is Genius?" by Spender (1952). Because of the adaptation that was effected on selections it was considered desirable to provide amended titles for all but one of the passages. "Atomic Energy in War and Peace," was retitled: "The Atomic Bomb." "Seeing Life," was given the title: "Death of a Dog." "Wallace," became "My Relations with Teachers." "Upsetting the Balance of Nature," was considered to be a more appropriate title for the selection adapted from "What Dare I Think?" The title of the selection: "What is Genius?" was thought to be sufficiently representative of the text it named so it was left unchanged.

The characteristics of the passages are set out in Table 6.1. This table indicates that, in general, the attempt to secure variation in the level of passage difficulty, was successful. At the same time, each passage was sufficiently difficult to make the discrimination of "good" from "poor" readers possible. The Dale-Chall readability index produced a range that extended from grade nine through college level. The range on the Fog readability index was from grade 8.5 through college level, though this formula did not distinguish between the passages as well as either of the other two. The Fry readability index range was from grade six through college level.

Table 6.1 also shows the way in which readability indexes, in general are sensitive to sentence length. The passage with the fewest sentences was rated by all three readability formulas to be the most difficult of the five passages. The passage with the most sentences, i.e., the passage with the shortest sentences, was rated as the easiest. The degree to which these measures of readability reflect the difficulty of the passages, as experienced by the Ss in the study, is discussed in Chapter 11.

No claim is made that these five passages are representative of a larger corpus of passages. That is, for the purposes of the statistical model that was used to analyze the data collected with these passages and the tests associated with them, the passages were considered to be a "fixed factor."

TABLE 6.1 -- Details of experimental passages

Title of Each Passage	No. of Words in Each Passage	No. of Sentences in Each Passage	Readability Indexes	
			Dale-Chall	Fog
The Atomic Bomb	201	6	*College	College
Death of a Dog	191	9	Grades 9 - 10	College Grade 9
My Relations With Teachers	198	14	Grades 9 - 10	Gde. 8.5 Grade 6
Upsetting the Balance of Nature	189	9	Grades 11 - 12	College Grade 12
What is Genius?	203	8	Grades 11 - 12	College

*College = Grade 13 and higher.

The Experimental Tests

Using the experimental passages, reading comprehension was assessed in three basic ways. The first test type was created by the application of the cloze procedure (Taylor, 1956; Jenkinson, 1957; Rankin, 1959; MacGinitie, 1961; Ruddell, 1963; Bormuth, 1963, 1966, 1967, 1969). The cloze procedure is discussed in more detail in Chapter 8. Each passage was prepared in five forms using the cloze procedure. This was done to ensure that over all the forms, every word of each passage was ultimately deleted. In this way, it was possible to avoid the production of a biased test such as could have resulted from the use of one form only. Each of the five subgroups ($n = 13$), in each group of 65, was randomly assigned to one form of the cloze test on one of the passages only.

The second test type was constructed according to "facet design" as proposed by Guttman and Schlesinger (1967) and Schlesinger and Weiser (1970). This method of test construction is explained in Chapter 8. The facet design test was used in two different ways in this study. In the first instance it was used as a post-test, while in the second, it was used as a pre-test and a post-test.

The third test type was constructed on the basis of linguistic algorithms as outlined by Bormuth (1968, 1970). That is, a set of explicit rules (of the linguistic type) were used for deriving various types of questions. Again, the manner in which these algorithms were applied to the

construction of the reading comprehension test items is fully explained in Chapter 8. As with the facet design test, the linguistic algorithm test was used for both pre-testing and post-testing.

Thus, five distinct testing situations were possible: (a) using tests constructed according to the cloze procedure; (b) using tests constructed on the basis of facet design as post-tests; (c) using tests constructed on the basis of facet design as both pre-tests and post-tests; (d) using tests constructed in accordance with linguistic algorithms as post-tests; (e) using tests constructed in accordance with linguistic algorithms as both pre-tests and post-tests.

The Experimental Formats

In this study, the passages were presented to the experimental Ss in five different ways or formats. These were: (a) a normal format (or FP-full presentation), i.e., the form in which printed text materials are usually encountered in a book, newspaper, or magazine. (b) A two-word format (or TW) in which a passage was presented to the S in segments or chunks comprised of two words. (c) A short meaningful format (LMC) in which a passage was presented to the S in chunks each consisting of one Lower Major Constituent. This term was defined in Chapter 1. The subdivision of a text into LMCs is explained more fully in Chapter 8. (d) A long meaningful format (HMC) in which a passage was presented to the S in chunks each consisting of one Higher

Major Constituent. This term, which was defined earlier, is also treated more fully in Chapter 8. (e) A long non-meaningful format (BL-bizarre long) in which a passage was presented to the S in chunks of exactly the same length as the HMCs for that particular passage. These were constructed according to the procedure described by Anglin and Miller (1968).

The Greco-Latin Square design used in this study required that each of the five passages had to be prepared in each of the five formats discussed above. It also meant that the five different test procedures had to be applied to each passage.

The Standardized Reading Test

In order to classify the Ss according to their levels of performance on vocabulary and reading comprehension, a standardized reading test was administered to the 631 Ss from whom the final sample was selected. The test was, Reading Comprehension Cooperative English Tests (1960 Revision), Form 1A (Educational Testing Service, 1960). This form of the test is considered to be appropriate for use with college freshmen and sophomores. As has been previously explained, the sample used in this study consisted of third and fourth year Faculty of Education students as well as freshmen and sophomores. As would have been expected, however, the majority of Ss were enrolled in either the first or second year of their degree programs. About

twenty per cent of the Ss in the final experimental sample were students for whom the test was not specifically designed, i.e., they were third and fourth year students.

The test consists of two parts. These are vocabulary and comprehension. The first requires 15 minutes to complete and the second, 25 minutes. The test produces three scores: vocabulary, level of comprehension, speed of comprehension, and a total reading score, which is really not an additional score in that it is simply the mean of the other three scores.

The vocabulary section of the test consists of 60 items. Each item has one word which has to be matched with the one word or phrase, from a set of four, which the S feels is synonymous with the word. The words are graded in difficulty from easy to hard. The time allowance for this sub-test proved to be appreciably more than was required for the completion of the 60 items.

Although the comprehension sub-test also makes use of 60 test items, it provides two sets of information: level of comprehension, and, speed of comprehension. The level of comprehension is computed from the first 30 items only. Speed of comprehension is assessed on all 60 items of the sub-test. This feature of the test has resulted in the first 30 items, and the paragraphs upon which they are based, becoming progressively more difficult up to the thirtieth item. There is a noticeable drop in difficulty, however, from item 31 through item 60. Because of this relationship in the

test between level of comprehension and rate of comprehension, the reader who experiences difficulty with the first 30 items but does not work at them more slowly as a result, completes many more of the second 30 of the total 60 items in the sub-test. The rate of comprehension score is, therefore, probably a poor and unreliable assessment of this aspect of reading as evaluated by this test.

The reliability coefficients were obtained on the basis of test-retest. No reliability coefficients, however, are reported for college students. The values reported for Form 1C, for example, are based on the performance of twelfth graders. These figures are: vocabulary, .88; level of comprehension, .77; speed of comprehension, .83; and total reading, .92. The inability of the test to discriminate adequately between rate of comprehension and level of comprehension is evident from these ratings. It could be stated that apart from unreliability of measurement, these two variables are perfectly correlated.

In view of the criticisms that can be levelled at the rate of comprehension score, and the fact that this measure is a significant part of the total reading score (33.33%), for the purposes of the present study, it was decided to make use of the vocabulary and level of comprehension scores only.

Test of Clustering in Recall

This test was used for the purpose of measuring and

classifying the strategy used by each S in synthesizing verbal materials. The data obtained from this test made it possible to evaluate the simultaneous synthesizing ability of each S and to detect whether a S preferred to apply another information strategy in a cognitive task biased towards the use of simultaneous synthesis.

The test was adapted from that employed by Bousfield (1953) in his investigation of clustering in the recall of randomly arranged associates. Bousfield defines a cluster as "a sequence of associates having essential relationships between its members (p.253)." The basic assumption in Bousfield's study, and one which is fundamental in the present research undertaking, is that "clustering is a consequence of organization in thinking and recall ... (it) ... provides additional information on the nature of organization as it operates in the higher mental processes (Bousfield, 1953, p.253)."

The variation of the test used by this experimenter consisted of presenting the Ss with a prepared list of nouns and having them recall as many as possible in a period of ten minutes. The list used was comprised of 60 nouns made up of 15 each from four different categories, viz., animals, names, professions, and vegetables. This was the list used by Bousfield. In order to ensure at least a minimum of control over the associative values of the words, Bousfield used the Lorge-Thorndike list of 30,000 words to match the four categories as closely as possible on the basis of

frequency of occurrence per million of words. These words appear in Table 6.2, p.160. The mean frequencies of occurrence are the same for each category, and the ranges of these frequencies approximately match (Bousfield, 1953).

The words were presented in the random order employed by Bousfield. This was,

muskrat, blacksmith, panther, baker, wildcat, Howard, Jason, printer, chemist, radish, mushroom, Otto, plumber, pumpkin, chipmunk, Amos, Wallace, parsnip, milkman, druggist, leopard, woodchuck, Adam, grocer, Simon, Owen, lettuce, giraffe, turnip, garlic, rhubarb, typist, eggplant, Noah, zebra, donkey, Gerald, dentist, otter, parsley, spinach, Oswald, weasel, broker, waiter, florist, Bernard, dancer, reindeer, Byron, cabbage, melon, badger, mustard, diver, carrot, Sherman, camel, baboon, Moses.

Each word was printed on a 10" x 3" card. The list was displayed to the Ss at the rate of three seconds per word. Consistency of presentation was achieved with the help of a stopwatch and extended practice. Three seconds after the last word had been displayed, Ss were asked to write down as many words as they could recall. They were provided with sheets of paper which required the writing of words in columns. For a period of ten minutes, subjects were requested to draw a horizontal line to mark the expiration of each minute.

Two scores that are obtained from the administration of this test were used in this study. The first was Bousfield's Ratio of Repetition (p.256). This score (RR) is computed from the number of words recalled in clusters and the total number of words recalled. The formula for deriving

this measure is

$$RR = \frac{R}{N-1}$$

where R is the number of words recalled in clusters and N is the total number of words correctly recalled. The R score is derived by adding all of the words correctly recalled from a single category which follow consecutively, subtracting one, and summing all such scores.

The second score, obtained from this test and used in this study, was the Ratio of Serial Repetition (RSR). This score is computed from the number of words recalled in the same serial order in which they were displayed, and the total number of words recalled. The formula used for deriving this measure is

$$RSR = \frac{SR}{N-1}$$

where SR is the number of words recalled in the correct serial order and N is the number of words correctly recalled. The SR score is obtained by adding all of the words correctly recalled in the order in which they were displayed, subtracting one, and summing all these scores. This second score was devised specifically for this study.

Because of the nature of the difference between these two scores, it is important to note the instructions that were given to Ss before the display of words. These were

I will show you a list of words. You are asked to

recall as many of them as you can after I have completed the showing. You are to start writing the words as rapidly as possible when I say, "Go!". Write the words in a column at the left side of the paper that has been given to you. You may write the words in any order you wish. At intervals I will say, "Draw a line." On hearing this signal please draw a short horizontal line under the last word you have written, and then continue with more words. In the event that you have thought of no more words since the last instruction, "Draw a line," you should draw another line just the same. Are there any questions?

TABLE 6.2 -- List of stimulus words. Taken from Bousfield (1953).

Animals		Names		Professions		Vegetables	
Word	Freq.	Word	Freq.	Word	Freq.	Word	Freq.
giraffe	1	Amos	1	milkman	1	eggplant	1
baboon	2	Gerald	1	typist	1	parsnip	1
zebra	3	Byron	3	florist	2	garlic	3
panther	5	Oswald	4	plumber	2	rhubarb	3
wildcat	5	Jason	5	diver	4	radish	4
leopard	6	Otto	5	druggist	4	melon	5
reindeer	6	Noah	6	broker	7	mustard	7
chipmunk	7	Wallace	7	printer	7	spinach	8
muskrat	7	Owen	7	dentist	9	parsley	8
woodchuck	7	Bernard	9	baker	10	carrot	9
otter	8	Adam	10	chemist	10	mushroom	10
weasel	9	Sherman	10	dancer	10	turnip	10
badger	11	Simon	11	grocer	11	lettuce	12
donkey	16	Moses	12	waiter	13	pumpkin	13
camel	18	Howard	19	blacksmith	19	cabbage	16
Mean	7.33		7.33		7.33		7.33
Freq.							

Collection of the Data

The data were collected in two separate parts during the months of September and October, 1971.

The Pencil and Paper Tests

The first part of the data collection consisted of

the data obtained from the standardized reading test and the Bousfield test of clustering in recall. These data were collected over a period of ten days from September 9 through September 18, 1971. Each testing session was about 60 to 65 minutes in duration. The reading test required 45 minutes and the test of clustering in recall needed between 15 and 20 minutes. Ss were tested at times that were convenient to them so that these tests were administered to groups as small as three Ss and as large as 160 Ss.

The Experimental Tests

All the data generated by the experimental tests were collected using the IBM 1500 Instructional System. A description of the system and of the manner in which it was employed in this study is set out in Chapter 9.

The Pilot Study

To assess the feasibility of using the IBM 1500 Instructional System for the collection of the data in this research project, an extensive pilot study was undertaken. Two additional purposes of the pilot study were to assess the basic research design and to evaluate the experimental testing instruments it was proposed to use in the main study. The procedures followed in the pilot study and the changes effected in the study proper because of the findings of the pilot study, are reported in Chapter 7.

Treatment of the Data

As described above, data collection was effected with two different sets of instruments. These instruments have been broadly classified as the "pencil and paper" tests and the "computer-based" tests. The manner of treating the data generated by these two sets of tests is described below.

Assessment of Pencil and Paper Tests

Subjects' responses to the Cooperative English Test of Reading Comprehension were hand scored with the marking key provided by the test publisher. The test of clustering in recall was hand scored according to the instructions set out by Bousfield (1953). In addition to testing for the comparability of the five groups, the data from these two tests were also used for the stratification of the sample to permit the testing of the specific hypotheses set out in Chapter 1.

Assessment of Computer-Based Tests

A specific computer program was written for the analysis of the answers elicited and stored by the IBM 1500 Instructional System. This analysis was carried out on the IBM 360/67 computer of the Computing Services Division of the University of Alberta. The answer analysis necessitated the transfer of the data from the 1500 system to the 360/67 system. To carry out the answer analysis the latter computer was programmed with each of the correct responses to

the multiple-choice test items and the exact words that had been deleted from the passages in the application of the cloze procedure. Ss' responses were then compared by the computer with the correct responses. Percentage correct scores were calculated by the computer for each S on each test and all cloze responses for individual Ss were recorded and "printed out."

All of the cloze responses made by the respondents were then collected and for each closure the acceptable synonyms were listed. The decision regarding the acceptability of these items as synonyms was based only on a consideration of prior context. That is, because all five types of format prevented the viewing of an entire passage at one time, only the portion of a passage which had preceded a specific closure could be considered in assessing the acceptability of the item used to effect that closure. This was done for the additional reason that the IBM 1500 Instructional System prevented the S from "going back" to alter an item completed earlier in the test. Thus, when the presentation of additional increments of a text provided certain evidence that an earlier response was incorrect, the S was unable to return and correct it. The result of this rationale for assessing cloze responses was that many items were found to be acceptable that would not have been acceptable if the S could have referred forward and returned to earlier portions of the test to effect corrections. All cloze test protocols were then reassessed by hand on the

basis of acceptable synonyms. Synonyms were accepted because the aim of this study was to assess the ability of of Ss to identify a feasible meaning for each text. It was felt that the selection of an acceptable synonym was a better indication of this than the selection of the exact word deleted.

Analysis of the Data

An existing one-way analysis of variance program from the library of the Division of Education Research Services, University of Alberta, was employed to assess the similarity of means of the experimental groups on all test scores.

A new computer program was written to carry out the analysis of variance based on the Greco-Latin Square which was used as the experimental design in this project. It was applied to the entire sample of 325 Ss. It was also applied to each of the subgroups which were created on the basis of the classification variables discussed above.

Following each application of the Greco-Latin Square analysis, Scheffe (Winer, 1971) a posteriori multiple comparison tests were carried out. This was done to determine which means were significantly different in the total sample and each subgroup.

In order to compare pairs of means associated with formats and taken from the corresponding cells of pairs of subgroups, tests of simple main effects were used. To

conduct these tests, data from each pair of matched subgroups were organized into a 2 x 5 two-way analysis of variance. Ability groups comprised the two levels of one factor. The different formats were used to create the five levels of the other factor. Repeated measures were obtained on the factor of "ability groups." The procedure adopted in this section of the analysis is described in detail in Chapter 11.

Summary

The target population in this study was 609 undergraduate students registered in the freshman through senior years of the Bachelor of Education in Elementary Education at the University of Alberta. The experimental sample consisted of 275 subjects randomly selected from this population plus 50 selected according to criteria based on performance in the pencil and paper tests.

The dependent variable in the study was reading comprehension. The independent variables of, groups of Ss, presentation formats, prose passages, and test types, each consisted of five levels. These variables were used to set up a Greco-Latin Square experimental design. The experimental data were collected by means of the IBM 1500 Instructional System located in the Faculty of Education at the University of Alberta.

To test the hypotheses generated from the theoretical position adopted in the study, subgroups were also set up.

Subgrouping was done by using as classification variables, the scores from a standardized reading test and a pencil and paper test of clustering in recall. These data were collected at group testing sessions.

Statistical treatment was based on analysis of variance techniques in which tests of main and simple effects were carried out. Where appropriate, Scheffe multiple comparison tests were applied to the data.

CHAPTER 7

THE PILOT STUDY

Introduction

It was considered essential to carry out a thorough pilot study to assess the feasibility of this study. Specifically, the pilot study was used to evaluate the suitability of: the experimental passages, the formats used for the presentation of the passages, the combination of cloze tests with varied formats for presentation of the passages, and, finally, the suitability of the IBM 1500 Instructional System for the generation and collection of data on the experimental tests. The major questions concerning the use of the IBM 1500 Instructional System were:

- (a) Would reading from the television-like screen of the CRT unit distort a reader's normal reading strategy to the extent that meaningful conclusions could not be drawn from the data so generated?
- (b) Would the response time of the IBM 1500 Instructional System be rapid enough to permit college readers to read at a speed which they would find comfortable and which, at the same time, would permit them to achieve an optimal level of comprehension?
- (c) Would the IBM 1500 Instructional System permit the presentation of reading tests compiled according to the cloze procedure?
- (d) Could a feasible method be devised for the collection of

cloze test responses if the IBM 1500 Instructional System were used for the administration of that test?

To assess the feasibility of the proposed study it was considered desirable to set up an exploratory postulate and to conduct tests of the hypotheses generated from it.

Experimental Materials Used in the Pilot Study

This section deals with the passages, the presentation formats, and the tests that were employed in the pilot study.

The Passages

Five passages, each comprised of approximately 200 words, were selected from two college reading texts (Anderson, 1963, 1965). The first passage was adapted from "General Genetics," by Srb and Owen (1952). It dealt with the scope of genetics. Passage two was based on "Thoughts on Composing," by Simpson (1959). Like the first passage, this one was a difficult selection. It outlined a specific philosophy of musical composition and therefore, made extensive use of abstract concepts. The third passage, which dealt with the psychology of recreation, was originally a portion of "Can Science Save Us?" by Lundberg (1947). This passage also addressed a number of questions basic to an examination of religion. The selection employed many difficult concepts and was expressed in quite complex sentences. Passage four also had its basis in a philosophical treatise. It was drawn from "Riches of the Mind," by Ikin

(1960). Again, the style of writing employed in this passage made use of very complex sentences. Abstract concepts were frequently used and one proper noun was included in the text. The final passage, while essentially concerned with the psychology of curiosity drew very heavily on concepts from astronomy, biochemistry, and philosophy. This passage was adopted from "Astronomy for Everybody," by Abell (1958).

Passages of a relatively even level of readability were sought because it was not feasible to make use of a fully balanced design at this very exploratory stage of the study. Ss' reading scores were pooled on the basis of format. This was done because, of the 15 Ss who took part in the pilot study, groups of 3 Ss only, could read the same combination of a specific passage with a particular format. It is important to note, then, that using the Dale-Chall (1948) readability formula, readability indices for all passages were found to be equivalent to a college level of difficulty. Without this consistency in readability it would not have been advisable to have drawn definitive conclusions about the impact of each format upon the readers' attempts to comprehend the written materials so presented.

Despite the desirable consistency that was achieved in the readability levels of the five passages, the Ss who took part in the pilot study reacted very negatively to the subject matter that was treated in each selection. All Ss complained of the fact that none of the passages had anything interesting to say. Most Ss also objected to the tone

that was used in the passages. Strong recommendations were made to secure more acceptable passages for the study proper. It was suggested that a variety of topics should be treated with some variation in style of writing and level of difficulty. The results of the pilot study also emphasized that passages which included proper nouns were not suitable for the application of the cloze procedure. The suggestions arising from the pilot study were acted upon. The passages employed in the pilot study were discarded and 30 additional selections were made. A final set of five was chosen for use in the main study.

The Formats

Each of the pilot study passages was prepared in five presentation formats.

The single line format -- (SL)

This format was created by using the width of the CRT screen--38 characters including punctuation and spaces between words--as the controlling factor in the creation of each chunk. That is, each chunk in the SL format was as near to the exact length of a line on the CRT screen as the individual words in any line would permit. Each chunk created in this way was displayed on the same portion of the screen.

The two word format -- (TW)

To create this format, each passage was broken into

chunks comprised of two words. These were displayed one chunk at a time on the same part of the CRT screen.

The syntactic format -- (SYN)

This was a format comprised of relatively short grammatical chunks. No formal algorithm was devised to generate them. In general, the chunking criteria listed by Carver (1970) were employed. Since these criteria are quite non-specific it was found that many chunks were created on a purely intuitive basis. For each passage, the chunks that were produced in this way were displayed on the same portion of the CRT screen.

The eight word format -- (BL)

The two word format discussed above was included to assess the reactions of Ss to a format comprised of short, bizarre chunks. The eight word format was used to permit the evaluation of Ss' reactions to a format made up of long, bizarre chunks. The chunks comprising the BL format were all displayed on the same portion of the CRT screen.

The semantic format -- (SEM)

This format was created solely on intuitive grounds. It consisted of chunks which seemed to represent a complete idea. The chunks so produced were marked by considerable variation in length, e.g., less than one line and up to five lines. In creating this format an attempt was made to discover the simple sentences that had been used to construct each compound or complex sentence.

Although the chunking procedures described above served to generate the rather gross data that were required in the pilot study it was clear from the experience gained in chunking the various texts for the pilot study that a more controlled method of chunking would have to be devised. Following the completion of the pilot study, it was realized that, apart from the novel theoretical underpinning that had been provided for this study, little was likely to be added to the extant research literature by a chunking research project that employed such arbitrary methods of chunk-generation. As a result of this realization and of discussions with Dr. G.D. Prideaux of the Department of Linguistics at the University of Alberta, two linguistic algorithms were devised for the creation of grammatical chunks of two different sizes. Two mechanical methods of generating chunks were retained although only one, the two word chunk, was employed exactly as it had been used in the pilot study. The chunk that was created by the constraint of line length was discarded in favor of a format which made use of a normal presentation. The production of all formats is fully discussed in Chapter 8.

A number of Ss who participated in the pilot study found the display of each chunk on the same part of the screen to be a distracting factor. To avoid this, the computer was programmed to have each chunk appear where it would have appeared if the full text had been displayed.

The Tests

In the pilot study, only one type of test was used. The cloze procedure was applied to the passages to produce five different forms of the test based on each passage. This approach resulted in every word of each passage being deleted and thus precluded the possibility of a biased test being constructed. Because the pilot study sample consisted of only 15 Ss, it was not possible to make use of all these forms. The sample was divided into five groups of three Ss each. Three forms of each set of five forms of the cloze test were randomly selected and randomly allotted to the three Ss in each group.

Procedure Followed for the Pilot Study

The Coursewriter II Language was used to program the IBM 1500 Instructional System with the three cloze test forms of each of the five passages selected for the pilot study. The program was designed to permit each Ss to obtain the rate of chunk display he desired by operating the space-bar on the typewriter keyword at the instructional terminal where he was located. Ss' selections for the clozures, required after every four words, were written on prepared, numbered, response sheets. The pilot study testing session occupied approximately 55 minutes.

The Pilot Study Sample

The sample of Ss for the pilot study included

faculty members and graduate students from the Departments of Linguistics, Educational Psychology, and Elementary Education at the University of Alberta. It can be assumed that each participant in the pilot study was a superior reader and that the sample was, therefore, an extremely biased one.

Exploratory Postulate and
Hypotheses Investigated in the Pilot Study

The chief purpose of the pilot study was to obtain an indication of the feasibility of the main study that had been proposed. That is, apart from providing information about the suitability of prose passages, presentation formats, variations of the cloze test, and the usefulness of the IBM 1500 Instructional System for the display of texts and tests, the reason for conducting the pilot study was to obtain preliminary data about the research proposal. This was considered desirable to ensure that viable research questions were posed, and that researchable hypotheses were generated from them that could be tested by a carefully planned research design.

Exploratory Postulate

The theoretical position outlined in Chapter 5 proposed that mature readers make use of two fundamental information processing strategies when they attempt to identify the meaning of continuous written discourse. These strategies are the simultaneous and successive syntheses

described by Luria (1966a, 1966b). The aim of the main study was to explore two levels of simultaneous synthesis. The aim in the pilot study, then, was to assess the feasibility of the study by providing advance, though unrefined, evidence about the role played by these two levels of simultaneous synthesis in the comprehension of written language.

Since the readers in the pilot study sample were all above average readers, the following postulate and hypotheses were considered appropriate for the preliminary examination of the theory and research methodology proposed for the main study.

Exploratory postulate

It is postulated that simultaneous synthesis is employed automatically by the superior reader to identify grammatical entities and the functional relationships that obtain between them within written sentences.

If it is true that high level reading makes use of the information processing strategy of simultaneous synthesis, operating at two levels, and making use of grammatical criteria, it would seem to follow that discretely presented bizarre chunks (non-grammatical and without the unity of meaningfulness) should disrupt the operation of that strategy. Again, if it is true that superior reading makes use of grammatically motivated simultaneous synthesis, discretely presented grammatical-meaningful chunks should optimize the operation of that synthesis. The quality of the functioning of this synthesis should be reflected in the Ss'

comprehension of passages, each presented according to a specific pattern of chunking.

Exploratory hypotheses

With regard to the superior readers who comprised the Ss in the pilot study sample:

1. There will be a significant variation in reading scores across the five formats.
2. The use of the SL format will result in significantly lower reading scores than the use of the SYN or SEM formats.
3. The use of the TW format will result in significantly lower reading scores than the use of the SYN or SEM formats.
4. The use of the BL format will result in significantly lower reading scores than the use of the SYN or SEM formats.
5. The use of the SYN format will result in significantly lower reading scores than the use of the SEM format.
6. The use of the TW format will result in significantly lower reading scores than the use of the SL or BL format.
7. The use of the SL format will result in significantly lower reading scores than the use of the BL format.

Scoring Procedure and Data Analysis for the Pilot Study

The scoring procedures and data analysis, set out below for the pilot study, were employed to make it possible to obtain a gross indication of data trends as economically as possible.

Scoring the Cloze Tests

In scoring the tests produced by the application of

the cloze procedure, only the exact word which had been deleted from the original text was assessed as correct. This approach was adopted in the pilot study although, as explained in Chapter 6, it was considered more appropriate to accept synonyms in the cloze test completed in the main study. The exact deletions only were accepted in order to save time in deciding whether or not format variation had a significant impact on the reading performance of superior readers.

Data Analysis for the Pilot Study

All the hypotheses formulated for the evaluation of the pilot study were tested by one-way analysis of variance and/or Scheffe multiple comparison tests.

The Findings of the Pilot Study

To test the exploratory hypotheses set out above, the scores secured by the 15 Ss who took part in the pilot study, were collected on the basis of like format.

Hypothesis 1

A one-way analysis of variance was conducted on the data to evaluate this hypothesis. The result of the analysis revealed significant variation across the five format types ($F = 10.23$, $df = 4/14$, $p < .001$). These data, therefore, provide support for hypothesis 1.

Hypothesis 2

The comparison of the means associated with the SL and SYN formats showed that the SYN format was read at a significantly superior level ($F = 4.91$, $df = 1/14$, $p < .05$). Likewise, the mean obtained on the SEM format was found to be significantly higher than the mean secured on the SL format ($F = 5.28$, $df = 1/14$, $p < .05$). Hypothesis 2 is thus found to be tenable.

Hypothesis 3

The comparison of the means associated with the TW and SYN formats revealed that the SYN format was understood at a significantly higher level ($F = 9.32$, $df = 1/14$, $p < .01$). Similarly, the SEM mean was found to be significantly better than the TW mean ($F = 9.65$, $df = 1/14$, $p < .01$). On this evidence exploratory hypothesis 3 is supported.

Hypothesis 4

The mean produced in response to the BL format was significantly lower than that produced in response to the SYN format ($F = 4.80$, $df = 1/14$, $p < .05$). The comparison between the BL and SEM means produced a similar result ($F = 5.13$, $df = 1/14$, $p < .05$). Hypothesis 4 is thus found to be tenable.

Hypothesis 5

The comparison of the SYN mean score with the SEM

mean score did not reach significance ($F = 1.21$, $df = 1/14$, n.s.). Hypothesis 5 is found to be untenable on this evidence.

Hypothesis 6

The mean score produced on the basis of the TW format was found to be lower than that associated with the SL format ($F = 4.17$, $df = 1/14$, $p < .1$). Similarly, the TW mean was also found to be lower than the BL mean ($F = 3.12$, $df = 1/14$, $p < .1$). In view of the nature of the pilot study, these findings are both considered to have been associated with acceptable significance levels. Tentative support, at least, is therefore claimed for hypothesis 6.

Hypothesis 7

No significant difference was found between the means which resulted from the display of reading materials using the SL and BL formats ($F = 0.45$, $df = 1/14$, n.s.). Hypothesis 7, is therefore, rejected.

Discussion of the Pilot Study Findings

There is evidence from these findings that the understanding of written discourse is probably optimized for superior readers when the discourse material is presented in the form of so-called "syntactic" or "semantic" chunks. From this evidence it is also probable that short bizarre chunks, as in the TW format, seriously disrupt the attempts

of superior readers to associate a meaning with the sentences of connected written discourse. Although significant differences were found between the impact of both the SL and BL formats and the SYN and SEM formats, it is not possible to state, on the basis of these findings, what the SL and BL formats had done to the normal reading strategies of these Ss. Similarly, although a significant difference was found between the effect of the TW and both the SL and BL formats, it is not possible to state, with certainty, which format most closely approximates the chunking strategy normally used by superior readers.

These findings clearly pointed to the need for the inclusion of a normal format to serve as a "bench-mark" against which to evaluate the impact of other formats. Such a format was included in the main study as a result of this finding.

The lack of a significant difference between the means associated with the SL and BL formats was interpreted as an indication that there was no good reason to include two bizarre long formats. One only was therefore included. In fact this was not the same as either the SL or BL format used in the pilot study. The exact manner of the production of the BL format is set out in Chapter 8.

In contrast with the conclusion regarding the SL and BL formats, the lack of a difference between the means produced with the SYN and SEM formats was interpreted as an indication that these chunks were not being produced in a

way that accurately reflected the two levels of simultaneous synthesis that had been postulated in the theoretical framework outlined in Chapter 5. As stated previously, this finding led to the formulation of separate linguistic algorithms for the production of lower and higher level grammatical chunks.

The gross findings of the pilot study suggested that language synthesis is basic to the reading strategies of superior readers. These findings also provided a tentative indication of the grammatical basis of this synthesis. As a result of these findings, then, it was decided that, provided a number of modifications were made to various aspects of the proposed methods of data collection, the main study was a feasible and worthwhile research undertaking. The modifications referred to are discussed in the remainder of this chapter and in more detail in Chapters 8 and 9.

Additional Pilot Study Findings

This section is chiefly concerned with the suitability of the IBM 1500 Instructional System as the agent of experimental data generation and collection. Although no specific data were collected in the pilot study regarding the recording and storing of cloze test responses, this topic is also examined in this section because the suggestions of the pilot study Ss, with regard to these problems, were solicited.

The IBM Instructional System

The preliminary data which were produced in the pilot study suggested that the exploratory postulate had been soundly formulated. However, the pilot study revealed a number of deficiencies in the functioning of the IBM 1500 Instructional System in this specific application.

Slow and erratic response of computer

The IBM 1500 Instructional System was programmed with the Coursewriter II Language. This language is apparently well suited to "computer assisted instruction applications" in which rapid computer responses are not required and consistent response-time is not an important factor. Very different computer characteristics were required in the study reported here. Since Ss were attempting to read texts that were displayed on the CRT screens one-chunk-at-a-time, it was essential that successive chunks could be made available to them as immediate responses to their individual demands. Equally important was the need for these computer response times to be consistent. It was felt that instantaneous response for the display of some chunks, followed by seemingly endless delays for other chunks, represented an extremely undesirable experimental situation and, therefore, a source of uncontrolled variance in the dependent variable.

During the course of data collection in the pilot study, it was clear that the number and frequency of demands

to display chunks of text drawn from storage disc, so overloaded the Central Processing Unit that extremely slow and erratic responses resulted. Since the display of succeeding chunks was demanded by each S's operation of the typewriter space-bar, the continuous rattling of space-bars throughout the room containing the Instructional Stations or terminals, was ample evidence of the unanswered demands being made upon the Central Processing Unit. The repeated operation of the space-bar was also a clear index of the level of frustration of Ss generated by the failure of the computer to "do their bidding." This high level of frustration probably resulted in the severe disruption of readers' natural reading strategies. An uncontrolled source of variation such as this would have weakened the validity of the main study.

Because of the serious implications of the slow and erratic response times of the computer, the main project was postponed for an indefinite period. In order to research the problem and evaluate possible solutions, a Research Assistant¹ from the Division of Educational Research Services was assigned to the project on a full-time basis. A detailed report of his work can be found in Cowper (1971) where the computer aspect of the work is fully described. The manner in which the response capability of the computer was upgraded for the purposes of the present study is reported in Chapter 9.

¹Mr. Donald Cowper.

As a result of the very extensive work carried out by Cowper, for the main study, the IBM 1500 Instructional System was programmed with the Minnesota Fortran Pack.¹ The use of this programming system solved three major problem areas which became evident during the programming of the computer for the pilot study and during the administration of the pilot study. These were:

- (a) The presentation of chunked texts at a rapid enough rate to satisfy Ss' reading demands.
- (b) The presentation of cloze tests and the recording and storage of the responses of Ss in these tests.
- (c) The presentation of multiple-choice tests and the recording and storage of answers elicited by these tests.

The computer difficulties that were created by these problems and the solutions that were devised and implemented by Cowper are discussed more fully in Chapter 9. It is sufficient to state at this point that very satisfactory solutions to the problems were found. The result was that a near optimum reading/testing situation was created.

Information regarding each S's subjective reaction to the reading/testing situation was obtained by means of a questionnaire which Ss who took part in the main study were asked to complete. The questionnaire was constructed as a direct result of the administration of the pilot study. Several Ss who took part in the pilot study complained about

¹See Chapter 9 and Cowper, 1971.

the level of eye-strain occasioned by reading from a CRT screen for a period of about one hour. Two of the Ss in this group reacted adversely to the unusual reading situation presented by the computer. Such Ss felt that because they did not understand the operation of the computer they could not possibly interact with it as effectively as they could have with more conventional modes of presentation. To gauge the extent to which such difficulties were present in the main study, in spite of the modifications that had been made to the operation of the computer, an extensive questionnaire was included in the study proper for completion by Ss at the time of the administration of the computer-based tests. As well as evaluating the impact upon Ss of reading materials presented by means of the computer, the questionnaires elicited information regarding Ss' reactions to the five testing conditions, the five presentation formats, and the five experimental formats.

The Assessment of Cloze Test Responses

The administration of the pilot study, and the discussion with participating Ss which followed, clearly demonstrated that modifications to the usual way of evaluating cloze test responses would have to be made for the study proper. That the cloze test is "context sensitive" is obvious. The context employed by testees in completing the cloze test consists of "prior" and "subsequent" context. When a passage, requiring closures every four words, is

presented by means of chunks, only prior context is available for consideration in making a specific closure. In addition, although subsequent chunks may provide the certain knowledge that a previous response was incorrect, the facility for "going back" to make corrections, could not be programmed into the system. Under these circumstances, it was clear that synonyms of deleted words would have to be accepted as correct. In addition, any word which made acceptable sense in the light of prior context, would also have to be accepted as correct.

Summary

The pilot study reported in this chapter indicated the need for a number of significant changes in several aspects of the proposed research project.

The prose extracts which had been selected for the study were found to be totally unsuitable. Others were chosen on the basis of the recommendations and results of the Ss who took part in the pilot study.

The methods which had been proposed for the creation of meaningful presentation formats were found to be unsuitable as a result of the pilot study. The controlled production of these formats was made possible by the formulation of two linguistic algorithms. The pilot study also clearly indicated the need for the inclusion of a format which consisted of a "normal" presentation. This format permitted the establishment of a basic level of reading

performance for each S.

The technique for displaying the cloze tests and multiple-choice tests was developed from the pilot study observations as were suitable methods for the collection and storage of the answers to these tests.

The total inadequacy of the Coursewriter II Language employed in conjunction with the "normal" mode of functioning of the IBM 1500 Instructional System was emphasized during the pilot study. As a result of this finding, the main research project was delayed to permit modification to the 1500 system and the implementation of the Minnesota Fortran Pack for handling the display of texts and tests, and the collection and recording of Ss' responses.

The pilot study also provided evidence that cloze test responses would have to be assessed in a special way to alleviate the detrimental impact of chunked presentations on Ss' attempts to effect closures.

The most important finding which stemmed from the pilot study was that the proposed research project was feasible and promised to generate data that should permit the drawing of valid conclusions about the reading act as performed by college students.

CHAPTER 8

THE CONSTRUCTION OF THE EXPERIMENTAL INSTRUMENTS

Introduction

This study was predicated upon the assumption that the comprehension of written language is essentially information processing. In order to draw conclusions regarding the information processing strategies employed by the Ss in the experimental sample, reading materials were presented to them by means of five different formats. The success of the Ss in comprehending written language so presented was evaluated by means of several different testing procedures. This chapter is devoted to a detailed description of the creation of these formats and the construction of the tests employed to gauge their impact on comprehension.

The Formats

As well as a normal format, four other types of format were used to conduct this investigation. In this section each format is described and its method of construction is outlined.

The FP Format

The normal format (or FP--full presentation) describes the form in which printed materials are usually encountered in a book, a newspaper, or a magazine. The use of the CRT (Cathode Ray Tube) screens of the IBM 1500 Instructional

System meant that the length of lines in this format was restricted to 38 characters including spaces between words and all punctuation marks. This number of characters is about equal to the number found in an average newspaper column. Again, because of the restrictions imposed by the CRT screens, only 11 lines of a passage could be displayed at the one time using this format. Thus, the complete display of each passage required two full screens and a portion of the third. The FP format was included with the experimental formats to provide a base level against which to evaluate the impact of the other formats.

The TW Format

The two-word chunk was selected for investigation on the basis of the study conducted by Cattell (1885) and substantiated by Erdmann and Dodge (1898). Both of these studies are reported in Smith and Holmes (1971). The original investigators established that from a single tachistoscopic exposure a mature reader can identify two unconnected words. Since all the Ss in the present study were college level students, the description "mature readers" seems to be appropriate.

The LMC Format

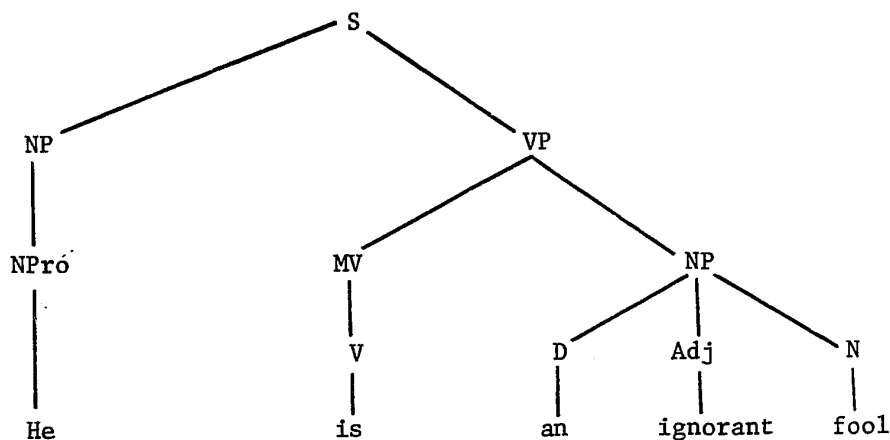
This format was comprised of lowest major constituent chunks which were created with the aid of the algorithm set out below. LMC chunks are word groups made up of words from

the surface sentences of written language. The surface sentences used in this study can be generated from sentences at some deeper level by the grammatical transformations which are listed in Appendix A.

LMCs are created by the application of the following algorithm to the sentences of the prose passages employed in the study:

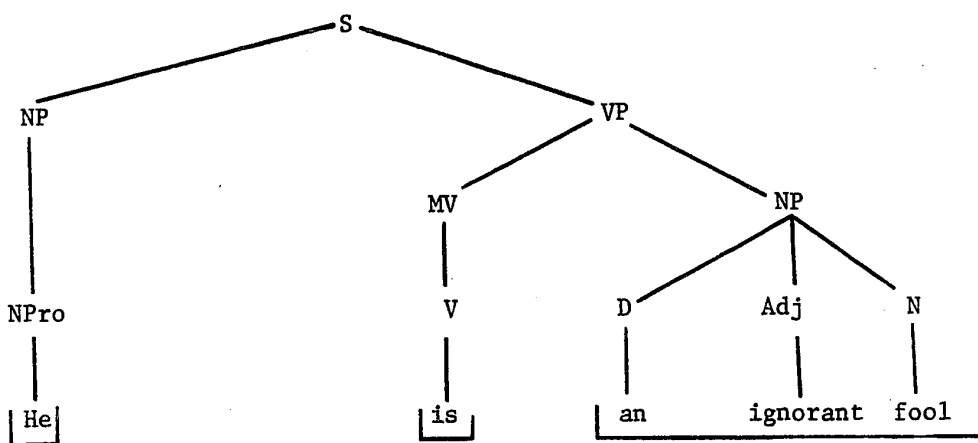
Lowest major constituents may be formed from all nodes in a surface structure tree except lexical nodes. They are found by locating those nodes which are immediately above the lexical nodes and deciding whether or not there are sister nodes to the lexical nodes. If there are no sister nodes to a specific lexical node then the node immediately above the lexical node, i.e., its dominating node is an LMC. If there are sister nodes to a specific lexical node, then the LMC associated with that node is the node which immediately dominates all sisters of the lexical node in question.¹

The surface structure phrase marker for the sentence, "He is an ignorant fool" would be:



¹This algorithm was created in consultation with Dr. G.D. Prideaux of the Department of Linguistics, University of Alberta. It appears in Chapter 1 as the definition of a Lowest Major Constituent.

The algorithm for producing LMCs firstly requires the identification of all those nodes that are immediately above the lexical nodes. In the sentence which has been diagrammed above, these are NPro for the lexical item "he," V for "is," D for "an," Adj for "ignorant," and N for "fool." The next step is to locate the nodes immediately above the lexical nodes. With the lexical node NPro this is NP. NPro has no sister nodes so that the node immediately dominating it, that is, NP, becomes an LMC in this sentence. The lexical node V is immediately dominated by MV. Since V has no sisters, MV becomes an LMC. The lexical nodes, D, Adj, and N are all immediately dominated by the node NP. D, Adj, and N are all sisters immediately dominated by the same node so that the dominating node, NP, becomes an LMC. Once again making use of the phrase marker for this sentence, the LMCs thus created can be identified.



Alternatively, these constituents can be indicated in the following way: / He / is / an ignorant fool./

The HMC Format

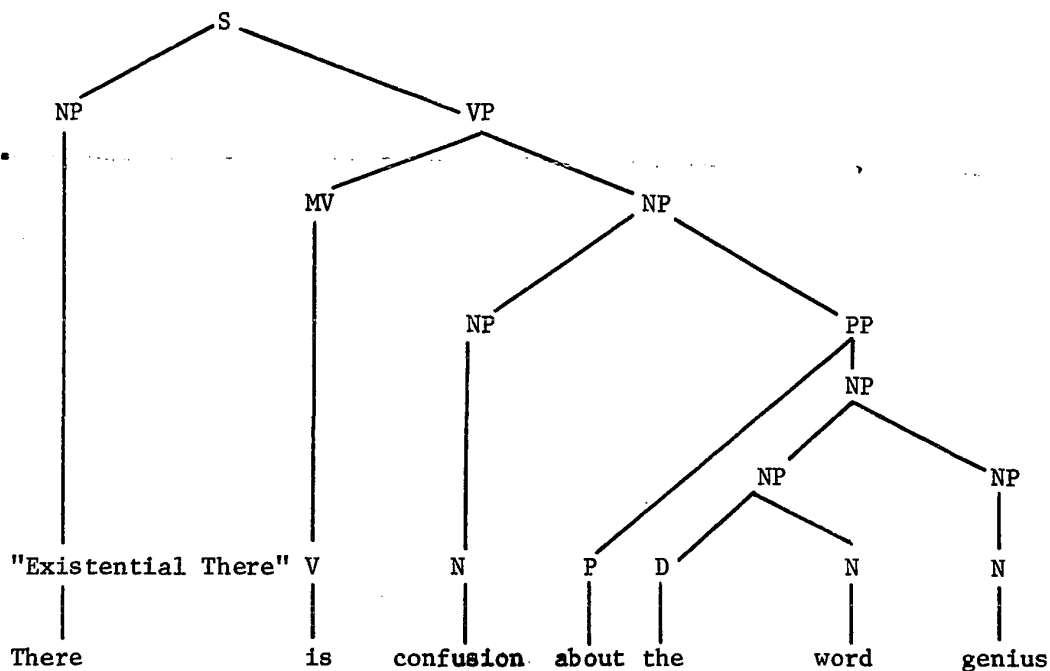
This format was comprised of higher major constituent chunks. These chunks were formed by employing the algorithm which appears below:

Higher major constituents may be formed only after the lowest major constituents for a sentence have been established. They are located by finding those nodes which are immediately above the lowest major constituents and deciding whether or not there are sister nodes to the lowest major constituents. If there are no sister nodes to a specific lowest major constituent then the lowest major constituent becomes a higher major constituent. If there are sister nodes to a specific lowest major constituent then the higher major constituent associated with that lowest major constituent is the node which immediately dominates all sisters of the lowest major constituent in question.¹

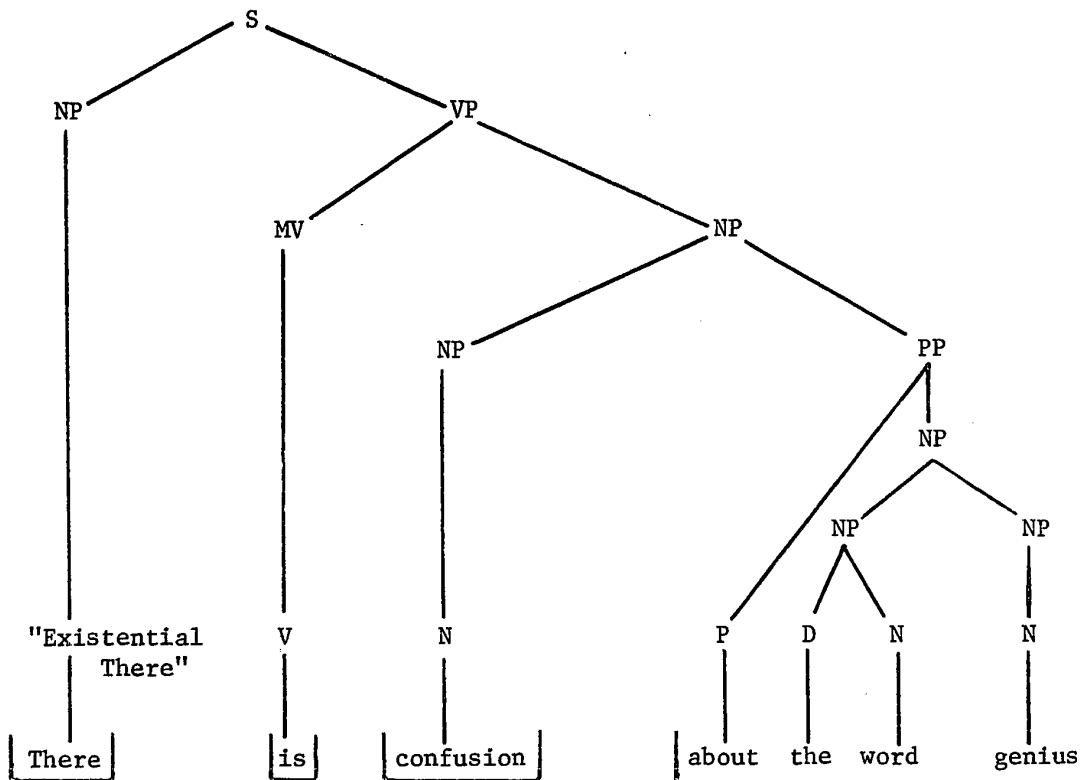
This algorithm can be iterated a number of times to permit the reconstitution of higher level units or complete surface sentences. Thus, higher major constituents can be created at various levels depending on the number of times the algorithm is applied to a specific word string. In this study, the algorithm was iterated three times or until a surface sentence was completely reconstituted.

The operation of the algorithm can be demonstrated with the sentence, "There is confusion about the word genius." The surface phrase marker for this sentence is:

¹This algorithm was created in consultation with Dr. G.D. Prideaux of the Department of Linguistics, University of Alberta. It appears in Chapter 1 as the definition of a Higher Major Constituent.



The LMCs for this sentence are shown below: /There / is / confusion / about / the word / genius /. The first application of the HMC algorithm produces the amalgamation shown in the phrase marker below.



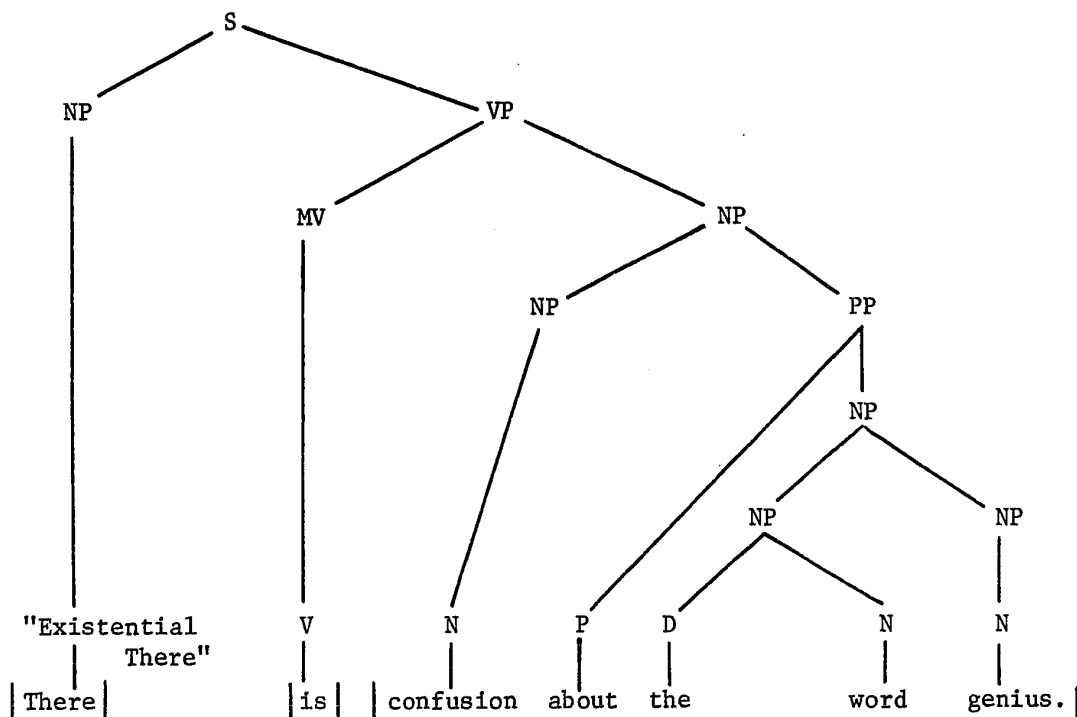
The first level HMCs are:

(There) (is) (confusion) (about the word genius.)

In prepositional phrases, the preposition is included with the noun phrase which immediately follows it. This is an ad hoc rule. It is included to avoid an excessive degree of fragmentation of parts of sentences which reflect a high degree of semantic cohesiveness. Similarly, connectives are included with the noun phrases which immediately follow them.

In the phrase marker above, the LMCs of "about the word" and "genius," are exhaustively amalgamated under the node PP. That is, "about the word" and "genius" are sisters at the LMC level. It is the node PP which dominates them both. At this level no other LMCs can be combined to form a higher level unit.

The second pass of this algorithm produces the amalgamation shown below.

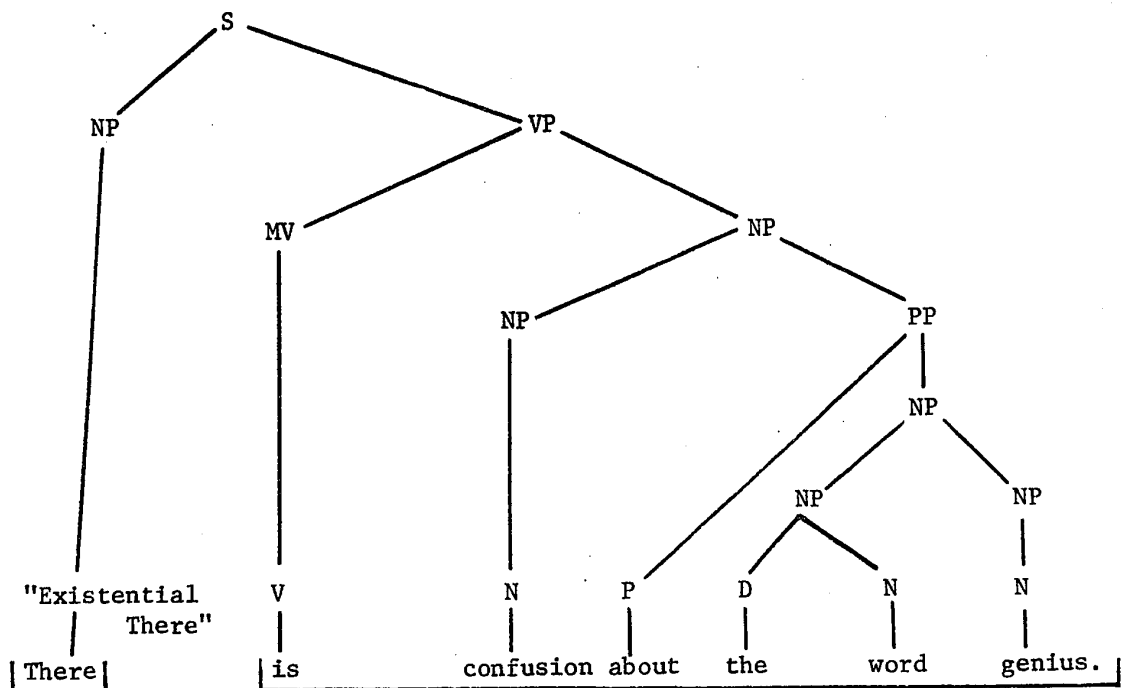


The second level HMCs are:

[There] [is] [confusion about the word genius.]

This phrase marker shows that the noun phrase "confusion" and prepositional phrase "about the word genius," are fully amalgamated under the node NP which dominates them both. Without obtruding into another "level of amalgamation" no other units can be combined on this application of the algorithm.

The third pass of the HMC algorithm produces the reconstitution which is shown in the phrase marker below:



The third level HMC's are:

{There} {is confusion about the word genius.}

This phrase marker demonstrates the way in which the noun phrase "confusion about the word genius" and the main verb "is," are exhaustively amalgamated under the node VP by

which they are both dominated. At this level no other constituents can be combined. In this sentence, therefore, the HMCs resulting from three applications of the HMC algorithm are:

{There} {is confusion about the word genius.}

The stages in the process of the reconstitution of HMCs can be represented as follows:

{[(/There/)]} {[(/is/)] [(/confusion/)] (/about the word/ /genius./)]}

In this representation the key used is:

1. / / = LMC boundaries
2. () = first level HMC boundaries
3. [] = second level HMC boundaries
4. { } = third level HMC boundaries.

The BL Format

This describes the use of a unit of disrupted meaning (BL--bizarre long). For this format, a passage is prepared in exactly the same way as for HMCs. That is, each passage is broken into HMCs, except that, in this case, the sentences are chunked at a point two words to the right of the HMC boundaries. This procedure ensures that fragments of two successive HMCs make up a single chunk which is displayed as a unit on the CRT screens of the IBM 1500 Instructional System. Thus, except for the first and last chunks, the number of words per chunk for a given passage is the same for the HMC format as for the BL format.

The number of words, sentences, full-screen presentations, and the number of chunks of each type per passage, are set out in Table 8.1. These data highlight the essential similarities and differences across the five experimental passages. While the total number of words in each passage is quite similar, there is considerable variation in the number of sentences, LMCs, and HMCs per passage. The dependence of BL chunks on the prior creation of the HMC chunks can be clearly seen in this table.

Table 6.1 in Chapter 6 provided data relevant to the readability of the five passages used in the study. When the data summarized in Table 8.1 are compared with those presented in Table 6.1 three additional pieces of information emerge. These are:

- (a) a higher average number of words per LMC can be equated with higher readability indices as assessed by the three formulas used in this study.
- (b) A higher average number of words per HMC can be equated with higher readability indices as assessed by the three formulas used in this study.
- (c) A higher ratio of LMCs to HMCs in any given passage suggests a higher readability index as assessed by the three formulas used in this study.

The Experimental Tests

Comprehension in this study was assessed using tests compiled according to three different paradigms. Two of the

TABLE 8.1 -- Data relating to the presentation of the five passages in the five different formats

Title of each Passage	No. of Words in each Passage	No. of sentences in each Passage	FP Screens	TWS	LMCs	HMCs	BLs
The Atomic Bomb	201	6	2+	101	70	27	27
Death of a Dog	191	9	2+	96	79	27	27
My Relations With Teachers	198	14	2+	99	101	45	45
Upsetting the Balance of Nature	189	9	2+	95	72	27	27
What is Genius?	203	8	2+	102	82	41	41

testing methods were administered in two ways. Thus, five test administration procedures in all, were followed. The three methods of test construction were: (1) the cloze procedure; (2) facet design; (3) the application of linguistic algorithms.

The Cloze Procedure

The cloze procedure is the term which is used to describe the systematic word-deletion whereby words are removed from a printed text. In responding to a test constructed in this way the S's task is to predict the exact word or a suitable synonym to fill the gap so created. In making his word predictions, the S makes use of prior knowledge, general understanding of the material, context clues, and a knowledge of language patterns and word usage. For each closure the S is forced to pay close attention to what the passage is saying as this is revealed by the prior and successive context provided by the other words in the text.

The cloze procedure was developed by Taylor (1953). He borrowed the word cloze from the Gestalt psychologists' concept of closure which, in this context, means filling in the parts in an incomplete message in order to discover the total message. Taylor's reasoning was that if a person could understand the meaning of a printed passage well enough to replace deleted words, he was experiencing a form of closure, hence the term "cloze." Since that time, researchers like Rankin (1957, 1959, 1964, 1965) and Jenkinson

(1957) have introduced the cloze procedure to the field of reading. Further research has been done by Bormuth (1963, 1966, 1969), Greene (1964), Manis and Dawes (1961), and Weaver (1965). Many studies (Fletcher, 1959; Ruddell, 1963; Hafner, 1963; Friedman, 1964; Gallant, 1965; and others) have attested to the usefulness of the cloze as a valid test of the comprehension of written language.

In this study, the cloze procedure was applied to the five experimental passages. The tests were created by the deletion of every fifth word from the passages. The five forms of the test thus possible for each passage were constructed. Form One was created by omitting words 1, 6, 11, etc. Form Two was constructed by deleting words 2, 7, 12, etc. Form Three was produced by removing words 3, 8, 13, etc., and so on for the remaining two forms of the test.

Tests Based on Facet Design

On each passage, tests were also constructed according to the facet design approach outlined by Guttman (1965), Guttman and Schlesinger (1967), and Schlesinger and Weiser (1970). The purpose of facet design is to make it possible to systematically construct items for a test. This design is specifically intended for application to the multiple-choice type of test item which presents a question and a correct answer together with several distractor statements. The testee is required to select the correct answer from the group of possible answers thus presented.

Distractors, as defined by English and English (1958), are designed to be attractive to the respondent who does not know the correct answer. Keeping the correct answer company is most often regarded as the only function of distractors. Distractors of this type do not satisfy the definition of English and English. A better criterion, they suggest, is that of sufficient attraction to interest the testee who does not know the correct answer. The degree of attractiveness is usually decided on the basis of the intuition of the test constructor. When intuition is depended upon in this way the test compiler does not have a clear notion of the precise impact upon a S of the distractor items he includes in his test. Another method of selecting distractors is by gleaning answers from tests which are first presented to representative groups in open-ended form.

With facet design it is argued that distractors can be constructed in a systematic manner on an a priori basis. This approach possesses at least three desirable features:

1. Predictability of the relative empirical difficulties of distractors;
2. Reduction of variation in test results due to undesired factors;
3. Possibility of classifying of Ss' scores on the basis of the types of incorrect answers to which they are attracted.

Thus, facet design is a way of devising questions systematically which leaves a minimum of room for arbitrary

decision. Also the systematic construction of distractors for the questions of parallel forms of tests is facilitated by the application of the same pattern of facets in each form of the test. Unless some such design is used, there could be no way of definitively predicting, beforehand, whether items included in two parallel forms of a test are of comparable difficulty. For two forms of a test to be truly parallel, it is necessary to have control over the distractors as well as the questions. Facet design provides the assurance that distractors will be selected according to the same criteria.

The proportion of respondents who choose a distractor instead of the correct answer will usually be an accurate indication of the degree of attractiveness possessed by a distractor. It is hypothesized by Guttman and Schlesinger (1967) that the degree of attraction of a distractor increases linearly with its "degree of similarity" to the correct answer. They suggest that a viable a priori definition of "degree of similarity" is one which is based only on considerations of content and which successfully predicts empirical attractiveness.

Table 8.2 provides a design for one item of a test constructed according to facet design. This test item employs figures which vary on three dichotomous facets--shape, position, and orientation. In this test item, a set of eight distractors, including the correct answer, is employed.

If one of these distractors is the correct answer

then there are three other distractors which differ from this correct answer on one out of the three facets, three distractors which differ from the correct one on two out of the three facets, and one distractor which differs on all three facets. If distractor 1 is the correct answer then distractor 2 differs from it in facet C only, distractor 3 in facet B, and distractor 5 in facet A. Distractors 4, 6, and 7 differ from it on two facets each, and distractor 8 is wrong on all three facets. This structure of a priori dissimilarity of the distractors from the correct answer, within the particular definitional system specified by the three facets, is diagrammed as a hierarchical order in Figure 8.1. The facet design depicted in Figure 8.1 represents such a definitional system.

TABLE 8.2 -- The eight distractors of a test item constructed according to facet design. The three facets used are figure shape (A), figure position (B), and figure orientation (C).

Distractor	Facet A	Facet B	Facet C
1	a ₁	b ₁	c ₁
2	a ₁	b ₁	c ₂
3	a ₁	b ₂	c ₁
4	a ₁	b ₂	c ₂
5	a ₂	b ₁	c ₁
6	a ₂	b ₁	c ₂
7	a ₂	b ₂	c ₁
8	a ₂	b ₂	c ₂

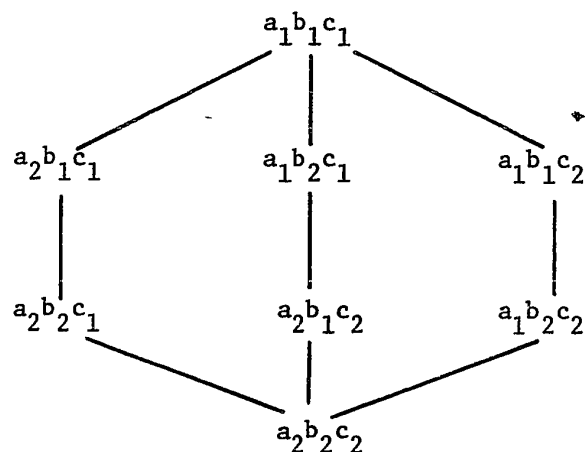


Fig. 8.1 --The structure of a priori dissimilarities of distractors to the correct answer within the particular definitional system of the dichotomous facets of figure shape (A), figure position (B), and figure orientation (C)--(after Guttman and Schlesinger, 1967).

Guttman and Schlesinger (1967) cite an example of this procedure. It is taken from a study conducted earlier by them (Guttman and Schlesinger, 1966). Each item on the test which their study used is a three-by-three matrix of small squares as shown in Figure 8.2. In the example shown in Figure 8.2 the missing ninth square has to be provided by the S. The figures show variation in the following facets: (a) shape, (b) position, and (c) orientation.

This example demonstrates how distractors may yield useful information which cannot be secured by simply dichotomizing answers on the basis of those which are correct and those which are incorrect, nor even, for that matter, by ranking from "most" to "least" correct. This sort of information may be of particular value where a test is required to perform a specific diagnostic function. The selection of a certain group of incorrect distractors, over a complete test, may indicate a weakness in the performance of the S

which would not be manifest with a test in which the items are simply assessed as correct or incorrect.

Facet design and the experimental reading tests

The facet design used in this study concentrates on the relationship between the test item and the text on which it is based, rather than on any skills and abilities presumed to be involved in reading and answering the question item. In this context, what a specific item measures is defined operationally in terms of how it is related to the information contained in the text.

As with the original approach of Guttman and Schlesinger (1966) the position adopted here was to develop a classificatory system which at the same time includes the correct answer and the incorrect distractors. For this purpose, it was convenient to look upon each possible answer in the multiple-choice item as a statement, related in a particular way, to the text upon which the comprehension test was based. In constructing these statements for each test, two facets were used. These were: (a) the form of the information, i.e., in the exact words of the text, or, in a paraphrase of the words of the text; and (b) the context in which the information occurs in the text, i.e., the correct context as it appears in the text, or, the incorrect context so that such a statement is drawn from two unconnected sections of the text.

The use of these facets for the selection of correct answer and distractor statements to appropriate questions,

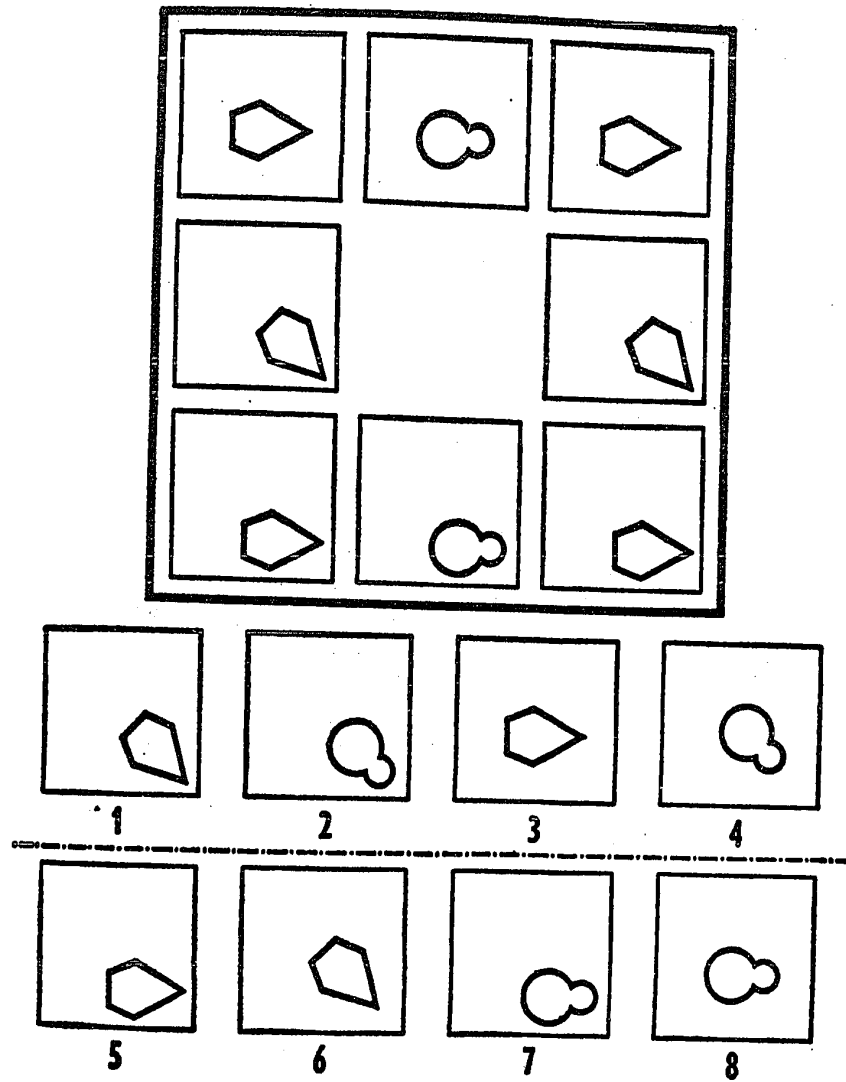
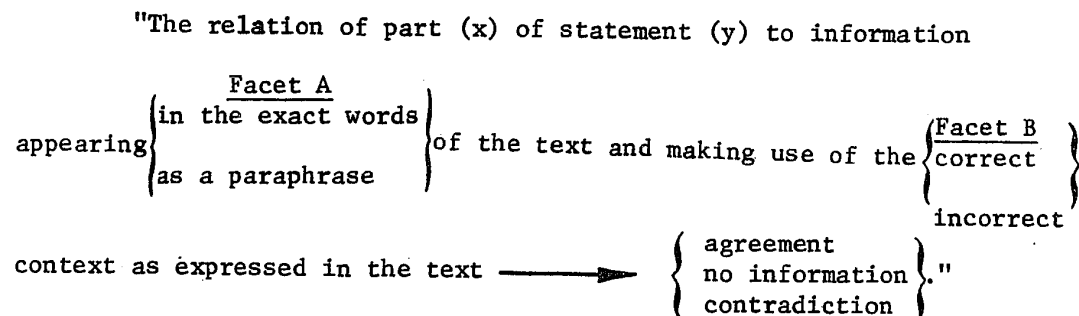


Fig. 8.2 -- An example of a test item based on facet design (after Guttman and Schlesinger, 1967). The respondent is required to select the square from the eight possibilities in the bottom set which would best complete the set of nine squares required for the top set.

can be summed up by means of a "mapping sentence"
 (Schlesinger, and Guttman, 1969; Schlesinger and Weiser,
 1970):



The "domain" of the mapping sentence, which is the part that precedes the arrow, contains the facets by which each distractor is analyzed. The "range" of the mapping sentence is found to the right of the arrow and contains the three basic categories of "agreement," "no information," and "contradiction." The sentence is read from left to right with one element being selected from each facet. Thus, in the mapping sentence employed in the construction of multiple-choice items for the tests based on facet design, the domain could be varied four different ways and the range could be varied three different ways. The operation of this mapping is diagrammed in Figure 8.3.

Given that a distractor statement consists of both a fixed and a variable portion, only the variable portion is used in the application of the facets shown in Figure 8.3. It can be seen that, employed in this way, the mapping sentence will provide for each variable part (x) of a distractor statement (y), as many mappings into the range as there are

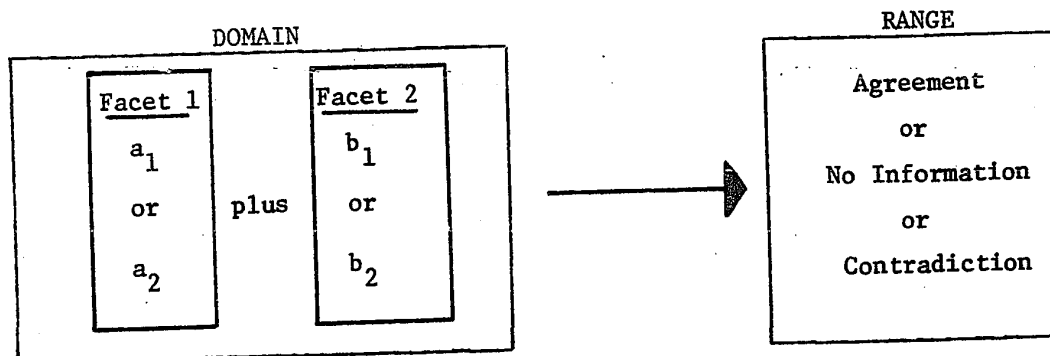


Fig. 8.3 --A diagrammatic representation of the operation of the mapping sentence applied in the use of facet design for the construction of multiple-choice reading test items. (a_1 = exact words, a_2 = paraphrase; b_1 = correct context, b_2 = incorrect context).

combinations of elements in the domain.

Table 8.3 gives a design for one item of a reading test varying on two dichotomous facets--form (exact words or paraphrase) and context (correct or incorrect)--and consisting of a set of four distractors including the correct answer. In this table it can be seen that if one of these distractors is the correct answer then there are two other distractors which differ from this correct answer on one out of the two facets, and one distractor which differs on both facets.

The structure of a priori dissimilarity of the distractors from the correct answer depicted in Table 8.3 is defined in Figure 8.4. This figure diagrams the hierarchical nature of the distractors so constructed.

In this study, the object of defining the content of test items and their distractors, as completely as possible in terms of facets, was to produce five multiple-choice comprehension tests (one based on each of the five experimental

TABLE 8.3 -- The four distractors of a test item constructed according to the facet design employed in this study. The two facets used are, Facet A: the form of the information (exact words or paraphrase), Facet B: the context of the information (correct or incorrect).

Distractor	Facet A	Facet B
1	a_1	b_1
2	a_1	b_2
3	a_2	b_1
4	a_2	b_2

passages) with sets of test items that would have identical facet profiles.

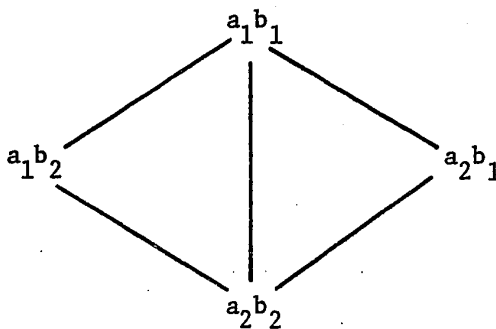
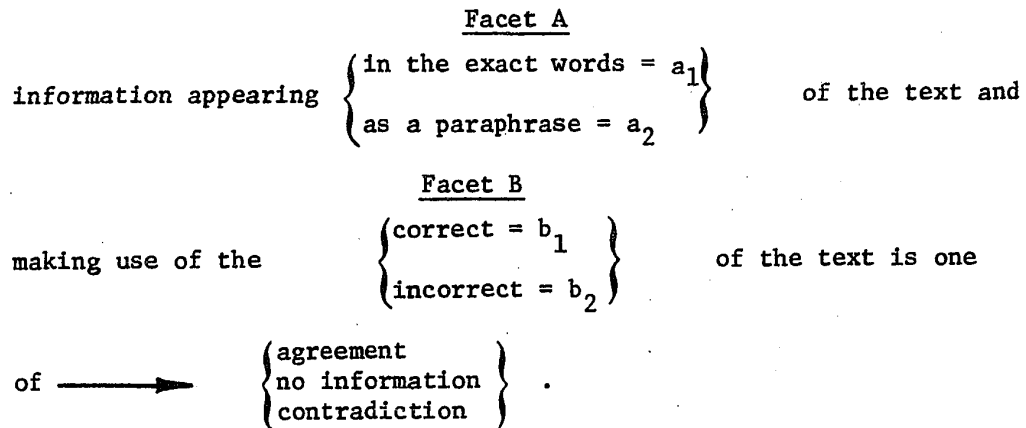


Fig. 8.4 -- The structure of a priori dissimilarities of distractors to the correct answer within the system defined for this study. The dichotomous facets are, Facet A: the form of the information, and Facet B: the context of the information.

The same mapping sentence was used for the creation of the 10 questions based on each passage. To obtain the same facet profile for all tests, questions of the same number across the tests, e.g., the five number two questions, employed the same combination of facets. The mapping

sentence used for the creation of all the test items based upon facet design is set out below:

The relation of the variable part of each distractor statement to



In the construction of these items, each distractor was created with a fixed and a variable portion. The mapping sentence above was applied only to the variable portion of each distractor. Thus, if the variable portion of a distractor was comprised of the exact words of part of the text and was taken from one contiguous section of the text, it was classified as using an $a_1 b_1$ facet combination. On the other hand, if the variable portion of a distractor was comprised of a paraphrase of part of the text and was taken from two separate sections of the text, it was classified as using an $a_2 b_2$ facet combination. The other two possible facet combinations were constructed in a similar manner. The creation of one test item based on the passage, "What is genius?" is set out in Table 8.4.

TABLE 8.4 -- The construction of one test item according to facet design. The item is based on the passage, "What is Genius?"

Question: With which statement would the writer agree?

Distractor	Domain Facet Combination	Distractor Statement	Range
A	a ₂ = paraphrase b ₁ = correct context	Geniuses sometimes have unusual talents.	Agreement
B	a ₂ = paraphrase b ₂ = incorrect context	Geniuses possess the unexpressed emotion and motives of others.	No information
C	a ₁ = exact words b ₂ = incorrect context	Men of genius are unable to know even what they feel.	Contradiction
D	a ₁ = exact words b ₁ = correct context	Men of genius always have exceptional gifts of virtuosity.	Contradiction

Tests Based on Linguistic Algorithms

The construction of these tests was based on the work of Bormuth and Menzel (1970) who have proposed a theory of testing which depends upon the transformational-generative grammar outlined by Chomsky (1957, 1965), and Katz and Postal (1964). Bormuth and Menzel employed the transformational model because of its ability to systematically state the relationships between the linguistic structures like phrases, sentences, etc., which their theory of testing employs. The essential features of this theory of language, as it is used by Bormuth and Menzel in their theory of testing, can be summarized as follows:

1. The theory posits a deep or underlying structure which is derived by application of phrase structure rules. This deep structure contains all the information necessary for semantic interpretation and the input to transformational rules.
2. The theory also posits a surface structure which is derived from the deep structure by the application of transformational rules. This surface structure is marked by the loss of a certain amount of the information that is present in the deep structure because the transformational rules "mutilate" strings to some extent in the mapping of surface sentences on their related deep structure sentences.

This theory of language can be applied in the construction of tests designed to assess a S's comprehension of

written materials because of the definitive account it provides of the relationships between sentences. The linguistic theory provides the user of a testing theory based upon it, with precise definitions of the types of questions which can be formulated. It also provides explicit rules (in the transformational sense) for deriving the various types of questions.

Transformational analysis and question construction

It has already been pointed out that transformational grammar attempts to provide an algorithm that permits the enumeration of surface structures from the deep structures which underlie them. The transformational analysis provided by Bormuth and Menzel, however, attempts to reverse the process described by transformational grammar. That is, instead of enumerating the operations necessary to arrive at a given surface structure from the deep structure which underlies it, this analysis starts out from a given surface structure e.g., a sentence of the text upon which questions are to be based, and attempts to derive the deep structure underlying that sentence. Because of this, there is an essential difference between the transformational analysis proposed by the transformationalists and that suggested by Bormuth and Menzel. The transformationalists demonstrate the relationship between deep and surface structure by means of formally stated algorithms or rules--Bormuth and Menzel have to rely upon the linguistic intuition of the analyst. Although this approach appears to be without scientific

warrant it is, in fact, what any transformational linguist finds himself doing whenever he constructs an argument that requires the positing of a deep structure. That the correct deep structure has been constructed is readily checked by the application of selected transformational rules to ascertain whether or not the original surface structure can be generated from the posited deep structure. Thus, although Bormuth and Menzel rely upon the analyst's linguistic intuition for the construction of sentence deep structures, the acceptability of such deep structures is verifiable.

Transformational-generative grammar is an algorithm for deriving surface structure sentences from their deep structures. That is, starting with the abstract symbol #S# as its input, the grammar produces a surface structure sentence. The testing theory outlined by Bormuth and Menzel, on the other hand, has as its input the surface structures of the instructional materials to be tested or the text to be read. This means that in order to apply transformational-generative grammar to the controlled creation of comprehension test questions it is first of all necessary to arrive at the deep structures of the sentences of the text to be tested. It is only when this has been done that it is possible to transform these deep structures into the questions that will comprise the comprehension test. A major difficulty, however, is that transformational grammar does not provide an algorithm for deriving deep structures from surface structures. Transformational linguists, in fact,

claim that no such algorithm exists. Bormuth and Menzel devote an entire section of their book (1970) to providing instructions for deriving deep structures from surface sentences of written texts and, in turn, deriving from these deep structures, the surface sentences of the required test. The identification of the deep structures of the sentences of a text and of the transformations by which test questions have been derived from them, permits the explicit statement of the relationship which exists between the text material and the test material. Thus, this method of test question compilation supplies precise definitions of the types of questions that can be asked and, at the same time, also provides explicit rules for deriving these various types of questions.

By following the directions of Bormuth and Menzel and making use of the extensive categorizing materials that they have compiled, it is possible for the analyst to derive both the deep structure underlying the sentence of a text and the surface structure of the question he wishes to base on that original sentence. This means that given any sentence in a sample of English discourse, the analyst can describe how the sentence came to have the surface structure it has, and the deep structure that underlies that sentence. This is done in the following way: Each sentence in the sample of English discourse is compared against the sentences listed in the 60 types that are set out by Bormuth and

Menzel. With the help of the "transforms"¹ that accompany each type of sentence, the deep structure of the sample sentence is identified. Each sentence type lists a set of "operations" or transformations (both obligatory and optional) by means of the application of which the surface sentence can be derived. It should be noted that this derivational history does not represent the manner in which the surface sentence was generated, but rather, the way in which transformational grammar describes the derivation of that sentence. When the deep structure associated with a particular surface structure has been reconstructed it is then possible for the test constructor to change the original sentence by applying the transformations listed under the transform. The changes that are carried out will depend on the type of question that the test constructor wishes to ask of the S. The use of this approach to the formulation of reading comprehension questions is demonstrated below.

The Derivation of Reading Questions Using Linguistic Algorithms

Bormuth (1968, 1970) describes a simple sentence as a device for the syntactic encoding of a single concept. In a sentence, the subject noun or noun phrase may refer to a broad class of entities. The other words or phrases in a sentence may serve either directly or indirectly to delimit

¹The term "transforms" does not conform to the linguists' "transformations."

or qualify the meaning of the subject of the sentence. This restriction or modification of the meaning of the subject occurs in a complex though relatively systematic manner. Which word or phrase modifies another and the order in which these modifications occur is determined by the phrase structure of the sentences. This process of modification is illustrated in Figure 8.4.

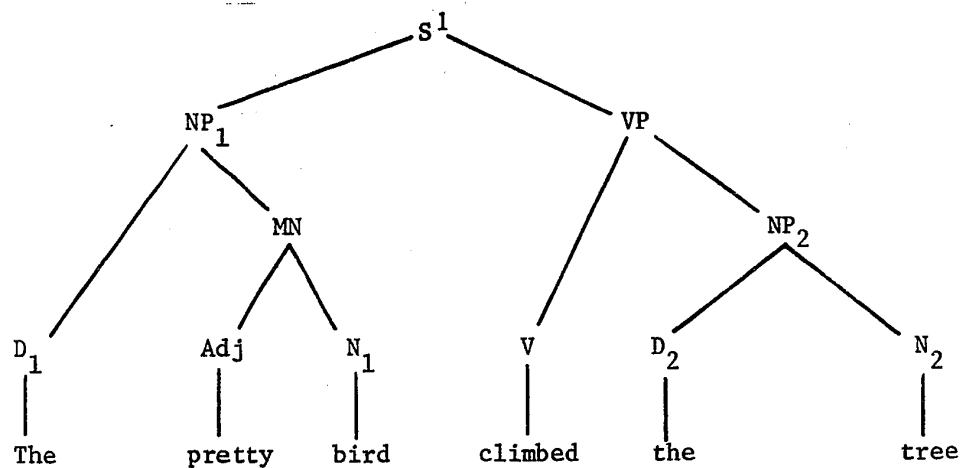


Fig. 8.4 --This diagram shows the manner in which a simple sentence can represent a single concept (after Bormuth, 1968).

In this figure, the first modification of the subject noun "bird" is provided by the adjective "pretty." This restricts the referent of the phrase to just those birds which are pretty. The modified noun, or the MN phrase as it has been designated in the diagram, is then further restricted to a single instance of the notion of "pretty bird." This

¹Symbols should be interpreted as follows: S = sentences, NP = noun phrase, VP = verb phrase, MN = modified noun, Adj = adjective, D = determiner, V = verb.

process of increasing restriction continues until the entire subject has been modified by the predicate and the single concept that the sentence represents as a whole has been presented.

A reader's knowledge of those modifications which occur between lexical constituents can be tested by questions (Bormuth, 1968). In this context, a lexical constituent describes a word which can be classified as a noun, verb, adjective, or adverb, or a phrase which contains such a word. Bormuth has devised types of questions which test information of this sort. Several such questions have been set out in Table 8.5.

Table 8.5 -- Examples of rote wh-questions which can be derived from the sentence, "The pretty bird climbed the tree."

Original sentence to be tested: The pretty bird climbed the
tree.
=====

Lexical Constituent Tested	Question	Lexical Constituent Tested	Question
S	Who climbed the tree?	S	What did the pretty bird do?
MN	Which bird climbed the tree?	MN	The pretty what climbed the tree?
VP	What did the pretty bird climb?	VP	What did the pretty bird do to the tree?

Rote wh-questions

One set of such questions has been classified by Bormuth (1968, 1970) as rote wh-questions. His directions

for the construction of these questions are set out below. Firstly, a lexical constituent is deleted from the sentence. It is then replaced by a suitable pro-word such as who, what, when, where, how, and so on. The wh-word is next front-shifted and the adjustments which this necessitates are made to the auxiliary and main verbs (see: Katz and Postal, 1964; Chomsky, 1965). The correct answers to the questions thus produced are the constituents which the wh-word replaced or acceptable synonyms of those words. The wh-questions which can be directly derived from the sentence diagrammed in Figure 8.4 are listed in Table 8.5. Thus, the testing of the entire sentence (S) can be achieved in two ways, viz., "Who climbed the tree?" and "What did the pretty bird do?" Likewise, the modified noun can be tested in two different ways, viz., "Which bird climbed the tree?" and "The pretty what climbed the tree?" There are two ways in which the verb phrase can be tested. These are: "What did the pretty bird climb?" and "What did the pretty bird do to the tree?" It is clear that some of the questions produced in this way are only marginally acceptable, e.g., "What did the bird do to the tree?" In compiling the reading tests in the actual study, an attempt was made to avoid such questions.

It is obvious that questions of this type are so easily answered that they represent a test of comprehension only at the most naive and literal level. Bormuth cites this as his reason for labelling such questions as rote

questions. They are of importance here because they illustrate the transformation that forms the basis for a large variety of questions which are much more useful in the assessment of literal comprehension.

The weakness with the rote wh-question is that its word order is almost the same as that of the sentence from which it is derived. This weakness is obviated to a considerable extent by other question types proposed by Bormuth. These additional types of questions are intended to evaluate a reader's understanding of the various types of modifications which can be found in written discourse. Table 8.6 provides examples of these question types and indicates the manner in which each can be derived from a text.

Transform questions

Lines 5 and 6 of Table 8.6 illustrate the formation of this question type. Firstly, a syntactic transformation is performed on the sentence. The sentence thus produced has to be semantically congruent with the original sentence. For example, commencing with the sentence, The boys climbed the tower, the following sentences can be derived: It was the tower that was climbed by the boys; It was the boys who climbed the tower; The tower was climbed by the boys. A wh-question is then formed from one of the derived sentences in the manner described under wh-rote questions.

Semantic substitute questions

The two stage process shown in lines 7 and 8 of

Table 8.6 is used to form semantic substitute questions. The process consists of substituting a synonymous word or phrase for one or more of the words or phrases in the sentence. A wh-question is then derived from the sentence formed in this way. It should be noted that the derived sentence is a device used only by the test-writer. This is not seen by the reader completing the test.

It is essential that any synonym that is substituted have an identical meaning to the word in the sentence or it must be a more general term which hierarchically includes the term used in the base sentence. The term "hierarchically includes" is used in the 1965 Chomsky sense of meaning that both words must be + human, + count, + concrete, and so on. For example, it is acceptable to substitute "people" for "boys" because all boys are people, but "boys" could not be substituted for "people" because not all people are boys.

Compound Questions

A further class of questions is created by deriving first, a syntactic transformation producing a semantic paraphrase of the basic sentence, and then, a semantic substitute sentence from the syntactically transformed base sentence. The wh-question is then formed from the semantic substitute sentence. Lines 9, 10, and 11 provide examples of the procedure followed.

Semantically cued questions

Line 12 provides an example of this question type.

TABLE 8.6 -- Examples of types of questions which can be used to test various modifications which occur in written discourse (after Bormuth, 1968).

Text
<p>The venturesome boys climbed the steel antenna. This was a dangerous act. One fell off. He crashed to the ground. This broke his neck.</p>
Question Types
<u>Rote Question</u>
<ol style="list-style-type: none"> 1. Wh-: Who climbed the steel antenna? 2. Tag: The venturesome boys climbed the steel antenna, didn't they? 3. Yes/No: Did the venturesome boys climb the steel antenna? 4. Inflectional: The venturesome boys climbed the steel antenna?
<u>Transform Question</u>
<ol style="list-style-type: none"> 5. Derived Sentence: The steel antenna was climbed by the venturesome boys. 6. Transform Question: By whom was the steel antenna climbed?
<u>Semantic Substitute Question</u>
<ol style="list-style-type: none"> 7. Derived Sentence: The adventurous boys scaled the metal tower. 8. Semantic Substitute Question: Who scaled the metal tower?
<u>Compound Question</u>
<ol style="list-style-type: none"> 9. Transform Derivation: The steel antenna was climbed by the venturesome boys. 10. Semantic Derivation: The metal tower was scaled by the adventurous boys. 11. Compound Question: By whom was the metal tower scaled?
<u>Semantically Cued Question</u>
<ol style="list-style-type: none"> 12. Which people climbed the steel antenna?
<u>Anaphoric Question</u>
<ol style="list-style-type: none"> 13. Derived Sentence: Climbing the steel antenna was a dangerous act. 14. Anaphoric Question: What was a dangerous act?
<u>Intersentence Relationship Question</u>
<ol style="list-style-type: none"> 15. Derived Sentence: Falling to the ground caused one boy to break his neck. 16. Intersentence Question: What caused one boy to break his neck?

It is derived by replacing the deleted constituent with a general synonym and a wh-word. The general synonym needs to bear a hierarchical relationship to the deleted constituent. For example, in line 12, the words "which children," "which lads," "which youngsters," could have been just as useful as the substitute phrase "which people."

Anaphoric questions

An anaphoric expression is a word or phrase which stands for some word, phrase, sentence, or even larger unit in a passage. The pronoun "he" in the illustrative text of Table 8.6 is anaphoric with respect to "one" in the previous sentence which in turn is elliptically anaphoric to one of the "venturesome boys" in the first sentence. "He," then, is also an example of sustained or continuous anaphora. The word "this" in the second sentence of the illustrative text is an anaphoric term which stands for the whole of the first sentence. The vital point to note is that any part of speech or any segment of text can be encompassed with a single anaphoric expression. For example, a paragraph discussing the total destruction of the prolific, wine-producing vineyards of the Hunter River Valley could be followed by a paragraph commencing with the words "THIS is shattering news for wine connoisseurs . . ." The word "this" would refer back to the entire preceding paragraph and the paragraph would be the antecedent of "this" in the anaphoric sense. For the comprehension of such a text it is important that a reader realize that any modifiers of "this" are also

modifiers of its entire antecedent. Anaphora occurs very frequently in most texts and is, therefore, a most important element in the cohesion of discourse. An understanding of anaphoric expressions is essential in the comprehension of written language.

Questions designed to assess how well anaphoric expressions are comprehended can be constructed as shown in lines 13 and 14. An intermediate sentence is derived by deleting the anaphoric item from the sentence in which it occurs and replacing it with its antecedent. A suitable wh-question is formed by deleting either the antecedent or the remainder of the sentence and replacing it with an appropriate wh-word.

Intersentence relationship questions

The juxtaposition of two sentences can signal important information in a passage. The sequencing of the last two sentences of the illustrative text in Table 8.6, indicates that falling to the ground caused the breaking of the neck. If the order of the last two sentences were reversed this meaning would be lost.

To formulate questions which test the comprehension of these relationships a three stage process is required. The first step is to identify the relationship between the sentences and sentence groups. In the sample text, the relationship between the first sentence and sentences three, four, and five (sentence two being interpolative with regard to sequence) could be described as "one" happened before

"three," "four," and "five," and the relationship between sentences three, four, and five, could be expressed as "three" caused "four," and "four" caused "five." The second step in this algorithm is the nominalizing of the sentence concerned. For example, the four sentences under discussion become, with this transformation: "The venturesome boys' climbing of the steel antenna;" "One's falling off the steel antenna;" "His crashing to the ground;" and, "The breaking of his neck." Two or more of these sentences are then inserted in the sentence frame created by using, singly or jointly, the relationships between the sentences. Thus, the four sentences and their relationships can be expressed in the following sentences: "The venturesome boys' climbing of the steel antenna happened before one's falling off the steel antenna;" "One's falling off the steel antenna caused his crashing to the ground;" "His crashing to the ground caused the breaking of his neck." Finally, in each case, a wh-question is then formed by deleting one of the nominalized sentences, e.g., "What caused the breaking of the boy's neck?"

In this study five of these algorithms, in association with varying degrees of paraphrase of the original text, were used to formulate the questions based on each of the five experimental passages. These produced questions of the following types: transform questions, compound questions, semantically cued questions, anaphora combined with semantic questions, and inter-sentence relationship questions. These

five were selected because it was considered that they result in the most challenging questions. Challenge was a necessary feature because of the supposedly high reading ability of the Ss who comprised the experimental sample. Two examples of each type of question were included in each test. In addition, the multiple-choice distractors which comprised each test item were constructed according to a two-faceted domain--facet A: the form of the distractor (exact words or paraphrase), and facet B: the context of the distractor (correct or incorrect context). The distractors were related to the text by means of a three-factor range. These factors were: agreement, contradiction, and no information. The order of presentation of the question types within a test was randomized for one test and then, since each test group completed one only of each of the five test procedures, the order thus produced was used for the other four forms of the test.

The application of a linguistic algorithm based on the use of a semantic cue is described below. The example is taken from the passage, "My Relations With Teachers." From this example, it can be appreciated that to contend with the constraint of limited space imposed by the use of the CRT screens of the IBM 1500 Instructional System for the display of test questions, a degree of paraphrasing of the original text had to be effected. The following is an example of the type of paraphrasing that had to be used:

Original sentence:

"There are, I have heard, inept pupils who bring out the best in teachers."

Paraphrased sentence: "Inept pupils sometimes bring out the best in teachers."

The modification it was desired to assess in this test item was the adjective "inept" which modifies the noun "students."

Semantically cued question: "What pupils sometimes bring out the best in teachers?"

The construction of distractors associated with this question was controlled by means of facet design. The application of this method of control is shown in Table 8.7. It should be noted that in the use of facet design no attempt was made to use any of the four possible facet combinations once only as it was in the tests which were based solely on facet design. For example, the combination of the facets of paraphrase and incorrect context was used twice in the test item shown in Table 8.7. Facet design was used in this way only to ensure that questions of approximately equal structure could be constructed across the five different tests based on linguistic algorithms.

The Validity and Reliability of the Tests

Since Taylor (1953) and Jenkinson (1957) pioneered the use of the cloze procedure for the construction of comprehension reading tests, a great deal of evidence has been amassed which adequately attests to the validity of the procedure as a test of reading comprehension (see: Rankin, 1959; MacGinitie, 1961; Ruddell, 1963; Bormuth, 1963, 1966, 1967, 1969; and numerous others). Similarly, the ability of this test to replicate results is supported by a

TABLE 8.7 -- The construction of the distractor statements for a test item based on the linguistic algorithm of semantic cue. The test item is taken from those associated with the passage, "My Relations With Teachers."

Question: What pupils sometimes bring out the best in teachers?	
Distractor	Range
Facet Combination	Distractor Statement
Domain	
A	Contradiction
a ₂ = paraphrase	Students who say nothing at all
b ₂ = incorrect context	
B	Contradiction
a ₁ = exact words	Insolent or intolerably stupid students
b ₂ = incorrect context	
C	Contradiction
a ₂ = paraphrase	Students who conceive a raging dislike for them
b ₂ = incorrect context	
D	Agreement
a ₂ = paraphrase	Below average students
b ₁ = correct context	

very extensive body of research findings.

Both the linguistic algorithm and facet design tests were constructed according to clearly delineated paradigms. That the linguistic algorithm tests had been produced according to the linguistic rules set out for each paradigm, was assessed by a linguist working independently. His finding was that all test items had been formulated according to the specifications enumerated by the experimenter.

A similar procedure was adopted for assessing the test items that had been compiled on the basis of facet design. Two teachers who had each completed a minimum of two senior undergraduate courses in reading and who were experienced in the construction of reading test items, checked that each test item, with its distractors, had been constructed according to the facets laid down for it.

Two additional, independent judges were used to establish that, in every test question, the four answer choices did include the correct answer. The same pair of judges also established that only one acceptable answer was included with the four distractors associated with each question. The linguistic algorithm and facet design tests were compiled specifically for this research project. Under these circumstances, no claim can be made with regard to their reliability as tests of reading comprehension.

In order to demonstrate that the multiple-choice tests were valid tests of reading comprehension an additional pilot study was conducted with two undergraduate classes

which possessed much the same characteristics as the experimental sample. The aim of this study was to ensure that Ss needed to read the passages on which the questions had been based in order to answer those questions. Each test was administered as a pencil and paper pre-test and post-test. Tables 8.8 and 8.9 show that, for the groups on which this testing was conducted, the answering of the test questions was very much enhanced by the reading of the prose passages. It can be seen from these two tables that the post-test results are quite high for these two groups. The sensitization stemming from the pre-testing and the fact that the testees could refer back in the text whenever they wished, probably accounted for this. The nature of the computer program, by means of which the tests were administered to the experimental sample, made this referring back impossible.

TABLE 8.8 -- The relationship of pre-test to post-test scores on linguistic algorithm tests for each passage (n = 26).

<u>Title of each Passage</u>	<u>Mean % for Pre-Test</u>	<u>Mean % for Post-Test</u>
The Atomic Bomb	8.46	83.84
Death of a Dog	7.61	91.62
My Relations With Teachers	6.92	94.73
Upsetting the Balance of Nature	10.34	85.29
What is Genius?	9.68	84.66

TABLE 8.9 -- The relationship of pre-test to post-test scores on facet design tests for each passage (n = 23).

<u>Title of each Passage</u>	<u>Mean % for Pre-Test</u>	<u>Mean % for Post-Test</u>
The Atomic Bomb	10.72	81.69
Death of a Dog	9.46	88.21
My Relations With Teachers	12.31	95.39
Upsetting the Balance of Nature	14.72	86.45
What is a Genius?	5.42	87.83

Summary

Five different formats were used for the presentation of the text materials in this study. These consisted of a normal format, a two-word format, two formats comprised of syntacto-semantic units (a small unit and a large unit), and a format using long chunks based on the "mutilation" of the longer syntacto-semantic units.

The impact of these five methods of presenting reading materials upon the reading comprehension of the Ss in the experimental sample, was assessed in five different ways. These test procedures used three different methods of test construction. The cloze procedure was used to produce five forms of the cloze test for each of the five prose passages utilized in the study. Facet design was used to

construct a ten-question multiple-choice test based on each passage. These tests were used in two different testing situations. The first approach used them as post-tests only, while the second used them as both pre- and post-tests. Five different linguistic algorithms were used for the preparation of ten-question multiple-choice tests associated with the five experimental passages. The tests prepared in this way were also used as both pre- and post-tests.

The manner in which these five testing procedures were used in this study has already been outlined in Chapter 6 which was devoted to the explication of the research design employed in the project.

Chapter 9 explains the way in which the IBM 1500 Instructional System was used for the display of the five different formats and the administration of the five test procedures.

CHAPTER 9

THE USE OF THE IBM 1500 INSTRUCTIONAL SYSTEM IN DATA COLLECTION

Introduction

An essential aspect of this study was to evaluate the impact of five different methods of text presentation upon the reading comprehension of college level readers. As was shown in Chapter 8, these presentation formats were constructed according to specifically delineated paradigms. Other studies have also attempted to assess the impact of chunked texts on the reading of a variety of Ss. Each of them, however, has used a method of chunk presentation that has been less than satisfactory with regard to the degree of separation it achieved. In this type of study, any method of presentation is employed in the hope that it will impose the use of a specific chunking strategy upon the reader. Ideally, it is considered that the most satisfactory way of achieving this is to have one chunk only, on display at any particular moment. While a method of presentation possessing this desirable feature could possibly be devised making use of a machine such as a Controlled Reader (EDL, 1963), it would suffer the severe restrictions of individual administration of the tests, no performance records, and a reading situation very removed from a normal reading setting. Although it cannot be denied that the use of the television-like screens of the IBM 1500 Instructional System does

disrupt the normal reading process of an individual to an unknown degree, the system provides every other function which is considered essential to the investigation of this type of research problem.

Because of the role played by the IBM 1500 Instructional System in this study, the present chapter is devoted to a description of its most important components and the various operations that can be performed by them. In addition, the specific use of the system in this project is discussed together with system modifications which had to be effected to achieve certain desirable functions.

The IBM 1500 Instructional System

The IBM 1500 Instructional System in the Division of Educational Research Services at the University of Alberta has been used extensively in Computer Assisted Instruction (CAI) projects. It has been used much less, however, for the collection of data in research situations. Figure 9.1 is a schematic diagram of the 1500 System. All the components except the Instructional Stations are housed in the computer control room. The fifteen Instructional Stations that comprise the teaching component of the 1500 System are in a separate, specially equipped classroom, adjacent to the computer control room. A sixteenth Instructional Station has been installed in the control room. It is most often used for various proctor functions. Figure 9.1 shows that the input, processing, and output operations in the

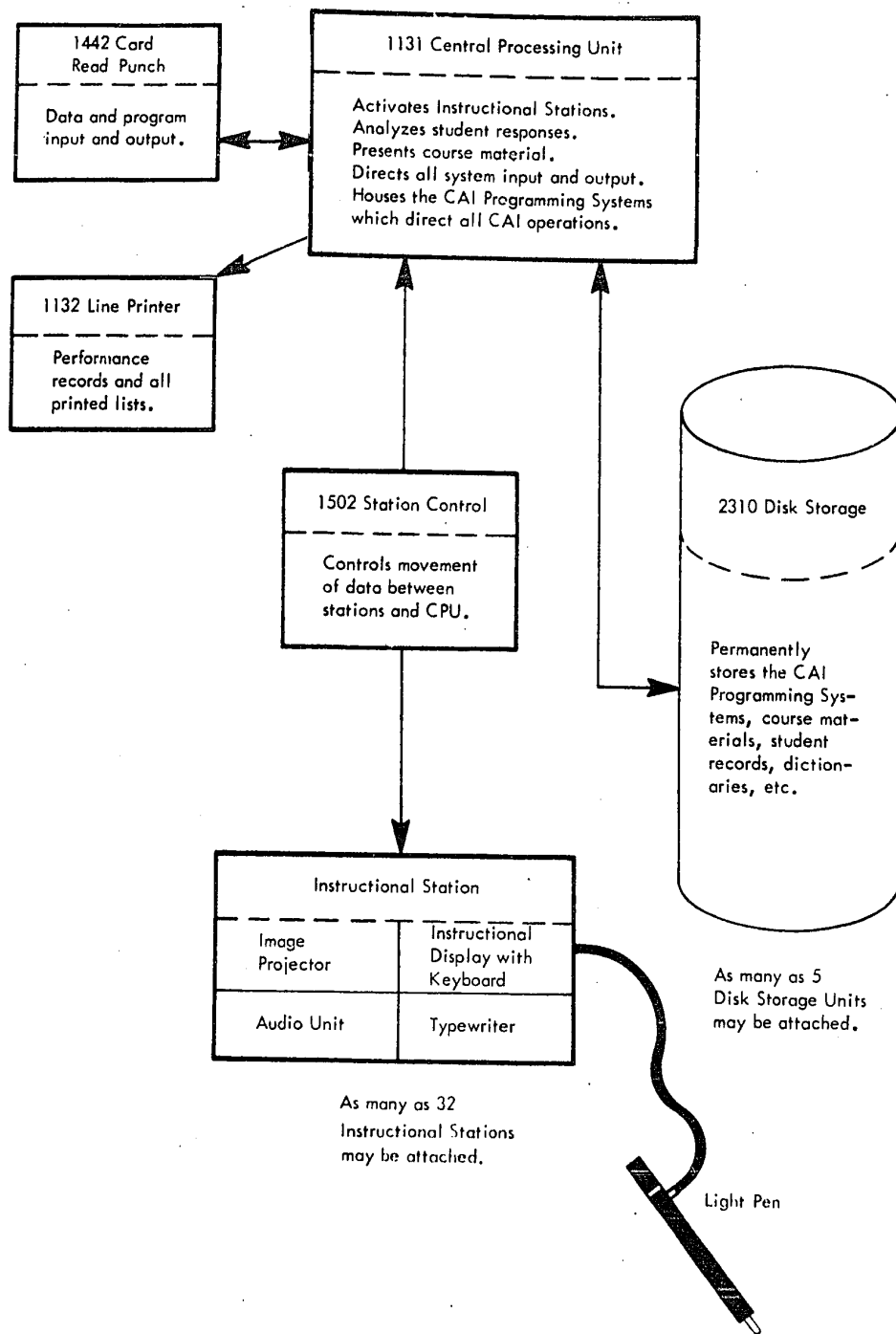


Fig. 9.1 -- IBM 1500 Instructional System Organization.

1500 System are performed by Instructional Stations, a Card Read/Punch (a card reading and punching device), a Line Printer, and a Central Processing Unit. The Disk Storage is used to preserve course materials and other information that must be used repeatedly (IBM, 1967).

The Instructional System

The 16 Instructional Stations of the 1500 System share the central computer equally. Each user of an Instructional Station is permitted to work independently of any other user of an Instructional Station (terminal). The Instructional Station consists of three separate parts--a combined screen and keyboard, an Image Projector which is located on the left of the screen, and an Audio Unit situated on the right of the screen. The mode of operation of the Instructional Stations can be tailored to meet the specific requirements of different student groups and teaching or testing situations. The present study made use of a testing situation rather than the more usual teaching situation. A number of modifications had to be effected to make this possible. These modifications permitted the creation of methods of test presentation, essential for this project, that could not have been created to handle such large numbers of Ss on any other machine. These modifications are discussed at a later point in this chapter.

The Instructional Stations allow for two-way communication between the system and the user. A television-

like console displays instructional and/or testing material using an expanded character set of 128 symbols, numerical characters, and special characters. This display screen is divided into 40 vertical columns and 32 horizontal rows which can display 40 characters on each of 16 lines. All characters are displayed as configurations of white dots on a black background.

The student or subject-testee can enter responses through the keyboard. This part of the system is also used by the S to sign himself on to the system. A special symbol called a "cursor" moves across the face of the display tube to show where the result of the S's next key depression will appear. The cursor is also used to direct the S's attention to specific areas of the display. The keyboard can be used for the automatic entry of other data, such as response latencies, into the system.

As pointed out above, each Instructional Station consists of other facilities. These include the Light Pen which the S uses for responses on the face of the screen; an Image Projector on which color or black-and-white images can be projected from 16mm. film; and an Audio Tape Drive which permits the S to listen to material which has been pre-recorded on a magnetic tape. This study did not employ any of these facilities so their operation will not be discussed in detail.

The Central Processing Unit

The computer of the IBM 1500 Instructional System is the 1131 Central Processing Unit (CPU). This executes the stored program instructions that direct the operation of all the other devices in the System. It also contains the controlling circuitry needed to perform the physical operations of transferring data from one place to another, operating certain input and output devices, checking machine functions, and so on.

The Storage Units

The place where data and instructions are kept during the actual processing operation is the Primary Storage Unit. In the 1500 System, this device is called magnetic core storage and is located in the CPU. Additional storage is provided with disk storage units. One disk storage unit is housed with the CPU. Four additional disk storage drives are located independently of the CPU. These five disk storage units can all be used concurrently. This means that the CPU has instantaneous access to all the data to execute a given operation. For example, during an instructional session, all courses and program instructions associated with the functioning of the operating system must be available in a fraction of a second. The operating system is the program which controls the CPU. When the System is in use, the operating system acts as an intermediary between the student and the material stored on the disk cartridges. For

example, the CPU retrieves a course question from the material stored on a disk cartridge and presents it to the appropriate student on the instructional display. When the student answers the question, his answer is compared to the answer or answers listed by the course author. After analyzing the student's answer the CPU will continue presentation as prescribed by the course author.

The design of the disk storage unit and the operating system make the instructional system more efficient by overlapping operations. This means, for example, that while the system is searching for a question for subject A, it can be displaying a question for subject B, and, at the same time, analyzing a response for subject C. The amount of overlapping that occurs at any given time is entirely dependent upon the requirements of the total operation. This was an extremely important facet of the system for the present study.

The Card Read/Punch

The Card Read/Punch "reads" the usual 80 column punch card. This means that the Card Read/Punch transfers the data from the card to the computer. The data can also flow in the opposite direction, from the computer to the card, in which case the Card Read/Punch will punch the data in a blank card. The Card Read/Punch reads cards at a rate of five cards per second, and punches at a rate of one card per second.

The Line Printer

The Line Printer of the 1500 System provides printed output of any data on magnetic tape or disk, or in core storage. It also prints out all system messages. A listing of any program can be provided by the Line Printer. It prints at a rate of about 100 lines per minute.

The Station Control

The Station Control connects the Central Processing Unit to all the system's Instructional Stations. It coordinates and directs the flow of data between the CPU and each Instructional Station. It also contains the optional display control, display adapter, and light pen adapter features when they are included as part of the IBM 1500 Instructional System.

The Station Control can send signals to the CPU periodically to give the stored program an opportunity to determine if a device needs service. These interruptions can be allowed or prohibited by the stored program by means of masking instructions. If the stored program determines that a device wants to transmit or receive data, it issues the appropriate input or output instructions. The Station Control interprets these instructions, using its data register and addressing facilities to control the data transfers.

Performance Records

The instructor or researcher can obtain Performance Records that indicate which questions were answered correctly or incorrectly, the actual responses, the response times, and other information which aids in evaluating an individual's or a group's performance. This facility made the IBM 1500 Instructional System particularly well-suited to the present study because of the immense amount of data the study generated.

Computer-Based Data Collection

The flow-chart depicted in Figure 9.2 shows the manner in which one of the five groups (n = 65) moved through the computer-based testing program. The order of test presentations was different for each such group as was the order of format-type presentation. From the flow-chart it can be seen that each group of 65 Ss was divided into five subgroups, each of 13 Ss. These subgroups were created to make use of the five forms of the cloze test which had been produced to avoid the use of a biased cloze test. Each subgroup was randomly assigned to one of the five forms of the test that had been derived from the passage which had been allotted to each main group for this purpose.

Modifications to the IBM 1500 Instructional System

The pilot study which was described in Chapter 7, revealed a number of weaknesses of the IBM 1500 Instructional

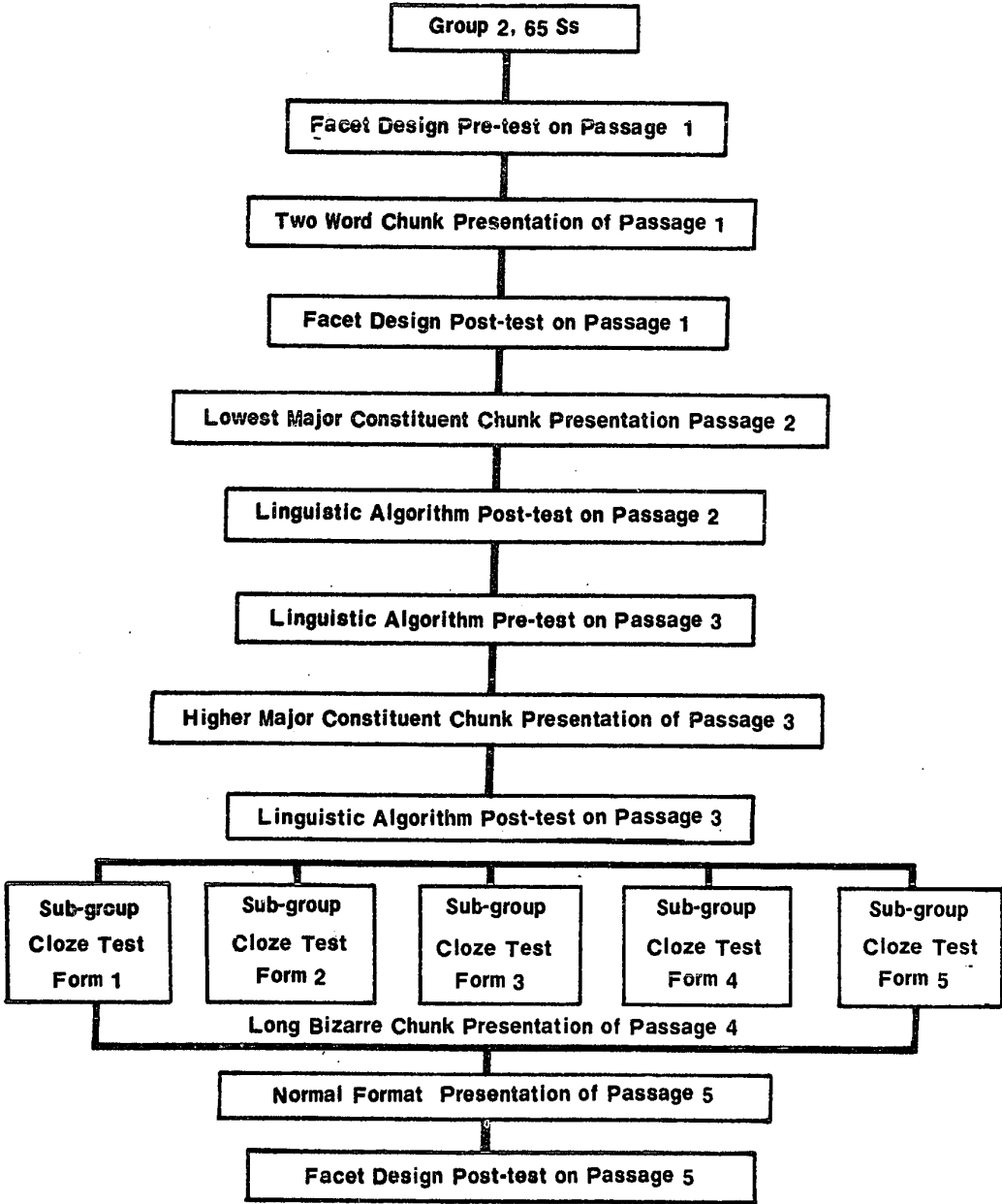


Fig. 9.2 -- Flow-chart showing administration of Computer-based tests to Group 2.

System in the application required of it in this study. These deficiencies, and the manner in which they were overcome, are outlined below.

Response Times

The pilot study made use of the Coursewriter II Language. While this language appears to be well-suited to CAI applications of the 1500 System, the pilot study clearly indicated that the Coursewriter II Language produces slow and erratic response times. As was explained in the chapter dealing with the pilot study, rapid and consistent response times were essential to the study that was planned.

The Minnesota Fortran Pack

As described by Cowper (1971), the biggest, single factor in the solution to the problem was the programming of the 1500 System with the Minnesota Fortran Pack. Although this was not a new language so far as the 1500 System was concerned, it had not been used previously at the University of Alberta. The use of this computer language therefore required the special self-training of an assistant¹ attached to the Division of Educational Research Services in the Faculty of Education at the University of Alberta. Assistance in this aspect of the undertaking was provided by the Technical Advisor² attached to the same division.

¹Mr. Donald Cowper.

²Mr. Norm McGinnis.

The fortran language possessed the potential to provide the desirable rapid and consistent response time because it is capable of holding the material for presentation to each S in magnetic core storage. This component, which is located in the CPU, is used for data and instructions only during the actual processing operation when the Coursewriter II Language is being used. Thus, the delay occasioned by the search of one or more storage disks that occurs with the use of coursewriter is obviated with the use of fortran.

The capacity of magnetic core storage

The holding of material for presentation in magnetic core storage ensured that rapid and consistent response times were achieved. The use of this component for storage, rather than the usual disk storage, however, created the problem of storage capacity. The core storage capacity of the IBM 1500 Instructional System at the University of Alberta is 16K or 16,000 "computer words." This amount of storage was found to be insufficient to contain any one of the five basic testing programs which had to be used at a single testing session. Since the project could not proceed without a solution to this problem, further research into the possible modification of the Minnesota Fortran Pack was carried out by Cowper and McGinnis.

The modification of the Minnesota Fortran Pack. By removing all unnecessary functions and routines from the Minnesota Fortran Pack, it was found that the capacity of

the core storage could be increased to 24K. Many of the capabilities of this computer language were not required for this project, e.g., no computer responses had to be provided, in any form, for Ss; neither the audio facility nor the movie projector was required; and, finally, the typewriter keyboard was required for minimal responses only. The removal of these sections of the fortran program from core reduced the space required for program storage to an absolute minimum and greatly increased the work-space in core which could then be used for the storage of Ss' responses.

Although the increased core capacity, achieved in the manner briefly described above, effected an immense improvement in System response delays and in the consistency of those delays, a noticeable lag occurred under certain conditions when all terminals were in use. It was found that these undesirable lags could be eliminated if each S were given a display of text or test three or four lines at-a-time. The nature of the text and test materials was ideally suited to this strategy. It was therefore adopted and a near optimum reading/testing situation resulted.

Peripheral Programs Required

Insufficient "software" was available to handle the problem of storing the large quantity of material contained in the reading texts and tests.

APL Files and the Fortran System

The problem of storing texts and tests was overcome with the help of the APL/1500 File Access Subroutine Package, developed at the Florida State University (Cowper, 1971). This package makes it possible to use material stored in APL files but operated under the control of the 1500 Fortran System.

The creation of APL files

In order to use this APL to Fortran facility, it was first necessary to have the required APL files created. The creation of these files was achieved with the "New Privileged User System Commands."

The storing of data in APL files

The storing of data in APL files is a simple process which is fully documented in the APL/1500 System notes. A set of these is held in the library of the Division of Educational Research Services at the University of Alberta. The procedures set down in this document were followed. A sample of an APL terminal session used in this project may be found in Cowper (1971).

The APL/1500 File-Access Subroutine Package. This is a self-contained collection of related subroutines which provides users of 1130/1800 Fortran and Assembler System with the facility for manipulating the data in APL/1500 disk files. The stored data can be used in calculations and outputted on the line printer or on cards. Such data, however,

cannot be written directly on disk. In order to transfer the data to the Fortran System pack from the APL pack, both must be mounted and ready.

The APL/1500 File-Access Subroutine Package was used extensively in this study. A copy of this package is also held in the library of the Division of Educational Research Services at the University of Alberta.

Vectors for Text-Chunking

The creation of a system of chunking five different texts, each broken up in five ways, was a difficult problem. The vectors which were eventually designed to do this (see: Cowper, 1971) were stored in APL files and transferred to disk file only when they were required for a specific testing session.

The Cloze Tests

A special problem was created by the adaptation of the cloze procedure for the creation of tests using the IBM 1500 Instructional System. The problem stemmed from two sources: (a) the combination of chunked texts and/or full texts with every fifth word deleted; and, (b) the provision of the storage for subsequent analysis of student's cloze responses made directly on the System typewriter keyboards.

The first problem was solved with the vector approach and storage in APL files outlined above. The solution to the second problem was a great deal more complex.

Constant blank size

The literature on the cloze procedure has emphasized the need for consistency in the size of blanks created by the deletion of every fifth word. This gap size is generally set at the space normally occupied by six characters. While it is a simple matter to produce, on the CRT screen, a blank marked by a line equivalent to six characters in length, it is far from a simple matter to provide for the insertion of Ss' responses in those spaces. In fact, because it is impossible to place more than six characters (in actual fact, four, allowing for a space before and after each insertion) in any one space, the blanks in the text could not be used for the insertion of Ss' word selections.

Use of the "cursor"

An additional problem was created by the use of the cursor to draw a S's attention to each succeeding blank to be filled. Arranging for the cursor to progress from blank to blank, as each was filled, created no difficulties. The insertion of the cursor in an underlined blank, however, broke the line and created the illusion of the requirement of a specific number of letters both before and after the cursor. The use of the cursor also prevented the numbering of blanks to assist the S in keeping his place as he responded to the test.

The use of the "cursor" and numbered blanks

A near-ideal solution was ultimately devised by

Cowper (1971). Extensive additional programming made it possible to number each blank and, at the same time, retain a continuous line of uniform length marking that blank. Numbers for blanks appeared in the appropriate space when the preceding blank had been completed. As a new number appeared in a specific blank that same number appeared below the text. The appearance of the cursor next to this number below the text, warned the S that his response would appear at that point when he commenced typing. When a blank had been completed its number remained on view in the text (i.e., as much of the text as was displayed) to assist the S in "keeping track" of the responses he had already made.

The Instructional Program

Even with the increase of core capacity from 16K to 24K it was still not possible to include the required extensive teaching program with any one of the five main testing programs. A detailed teaching session was included to ensure that all Ss were thoroughly conversant with the operation of the IBM 1500 Instructional System. In order to attain the desired level of demonstrated understanding, it was necessary to make provision for the computer's acceptance, assessment, and response to Ss' performances. Again, this created programming difficulties that were solved only after extensive trial and error.

In order to solve the core capacity problem that was occasioned by the use of a satisfactory instructional session,

it was necessary to create two separate programs: the Instructional Program, and the Testing Program with its five main sub-testing programs. This was not an ideal solution because it meant that all the Ss at any one test session had to complete the teaching session before any S could commence the testing session.

The Instructional Program differed from the Testing Program in two ways. Firstly, it did not need the facility for recording and storing Ss' responses whereas this was an essential aspect of the Testing Program. Secondly the Instructional Program had to be able to indicate, at several points, whether or not the S had responded correctly. This did not need to be a feature of the Testing Program.

Storage of Ss' Responses

Ss' responses to both the cloze tests and the multiple-choice tests were recorded on disk. To avoid the possible confusion of the data generated from different sessions, the responses from each testing occasion were placed in a separate file. These responses were subsequently transferred to a tape for sorting at a later date. The necessary sorting of Ss' responses was carried out on the IBM 360/67 computer located in the Computing Services Division of the University of Alberta.

Summary

The IBM 1500 Instructional System was employed in the administration of the experimental texts and tests, and

the collection of the data produced by them in this study. There were four main reasons why the 1500 System was considered to be very well suited to fulfilling this function. Firstly, it permitted the separate presentation of each of the different chunks which comprised the experimental formats. Secondly, the 1500 System made it possible to collect data from 13 Ss simultaneously. Thirdly, performance records were collected and stored in the System. This made the experimental data relatively easy to collect and subsequently process. Fourthly, the modifications which it was possible to effect within the System provided for individual reading and response rates.

CHAPTER 10

FINDINGS: THE RESULTS OF THE TOTAL SAMPLE AND THE FIVE EXPERIMENTAL GROUPS ON ALL TESTS

Introduction

This chapter provides data on the performance of Ss on the five experimental tests of reading, the subtests of the Cooperative English Test of Reading Comprehension (Educational Testing Service, 1960), and the adaptation of Bousfield's clustering in recall test.

Inter-Correlations of Experimental Test Scores

Table 10.1 shows the correlations between the five experimental tests of reading. This table reveals that each of these tests is significantly related to every other test. The inter-correlations range from .43 to .64 ($p < .01$). This evidence indicates that the profiles of the scores obtained by the total sample on these tests were substantially similar. Figure 10.1 also demonstrates the similarity of results obtained on the five test types.

The pattern of similarity across the means and variances of test scores (reflected in a non-significant F-ratio), and the similarity of the profiles of the scores in each test (reflected by the positive, significant correlations between tests), suggest not only that the tests were similar in the demands which they made upon the subjects completing them, but also that no test was more difficult to

TABLE 10.1 -- Inter-correlations between results achieved by the total sample on the five experimental reading tests

Type of Test #	CL	FDP	FDPP	LAP	LAPP
CL		.52**	.64**	.45**	.46**
FDP			.62**	.43**	.60**
FDPP				.50**	.57**
LAP					.50**
LAPP					

** p < .01 #See: Chapter 1 - "Definitions," for the key to these abbreviations.
 * p < .05

handle in interaction with the IBM 1500 Instructional System than any other test. The evidence gathered in the pilot study reported in Chapter 7 indicated that the method of completing the cloze test (by typing the response on the computer terminal keyboard) may have depressed the scores obtained by Ss on that test. Clearly, the alterations in response procedure, effected as a result of the pilot study observations, eradicated this as a source of undesirable variation.

It is conceded that the correlations in Table 10.1 are not high. They are considered to be significant for other than statistical reasons, however, because for each experimental group of 65 Ss the individual test types were based on a different passage of prose presented by means of a different format. This would also suggest that the interactions between specific tests and particular passages, and between tests and formats, did not have a significant

influence on the test results. This suggestion is supported by evidence to be presented in the section dealing with the impact of the various formats upon the comprehension performance of the Ss.

Summary

The data reported in this section have established that the five experimental tests produced significantly similar score profiles. These data were generated in spite of the use of five different presentation formats and five different prose passages. That is, although the five sets of test stimuli were widely divergent in nature, the response patterns they generated were characterized by similarity.

Performance of the Total Sample on the Subtests of the Standardized Reading Test

Mean Test Scores

The means and standard deviations for the Level of Comprehension and Vocabulary subtests of the Cooperative English Test of Reading Comprehension (Educational Testing Service, 1960) are presented in Table 10.2. This table indicates a substantial disparity between the means of the converted scores for these two subtests. The Cooperative English Tests Manual for Interpreting Scores (Educational Testing Service, 1960) lists the norms obtained from the college sophomore norming sample (spring testing). These norms quote the means set out in Table 10.3. The authors of the test claim that a student's standings in these two areas

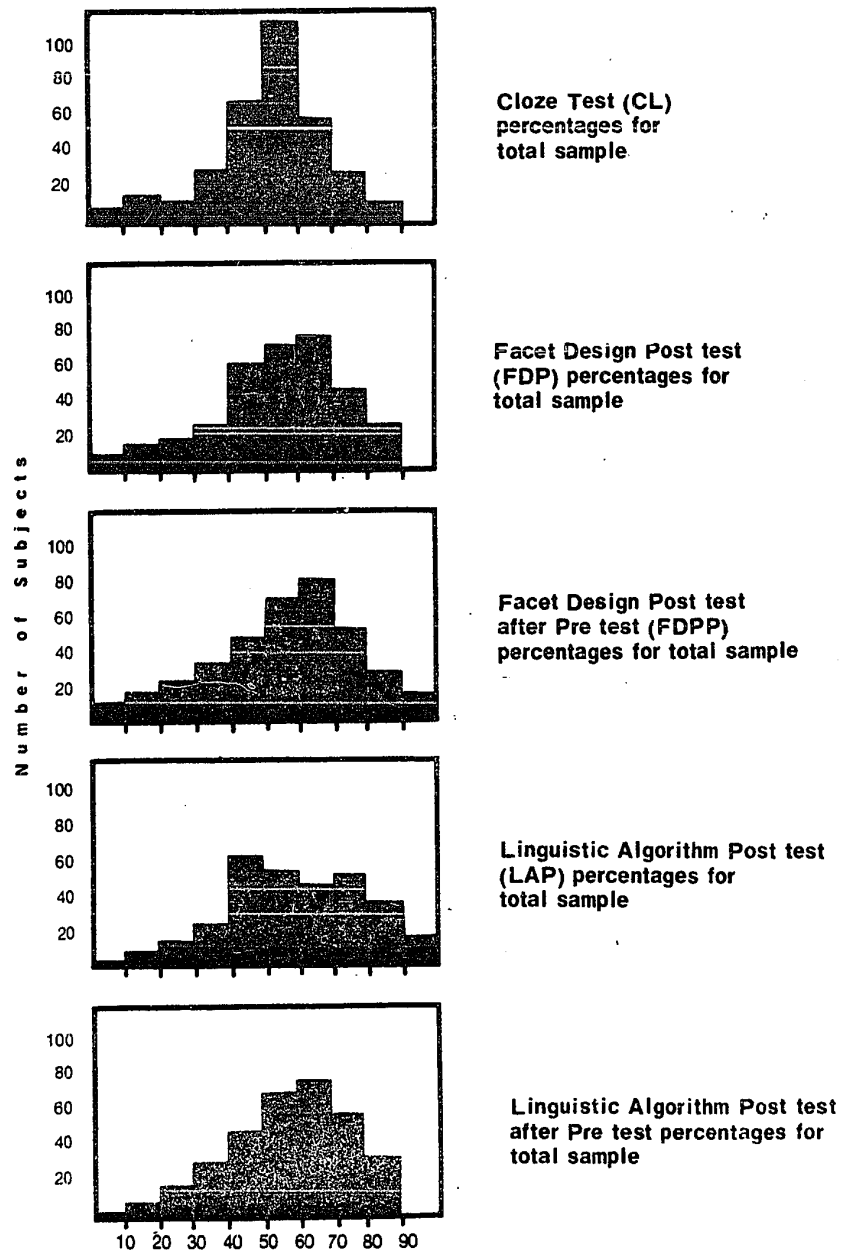


Fig. 10.1 -- Distributions of percentages for total sample (N = 325) on the five experimental reading tests.

will generally not be markedly different. Since the largest disparity between these scores in the means of the norms set out in Table 10.3 is 3.62 converted score points for the upper quartile, it would appear that the disparity in the scores of the experimental sample are significantly different. In view of the size of the sample used in this study (N = 325) this difference cannot be regarded as a variation due to chance. As stated above, this test has not been normed for college students beyond the sophomore level. The experimental sample, however, did comprise students at the third and fourth year levels of the B.Ed. program. It is possible that the presence of these Ss in the sample distorted the results of the standardized reading test in the manner described. There are two further points which should be considered. The first is that the norms were constructed with a norming sample of only 252 college sophomores. These Ss were all students attending junior colleges of universities in the United States of America. The norming sample was drawn from 23 such institutions. In view of these facts,

TABLE 10.2 -- Means and standard deviations obtained by the total sample on the subtests of the standardized reading test

Standardized Reading Test Subtests*	Number	Mean	Standard Deviation
LC	325	162.29	7.46
VOC	325	171.17	6.64

*See: Chapter 1 - "Definitions" for the key to these abbreviations.

TABLE 10.3 -- Norms for quartile mean scores of the subtests of the Cooperative English Test of Reading Comprehension (Educational Testing Service, 1960)

<u>Quartile</u>	<u>Converted Scores</u>	
	<u>Level of Comprehension</u>	<u>Vocabulary</u>
Median	161.4	163.4
Lower Quartile	156.5	157.4
Upper Quartile	166.3	169.9

and the fact that the population from which the sample (N = 325) for the present study was selected, attended a single university, and was not necessarily drawn from a population representative of American college students, perhaps comparisons should not be made between the two groups. The second point is that the norms for this level of the test were obtained from a severely limited testing program conducted in the spring of 1959. The norms, therefore, are 13 years old and may well be due for revision. This aspect of the results of the subtests of the standardized reading test has been examined in some detail because these results were employed in this research project for classifying Ss. The disparity noted between the subtest scores was of vital importance to this classifying process. In this case, it is unfortunate that additional evidence could not be collected using another suitable standardized reading test comprised of both vocabulary and level of comprehension subtests. It is interesting to note, however, that the study reported by

Cromer¹ (1970) also produced quite disparate subtest scores on the same standardized test.

Inter-Correlation of Reading Subtest Scores

The correlation of the results achieved by the total sample on the subtests of the Cooperative English Test of Reading Comprehension was positive and significant ($R = .42$, $p < .01$). Since the Cooperative English Tests Manual for Interpreting Scores does not provide a correlation for the norming sample against which this figure might be compared it is not possible to state whether a correlation of .42 may be considered an adequate relationship between the results of these two subtests. The distributions of the two sets of scores are shown in Figure 10.2 and 10.3.

Summary

The foregoing data show that although the converted scores on the subtests of the standardized reading test are positively and significantly correlated, there is a substantial disparity between their means. The relationship between an individual's scores on each of these subtests is of basic importance in the stratification of the sample that was carried out to permit the testing of some of the research hypotheses. Although this section did suggest reasons for the disparity noted, it also emphasized the need for the application of another standardized reading test with

¹ See: Chapter 4

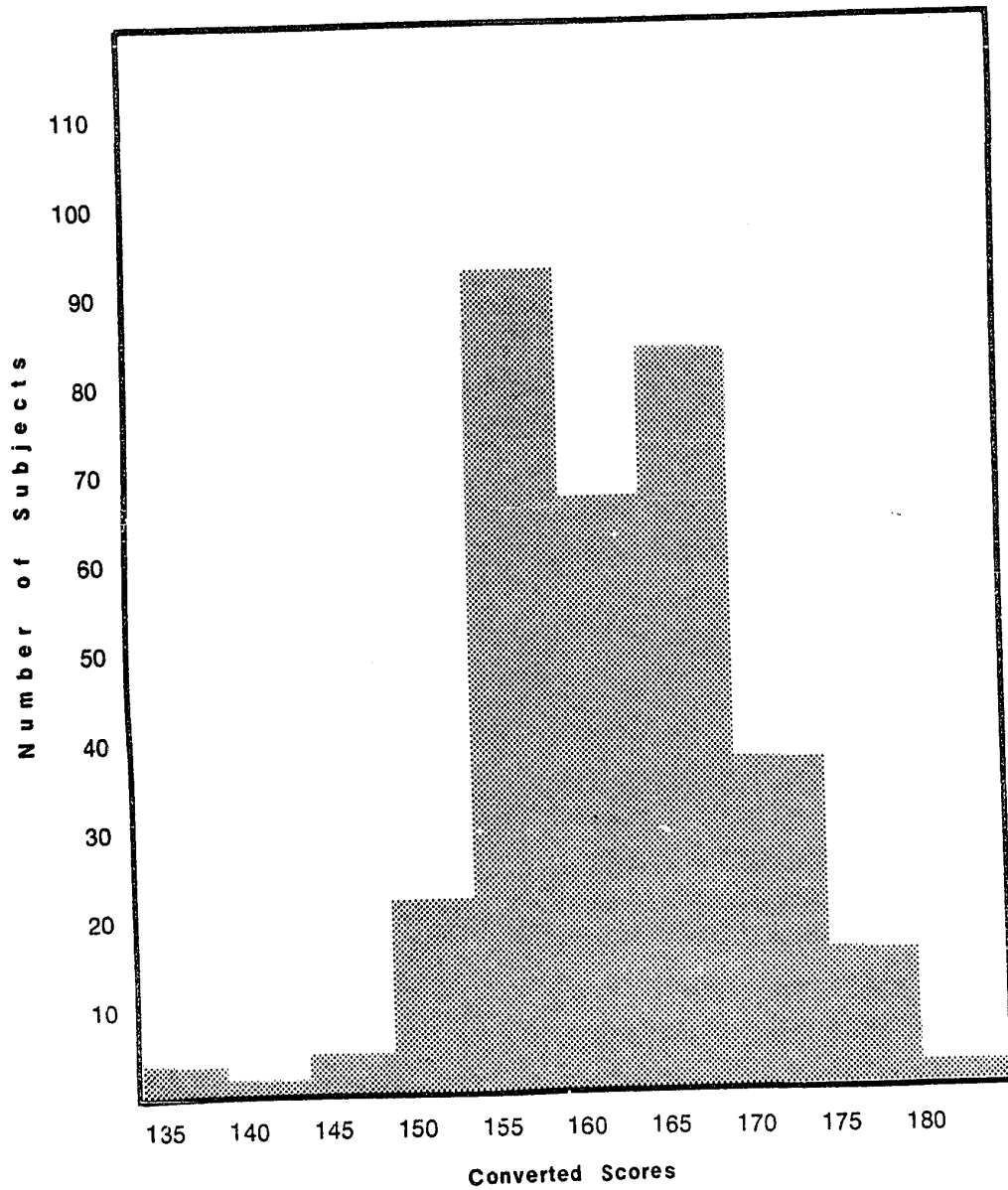


Fig. 10.2 -- Distribution of converted scores for total sample (N = 325) on Level of Comprehension subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION.

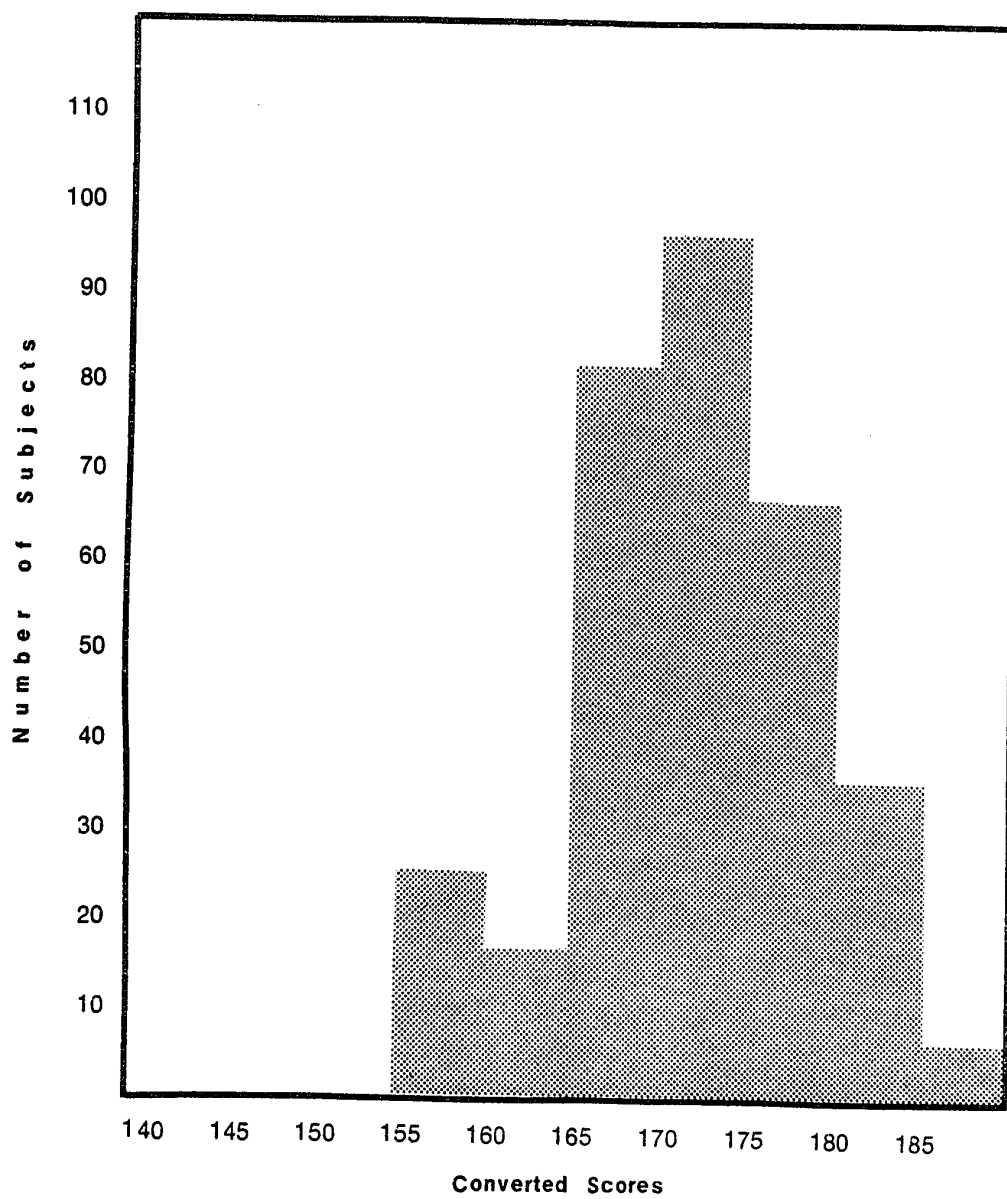


Fig. 10.3 -- Distribution of converted scores for total sample (N = 325) on Vocabulary subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION.

similar subtests. Since this could not be done, some suspicion must be directed towards the validity of the stratification conducted. This, in turn, means that the findings based on this sub-division of the experimental sample must be accepted with reservation.

Performance by the Total Sample
on the Test of Clustering in Free Recall

As was explained in Chapter 8, Bousfield's test of clustering in free recall was adapted for use as a visual test in this study (as opposed to its use as an auditory test by Bousfield), and was employed to provide two items of data. These were (1) the RR score or Ratio of Repetition; and, (2) the RSR score or Ratio of Serial Repetition. It has already been pointed out that these scores were obtained in order to classify Ss according to the information processing strategy they employed in the specific, structured situation provided by the adapted Bousfield test of clustering in recall.

Mean Test Scores

Table 10.4 shows the performance of the full sample on the test of clustering in recall. The scores represent

TABLE 10.4 -- Means and standard deviations of RR and RSR scores obtained by the total sample

<u>Method of Classifying Scores</u>	<u>Number</u>	<u>Mean</u>	<u>Standard Deviation</u>
RR	325	41.63	17.66
RSR	325	4.74	10.26

the means and the standard deviations obtained by the 325 Ss on both the RR and RSR scores. The RR and RSR scores do not stand for the number of words recalled, but rather the way in which the recall task was carried out. The RR score, for example, represents the index of the number of words recalled in the four broad categories of which the 60 word Bousfield list is comprised. This index indicates the percentage of the 60 word list, common to one category, that are recalled consecutively. The RSR score represents the percentage of the total words that are reproduced in the precise serial order in which they were displayed.

Inter-Correlations of Recall Test Scores

The RR and RSR scores represent distinctly different methods of processing the information in the recall task. It is not surprising, therefore, to note a significant negative correlation between them ($R = -.60$, $p < .01$). This finding is supported by the markedly dissimilar score distributions in Figures 10.4 and 10.5.

Summary

Data were collected using an adaptation of the Bousfield test of clustering to recall. This was done to permit the classification of Ss according to the information processing strategy they employed to complete the task.

This test is strongly biased towards the use of the information processing strategy of simultaneous synthesis. For this reason the most efficient recall was effected by Ss

who employed this technique. This fact is reflected in the high mean for the RR score in comparison with the mean for the RSR score. That these approaches to the processing of the information in this task are disjunctive is substantiated by the significant, negative correlation between the two sets of scores.

Relationship between the Results
of the Experimental Tests, the Recall Test, and the
Subtests of the Standardized Reading Test for the Total Sample

Table 10.5 presents the correlation matrix for the nine variables discussed in the previous sections.

TABLE 10.5 -- Inter-correlations between the results obtained by the total sample on all tests

Tests	CL	FDP	FDPP	LAP	LAPP	LC	VOC	RR	RSR
CL		.52**	.64**	.45**	.46**	.59**	.44**	.56**	-.31**
FDP			.62**	.43**	.60**	.46**	.37**	.27**	-.08
FDPP				.50**	.57**	.52**	.29**	.32**	-.16**
LAP					.50**	.49**	.32**	.26**	-.12
LAPP						.55**	.34**	.29**	-.08
LC							.42**	.49**	-.22**
VOC								.39**	.01
RR									-.59**
RSR									

** p < .01

* p < .05

The standardized subtests and the experimental tests

The positive relationship between the results for the five experimental reading tests and both the subtests of the standardized reading test is evident in Table 10.5. It

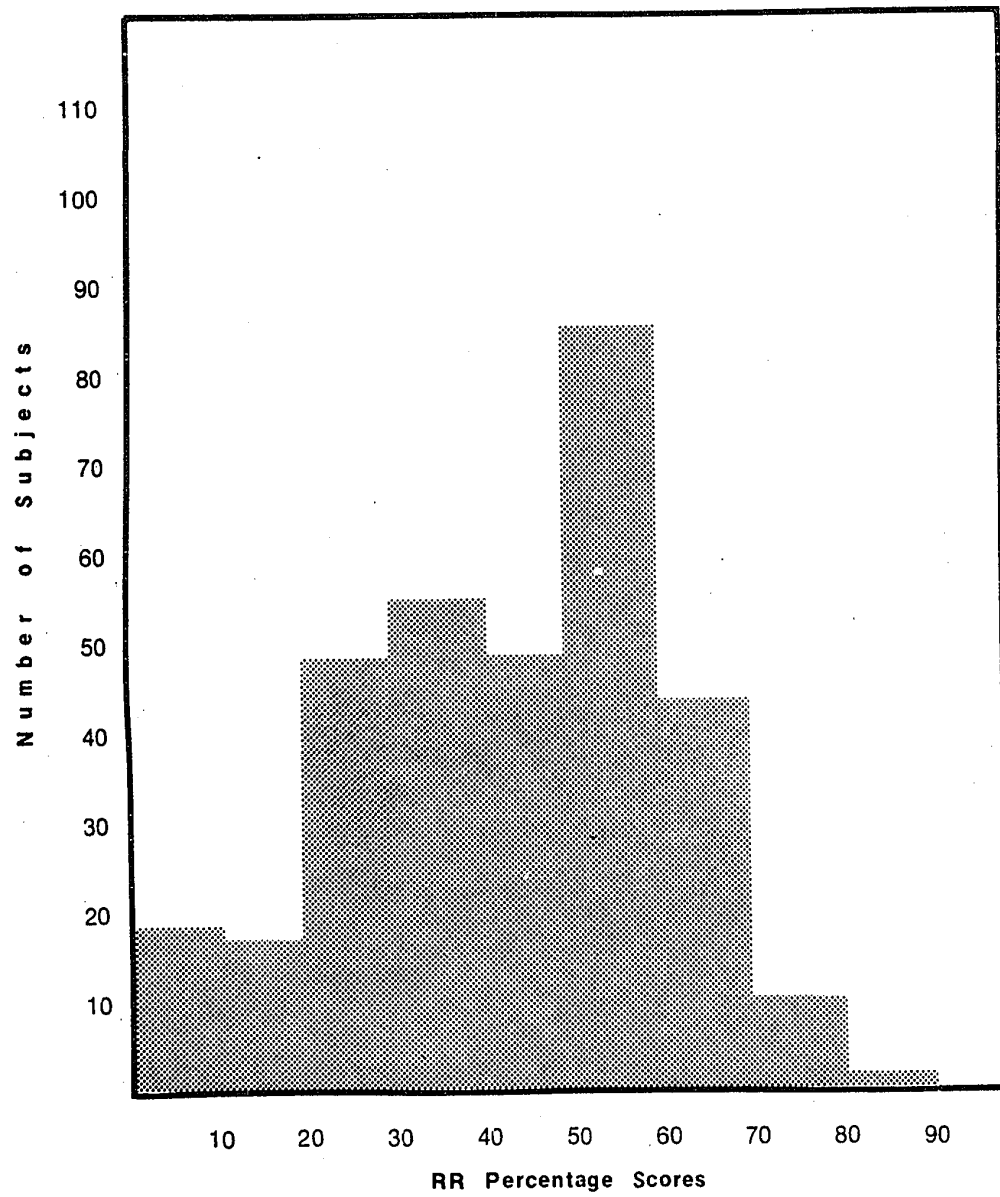


Fig. 10.4 -- Distribution of Ratio of Repetition percentages for total sample (N = 325).

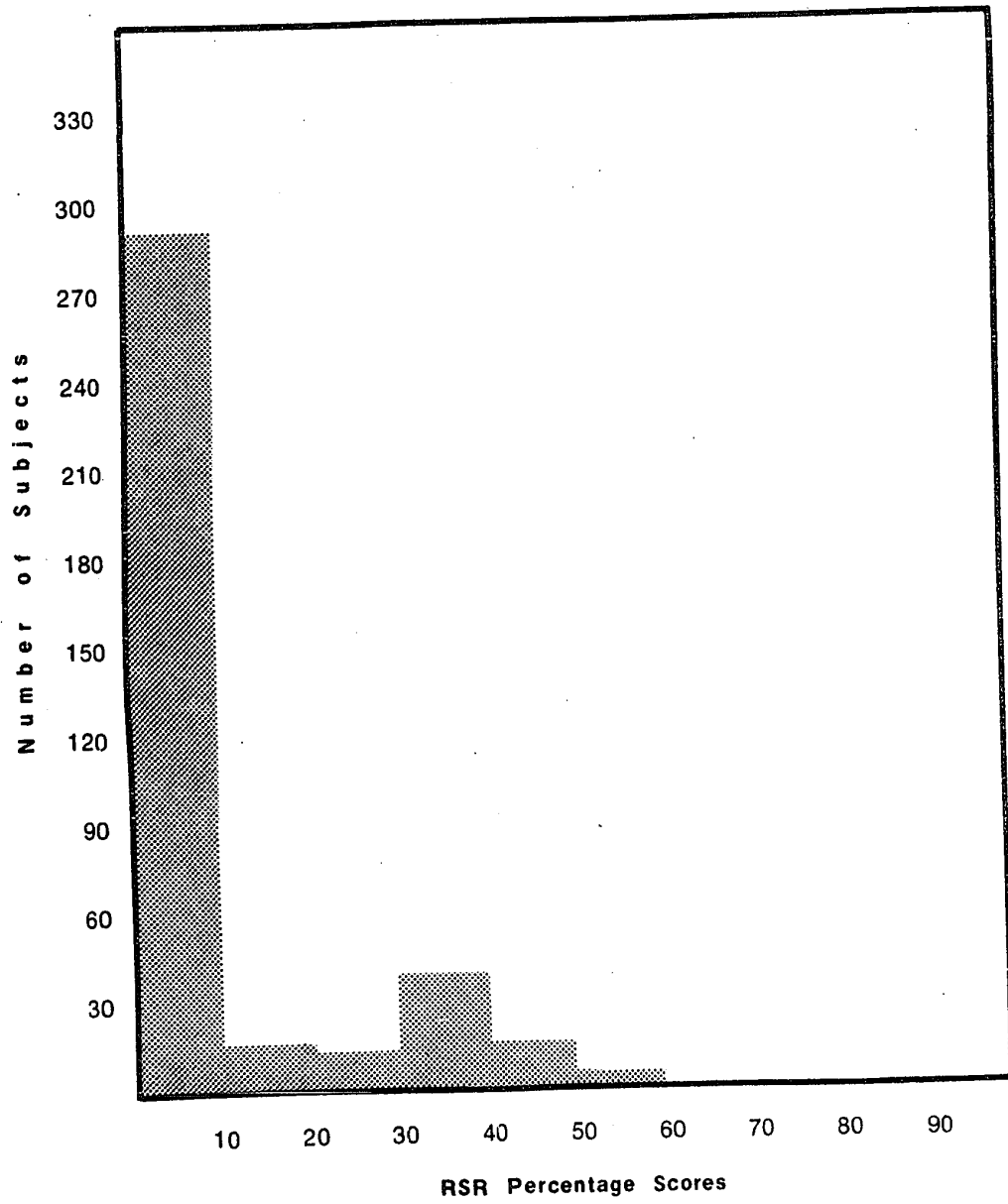


Fig. 10.5 -- Distribution of Ratio of Serial Repetition percentages for total sample (N = 325).

can be seen from this table, however, that the correlations between the Level of Comprehension subtest and the five experimental tests are higher than the correlations between the Vocabulary subtest and the experimental tests. The reason for this was evident in Table 10.2 which showed that the correlation between the two subtests was lower than any of the correlations between the results on the Level of Comprehension subtest and the results on the experimental tests. Although this set of lower correlations exists between the Vocabulary subtest and the experimental tests, the pattern of these correlations is similar to those between the Level of Comprehension subtest and the experimental tests. That is, the experimental tests which correlate most highly with the Level of Comprehension subtest tend also to correlate most highly with the Vocabulary subtest. The stable pattern of these sets of inter-correlations substantiates the point made in an earlier section: the five different types of experimental reading tests produced similar score profiles and these, in turn, were similar to the profiles of the scores obtained on both the subtests of the standardized reading test. The unexpectedly high scores in the vocabulary subtest may be attributable to the fact that the subtest loses its capacity to discriminate between Ss in the range of its higher scores. That is, it would seem likely that a substantial proportion of these Ss reached the "ceiling" of the test which, thus, lost its power to discriminate between them.

There is clear evidence in Table 10.5 that although the cloze tests were constructed from passages of about 200 words rather than the widely recommended minimum number of 250 words, the cloze tests provided acceptable and consistent measures of reading ability. The cloze test scores correlated positively and significantly with the Level of Comprehension subtest scores of the standardized reading test and also with the other four experimental reading tests.

The reading tests and the test of recall

The 60 words used in the recall test were drawn in equal numbers from four common categories: "animals," "professions," "vegetables," and "given names." The words were displayed in random order. After all words had been shown, Ss were required to recall as many as possible. As proposed in Chapter 8, the task is structured to favor use of the information processing strategy of simultaneous synthesis (Luria, 1966a, 1966b). That is, Ss who use simultaneous-synthesis in appropriate situations, were expected to recall the words reorganized as simultaneous members of the above categories. Since the list is extensive (60 words), it is contended that the successful¹ performance of

¹For the purposes of this study "successful" is not defined in absolute terms. Ss were ranked according to their RR scores and then, on the basis of this ranking, were assigned to groups for the purpose of testing the hypotheses formulated in Chapter 5.

the task requires the highest level of simultaneous synthesis as defined by Luria. It was also argued in Chapter 8, that Ss who failed to make use of the word categories to organize the words for recall, would be revealing a tendency to use an inappropriate information processing strategy, or none at all. In addition, it was suggested that Ss who recalled words in the serial order in which they were displayed, in preference to the four categories, would be showing a propensity for the inappropriate use of successive synthesis (Luria, 1966a, 1966b). The theoretical position adopted in Chapter 5 emphasizes that the successful reading act, in addition to numerous other skills, most likely requires the appropriate application of both types of cognitive synthesis discussed by Luria. The theory further proposed that the appropriate use of these syntheses in fluent reading probably requires the prior application of simultaneous synthesis. An examination of the relationships of the two recall scores, derived from the adapted Bousfield test, to the various reading tests is, therefore, of fundamental importance in the interpretation of the experimental findings to be analyzed in Chapter 11.

Table 10.5 shows the positive and significant correlation between the ratio of repetition scores (RRs) and the results obtained on both the experimental tests of reading and the subtests of the standardized test of reading. This suggests that there is an important relationship between a reader's ability to comprehend the materials of written

discourse and his ability to select and employ an appropriate information processing strategy for a specific task.

The usefulness of the recall test as a crude predictor of the ability to comprehend written language is indicated by the correlations between the RSR scores and all other sets of scores (see: Table 10.5). The RSR score was, in effect, a measure of the extent to which a student tended to employ an inappropriate information processing strategy for the recall task. All correlations between the RSR scores and all other scores were either negative and significant, or, positive but not significant. The RSR scores were the only ones to produce negative correlations or positive but non-significant correlations.

Summary

This section has reported significant, positive correlations between the results on the experimental reading tests, the results on the subtests of the standardized reading test, and the RR scores achieved on the test of clustering in recall. The correlations of these variables with the RSR scores of the test of clustering in recall were either negative and significant or positive but not significant. The coefficients of correlation between the results on the experimental reading tests and the results on the Level of Comprehension standardized subtest reflect substantially similar distributions of scores.

The Results Obtained
by the Five Experimental Groups

The research design employed in this study called for the haphazard assignment of Ss to five main experimental groups each comprised of 65 Ss (see: Chapter 6). This assignment of Ss was carried out and the experimental tests, the standardized subtests, and the adapted Bousfield test, were administered to Ss on the basis of their membership in these groups.

The Comparability of the
Five Groups on the Standardized Subtests

Some data have already been presented in Chapter 6 regarding the similarity of the five experimental groups. The data presented here, on selected variables, are intended to supplement that information.

Level of comprehension

Table 10.6 presents the means and standard

TABLE 10.6 -- Means and standard deviations of the results achieved by the five experimental groups on the Level of Comprehension subtest of the Cooperative English Test of Reading Comprehension

<u>Group</u>	<u>Number</u>	<u>Mean</u>	<u>Standard Deviation</u>
1	65	162.37	7.71
2	65	162.23	7.12
3	65	162.71	6.90
4	65	162.90	7.74
5	65	161.17	6.95

deviations obtained by each of the five groups on the Level of Comprehension subtest of the Cooperative English Test of Reading Comprehension. This table clearly reflects the marked similarity of the five groups on this variable. This evidence is further supported by the one-way analysis of variance that was carried out on these data. The result of this analysis ($F = 0.44$, $df = 4/320$, n.s.) indicates the similarity of the five sets of scores. The distribution of the scores achieved by the five groups on this subtest are presented in Figure 10.6.

Vocabulary

The results obtained by the five groups on the Vocabulary subtest of the Cooperative English Test of Reading Comprehension are set out in Table 10.7. This table shows the similarity of the groups on this variable. The one-way analysis of variance conducted on these data revealed no statistical difference between the five data

TABLE 10.7 -- Means and standard deviations of the results achieved by the five experimental groups on the vocabulary subtest of the Cooperative English Test of Reading Comprehension

<u>Group</u>	<u>Number</u>	<u>Mean</u>	<u>Standard Deviation</u>
1	65	170.40	6.37
2	65	171.71	6.69
3	65	172.31	7.25
4	65	171.55	7.26
5	65	169.90	5.95

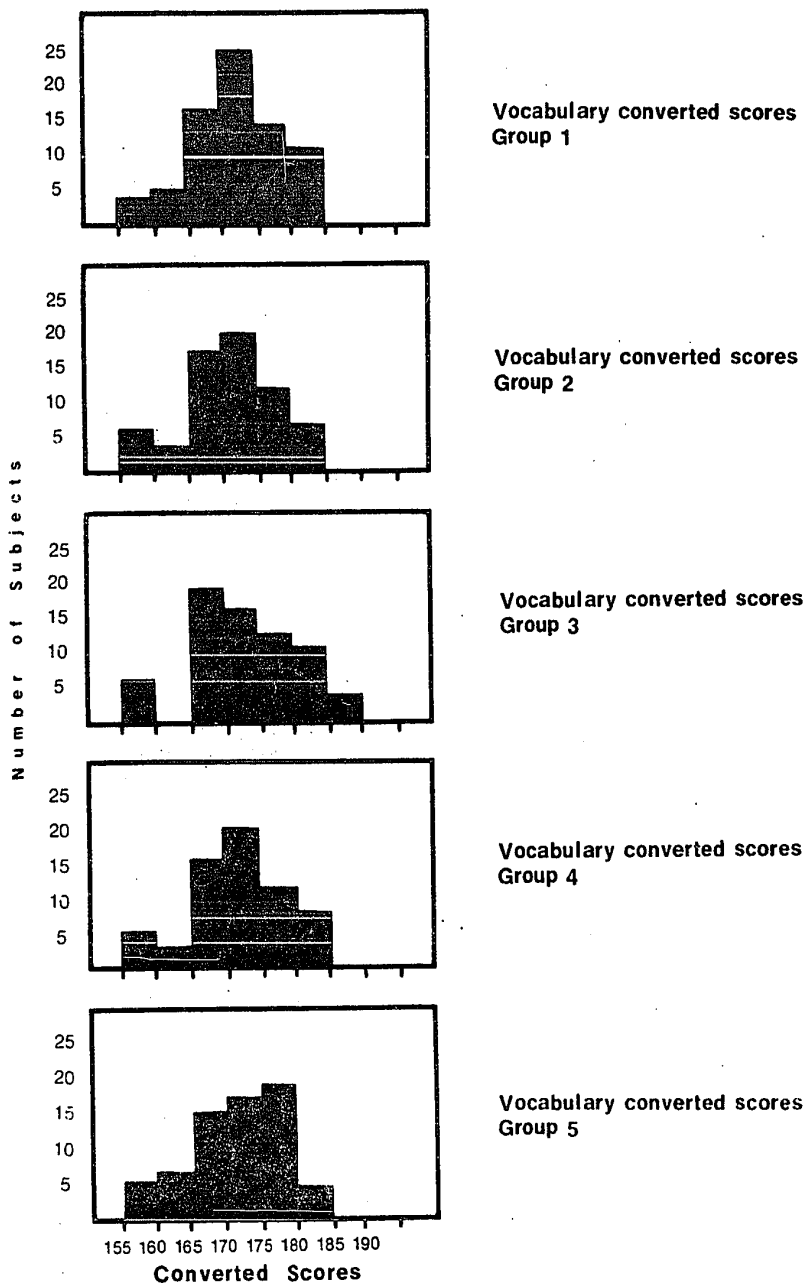


Fig. 10.6 -- Distributions of converted scores for experimental groups (n = 65) on Vocabulary subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION.

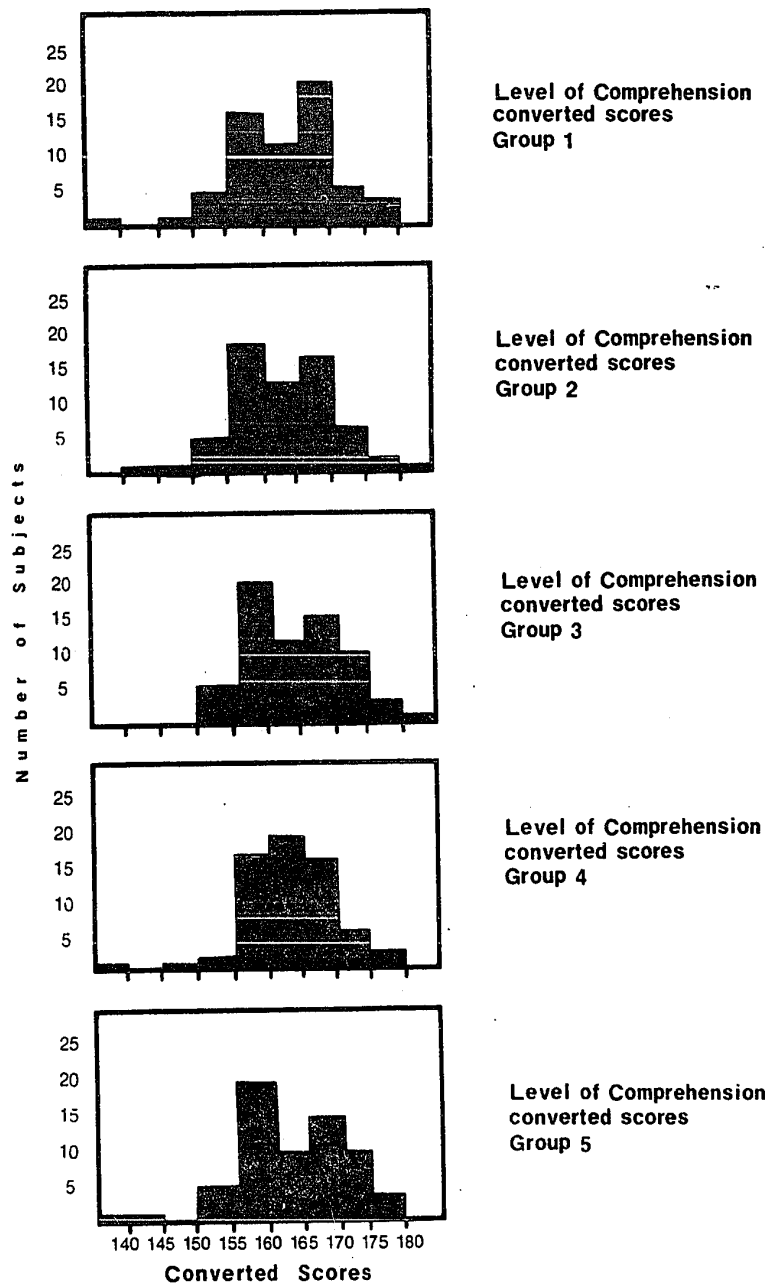


Fig. 10.7 -- Distributions of converted scores for experimental groups (n = 65) on Level of Comprehension subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION.

TABLE 10.8 -- Means and standard deviations of the RR scores obtained by the five experimental groups on the test of clustering in recall

<u>Group</u>	<u>Number</u>	<u>Mean</u>	<u>Standard Deviation</u>
1	65	42.06	18.24
2	65	42.28	17.86
3	65	41.88	18.03
4	65	41.80	17.73
5	65	41.69	17.62

sets ($F = 1.48$, $df = 4/320$, n.s.). The distribution of the groups' scores on this subtest are indicated in Figure 10.7.

The Comparability of the Five Groups on the Test of Recall

Because the results of the tests of clustering in recall were of basic importance in stratifying the experimental groups for testing the research hypotheses, the results achieved by the five groups on this test are presented in this section.

The ratio of repetition in recall (RSR)

Table 10.8 presents the means and standard deviations of the RR indexes obtained by each of the five groups in completing the test of clustering in recall. This table again indicates the extremely close similarity of the groups. The one-way analysis of variance carried out on these data produced no significant difference across the five sets of data ($F = 0.11$, $df = 4/320$, n.s.). The distributions

TABLE 10.9 -- Means and standard deviations of the RSR scores obtained by the five experimental groups on the test of clustering in recall

<u>Group</u>	<u>Number</u>	<u>Mean</u>	<u>Standard Deviation</u>
1	65	4.26	9.86
2	65	4.34	10.12
3	65	4.31	10.27
4	65	4.24	9.63
5	65	4.35	10.22

of scores for the five groups are shown in Figure 10.8

The ratio of serial recall (RSR)

As already mentioned the structure of the adaptation of the Bousfield test of clustering in recall used in this study discouraged the use of an information processing strategy based on serial organization--see Figure 10.9. The RSR index was used in identifying a very small number of Ss who nevertheless used this strategy. These data are therefore presented in Table 10.9. As would be anticipated with such consistently low scores and the large groups involved, the five mean scores on this variable are also very close. The majority of Ss scored an RSR index of between 0 and 5 per cent. Not surprisingly, the one-way analysis of variance on these data produced an F-ratio of 0.00.

Summary

The purpose of this chapter has been to establish the inter-relatedness of the nine variables on which data were generated.

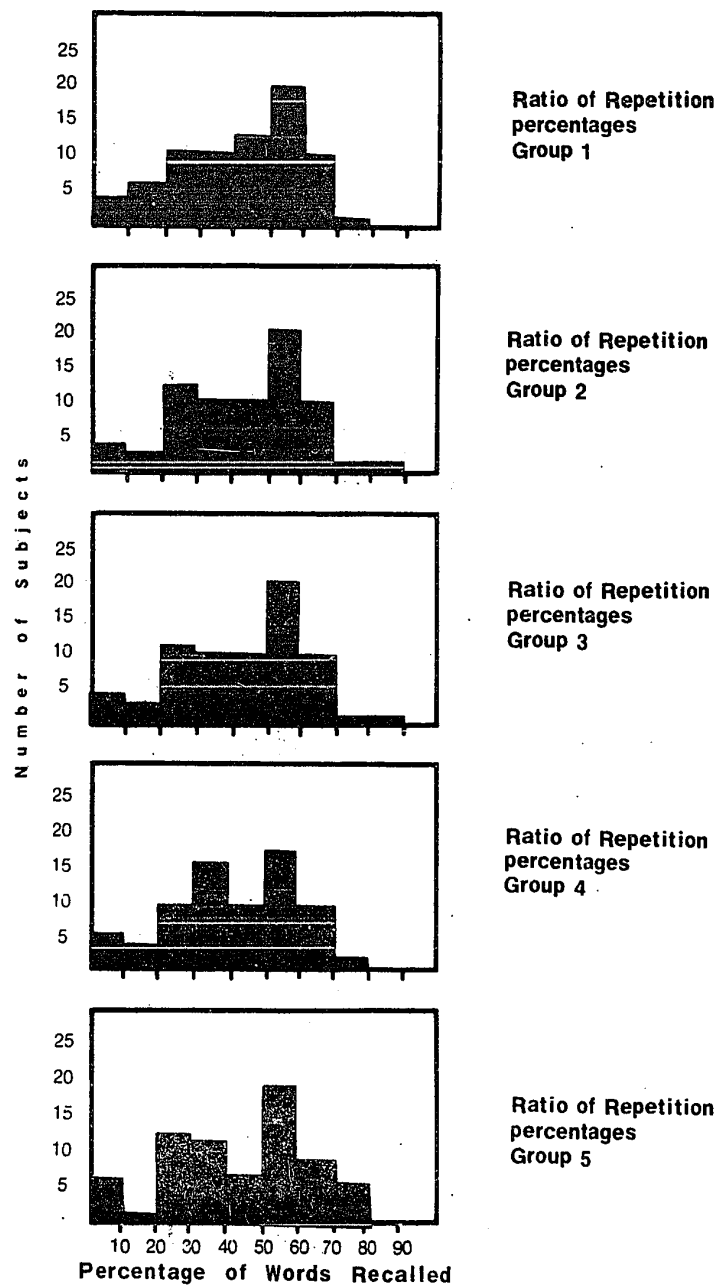


Fig. 10.8 -- Distributions of Ratio of Repetition scores for experimental groups (n = 65).

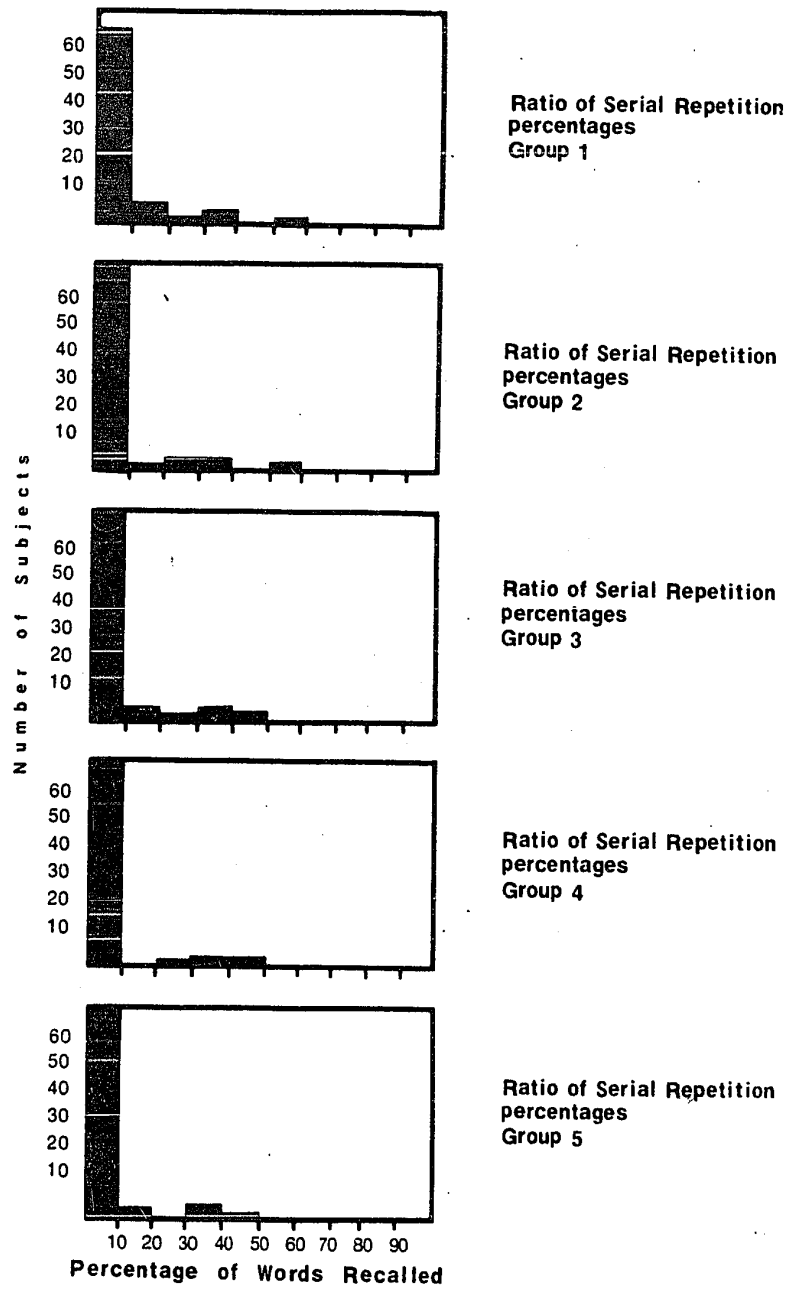


Fig. 10.9 -- Distributions of Ratios of Serial Repetition percentages for experimental groups (n = 65).

The subtests of the standardized reading test produced scores which were found to be positively and significantly correlated. At the same time it was noted that the means of the two sets of subtest converted scores were a considerable distance apart. While it was pointed out that this disparity could have stemmed from several causes it was also conceded that, since the disparity between these scores formed the basis of the classification of sub-groups for hypothesis testing, another test should have been employed to substantiate the results.

An adapted form of the Bousfield test of clustering in recall was used to classify the experimental Ss into two broad categories: (1) those who employed an appropriate information processing strategy; and, (2) those who employed an inappropriate information processing strategy.

This chapter has also reported the positive, significant correlation between the scores for all variables except those associated with the variable of serial recall.

CHAPTER 11

FINDINGS: INFORMATION PROCESSING STRATEGIES AND COMPREHENSION: UNITS OF RECEPTIVE, WRITTEN LANGUAGE PROCESSING AND COMPREHENSION: SIMULTANEOUS SYNTHESIS AND COMPREHENSION

Introduction

The main purposes of this study were to investigate the relationships between comprehension in college readers and, (a) the ability to select an appropriate information processing strategy for a specific verbal task; (b) the types of units used in the receptive processing of written language; and, (c) on the basis of this investigation, to draw conclusions about the role of simultaneous synthesis in the comprehension of written language.

The data from the standardized test of reading comprehension and the test of clustering in recall were used to establish the relationship between comprehension and the ability to select an appropriate information processing strategy. The data for the other aspects of the study were secured by assessing the comprehension of the Ss when they were presented with samples of prose material in various preorganized formats made up of chunks comprised of one or more words.

In order to increase the generalizability of the findings produced by these experimental procedures, a large sample was employed together with five different prose

passages and five different methods of evaluating comprehension. Thus, the design for data collection made use of four factors: (a) five groups to which the 325 Ss were assigned in the manner described in Chapter 6; (b) five different prose passages selected to provide a variety of themes and prose styles, and some variation in readability; (c) five different testing techniques for assessing the Ss' comprehension of the prose passages; and, (d) the five different presentation formats which represented the chief factor under investigation. The five levels of these four factors were arranged into a fully balanced Greco-Latin Square with repeated measures being obtained on the factor of groups.

The purpose of this chapter is to examine the results of various analyses on the total sample and the subgroups created with the assistance of the various classifying variables.

The Selection of an Appropriate Information Processing Strategy

The theoretical discussion in this study has emphasized the probability that the comprehension of language, whether spoken or written, is, in a fundamental way, a synthesizing activity. The information contained in incoming, language-based messages is processed according to two synthesizing strategies--simultaneous and successive syntheses. The purpose of this section is to examine the relationship between the ability to select the appropriate information processing strategy for the completion of a

specific verbal task and level of comprehension of written discourse.

The findings discussed here are based on the assumption that a viable argument has been presented elsewhere in this study that the test of clustering in recall is a task for which simultaneous synthesis is the appropriate information processing strategy.¹ This analysis is intended to address Question 1 in Chapter 5 and the hypotheses generated from it in that chapter.

Question 1

Is the ability to select an appropriate information processing strategy for the completion of a specific verbal task, related to reading performance?

Hypothesis 1A

The correlation between Level of Comprehension subtest converted scores and the RR scores of the test of clustering in recall will be positive and significant.

The correlation between these sets of scores was .49 ($p < .001$). Hypothesis 1A is found, therefore, to be tenable.

Hypothesis 1B

Groups of Ss whose mean RR scores are "good" will also produce "good" means on the Level of Comprehension subtest.

As was outlined in Chapter 6, the sample was

¹See: Chapters 2 and 5.

dichotomized according to Level of Comprehension subtest scores. It was possible to assign all but 25 Ss to one of two relatively distinct groups. These groups were classified as consisting of "good" and "poor" readers respectively. The Ss who took part in this research project were all undergraduate university students. The term "poor" readers, therefore, should not be interpreted in any absolute sense.

The mean RR score for the "good" group ($n = 150$) was found to be significantly better than the mean for the "poor" group ($n = 150$)--($t = 9.00$, $df = 298$, $p < .0001$ one tailed). This finding is consistent with the positive and significant correlation found between the LC and RR scores for the total sample.¹

The 25 Ss with the lowest RR scores were the members of the RSR group.² This group was withdrawn from the "poor" group reducing it to 125 Ss. The RSR group had been matched to the FSG group² so this group was withdrawn from the "good" group to maintain the equality of the "good" and the "poor" groups. On the mean RR scores it was discovered that the reduced "good" group was still significantly better than the "poor" group ($t = 7.85$, $df = 248$, $p < .001$ one tailed).

The Deficit group² also produced low RR scores so these readers were removed from the "poor" group to reduce

¹See: Chapter 10.

²See: Chapter 6.

it to 100 Ss. The Deficit group had been matched to the FSG group¹ which was withdrawn from the "good" group to reduce its size to 100 Ss. The means for the RR scores for the two reduced groups remained significantly different ($t = 6.46$, $df = 198$, $p < .0001$ one tailed), in favor of the group of "good" readers.

The remaining group with the lowest RR scores was the SLD group¹ which had been matched to the SLG group.¹ The withdrawal of these groups reduced the "good" and "poor" groups to 50 Ss each. The means of the RR scores of the two groups were found to be no longer statistically different ($t = 0.65$, $df = 98$, n.s. one tailed).

The results of these analyses indicate that hypothesis 1B is untenable. Notwithstanding this, when the RR scores are used as a classifying variable, the comprehension ability of 66 per cent of the Ss in this sample can be correctly, though broadly, classified as "good" or "poor." Although no causal connection between comprehension scores and RR scores can be predicated on the basis of these findings, there is clearly a relationship between the two. Thus, there would seem to be a relationship between the comprehension of connected, written discourse and the ability to complete a verbal task calling for simultaneous synthesis.

¹See: Chapter 6.

Hypothesis 1C

Ss who employ successive synthesis in the test of clustering in recall will be below the sample average in their performance on the Level of Comprehension subtest.

It has been argued elsewhere in this study that simultaneous synthesis is the appropriate information processing strategy to use in completing the test of clustering in recall. The close examination of the protocols of all the Ss who completed this test revealed that a very small number of Ss had recalled the items in the test in the order in which they had been displayed. The fact that this was an inappropriate strategy to employ for this task is indicated by the poor recall results of these Ss.

Support was advanced in an earlier section of this report for the notion that the reading act appears to require the application of both simultaneous and successive syntheses. These synthesizing strategies must be applied in a particular order. Simultaneous synthesis seems to be called for prior to the application of successive synthesis. The fact that simultaneous synthesis applies, in general, at the sentence level, and successive synthesis and simultaneous synthesis at the discourse level, suggests that simultaneous synthesis may be a necessary antecedent to successive synthesis in the understanding of continuous, written discourse. This hypothesis was formulated to ascertain the extent of any relationship between the use, by some Ss, of an inappropriate information processing strategy

on a concept-based task, and the standard of their performance on the Level of Comprehension subtest.

The RSR group¹ was comprised of 25 Ss who had apparently used an approach based on successive synthesis to complete the recall task. The mean RR score for this group was 6.76 per cent. For the full sample (N = 325) it was 42.12 per cent. The mean RSR score (ratio of serial recall) for the RSR group was 37.08 per cent while for the total sample it was 4.38 per cent. The RSR group achieved an LC mean score of 156.84. This was substantially below the mean score for the full sample--162.19. On this evidence, hypothesis 1C is upheld.

A crucial point about these results is that the RSR group achieved a vocabulary score that was slightly higher than the mean Vocabulary subtest score for the total sample (Voc mean RSR group = 172.28; Voc mean full sample = 171.77). The lower LC scores of the members of the RSR group cannot be attributed, then, to a restricted knowledge of verbal concepts.

Summary

The following conclusions appear to be justified at this point. If, as has been argued, high RR scores on the recall task do require facility in simultaneous synthesis, it seems likely that a similar cognitive skill is called for in the comprehension of written discourse by college readers.

¹See: Chapter 6.

The fact that simultaneous synthesis is applied successfully in a related task does not ensure that it will be generalized to the reading situation. It may be that the dependence of the successful synthesis of written language upon grammatical factors accounts for the fact that 50 "poor" comprehenders' mean RR score was not significantly different from the mean RR score of 50 "good" comprehenders.

An additional conclusion which appears to be justified on the basis of the above analyses is that Ss who do not employ an appropriate information processing strategy in a related activity are likely to reveal a below average performance in the comprehension of written materials.

Units of Written Language Processing

One assumption is basic to the examination of the data that are analyzed here. Because language processing is not susceptible to direct observation, it is assumed that the manner of presentation of specific language chunks to readers in the experimental sample compelled them to process each chunk or part of a chunk as a unit. This assumption can be made more legitimately in the present context than in other studies that were examined in the section on related literature. Presentation of each chunk was completely separate. If Ss did not wish to adopt the chunking strategy inherent in the method of presentation, they would have had to read in smaller units or have been involved in a most difficult rechunking process that crossed the discrete

presentation of chunks and would have placed an immense burden on short term memory.

A Greco-Latin Square analysis of variance was carried out on the data produced by the total sample on the five experimental reading tests. This analysis produced a non-significant residual term ($F = 1.37$, $df = 8/1280$, n.s.). Although this is not conclusive evidence, it does suggest that the interactions among the four factors of groups, passages, test-types, and formats, did not contribute significantly to the main effects that emerged from the analysis. The data, organized according to the above four factors, are compared in diagrammatic form in Figure 11.1. The format effect was found to be significant ($F = 8.37$, $df = 4/1280$, $p < .001$).

The hypotheses that are discussed in the remainder of this chapter will be evaluated in the light of the data produced by the following groups:¹ the total sample ($N = 325$), the group of "good" readers ($n = 150$), the group of "good" readers ($n = 150$), the group of "poor" readers ($n = 150$), the FLG group ($n = 50$), the FLD group ($n = 50$), the SLG group ($n = 50$), the SLD group ($n = 50$), the FSG group ($n = 25$), the RSR group ($n = 25$), the SSG group ($n = 25$), and the Deficit group ($n = 25$). Comparisons² across groups,

¹For a detailed discussion of the creation of these groups refer to Chapter 6.

²All a posteriori multiple comparisons reported in this chapter were computed according to the procedure attributed to Scheffe (Winer, 1971).

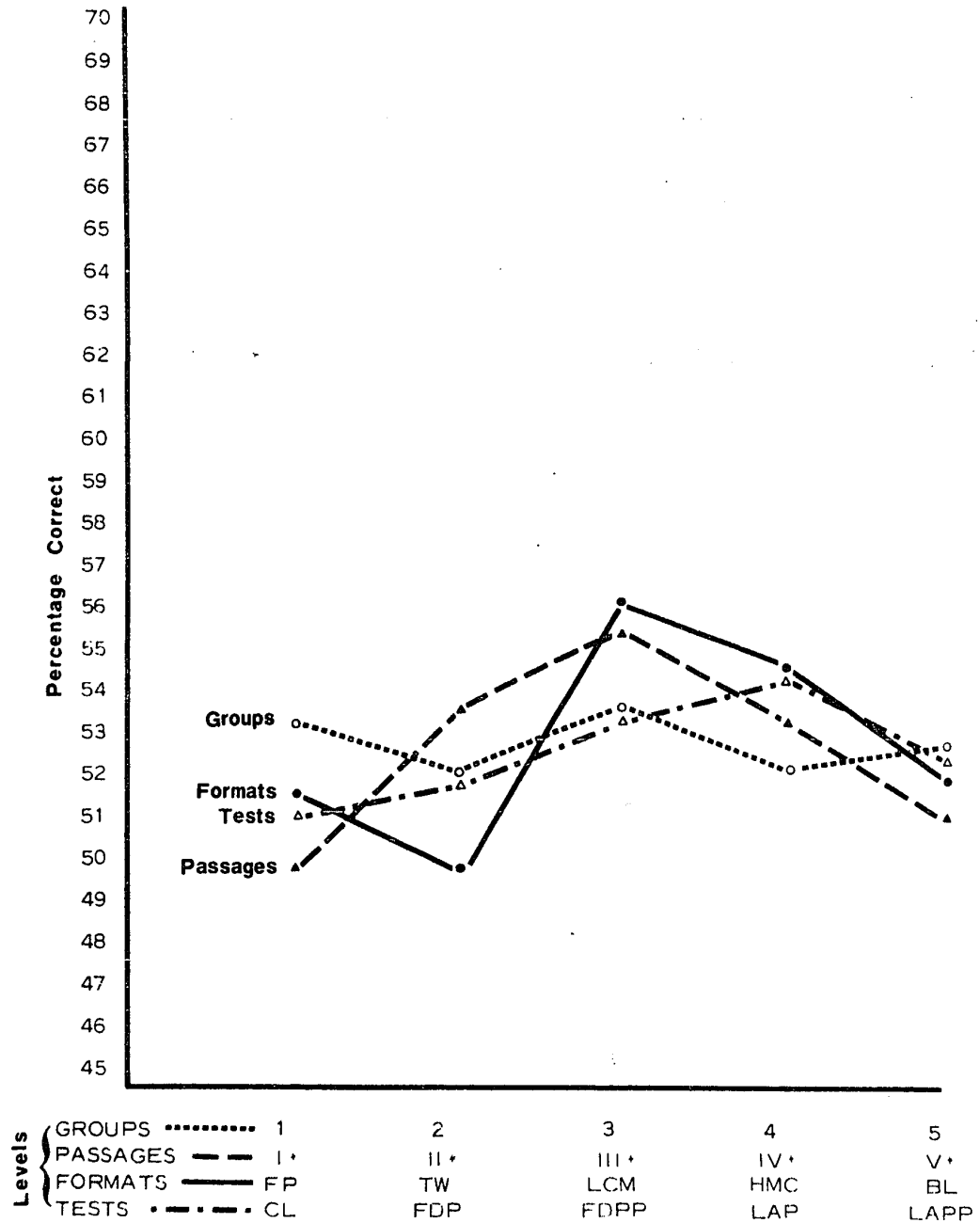


Fig. 11.1 -- Comparison of the mean test scores organized for GROUPS, PASSAGES, FORMATS, and TEST TYPES. Computed for the full sample (n = 325).

*See: Appendix A

matched as described in Chapter 6, will be made where they seem to be appropriate.

The analyses presented and discussed in this section are intended to address Question 2 of Chapter 5 and the hypotheses associated with it as set out in that chapter.

Question 2

Is it possible to identify units used for written language processing by college readers?

Hypothesis 2

For college readers, written materials will be comprehended at equivalent levels when they are displayed by:

- 2A. the full presentation format (FP) and the two-word format (TW);
- 2B. the FP format and the lowest major constituent format (LMC);
- 2C. the FP format and the higher major constituent format (HMC);
- 2D. the FP format and the bizarre long format (BL).

This hypothesis has been formulated in this way on the basis of one of two assumptions: (a) any format that is comprehended at the same level as the FP format will be comprised of chunks used by Ss in a "normal" reading situation; or, (b) any format that is comprehended at the same level as the FP format permits, within it, the type of chunking used by Ss in a "normal" reading situation, e.g., any format permits processing by single words which may be the strategy employed by Ss in a "normal" reading situation.

The Total Sample

Following the application of multiple comparisons, the mean test score achieved using the LMC format was found to be significantly higher than the mean achieved using the FP format ($F = 20.70$, $df = 4/1280$, $p < .001$). The other three comparisons produced non-significant F-ratios. Thus, with regard to the total sample, hypotheses 2A, 2C, and 2D are supported, but 2B is found to be untenable.

From these data, it cannot be stated that one chunk has been identified that matches the unit employed by this group of readers in their attempts to understand written materials. Three of the formats produced results that were not significantly different from the results achieved on a normal format. This suggests that each of these formats is being approached in the way used by the major portion of the group in dealing with written language. Since the only common factor across these formats and the FP format is that each consists of two or more words, it is possible that all formats are being processed, by most of the Ss of the group, one or two words at a time. This leaves unexplained the enhancement of comprehension associated with the use of the LMC format. It is likely that the range of reading abilities encompassed by the total sample obscured the reading strategies that may have been specific to Ss possessing a narrower range of reading ability.

The "Good" Group

The Greco-Latin Square analysis of variance was

applied to the data produced by this sub-sample. The residual term was again non-significant ($F = 1.11$, $df = 8/580$, n.s.). The format factor was significant ($F = 50.98$, $df = 4/580$, $p < .001$). Formats are discussed in greater detail below.

The formats

Multiple comparisons established that the LMC and HMC formats, were comprehended at the same level as the FP format which, in turn, was understood significantly better than the TW format ($F = 101.77$, $df = 4/580$, $p < .001$), and the BL format ($F = 60.54$, $df = 4/580$, $p < .001$). For the group of "good" readers, hypotheses 2B and 2C are upheld but 2A and 2D are rejected.

Although these analyses have not produced one chunk that matches the unit used by "good" college readers in their attempts to comprehend written materials, two highly related formats (the LMC and HMC) produced results statistically equal to those achieved with the normal format. The LMC and HMC formats make use of units built from the same chunk--the lowest major constituent. The impact on level of comprehension is highlighted in Figure 11.2.

This finding suggests that one chunk, the lowest major constituent, is a basic unit of written language processing for most of the "good" college readers in this sample. That the basic unit is grammatical in nature is supported by the severely depressed results that were obtained on the TW and BL formats. The chunks comprising these

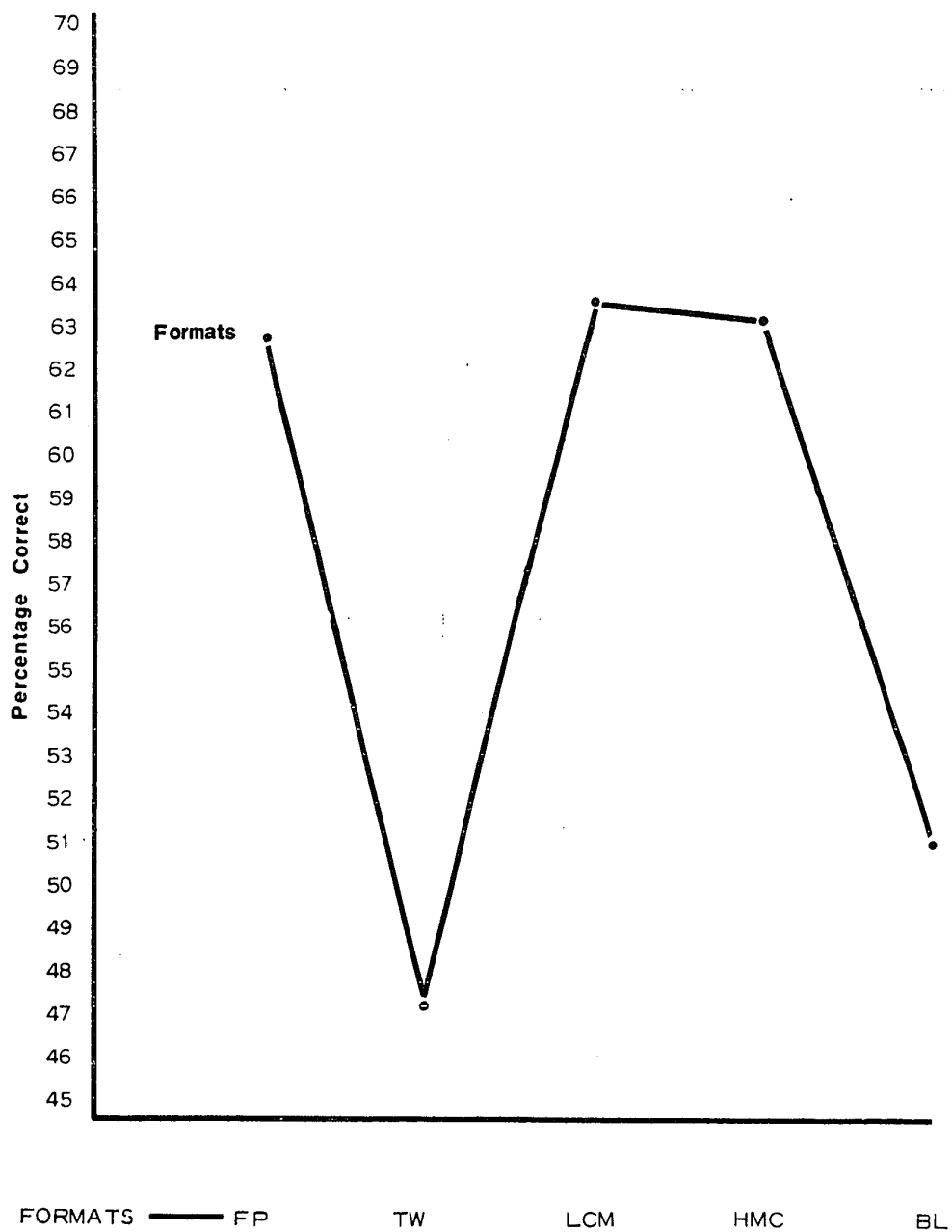


Fig. 11.2 -- Comparison of mean test scores organized for FORMATS. Computed for the Good group (n = 150).

formats are, in general, non-grammatical. In each passage one or two of the TW chunks were found to be grammatical units. These were chance occurrences as in "the dog," "was seen," and similar examples.

The "Poor" Group

Analysis of variance of the results produced by these readers showed a non-significant residual term ($F = 1.41$, $df = 8/580$, n.s.). The format factor was found to be significant ($F = 24.44$, $df = 4/580$, $p < .001$). This effect is clearly indicated in Figure 11.3.

The formats

Multiple comparisons indicated that the LMC format was understood significantly better than the FP format ($F = 45.67$, $df = 4/580$, $p < .001$) and that the HMC format was also comprehended better than the FP format ($F = 21.36$, $df = 4/580$, $p < .001$). The means obtained on the TW and BL formats were not statistically different from that obtained using the FP format. With regard to this group of "poor" college readers, support is provided for hypotheses 2A and 2D but hypotheses 2B and 2C are found to be untenable. The essential difference in the responses of the "good" and "poor" groups can be appreciated when Figures 11.2 and 11.3 are viewed together. These figures graphically show the reaction of each to variation in the format used for the presentation of written language.

These findings suggest that, as a group, these

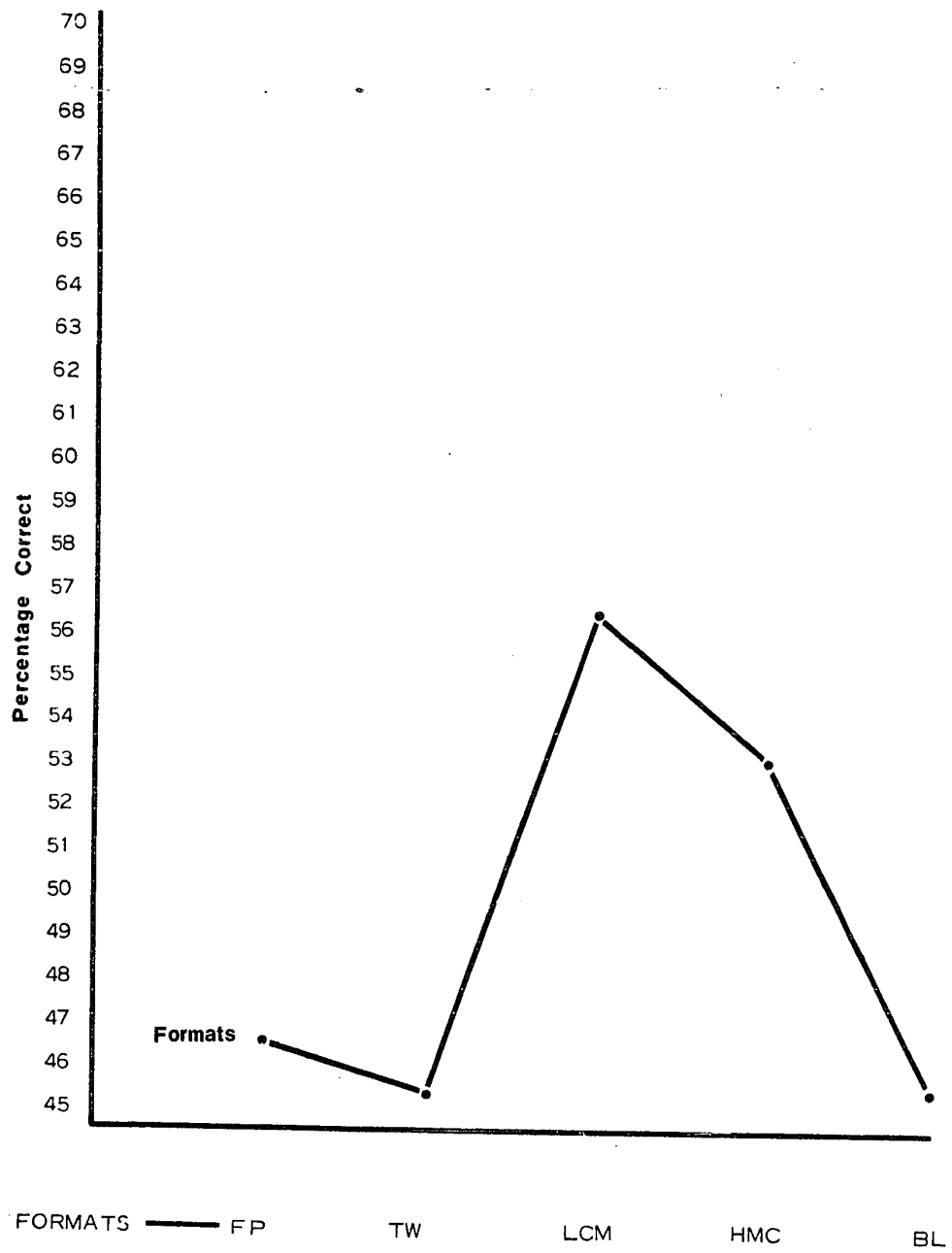


Fig. 11.3 -- Comparison of the mean test scores organized for FORMATS. Computed for the Poor group (n = 150).

readers process written materials displayed by means of a normal format in the same way as they process materials presented by means of long or short bizarre chunks. Since these bizarre chunks do not possess internal coherence, it would seem likely that the readers in this college group approach written materials in much the same way that they approach unrelated words. The evidence presented here indicates that for these "poor" college readers, the basic unit of written language processing may be the single word.

Summary

The purpose of this section was to identify language units that are employed by college readers in their attempts to comprehend continuous, written discourse. Because the findings based on the total sample were inconclusive, further analyses were conducted after 300 of the subjects had been assigned to one of two groups. These Ss were placed in "good" and "poor" groups according to their performance on the Level of Comprehension subtest of the Cooperative English Test of Reading Comprehension. The analyses conducted on these two groups suggested that no single unit of written language processing is used by college readers in general. Rather it appears that "good" college readers, such as those in this sample, make use of a grammatical unit like the lowest major constituent comprising the LMC format and which was used to construct the HMC format. On the other hand, the evidence suggests that "poor" college readers, like those identified in this study, probably

process written discourse without employing meaningful language structures like the LMC or HMC chunks.

Types of Units of Written Language Processing

In Chapter 5 it was hypothesized that an aspect of the processing of written language, necessary to facilitate the identification of the information conveyed by it, is the simultaneous synthesis of words into grammatical groups. Another aspect, hypothesized as performing an essential part of the processing of written language aimed at meaning identification, is the simultaneous establishment of the functional relationships that obtain between these grammatical groups. The LMC and HMC chunks discussed in Chapter 8 were designed to reflect each of these aspects of simultaneous language synthesis.

Clearly, both these formats may be typed as "grammatical." By means of combination and recombination of four of the formats a variety of types were created. These were: (a) the normal format or full presentation (FP); (b) long or short formats (HMC and BL formats use long chunks of the same length; TW and LMC formats use short chunks of different lengths); (c) bizarre or grammar-based formats (TW and BL formats use bizarre chunks--each type of chunk is created by the application of an arbitrary mechanical rule; LMC and HMC formats use grammar-based chunks--each chunk type is produced from sentences by the application of a grammatical algorithm). The purpose of this section is to address

Question 3 of Chapter 5:

Question 3

Does the type of chunk used in a format for presenting reading materials to college readers affect their comprehension of those materials?

The receptive processing of written language is aimed at the identification of its meaning. It is hypothesized that synthesis is an important component in this process. The findings presented in the previous section suggest that the formats using grammar-based chunks will optimize comprehension for these college readers. The hypotheses generated from the above questions were designed to provide tests of the validity of this claim of grammatical motivation for the simultaneous syntheses that have been postulated as important in this receptive processing of written language.

Hypotheses 3

Reading materials will be comprehended at equivalent levels when they are presented by:

- 3A. formats comprised of long chunks and the FP format;
- 3B. formats comprised of short chunks and the FP format;
- 3C. formats comprised of bizarre chunks and the FP format;
- 3D. formats comprised of grammar-based chunks and the FP format;
- 3E. formats comprised of long chunks and formats comprised of short chunks;
- 3F. formats comprised of grammar-based chunks and formats comprised of bizarre chunks.

The total sample

Multiple comparisons were carried out on the means associated with each of the five formats in the various combinations listed above. The combined mean scores for the "long" formats, the "short" formats, and the "bizarre" formats were not significantly different from the mean obtained on the FP format. The grammatical formats produced significantly better combined mean scores than the FP format ($F = 12.97$, $df = 4/1280$, $p < .05$). The combined mean scores for "long" and "short" formats were not statistically different. The combined mean scores of the "grammatical" formats were convincingly superior to the combined means of the "bizarre" formats ($F = 54.37$, $df = 4/1280$, $p < .001$). These findings provide support for hypotheses 4A, 4B, 4C, and 4E. Hypothesis 4D is tentatively rejected, while hypothesis 4F is clearly untenable.

These findings indicate that, for the total sample, the comprehension of prose materials is optimized when the format for their presentation is chunked according to grammatical paradigms. The conclusion can be tentatively drawn that, when the synthesis of grammatical chunks is encouraged, comprehension is improved. The conclusion can only be tentative because the improvement over the results achieved with the FP format was barely significant while the FP format did not produce better results than any of the other format types. Thus, the superiority of the grammar-based formats over the other types of format, with the

exception of that based on bizarre chunks, is not clear-cut.

The "good" group

Comparisons among the mean scores achieved by this group established that the FP format was comprehended significantly better than the "long," "short," and "bizarre" formats (FP versus "long": $F = 21.17$, $df = 4/580$, $p < .001$; FP versus "short:" $F = 38.09$, $df = 4/580$, $p < .001$; FP versus "bizarre:" $F = 128.67$, $df = 4/580$, $p < .001$). The difference between the mean test scores produced by the FP format and the "grammatical" formats was not significant. The "long" and the "short" formats were also comprehended at equivalent levels. "Grammatical" formats were understood significantly better than the "bizarre" formats ($F = 137.32$, $df = 4/580$, $p < .001$). Support is provided for hypotheses 4D and 4E, but hypotheses 4A, 4B, 4C, and 4F are without support.

These findings clearly show that for these "good" college readers, the display of reading materials by means of formats using grammar-based chunks, permits them to comprehend at their best standard. That this level is also achieved with the FP format suggests that the majority of these readers use similar chunking strategies in their normal reading. This probability is strengthened by the finding that the "long," "short," and "bizarre" formats caused a significant decrement in the comprehension of these readers. That is, grammatical chunks permitted the application of their normal synthesizing strategies.

"Long," "short," and "bizarre" formats disrupted the application of these strategies. It is true that the "long" and "short" formats each comprised one format employing grammar-based chunks but since these chunks maximize the comprehension of these readers only to the level achieved with a "normal" format, the overall effect of the formats comprising either the "long" or "short" formats, compared with the FP format, must be one of depressed results.

The poor group

The multiple comparisons conducted on the means generated by the various formats with the Ss in this group, showed that the "long" and "bizarre" formats were understood at the same level as the FP format. The "short" formats were better comprehended than the FP format ($F = 14.30$, $df = 4/580$, $p < .01$) and the "grammatical" formats also produced better results than the FP format ($F = 52.09$, $df = 4/580$, $p < .001$). The "long" and "short" formats produced means that were not significantly different but the "grammatical" formats were convincingly better than the "bizarre" formats ($F = 83.55$, $df = 4/580$, $p < .001$). Therefore, hypotheses 4A, 4C, and 4E are supported while 4B, 4D, and 4F are rejected.

These analyses, based on type of format, show that most of these "poor" college readers customarily deal with written language without employing a clearly identifiable synthesizing strategy. The evidence for this is that "long" and "bizarre" formats are understood as well as the FP format, but the "grammatical" formats enhance comprehension.

That is, synthesis based on grammatical chunks is not a natural strategy employed by these readers. However, most of them are clearly sensitive to such chunks and the additional meaning that can be derived from language when it is processed in this way, but they are unable to effect this chunking spontaneously for themselves. That the "short" formats (comprised of TW chunks and LMC chunks) were comprehended significantly better than the FP format while the "long" formats (comprised of HMC and BL formats) were comprehended at the same level, suggests that the majority of these readers can benefit from the presentation of single, lowest major constituent chunks. The improved comprehension of the "short" formats over the FP format can be attributed to the LMC format because of the evidence already cited on p.293. This evidence shows that, for this group, the TW format and the FP were comprehended at equivalent levels. When several LMC chunks are combined to form a higher level chunk (the HMC chunk), however, synthesizing again becomes a confusing task.

Summary

This section has established that the type of format does, in general, have an impact upon the comprehension of college readers. The reason for the inclusion of various types of format was to gather preliminary evidence regarding the hypothesis that the synthesis of written language by college level readers is under the control of grammar. With the "good" readers in this sample, convincing evidence was

found that grammar is the basis of their attempts to effect the synthesis of words. Equally convincing evidence was discovered that, for the majority of the "poor" readers in the sample, the presentation of written materials in the form of separate grammatical chunks seems to trigger the synthesis of these words into meaningful units. All the other types of formats, excluding the FP format, either disrupted comprehension or failed to enhance it.

Simultaneous Synthesis and Comprehension

One of the sections already treated in this chapter has indicated the probability that, for college readers, performance on a verbal concept task calling for the use of the information processing strategy of simultaneous synthesis, is positively and significantly related to performance on the Level of Comprehension subtest of the standardized reading test. The previous section in this chapter has suggested that grammar plays a vital role in the synthesizing of words into units to help the reader associate meaning with the sentences of continuous, written discourse. The purpose of the present section is to examine the impact of each individual, chunked format on the various groups described in Chapter 6 and thus draw conclusions about information processing strategies and the comprehension of written materials. Question 4 of Chapter 5 is the focus in what follows:

Question 4

With college readers, what are the specific comparative effects of presenting written materials by means of formats based on different chunk-types?

In this section the effect on comprehension of each format will be compared. The four chunked formats lend themselves to six such comparisons which were conducted on the total sample, the "good" group, and the "poor" group. Thus, the above question can be translated into six hypotheses.

Hypotheses 4

Reading materials will be comprehended at equivalent levels when they are presented by:

- 4A. the TW and LMC formats;
- 4B. the TW and HMC formats;
- 4C. the TW and BL formats;
- 4D. the LMC and HMC formats;
- 4E. the LMC and BL formats;
- 4F. the HMC and BL formats.

The mean scores associated with each of the pairs of formats listed in hypotheses 4 were evaluated by means of pairwise comparisons.

The total sample

With the total sample of the LMC format was understood significantly better than the TW format ($F = 25.04$, $df = 4/1250$, $p < .001$), and the BL format ($F = 18.66$, $df = 4/1280$, $p < .01$). The HMC format also produced better comprehension scores than the TW format ($F = 23.91$, $df = 4/1280$, $p < .001$). All other means were found to be

statistically equivalent. These findings provide support for hypotheses 4C, 4D, and 4F. No support is provided for hypotheses 4A, 4B, and 4E.

The superiority of the comprehension of the LMC format over the other non-grammatical formats provides convincing evidence that written language becomes meaningful for these college readers when it is presented to them in small grammatical chunks. The LMC format is based on the LMC (lowest major constituent) chunk. It has been postulated elsewhere in this study that the synthesis of the LMC chunk calls for the information processing strategy of simultaneous synthesis. The evidence presented here indicates that this simultaneous synthesis is encouraged much more by the use of small grammatical chunks than other non-grammatical chunks.

The superiority of the comprehension of the HMC format over the other non-grammatical formats provides less convincing evidence that written language becomes meaningful for these college readers when it is presented to them in large grammatical chunks. The HMC format is based on the HMC (higher major constituent) chunk. As with the LMC chunk, it has been proposed that the synthesis of the HMC chunk is also dependent upon the information processing strategy of simultaneous synthesis. The outcome of the application of simultaneous synthesis at this level is the apprehension of the functional relationships between the syntacto-semantic units represented by LMCs. With the total sample,

comprehension of the HMC format was superior to the comprehension of the TW format only. The BL format was understood just as well as the HMC format.

From this evidence it would seem that the majority of these readers have more difficulty in spontaneously recognizing grammatical units in sentences than they do in discerning the relationships that may obtain between such units once they are identified.

The "good" group

This group comprehended the LMC format significantly better than the TW group ($F = 109.9$, $df = 4/580$, $p < .001$), and significantly better than the BL format ($F = 66.85$, $df = 4/580$, $p < .001$). The HMC format was also understood better than the TW format ($F = 105.89$, $df = 4/580$, $p < .001$) and the BL format ($F = 63.65$, $df = 4/580$, $p < .001$). There were no significant differences between the levels of comprehension on the TW and BL formats or the LMC and HML formats. These data support hypotheses 4C and 4D. No support is found for hypotheses 4A, 4B, 4E, and 4F.

Given that the LMC and HMC formats encourage the use of two levels of simultaneous synthesis, it is clear from these findings that the "good" readers in this sample are able to make use of both when they are confronted with appropriately chunked formats. It is equally clear that such readers are severely restricted in the use of either when written materials are presented by means of long or short non-grammatical chunks. It can be concluded then,

that, among other factors, the comprehension of written language is maximized when the appropriate use of the information processing strategy of simultaneous synthesis is encouraged.

The "poor" group

The Ss in this group comprehended the LMC format at significantly superior levels than the TW format ($F = 57.08$, $df = 4/580$, $p < .001$) and the BL format ($F = 56.04$, $df = 4/580$, $p < .001$). Likewise, the HMC format was understood better than the TW format ($F = 37.11$, $df = 4/580$, $p < .001$), and the BL format ($F = 28.92$, $df = 4/580$, $p < .001$). No other pairs of means were found to be significantly different. On this evidence, with regard to this group, hypotheses 4C and 4D are upheld but hypotheses 4A, 4B, 4E, and 4F are rejected.

As with the "good" readers in the sample, the "poor" readers, as a group, were able to make use of both levels of simultaneous synthesis when they were presented with appropriately chunked formats. When formats comprised of short and long, non-grammatical chunks were used, the use of either level of simultaneous synthesis was not encouraged. This resulted in the level of comprehension being significantly lower in both cases than when grammatical chunks were used.

Summary

The material in this section has been presented on

the assumption that a convincing argument has previously been submitted that language processing, and specifically, written language processing, involves the use of the information processing strategies of simultaneous and successive synthesis. The purpose of this section has been to show that successful simultaneous synthesis is dependent upon the ability of readers to synthesize words into syntactosemantic units and to discern the functional relationships that obtain between such units.

Of the chunked formats investigated in this section, evidence has been presented that for "good" college readers in the sample, formats using small or large grammatical chunks were comprehended at significantly higher levels than other formats consisting of non-grammatical chunks. The conclusion drawn is that grammatical chunks permit more effective synthesis than non-grammatical chunks. It was earlier established that, written language, displayed by grammatical chunks, is understood as well as "normally" presented written language, but, that when long or short non-grammatical chunks are used, the level of comprehension is substantially reduced. These facts, together, show conclusively that these "good" college readers can synthesize the individual words comprising continuous, written discourse into meaningful, grammatical units and can inter-relate such units, provided that the grammatical units to be identified and synthesized are not disrupted by broken presentation.

For the majority of "poor" college readers in the sample, it was found that synthesis of written language was effected in a convincingly superior way when it was presented by means of grammatical chunks rather than non-grammatical chunks. In a previous section it was demonstrated that these Ss read at equivalent levels when the reading materials were presented in a "normal" way or by means of formats using long or short chunks but that substantial improvement was effected with the use of formats employing grammatical chunks. These findings demonstrate that the majority of these "poor" readers are able to synthesize the words of written language into small meaningful units provided the presentation of such units preserves their complete separation.

Simultaneous Synthesis and Comprehension
in "Good" Readers Matched with "Poor" Readers

This section presents comparisons of the performances of the "good" and "poor" groups and their respective subgroups. The analyses make use of the pooled experimental test results as the dependent variable. These results are organized according to formats. For each comparison, separate two-way analyses of variance were carried out using the "good" and "poor" readers as the two levels of one factor and the five formats as the five levels of the other factor for each of the analyses respectively. Repeated measures were obtained on each of the reading groups, i.e., both levels of factor A.

The existence of main effects for format with each of the groups and the various subgroups was established using Greco-Latin Square analyses. The purpose of the analyses reported here was to directly compare the performance of "good" and "poor" groups on the five different formats.

The discussion presented in this section addresses Question 5 of Chapter 5:

Question 5

On reading materials displayed by means of various formats, how do the comprehension scores of "good" and "poor" college readers compare?

Five hypotheses were derived from this question:

Hypotheses 5

"Good" and "poor" college readers will comprehend reading materials at equivalent levels when they are displayed by:

- 5A. the FP format;
- 5B. the TW format;
- 5C. the LMC format;
- 5D. the HMC format;
- 5E. the BL format.

The "good" compared with the "poor" group

The overall difference in the performance of these two groups on the experimental reading tests is indicated by the significant main effect for ability groups ($F = 85.00$, $df = 1/298$, $p < .001$). The assessment of simple main effects is reported for each format individually. The comparative performances of each of these groups for formats are

presented in Figure 11.4

The FP format

The "good" group comprehended the FP format at a significantly higher level than the "poor" group ($F = 14.56$, $df = 1/1192$, $p < .001$). Hypothesis 5A is, therefore, rejected. That is, this result was achieved on the "normal" presentation of the prose material used in the experimental tests. The relationship between the scores for these groups on this mode of presentation closely parallels the relationship between the scores for these groups on the Level of Comprehension subtest of the Cooperative English Test of Reading Comprehension.

The TW format

The difference between the mean scores achieved by the two groups in response to this format was not significant ($F = 0.25$, $df = 4/1192$, n.s.). On this evidence, hypothesis 5B is upheld. It has been demonstrated elsewhere that the "poor" group comprehended the TW format at a level equivalent with the FP format but that the "good" group produced significantly poorer scores on the TW format than the FP format. These findings constitute strong evidence that the TW format permits the "poor" readers to employ their normal method of processing written language but that it severely disrupts the strategy customarily employed by the "good" readers.

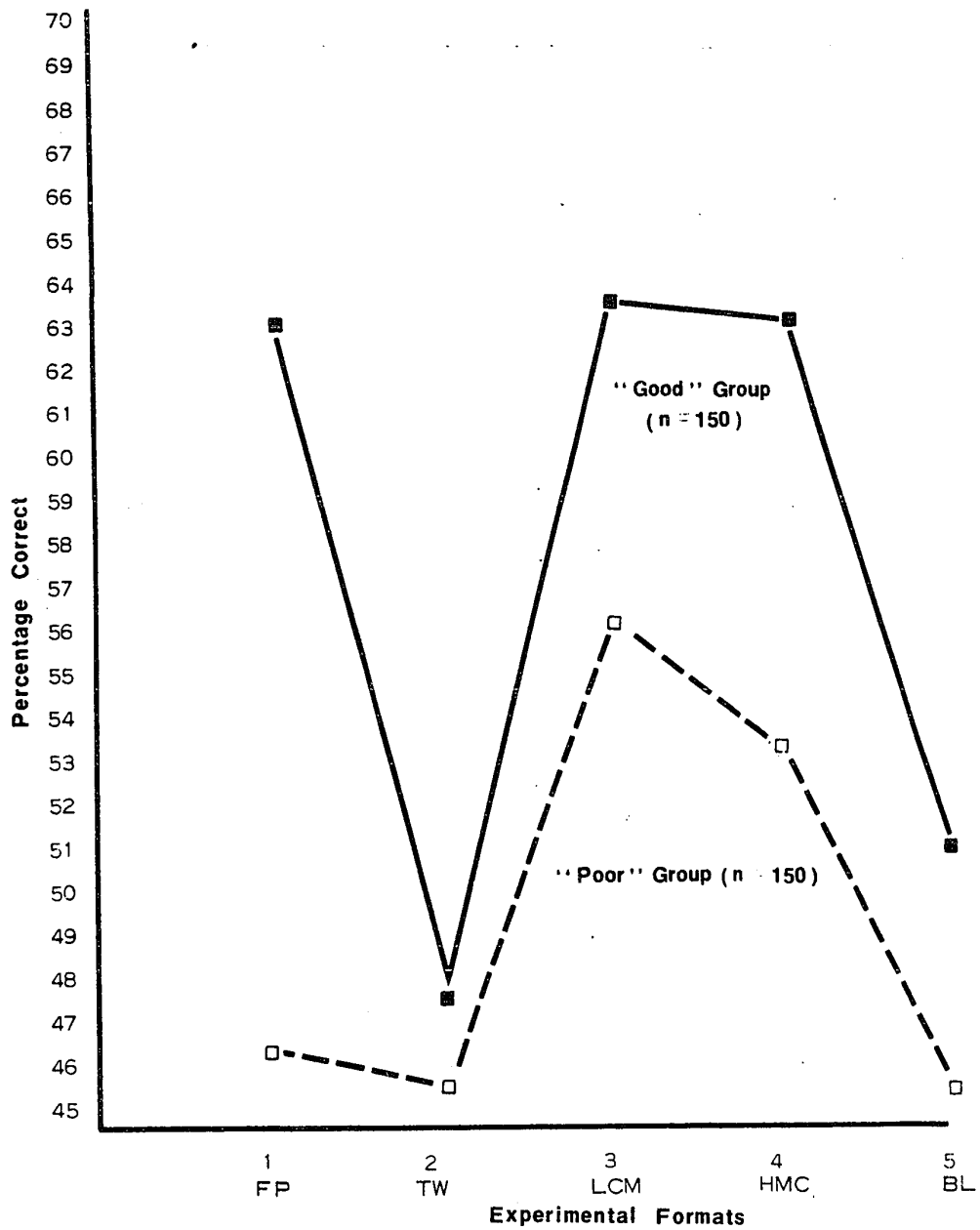


Fig. 11.4 -- Mean experimental test scores organized on the basis of the FORMAT factor. Comparison of "Good" Group (n = 150) with "Poor" Group (n = 150)

The LMC format

The difference between the mean scores produced by this format barely reached significance ($F = 2.75$, $df = 4/1192$, $p < .05$). On this evidence, hypothesis 5C is tentatively rejected. There was no significant difference in the performance of the "good" group on the FP and LMC formats. The LMC format was convincingly better understood by the "poor" group than the FP format. It is clear, then, that the use of the LMC format with the "poor" group improved their comprehension almost to the point of no significant difference between the "good" and the "poor" groups.

This finding is additional evidence that these "good" college readers synthesize the words comprising written discourse according to grammatical criteria. There is further testimony here, too, that "poor" college readers do not employ grammar to assist them in their attempts at the synthesis of the words in written language but that when presented with small, discrete grammatical units, they are apparently able to discern their fundamental unity and, thus, synthesize on this basis. This results in an additional, impressive increment to their comprehension.

The HMC format

The "good" readers understood this format significantly better than the "poor" readers ($F = 5.38$; $df = 4/1192$, $p < .001$). Hypothesis 5D, therefore, is found to be untenable.

For the "good" readers the HMC format was understood at the same level as the FP format. This was also true for the "poor" readers. It can be assumed, on the basis of this evidence and that already presented with regard to the LMC format, that the simultaneous synthesis of the "good" readers was optimized by this format but that for "poor" readers the comprehension-enhancing effect of the separate presentation of LMCs was, to some degree, lost when these were amalgamated into the higher level HMCs.

The BL format

On this format, the mean scores for the two groups were not significantly different ($F = 1.71$, $df = 4/1192$, n.s.). This finding upholds hypothesis 5E.

In an earlier analysis it was established that the comprehension of the "good" readers suffered a substantial decrement under the impact of the BL format, whereas the comprehension of the "poor" readers was not significantly affected. Clearly, the BL format disrupted the customary mode of synthesizing of these "good" college readers. It is concluded that the lack of syntactic and semantic unity of the chunks employed in this format forced these "good" readers to attempt to process one and/or two words at a time. The "poor" readers apparently processed this format in the same way but since the result was not significantly different from their performance on the FP format, it can be concluded that this is the strategy used by these readers when they attempt to associate meaning with written language

under "normal" circumstances.

The FLG group compared with the FLD group

It was explained in Chapter 6 that these two groups had been formed by selecting one reader from the "good" group and matching him with another reader from the "poor" group on the basis of equal Vocabulary subtest scores and equal RR scores. The assumption made in following this procedure was that these readers possessed approximately equal knowledge of verbal concepts, showed the same propensity to select an appropriate information processing strategy for a specific task, and produced approximately equal ratings in the assessment of their ability to use simultaneous synthesis. The comparative status of these two groups on each of the classifying variables is shown in Figures 11.5, 11.6, 11.7, and 11.8.

The overall difference in the performances of these two groups on the experimental reading tests is indicated by the significant main effect for ability groups ($F = 7.71$, $df = 4/392$, $p < .001$). The main effect for format for these two groups has already been reported from the Greco-Latin Square analyses--(FLG group: $FP = LMC = HMC$ formats, but $< TW = BL$ formats; FLD group: $HMC = LMC$ formats but $< FP = TW = BL$ formats). The evaluation of simple main effects is reported for each format individually. The comparative performances of each of these groups for formats are set out in Figure 11.9.

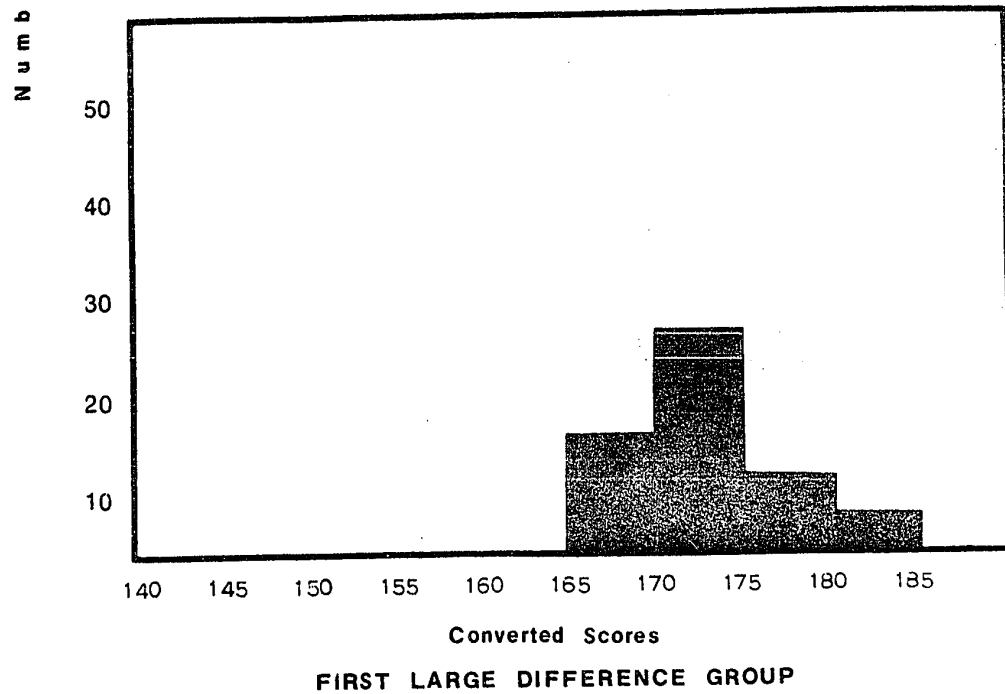
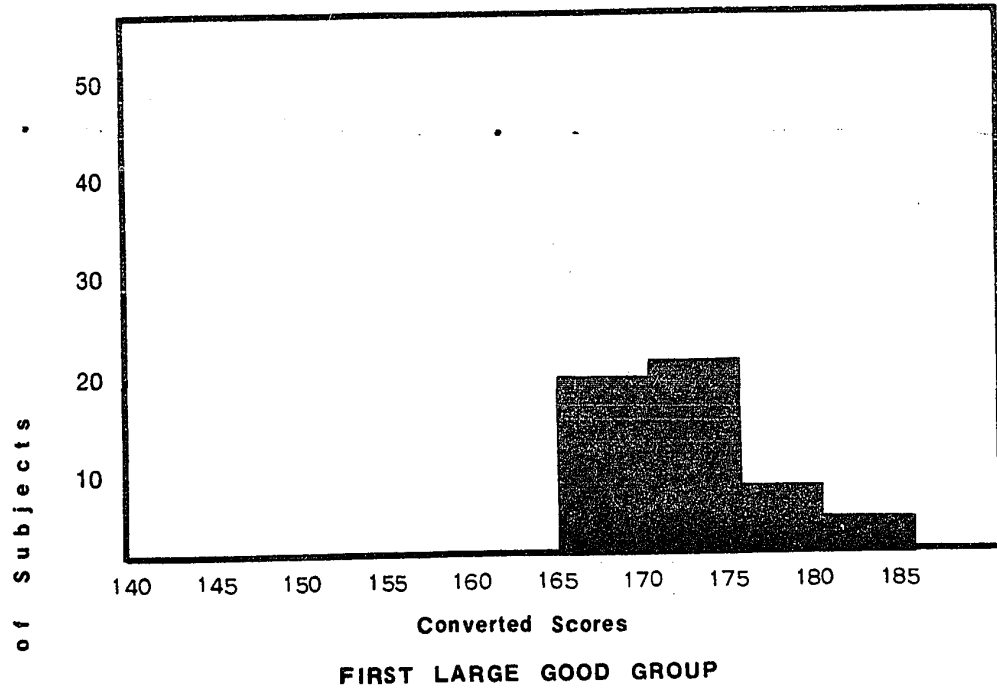


Fig. 11.5 -- Distributions of converted scores on Vocabulary subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for First Large Good group (n = 50) matched to First Large Difference group (n = 50).

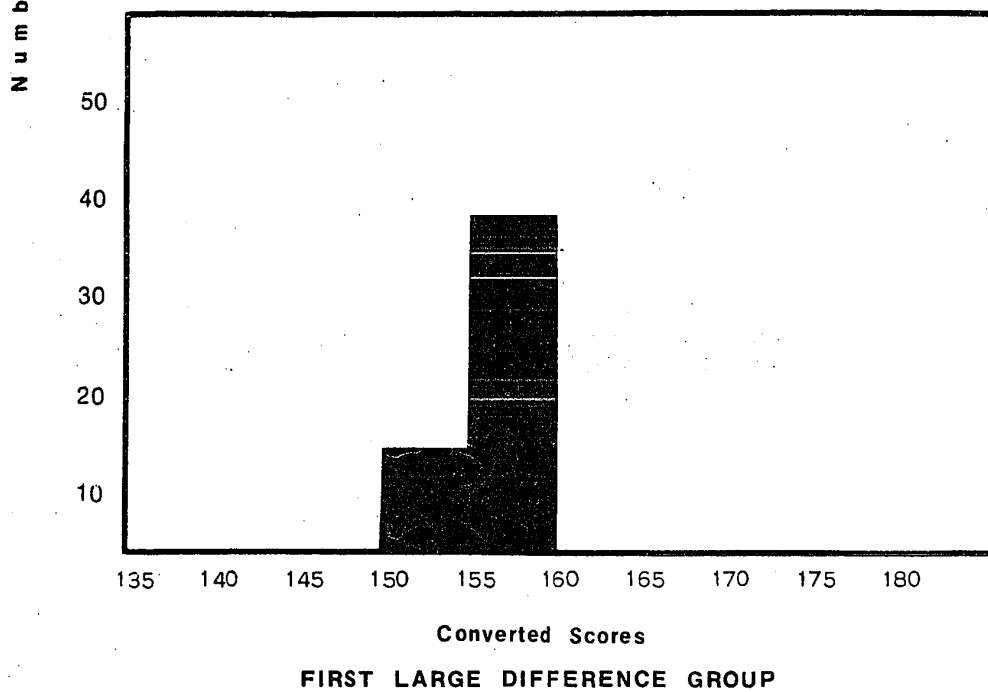
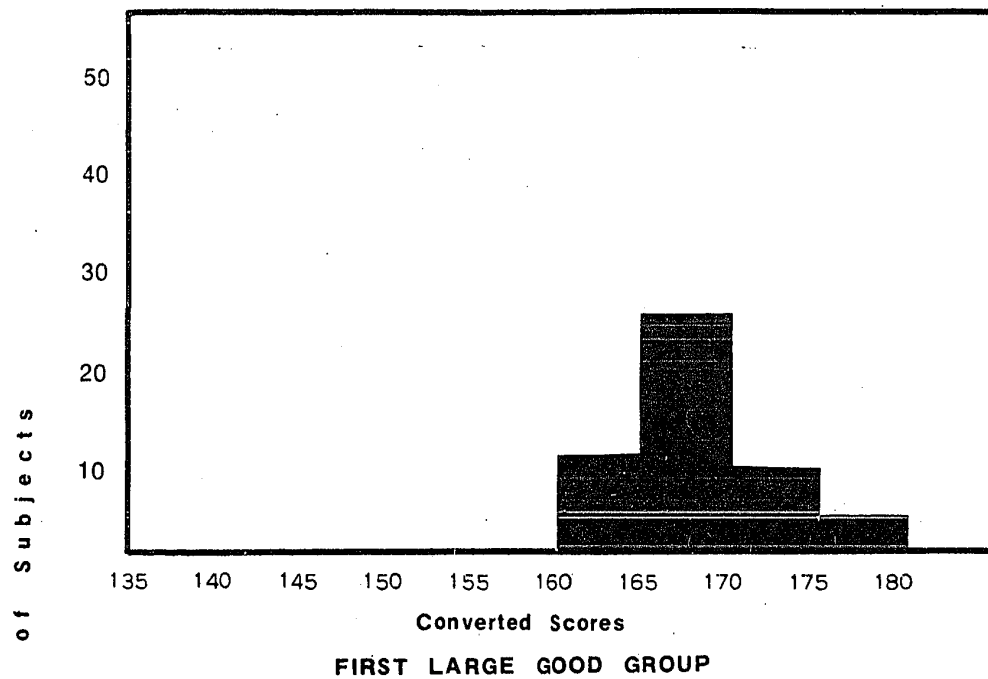


Fig. 11.6 -- Distributions of converted scores on Level of Comprehension subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for First Large Good group (n = 50).

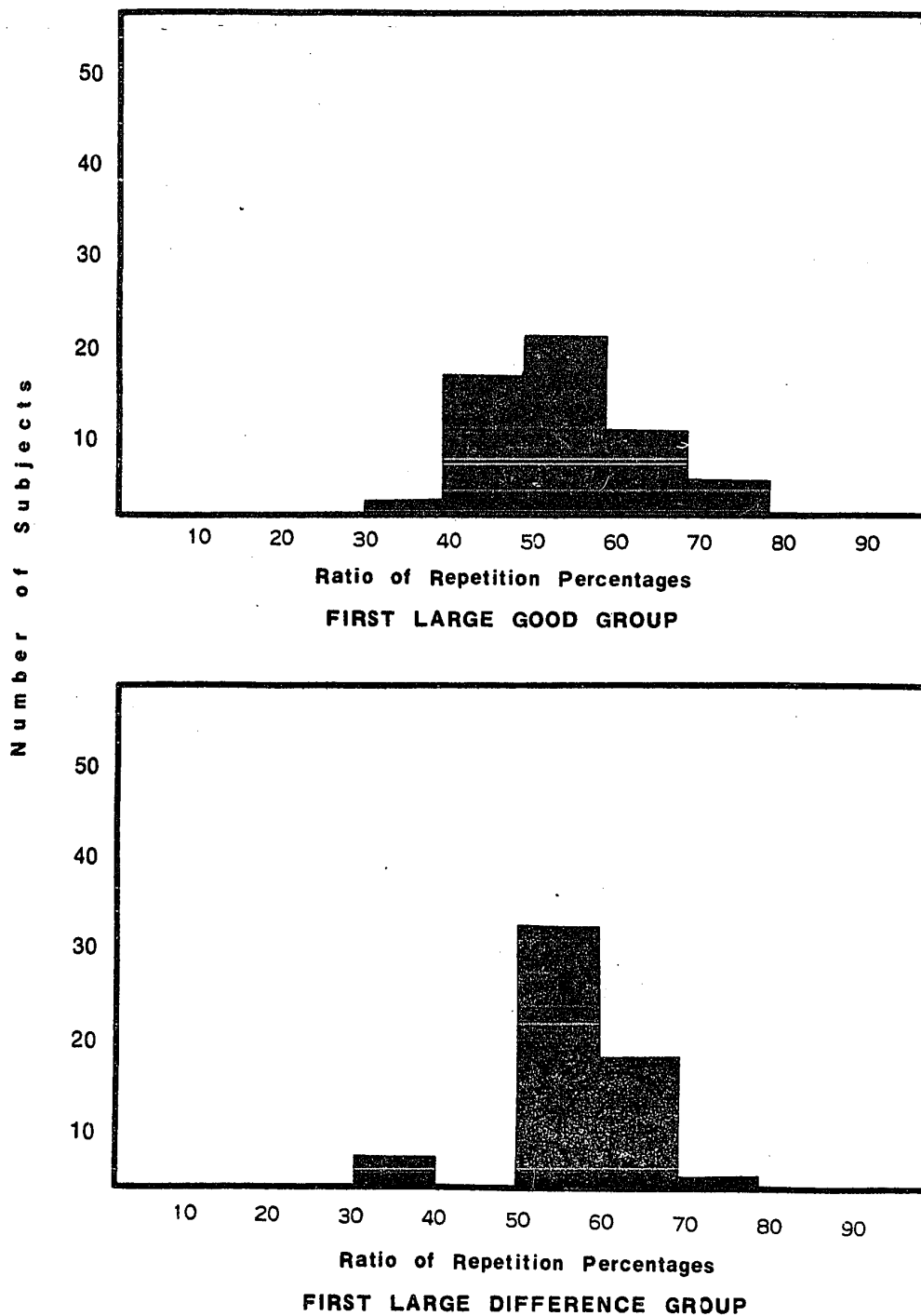


Fig. 11.7 -- Distributions of Ratio of Repetition percentages for First Large Good group (n = 50) matched to First Large Difference group (n = 50).

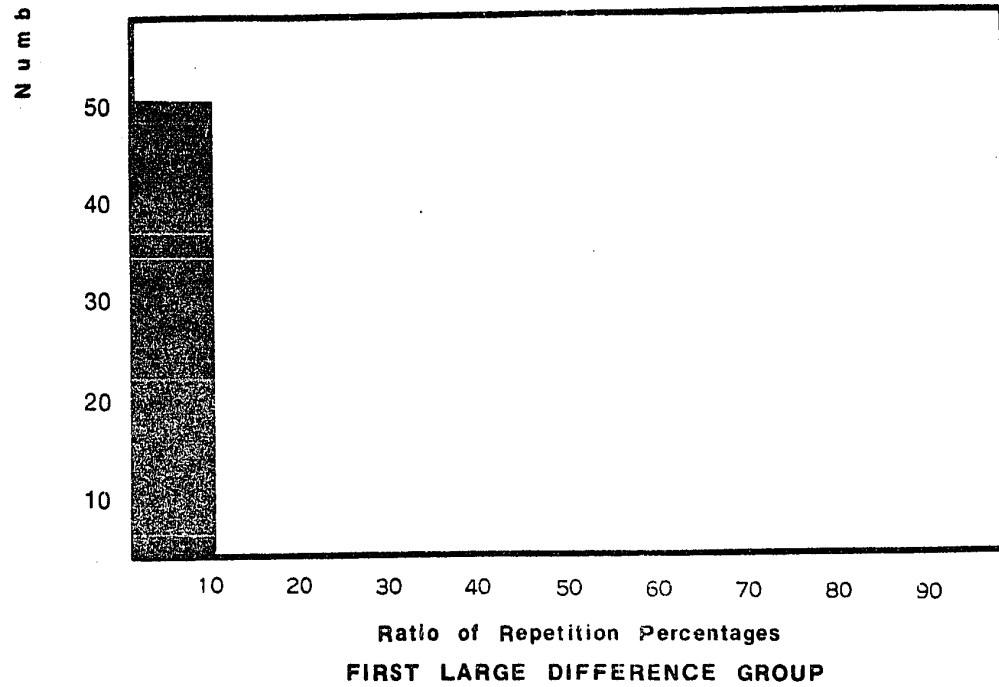
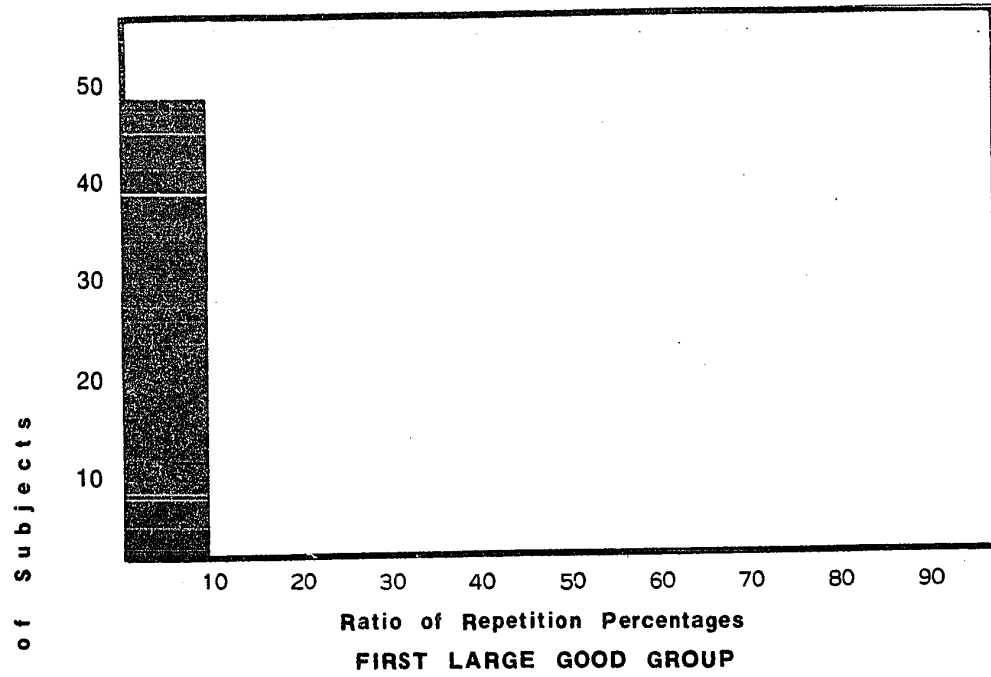


Fig. 11.8 -- Distributions of Ratio of Serial Repetition percentages for First Large Good group (n = 50) matched to First Large Difference group (n = 50).

The FP format

The difference between the mean scores obtained by these two groups was significant ($F = 26.56$, $df = 1/392$, $p .001$). Hypothesis 5A is found to be untenable on this evidence. This finding substantiates the results produced on the comprehension subtest of the standardized reading test.

The TW format

These two groups produced statistically equivalent scores in reading text material displayed in this format ($F = 1.10$, $df = 1/392$, n.s.). For these two groups, the finding supports hypothesis 5B. For the FLG group, the difference between the scores on the FP and TW formats was found to be significant. For the FLD group, the same formats did not produce significantly different scores. From this evidence, it is clear that the TW format seriously impedes the efforts of the Ss in this subgroup of "good" readers to effect the same degree of simultaneous synthesis as the FP format permits them. They are forced to attempt processing by non-grammatical chunks consisting of one or two words. It is also clear that grammatically motivated synthesis is not an information processing strategy employed by the "poor" readers in the FLD group as an important component in their attempts to identify the meaning of continuous written discourse.

The LMC format

This format did not produce significantly different

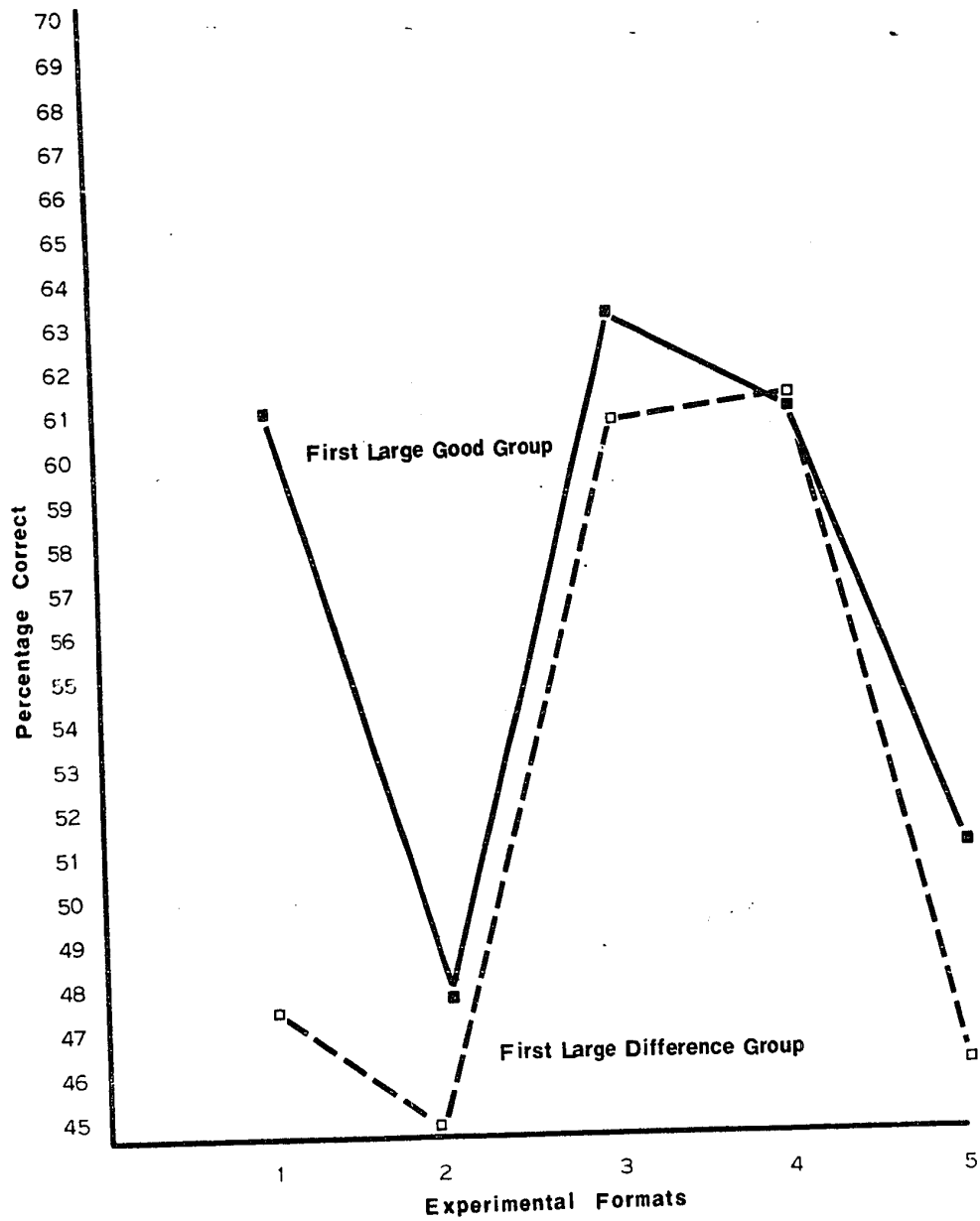


Fig. 11.9 - Mean test scores organized on the basis of the FORMAT factor. Comparison of First Large Difference group (n = 50).

means for these two groups ($F = 0.36$, $df = 1/392$, n.s.). Hypothesis 5C, with regard to these two groups, is supported.

The FLD group had registered Vocabulary subtest scores and RR scores that were approximately equal to those of the FLG group. The FLD group is "different" from the FLG in that its members apparently do not spontaneously effect the simultaneous synthesis of the individual words making up the sentences of written language. That these "different" readers have the potential for high level synthesis, of a type similar to that required in reading, is suggested by the RR scores achieved by this group. The extent of improvement effected with the isolated presentation of LMC chunks provides confirmation that these readers are capable of this type of synthesis of written language.

The HMC format

There was no significant difference between the means of the two groups in responding to this format ($F = 0.64$, $df = 1.392$, n.s.). Hypothesis 5D, therefore, is found to be tenable. The same level of improvement in the FLD group is reflected in this finding as was achieved with the LMC format. Again, it would seem that these "poor" readers can be encouraged to synthesize by the isolated presentation of grammatical chunks even when these consist of several lower level chunks (LMCs). Under this mode of presentation their comprehension of prose materials is as efficient as that of "good" readers whose written language synthesizing skills operate without the assistance of

specific techniques of presentation.

The BL format

The comparison of the means associated with this format was not significant ($F = 1.40$, $df = 1/392$, n.s.). This finding supports hypothesis 5E. The BL format depressed the standard of comprehension achieved by the "good" group. The non-grammatical nature of the long chunks used in this format impaired the "set" to synthesize of these readers and probably forced them to rechunk within the boundaries of each BL format. Up to a point, this could be accomplished according to grammatical criteria because each BL chunk generally contained one or more LMCs. The difficulty with the BL chunk, for this group, was that the beginning and end of each chunk consisted of a disrupted LMC, thus destroying the grammatical unity of the group of words as a whole. The score of the FLG group on this format was not reduced to the absolute level of the score achieved by the FLD group, though statistically there was no difference. The "natural" strategy of the "good" readers to form "sense" units apparently assisted some of these readers, though, for the most part, it seems likely that they were reduced to using much the same processing strategy as was used by the Ss in the FLD group.

The SLG group compared with the SLD group

Chapter 6 described the formation of these two groups. "Good" readers were matched with "poor" readers

who had produced approximately equal Vocabulary subtest scores but who had achieved RR scores, on the test of clustering in recall, which were between 20 and 30 percentage points lower than those achieved by the matching "good" readers. The assumption underlying this procedure was that these readers possessed approximately equal knowledge of verbal concepts, revealed the same propensity to select an appropriate information processing strategy for a specific verbal task, but the readers in the SLD group produced substantially lower ratings in the assessment of their ability to use simultaneous synthesis. The comparative status of these groups on each of the classifying variables is shown in Figures 11.10, 11.11, 11.12, and 11.13.

The overall difference in the performances of these two groups on the experimental reading tests is reflected in the significant main effect for ability groups ($F = 48.81$, $df = 4/392$, $p < .001$). The main effect for format has been previously reported as a result of the Greco-Latin Square analysis on each of these groups--(SLG group: $FP = LMC = HMC$ formats but $< TW = BL$ formats; SLD group: $LMC < HMC$ format but both $< FP = TW = BL$ formats). This section reports the simple main effects for each format separately. The comparative performances of each of the groups for formats are set out in Figure 11.14.

The FP format

The SLG and SLD groups differed significantly on the mean score they produced on the FP format ($F = 65.18$, $df =$

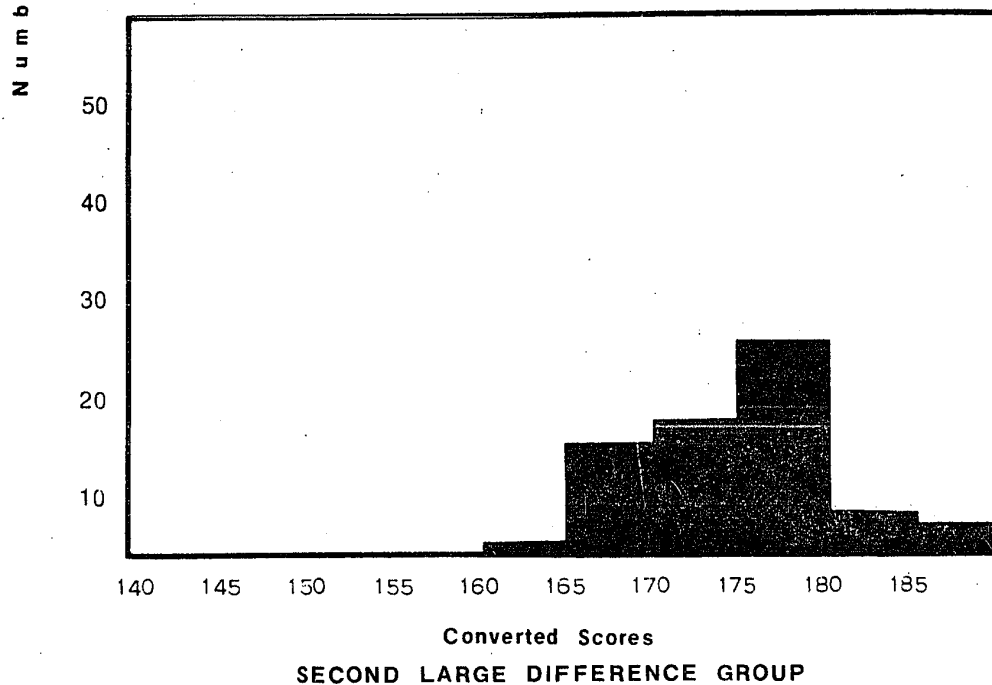
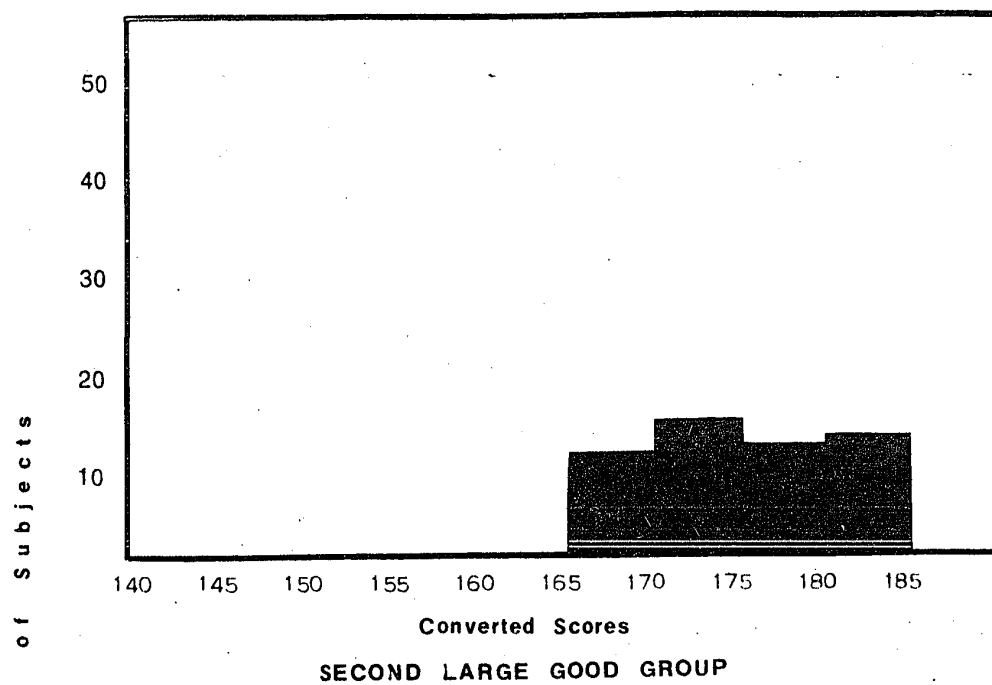


Fig. 11.10 -- Distributions of converted scores on Vocabulary subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for Second Large Good group (n = 50) matched to Second Large Difference group (n = 50).

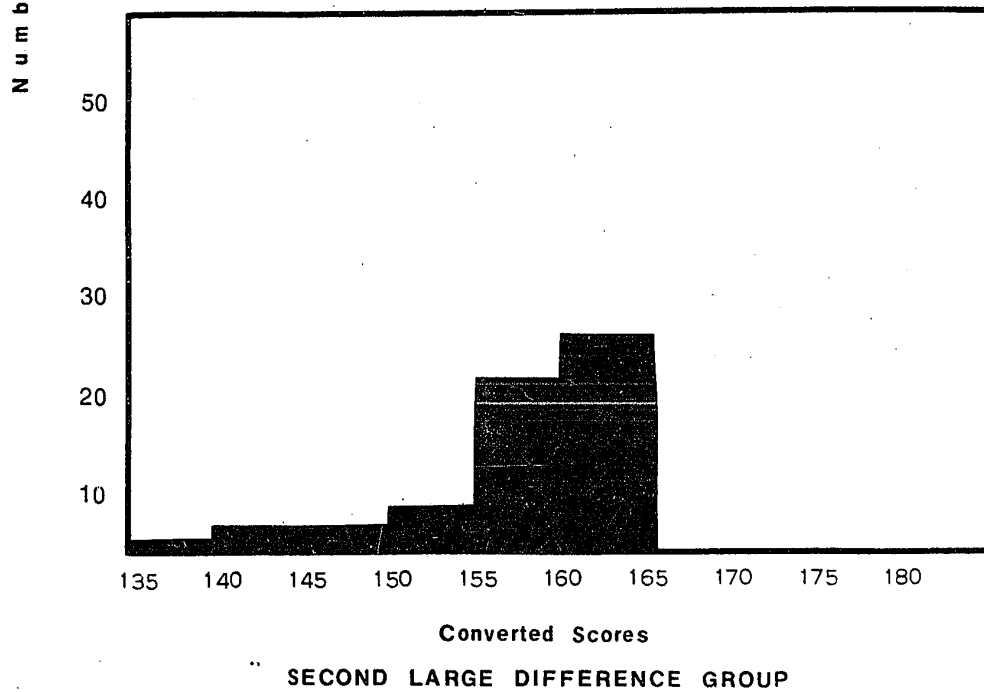
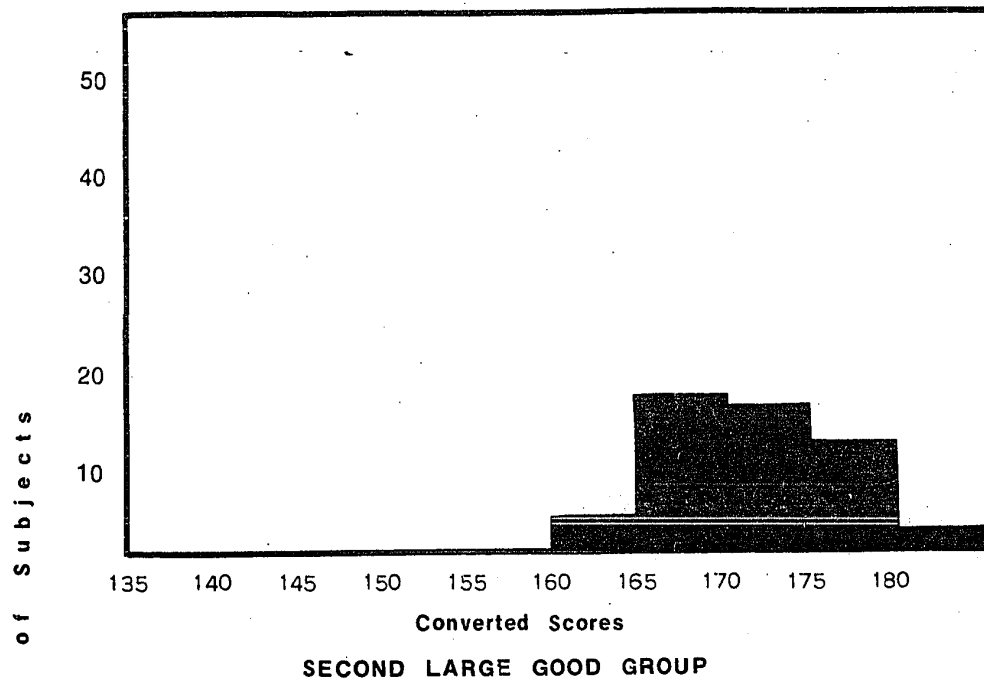


Fig. 11.11 -- Distributions of converted scores on Level of Comprehension subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for Second Large Good group (n = 50) matched to Second Large Difference group (n = 50).

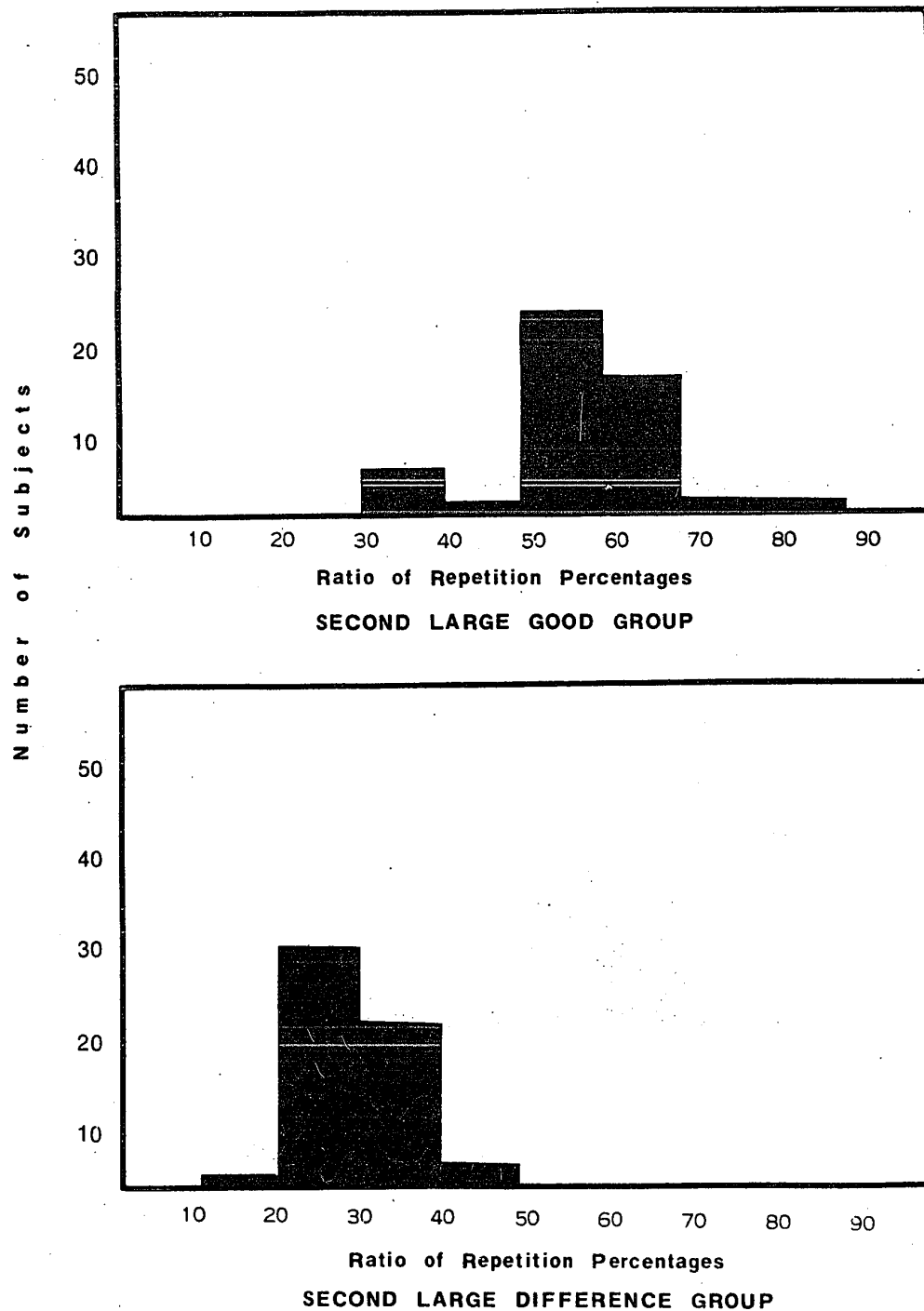


Fig. 11.12 -- Distributions of Ratio of Repetition percentages for Second Large Good group (n = 50) matched to Second Large Difference group (n = 50).

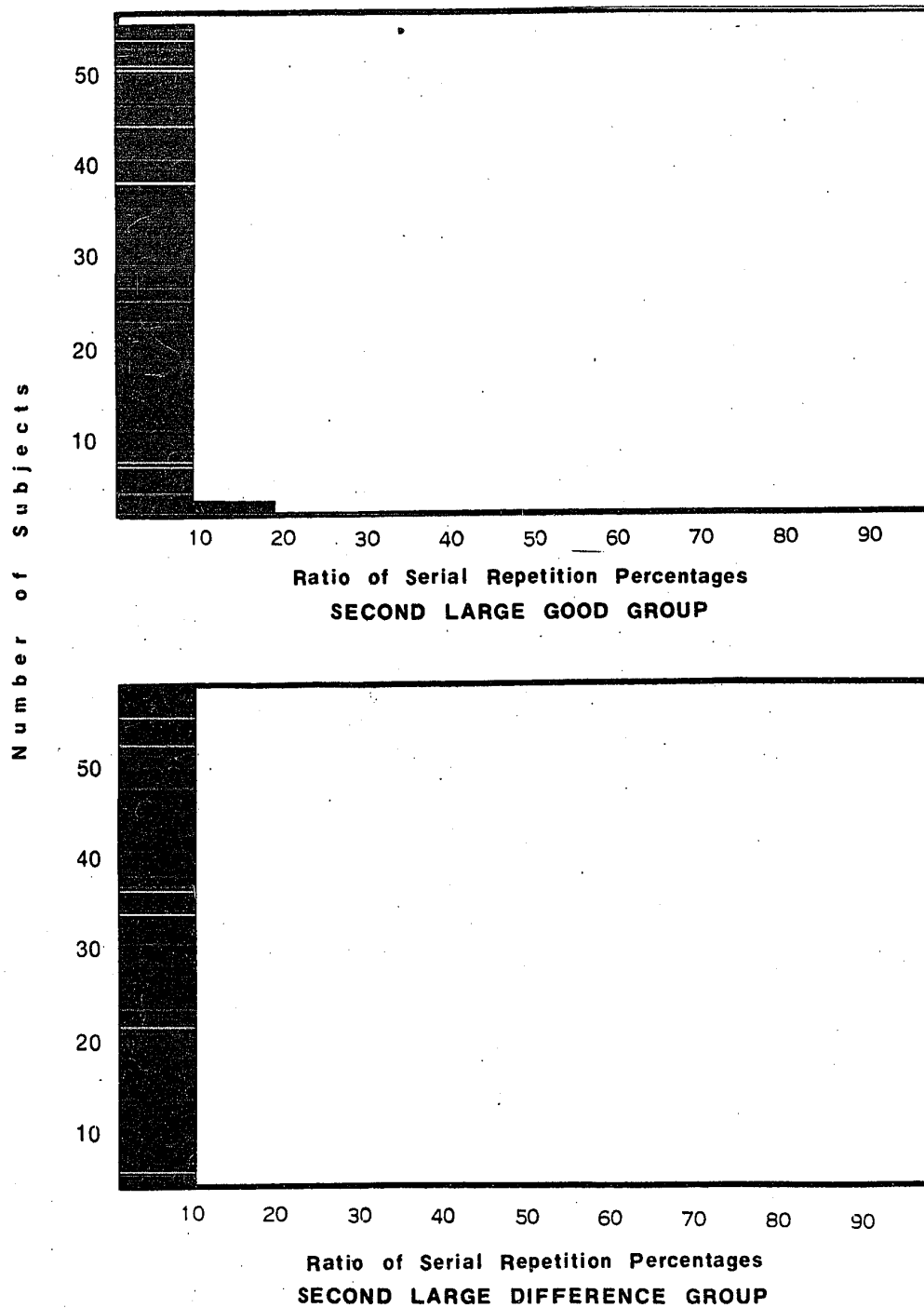


Fig. 11.13 -- Distributions of Ratio of Serial Repetition percentages for Second Large Good group (n = 50) matched to Second Large Difference group (n = 50).

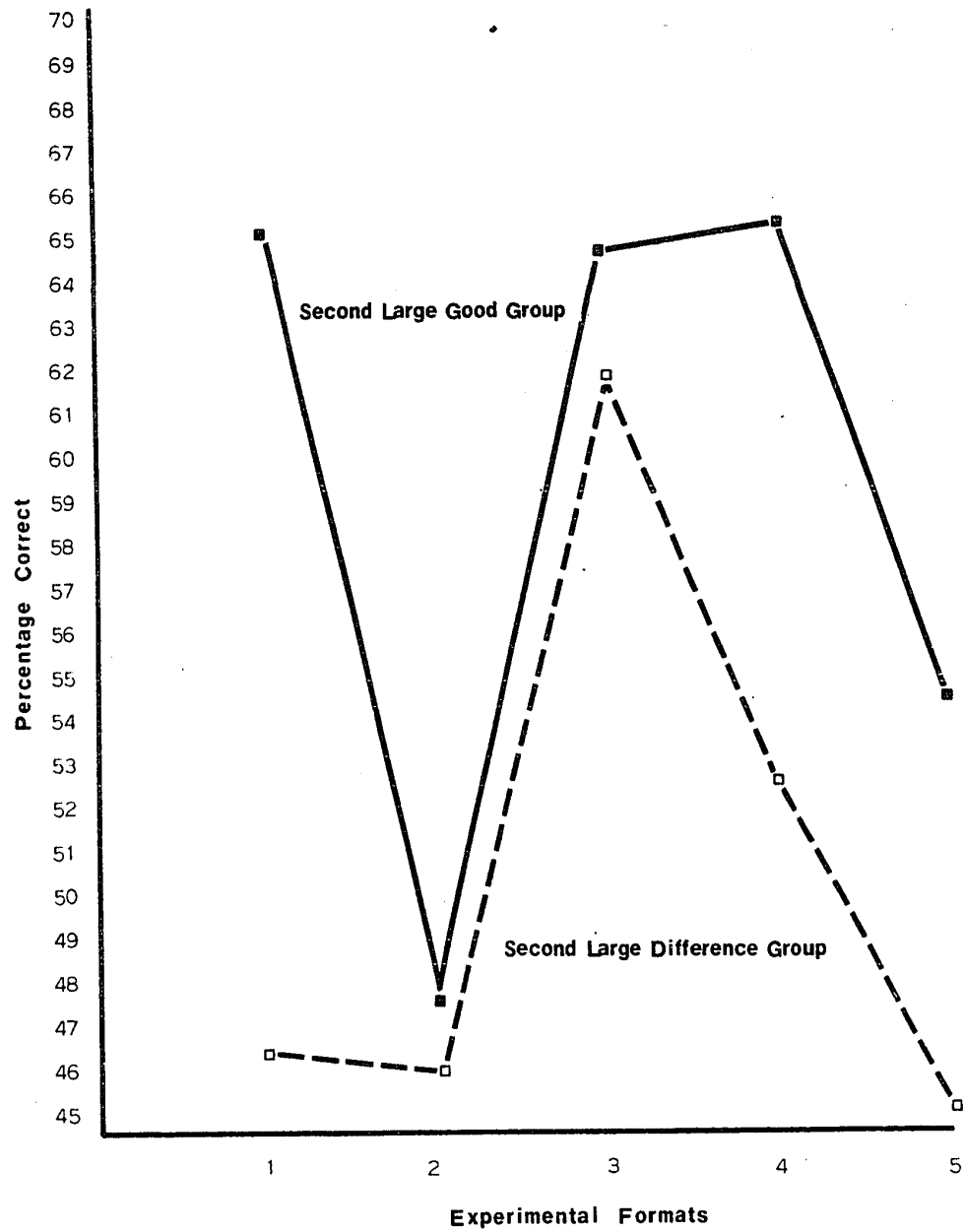


Fig. 11.14 -- Mean test scores organized on the basis of the FORMAT factor. Comparison of Second Large Good group (n = 50) with the Second Large Difference group (n = 50).

1/392, $p < .001$). For the SLG and SLD groups, then, hypothesis 5A is not supported.

The TW format

The mean scores for the groups on this format were not significantly different ($F = 0.22$, $df = 1/392$, n.s.). These data support hypothesis 5B. As with the FLG group, the format comprised of short bizarre chunks caused a substantial depreciation in the comprehension of the SLG group. These results indicate that the performance of the Ss in this group was depressed to the same point as that of the Ss in the SLD group. It can be concluded, therefore, that these "good" readers are prevented from applying their "natural" synthesizing strategy by the use of short bizarre chunks.

The TW format was comprehended by the SLD group at the same level as the FP format indicating that the members of this group respond to written materials with an inappropriate mode of chunking.

Thus, it would seem that grammar plays a minimal role in the attempts at language synthesis made by this group of "poor" readers. On the other hand, the reaction of "good" readers to the presentation of small, non-grammatical word groups, indicates that without the opportunity to form grammatical units, the drive to effect simultaneous synthesis of these readers is frustrated to a significant extent.

The LMC format

The means for the two groups using this format were not significantly different ($F = 0.84$, $df = 1/392$, n.s.). For the SLG and SLD groups hypothesis 5C is upheld. The SLD group is capable of effecting simultaneous synthesis, at least up to the level of LMCs, provided these are presented as quite discrete chunks. It would seem that separate presentation is sufficient to initiate the lower level of simultaneous synthesis. When these readers are assisted with the lower level of simultaneous synthesis in this way, they appear to be able to establish the functional relationships among the units for themselves. The improvement effected in the quality of comprehension for these readers brought their scores up to the standard of the "good" readers with whom they had been matched.

The "good" readers in the SLG group again show that the synthesis of grammatical chunks is the approach employed by them in a "normal" reading situation.

The HMC format

The mean achieved by the SLD group in response to reading this format was significantly below that achieved by the SLG group ($F = 30.86$, $df = 1/392$, $p < .001$). Hypothesis 5D is thus rejected. Although the facilitating effect of the LMC format was sufficient to elevate the comprehension of the SLD group of "poor" readers, to that achieved by the SLG group, the HMC format did not produce so dramatic an improvement. Since the readers in these groups were matched

on their equal knowledge of verbal concepts but a specific difference in RR scores, a feasible explanation of the lower scores revealed by the SLD group on the HMC format, may be that they possess less skill in the information processing strategy of simultaneous synthesis. The degree of improvement in comprehension effected with the separate presentation of LMCs has demonstrated the existence of some skill. The embedding of LMCs in the higher level HMCs, however, is probably sufficient to prevent these readers from separating the LMCs with sufficient efficiency to significantly enhance their comprehension. The possibility that this can be associated with lower synthesizing skill in written, verbal situations is suggested by the lower RR scores achieved by the SLD group.

The BL format

Although the BL format is non-grammatical, it is apparent that its greater length and the presence of one or more LMCs within it, prevented the comprehension of the SLG group being depressed to the standard of the SLD group. The result of this was that the comprehension of this format by the SLG group was significantly better than the comprehension of it by the SLD group ($F = 16.44$, $df = 1/392$, $p < .001$), Hypothesis 5E is rejected on this evidence. Without the aid of separately presented LMCs, the Ss in the SLD group reverted to the less efficient method of language processing usually employed by them. Thus, on the one hand, the use of non-grammatical chunks impedes the attempts at

simultaneous synthesis of "good" college readers and, therefore, adversely affects comprehension. On the other hand, since "poor" readers with the characteristics of those in the SLD group require specific assistance in order to effect simultaneous synthesis, they read the BL format at the same standard as they read the FP format.

The FSG group compared with the RSR group

"Good" readers were matched with "poor" readers who produced approximately equal Vocabulary subtest scores but who had used the information processing strategy of successive synthesis in the task calling for clustering in recall. Thus, while the RSR group possessed about the same knowledge of verbal concepts as the FSG group, they had displayed a tendency to use an inappropriate information processing strategy on a specific verbal task. The comparative status of these groups on each of the classifying variables is shown in Figures 11.15, 11.16, 11.17, and 11.18.

The overall difference in the performances of the two groups is shown by the significant main effect for ability groups ($F = 42.15$, $df = 1/48$, $p < .001$). These analyses indicated a significant main effect for format for the FSG group but not for the RSR group--(FSG: FP = LMC = HMC formats but $<$ TW = BL formats; RSR: FP = TW = LMC = HMC = BL formats). The combined main effect, under the two-way analysis of variance, for the two groups, was significant ($F = 8.78$, $df = 4/192$, $p < .001$).

This section reports the simple main effects for

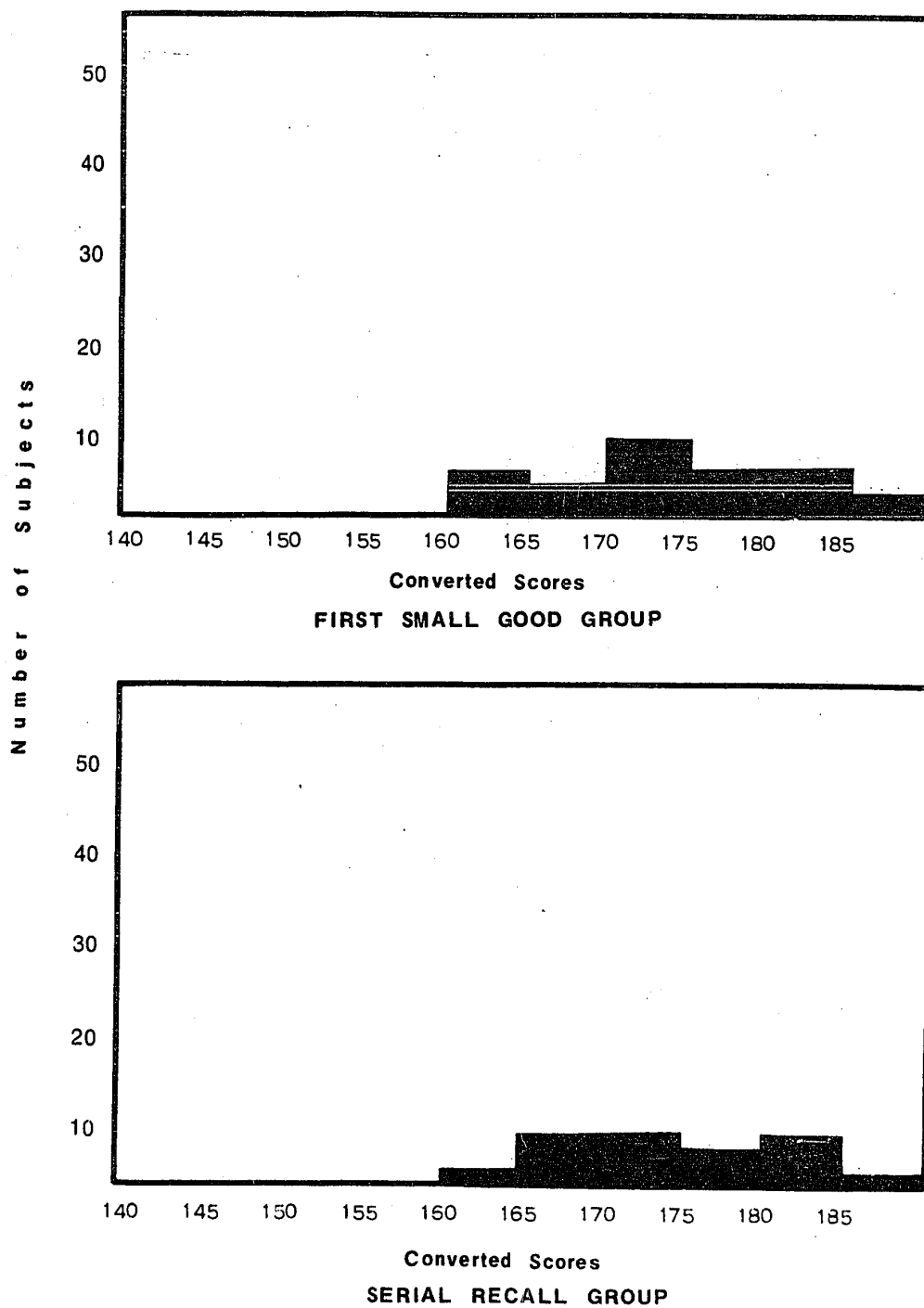


Fig. 11.15 -- Distributions of converted scores on Vocabulary subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for First Small Good group (n=25) matched to Serial Recall group (n=25).

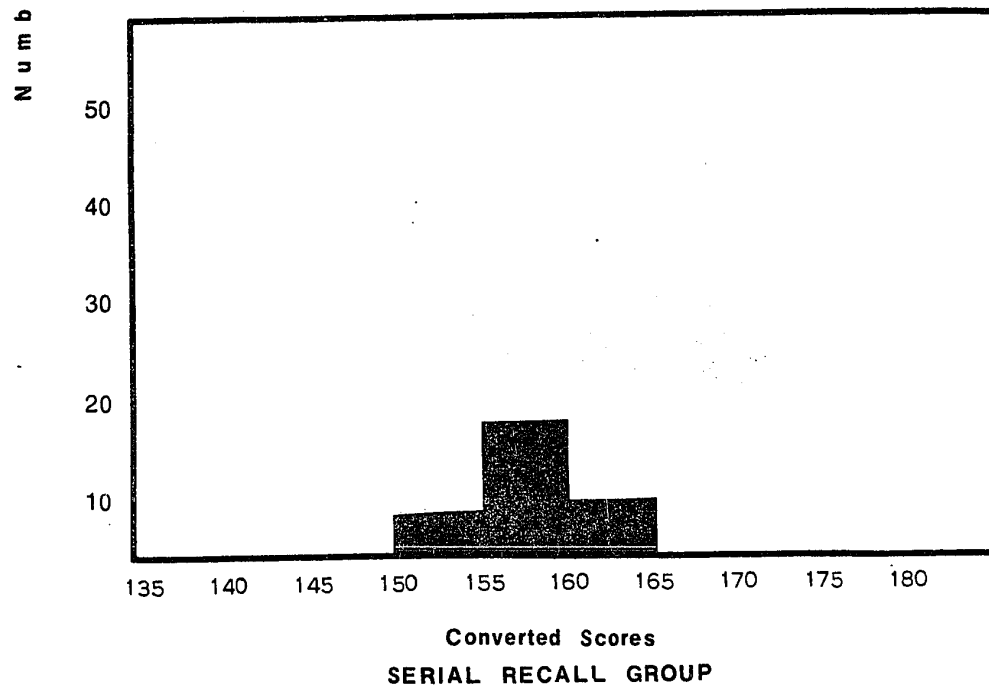
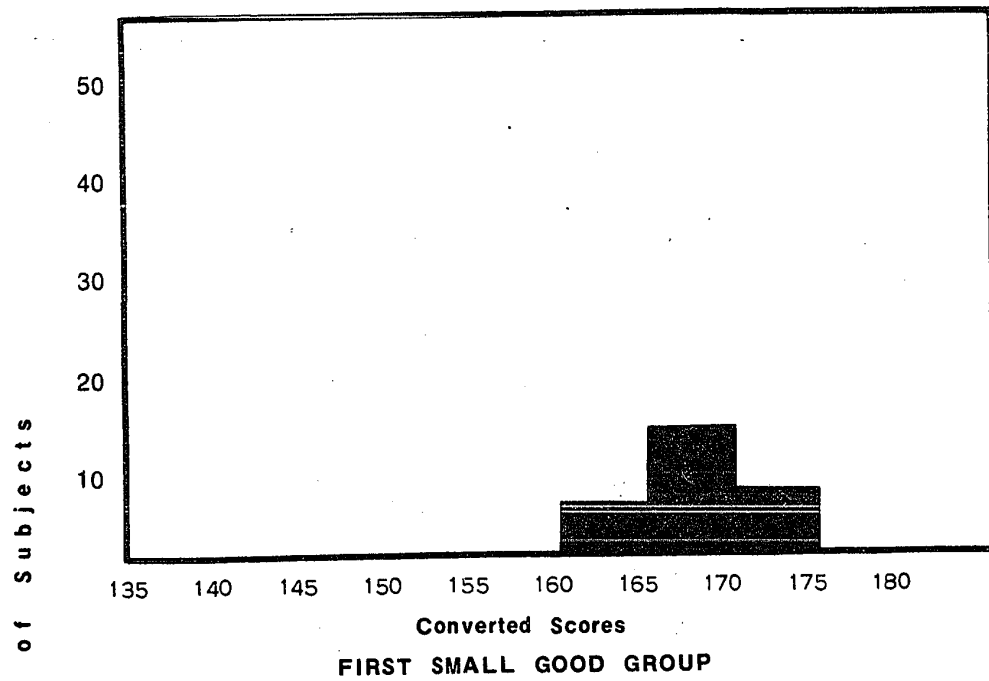


Fig. 11.16 -- Distributions of converted scores on Level of Comprehension subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for First Small Good group (n = 25) matched to Serial Recall group (n = 25).

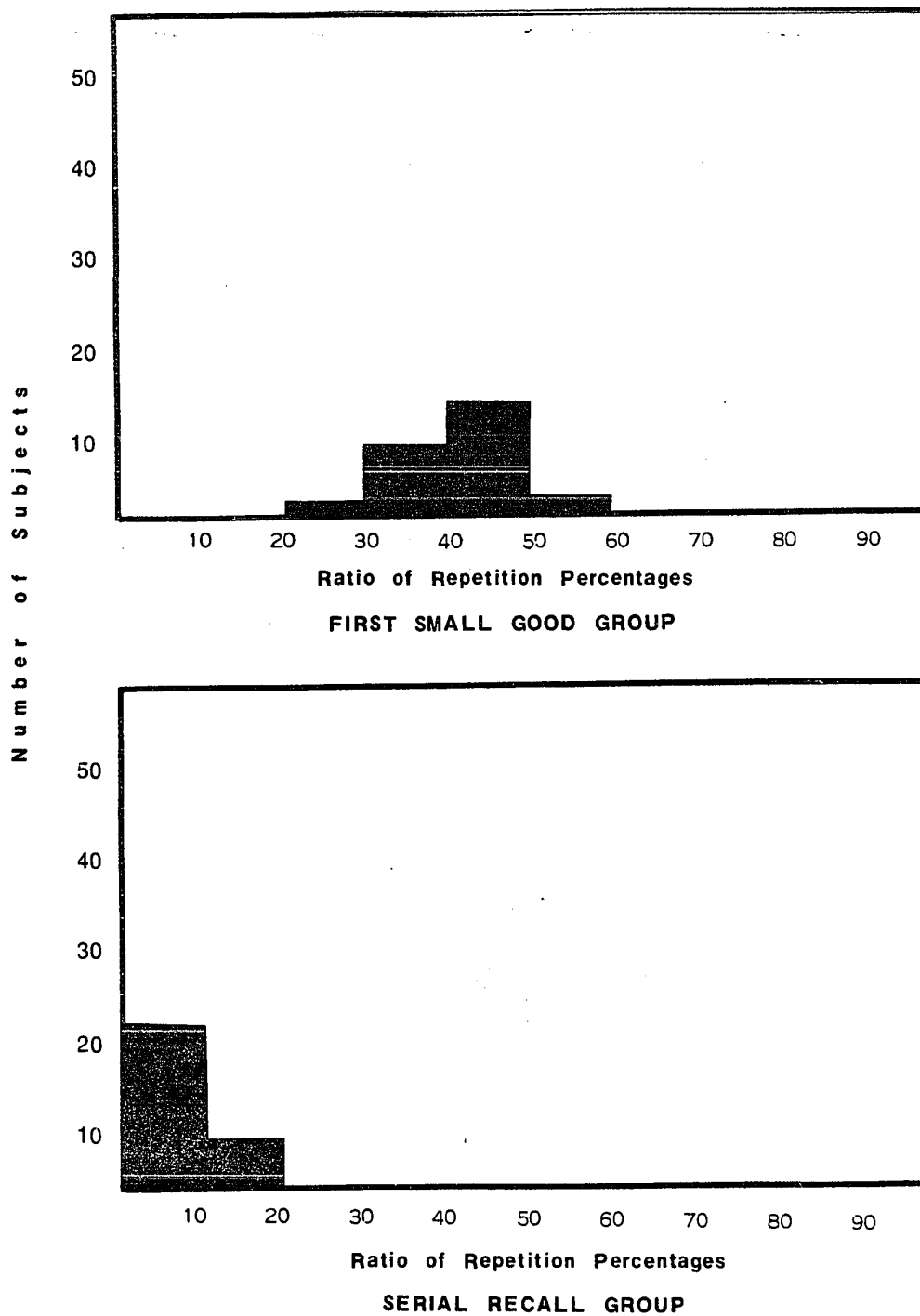


Fig. 11.17 - Distributions of Ratio of Repetition percentages for First Small Good group (n = 25) matched to Serial Recall group (n = 25).

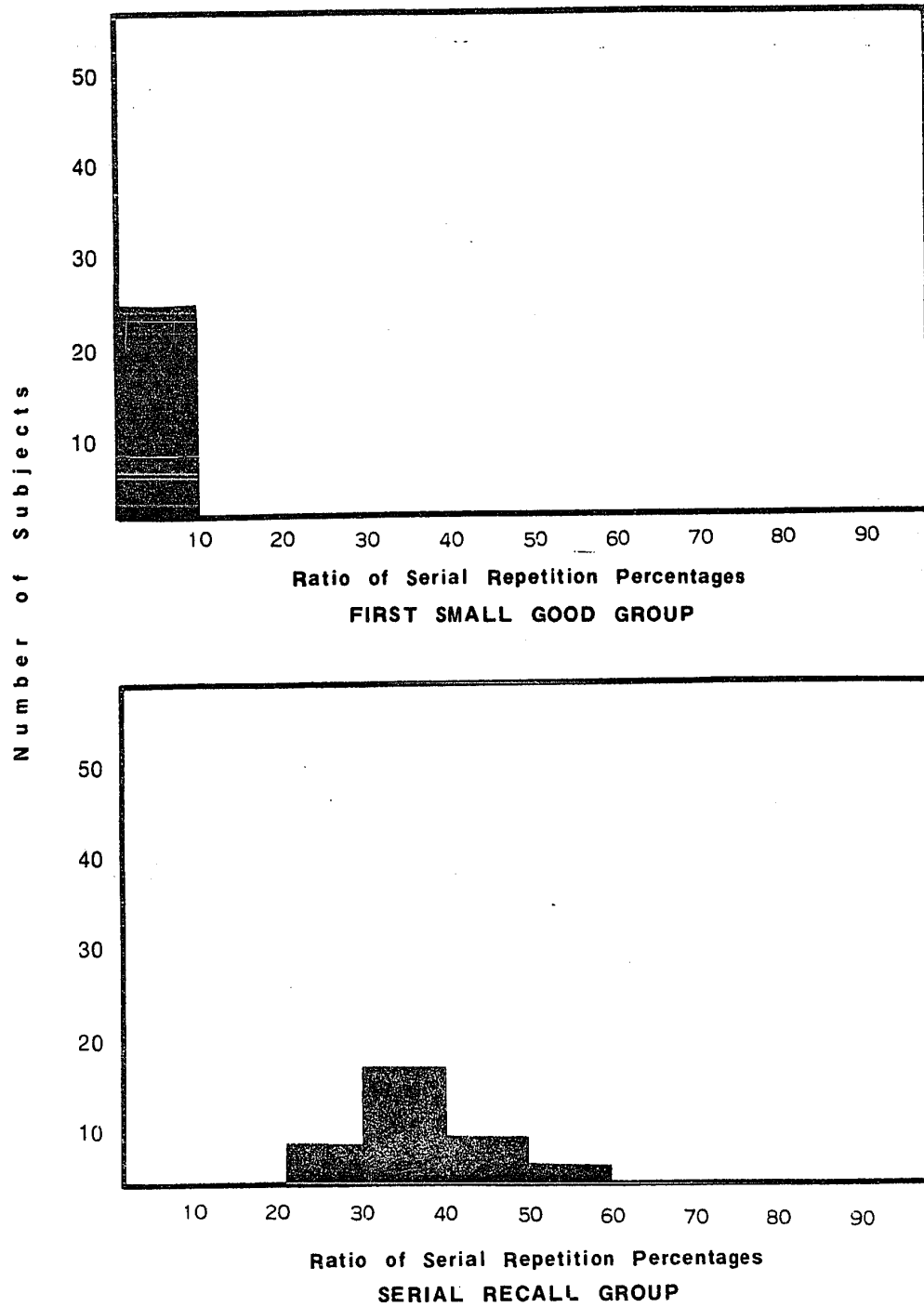


Fig. 11.18 -- Distributions of Ratio of Serial Repetition percentages for First Small Good group (n = 25) matched to Serial Recall group (n = 25).

each format. The comparative performances for the FSG and RSR subgroups for formats are shown in Figure 11.19.

The FP format

Despite the approximately equal knowledge of verbal concepts possessed by the Ss of these two groups, the mean scores on the FP format were significantly different ($F = 20.16$, $df = 1/192$, $p < .001$). Hypothesis 5A is rejected with regard to these two groups. This finding suggests that the Ss in the RSR group read at a lower level than the Ss in the FSG group because of a difficulty with language synthesis. The fact that these readers used the information processing strategy of successive synthesis in the completion of a task strongly biased towards the use of simultaneous synthesis suggests that they may attempt to identify the meaning of written discourse by summing, in a linear manner, the individual words which comprise it.

The TW format

The Ss in the RSR group understood the TW format as readily as they understood the FP format but the readers in the FSG group produced significantly lower scores than on the FP format. The effect of the TW format on the FSG group was to reduce the scores to the level of those produced by the RSR group ($F = 0.02$, $df = 1/192$, n.s.). For these groups, hypothesis 5B is upheld. While the attempts of the Ss in the FSG group to effect simultaneous syntheses according to grammatical criteria are plainly disrupted by the

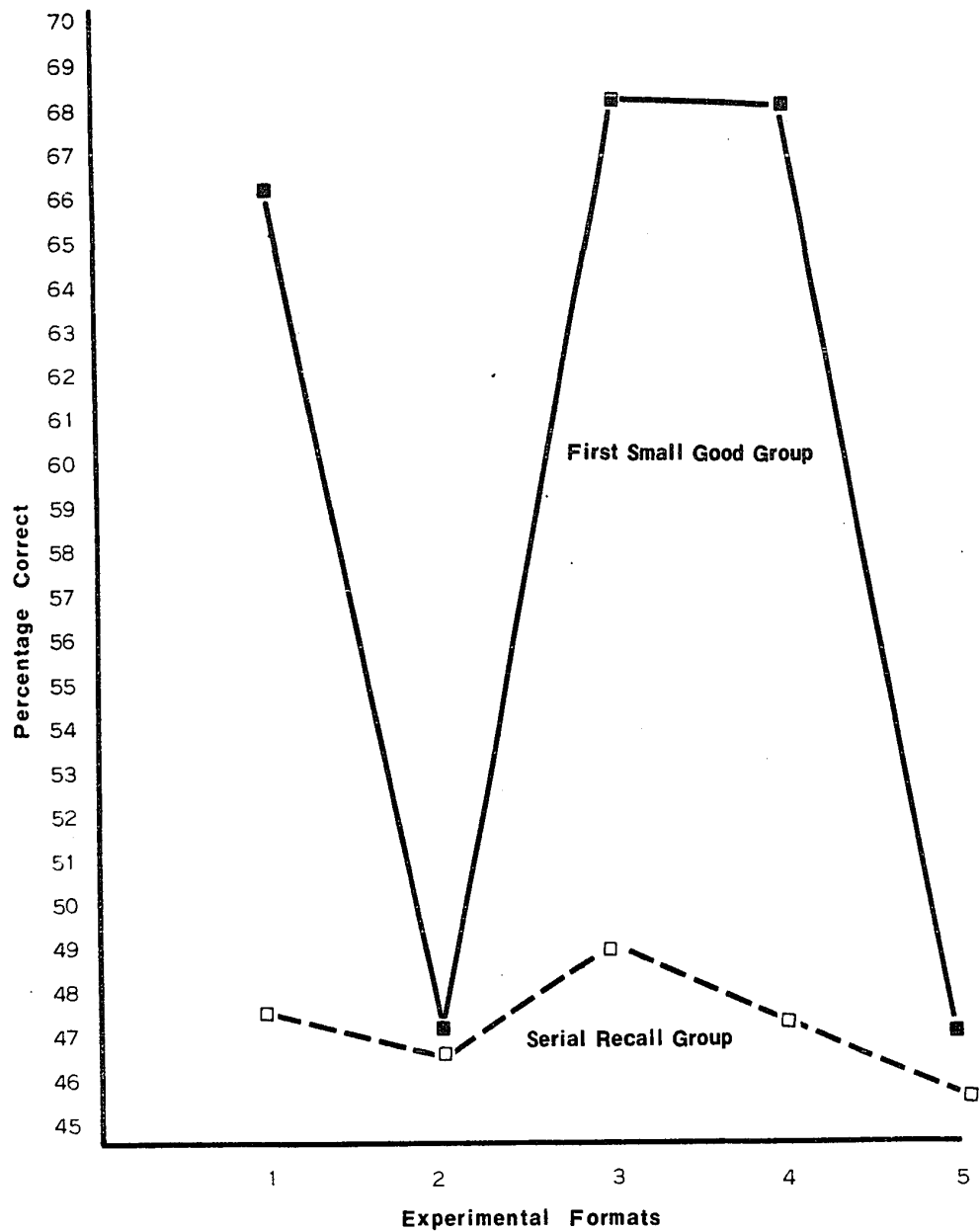


Fig. 11.19 -- Mean test scores organized on the basis of the FORMAT factor. Comparison of First Small Good group (n = 25) with Serial Recall group (n = 25).

presentation of written materials in short, bizarre chunks, the "normal" approach of the RSR readers is not disturbed. Their understanding of written materials presented in this way remains at the low level of performance associated with the FP format.

The LMC format

The performance of the RSR group on this format was different from the other "poor" groups reviewed to this point. The LMC format did not enhance their comprehension. Since sensitivity to the LMC chunk would appear to involve the recognition of an appropriate application for simultaneous synthesis it would seem likely that the Ss in the RSR group have generalized the strategy of successive synthesis to an inappropriate aspect of the act of comprehension of written language.

As with the other "good" subgroups, the members of the FSG group comprehended the LMC format at the same standard as they understood the FP format. The means obtained by the two groups on this format were significantly different ($F = 21.68$, $df = 1/192$, $p < .001$). Hypothesis 5C is not supported by these data.

The HMC format

As with the LMC format the means for the two groups were significantly different on the HMC format ($F = 25.08$, $df = 1/192$, $p = .001$). Hypothesis 5D is, therefore, rejected. This format did not assist the Ss in the RSR group in

identifying the meaning of the material so presented. The FSG group comprehended the HMC format as well as they comprehended the FP format.

The BL format

The FSG group produced scores consistent with the other "good" groups in reading materials displayed by means of the BL format--comprehension was severely impaired. Again, it can be concluded that the non-grammatical nature of the BL chunk was sufficient to inhibit the attempts of these readers to effect the simultaneous synthesis that has been postulated as a fundamental component in their successful comprehension of written language. The RSR group read this format at the same standard as the other four formats. The difference between the mean scores of the two groups in response to the BL format was not significant ($F = 0.12$, $df = 1/192$, n.s.). On this evidence, hypothesis 5E is found to be tenable.

The SSG group compared with the Deficit group

The formation of the Deficit group was carried out by selecting the 25 readers from the "poor" group who had registered the lowest Vocabulary subtest scores together with low RR scores not offset by high RSR scores. The SSG group was comprised of the 25 "good" readers who remained after the three other "good" groups had been formed. The comparative status of these groups on each of the classifying variables is depicted in Figures 11.20, 11.21, 11.22,

and 11.23.

The overall difference in the performances of these two groups on the experimental reading tests is shown by the significant main effect for ability groups ($F = 19.35$, $df = 4/192$, $p < .001$). The main effect for format for the two groups, organized for the present two-way analysis of variance, barely reached significance ($F = 2.88$, $df = 4/192$, $p < .05$). The evaluation of simple main effects of ability grouping on each type of format is reported individually for each of the five formats. The comparative performances of each of these groups for formats are set out in Figure 11.24.

The FP format

The difference between the mean scores obtained by these two groups was significant ($F = 16.20$, $df = 1/192$, $p < .001$). Hypothesis 5A is, therefore, not supported by the experimental evidence.

The TW format

The mean scores for the groups on this format were not significantly different ($F = 0.90$, $df = 1/92$, n.s.). These data support hypothesis 5B with regard to these two groups. As with the other three "good" subgroups the format comprised of short bizarre chunks caused a substantial drop in the comprehension of the SSG group. Again, it is concluded that these "good" readers are prevented from applying their "natural" synthesizing strategy by the use of short bizarre chunks.

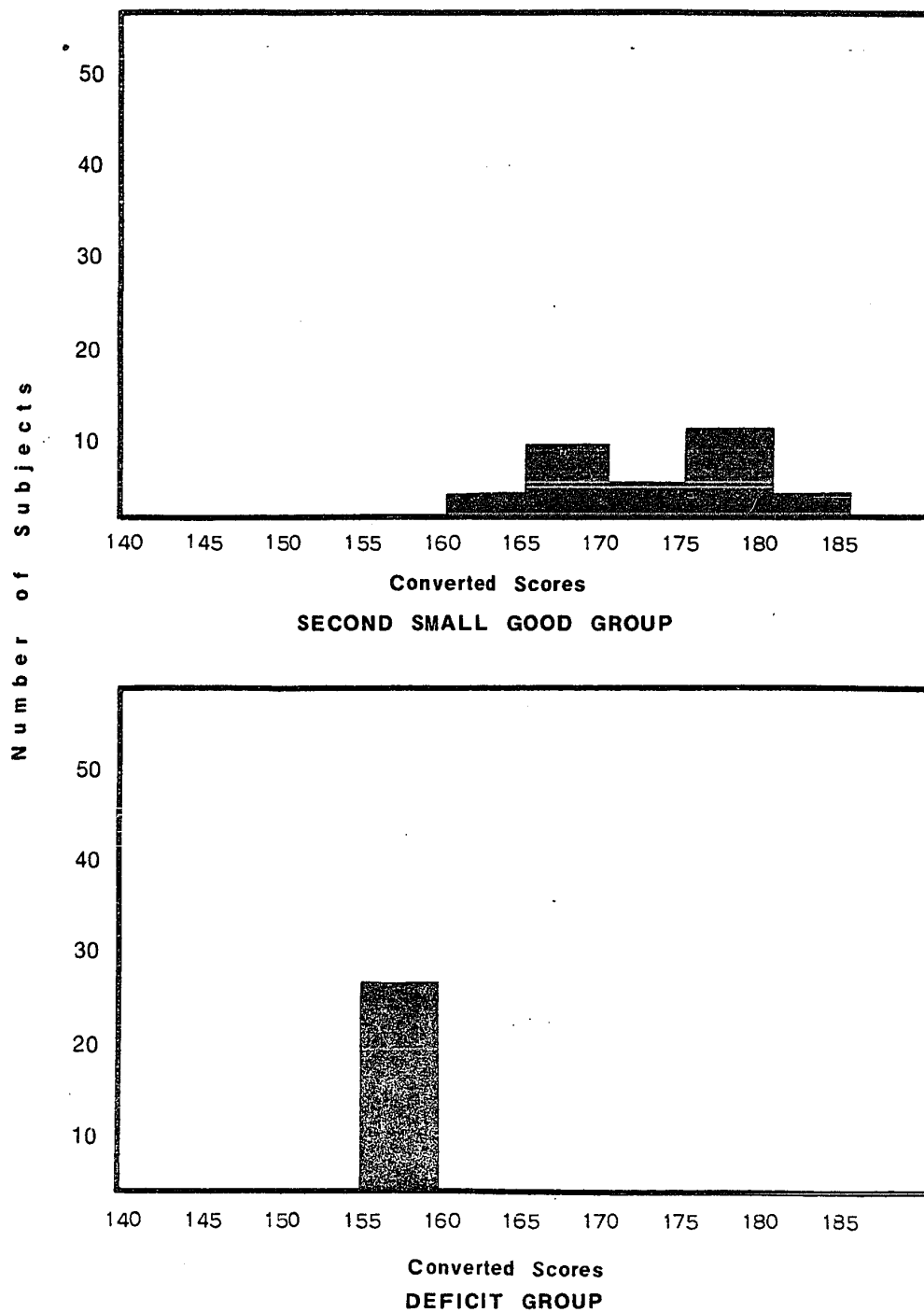


Fig. 11.20 -- Distributions of converted scores on Vocabulary subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for Second Small Good group (n = 25) matched to Deficit group (n = 25).

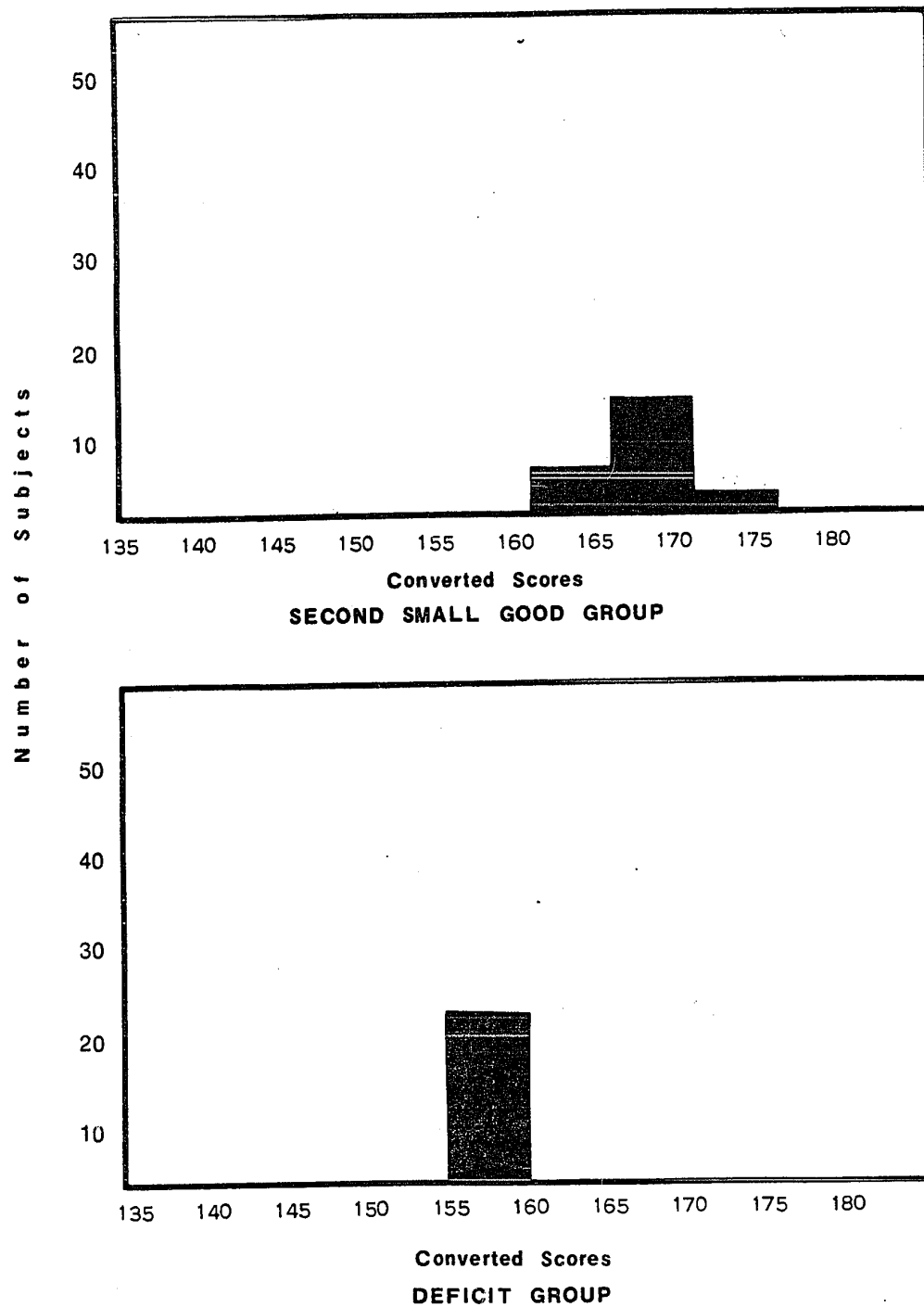


Fig. 11.21 -- Distributions of converted scores for total sample (N = 325) on Level of Comprehension subtest of COOPERATIVE ENGLISH TEST OF READING COMPREHENSION for Second Small Good group (n = 25) matched to Deficit group (n = 25).

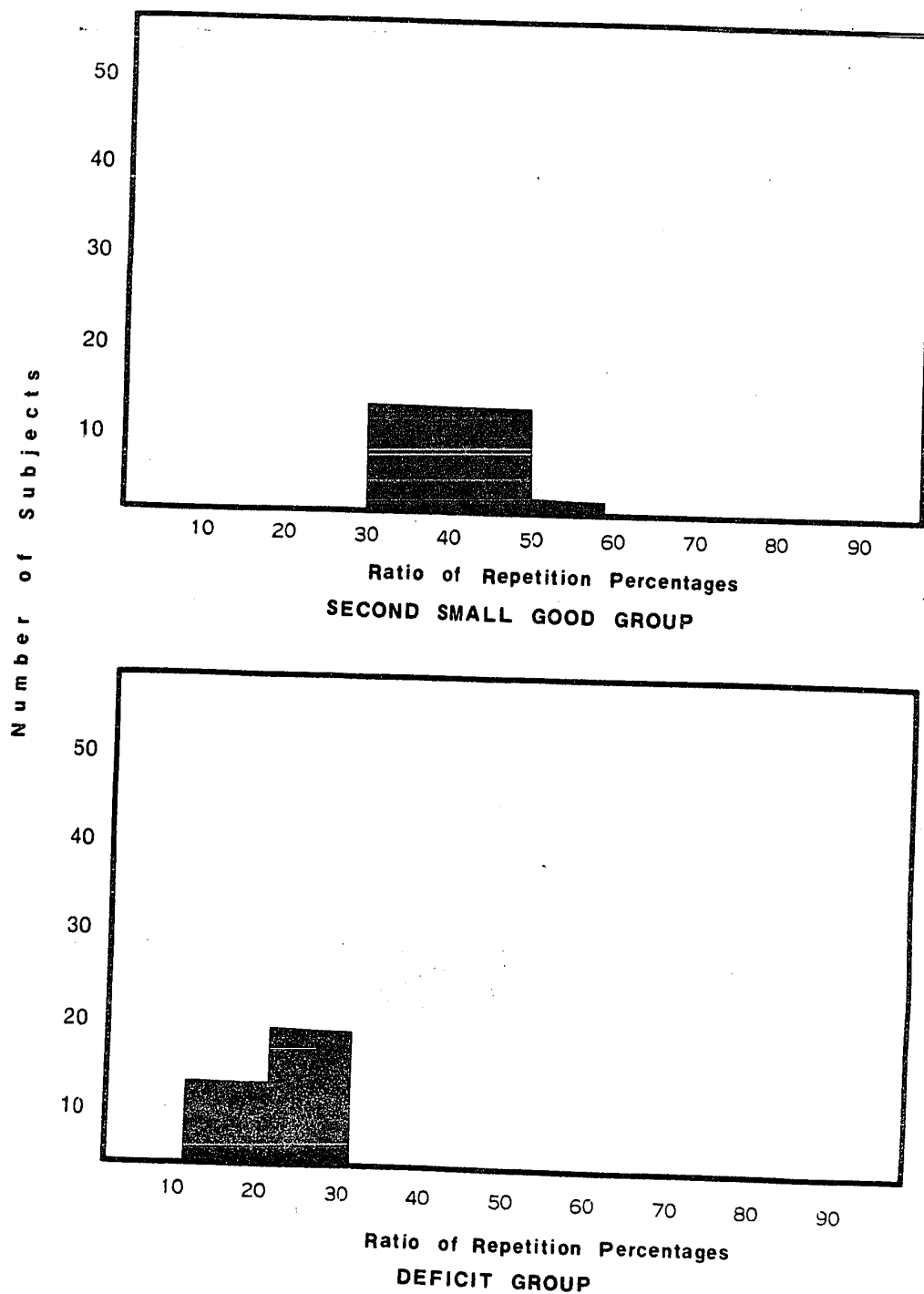


Fig. 11.22 -- Distributions of Ratio of Repetition percentages for Second Small Good group ($n = 25$) matched to Deficit group ($n = 25$).

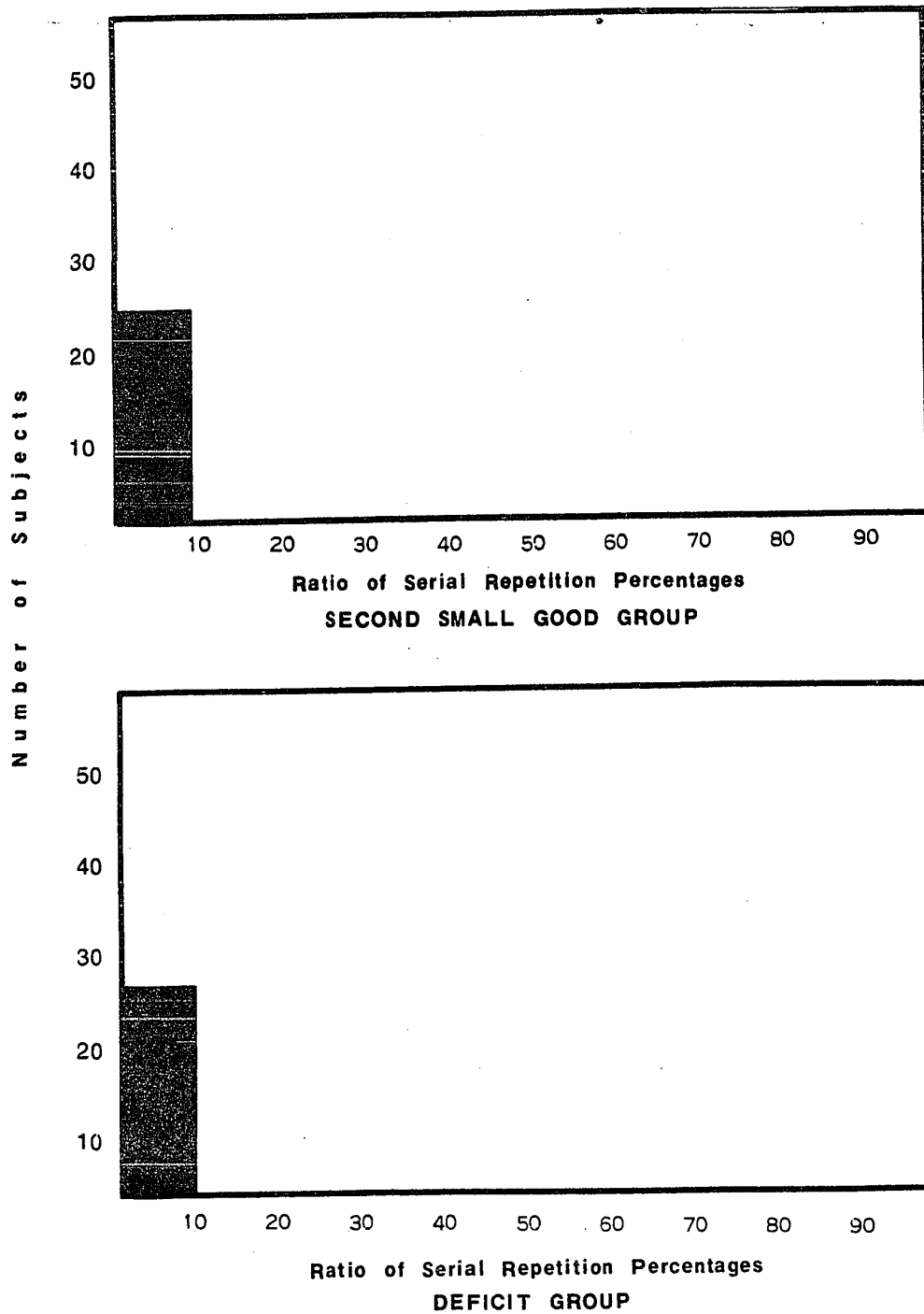


Fig. 11.23 -- Distributions of Ratio of Serial Repetition percentages for Second Small Good group (n = 25) matched to Deficit group (n = 25).

The FP format

The difference between the mean scores obtained by these two groups was significant ($F = 16.20$, $df = 1/192$, $p < .001$). Hypothesis 5A is, therefore, not supported by the experimental evidence.

The TW format

The mean scores for the groups on this format were not significantly different ($F = 0.90$, $df = 1/92$, n.s.). These data support hypothesis 5B with regard to these two groups. As with the other three "good" subgroups the format comprised of short bizarre chunks caused a substantial drop in the comprehension of the SSG group. Again, it is concluded that these "good" readers are prevented from applying their "natural" synthesizing strategy by the use of short bizarre chunks.

The LMC format

The mean scores for the two groups using this format were significantly different ($F = 11.96$, $df = 1/192$, $p < .001$). Thus, for the SSG and Deficit groups, hypothesis 5C is rejected. The presentation of written materials by means of small grammatical chunks does not assist the Ss in the Deficit group in their attempts at comprehension. The "good" readers in the SSG group achieved equivalent scores on the LMC and FP formats. The breaking of connected word strings into grammatical groups each of which is then synthesized into a single entity is, clearly, an internalized

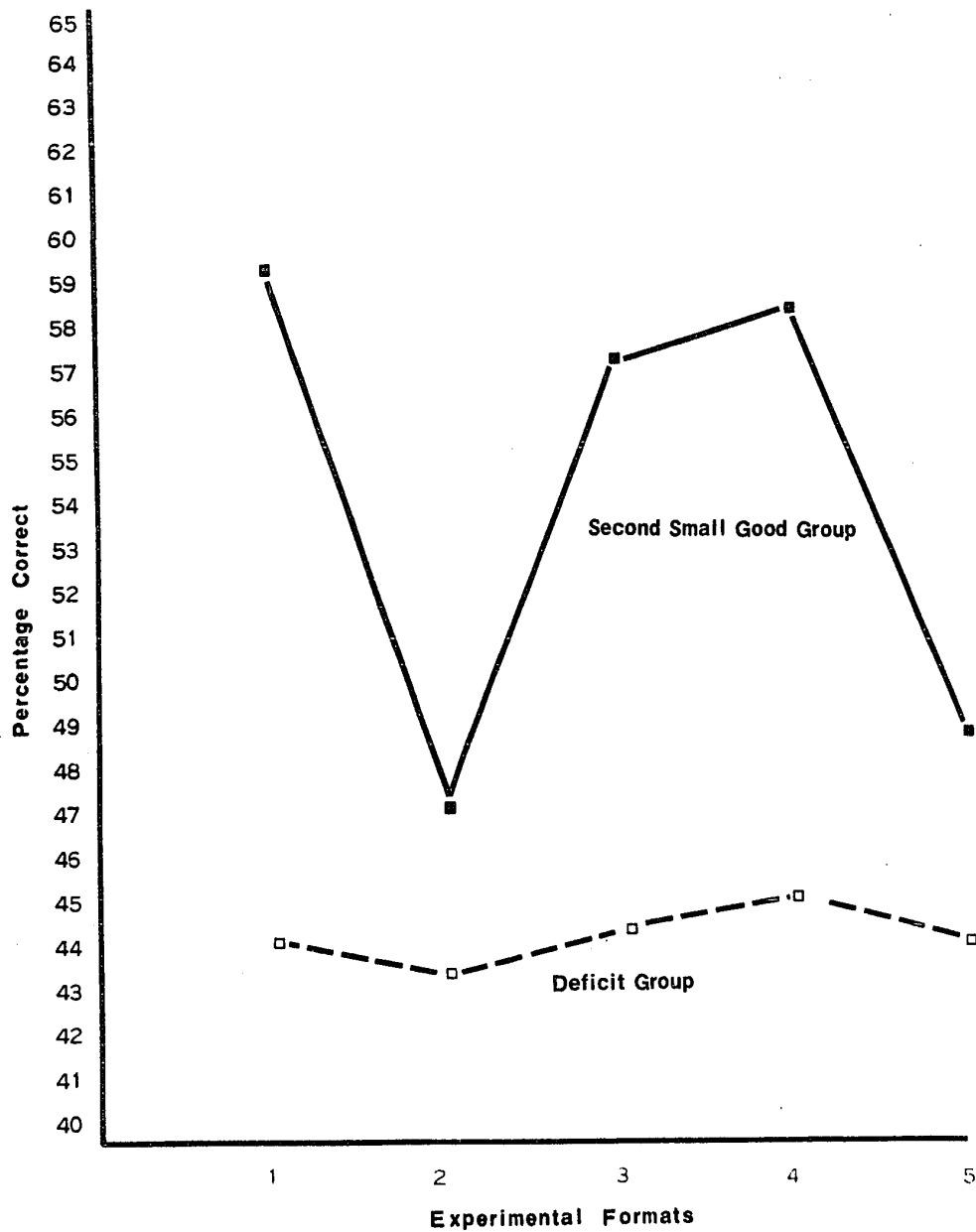


Fig. 11.24 -- Mean test scores organized on the basis of the FORMAT factor. Comparison of the Second Small Good group (n = 25) with Deficit group (n = 25).

strategy for these "good" college readers.

The HMC format

The mean produced by the Deficit group on this format was significantly below that achieved by the SSG group ($F = 12.56$, $df = 1/192$, $p < .001$). Hypothesis 5D is thus rejected. Again, the HMC format did not show any tendency to improve the comprehension of the Deficit group. The "good" readers once more demonstrated that they are able to deal efficiently with a chunked format provided that format consists of word groups displaying grammatical unity or having the potential to be grouped into a grammatical unit or units.

The BL format

The difference in the mean comprehension scores of these two groups on this format was not significant ($F = 1.54$, $df = 1/192$, n.s.). For these two groups, then, hypothesis 5E is found to be supported by the experimental evidence. While the non-grammatical nature of the chunks used in the BL format had no measurable impact on the comprehension of the Ss in the Deficit group, it did cause the comprehension of the Ss in the SSG group to drop sharply.

From the effects of the five formats on these two groups it can be concluded that the Ss comprising the SSG group process written language in much the same way as the other "good" readers whose data have already been analyzed. The members of the Deficit group were consistent in their

response to all five formats. All scores were low and there was no significant difference among them. Although the RR scores for this group were lower than for any of the other groups except the RSR group, their low Vocabulary subtest scores suggest that it is a severe deficiency in verbal concepts that is inhibiting the comprehension of these readers. On the basis of the low RR scores, however, it could have been predicted that these Ss would probably have had trouble with the comprehension of written materials even if their knowledge of verbal concepts had been adequate. It is contended, however, that comprehension is blocked at the antecedent point of the knowledge of the concepts that should be available for synthesis. There is specific evidence that these Ss do not possess sufficient concepts to permit successful reading at the college level.

Summary

The purpose of this section has been to provide a direct comparison of subgroups of "good" readers with subgroups of "poor" readers with whom they had been matched on certain criteria. These criteria were established to permit the highlighting of the role played by the information processing strategy of simultaneous synthesis in the comprehension of written language by college level readers.

Three variables were used to classify and match Ss. These were the scores achieved on the Level of Comprehension

and Vocabulary subtests of the Cooperative English Test of Reading Comprehension and the RR (or RSR) scores derived from the test of clustering in recall. The RSR scores were used in place of the RR scores where the former were larger, indicating a preference for successive synthesis over simultaneous synthesis.

By using the scores on these tests to categorize Ss it was possible to match certain "good" readers with specific "poor" readers and, thus, to examine the differences between their performances on the experimental reading tests with some precision. In this way, "good" readers were matched with "poor" readers who showed approximately the same knowledge of concepts, the same ability to select an appropriate information processing strategy for a specific verbal task, and about the same level of performance in applying simultaneous synthesis to the completion of that same task. It was discovered that these "good" readers synthesized the verbal concepts, and the interacting syntactic and semantic information, conveyed in words, largely by means of grammatically motivated simultaneous synthesis. The "poor" readers, matched with these "good" readers, revealed no such strategy which assisted their attempts to apprehend the meaning of written discourse. These "poor" readers could be encouraged to comprehend at the same level as the "good" readers, however, by presenting written materials to them by means of small grammatical chunks (LMCs). Apparently, viewing these chunks in isolation was sufficient

to permit such readers to see their underlying unity and to synthesize accordingly. From this finding it can be concluded that some "poor" college readers comprehend written materials at an indifferent level largely because they have not learned how to apply the information processing strategy of simultaneous synthesis to written language. This evidence further indicates that the deficiency in synthesis with these readers is at the "word group level" rather than the "functional relationships level." That is, the individual presentation of LMCs is sufficient to lift the comprehension of these readers to that of the "good" readers with whom they had been matched. It can be assumed, therefore, that the higher level of simultaneous synthesis which establishes functional relationships, presents no difficulties for these readers provided they have been assisted to successfully amalgamate individual words into meaningful, grammatical units.

The presentation of HMCs to this group of "poor" readers produced the same degree of improvement in their comprehension. The reason for this response to the HMC format which was created by the reconstitution of LMC chunks is less clear. It is possible that the unified nature of these larger chunks permitted these readers to perceive both the LMCs of which the larger chunk was comprised and the relationships operating amongst the LMCs within the HMC. This possibility raises the question of the upward limit for the size of reconstituted chunks that are capable of

triggering the information processing strategy of simultaneous synthesis in readers of this type.

"Good" readers were also matched with "poor" readers who possessed the same knowledge of verbal concepts, revealed the same ability to select an appropriate information processing strategy for a specific verbal task, but who performed at a substantially lower level in employing the simultaneous synthesis that was required for the completion of that task.

The "good" readers with whom these "poor" readers had been matched produced the same pattern of performance as the "good" readers discussed above. It was found that by the chunking of written language into LMCs that were displayed separately, it was possible to lift the standard of comprehension of these "poor" readers to the same level as that achieved by the "good" readers with whom they had been matched. Again, it can be assumed from this, that the higher level of simultaneous synthesis which permits the apprehension of functional relationships, presents no difficulties for these readers, provided they have been assisted to make the first step of integrating individual words into meaningful, grammatical units.

The presentation of HMC chunks to these "poor" readers did not initiate synthesis to the same extent as the separate presentation of LMC chunks. The reason for this would appear to be that, although HMCs are comprised of LMCs, the LMCs have to be isolated by the reader before

their synthesis can be effected. Either this has to occur as a more or less independent process which is then followed by the establishment of inter-unit relationships, or, the entire HMC chunk is synthesized as a single unit. Since the latter would somehow require the simultaneous synthesis of LMC like units and the apprehension of the relationships in which they stand to each other, this explanation is rejected as not feasible. A more likely reason for the comparative failure of the HMC chunk is the inability of this type of reader to separate LMCs and synthesize them as independent entities. In this case, synthesis fails because of an apparent inability to discern individual LMCs when they are subsumed within higher level units. That this is a deficiency in the ability to effect simultaneous synthesis, under specific circumstances, is suggested by the lower RR scores produced by this group of readers.

"Good" readers were also matched with "poor" readers who possessed approximately the same knowledge of verbal concepts but who chose the inappropriate information processing strategy of successive synthesis for the clustering in recall task. Apparently successive synthesis was applied inappropriately to the initial aspects of the receptive processing of written language. Comprehension of written materials by this group of readers was not enhanced by any format. It can be concluded from these findings that these readers process written language a word or two at a time.

Finally, "good" readers were matched with "poor"

readers who had a significantly poorer knowledge of verbal concepts and who achieved much lower RR scores. These "poor" readers had selected an appropriate information processing strategy for the clustering in recall task but they performed very poorly on it. Comprehension of written materials by this group of "poor" readers was not enhanced by any format. It is concluded that these Ss did not possess the verbal concepts required for success in college level reading.

Summary

This chapter has shown that, for this sample, the ability to select the appropriate information processing strategy for the completion of the clustering in recall task is positively and significantly related to ability to understand reading materials though, again, success in this test did not ensure the successful comprehension of written language. While no specific unit of written language processing could be identified for the total sample, considerable evidence was produced that suggested that the "good" readers in the sample base their written language processing on the lower major constituent (LMC), and "poor" readers operate on only one or two words at a time. A large body of data has been examined which suggests that the difference between most of the "poor" readers in this sample and the "good" readers, is the inability of the "poor" readers to effect the simultaneous synthesis of the verbal concepts and

the interacting syntactic and semantic information conveyed
by the words comprising continuous, written discourse.

CHAPTER 12

SUMMARY, FINDINGS, CONCLUSIONS, AND IMPLICATIONS

Introduction

Throughout this study the term "information processing" has occurred. Much of what has been proposed as theory, and all the experimentation that has been effected, has been based on the assumption that when a person reads he is processing information. Although the term has been used in a quite specific way, the breadth of the original concept has not been diminished. Reading, as information processing, remains an aspect of an organism's attempts to come to terms with its environment by dealing with the external stimuli that impinge upon it. In this case, the organism is the human species, and the specific type of information processing that has been focussed upon is uniquely human. The general processing activities employed, however, are strikingly similar to those employed by other organisms in dealing with incoming stimuli. They are also very similar to the other processing activities employed by human beings in performing different non-reading tasks. What is different about the information processing that is encompassed by the term "reading" is that it requires a special and highly complex integration of different information processing abilities. Such processing abilities range from those at a purely sensory level to other forms of highly complicated, cognitive activity. In reading, the emphasis on different

information processing abilities will vary according to the stage of acquisition being considered. The beginning stages of reading call for a different emphasis from that required in the later acquisitive stages or that used when the stage of accomplished reading has been reached.

The chief purpose of this study was to investigate the role of simultaneous synthesis in the reading of college level adults. Ancillary purposes were to determine the relationship between their ability to select an appropriate information processing strategy for the recall task and their comprehension of written materials; and to investigate units of written language processing employed by college readers.

This chapter will present a brief summary of the study and its findings. The conclusions that are feasible in the light of these findings will be presented and the implications arising from the investigation will also be examined. In addition, certain limitations of the study will be discussed and proposals for further research will be put forward.

Summary of the Study

Because the study was essentially concerned with an investigation of the importance of the simultaneous synthesis of words in the comprehension of written language, a review of the literature relating to the synthesis of incoming, language-mediated messages was carried out. As an important facet of this, consideration was given to the

literature dealing with the influence of grammar on receptive language processing. This, in turn, led to the review of the literature relating to grammar and reading, and hence, to the critical review of the studies that have been conducted on language chunking and reading.

From this review of the literature a theoretical position was developed which proposed the probable part played by the information processing strategy of simultaneous synthesis in the comprehension of written language. This theory was then translated into a set of hypotheses susceptible to empirical testing. The study which has been reported here was designed to provide these empirical tests and thus permit the drawing of strong inferences about the hypotheses generated from the theory.

The theoretical position was outlined in Chapter 5. It stressed the importance of a knowledge of grammar in the simultaneous synthesis by a fluent reader, of the words comprising written discourse. Two levels of simultaneous synthesis were proposed and the function of grammar in the effecting of each was outlined. To evaluate the relationship between grammar and simultaneous synthesis, various synthesizing strategies were imposed upon readers by presenting them with written materials chunked in different ways. Accordingly, for the display of reading materials, four different types of chunks were used in addition to a "normal" format.

The IBM 1500 Instructional System was used to permit

the completely separate presentation of each chunk or the connected presentation of the normal format. The use of the IBM 1500 Instructional System meant that Ss had to read from CRT screens. Because this was an atypical reading situation, Ss' reactions to interaction with the system were gathered and collated.

Five different testing procedures were employed to avoid any bias in the findings that may have stemmed from the use of a single testing procedure and to permit the use of a balanced, though incomplete, experimental design. Three basic test types were employed to create these five testing procedures. The first type made use of the cloze procedure which was applied to the five passages used in the study. The second was based on the application of five linguistic algorithms to various sentences in each passage. Facet design was used to control the production of the multiple choice distractor statements associated with each question. These tests were used in pre-test and pre-test: post-test situations. The third type of test was based solely on facet design. Two facets were employed and the tests thus produced were also used in pre-test and pre-test: post-test situations. The five test procedures, therefore, were: (a) the cloze test (CL); (b) the linguistic algorithm post-test (LAP); (c) the linguistic algorithm pre-test:post-test (LAPP); (d) the facet design post-test (FDP); (e) the facet design pre-test:post-test (FDPP). These test procedures were applied to each of the five different prose

passages.

The experimental sample was drawn from a population of 631 volunteer undergraduate university students registered in the Faculty of Education at the University of Alberta. Three hundred and twenty-five Ss were selected from this population and, in general, were haphazardly assigned to one of five experimental groups.¹

The data pertinent to units of written language processing, types of formats, and the role of simultaneous synthesis in the comprehension of written language, were evaluated with a variety of statistical techniques. These included product-moment correlation, t-tests, and analysis of variance procedures.

Main Findings and General Conclusions

In this section the most significant findings from Chapters 10 and 11 are summarized. The conclusions which these findings imply are also discussed.

Main Findings

The detailed findings presented in Chapters 10 and 11 demonstrate that from this sample of college level Ss at least five significantly different types of readers have been identified.

¹See: Chapter 6.

Types of college readers

These college readers can be typed as follows: (a) "good" readers who, for the most part, achieved scores above the sample median in the comprehension subtest of the standardized reading test and chose simultaneous synthesis as the appropriate information processing strategy for the recall task in which they recorded high recall scores; (b) "poor" readers who achieved poor scores (in a relative sense) in the comprehension subtest of the standardized reading test but good scores on the vocabulary subtest and chose simultaneous synthesis as the appropriate information processing strategy for the recall task in which they produced high scores; (c) "poor" readers who achieved poor scores on the comprehension subtest of the standardized reading test but good scores on the vocabulary subtest and selected simultaneous synthesis as the appropriate information processing strategy for the recall task but achieved recall scores slightly below the sample average using that strategy; (d) "poor" readers who achieved poor scores on the comprehension subtest of the standardized reading test but good scores on the vocabulary subtest and chose successive synthesis as the information processing strategy appropriate for the recall task but recorded low recall scores which reflected higher successive synthesis indices than simultaneous synthesis indices; and finally, (e) "poor" readers who produced poor scores in both subtests of the standardized reading test and chose simultaneous synthesis as

the appropriate information processing strategy for the recall task but recorded very low scores using that strategy. It should be noted that readers of the types described under (b), (c), and (d) cannot be separated into these discrete types on the basis of their performances on either of the subtests of the standardized reading test. The separation described was effected using response to the recall task as the means of categorization. Despite the apparent similarity of the reading level of these three types of readers, each of them, as well as the types described under (a) and (e) above, revealed a distinctive pattern of responses to the five formats used for the presentation of written materials in this study. At all times, the performances of Ss on the five experimental tests of reading, devised specifically for this study, are reviewed in terms of reading ability or disability defined as deriving meaning from written language.

"Good" readers

The four groups of "good" readers all produced high Vocabulary subtest scores in addition to achieving high Level of Comprehension subtest scores.

All of the 150 Ss who were classified as "good" readers for the purposes of this investigation selected the information processing strategy of simultaneous synthesis for the recall task. That is, all of these "good" readers indicated an ability to select the appropriate information processing strategy for the completion of a visual-verbal

task strongly biased toward the use of simultaneous synthesis. Their recall scores were, for the most part, equal to, or higher than, the sample average.

The four groups of "good" readers revealed strikingly similar profiles of average scores on the tests associated with the reading materials presented by means of the five different formats.

Within each group, statistically equivalent mean scores were achieved on the tests of comprehension of the passages displayed by means of the FP, the LMC, and the HMC formats. However, each "good" group read the passages presented in the TW and BL formats at levels significantly below those achieved in reading materials displayed by means of the other formats. That is, while the passages presented by means of chunks created by the application of grammatical criteria were comprehended by these "good" readers as well as the passages displayed in a "normal" format, the passages presented in chunks which did not possess grammatical unity were comprehended at substantially lower levels.

"Poor" readers

The four groups of "poor" readers produced quite distinctive patterns of responses to the various tests employed for the collection of data in this study. The main findings relating to each such group, therefore, will be summarized separately.

The First Large Difference group (FLD group). This group of "poor" readers achieved high Vocabulary subtest

scores. In fact, the mean vocabulary score for this group was equal to that of the First Large Good group (FLG group). Level of Comprehension subtest scores, however, were in the lower half of such scores for the total sample.

Each of the 50 Ss who comprised this group of "poor" readers selected the information processing strategy of simultaneous synthesis for the recall task. Using this approach for the recall task these Ss earned recall scores that were equal to, or higher than, the sample average.

In response to the various comprehension tests based on the passages displayed in the five different formats the Ss in this group achieved equivalent scores on the FP, TW, and BL formats. Their scores on the LMC and HMC formats were not significantly different, though both these formats were comprehended at levels significantly superior to those achieved on the remaining three formats. In other words, these readers understood written language substantially better when it was presented to them in the form of separately displayed grammatical chunks than when it was presented to them in a "normal" way (i.e., by means of continuous prose) or by means of short or long chunks neither of which possessed grammatical unity.

The Second Large Difference group (SLD group). The members of the SLD group also recorded high Vocabulary subtest scores. The mean vocabulary score achieved by this group was equal to that achieved by the Second Large Good group (SLG group) of readers. Again, however, Level of

Comprehension subtest scores were in the lower half of such scores for the total sample.

Each of the 50 Ss in this group chose simultaneous synthesis as the information processing strategy appropriate for the completion of the recall test. The recall scores produced by these Ss, however, were below the sample average.

The comprehension tests of the passages displayed by the five formats produced equivalent results in response to the FP, TW, and BL formats. The Ss in this group comprehended the passages presented in the LMC and the HMC formats at levels superior to materials presented by means of the FP, TW, and BL formats. Unlike the Ss in the FLD group, the Ss in the SLD group comprehended the passages displayed in the LMC format significantly better than they comprehended the passages which made use of the HMC format. In general terms, these findings mean that these readers understood written language significantly better when it was displayed for them in the form of separately presented grammatical chunks than when it was displayed in a "normal" way (i.e., by means of continuous prose), or by means of short or long chunks neither of which possessed grammatical unity. The pattern of comprehension responses of the members of this group differed from those of the members of the FLD group in that short grammatical chunks (LMCs) were understood better than long grammatical chunks (HMCs).

The RSR group. This group of 25 "poor" readers also achieved high Vocabulary subtest scores. The mean

vocabulary score for this group was equal to that of the First Small Good group (FSG group). The scores produced in the Level of Comprehension subtest were substantially below the average for the total sample.

The Ss who comprised this group apparently all selected the information processing strategy of successive synthesis for the recall task. The use of this strategy produced recall results which were very markedly below the mean recall score for the total sample.

The comprehension tests associated with the passages which were displayed by means of the five different formats produced statistically equal mean scores with the Ss in this group. That is, the standard of comprehension of the RSR readers was not differentially affected by the use of long or short grammatical or non-grammatical chunks or by the use of "normal" connected prose. The level of comprehension across all five formats was about equal to the lowest level achieved by any of the groups analyzed to this point.

The Deficit group. The Ss in this group were the only ones who produced relatively low Vocabulary subtest scores. The mean for the group was lower than the mean quoted by the test manual for the lowest quartile of college sophomores. The Level of Comprehension subtest scores for these Ss were equally low. In both tests the means for this group were substantially below the means for the full sample.

The members of the group all made use of the information processing strategy of simultaneous synthesis for the

completion of the recall task. The results achieved, however, were very much lower than the mean produced by the total sample.

With the Ss in this group, the tests used to assess the comprehension of the passages presented by means of the five different formats produced statistically equivalent results. In general terms, this finding means that the standard of comprehension of the Deficit readers was not affected by the use of long or short grammatical or non-grammatical chunks or by the use of "normal" connected prose. As with the RSR group, the level of comprehension across all five formats was approximately equal to the lowest level produced by any of the other seven groups.

General Conclusions

Verbal concepts and comprehension

A positive and significant correlation between a knowledge of verbal concepts and the comprehension of written language has earlier been reported for the total sample involved in this study. Clearly, for college students like those in the present study, a knowledge of verbal concepts is necessary for the understanding of written language.

The fact that approximately 84% of the 150 "poor" readers in this sample produced vocabulary scores equivalent to "good" readers with whom they had been matched, yet failed to produce equally "good" comprehension scores, demonstrates that while a knowledge of verbal concepts is

necessary for the comprehension of written language, it is not a sufficient condition to ensure that such comprehension will occur.

The selection of an appropriate information processing strategy

In the sample under investigation, no S who apparently selected successive synthesis for the completion of the recall task, produced a Level of Comprehension subtest score that fitted into the top half of such scores for the total sample. It was postulated in Chapter 5 that both simultaneous and successive syntheses are necessary for the comprehension of written language. It was further postulated, however, that each of these must be employed at appropriate points in the processing of written language if comprehension is to take place. The recall task was strongly biased towards the use of simultaneous synthesis. Thus, it can be concluded that those Ss who appeared to choose successive synthesis for the recall test displayed a distinct tendency to employ an inappropriate information processing strategy for a visual-verbal task. Since the 25 Ss who comprised the RSR group all displayed as high vocabulary scores as the 25 "good" readers with whom they had been matched, it is reasonable to conclude that their demonstrated propensity to choose an inappropriate information processing strategy for a specific task suggests that they employ such a strategy for the receptive processing of written language. The result of this is, apparently, a poor level of comprehension.

On the basis of this evidence it can be concluded that the ability to select the appropriate information processing strategy appears to be a necessary condition for the comprehension of written language. Eighty-three per cent of the 150 relatively "poor" readers in the sample did select the appropriate information processing strategy for the recall task and did possess a good knowledge of verbal concepts. Notwithstanding such performances these Ss still recorded low Level of Comprehension subtest scores. This indicates that, while the ability to select an appropriate information processing strategy, in addition to possessing an adequate knowledge of verbal concepts, is a necessary condition for the comprehension of written language, it is not a sufficient condition to ensure that comprehension.

Level of performance on a task involving simultaneous synthesis

A positive and significant correlation between scores on the Level of Comprehension subtest and the scores on the recall task has been reported previously. In addition, no S who achieved a good comprehension score, produced a low recall score. On the other hand, 50 "poor" readers recorded an adequate knowledge of verbal concepts, selected the appropriate information processing strategy for the recall task in which they produced good scores, yet produced Level of Comprehension subtest scores which placed them in the lower half of the sample on this criterion.

On the basis of this evidence, it can be concluded

that level of performance in simultaneous synthesis is related, in some important way, with the Level of Comprehension subtest scores of college readers such as those in this sample. It has been pointed out, however, that a high standard of performance in a related task calling for simultaneous synthesis, even when combined with an adequate knowledge of verbal concepts, does not ensure that written language will be processed with comprehension.

College readers and reading strategies

As reported in the section on Main Findings, five types of college readers could be identified in the sample of Ss used in this study. The distinctive patterns of responses to the five experimental comprehension tests, produced by these different types of readers, permit the drawing of general conclusions about the reading strategies employed by such readers.

"Good" college readers

These findings strongly suggest that these "good" college readers typically make use of their internalized, tacit knowledge of grammatical structure when they read. That this structure is fundamentally similar to that employed by the writer in his production of a specific prose passage, is indicated by the high level of comprehension of that passage by such readers. That is, both writer and reader, in performing their respective production and perception tasks, make use of markedly similar non-visual

knowledge--the grammar of the language (F. Smith, 1973; Goodman, 1973). The basic unit of this grammatical structure employed by these "good" readers, and therefore, by the writers of the passages, is the lowest major constituent (LMC) used in this study, or a grammatical unit that is extremely similar to it. This conclusion is based on the fact that three of the formats that were comprehended at equal levels by the "good" readers made use of chunks that were comprised of one complete LMC (the LMC format), several complete LMCs (the HMC format), and many complete LMCs (the FP or normal format).

Support for this conclusion is provided by the levels of comprehension achieved by the "good" readers on the passages presented by means of the short bizarre chunks (the TW format) and the long bizarre chunks (the BL format). Each of these formats, the chunks of which specifically lacked grammatical unity, impaired the comprehension of the "good" readers. The TW format consisted almost exclusively of disrupted LMCs. The BL format did not display grammatically complete units in that, while some LMCs were found in most BL chunks, the beginning and ending of each such unit consisted only of parts of LMCs. Thus, where a reader's natural reading strategy involved the discerning of LMC-type units in the word strings comprising written sentences, this strategy was frustrated by the completely discrete presentation of word groups that were not LMCs or an exact number of amalgamated LMCs. That some "good" readers comprehended

the BL format significantly better than the TW format suggests that these readers were able to identify some LMC units and thus apprehended more of the meaning of such texts than when all chunks were completely bizarre, grammatically. The response protocols of these Ss suggested that, for them, the long bizarre chunks impeded their attempts to establish the functional relationships operating within sentences. Thus, an important component contributing to the meaning of the passages so presented, was rendered extremely difficult of access for these readers.

It can be concluded, then, that college readers, such as the "good" readers involved in this study, typically employ a reading strategy that makes use of one level of simultaneous synthesis to find complete grammatical entities such as noun group, verb group, prepositional group, and so on. It can be further concluded that, by means of another level of simultaneous synthesis, the functional relationships that obtain amongst these word groups in sentences, e.g. subject of, object of, modifier of, verb, and the like, together with the semantic information they convey, are established. In this way, it can be seen that at least one aspect of the process of the comprehension of written language by "good" readers, involves the constitution of grammatical entities and the repeated reconstitution of these units into higher level units that reveal within-sentence relationships. That the ability to do this depends upon knowledge possessed by the reader rather than overtly

signalled information from the page has been cogently argued by both Smith (1973) and Goodman (1973).

"Poor" college readers

In the section devoted to the summary of the findings it was shown that the 150 Ss who obtained the lowest scores on the Level of Comprehension subtest could be subdivided into four groups of "poor" readers. These have been designated as the First Large Difference group (FLD group), the Second Large Difference group (SLD group), the Serial Recall Group (RSR group), and the Deficit group respectively. The general conclusions which follow will be presented for each of these groups separately.

The FLD group. This group of "poor" readers has been described as a "difference" group after the usage of Cromer (1970). That is, the typical mode of response to written input for these readers is "different" from that of "good" readers with whom they are similar in other basic respects. The "difference poor" readers identified by Cromer had been matched with "good" readers on the basis of I.Q. and knowledge of verbal concepts. In the present study the "difference poor" readers were matched with "good" readers on knowledge of verbal concepts and level of performance on a task calling for simultaneous synthesis.

The findings of this study permit the drawing of a similar conclusion to that of Cromer. These "poor" readers were "different" from the "good" readers with whom they had been matched in that they failed to discern a meaningful,

grammatical structure within written input. This conclusion is based on the finding that these Ss read the normal (FP) and bizarre formats (TW and BL) at equivalent levels. It can be concluded, therefore, that the customary reading strategy of this group of college students does not involve the synthesis of individual words into grammatical groups. The lack of a significant difference in the level of understanding of passages displayed in the form of connected prose, in the form of separate two-word chunks, or in the form of separate, longer, non-grammatical chunks, strongly suggests that these readers normally respond to written language a word or two at a time. For these readers, language, in its written form, is processed in an essentially linear fashion. The meaning of a written sentence is pursued by a process of simple summation of individual word meanings.

The Ss in the FLD group obtained their best results on the formats comprised of grammatical chunks. In fact, these readers performed as well in reading the "grammatical" formats as their matched "good" group did on either these formats or the normal format. Thus, it can be concluded that the display of written materials in the form of grammatical chunks enhances the comprehension of these "poor" readers to the extent that they read like "good" readers.

It is evident that some "poor" college readers, like those in this group, are capable of the synthesis of groups of words into single entities and of inter-relating such

units to discover the functional relationships within sentences. It is also evident that they can still operate in this way when they are confronted with longer grammatical chunks amalgamated from several lower level grammatical units. Typically, however, they do not do this when the units for synthesis have to be identified, by them, from continuous word strings such as occur in longer, complex sentences.

The results achieved by these Ss in the test of clustering in recall and in the tests of comprehension associated with the grammatical formats, plus the fact that, apparently, they have no difficulty in comprehending spoken language, suggests that the problem in simultaneous synthesis experienced by them is peculiar to continuous written language. Specifically, the inhibiting factor for these readers appears to be an inability to delineate the words which possess the potential for synthesis. When this process of delineation is fully, or even partially, effected for them, they are able to synthesize as efficiently as the "good" readers in the sample. The difficulty experienced by these readers does not appear to be a deficiency in the grammatical aspect of non-visual knowledge. The inhibiting factor seems to be that these readers do not have the ability to apply this knowledge to connected strings of written words.

It was proposed in Chapter 5 that the chunking of connected prose is a product of focal attention which is guided by the reader's internalized knowledge of the grammar

of his language. In the reception of spoken language the operation of focal attention in this way is extensively assisted by the stress, pitch, juncture, intonation, and gestural signals provided by the speaker of the communication. In dealing with written language the reader, in large measure, has to generate hypotheses about this type of information in word strings, himself. It seems extremely likely that a substantial proportion of the college readers in the sample employed in this study are not able to deal with this step in reading by the application of focal attention as they are in the receptive processing of speech. Thus, focal attention, which, with an accomplished reader, would be devoted, for the most part, to the synthesis and inter-relating of the words which are segmented by pre-attentional processes, is diverted to the consideration of individual words. In this way, the automatism of preattentional processes is lost and word-by-word reading occurs with the result of a substantial reduction in meaning. That is, the component of the meaning of written language that is contributed by the full appreciation of the syntactic and semantic function of words occurring in groups, together with the consideration of the relationships which groups of words bear to each other, is drastically diminished.

The SLD group. This group of "poor" readers has also been termed as a "difference" group, again, because their typical mode of response to written input appears to be different from that of "good" readers with whom they are

similar in other respects. As with the FLD group the "difference" seems to lie in the failure of these readers to impose a meaningful, grammatical structure upon written input. This conclusion is based on the finding that these Ss read the normal (FP) and bizarre (TW and BL) formats at equivalent levels. Again, therefore, it can be concluded that the customary reading strategy of this group of college students does not involve the synthesis of individual words into grammatical groups. Rather, this evidence suggests that these readers usually respond to written language a word or two at a time and thus process in a linear and summative fashion.

The SLD "poor" readers also obtained their best results on the formats comprised of grammatical chunks. The pattern of scores produced by the SLD group was similar to that produced by the FLD group with the exception that the response to the format comprised of HMC chunks was significantly poorer than the response to the format using LMC chunks. The HMC format, notwithstanding, was still comprehended significantly better than the FP, TW, or BL formats.

It is clear from these findings that the presentation of reading materials by means of LMC chunks permits "poor" readers of this type to read like "good" readers. These readers are capable of the synthesis of groups of words into single, grammatical entities when those words are displayed in a specific way. Under these conditions they are also

capable of inter-relating such units to discover the functional relationships within sentences. It is not typical of such readers, however, to do this when the units for synthesis have to be identified, by them, from the unchunked words of any given sentence.

It is evident, though, that when written language is displayed by means of LMCs that have been amalgamated to form the higher level HMCs, difficulty is again experienced in identifying the individual LMCs and synthesizing the words comprising them to form single units. Without success in identifying the basic LMC units, it follows that these readers are frustrated in their attempts to establish the functional relationships that contribute a vital increment to sentence meaning.

It is important to note, that unlike the FLD group, the readers in the SLD group recorded lower scores on the test calling for simultaneous synthesis than the "good" readers with whom they had been matched. The average score the SLD group achieved on this test was slightly below that for the total sample. It may be more apt, then, to describe the readers of this group as "difference-deficit" in type.

The conclusion that seems to be feasible from these findings is that, while the Ss in the SLD group have a problem in simultaneous synthesis that is manifest with particular clarity in their attempts to process written language, they also appear to possess less competence in effecting simultaneous synthesis and, therefore, probably

have less potential to successfully process written language. One inhibiting factor affecting the reading of these Ss is an inability to delineate the words which possess the potential for synthesis. Additionally, it seems likely that they are less able simultaneous synthesizers than many other Ss who have been identified in this sample. With these readers, the outcome of this lower level of ability to effect simultaneous synthesis is that they require more assistance in the delineation of the basic units of written language if they are to achieve comprehension of that written language. It is possible that an essential aspect in any task calling for the simultaneous synthesis of apparently discrete elements, is the recognition of the agent or factor that provides those elements with the potential for synthesis. Thus, readers of the type in the SLD group displayed less ability than the "good" readers in the sample to employ their internalized knowledge of the grammar of the language. Certainly, they did not show the ability to employ it in the application of focal attention by means of which, it has been proposed, good readers effect the chunking of the connected words of sentences.

When confronted with prose that is displayed as connected sentences rather than in the form of small grammatical chunks, the outcome for readers of the FLD and SLD types is the same. Focal attention is charged with the function performed by preattentive processes in accomplished readers. The result for both types of readers is word-by-

word processing with significantly reduced comprehension. The different response to the two types of grammatical units and the variation in performance in simultaneous synthesis have revealed a basic difference in two categories of readers. It is considered essential that basic deficiencies, such as those associated with the "poor" readers so far discussed, need to be recognized if effective remedial measures are to be undertaken to assist such readers overcome their "problem."

The RSR group. This group of "poor" readers was termed the RSR group because of the compelling evidence they provided in their responses to the test of clustering in recall that for its completion they had employed the information processing strategy of successive synthesis rather than the more appropriate strategy of simultaneous synthesis. In so doing they recorded a ratio of serial repetition (RSR) that was higher than the ratio of category repetition (RR) they attained.

It was possible to match each of the members of this group with a "good" reader on the basis of equal performance in the Vocabulary subtest of the standardized reading test. The uniformly poor comprehension scores of these readers, despite their adequate knowledge of verbal concepts, provides a clear indication that their manner of response to written input is markedly different from that of matched "good" readers. The classification of "difference poor" readers is considered inadequate to describe the difficulties

experienced by these Ss in responding to written language because of their consistently poor comprehension of passages displayed by each of the five experimental formats.

It is clear that their apparent use of the information processing strategy of successive synthesis, in the recall task, seriously disrupted their attempts to effect the efficient recall of the words in the list. There is no direct evidence in the findings presented in Chapter 11 that these Ss did apply successive synthesis at an inappropriate point in the reading act. The evidence already cited, however, suggests that the disruption of the reading process is due to a very different cause from that used to account for the poor comprehension of the two groups of "difference poor" readers. It is not improbable that the cause is associated with a tendency to misapply the information processing strategy of successive synthesis. This conclusion is strongly supported by the fact that the comprehension of none of these readers improved with the presentation of prose passages by means of grammatical chunks. The strength of the propensity of these Ss to process each word successively was apparently sufficient to inhibit any incentive to synthesize words into simultaneous groups provided by the display of separate LMCs.

Although it is possible to speculate on the cause of this preference for cognitive synthesis that is based solely on the successive consideration of the elements in an array, it is not possible to produce a definitive statement of cause. It is possible that specific circumstances in the

developmental learning history of these Ss were sufficient to nurture such a strong predisposition for the use of successive synthesis. If it were possible to trace and identify such a cause then the reading difficulty of these Ss could be legitimately ascribed to the disruptive effect of an over-learned and over-generalized information processing strategy.

The neurological work reported by Luria (1966a, 1966b) which was based on both physiological and psychological investigative procedures suggests the distinct possibility of a physiological defect as the basis for the preference of one, apparently unvarying, approach to cognitive tasks calling for synthesis of separate elements. Luria's identification of specific and separate cortical areas responsible for each of the two syntheses which he sees as fundamental to cognitive activity, indicates that while both types of synthesis might well be required for the completion of a complex act such as reading, one may not be available--or, perhaps, not as fully available as the other.

In his reporting of particular case histories and his subsequent analyses of the phenomena of cognitive syntheses (1966a, 1966b), Luria examines only two causes of the breakdown of the specific portion of the cortex. These are lesions of a cortical area resulting from (a) the intrusion of a growth, or, (b) lesions caused by the entry of a foreign body (such as a bullet or a shell-fragment), or sustained in accidents involving moving vehicles. The

ensuing brain cell destruction results in the deletion or distortion of the cognitive behavior normally under the control of the damaged section of the brain. Luria details no cases where such cognitive dysfunctioning is ascribed to congenital causes or the failure of development of particular cortical areas because of impoverished environmental demand. Luria's cases include no instances of minimal dysfunction of the cortical areas under discussion: the fronto-temporal region and the occipito-parietal area. It is feasible to conclude that, if the relatively poor reading performance of some college students can be accounted for in terms of the indifferent functioning of a specific area of the cortex, any physical impairment which is responsible will be minimal in nature, and therefore likely to elude detection by the comparatively gross techniques now available to investigators.

In view of these speculations it is contended that the depressed reading performance of the RSR Ss is due to the disruptive influence of a tendency to use an inappropriate information processing strategy for an inordinate proportion of cognitive tasks. The disruptive strategy in the case of these Ss is that of successive synthesis. Since it seems feasible that one possible cause of such biased cognitive functioning may be a physical defect, it is proposed to describe the RSR readers as "disruptive-defect poor" readers.

Notwithstanding the above comments, the most likely

explanation of the apparent failure of some readers to employ simultaneous synthesis at the appropriate point in the reading act is that they have failed to develop, within cognitive structure, that aspect of knowledge that permits the inter-relating of separate entities to permit their apprehension as a simultaneous group. Since it is likely that the formation of high-level, superordinate concepts which subsume specific subordinate concepts requires the same information processing strategy it is possible that a more discriminatory test than the adapted Bousfield test could be developed to assist in the identification of readers hampered by this lack of non-visual knowledge. Speculation of this type could be readily extended to address the question of the creation of teaching strategies designed to avoid or overcome such a deficiency.

The Deficit group. This group of "poor" readers has been termed a "deficit" group because of the relative deficiency of their vocabulary skills as assessed by the Vocabulary subtest of the Cooperative English Test of Reading Comprehension. As reported in Chapter 11, the Deficit group did not respond to varied methods of text display as reflected by the five different experimental formats. Since no mode of input for written materials had a facilitating effect upon the reading of these Ss it is unlikely that the major source of their reading problem lies in the manner in which they are able to appreciate the structure and system of written language. It can be

concluded, therefore, that the Deficit readers possess an inadequate knowledge of verbal concepts for success in college level reading. Although the major source of difficulty for these readers is quite clearly insufficient word-power, it is worth noting that their very low scores in the test of recall suggest an ineffective level of performance in effecting the simultaneous synthesis of verbal concepts. Given that the deficiency in word-power could be overcome, it is likely that the reading of these Ss would still be substantially impaired by the deficiency of their skill in simultaneous synthesis. That is, they would remain "difference poor" readers rather than "difference-deficit poor" readers.

In view of the findings of this study it is concluded that, as observed in the "good" college reader, the accomplishment of the reading act, i.e., the identification of meaning, is substantially dependent upon the following components: an adequate knowledge of verbal concepts; skill in selecting an appropriate information processing strategy for the reading of a specific level of written language, i.e., the sentence level, or the discourse level; and a high standard of performance in effecting the appropriate synthesizing strategy. In addition it is contended that these components must be associated in a particular sequence. For example, a knowledge of verbal concepts would seem to be prerequisite to the application of any synthesizing strategy; the appropriate synthesizing strategy

must be selected before the integration of separate elements is attempted. Finally, it is concluded that a high level of performance in any or all of these components will not ensure the accomplishment of reading. Firstly, this is so, because the synthesis of the individual elements that comprise written language seems to require something in addition to whatever is required for a high level of performance on a specific, related task which also calls for cognitive synthesis. It seems likely that this "additional something" is an implicit knowledge of, and ability to use grammatical structure as the agent for the synthesis of the elements of written language. How this might occur remains a matter of conjecture. Secondly, as pointed out above, good performance in these three components does not ensure understanding because a satisfactory integration and sequencing of all three components is essential if comprehension is to be realized.

From this study, it is clear that the language sampling, predicting, testing, and confirming-disconfirming which Goodman (1973) sees as the vital elements of the reading strategy employed by fluent readers, are significantly dependent upon grammatical knowledge--especially knowledge of the syntactic and semantic components of the grammar of the language. It is equally clear that this is information that is not present in the visual "noise" of printed language symbols. It is knowledge which the reader brings to the page. It is knowledge which the reader

possesses even if the "light is turned off (Smith, 1973)."

Implications of the Study

The findings of this investigation have implications for theories of reading and reading difficulty, the construction of instructional materials designed to assist in the teaching of reading, for teacher education, and for the in-service education of teachers.

The Relationship of Research to Theory in Reading

The study that has been reported here was designed to permit the empirical testing of an aspect of a specific theory of reading. Considerable space has been devoted to the theoretical basis of the study in an effort to avoid a weakness that has been typical of much of the research in reading conducted in the last fifty years. This weakness has been well summarized by Simons (1971) who states that, despite the production of an immense volume of research during this period, almost no progress has been made in providing a description of the fundamental intellectual processes that are involved in the reading act.¹ Simons contends that the accumulated research of the period has

¹ Simons directs his comments at "reading comprehension" rather than at reading per se. In view of the definition of reading that has been followed throughout this report, however, the paraphrasing of Simons' remarks will refer to "reading" only.

revealed little, if anything, about these processes because it has been conducted without the orientation provided by a clearly explicated theoretical position.

Reading research and the need for theory

As Simons asserts, the essential purpose of any theory of reading is to permit the conducting of research on a reasoned and systematic basis. That is, a theory provides a set of principles. These can be employed for the separation of relevant from irrelevant facts. They can be used for deciding upon useful and appropriate behavioral criteria. Perhaps most important, a set of principles can serve as the basis for the generation of meaningful hypotheses that will be susceptible to empirical testing. Thus, a sound theory should lead to the type of research that will provide an understanding of the psychological processes that underlie the reading act (Simons, 1971).

Successful, theory-based research which ultimately leads to an understanding of the relationship between psychological processes and the reading act should result in improved techniques of reading instruction. This claim is predicated on the assumption that effective instructional techniques, ideally, make use of the actual psychological processes which are employed in a specific cognitive act and in the learning of that act. Research endeavors which are directed towards the discovery of fundamental processes, if successful, will make it possible to incorporate such processes in new teaching strategies.

An additional advantage which accrues from the uncovering of basic psychological processes is the assistance which such knowledge provides for the diagnostician in identifying sources of reading problems. It follows, then, that with diagnoses made in terms of process deficiencies, remedial programs can be designed with a view to directly eradicating such deficiencies.

The contribution of this study

The findings of this study have provided preliminary evidence that one type of intellectual processing that is basic to the reading act is that of language synthesis. Specifically, the findings of this study have permitted the tentative conclusion that the information processing strategy of simultaneous synthesis plays a fundamental role in the identification of the meaning of written sentences. This conclusion resulted from the testing of the hypotheses that were generated from an aspect of the theoretical position that was fully outlined in Chapter 5. This theoretical position stated that, in part, for the mature reader, the understanding of written language requires an adequate knowledge of verbal concepts, the ability to select the appropriate information processing strategy for specific steps in the reading act, and the ability to perform at adequate levels in the effecting of these syntheses of written language.

The findings of this study have suggested that, among other skills, two levels of simultaneous synthesis are

essential to the success of the reading act. To both of these, the ability to apply an internalized knowledge of grammar is essential. Grammar is the unifying agent that motivates the synthesis of individual, written words into meaningful word groups. It is also the means by which the functional relationships within sentences are apprehended.

The theoretical stance which has been the foundation of this research project is portion of a total theory of reading which is briefly summarized below.

Theory of reading

One writer has recently provided a succinct definition of reading as it is performed by the mature reader. This effectively summarizes the larger theoretical foundation of this study:

When a person reads a text, he is attempting to discover the meaning of what he is reading by using the visual clues of spelling, his knowledge of probabilities of occurrence, his contextual-pragmatic knowledge, and his syntactic and semantic competence to give a meaningful interpretation to the text (Wardhaugh, 1969).

An essential point about this definition of reading is the emphasis which Wardhaugh places upon the contribution of the reader to the act. Reading cannot be considered a passive process. The reader does not simply take something from the text or merely recognize what is in it. For the reader, reading is very much an active process. He must make a contribution by drawing upon, and applying, at the same time, the various abilities and knowledge that he has spent his life-experience acquiring.

These abilities cover a wide range. For example, at one end of the range, the reader must be able to react to significant rather than nonsignificant visual clues or distinctive visual features. During the processing involved in reading the reader has to be able to make use of both short- and long-term memories. The processing of written language is not simply the processing of visual signals to convert these signals into some form of inner speech. This conversion, if it occurs at all, is not the conclusion of the process. In fact, with the mature, accomplished reader, the process probably completely avoids the conversion of the visual symbols into any form of inner speech, and goes directly to meaning as proposed by Smith (1971).

At the other end of the range, semantic and syntactic processing are necessary (Wardhaugh, 1969). The ability to effect both semantic and syntactic processing is dependent upon a knowledge of language. In addition to a knowledge of verbal concepts this knowledge means an implicit understanding of the semantic constraints and co-occurrences of the language and its acceptable structural configurations. The reference here, is to a knowledge of language in the competence sense, that is, a tacit knowledge of language. Finally, as well as an underlying competence in language, the success of the reading act calls for some knowledge of the subject matter with which a printed text deals.

One aspect of this theory has been illuminated by

the findings of the present study. These findings have demonstrated that at least one function of the semantic and syntactic processing of written language is the synthesis of its individual elements--words. It has been shown that an implicit knowledge of grammar is required for the simultaneous synthesis of individual words into meaningful groups and for the meaningful inter-relating of such groups within sentences. From the theoretical position that was outlined in Chapter 5, it is obvious that, in reading, the need for an understanding of grammar goes beyond these applications. For example, the role played by grammar in an understanding of written language at the discourse level has not been examined.

A theory of reading difficulty

Wiener and Cromer (1967) and Cromer (1970) have described four models useful in conceptualizing reading difficulty. In summary, the four models propose that reading difficulty can be accounted for by (a) a defect, that is, a nonfunction or a dysfunction, (b) a deficit or the absence of an ability which must be added before acceptable reading can occur; (c) a disruption, that is, the presence of an atypical function that impedes attempts to read--the disruption must be removed if adequate reading is to be realized; and, finally, (d) a difference which describes a mismatch between the individual's typical mode of responding and the pattern of responding considered necessary for adequate reading to occur.

The findings of this study provide clear evidence of the explanatory usefulness of the "difference" and "deficit" models. The evidence regarding the "defect" and "disruption" models is less clear-cut. It is possible that this is a function of the experimental sample rather than the weakness of the models.

Although Wiener and Cromer do not consider the possibility of combinations of models to describe the reading difficulties experienced by some readers, their conceptual framework does not preclude such a possibility.

One group of Ss identified in this study--those in the SLD group--can best be described under a model which combines elements of the Difference model and the Deficit mode. These Ss revealed an inappropriate mode of responding to written language. Their reading difficulty, therefore, is explained, at least in part, by the Difference model. The evidence provided by the scores of these Ss on the test of clustering in recall suggests a "deficiency" in their ability to effect simultaneous synthesis (in a relative sense only). Their reading difficulty, therefore, is also explained, in part, by the Deficit model. Thus, for these college readers, it would seem to be desirable to consider the possibility of a reading difficulty that stems from a combination of two fundamental causes. Such Ss can be usefully thought of as "Difference-Deficit poor" readers. It may be that a "deficiency" in the ability to effect simultaneous synthesis is closely related to more general

measures such as I.Q. A measure of this type may have provided additional, useful data. Its use should be considered in any extension of this study. Also, as has already been suggested, a more demanding concept-formation task than the Bousfield test of clustering in recall, could probably be devised as a useful means of discriminating between Ss on the basis of their ability to make use of the information processing strategy of simultaneous synthesis.

Another group of Ss, isolated as a result of this investigation--those in the RSR group--can best be described with a combination of two of the models proposed by Wiener and Cromer. The Ss in this group produced an indication that their attempts at the comprehension of written language were disrupted by their unnatural tendency to employ successive synthesis at inappropriate points in the reading act. No definitive statement of cause can be made with regard to this impediment to successful reading. That the impediment has its origin in a defect of some sort is a possibility. Thus, a combination of the Disruption and Defect models of Wiener and Cromer would seem to provide the most useful explanation of the reading difficulty evidenced by these Ss. They may be described, therefore, as "Disruption-Defect poor" readers.

Implications for Instructional Programs

Long before he commences his formal schooling a child has tacitly learned, from his experience with spoken

language, that words derive a substantial part of their meanings from the semantic and syntactic contexts in which they are found. Although a child already has a firm grasp of this knowledge it seems that much of the written material employed in the child's beginning reading experience tends to undermine this knowledge. It is possible that this is caused more by the teaching technique employed rather than the reading materials that are used. Whatever, the cause, in order to avoid the over-learning of a word-by-word method of reading, instructional programs, and the materials they use, should ensure that the child is exposed to the meaningful grouping of written words right from the beginning of the learning to read process. Any teaching approach which emphasizes word-by-word identification initially, and turns to the question of comprehension only after a specific level has been achieved in this identification, should be modified to include the teaching of comprehension skills also. In particular, attention should be given to the meaning which can be ascribed to certain groupings of words.

Beginning reading books could be printed in pre-established meaningful word groupings. This grouping would need to be effected by the consistent application of grammatical algorithms such as those employed in this study to create the LMC and HMC chunks. The words in these groups should be varied so that words occur in a variety of systematically controlled contexts. This approach would allow for the treatment of the various qualitative dimensions of

vocabulary (Russell, 1954) as well as emphasizing the power of grammar in influencing meaning.

This study provides evidence that mature readers who have not learned to respond to written language in terms of meaningful units can be encouraged to do so by means of the pre-chunking of texts for them. Such a finding suggests that certain mature readers may be fairly readily retrained to overcome this deficiency in their processing of written language. Materials and programs aimed at achieving this, need to be developed.

In view of the success achieved in this study with the encouragement of mature readers to process written language in terms of meaningful units, suitable materials should be developed to establish whether or not readers at varying stages of acquisition can be trained to deal with written materials in this way. Such materials, produced by the application of consistently applied linguistic algorithms, could make use of tachistoscopic techniques, the film techniques reported by Amble (1969), or the techniques of Computer Assisted Instruction as used for data collection in this study. In the earlier, primary grades, it is likely that color coding could also have a useful application.

With regard to the Ss who revealed a distinct deficiency in the information processing strategy of simultaneous synthesis and with regard to those who applied successive synthesis where simultaneous synthesis seemed to be called for, it is not known what instructional materials

or programs might alleviate the difficulty. Das (1972), in his discussion of the use of an inappropriate information processing strategy by retardates, suggests that "...if the retarded child were taught to approach problems as the normal child does, he will be as efficient in his performance (p.10)." Das, however, does not address the question of how this might be achieved. Perhaps the reason for the difficulty of specifying remedial techniques that can be employed to overcome identified deficiencies in cognitive syntheses is best summarized by Luria (1966b):

All these problems must be the subject of special investigation, and the material presented here, which gives only the most general account of the disturbance of the two forms of integrative activity in lesions in different parts of the brain, must be regarded as merely the very first step in this complicated field (p.127).

Implications for Teacher Education

The fundamental role of the reading act in the total educative process cannot be over-stressed. It follows, then, that the preparation of teachers, and the continuing education of practising teachers, should place the appropriate emphasis on ensuring that teachers are well-equipped to teach reading. To do this, teacher educators must be prepared, and able to identify the subject matter of the teaching of reading. Suitable learning experiences must then be devised so that all teachers of reading will possess the knowledge required to teach the subject.

This study has demonstrated the dependence of the

reading act upon an implicit knowledge of language. In order to teach reading, therefore, teachers must be armed with the linguistic knowledge that will permit them to nurture the necessary language skills in their pupils.

Many readers were found in this sample who apparently respond to written language in a word-by-word manner. It is difficult not to conclude that this finding may be, in part, due to the wide-spread use of a method of teaching reading that first requires word-by-word identification and only later emphasizes comprehension. If such a conclusion is justified, the implication for teacher educators is clear. It is essential that teachers of reading be shown that the translation of single words into auditory signals may not be the helpful step in the acquisition of skill in reading which many reading teachers apparently think it is. It is the identification of the meaning of connected words and not the perfect naming of individual words that is paramount. Thus, teacher education programs, while placing due emphasis on the teaching techniques necessary to assure the acquisition of various facilitating skills, must, at the same time, guarantee the appreciation by teachers that the association of meaning with written language has to be the outcome of the reading act.

The ease with which "difference poor" readers may be identified and persuaded to read in a more efficient manner has been demonstrated in this study. Programs devoted to the continuing education of teachers should

provide for the preparation of reading specialists who are familiar with the techniques involved. Since the informed use of this powerful diagnostic tool¹ would call for a quite extensive knowledge of linguistics, it is clear that any program for the training of reading specialists should include a substantial linguistic component.

Suggestions for Further Research

The significance of the findings of this research project call for its early and careful replication. Although it is unlikely that these findings can be attributed solely to the nature of the experimental sample, it is important that any replication should be conducted with a sample which is fully representative of a specified population.

Again, the significance of the findings indicates the need for the undertaking of similar studies with Ss who are at various stages of the process of acquiring skill in the act of reading. It may well be that, with the use of instruments such as those employed by Farnham-Diggory (1967, 1970) and Denner (1970), it will be possible to identify Ss at the pre-school stage who indicate their potential for later synthesis-based reading difficulties. Data of this type should be produced by means of

¹The usefulness of this tool for remediation cannot be considered as established on the basis of this study.

longitudinal studies as well as studies conducted concurrently with Ss from various reading performance levels. In addition, data should be collected which demonstrates the relationship between mental age and the ability to effect cognitive syntheses of the type which appear to be involved in reading.

The dependence of this study on the assumption that the test of clustering in recall is a valid and reliable test of simultaneous synthesis, is obvious. It is possible that this is the weakest aspect of the study. To assess the usefulness of the recall task, the results obtained with it should be compared with other established procedures known to call for simultaneous synthesis. For example, Das (1972) has shown that Raven's Progressive Matrices require simultaneous synthesis. Luria (1966a) has cited numerous examples of verbal tasks which depend upon the effective use of simultaneous synthesis for their successful completion. These tests, which Luria reports in his treatment of disturbed logical-grammatical operations and semantic aphasia, are designed as individual tests to be used in the clinical setting. Some adaptation would be necessary to permit their application to groups of Ss. Perhaps a major research effort should be directed at the development of adequate instruments for the assessment of the cognitive syntheses before investigations like the present one are extended.

The dependence of the formation of superordinate

concepts on the ability to simultaneously consider and abstract the attributes of subordinate concepts seems obvious. Since little empirical research has been conducted on the teaching of concept formation, at all elementary school age levels, as proposed by Taba (1967), it may be very useful to undertake a longitudinal study of the usefulness of the teaching strategies suggested by Taba in the acquisition of this skill. The impact of this type of teaching on performance in a "marker" test for simultaneous synthesis, such as Raven's Progressive Matrices, could then be assessed. At the same time the effect of teaching concept formation on reading could be evaluated.

This study assessed, in an indirect way only, a reader's ability to apprehend the functional relationships that contribute an important increment of meaning in sentences. Research should now be directed at the development of an instrument capable of making such an evaluation in a valid and reliable way. A test of this type would have to be capable of measuring a reader's appreciation of the semantic relationships that are coded by syntactic structure. The construction of items for this instrument could possibly utilize the linguistic algorithm approach with deletions of grammatical entities, and the substitution of question words, planned to test the understanding of fundamental semantic relationships operating at the sentence level.

It was not possible to subject the full theoretical

position outlined in Chapter 5 to empirical test. Important gaps could be filled by the planning of research which provides for the assessment of successive synthesis and the comprehension of the discourse level of written language. While Luria (1966a) and Das (1972) have listed tests which could be used directly, or after modification, for evaluating performance in effecting successive synthesis, the testing of discourse would pose problems of considerable difficulty. For instance, any such instrument would almost certainly involve the prior assessment of comprehension at the sentence level because of the hierarchical nature of the relationship between sentences and the discourse they collectively comprise.

The investigation that has been reported here has been concerned with a reader's ability to deal with information that is received "through the eyeballs" in terms of information that is available to the reader from "behind the eyeballs." It seems to the present writer that, in the past, attempts to inquire into the reading process have placed a disproportionate emphasis upon the aspect of reading that is concerned with visual processing and insufficient emphasis has been placed on the non-visual, cognitive processing that is contributed by the reader. Kolers (1970) has provided a convincing demonstration that reading is not primarily visual. The work of Kolers supplements and confirms the much earlier work of Cattell (1885) and Erdmann and Dodge (1898) whose demonstrations

permit the drawing of the conclusion that ease of reading is directly proportional to the magnitude of the contribution that the reader can make to it (F. Smith and Holmes, 1971; F. Smith, 1973). In fact the pioneering work of Cattell demonstrates that the relationship between the knowledge which a reader obtains from the printed page and the knowledge which he contributes from his own cognitive structure, i.e., the relationship between visual and non-visual information, is, in fact, a relationship of inverse proportion. The more non-visual information a reader possesses, both syntactic and semantic, the less visual sampling he will have to effect from the printed page. On the other hand, the less non-visual information possessed by the reader, whether syntactic or semantic, the more visual sampling he will have to effect from the printed page to permit him to generate viable hypotheses about the author's intended communication. In addition, the confirmation or disconfirmation of such hypotheses will require more complete sampling, i.e., closer attention to the printed material. A paucity of non-visual information in the possession of the reader can result in visual information overload otherwise described as tunnel-vision. In this case the reader has to select more information from the printed page than the brain of the reader can process at once and still be dealing with meaningful chunks (F. Smith, 1971).

There is an urgent need for far more definitive and

searching investigations into the precise relationship between visual and non-visual knowledge. Research of the type reported by Gibson (1969) which deals with non-visual knowledge at the letter-sequence level could be extended to produce significant implications suggesting the modification of existing approaches or emphasis in the teaching of beginning reading. The Fodor, Garrett, and Bever (1968) research and that of Ammon (1970) and Gamlin (1970) needs to be developed in an attempt to specify the systematic syntactic and semantic non-visual knowledge which a reader requires at various stages of the process of skill acquisition in reading. The notion of the building of cognitive structure in the manner described by F. Smith (1973) requires further investigation as does the child's construction of his intelligence as formulated in Piagetian terms by Rawson (1969).

The present research endeavor has attempted to demonstrate that non-visual knowledge of synthesizing strategies is required for fluent reading. It is clear that success in the areas of further research which have been listed would illuminate much of what has been attempted here and would more clearly point to the way in which this specific research could be furthered.

Limitations of the Findings

The general limitations of the study were set out in Chapter 1. The limitations discussed in this section

indicate additional reasons why caution should be exercised in the application of these findings to reading situations in general. These additional reasons for caution became evident as the study progressed.

The display of reading materials by means of the CRT screens of the IBM 1500 Instructional System created an unnatural reading situation. In most essential features, the computer display called for the same skills as are required in reading from the pages of a book. In other aspects, however, there were significant differences. Several of these are discussed below.

The Instructional Station or Computer Terminal was a very strange piece of machinery to almost all Ss. This strangeness caused considerable variation in S reaction to the test situation. For many Ss there was a pronounced novelty effect which apparently secured their interest and maintained it at a higher level than would have been the case with a normal reading test situation. Some Ss, on the other hand, were very much awed by the technical complexity of the equipment. Moreover, these Ss never seemed to attain a relaxed attitude at any time during the test. They appeared to be hampered by a real fear that they would damage the equipment or that they would commit an irreparable error.

The color combination of the display--white printing on a black background provided a reversal of the combination usually encountered by readers. In addition, the brilliance

of the image varied from terminal to terminal. This phenomenon was sufficiently pronounced for some Ss to claim that the image was blue in color. A majority of Ss complained of eye-strain at the conclusion of the testing period.

The complexity of computer programming meant that "going back" in the text could not be provided for. This feature, although consistent for all Ss, did place an unnatural strain on memory. It cannot be stated, with any conviction, that the multiple-choice test results, in particular, were not contaminated by the intrusion of this memory factor.

In order to record answers for storage within the IBM 1500 Instructional System, a specialized response procedure had to be learned by all Ss. Although this required an extremely simple sequence of steps it was new to the majority of testees. Most Ss found the procedure novel and, therefore, highly motivating. With other Ss, the intimidating effect of the Computer Terminal generalized to the response situation with the result that they were often reluctant to record an answer and ultimately tentative and timid in doing so. Under these circumstances, it must be conceded that a small number of Ss were more concerned with coping with the computer than with reading efficiently.

The final limitation on findings associated with the use of the IBM 1500 Instructional System for data collection is that of response time. Subject progress

through each passage and test was controlled by each S via the space-bar on the typewriter keyboard.. When a specific set of demands were placed on the central computer the responses to Ss' commands were less than instantaneous. Although all Ss were questioned about the effect of such delayed responses, less than 20 in the entire sample could state that they had experienced any delays. Ten Ss found the delays frustrating and distracting.

A second major limitation on the generalizability of the findings of the study stems from the fact that, for all Ss, 80 per cent of the prose materials were presented to them in separate groups of words of varying size. It is obvious that this is an unusual way of encountering written language. There is no way of knowing, however, to what extent this procedure affected the reading of Ss. The discrete display of chunks, without the facility to go back, was employed to obviate the possibility of rechunking by Ss to accommodate a chunking strategy more palatable to them. The distinct potential for rechunking has been a marked weakness in some studies of reading involving chunking, e.g., Carver (1970). Where rechunking is a simple matter for Ss the variation in the independent variable being sought is lost, with the result that meaningful conclusions about variations in the dependent variable can no longer be made. Thus, the phenomenon which was being investigated could only be observed under conditions which had the potential to create a pathological state in the

reading act. Under these circumstances, some restraint must be exercised in transferring, to the normal reading situation, the insights that are derived from this reading situation.

The third significant limitation which should be placed on the interpretation of these experimental findings concerns the tests that were employed to evaluate the comprehension of written discourse. Sets of ten multiple choice items with four distractor statements for each item were compiled as tests of comprehension of each of the five passages. Since the average length of the passages was slightly less than 200 words, the multiple choice tests generally involved at least as much reading as the passages on which they were based. This lack of balance between the tests of comprehension and the passages with which they were associated led to the tests being as demanding of reading skill as the passages themselves. In addition, these short passages did not contain sufficient information to permit the construction of 40 distinct statements on each. The outcome of this situation was that the selection of the correct distractor statement for each test item required an extremely detailed and precise knowledge of the passage from which it was drawn. Although the construction of the test items for both the linguistic algorithm and facet design multiple choice tests was rigidly controlled, many of the distractor statements were too similar and, therefore, too difficult to discriminate between. The

difficulty of the tests themselves is not considered to be a limitation on the findings of the study because of the fully balanced nature of the design employed. The limitation involved is that deriving from the confusion generated by extremely close distractors. In conjunction with the restriction on "going back," this factor was probably sufficient to raise frustration levels significantly or to encourage random guessing. One S refused to complete the test session. He received the sequence that required four multiple choice tests to be completed consecutively. This S stated that he was frustrated to the point where he felt he could not go on. His was an isolated case. Moreover, no S confessed to random guessing in the selection of the correct distractor statements. Notwithstanding this lack of direct evidence, the nature of the multiple choice tests is such that the findings should be interpreted with some reservations.

The normal application of the cloze procedure was distorted in its use with the passages that were presented by means of separate groups of words. The availability of prior context only, lessened the degree to which a S could reduce his uncertainty about the manner in which a specific blank should be filled. In view of this, it was decided to accept all synonyms that made acceptable sense after consideration of prior context in conjunction with the chunk

or portion of the passage that was displayed at any one time. Although no markedly deviant results could be linked to this use of the cloze, the fact of its use, together with the short passages (250 words is the recommended minimum length for a passage to which the cloze procedure is applied), suggests that these findings may not generalize to test situations involving the more usual use of the cloze procedure.

A substantial portion of this concluding chapter has been predicated upon the assumption that the test of clustering in recall is indeed a test requiring the application of the information processing strategy of simultaneous synthesis. In fact, no empirical evidence can be cited to support such an assumption. This use of the test is clearly in accord with the definition of simultaneous synthesis provided by Luria (1966a, 1966b) and with the interpretation placed on that definition by Das (1972). However, until suitable research data are available the use of the test in this role should be considered exploratory only and the findings of the study, therefore, tentative.

Concluding Statement

This study was concerned with an analysis of the processes by which mature readers try to identify the meaning of written language. In planning the investigation an attempt was made to integrate basic ideas from psychology and

linguistics. This integration involved the consideration of extant knowledge on cognitive synthesis, the psychology of the reading act, the theory of test construction, computer technology, and the techniques of Computer Assisted Instruction.

Some of the conclusions arrived at in this study have been documented by others--notably Wiener and Cromer (1967) and Cromer (1970). If the investigation has made a unique contribution it probably lies in the demonstration of the possible role of the information processing strategy of simultaneous synthesis in the reading act and the connection between the effecting of this synthesis and a reader's implicit knowledge of the grammar of the language.

In recent years the question of cognitive synthesis has interested a number of psychologists. Among these are Luria (1966a, 1966b), Farnham-Diggory (1967, 1970), Denner (1970), Das (1972), and others. At this stage, the present study appears to be the first in which an attempt has been made to establish the importance of synthesis in reading. It is natural, therefore, that the findings should be tentative and characterized by a variety of restrictive limitations. In this case, the usefulness of its contribution will be measured by the definitive studies that grow out of it.

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APPENDICES

APPENDIX A
GRAMMATICAL RULES

1. Sample Branching Rules, illustrative of those generating the underlying structures of the text material.

Given: # S #

1. S → S (C_{coor} ^ S)ⁿ
(NEG) ($\begin{matrix} \text{ADV}_s \\ Q \end{matrix}$) NP ^ VP n > 1
2. VP → MV ($\begin{matrix} \text{NP} \\ \text{PP} \\ \text{AP} \end{matrix}$) ($\begin{matrix} \text{PP} \\ \text{NP} \end{matrix}$) ($\begin{matrix} \text{ADV} \\ \text{PP} \end{matrix}$)
3. MV → AUX (ASP) V
4. AUX → T (M)
5. ASP → (have ^ EN) (be ^ ING)
6. AP → (DEG) A (S)
7. ADV → $\begin{matrix} \text{Adverb} \\ \text{C}_{\text{sub}} \end{matrix}$ ^ S
8. PP → P ^ NP
9. NP → NP (C_{coor} ^ NP)ⁿ
NP ^ S n > 1
(D) N (S)
10. D → (ART) (QUANT)
11. T → PRES
PAST
12. DEG → QUAL
COMP ^ S
SUP

2. Transformational Rules. These transformations are required to account for the surface structures of the sentences used in the experimental passages. It should be noted that such minor rules as agreement, wh shape, etc. are not included in the list.

T. Passive (optional)

SD:	NP	X	V	NP	
SC:	1	2	3	4	→
	4	2	<u>be</u> ^EN^3	<u>by</u> ^1	

John ate a fish. →
A fish was eaten by John.

T. Truncated Passive (optional)

SD: be EN V by [+PRO]
 SC: 1 2 3 4 5 →
 1 2 3 ∅ ∅

A fish was eaten by PRO. →
 A fish was eaten.

T. Auxiliary Filler

SD: T have
 be
 SC: 1 2 →
 1^2 ∅

John PAST have^EN leave. →
 John PAST^have EN leave.

T. Negative Placement

SD: NEG X NP AUX
 SC: 1 2 3 4 →
 ∅ 2 3 4^1

NEG (John has left). →
 John hasn't left.

T. There Insertion (optional)

SD: [X] AUX (have)
 NP NP
 SC: 1 2 3 →
 1 there 3^1

Thieves are in the library. →
 There are thieves in the library.

T. Question Formation

SD: Q NP AUX
 SC: 1 2 3 →
 3 2 ∅

There are thieves in the library. →
 Are there thieves in the library?

T. Relative Clause Formation

SD: NP [W [ART X N Y] Z]
 S NP NP S
 SC: 1 2 3 4 5 6 7 8 →
 1 2 3 wh ∅ [+PRO]∅ 8

Cond: 1 = 3

The man (John saw the man) →
 The man (John saw whom)

T. WH Attraction

SD: [X NP Y]
 S S

SC: 1 2 3 →
 2^1 ∅ 3

Cond: NP dominates wh^Z

The man (John saw whom) →
 The man (whom John saw)

T. Relative Clause Reduction (optional)

SD: NP [[wh X] [be^T] Y]
 S NP NP NP S

SC: 1 2 3 4 →
 1 ∅ [∅] 4

The boy (who was in the garden) →
 The boy in the garden.

T. Adjective Shift

SD: D N AP
 SC: 1 2 3 →
 1 3^2 ∅

The boy very handsome →
 The very handsome boy

T. Possessive Formation (optional)

SD: D N [[wh X] NP have T]
 S NP NP NP S

SC: 1 2 3 4 5 6 →
 6^1s2 ∅ ∅ ∅ ∅

The hat (which the man has) →
 The man's hat

T. Adverb Fronting (optional)

SD: [X ADV Y]
 S S

SC: 1 2 3 →
 2^1 ∅ 3

The man left yesterday. →
 Yesterday the man left.

T. Complementizer

SD: NP [NP VP]
 S S

SC: 1 2 3 →
 1 comp^2 3

John wants it (Bill leave) →
 John wants it (Bill to leave)

T. Equi-NP Deletion

SD: NP X [X NP Y]
 S S
 SC: 1 2 3 4 5 →
 1 2 3 Ø 5

Cond: 1 = 4, and 4 is within an embedded, complement S.

John wants (John to leave). →
 John wants to leave.

T. Dative Movement (optional)

SD: V NP P NP
 SC: 1 2 3 4 →
 1 4^2 Ø Ø

John gave the book to Mary. →
 John gave Mary the book.

T. Extraposition (optional)

SD: N S X]
 S
 SC: 1 2 3 →
 1 Ø 3^2

That I am late is obvious. →
 It is obvious that I am late.

T. Interposition (optional)

SD: NP AUX (ASP) V [NP AUX X]
 S S
 SC: 1 2 3 4 5 6 7 →
 5^6^1 2 3 4 Ø Ø 7

I have heard there are thieves in the library. →
 There are, I have heard, thieves in the library.

T. Pronominalization

SD: NP X [X N Y]
 NP NP
 SC: 1 2 3 4 5 →
 1 2 3 Ø [+PRO] 6

Cond: 1 = 3; 3 is not within a VP complement S.

John said that John was hungry. →
 John said that he was hungry.

T. Comparative

SD: COMP [NP X A] A
 S S
 SC: 1 2 3 4 5 →
 1 ∅ ∅ ∅ 5^1^2

Cond: 4 = 5

John is (as-as (a bear is hungry)) hungry. →
 John is as hungry as a bear.

T. Conjunction Reduction (optional)

SD: [X Y] C_{coord} [W Y]
 S S S S
 SC: 1 2 4 5
 1^3^4 2 ∅ ∅

John left and Mary left. →
 John and Mary left.

John is fat but John is handsome. →
 John is fat but handsome.

John runs quickly and John runs lightly. →
 John runs quickly and lightly.

T. Affix Shift

SD: AF v
 SC: 1 2 →
 ∅ 2^1

Cond: AF = any Affix, v = verb

John PAST have EN leave. →
 John have PAST leave EN.

T. Do Support

SD: X AF
 SC: 1 2 →
 1 do^2

Cond: x ≠ Y ^ v

John PAST not leave. →
 John did not leave.

3. Key to symbols

A:	adjective	MV:	main verb
ADV:	adverbial	N:	noun
ADVs:	sentence adverb	NEG:	negative (not)
AP:	adjective phrase	NP:	noun phrase
ART:	article	P:	preposition
ASP:	aspect	PAST:	past tense suffix
AUX:	auxiliary	PRES:	present tense suffix
^C coor:	coordinate conjunction	PP:	prepositional phrase
^C sub:	subordinate conjunction	Q:	question
COMP:	comparative	QUAL:	quality
D:	determiner	QUANT:	quantifier
DEG:	degree marker	S:	sentence
EN:	perfect participle suffix	SUP:	superlative
ING:	progressive participle suffix	V:	verb
M:	modal	VP:	verb phrase

APPENDIX B

THE EXPERIMENTAL PASSAGES

Passage One

- THE ATOMIC BOMB -

As to the ethical questions precipitated by the atomic bomb, unquestionably the moral sense of mankind will have to come to the fore to establish strict, yet not political control over the development and use of this ruinous weapon, and to ensure that any peacetime applications that grow out of it are not too readily convertible to military ends. The most effective deterrent would appear to be the common possession of this power to prevent its military use through fear of reprisal in kind. As a precedent for this we have the failure to use gas by any of the combatants in World War Two.

Notwithstanding the fact that the moral sense and education of the people of all nations is the only real hope of preserving permanent peace, the future technical secrets of atomic energy should be pooled among the peace loving nations and centralized in a supervisory council established under the United Nations Charter. Further research should be placed under government control in all countries, and every means should be exhausted to use this great power for the benefit of humanity, and not for its destruction. The question is not one of ethics, but of survival.

Passage Two

DEATH OF A DOG

The young dog is inexperienced and sadly lacks even the most rudimentary education. He ambles and frisks along the sidewalk of the busy road, near the mysterious gates of a convent. He is a large puppy, on the way to being a dog of much dignity, but at present he has little to recommend him but that gawky elegance, and that bounding gratitude for the gift of life, which distinguish the normal puppy. He is an ignorant fool. He might have entered the convent of nuns and had a fine time, but instead he steps off the sidewalk into the road, the road being a vast and interesting continent imperfectly explored. His confidence in his nose, in his agility, and in the goodness of God is touching, absolutely painful to witness. He glances casually at a huge towering vermilion construction that is whizzing toward him on four wheels, and then with disdain he ignores it as less important than a speck of odorous matter in the mud. The next instant he is lying inert in the mud. His confidence in the goodness of God has been misplaced.

Passage Three

MY RELATIONS WITH TEACHERS

As a schoolboy, my relations with teachers were almost always tense and hostile. I disliked my studies and did very badly in them. There are, I have heard, inept students who bring out the best in teachers, who challenge their skill and move them to sympathy and affection. I seemed to bring out the worst in them. I think my personality had more to do with this than my poor classroom work. Something about me was deeply offensive to the pedagogic temperament.

It took a teacher no more than a few minutes to conceive a raging dislike for me. I recall an instructor who threw a book at my head the very first day I attended his class. We had never laid eyes on each other until fifteen or twenty minutes before he assaulted me. I no longer remember what provoked him to violence. It is possible that I said something that was either insolent or intolerably stupid. It is also possible that I said nothing at all. Even my silence could annoy my teachers. The very sight of me, the mere awareness of my existence on earth, could be unendurably irritating to them.

Passage Four

UPSETTING THE BALANCE OF NATURE

The balance of nature is a very elaborate and very delicate system of checks and counterchecks. It is continually being altered as climates change, as new organisms evolve, as animals and plants permeate to new areas. But the alterations have in the past, for the most part, been slow, whereas with the arrival of man, and especially of civilized man, their speed has been multiplied many times. From the evolutionary time scale, where change is measured by periods of ten- or a hundred-thousand years, they have been transferred to the human time scale in which centuries and even decades count.

Everywhere man is altering the balance of nature. He is facilitating the spread of plants and animals into new regions, sometimes deliberately, sometimes unconsciously. He is covering huge areas with new kinds of plants, or with houses, or factories and other products of his civilization. He exterminates some species on a large scale, but favors the multiplication of others. In brief he has done more in five thousand years to alter the biological aspect of the planet than has nature in five million.

Passage Five

WHAT IS GENIUS?

There is confusion about the word genius. It is sometimes taken to mean talent which is prodigious and altogether exceptional, such as the talent of mathematical prodigies, or of great virtuosi. Although men of genius sometimes have exceptional gifts of virtuosity, creative genius in itself does not consist in exercising that which is inaccessible to the rest of humanity. On the contrary, it lies in the deepest understanding of that which is common to all human beings. The great creative geniuses tower above the rest of humanity as do mountainous volcanoes which, seemingly most high, reach down far below into depths where all the surrounding landscape, and the valleys even, are melted into one unity. The writer of genius is not isolated, drawing force from idiosyncrasies which divide him from other people. He is exceptional in having the deepest understanding of situations in life which are shared by many people, and in being able to give voice to the unexpressed needs and feelings of the people round him. He releases, not his own genius only but the genius of all men, who, for the most part, are gagged and silenced, unable to express themselves, to know even what they feel.

APPENDIX C
THE EXPERIMENTAL FORMATS

The Normal Format

THE ATOMIC BOMB

First Screen

As to the ethical questions precipitated by the atomic bomb, unquestionably the moral sense of mankind will have to come to the fore to establish strict, yet not political, control over the development and use of this ruinous weapon, and to ensure that any peacetime applications that grow out of it are not too readily convertible to military ends. The most effective deterrent would appear to be the common

Second Screen

possession of this power to prevent its military use through fear of reprisal in kind. As a precedent for this, we have the failure to use gas by any of the combatants in World War Two.

Notwithstanding the fact that the moral sense and education of the people of all nations is the only real hope of preserving permanent peace, the future technical secrets of atomic energy should be pooled among the peace loving nations and centralized in a supervisory council established under the United

Third Screen

Nations Charter. Further research should be placed under government control in all countries, and every means should be exhausted to use this great power for the benefit of humanity, and not for its destruction. The question is not one of ethics, but of survival.

THE DEATH OF A DOG

First Screen

The young dog is inexperienced and sadly lacks even the most rudimentary education. He ambles and frisks along the sidewalk of the busy road, near the mysterious gates of a convent. He is a large puppy, on the way to being a dog of much dignity, but at present he has little to recommend him but that gawky elegance, and that bounding gratitude for the gift of life, which distinguish the normal puppy. He is an ignorant

Second Screen

fool. He might have entered the convent of nuns and had a fine time, but instead he steps off the sidewalk into the road, the road being a vast and interesting continent imperfectly explored. His confidence in his nose, in his agility, and in the goodness of God is touching, absolutely painful to witness. He glances casually at a huge, towering vermilion construction that is whizzing toward him on four wheels, and then with disdain he ignores it as less important than a speck of odorous matter in the

Third Screen

mud. The next instant he is lying inert in the mud. His confidence in the goodness of God has been misplaced.

MY RELATIONS WITH TEACHERS

First Screen

As a schoolboy, my relations with teachers were almost always tense and hostile. I disliked my studies and did very badly in them. There are, I have heard, inept students who bring out the best in teachers, who challenge their skill and move them to sympathy and affection. I seemed to bring out the worst in them. I think my personality had more to do with this than my poor classroom work. Something about me was

Second Screen

deeply offensive to the pedagogic temperament.

It took a teacher no more than a few minutes to conceive a raging dislike for me. I recall an instructor who threw a book at my head the very first day I attended his class. We had never laid eyes on each other until fifteen or twenty minutes before he assaulted me. I no longer remember what provoked him to violence. It is possible that I said something that was either insolent or intolerably stupid. It is also possible

Third Screen

that I said nothing at all. Even my silence could annoy my teachers. The very sight of me, the mere awareness of my existence on earth, could be unendurably irritating to them.

UPSETTING THE BALANCE OF NATURE

First Screen

The balance of nature is a very elaborate and very delicate system of checks and counterchecks. It is continually being altered as climates change, as new organisms evolve, as animals and plants permeate to new areas. But the alterations have in the past, for the most part, been slow, whereas with the arrival of man, and especially of civilized man, their speed has been multiplied many times. From the

Second Screen

evolutionary time scale, where change is measured by periods of ten-or a hundred-thousand years, they have been transferred to the human time scale in which centuries and even decades count.

Everywhere man is altering the balance of nature. He is facilitating the spread of plants and animals into new regions, sometimes deliberately, sometimes unconsciously. He is covering huge areas with new kinds of plants, with houses, or factories and other products of his civilization. He

Third Screen

exterminates some species on a large scale, but favours the multiplication of others. In brief, he has done more in five thousand years to alter the biological aspect of the planet than has nature in five million.

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Second Screen

the deepest understanding of that which is common to all human beings. The great creative geniuses tower above the rest of humanity as do mountainous volcanoes which, seemingly most high, reach down far below into depths where all the surrounding landscape, and the valleys even, are melted into one unity. The writer of genius is not isolated, drawing force from idiosyncrasies which divide him from other people. He is exceptional in having the deepest understanding of situations in life

Third Screen

which are shared by many people, and in being able to give voice to the unexpressed needs and feelings of the people around him. He releases, not his own genius only but the genius of all men, who, for the most part, are gagged and silenced, unable to express themselves, to know even what they feel.

The Two-Word Format

THE ATOMIC BOMB

As to / the ethical / questions
precipitated / by the / atomic bomb, /
unquestionably the / moral sense / of
mankind / will have / to come / to the / fore to /
establish strict, / yet not / political,
control / over the / development and / use of /
this ruinous / weapon, and / to ensure / that
any / peacetime applications / that grow / out
of / it are / not too / readily convertible / to
military / ends. The / most effective /
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military use / through fear / or reprisal / in
kind. / As a / precedent for / this, we / have
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combatants in / World War / Two.

Notwithstanding / the fact / that the /
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of / all nations / is the / only real / hope of /
preserving permanent / peace, the / future
technical / secrets of / atomic energy /
should be / pooled among / the peace / loving
nations / and centralized / in a / supervisory
council / established under / the United /
Nations Charter. / Further research / should
be / placed under / government control / in
all / countries, and / every means / should be /
exhausted to / use this / great power / for
the / benefit of / humanity, and / not for / its
destruction. / The question / is not / one of /
ethics, but / of survival. /

DEATH OF A DOG

The young / dog is / inexperienced and /
sadly lacks / even the / most rudimentary /
education. He / ambles and / frisks along /
the sidewalk / of the / busy road, / near the /
mysterious gates / of a / convent. He / is a /
large puppy, / on the / way to / being a / dog
of / much dignity, / but at / present he / has
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UPSETTING THE BALANCE OF NATURE

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and / silenced, unable / to express /
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The Lowest Major Constituent Format (LMC)

THE ATOMIC BOMB

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mankind / will have to come / to the fore / to
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and silenced, / unable / to express /
themselves, / to know even / what / they / feel. /

The Higher Major Constituent Format (HMC)

THE ATOMIC BOMB

As to the ethical questions precipitated by the atomic bomb, / unquestionably the moral sense of mankind will have to come to the fore / to establish strict, yet not political, control over the development and use of this ruinous weapon, / and to ensure / that any peacetime applications that grow out of it / are not too readily convertible to military ends. / The most effective deterrent / would appear to be / the common possession of this power / to prevent is military use through fear of reprisal in kind. / As a precedent for this, / we / have / the failure to use gas by any of the combatants in World War Two. /

Notwithstanding the fact / that the moral sense and education of the people of all nations / is the only real hope of preserving permanent peace, / the future technical secrets of atomic energy / should be pooled / among the peace loving nations / and centralized in a supervisory council established under the United Nations Charter. / Further research / should be placed under government control in all countries, / and every means / should be exhausted / to use this great power for the benefit of humanity, / and not for its destruction. / The question is not one of ethics, but of survival. /

DEATH OF A DOG

The young dog is inexperienced and sadly lacks even the most rudimentary education. / He / ambles and frisks along the sidewalk of the busy road, near the mysterious gates of a convent. / He / is / a large puppy, / on the way to being a dog of much dignity, / but at present he / has / little to recommend him / but that gawky elegance, and that bounding gratitude for the gift of life, which distinguish the normal puppy. / He is an ignorant fool. / He might have entered the convent of nuns and had a fine time, / but instead he steps / off the sidewalk / into the road, / the road being a vast and interesting continent imperfectly explored. / His confidence in his nose, in his agility, and in the goodness of God / is touching, absolutely painful to witness. / He / glances casually / at a huge, towering vermilion construction that is whizzing toward him on four wheels, / and then with disdain / he / ignores it as less important than a speck of odorous matter in the mud. / The next instant he is lying inert in the mud. / His confidence in the goodness of God has been misplaced. /

MY RELATIONS WITH TEACHERS

As a schoolboy, my relations with teachers were almost always tense and hostile. / I / disliked my studies and did very badly in them. / There / are, / I have heard, / inept students / who bring out the best in teachers, / who challenge their skill / and move them to sympathy and affection. / I / seemed to bring out the worst in them. / I / think / my personality had more to do with this than my poor classroom work. / Something about me was deeply offensive to the pedagogic temperament. /

It / took / a teacher / no more than a few minutes to conceive a raging dislike for me. / I / recall / an instructor / who / threw / a book at my head / the very first day I attended his class. / We / had never laid / eyes on each other / until fifteen or twenty minutes before he assaulted me. / I / no longer remember / what provoked him to violence. / It / is possible / that I / said / something that was either insolent or intolerably stupid. / It / is also possible / that I said nothing at all. / Even my silence could annoy my teachers. / The very sight of me, the mere awareness of my existence on earth, / could be unendurably irritating to them. /

UPSETTING THE BALANCE OF NATURE

The balance of nature is a very elaborate and very delicate system of checks and counterchecks. / It / is continually being altered as climates change, as new organisms evolve, as animals and plants permeate to new areas. / But the alterations have in the past, for the most part, been slow, / whereas with the arrival of man, and especially of civilized man, their speed has been multiplied many times. / From the evolutionary time scale, / where change is measured by periods of ten-or a hundred-thousand years, / they / have been transferred / to the human time scale in which centuries and even decades count. /

Everywhere man is altering the balance of nature . / He / is facilitating / the spread of plants and animals into new regions, / sometimes deliberately, sometimes unconsciously. / He / is covering / huge areas / with new kinds of plants, / or with houses, or factories and other products of his civilization. / He / exterminates some species on a large scale, but favors the multiplication of others. / In brief, / he / has done / more in five thousand years / to alter the biological aspect of the planet than has nature in five million. /

WHAT IS GENIUS?

There / is confusion about the word
genius. / It / is sometimes taken to mean /
talent which is prodigious and
altogether exceptional, / such as the
talent of mathematical prodigies, or of
great virtuosi. / Although men of genius
sometimes have exceptional gifts of
virtuosity, / creative genius in itself /
does not consist / in exercising / that /
which is inaccessible to the rest of
humanity. / On the contrary, / it / lies / in
the deepest understanding / of that which
is common to all human beings. / The great
creative geniuses / tower / above the rest
of humanity / as do mountainous volcanoes
which, seemingly most high, / reach down /
far below / into depths where all the
surrounding landscape, and the valleys
even, are melted into one unity. / The
writer of genius is not isolated, /
drawing / force / from idiosyncrasies / which
divide him from other people. / He / is
exceptional / in having / the deepest
understanding / of situations in life
which are shared by many people, / and in
being able / to give voice to the
unexpressed needs and feelings of the
people around him. / He / releases, / not his
own genius only / but the genius / of all
men, / who , / for the most part, are gagged
and silenced, / unable to express
themselves, / to know even what they feel. /

The Bizarre Long Format

THE ATOMIC BOMB

As to the ethical questions precipitated by the atomic bomb, unquestionably the / moral sense of mankind will have to come to the fore to establish / strict, yet not political, control over the development and use of this ruinous weapon, and to / ensure that any / peacetime applications that grow out of it are not / too readily convertible to military ends. The most / effective deterrent would appear / to be the common / possession of this power to prevent / its military use through fear of reprisal in kind. As a / precedent for this, we have / the / failure / to use gas by any of the combatants in World War Two.

Notwithstanding the / fact that the / moral sense and education of the people of all nations is the / only real hope of preserving permanent peace, the future / technical secrets of atomic energy should be / pooled among the / peace loving nations and centralized / in a supervisory council established under the United Nations Charter. Further research / should be placed under government control in all countries, and every / means should be / exhausted to use / this great power for the benefit of humanity, and not / for its destruction. The question / is not one of ethics, but of survival. /

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is common to all human beings. The great /
creative geniuses tower above / the / rest
of humanity as do / mountainous volcanoes
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which are shared by many people, and in /
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unexpressed needs and feelings of the
people around him. He releases, / not / his /
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and silenced, unable to / express
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APPENDIX D

MULTIPLE CHOICE TESTS

Tests Constructed with Linguistic Algorithms

THE ATOMIC BOMB

1. What might bring permanent peace?
 - A. A supervisory council established under the United Nations Charter.
 - B. The moral sense and education of the people of all nations.
 - C. Common possession of atomic power.
 - D. Peacetime applications of atomic energy that are developed from the atomic bomb.
2. What is the precedent for the effectiveness of common possession of atomic power as a deterrent to its military use?
 - A. Reprisal in kind in World War Two.
 - B. The use of gas by all countries in World War Two.
 - C. Gas was not used in World War Two.
 - D. This ruinous weapon was not used in World War Two.
3. What should be placed under government control in all countries?
 - A. Future research into the field of atomic energy.
 - B. Military use of the atomic bomb.
 - C. The development and use of the atomic bomb.
 - D. The ethical questions precipitated by the peacetime applications that grow out of the atomic bomb.
4. What council should be established for centralizing the future technical secrets of atomic energy?
 - A. A centralized, supervisory committee.
 - B. A political council of all nations.
 - C. A supervisory council established under government control.
 - D. An international, supervisory council.
5. What will establish strict, yet not political control over the development and use of the atomic bomb?
 - A. The future technical secrets of atomic energy pooled among the peace loving nations.
 - B. A supervisory council established among the peace loving nations.
 - C. The moral sense of mankind.
 - D. Peacetime applications of the atomic bomb readily convertible to military ends.
6. What should be pooled among the peace loving nations?
 - A. The development and use of the atomic bomb.
 - B. The peacetime applications of atomic energy.
 - C. The power to use the atomic bomb for military ends.
 - D. The future technical secrets of atomic energy.

7. What should not be readily convertible to military ends?
 - A. The peacetime uses of nuclear weapons.
 - B. The peacetime uses that are developed from the atomic bomb.
 - C. Further research connected with atomic energy.
 - D. The future technical secrets of atomic energy that are controlled by the United Nations.

8. What are precipitated by the atomic bomb?
 - A. Questions of moral principle.
 - B. Peacetime applications of this ruinous weapon.
 - C. Questions of political control over the atomic bomb.
 - D. Further research and technical secrets relating to its peacetime use.

9. The education of what people is the only hope of preserving permanent peace?
 - A. The people of all the military nations.
 - B. The people in government control in all countries.
 - C. The people of all nations.
 - D. The people that use atomic power for military applications.

10. What will ensure that the development of the peacetime applications of the atomic bomb are not easily adapted to military ends?
 - A. The moral sense of the peace loving nations.
 - B. Strict control over the development and use of this ruinous weapon.
 - C. Further research into the peacetime applications of atomic energy.
 - D. The education of the people of all nations.

DEATH OF A DOG

1. What had been misplaced by the dog?
 - A. Confidence in his nose.
 - B. Confidence in the goodness of God.
 - C. Confidence in his agility.
 - D. Confidence in his past experience.

2. What does the dog ignore as of no importance?
 - A. An interesting odor at the convent gates.
 - B. The unexplored sidewalk.
 - C. A vehicle on the road.
 - D. The mysterious nuns at the convent.

3. Into what might the large, youthful animal develop?
 - A. A very dignified dog.
 - B. A dog of much elegance.
 - C. An ignorant puppy.
 - D. A normal dog.

4. The dog wanders and gambols along the sidewalk near what gates of a convent?
 - A. The interesting gates.
 - B. The vermilion gates.
 - C. The towering gates.
 - D. The mysterious gates.
5. What causes the puppy to be lying in the mud?
 - A. His bouncing confidence in the nuns.
 - B. His stepping off the road.
 - C. His ignoring of the huge, towering vermilion construction.
 - D. His gratitude for finding a speck of odorous matter in the mud.
6. Along what does the young dog frisk and amble?
 - A. The vast and interesting road.
 - B. The poorly explored road.
 - C. The mysterious sidewalk.
 - D. The sidewalk near the convent.
7. The large puppy is what?
 - A. An inelegant, young animal.
 - B. An inexperienced animal.
 - C. A gawky, inelegant animal.
 - D. An animal of much dignity.
8. What is looked at offhandedly by the animal?
 - A. An immensely tall, bright red monster.
 - B. The mysterious gates of the convent.
 - C. The sidewalk of a busy road.
 - D. An extensive and little explored continent.
9. The dog might have entered the convent and done what?
 - A. Found an odorous speck of matter in the mud.
 - B. Found the goodness of God.
 - C. Had a fine time.
 - D. Been filled with bounding gratitude for the gift of life.
10. Why does the dog step off the sidewalk into the road?
 - A. Because he has absolute confidence in his agility.
 - B. Because he is an ignorant fool.
 - C. Because he detects an interesting odor in the gutter.
 - D. Because he is a normal puppy.

MY RELATIONS WITH TEACHERS

1. Which students bring out the best in teachers?
 - A. Students who dislike their studies.
 - B. Students who are inept at their studies.
 - C. Students who challenge teachers' skill.
 - D. Students who conceive a raging dislike for teachers.

2. What did I appear to bring out in my teachers?
 - A. Their teaching skill, understanding, and affection.
 - B. The best facets of their personalities.
 - C. The worst facets of their personalities.
 - D. Either raging violence or sympathy and affection.
3. What was extremely upsetting to my teachers?
 - A. Something about me.
 - B. My insolent silence.
 - C. My sympathy and affection for them.
 - D. The raging dislike I had for them.
4. With which teachers were my relations always tense and hostile?
 - A. Intolerant teachers.
 - B. Inept teachers.
 - C. Violent teachers.
 - D. All teachers.
5. What might have provoked one particular teacher to violence?
 - A. I disliked by studies.
 - B. I did very badly in my classroom studies.
 - C. I said something that was either insolent or intolerably stupid.
 - D. I threw a book at that instructor.
6. What could be unendurably irritating to my teachers?
 - A. My insolent temperament.
 - B. The way I challenged their sympathy and affection.
 - C. My poor classroom work.
 - D. The mere awareness of my existence on earth.
7. What was most influential in producing the worst in my teachers?
 - A. The speed with which I developed a dislike of them.
 - B. My distinctive personality.
 - C. My inability to be silent.
 - D. My dislike of my studies.
8. When was a book thrown at me by one teacher?
 - A. On the first occasion I joined his class.
 - B. When I could remember something no longer than fifteen or twenty minutes.
 - C. When I had no more sympathy and affection for him.
 - D. The very first day he saw me.
9. What relations marked my experiences with teachers?
 - A. Relations deeply offensive to inept students.
 - B. Relations always attended by silence.
 - C. Tense and hostile relations.
 - D. Relations always attended by violence.

10. What was possibly provoked by my silence?
- A. One teacher's raging dislike for me.
 - B. One teacher's throwing of a book at me.
 - C. A fifteen or twenty minute attack upon me.
 - D. One teacher's unendurable irritation.

UPSETTING THE BALANCE OF NATURE

1. What are exterminated by man on a large scale?
- A. New organisms.
 - B. Some species of plants.
 - C. New kinds of plants.
 - D. Plants and animals that permeate to new areas.
2. What is continually being altered as new forms of life are developed?
- A. The balance of time in which evolution alters.
 - B. The evolution of man.
 - C. The balance of nature.
 - D. The biological balance of new organisms.
3. What is the balance of nature?
- A. A very sensitive and involved complex of checks and balances.
 - B. The very delicate and intricate biological aspect of the planet.
 - C. The balance of plants with animals in some areas.
 - D. The biological aspect of evolution.
4. What is man facilitating?
- A. The alteration of climates.
 - B. The very delicate balance in the spread of animals and plants.
 - C. The impact of nature on the biological aspect of the world.
 - D. The spread of animal and plant life into fresh areas.
5. What is altering the balance of nature?
- A. The biological aspect of the planet.
 - B. A very elaborate and delicate system of checks and counterchecks.
 - C. Man's facilitation of the spread of plants and animals into new regions.
 - D. Civilized man whose speed has been multiplied many times.
6. With what are huge areas being covered by man?
- A. New organisms from the evolutionary time scale.
 - B. Checks and counterchecks in the balance of nature.
 - C. Animals and plants of new areas.
 - D. New kinds of plants.

7. What have been shifted to the human time scale in which tens and hundreds of years are important?
 - A. Changes in climates.
 - B. Changes in the system of checks and counterchecks in nature.
 - C. Alterations in factories and other products of man's civilization.
 - D. Changes in the evolutionary time scale.
8. What is sometimes deliberate and sometimes unconscious?
 - A. Man's facilitation of the spread of plants and animals.
 - B. Man's extermination of some species on a large scale.
 - C. Man's multiplication of some species on a large scale.
 - D. Man's changes to the human time scale.
9. What aspect of the planet has been altered in five thousand years?
 - A. The human aspect.
 - B. The evolutionary aspect.
 - C. The biological aspect.
 - D. The civilized aspect.
10. What has man's upsetting of the balance of nature altered?
 - A. The evolutionary time scale of decades and centuries.
 - B. The biological aspect of the planet.
 - C. The human time scale of hundreds of thousands of years.
 - D. The system of checks and counterchecks in new regions.

WHAT IS GENIUS?

1. What is released by the writer of genius?
 - A. The unexpressed needs and feelings of the people round him.
 - B. The genius of all men.
 - C. That which is inaccessible to the rest of humanity.
 - D. The exceptional feelings and emotions of other people.
2. In what alone does creative genius lie?
 - A. Skills not possessed by others.
 - B. Strength which derives from personal attributes displayed by many people.
 - C. The most penetrating grasp of the skills and knowledge that are available to everybody.
 - D. The deepest understanding of that which is inaccessible to the rest of humanity.
3. Who is exceptional in being able to express the needs and feelings of people round him?
 - A. The writer of genius.
 - B. The exceptional writer.
 - C. The writer of great virtuosity.
 - D. The writer of exceptional talent.

4. What geniuses tower above the rest of humanity?
 - A. Mathematical prodigies who have exceptional insight.
 - B. Writers of genius with idiosyncrasies which divide them from other people.
 - C. Great virtuosi with talents not available to the rest of humanity.
 - D. Exceptional writers with outstanding creativity.

5. What makes the writer of genius exceptional?
 - A. He has exceptional gifts of virtuosity.
 - B. He releases his own exceptional gifts of virtuosity.
 - C. He releases the genius of all men.
 - D. He is exceptional in drawing force from idiosyncrasies which divide him from other people.

6. Where do mountainous volcanoes reach?
 - A. Down below valleys that are prodigious and altogether exceptional in depth.
 - B. To heights inaccessible to man.
 - C. Down below the deepest valleys.
 - D. Down below the surrounding landscape.

7. Genius is sometimes taken to mean
 - A. the unspoken needs and feelings of everyday people.
 - B. the possession of a talent which is completely outstanding.
 - C. an exceptional ability to express oneself.
 - D. a penetrating understanding of the unusual in life.

8. What is expressed by the writer of genius?
 - A. The desires and emotions of everyday people.
 - B. The exceptional gifts of the people round him.
 - C. The feelings of great virtuosi.
 - D. His deep understanding of his own life situation.

9. What attributes of mathematicians is sometimes taken for genius?
 - A. A talent in understanding that which is prodigious and altogether exceptional.
 - B. An understanding which is prodigious and altogether exceptional.
 - C. A talent which is prodigious and altogether exceptional.
 - D. A talent which is accessible to the rest of humanity.

10. Why is the writer of genius not isolated?
 - A. He has the deepest understanding of all people.
 - B. He has the deepest understanding of situations in life which are shared by many people.
 - C. He has the deepest understanding of the needs of all people.
 - D. He has the deepest understanding of the feelings of all people.

Tests Constructed According to Facet Design

THE ATOMIC BOMB

1. In the author's view the future technical secrets of atomic energy
 - A. should be used under supervisory control in all countries.
 - B. are the only real hope of preserving peace.
 - C. should be made available to all the peace loving nations.
 - D. should be used to ensure the survival of man.
2. With which statement would the writer agree?
 - A. Each country's government should control future atomic research.
 - B. Ethical problems of the atomic bomb should be solved by the United Nations.
 - C. Every means should be used to ensure further research into military use of atomic energy.
 - D. The question is one of ethics not of survival.
3. According to the passage what appears to be the most effective, immediate deterrent to the military use of atomic energy?
 - A. The possession by all peaceful nations of atomic technology.
 - B. The moral sense and education of the people of all nations.
 - C. The guarantee that any peacetime uses of the bomb will be easily converted to military ends.
 - D. Fear of reprisal by military nations.
4. The author asserts that the only real hope of preserving permanent peace is
 - A. the common possession of the atomic bomb.
 - B. having all nations possess the secrets relating to the use of atomic power.
 - C. political control over the development of the atomic bomb.
 - D. the education of the people of all nations.
5. Which statement agrees with information in the passage?
 - A. The atomic bomb caused ruinous destruction in World War Two.
 - B. Every avenue should be explored for means to use atomic energy for the benefit of man.
 - C. Every means should be exhausted to control the military use of this great power.
 - D. The future secrets of atomic energy should be pooled among all nations.
6. The writer suggests that the most effective deterrent to the use of the atomic bomb
 - A. is the fact that the combatants in World War Two didn't use gas.
 - B. is common possession of this power.
 - C. is government control over future research.
 - D. is political control over atomic research and development.

7. The writer asserts that
- A. the future technical secrets of atomic energy should permit its military use.
 - B. the United Nations should provide promise for the education of all people.
 - C. the question is not one of ethics, but of survival.
 - D. control is needed to ensure peacetime applications of the atomic bomb are easily convertible to military needs.
8. In the passage, which is false?
- A. The best deterrent to the military use of atomic energy is its common possession.
 - B. Atomic knowledge should be pooled among the peace loving nations.
 - C. The moral sense of mankind is the only hope of permanent peace.
 - D. Further atomic research should be controlled by a centralized supervisory council of the United Nations.
9. The passage suggests that to preserve permanent peace
- A. every attempt should be made to apply this great power to assist man as well as to destroy him.
 - B. the most effective encouragement would appear to be common possession of this power.
 - C. a supervisory council should be established to control the military use of atomic energy.
 - D. moral intelligence will be needed.
10. How would the writer complete this sentence? Every means should be exhausted
- A. to ensure that peacetime applications grow out of the atomic bomb.
 - B. to harness the mighty power of atomic energy.
 - C. to obtain political control of the development of the atomic bomb.
 - D. to prevent the military use of atomic energy and its future technical secrets.

DEATH OF A DOG

1. The puppy in the passage
- A. had a fine time.
 - B. is not an ignorant fool.
 - C. is a big youngster bound to become an extremely dignified animal.
 - D. sees the convent as an immense and interesting place that has never been properly explored.

2. With which statement would the writer agree?
 - A. Almost immediately the dog is lying in the mud.
 - B. An ignorant fool might have entered the convent of nuns and had a fine time.
 - C. The goodness of God is the gift of life.
 - D. The dog smells nothing interesting in the mud at the edge of the road.
3. What shows that the young dog in the passage is inexperienced?
 - A. He disdainfully pays no attention to the vehicle that is bearing down upon him.
 - B. He sees the road as a vast and interesting continent imperfectly explored.
 - C. He goes into the convent and has a marvellous time.
 - D. He glances casually at a speck of odorous matter in the mud.
4. The young dog in the passage
 - A. is a dog of much dignity.
 - B. glances disinterestedly at the mysterious gates of a convent.
 - C. is inexperienced but he is not an ignorant fool.
 - D. has very little in his favor other than an awkward elegance.
5. Which statement agrees with information in the passage?
 - A. Almost immediately the dog is lying close to the gates of the convent.
 - B. The frisky pup steps off the sidewalk into the busy road.
 - C. The young dog glances casually at the four wheels and then steps off the sidewalk into the road.
 - D. He is a large puppy on the way to being a dog of little dignity.
6. The writer suggests that the normal puppy
 - A. is a foolish animal.
 - B. has a bounding gratitude for the gift of life.
 - C. is a large dog of much dignity.
 - D. frolics and gambols near busy roads.
7. With which would the writer agree?
 - A. The vast convent is an interesting continent imperfectly explored.
 - B. The puppy glances casually at the convent.
 - C. Gawky elegance and bounding gratitude for the gift of life distinguish the normal puppy.
 - D. The puppy's confidence in his sense of smell, his agility, and God's goodness, are reassuring to see.
8. According to the passage which statement is false?
 - A. The young animal has not received even the most basic training.
 - B. The young dog glances casually at a huge, towering vermilion construction that is whizzing toward him on four wheels.
 - C. He is a large puppy but the next instant he is lying in the road.
 - D. The dog's confidence in his agility shows his inexperience.

9. The passage states that the road
- A. is a huge and intriguing place but it is well-known to the dog.
 - B. is not busy near the mysterious gates of the convent.
 - C. lacks even the most rudimentary sidewalk.
 - D. is huge and intriguing but is no place for a normal, ignorant foolish puppy.
10. How would the writer complete this sentence? The young dog's
- A. confidence in the goodness of God has been well-placed.
 - B. complete confidence in his nose, his agility, and the goodness of God, is touching yet most distressing to see.
 - C. disdain for his senses leads him to ignore an interesting smell in the mud.
 - D. gawky elegance is absolutely painful to witness.

MY RELATIONS WITH TEACHERS

1. According to the passage my silence
- A. provoked my teachers to conceive a raging dislike for me.
 - B. was either insolent or intolerably stupid.
 - C. could annoy my teachers.
 - D. could be strained and unfriendly.
2. With which statement is the passage in agreement?
- A. A teacher could dislike me very quickly.
 - B. Even my poor classwork annoyed my teachers.
 - C. Inept students bring out the worst in teachers.
 - D. My relations with teachers were almost always tense and hostile so I disliked by studies.
3. According to the passage what may have caused the tenseness between my teachers and me?
- A. My appearance.
 - B. My poor classroom work.
 - C. I disliked school work.
 - D. I challenged the pedagogic temperament.
4. The passage states that
- A. All inept students challenge teachers' skill and move them to sympathy and affection.
 - B. I was indifferent to my school work and this appeared to seriously upset my teachers.
 - C. Violence could annoy my teachers.
 - D. Some inept students bring out the best in teachers.

5. Which statement agrees with information in the passage?
- A. I was deeply offensive to a violent teacher.
 - B. A book was thrown at me within twenty minutes of meeting one teacher for the first time.
 - C. Teachers took no longer than fifteen minutes to become tense and hostile with me.
 - D. Sympathy and affection seemed to bring out the best in my teachers.
6. The passage suggests there was something about me that was
- A. deeply offensive to inept teachers.
 - B. offensive to the pedagogic temperament.
 - C. always tense and hostile.
 - D. unendurably irritating to one teacher.
7. With which statement would the writer agree?
- A. At the very sight of me a teacher threw a book at me.
 - B. Because of my insolence a teacher assaulted me.
 - C. The mere awareness of my existence on earth could be unendurably irritating to my teachers.
 - D. My intolerable stupidity provoked my teachers.
8. According to the passage, which statement is false?
- A. At school my dealings with my teachers were strained and unfriendly.
 - B. I disliked my studies and did very badly at them.
 - C. I no longer remember what could annoy my teachers.
 - D. Inept students can be upsetting to teachers.
9. The passage suggests that I could recall an instructor
- A. who had more to do with my poor relations with teachers than my poor school performance did.
 - B. who provoked me to violence.
 - C. who was either intolerably stupid or unendurably irritating.
 - D. who assaulted me possibly because I was disrespectful or hopelessly dull.
10. How would the writer complete this sentence? The very sight of me
- A. was either insolent or intolerably stupid.
 - B. was unbearably disturbing to some of my teachers.
 - C. in the school could move teachers to sympathy and affection.
 - D. seemed to bring out my worst relations with teachers.

UPSETTING THE BALANCE OF NATURE

1. According to the passage man is changing
 - A. the very elaborate and delicate system of nature.
 - B. evolution.
 - C. the intricate system of checks and balances in nature.
 - D. the evolution of civilized man.
2. With which statement would the writer agree?
 - A. The balance of nature is an involved and sensitive system.
 - B. Alterations to the products of the civilization of man have been very rapid.
 - C. The evolutionary time scale is measured by decades and centuries.
 - D. Everywhere man is altering the spread of plants.
3. In the author's view what is altering the balance of nature?
 - A. Man's facilitation of the propagation of plants and animals.
 - B. Man's influence on the change of climates.
 - C. Man's influence on the evolutionary time scale.
 - D. Man's influence on the time scale.
4. The author asserts that man is changing
 - A. the evolutionary time scale.
 - B. the biological aspect of the evolutionary time scale.
 - C. the human time scale.
 - D. the time scale of the balance of nature.
5. Which statement agrees with information in the passage?
 - A. Man's impact on the balance of nature has been constant.
 - B. Man assists in the spread of plant and animal life.
 - C. Man is populating huge areas.
 - D. The balance of nature changes rapidly with changes in climate.
6. The writer suggests that some species are being exterminated
 - A. as animals and plants spread to new areas.
 - B. under the influence of civilized man.
 - C. with the slow change of climates.
 - D. as new organisms evolve in the natural process of evolutionary development.
7. With which statement would the writer agree?
 - A. In altering the balance of nature, man has done little in a hundred thousand years.
 - B. Man has increased several fold, the construction of houses and factories.
 - C. The spread of plants and animals is sometimes planned and sometimes not.
 - D. Man has done little in five thousand years to change the pattern of animal and plant distribution on earth.

8. According to the passage which statement is false?
- A. The balance of nature is in a state of perpetual change resulting from the slow change of climates.
 - B. The balance of nature is continually being altered by new organisms.
 - C. Man alters the balance of nature both deliberately and unconsciously.
 - D. The rate of evolutionary change has been little affected by the arrival of civilized man.
9. The passage suggests that as animals and plants permeate to new areas
- A. the rate of arrival of civilized man multiplies many times.
 - B. some species are exterminated on a large scale.
 - C. alterations to the balance of nature are multiplied many times.
 - D. the balance within the earth's biological realm is altered.
10. How would the writer complete this sentence? A hundred thousand years is used to measure
- A. a period that applies to the human time scale.
 - B. a period that applies to the time scale of evolution.
 - C. the influence of man on the balance of nature.
 - D. changes in the biological aspect of the planet.

WHAT IS A GENIUS?

1. The writer states that creative genius lies only in
- A. the deepest understanding of that which is inaccessible to the rest of humanity.
 - B. talent which is prodigious.
 - C. the most penetrating grasp of the skills and knowledge that are available to everybody.
 - D. the strength of personal oddities.
2. With which statement would the writer agree?
- A. Geniuses sometimes have unusual talents.
 - B. Geniuses possess the unexpressed emotions and motives of others.
 - C. Men of genius are unable to know even what they feel.
 - D. Men of genius always have exceptional talents.
3. In the passage what is the major characteristic of a genius?
- A. A deep understanding of the life situations common to many people.
 - B. He is able to give voice to the unexpressed needs and feelings of the people round him.
 - C. He is able to exercise that which is beyond the reach of other men.
 - D. He is able to give voice to the needs and feelings of the people round him.

4. The author asserts that the writer of genius
 - A. has idiosyncrasies which divide him from other people.
 - B. understands most men who are gagged and silent.
 - C. has the talent of mathematical prodigies.
 - D. releases not only his own exceptional talent but that of other men too.

5. Which statement agrees with information in the passage?
 - A. Most men are unable to express the needs and feelings of individuals around them.
 - B. Most men rarely know what they feel and therefore remain silent.
 - C. Men, for the most part, know the unexpressed needs and feelings of people about them.
 - D. Most men know what they feel but are unable to express themselves.

6. The writer suggests that a mathematical prodigy possesses
 - A. the deepest understanding of situations in life.
 - B. an outstanding talent.
 - C. a stupendous creative talent.
 - D. idiosyncrasies as does the writer of outstanding ability.

7. With which statement would the writer agree?
 - A. All mathematical prodigies are men of genius.
 - B. In creative genius, mathematical prodigies are superior to all other human beings.
 - C. Men of genius sometimes have exceptional gifts of virtuosity.
 - D. The meaning of the word "genius" is "an outstanding and quite exceptional talent."

8. According to the passage which statement is false?
 - A. Mountainous volcanoes pierce the heavens and plumb the depths.
 - B. Great creative geniuses tower above the rest of humanity.
 - C. The writer of genius is exceptional in being able to release not his own genius only but the genius of all men.
 - D. Men of genius have a prodigious and outstanding talent.

9. The passage suggests that the writer of genius
 - A. produces fine work because of his special talent.
 - B. is not isolated in having the deepest understanding of situations in life which are shared by many people.
 - C. is accessible to the rest of humanity.
 - D. understands and expresses all men's needs and feelings.

10. How would the writer complete this sentence? Men for the most part
 - A. take the word genius to mean talent which is prodigious and altogether exceptional.
 - B. have an inability to express what they know and feel.
 - C. possess a deep appreciation of and feeling for life.
 - D. have idiosyncrasies which are shared by many people.