DOCUMENT RESUME

ED 201 977 CS 006 074

AUTHOR Mathews, Samuel R., II
TITLE Age Related Effects of the Interaction of Prior Knowledge and Text Structure on the Recall of Prose.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Individualized Schooling.
SPONS AGENCY National Inst. of Education (ED), Washington, D.C.
REPORT NO WRDCIS-TR-559
PUB DATE Apr 81
GRANT OB-NIE-G-81-0009
NOTE 114p.; Appendix G may be marginally legible.

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Age Differences; Elementary Education; Grade 4; Grade 8; Interaction; *Prior Learning; Reading Comprehension; *Reading Research; *Recall (Psychology)
IDENTIFIERS *Text Structure

ABSTRACT

A study assessed the effects of text structure and prior knowledge about its content on comprehension and recall of text by fourth and eighth grade students. Three groups, each with 15 students, were tested at each grade level. Subjects in the prior knowledge group heard and mastered a passage on one day and then heard, freely recalled, and answered probe questions about a target passage on the next day. The prior knowledge passage and target passage were written so that information in the former was related to information in subordinate levels of the latter. An unrelated knowledge group heard and mastered a passage unrelated to the target materials on one day and performed the same tasks as the prior knowledge group on the next day. A control group participated only in the target passage tasks. The results showed that both the accessibility (free recall) and the availability (probe questions) of information by the fourth grade subjects were affected by prior knowledge. These effects were not present, however, with the eighth grade subjects. The difference between age groups is consistent with the notion that children become more text bound in their comprehension as they move through school. (Author/RL)

Technical Report No. 569

AGE RELATED EFFECTS OF THE INTERACTION OF PRIOR KNOWLEDGE AND TEXT STRUCTURE ON THE RECALL OF PROSE

by

Samuel R. Mathews II

Report from the Project on
Studies of Instructional Programming for the Individual Student

Steven R. Yussen
Faculty Associate

Wisconsin Research and Development Center
for Individualized Schooling
University of Wisconsin
Madison, Wisconsin

April 1981

This Technical Report is a doctoral dissertation reporting research supported by the Wisconsin Research and Development Center for Individualized Schooling. Since it has been approved by a University Examining Committee, it has not been reviewed by the Center. It is published by the Center as a record of some of the Center's activities and as a service to the student. The bound original is in the University of Wisconsin Memorial Library.

The project presented or reported herein was performed pursuant to a grant from the National Institute of Education, Department of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement by the National Institute of Education should be inferred.

Center Grant No. OB-NIE-G-81-0009

WISCONSIN R&D CENTER

MISSION STATEMENT

The mission of the Wisconsin Research and Development Center is to understand, and to help educators deal with, diversity among students. The Center pursues its mission by conducting and synthesizing research, developing strategies and materials, and disseminating knowledge bearing upon the education of individuals and diverse groups of students in elementary and secondary schools. Specifically, the Center investigates

- diversity as a basic fact of human nature, through studies of learning and development
- diversity as a central challenge for educational techniques, through studies of classroom processes
- diversity as a key issue in relations between individuals and institutions, through studies of school processes
- diversity as a fundamental question in American social thought, through studies of social policy related to education

The Wisconsin Research and Development Center is a noninstructional department of the University of Wisconsin-Madison School of Education. The Center is supported primarily with funds from the National Institute of Education.

ACKNOWLEDGMENTS

Among the many who deserve thanks for their help are the members of my dissertation committee, Steven R. Yussen, Joel R. Levin, Robert E. Davidson, Robert M. Enright, and Alex Kerry-Wilkinson. Steve Yussen has been a most honest critic, an advisor and major professor in the best sense, and a good friend during my time at Wisconsin. Joel Levin has contributed much to my ability as a researcher through our interactions about design and quantitative issues. I would also like to acknowledge the contributions of Dr. Bruce R. Dunn who is responsible for my interest in the field of comprehension.

Many of my peers at Wisconsin have also contributed to my education. Kaybeth Camperell provided hours of critical discussion and interrater reliability in this study. Patrick T. Kane supplied not only much discussion, but a generous portion of friendship and insanity which helped me through this experience. Also, without Dorothy Egener's editing and typing ability, the quality of this document would be decreased.

Finally, there are people who affect our entire lives in a positive manner and acknowledging them for support in one small but significant time, seems inadequate. I will attempt it. One source of support came from my parents who never doubted and always supported. They provided an appreciation of people and

a willingness to give which affected my life in an always positive way. Jo Mathews has been my greatest source of strength. She provided inspiration, incentive, and support in a way only one who is a friend in every sense of the word can.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

AGE RELATED EFFECTS OF THE INTERACTION OF PRIOR KNOWLEDGE AND TEXT STRUCTURE ON THE RECALL OF PROSE

Samuel R. Mathews II

Under the Supervision of Professor Steven R. Yussen

Abstract

The structure of a text and prior knowledge about its contents have both been shown to impact on comprehension of that text. The present study was designed to assess the effects of those variables on comprehension and recall of text by subjects at two age levels--fourth and eighth grade. It was hypothesized that prior knowledge would have more of an impact on the fourth graders' performance than on that of the eighth graders. That impact would be manifested in recall of prior-knowledge-related information regardless of its location in the text structure.

In order to assess this effect, three groups at each grade were tested. Subjects in the prior knowledge group heard and mastered a passage on one day and then heard, freely recalled, and answered probe questions about a target passage on the next day. The prior knowledge passage and target passage were written so that information in the former was related to information in subordinate levels of the latter. An unrelated knowledge group heard and mastered a passage unrelated to the target materials on Day 1 and on Day 2 performed the same tasks as the prior knowledge group. A third group,

a no knowledge control, participated only in the target passage tasks. That is, they heard, freely recalled, and answered probe questions about the same target passage, but with no prior information.

The predictions were that at the fourth grade, the prior knowledge group would have better recall of material from the subordinate levels of the target passage (that information being related to their prior knowledge) than the unrelated knowledge group. The unrelated knowledge group, following the prediction based on text structure, would have better recall of information at superordinate levels of the text than the prior knowledge group. The additional effect of practice or "warm-up" was assessed by comparing the performance of the no knowledge control with the performance of the unrelated knowledge group. For performance on the probe questions, any advantage would be in favor of the prior knowledge group at both grades. This prediction was based on past research indicating a general facilitative effect of prior knowledge on probed recall.

The prediction of differential recall by the prior knowledge group and the unrelated group was supported at the fourth grade. That is, the prior knowledge group recalled significantly more information at the lowest level of subordination than did the unrelated knowledge group. The unrelated knowledge group recalled more information at the most superordinate level in the target

passage than the prior knowledge group. This is consistent with a text structure hypothesis. At the fourth grade, the prior knowledge group generally performed better on the probe questions than did the unrelated knowledge group. At the eighth grade, no consistent differences in performance among the groups were detected. Additionally, performance on probe questions did not differ between groups at the eighth grade.

The accessibility (free recall) and availability (probe questions) of information by the fourth graders are both affected by prior knowledge. These effects are not present with the eighth graders. This difference between ages is consistent with the suggestion that children become more text-bound in their comprehension as they move through the school years (Olson & Nickerson, Note 8).

Major Professor _____

I

INTRODUCTION

Statement of the Problem

The study of comprehension of verbal information has long been of interest to psychologists and educators interested in the nature of cognition. Organization of information by subjects in memory experiments has been used to infer the nature of processes involved in comprehension. Early on in the evolution of cognitive psychology, word lists were perhaps the primary stimulus used in experiments on cognitive structures and processes (Bousfield, 1953; Mandler & Pearlstone, 1966; Shuell, 1969; Tulving & Pearlstone, 1966). In this research, subjects were able to use both experimenter-determined (Shuell, 1969) and subject-determined (Bousfield, 1953) categories to organize words into memorable units.

Learning from prose is an area of research which has been gaining in popularity since psychology and linguistics became disenchanted with the strict behavioristic approach to the study of linguistic behavior (e.g., Chomsky, 1959). Beginning with Chomsky's transformational grammar (Chomsky, 1957), systems of discourse analysis have been used to investigate complex mental activity such as comprehension. Much like the research on word lists, current research on prose has demonstrated that significant differences in comprehension can be

accounted for by both stimulus variables and subject variables. More specifically, text analysis systems (e.g., Frederiksen, 1975; Grimes, 1975; Kintsch, 1974; Meyer, 1975; & Rumelhart, 1975) have been used to identify aspects of text which affect recall. It has also been shown that a subject's prior knowledge and expectancies about information in a text (e.g., a subject's knowledge about the topic of text--Anderson & Pichert, 1977; Brown, Smiley, Day, Townsend, & Lawton, 1977) influence the interpretation and recollection of that text. The effects of text structure and prior knowledge upon recall and comprehension are examined in this paper. A study is presented in which the impact of the two variables is examined at two age levels.

The rationale for such an endeavor is based on a theory of information processing (Bobrow & Norman, 1975) and a theory of cognitive development (Piaget, 1952) which both view the acquisition of information as an interaction between incoming information and the existing cognitive structures (schemata) of the individual. Current research and theory in reading comprehension reflect precisely such a view (e.g., Adams & Collins, 1979).

Bobrow and Norman (1975) have proposed that information processing proceeds as a function of the relationship between the subject's expectations and the incoming information. If the information is consistent with the expectancies, the processing is continued within the framework of those expectancies. This is

termed "top-down" processing. Should the information not be consistent with the expectancies or if no specific expectancies exist for a given body of information, then processing proceeds primarily as a function of the nature of the incoming information. This has been termed "bottom-up" processing. These two complementary aspects of the processing are both hypothesized to be present in most encounters with prose.

This perspective has been discussed with regard to reading comprehension by Adams and Collins (1979). They adopt the "top-down" and "bottom-up" analogies to describe reading at the graphemic, morphemic, syntactic, and semantic levels of comprehension. In other words, expectancies are "generated" for encoding letters, words, and larger linguistics units. In this system, the structure and content of the incoming information in addition to expectancies constrain the amount of top-down processing which can occur.

Piaget's developmental theory, available long before the current information processing model, provided us with an early version of top-down and bottom-up processing. Piaget (1952) has stated that an individual "accommodates" or makes some change in existing schemata based on incoming information as well as "assimilating" information into existing structures or schemata. This is similar in concept to the simultaneous nature of "top-down" and "botton-up" processing.

It is consistent with both a cognitive developmental view and a more general information processing theory to propose that the interaction between characteristics of the incoming information and prior knowledge is operative in the acquisition of information in general and, more specifically, the comprehension of prose. The present study was conducted to document the impact of text structure and prior knowledge on the recall and comprehension of prose by subjects at two age levels. In the next section, literature relevant to text structure and the effects of prior knowledge on comprehension will be reviewed. Pertinent studies from each area will be reviewed in order to establish the rationale for the present study.

Review of the Literature

Text Structure and Learning from Prose

The author of any text strives to structure the text in such a way that the reader can "make sense" of it given a working knowledge of the language of the text. Structural characteristics which affect the acquisition of information from text have been the subject of much discussion and research lately (Grimes, 1975; Kintsch, 1974; Meyer, 1975; van Dijk, 1972, 1977; among others). Among the structural variables examined by these authors are the hierarchical nature of the organization of prose and the degree of cohesion of a given text.

Two levels of text structure will be considered in the present study. One level of structure consists of the phrase-to-phrase or

word-to-word organization. This level of organization provides much of the intra-sentence cohesion and establishes a hierarchical structure within those units. This level has been represented by Kintsch's (1974) text base. The second level of structure is more global--it provides the cohesion between sentences and establishes a hierarchy of larger text units. This level has been described by Grimes' (1975) "content structure." Both levels of analysis will be discussed below.

That prose is hierarchical means simply that for most prose some ideas or concepts are important to the "gist" of the text than others. For example, in the sentence: Johnny's teacher made him solve math problems while he was at school, the idea that Johnny's teacher made him work math problems is more important to the theme of the sentence than the fact that this occurred while Johnny was at school. That is, the description of the action is superordinate to its location. This follows from the text analysis systems proposed by Kintsch (1974) and Grimes (1975).

Cohesion can be illustrated by this example. Here, cohesion is maintained in at least two ways. One is the use of the anaphoric referent for the pronouns he and him. The other is the logical relationship between the action--Johnny's teacher making him solve problems--and the location and time of that action--while he was at school. If the sentence were altered so that it read: While

Johnny was at school, Tom's teacher made him solve math problems, there would be some degree of confusion as to which referent the pronoun him should take. In the first case, the cohesion of text is maintained by the implicit repetition of the concept Johnny through the use of the pronouns he and him. In the second example, the cohesion of the sentence is disrupted by the ambiguity of the relationship between the nouns and the pronoun him.

While the examples provided are much less complex than the prose most of us read and attempt to comprehend, the effects of hierarchical organization in more complex material can be readily documented. In order to do so, a rule-based structural analysis is required to explicate both the hierarchical organization of prose and the logical relationships between ideas in a passage.

Text Base--Kintsch's System. One such method of analysis is that of Kintsch and his associates (Kintsch, 1974; Kintsch & van Dijk, 1978). Kintsch and van Dijk (1978) have presented a processing model which presupposes a "multi-tiered" representation of prose. They propose that comprehension involves the construction of a representation of a given text in memory. In order to arrive at this representation, the subject must first extract the "microstructure", or the sentence level organization of a text. The next step in the processing of text is the construction of a higher level organization of information in prose. This may be thought of as a summary-like representation. The exact nature of this representation in memory

depends upon the nature of the text itself (style, logical relations present, number of concepts in the text, etc.) and the cognitive "state" of the reader (memory capacity, motive for reading, knowledge about the topic of the text, etc.).

In a recent paper, Kintsch (1979) has discussed three levels of text representation and processing. The levels are: (1) "The input propositions are arranged in a network called a coherence graph" (page 5)--the representation of this level is generally thought of as the microstructure of a text; (2) ". . . the propositions are grouped together whenever they belong to the same fact" (page 5)--the representation of this "grouping" may consist of propositions sharing a common argument or related to a common, superordinate proposition; and (3) facts relevant to the "gist" of a passage are distinguished in ". . . further levels of representation, namely, the macrostructure of the text" (page 6)--the macrostructure of a text may be represented by any of several levels of abstraction (e.g., summary, a single sentence, or a title). Although Kintsch (1979; Kintsch & van Dijk, 1978) has discussed these three levels in terms of a processing system, his representation system is limited to the first--the microstructure. Others, most notably Grimes (1975) and Meyer (1975) have represented the organization of text at the second and third level. Grimes' system will be discussed with regard to his representation subsequently. A closer examination of Kintsch's microstructure is in order now.

Microstructure Representation. The template text base, as Kintsch (1974; Kintsch, Kozminsky, Strelby, McKoon, & Kennan, 1975; Turner & Greene, Note 1) has termed the representation of the meaning of a passage, is made up of propositions. Kintsch uses the proposition to represent "conceptual units," not as merely a rewrite of the text. In other words, Kintsch utilizes the propositional representation as a representation of meaning in memory. Turner and Green (Note 1) have distinguished three types of text bases in Kintsch's system. The base structure represents the meaning of the prose as its author intended. This structure includes those ideas explicitly stated in the text, those ideas implicit from the text, and a certain proportion of ideas not expressed in either an implicit or explicit manner. Thus, the base structure remains unspecified in Kintsch's system. The second type of text base is the template text base. This includes all explicit as well as implicit propositions. Implicit propositions are those propositions necessary to maintain cohesion in a text. A template text base represents an "idealized representation of the meaning of a given text" (Turner & Greene, Note 1, page 4) and is used as the standard to which the recall protocols of readers and listeners may be compared for scoring. The third base is the protocol base. This base is composed of the propositions of the recall protocols of readers or listeners. The protocol base is considered to be a more conservative representation of the meaning of a text than the template text base since it has been analyzed by a human processor.

Within each base representation, there are three types of propositions: (1) Predicate, (2) Modification, and (3) Connective. The predicate proposition specifies a state or action. The arguments of a predicate proposition are related to the predicate, when it is a verb, by Fillmore's (1968) case grammar. The cases used by Kintsch in his work are listed and defined in Table 1.

Table 1

Case Roles

Case	Definition
1. Agent (A)	usually animate instigator of the state or action identified by the verb
2. Experiencer (E)	experiencer of a psychological event
3. Instrument (I)	typically inanimate stimulus of an experience, a force or object causually involved in the state or action identified by the verb
4. Object (O)	object of an action which undergoes change or movement
5. Source (S)	source or state of action identified by the verb
6. Goal (G)	result or goal of state or action identified by the verb

If a required case is absent, it is usually in a situation in which the required case must be inferred from the content of the passage. In the case of the missing case category, Turner and Greene (Note 1) propose expressing an "empty case marker" to represent the missing but required case. For example, the sentence: John hit the ball with the bat, would be analyzed into the following predicate proposition: (HIT, Agent:John, Instrument:Bat, Object:Ball). The predicate is HIT. The arguments John, Bat, and Ball assume the specified relationships to the predicate following Fillmore's case roles.

Modification propositions specify a restriction or limitation of some concept, either an argument or proposition. Consider the example: The building is tall. This sentence can be analyzed into the following proposition: (Quality of: Building, Tall). In Kintsch's system, the term Quality of indicates that the concept (usually a noun) is limited by the attribute specified, in this case, Tall.

Connective propositions specify relations between other propositions or concepts in the text. The connective propositions serve to specify those connections which are both implicit and explicit and provide the cohesion in connected prose. The arguments of connective propositions are typically other propositions. Consider the sentence: John went to town to buy a book. There are two predicate propositions in this sentence: 1(WENT, Agent:John, Goal:Town) and 2(BUY, Agent:John, Object:Book). These propositions are related by the connective

proposition: 3(Purpose:To, 1,2). Purpose is one of several predicates Kintsch has defined. Proposition 3 can be read: The purpose of Proposition 1 is Proposition 2. The term To is included to show explicitly how Propositions 1 and 2 are connected in the text.

While the connective propositions provide one aspect of the cohesion of a text, the repetition of arguments provides the proposition to proposition flow of prose. In other words, two propositions are connected if they contain the same argument. For instance, in the previous example: John went to town to buy a book, cohesion is maintained not only by the connective proposition, but also by the repetition of the argument John in Propositions 1 and 2.

In their work, Turner and Greene (Note 1) have provided an extensive description of the mechanics of construction of a propositional text base. This is based on Kintsch's theoretical position and previous work (Kintsch, 1974). Since this other analysis is available, a detailed analysis of the procedure will not be presented here with the exception of those components which bear direct theoretical importance to Kintsch's system.

Briefly, the analysis proceeds by analyzing the first main clause of the prose selection into its component propositions, then proceeding into the following propositions. Turner and Greene (Note 1) provide a general rule for the order of analysis of various types of propositions. Stated generally: "Ordering Rule: A proposition 'A' which is embedded in another proposition 'B' is written before that

proposition 'B' whenever possible" (Turner & Greene, Note 1, page 46). The analysis yields an ordered list of propositions whereby the number of both implicit and explicit propositions may be obtained. In the case of an argument being repeated, the 1 + nth repetition is not considered to be a "new argument," even if the argument assumes a new case relation to the verb. Only the first occurrence of an argument or concept is considered to be the introduction of a new argument. Thus, in the ordered list of propositions, a repeated argument represents the same concept as in the initial occurrence of that argument. In the previous example, John represents the same concept in Propositions 1 and 2. The more repetitions of an argument in a given text, the fewer occurrences of new arguments in that text and the more cohesive the text is at the microstructure level.

In addition to the cohesion of text, the microstructure explicates the hierarchical arrangement of information at this level of analysis. The rule stated by Kintsch et al. (1975) for determining the level of subordination of a given proposition is: "A proposition is said to be subordinate to another if it contains an argument that also appears in the first proposition" (page 199). Kintsch and his associates (Kintsch, 1974; Kintsch et al., 1975) have conducted studies which were intended to determine the parameters of cohesion and hierarchy of information in the microstructure of a text. The points to be made are perhaps best illustrated by the experiments presented in Kintsch et al. (1975).

Research on the Microstructure. Kintsch et al. (1975) conducted four experiments in which the number of arguments and propositions were varied systematically. There were two levels of the number of new arguments (few or many), crossed with two levels of the number of propositions (few or many). This yields four categories of text bases with the number of words per text base approximately constant within topic. The text bases were constructed in a hierarchical manner according to the subordination rule (Kintsch, 1974; Kintsch et al., 1975) so that the effects of this structure on recall could be investigated.

Two experiments were conducted utilizing the same methodology but with different prose passages. Since the findings of the second replicate the first, only the first experiment will be discussed. In this experiment (Kintsch et al., 1975) undergraduate subjects read a paragraph at their own pace, then wrote their recalls. The recalls were scored by comparing each recall to the text base. The hypothesis that those passages with fewer "new" arguments would require less reading time than those passages with more new arguments was supported. The effect of this variable on recall did not reach significance, however. Kintsch et al. (1975) speculate that in an unlimited reading time situation subjects read the texts until they reached some criterion of understanding which masked the differences in processing. In a post hoc examination of the data, Kintsch et al. (1975) argue that perhaps a better measure is an efficiency rating, reading time per proposition

recalled. While only descriptive data is presented, the mean of the reading time-per-proposition-recalled is less for the paragraphs containing relatively few arguments.

With regard to the level of subordination in the hierarchy of a text, Kintsch et al. (1975) found that those propositions in the first or highest level in the hierarchy were recalled 80% of the time while those propositions lower in the hierarchy were recalled only 30% of the time. This effect reached statistical significance while serial position effects did not. This finding lends further support to the hierarchical text base as a useful representation of a passage. In a third experiment, the effect of these variables on comprehension in a listening task was tested and similar outcomes resulted. So the text variables under consideration operate both in reading and listening to prose.

In the fourth experiment reported by Kintsch et al. (1975), the effect of text variables was tested on delayed recall. The procedure was the same as in Experiment 1, but with no immediate recall. The same stimulus material and design used in Experiment 1 was used in Experiment 4. The recall trial for Experiment 4 occurred 24 hours after the initial reading of the passage. The recall procedure differed from that of Experiment 1 in that a cue, the most superordinate proposition of the particular text base, was given. Even so, the delayed recall condition produced significantly lower recall than the immediate recall in Experiment 1. Of those propositions recalled, those highest in the hierarchy were recalled significantly more often

than those lower in the hierarchy. Kintsch et al. (1975) also observed a higher frequency of intrusions in the delayed recall condition than in the immediate recall condition. They attribute this to the integration of the text information into the individual's general knowledge base. It is interesting to note that even with a greater number of intrusions, the material which was recalled from the original text was most likely to be from the superordinate levels in the hierarchy.

Manelis and Yekovich (1976) tested the assertion that argument repetition (cohesion by Kintsch & Vipond's, 1979 definition) leads to better recall and more efficient reading. To determine the effects of argument repetition on reading and recall, Manelis and Yekovich (1976) constructed sentences which contained either many arguments with few repetitions or few arguments with many repetitions. Subjects then read these sentences with no time constraints on reading and participated in a free recall task. The investigators found that those sentences which contained more argument repetitions required a shorter reading time (1.88 seconds per proposition) than those sentences which contained fewer argument repetitions (2.74 seconds per proposition). No convincing recall differences were observed, but given the reduced reading time for the sentences with many argument repetitions, the effect of argument repetition may be seen in terms of efficiency of processing.

The second experiment (Manelis & Yekovich, 1976) was identical to the first with the exception that reading time was constrained.

This allowed the experimenters a second measure of the facilitative effect of argument repetition on recall. Here, they found that with constrained reading time, the sentences with many argument repetitions were recalled better than those with few repetitions.

The experiments conducted by Kintsch et al. (1975) as well as other reported studies (Kintsch, 1974; Manelis & Yekovich, 1976) indicate that the representation of one level of the organization of information in prose is captured by the microstructure. Two caveats are necessary here. One is that the passages used by Kintsch and his associates were relatively short and may not reflect problems encountered when lengthier texts are considered. The other caveat follows from the first and is related to the levels of representation and processing identified by Kintsch (1979). That is, the effects of the logical relationships between propositions in the microstructure have received little attention. One such study was conducted as part of Manelis and Yekovich's (1976) investigation.

In a third experiment, Manelis and Yekovich (1976) investigated the role of the logical relations between propositions in the recall of prose. In order to do this, three types of sentence sequences were presented to subjects. One sequence contained both argument repetition and logical interrelatedness of the sentences (e.g., Harold lunged at Norman. Norman called the doctor. The doctor arrived. Manelis & Yekovich, 1976, p. 307). For other sequences, either the arguments were not repeated (e.g., Arnold lunged at Brian. Norman called the doctor. The police arrived.

Manelis & Yekovich, 1976, p. 307), or they were repeated but they were not logically interrelated (e.g., Ellen pushed Judith. Judith obeyed the nurse. The nurse coughed. Manelis & Yekovich, 1976, p. 308). Manelis and Yekovich found that when subjects read and recalled these passages, recall for the passages was highest when the sentences were interrelated and the arguments repeated. Taken together, the findings of the three experiments (Manelis & Yekovich, 1976) support two levels of cohesion operative in text. One can be represented using the microstructure defined by Kintsch (1974). The other is a logical cohesion which Kintsch (1979) and Kintsch and van Dijk (1978) have discussed as the "fact" level of processing.

Content Structure: A Representation of the "Fact" Level: Grimes' System. The representation of the second level of processing and organization discussed by Kintsch (1979; Kintsch & van Dijk, 1978) is the "fact" level. This processing level involves organizing individual propositions into "higher-order fact units" (Kintsch & van Dijk, 1978, p. 390). The internal structure of these fact units is based upon the case structure (Fillmore, 1968) of linguistic units such as clauses or sentences and the proposition(s) resulting from the interrelations of those units. The "fact" unit is usually a complex proposition which takes microstructure propositions as its arguments. For example, earlier we considered the sentence: John went to town to buy a book. This sentence was analyzed into three propositions. At the most basic level, the connective

proposition (Proposition 3, page 9) represents a fact unit. This fact unit could in turn be embedded in a more complex fact unit. Van Dijk (1977) has specified a series of operating rules by which these units can be analyzed. He has provided no means of representing this level as of yet. While the microstructure is sufficient to represent the intrafact cohesion and hierarchy, an additional level of representation is necessary to represent the interfact cohesion.

One system of describing the structure and interrelationships of these fact units has been suggested by Grimes (1975) and Meyer (1975). One component of Grimes' system is termed the content structure. The content structure is a network of propositions which are interconnected by certain relational terms called rhetorical predicates (Grimes, 1975). These rhetorical predicates specify the logical and temporal relations existing between propositions in a text. These terms are listed and defined in Table 2. They are defined by implicit or explicit "signals" in a text (e.g., either by context or content words such as because, but, etc.). Interestingly enough, while Kintsch and van Dijk (1978) do not specify a means of relating fact units in text, they hypothesize that relations similar to Grimes' rhetorical predicates can be identified through such linguistic devices.

These rhetorical predicates (Grimes, 1975) can be used to specify the interrelationships between "fact" units. The rhetorical predicates have as their primary purpose "that of organizing

Table 2

Rhetorical Predicates

Predicate	Definition
Predicates with Arguments at Same Level	
Alternative	equal weighted alternative options
Response	equal weighted Question(s) and Answer(s), Remark and Reply, or Problem(s) and Solution(s)
Predicates with Arguments at Different Levels	
Attribution	describes qualities of a proposition
Equivalent	restates same information in a different way
Specific	gives more specific information about something that was stated in a general manner
Explanation	previously stated information is explained in a more abstract manner or more concrete manner
Analogy	anology given to support an idea
Manner	way an event or event complex is performed
Adversative	relates what did not happen to what did happen
Setting Time	gives time of setting in which information being related occurs
Setting Location	gives location of setting in which information being related occurs
Setting Trajectory	gives changing background of location and time that occurs in a narrative when characters travel through various places

Table 2 (continued)

Rhetorical Predicates

Predicate	Definition
Representative Identification	singles out one element of a group and makes it stand for the group as a whole
Replacement Identification	one thing standing for something else
Constituency Identification	identifies a part in relation to some whole
Predicates with Argument Subordination Determined by Context	
Collection	list of elements related in some unspecified manner
Covariance	relation often referred to as condition, result, or purpose with one argument serving as the Antecedent and the other as the Consequent or result of the Antecedent

the content of discourse. They join . . . propositions together" (Grimes, 1975, p. 207). These predicates form a logical cohesion within connected discourse. In other words, if one considers a lengthy text in which there might be two or more propositions or strings of propositions which are not interconnected by argument repetition, it could be the case that they are logically interrelated. So, although a text may be disjointed based solely on argument repetition, when the logical interrelations between propositions are considered, the text may indeed be cohesive.

There is also a hierarchical component to Grimes' (1975) system. This is explicated by three classes of rhetorical predicates. In the first class of rhetorical predicates, the propositions connected by the predicates share a common level in the hierarchy. For instance, in the sentence: John could either walk home or stay overnight., the alternatives share an equal probability of selection. In Grimes' (1975) system, the term Alternative is used to express the relationship in this example, and its components share the same level in the hierarchy of information. The second class of rhetorical predicates express a relationship between two or more propositions in such a way that one is superordinate to the other(s). In the example: There were people everywhere, They were in the water, on the beach, and at the bar, the proposition concerned with " . . . people everywhere," is superordinate to the specific information about their whereabouts. The term Specific is used in Grimes' (1975) system to denote the relationship between a general statement and more detailed information about that statement. The general statement is superordinate to the more detailed information.

The third class of rhetorical predicates relates propositions which occur either at the same level in the passage hierarchy or at different levels in that hierarchy. This class of predicates has been appropriately termed Neutral Rhetorical Predicates. In this class of predicates, the emphasis of the text determines the level of the propositions connected by a given Neutral predicate.

In the example: Don smokes cigarettes, Therefore, he coughs, a casual or antecedent-consequent relationship is stated. Grimes (1975) has termed this relationship Covariance. In this case, neither proposition appears to be subordinate to the other since no emphasis is given to either by the author. This casual relationship can assume a hierarchical nature as well. In the sequence: Don smokes cigarettes which is why he coughs., the fact that Don smokes cigarettes is emphasized. Here, the first assertion is superordinate to the second. No doubt, there are contexts in which the hierarchy of these examples would be altered. This is a strength, not a weakness, of Grimes' (1975) system of analysis. That is, it is context sensitive.

The issue of the overall organization of the "fact" units in the content structure as described by Grimes (1975) is related to the macrostructure discussed by Kintsch (1979) and Kintsch and van Dijk (1978). Both the content structure and the macrostructure represent an overall, global organization and coherence of prose. This organizational level may be represented in most prose by a "topic" statement, a summary and in some cases, a title. In the content structure, the highest level is made up of the most superordinate rhetorical proposition(s). The macrostructure (Kintsch, 1979; Kintsch & van Dijk, 1978) is the hypothesized result of cognitive processes operating on a text. For some cases, the macrostructure resulting from these hypothesized cognitive processes

can be isomorphic to the highest level in the content structure (Grimes, 1975). Recent research (Meyer, 1975; 1977) provides cases in which the content structure of a passage appears to be isomorphic to the macrostructure of subjects' recall.

Research on the Content Structure. Meyer (1975) used Grimes' (1975) content structure of prose to analyze passages into a hierarchically arranged network of propositions. Two versions of each passage were written so that in one version certain information appeared at a superordinate level, and in another version, the same information appeared at the most subordinate level. College students read and recalled the passages in both an immediate and delayed free-recall task and a delayed cued-recall task. In all cases, recall of the information in question was significantly better when that information appeared in a superordinate position in the passage. This lead Meyer (1975) to conclude that the content structure reliably identified characteristics of prose which affected recall. In this case, the content structure of the text and the macrostructure of the subjects' recalls were similar.

In a subsequent study, Meyer (1977) tested the strength of this effect on a younger subject population, sixth graders. Here, Meyer had her subjects (high-, middle-, and low-ability sixth graders) listen to a 600-word passage and then answer questions. One-half of the questions addressed information in the "top" of

the hierarchy of the passage and half addressed information at the lowest levels in the hierarchy. The results indicated that for all ability levels tested, the performance of the children on questions regarding "high" level information was significantly better than performance on questions regarding "low" level information. Further, for all questions, the high-ability subjects performed better than the middle- and low-ability subjects and the middle-ability subjects performed better than the low-ability subjects. Interestingly enough, the pattern of performance was the same for all ability levels. That is, the level of the hierarchy from which a question was taken and ability level did not interact. Again, this indicates that the highest level organization of information acquired from prose (the macrostructure) can be represented by the content structure of prose. Other studies, however, lead one to conclude that this is not necessarily the case for all subjects.

One such study was conducted by Meyer, Brandt, and Bluth (Note 2). Meyer et al. (Note 2) wanted to determine if there was a reliable difference between good and poor readers with regard to recall of the highest level of organization of prose as described by the content structure. In order to accomplish this, Meyer et al. (Note 2) had ninth graders (who varied from low- to high-reading ability) read and recall passages. Her major dependent variable was whether or not the highest level relationships from the passage were present in the subjects' recall. Meyer et al. (Note 2) found

that the rhetorical predicates located at the most superordinate level of the content structure of the passage were also found at the highest level in the high-ability subjects' protocols. This was not the case for the low-ability subjects. In this case, the authors propose that a production-mediation deficiency (Flavell, 1977) was responsbile for the lower performance of subjects with lower-reading ability. In other words, they speculate that identifying and using the highest level relationships in the content structure to organize one's recall is the optimal strategy. The low-ability subjects either could not identify those structures or could identify them but lacked the skill to use them. Interestingly enough, in another study (Meyer, Freedle, & Walker, Note 3), she provides data and arguments which support a somewhat different explanation.

Meyer et al. (Note 3) investigated the effects various high level rhetorical predicates have on recall of prose by different populations (graduate students and retired adults). They constructed a passage so that the highest level rhetorical proposition was either (1) a descriptive sequence or (2) a conflict between two views. Although two experiments are reported, the findings of the second are general enough for the present discussion. The subjects were a group of graduate students and a group of retired adults. Each subject from the group of graduate students listened to one of the versions of the passage while each subject from the group

of retired adults read one of the versions. Members of both groups wrote their recall immediately following their learning (reading or listening) task.

For the graduate students, recall was best when information was presented as a conflict between two views. For the retired adults, recall was best when the information was presented as a descriptive sequence. Meyer et al. (Note 3) invoke an explanation which is consistent with a "schemata-theoretic" view of comprehension (Adams & Collins, 1979). That is, the graduate students had a "schema" for contrasting viewpoint and the retired adults presumably had a "schema" for descriptive sequences. For the graduate students, the descriptive sequence produced significantly lower recall as did the contrastive views for the retired adults.

These studies (Meyer et al., Note 2; Meyer et al., Note 3) indicate that the highest level rhetorical proposition is not necessarily the most salient information for all individuals reading the same passage. The question arises as to which variables might affect the prominence of any given piece of information in a passage. For a discussion of this question we must re-examine the concept of a macrostructure as described by Kintsch (1979; Kintsch & van Dijk, 1978).

The macrostructure is characterized as the highest, most inclusive level of organization that a comprehender abstracts from prose. It may be variously thought of as a topic sentence, a title,

or a summary. For some of Meyer's subjects (Meyer, 1975; Meyer, et al., Note 2--good readers; Meyer et al., Note 3), the highest level rhetorical proposition in the content structure was roughly equivalent to the macrostructure. For others, (Meyer et al., Note 2--poor readers; Meyer et al., Note 3) this was not the case.

Kintsch and van Dijk (1978) have suggested several variables which may account for the different organizational schemes observed by Meyer in her work. Among those variables, and the one of interest in the present study, is the prior knowledge a comprehender has about the topic of a text. A great deal of research has been conducted in order to assess the effects of prior knowledge on comprehension. Much of it falls under a theoretical umbrella known as "schema theory." This view of comprehension is one of a primarily "top-down" or conceptually driven process in which our expectations and knowledge play the lead role in comprehension. The review of this literature constitutes the next section.

The Effects of Prior Knowledge on Prose Comprehension

The fact that what we know affects our efforts to learn new information is rather well accepted by the majority of society. Historically, psychologists and educators have long proposed that the existing knowledge of a subject influences both the amount and organization of what we learn (Ausubel, 1965; Bartlett, 1932). The parameters of this effect are currently being investigated

by individuals interested in prose comprehension. Two lines of research are to be found in the literature. One involves the case in which a subject is given a bias or perspective prior to reading or hearing some passage. Here, the subject is asked to report in some manner what is recollected from the passage (Anderson & Pichert, 1978; Pichert, Note 4; Pichert & Anderson, 1977). Typically, the experimenter is interested in selective recall of perspective-specific information.

The other line of research involves the case in which a subject's level of prior knowledge about a topic is the independent variable and recollection of a text about the topic is the dependent variable (Brown, Smiley, Day, Townsend, & Lawton, 1977; Pace, Note 5; Royer & Cable, 1975). In this case, the experimenter is usually interested in differences in the amount of information recollected from a text by subjects who have different levels of knowledge about the subject of the text.

In both cases, the subject is primed by either a prior expectancy or knowledge to abstract certain high-level structures from the text. The prediction is that given varying perspectives or levels of text-related knowledge, subjects will construct (or reconstruct) different macrostructures from the same information in a text. This difference in macrostructures is manifested in the subjects' memories for the prose.

The impact of prior knowledge on comprehension and recall of text varies from a general improvement in memory for all information to an increase in memory for prior knowledge-specific information contained within the text. One example of a general facilitation of memory for text has been presented by Royer and Cable (1975). They wanted to determine if the form of the prior knowledge made a difference in its effect. That is, were there differences in the effect of prior knowledge when it was presented in a concrete vs. an abstract form. The experimenters constructed two versions of each of the two passages. One version of each passage was written at a very concrete level and the other at a very abstract level. The topics of the passages were related so that each could provide background information for the other. The subjects read either the concrete or abstract version of one passage or a non-related control passage first. Then, the subjects read the opposing versions of the related passage and freely recalled the second passage.

The results indicate that for every possible combination of the version by passage presentation, the combination which most facilitated the recall of the second passage was the presentation of a concrete version for prior knowledge and the abstract version of the related passage for recall. Royer and Cable contend that by having concrete information about concepts in the first passage,

a "bridge" is established between the existing knowledge and the new information in the second, abstract passage (Haviland & Clark, 1974). Here, prior knowledge has been shown to have a non-specific, facilitative effect on the comprehension of new information for the college students participating in the Royer and Cable (1975) study.

This general, facilitative effect of prior knowledge is also present for young children. Pace (Note 5) has conducted a study which examined the effects of prior knowledge on young children's comprehension of stories. In this study, topics were selected so that they ranged from very familiar to her sample of kindergarteners, second, fourth, and sixth graders to topics which were totally unfamiliar to even the oldest children. Pace assessed the children's knowledge of the topics by asking them to provide as much information as possible about each topic. Adults were then asked to provide information on the same topics. The responses of the children were compared to those of the adults. For some topics, all subjects had similar knowledge. For others, the older subjects provided more information. Pace (Note 5) then constructed stories about each topic. The children then listened to each story twice. Following this, the children answered comprehension questions about the story. Although much of Pace's data did not meet the assumptions necessary for parametric analysis, there are two findings which are clearly significant.

First, for those passages written on topics unknown to all ages, the older subjects performed better than the younger subjects. In other words, the lack of prior knowledge had less of a debilitating effect for older subjects than for younger subjects. The other finding of interest is consistent with the findings of Royer and Cable (1975). That is, when Pace's subjects had a conceptual knowledge base related to the to-be-read story, their performance on a comprehension task was better than when they had no such knowledge. Even with the problems of data analysis in Pace's study, there is strong evidence that at all ages tested, prior knowledge facilitates comprehension of knowledge related material. When that knowledge is missing, however, older subjects are less affected than younger subjects.

Another method used to assess the effect of prior knowledge on comprehension is a perspective taking task. Passages are written so that they can be read from two (or more) perspectives. Subjects are then assigned to one of the perspectives and asked to read and recall the passage. Anderson and Pichert (1978; Pichert, Note 4; Pichert & Anderson, 1977) have conducted several studies using this method. In one of them (Pichert & Anderson, 1977), the authors were interested in whether or not subjects given one of two perspectives on a passage would: (1) show superior recall for perspective-specific information and (2) rate perspective-specific information in the passage as more important than non-perspective information.

In the first experiment, Pichert and Anderson asked subjects to rate the relative importance of idea units in a passage from one of two perspectives or with no perspective provided. Specifically, the subjects were asked to rate the importance of idea units of a passage about two boys playing hooky in a house. One group was directed to complete the task from the perspective of a burglar, another group from the perspective of a home buyer while a third group was asked to complete the task with no specific perspective in mind. If the importance of various idea units of the passage were independent of the subjects' perspectives, the intercorrelation of the various perspective-groups' judgments should be high. If, however, the judgments about what is more important depended upon the subjects' perspectives, the intercorrelation should be low. Pichert and Anderson's data were consistent with the second prediction. That is, the ratings of what was important in the passage was different for different perspectives. In other words, subjects selected "perspective-specific" information as important. The correlation between importance ratings across perspectives was relatively low (mean Kendall's Tau = .11).

In a second experiment, Pichert and Anderson (1977) had subjects read and recall the passage from Experiment 1, again taking one of two perspectives. The question of interest here is whether or not subjects' recall would be influenced by the perspective taken during reading. More concretely, does the particular perspective taken

determine what is important and subsequently influence recall? Their data indicate that the particular perspective does affect the material learned and rememberd from text. Further, Pichert and Anderson (1977) state that although what is important in a text is remembered better than unimportant information, "It is an idea's significance in terms of a given perspective that influenced whether it was learned and independently whether it was recalled" (p. 314). They contend that it is "inappropriate" to consider the importance of certain information in a text without considering a reader's perspective. In these experiments, the reader's implicit knowledge about the given perspective guided comprehension and retrieval. This idea is entirely consistent with Kintsch and van Dijk's (1978) idea that the knowledge of a topic and the goal for reading a text guide the construction of the macrostructure.

One of the major conclusions of Pichert and Anderson's (1977) study is that the hierarchy of information in a text cannot be determined by consideration of the text alone. They contend that the relative importance of information in prose is dependent upon the perspective and knowledge of the reader. This is in contrast with Meyer's (1975) conclusion that a text has a natural, hierarchical structure of information. One explanation for the difference in results is that Meyer (1975) treated subjects' perspectives and knowledge as essentially a random variable. Another explanation is that there was a near total lack of prior knowledge by Meyer's

subjects. This would make them quite susceptible to the effects of text variables. In this situation, her subjects performed as predicted by recalling more of the top level information in the hierarchy than the low level information. Although Pichert and Anderson (1977) used an atheoretical approach to identify levels of importance (Johnson, 1971), their findings suggest that by systematic variation of perspective (or conceivably prior knowledge), specific predictions about the subject's macrostructure of a passage can be made.

In a similar study conducted with children, Brown, et al. (1977) obtained results consistent with the general interpretations of Pichert and Anderson (1977). That is, biasing orientations (either different perspectives or prior knowledge) affect what is recalled from prose. This approach combines the perspective and prior knowledge components. In the Brown et al. (1977) study, two experiments were conducted. The first involved merely instructing children in third, fifth, and seventh grade to read a story with one of two biases. Brown et al. (1977) had the children judge sentences, one-at-a-time, as to whether or not the sentences were old (from the text) or new. In these recognition tasks, children at all ages were able to accurately distinguish between statements totally unrelated to the orientation and statements from the story. It was quite different for statements which did not appear in the story but were very consistent with the orientation provided. In this case, the

children were not able to reliably distinguish between orientation-consistent statements and statements from the text. No age related differences were detected on this task.

A second recognition task was employed by Brown et al. (1977) to further investigate this phenomenon. Here, the foil statement reflecting the bias was presented simultaneously with a sentence taken from the story. The children's task was to select the sentence which they felt was from the text. Here, older children's judgments were more accurate than the younger children's.

In the second experiment conducted by Brown et al. (1977), children in second, fourth, and sixth grades were asked to read and recall an ambiguous passage. The children were divided into three groups at each grade. Two of the groups were provided "orientation information which disambiguated the passage and one group received orientation information unrelated to the passage. One week after receiving the orientation, each child listened to the passage, freely recalled it, and answered probe questions about the passage.

The analysis of recall data indicated that older children recalled more of the passage than younger children and those children receiving relevant orientation recalled more than those receiving the irrelevant orientation. The recall data are interpreted as reflecting the often found increase in performance as age increases and, more important to the present effort, the general facilitative effect of prior knowledge.

Brown et al. (1977) also analyzed the recall data for information considered to be intrusive. They found that overall, the number of intrusions was quite low and did not differ across age. But, when the intrusions were divided into those consistent with orientation versus those which were not consistent, the older children produced more consistent intrusions than the younger ones.

The second dependent measure in the Brown et al. (1977) study was subjects' performances on a series of 10 probe questions. Six questions which addressed "filler" information about the character and four "critical probe" questions which addressed information available from the orientation information were asked of each child. Of interest is the performance on the "critical probe" questions. These questions addressed information which required an inference between the target passage and the orientation information. For these questions, 80% of all responses made by the children (across grades) were judged with high confidence to have been from the target passage when in fact the information was not available from the passage.

Beyond the obvious conclusion that older subjects perform better than younger subjects, the effects of orienting information were quite apparent in Brown et al. (1977). That is, if a subject has appropriate information to begin with, performance on a learning task of new but related information is enhanced. Further,

for the ages examined by Brown et al. (1977) (second, fourth, and sixth grades), subjects were unable to discriminate between information acquired from the passage and information related to the orientation information.

Another study which bears on this topic was recently completed by Pichert (Note 4). In this study, he asked children in the third, fifth, and seventh grades to listen to the story used by Anderson and Pichert (1978) and freely recall it following an interpolated task. The children from each grade were divided into three groups prior to hearing the story. One group served as a control and simply heard and recalled the story. The other two groups were each given one of two perspectives (either a safety expert or a burglar) on the story. Pichert had previously rated the information in the story on its relevance to each perspective. He reasoned that the subjects' perspective would facilitate recall of perspective appropriate information. In the free recall task, this was not the case. That is, the recall of the passage by all groups was best predicted by the ratings of the no-perspective control group. In this case, a perspective taking task was not sufficient to alter the subjects' recall of the story.

Two problems which account for Pichert's (Note 4) findings are worthy of note. First, his raters, rated the relevance of story content to a perspective, not the story theme. That is, text structure was not considered by the raters in their judgments.

Second, there was no pre-assessment to determine if the perspective relevant information for the two perspectives was distinct and independent as well as familiar to the subject population. Although Pichert's (Note 4) findings conflict with others (Brown et al., 1977), the case can still be made that prior knowledge and biasing information affect children's comprehension by children.

Based on the research reviewed in this section, a reasonable conclusion is that prior knowledge affects comprehension in a generally positive manner. Historically, the subject's background has been considered an important variable in studies of comprehension (Bartlett, 1932). More recently, researchers have attempted to obtain more specific information about the parameters of this variable but as stated by Pace (Note 5), ". . . investigators have lacked theoretically interesting and empirically useful ways to characterize people's existing knowledge, as well as appropriate analytical tools to describe the structure and content of texts" (p. 2). At this time, a more positive statement can be made regarding this problem. With the recent advances in text linguistics and discourse analysis (Grimes, 1975; Kintsch, 1974) and methodologies for assessing the effect of prior knowledge (Brown, et al., 197?; Royer & Cable, 1975), attempts can be made to investigate the relationship between text structure and prior knowledge. The next section provides the rationale for such an attempt.

The Interaction of Text Characteristics and Prior Knowledge on Comprehension: Rationale for the Dissertation Study

An information processing model (Bobrow & Norman, 1975) and a cognitive developmental theory (Piaget, 1952) were discussed earlier. Both characterized change in cognitive structures as being due to the interaction of existing knowledge and new, incoming information from the environment. The focus of this paper has been on what information the individual can acquire from prose. Research was presented which explicated certain components of texts which have been shown to affect comprehension--cohesion of information and the level of information in the hierarchy of text. These components reflect those characteristics of prose which yield consistent performance across disparate populations (cohesion and hierarchy by argument repetition) as well as those which have yielded differential affects across disparate populations (cohesion and hierarchy by logical relationships).

Further, research conducted to assess the effects of prior knowledge on comprehension was discussed and several interesting findings were noted. First, the studies indicated that for all ages a conceptual knowledge base about a topic facilitates comprehension of prose written about that topic. The other finding, suggested by the Brown et al. (1977) study, was that older subjects (seventh graders) appear to be less biased by prior knowledge in learning from prose than younger ones (third graders). That

is, older subjects can discriminate between information from the text and background knowledge about the topic of the text. Younger subjects are not as proficient at this task. In addition, intrusions in the recalls of older subjects are relevant to the topic and add to the organization of the protocol. Younger subjects showed no such tendency.

The question regarding how prior knowledge might affect the subjects' recall with regard to the structure of the text is unanswered. Brown et al. (1977) have suggested that at least for older subjects the intrusion of prior knowledge into their recall added to the organization of the text. This is consistent with the results obtained in a unique study conducted by Lewis (Note 6).

Lewis utilized Kintsch's (1974) system for parsing passages into a series of interrelated propositions to determine the structure of the stimulus passages in the study. In order to block his subjects on prior knowledge regarding the topics of the passages, Lewis gave them a pretest on the topic of each passage. The subjects were then blocked into high, medium and low knowledge groups and read the stimulus passages. After reading each passage, the subjects sorted paragraphs from the passage into groups that "went together best." Lewis found that as a subjects' degree of prior knowledge increased, the more highly organized their sorts became. Further, an interaction of text structure (cohesion of the text) and prior knowledge was significant. When the text

was highly organized, the subjects with high prior knowledge sorted the paragraphs into more highly organized units than those subjects in the low knowledge group. When the text was not as organized, this difference between the knowlege groups was negligible.

One conclusion which these data support is that when the text is well organized, prior knowledge of the topic has a facilitative influence on the organization of information from the text. If the text is poorly organized, prior knowledge does not overcome problems presented by a lack of cohesion. Thus, the Lewis study supports a position in which both the structure of a text and prior knowledge affect the organization of information in prose.

While the Lewis (Note 6) study does suggest that text structure and prior knowledge affect performance on a sorting task, it does not provide information about how these variables affect recall when they are considered simultaneously. If a highly organized body of knowledge is more easily recalled than one poorly organized, then recall for the high knowledge, well organized groups should be greater than for any other group. Again this is speculation.

With regard to any age related differences in this phenomena, little has been said. What can be stated with regard to this interaction, based upon the literature reviewed? Unfortunately, the research existing on age related differences in the effects of prior knowledge on comprehension has dealt almost exclusively with narrative prose and not considered text structure in a theoretical

manner. Further, the research on the effects of text structure on comprehension has virtually ignored the prior knowledge of the subject.

The present study seeks to resolve these problems by examining the interaction of prior knowledge and text structure on the spontaneous accessibility and availability of information in text. The accessibility is measured by free recall and the availability by probed recall. From a text structure perspective, it would be expected that information from the highest levels will be remembered better than information from the lowest. However, one's prior knowledge can nullify this effect if it is related to concepts which appear at a relatively low level in the text. With such prior knowledge, one's recall of lower level information would be better than without such knowledge.

Performance on probe questions has been shown to be generally facilitated by prior knowledge (Pace, Note 5). This being the case, the group receiving prior knowledge will generally do better on probe questions than a group receiving no such knowledge.

Olson and Nickerson (Note 7) have suggested that as children progress through the school years, they learn to become more text dependent. That is, they become more likely to constrain their responses on comprehension tasks to information within the text. Younger subjects then should be more affected by their prior knowledge than older subjects. This leads to a grade/age related

hypothesis. That is, the effects regarding differential recall patterns should be more pronounced for a younger population than for an older one. For the present study, the younger sample of subjects is drawn from fourth grade classes. By this grade, children have begun to encounter non-story texts in school and should be comfortable with a wider range of topics of discourse. The older sample is drawn from eighth grade classes. By this point in their education, these individuals have had experience at reading texts for testing and as Olson and Nickerson (Note 7) claim, should have learned to confine their performance to information in the text.

The dependent measures to be employed are: (1) the number of propositions at each level of the hierarchy of a given text, recalled by each subject; (2) the organization of information from the text included in the recall of each subject (as measured by the Kendall tau statistic); (3) the number and type of extra-text intrusions of information not from the text into each subject's recall; and (4) the number of subjects providing correct answers to a series of probe questions about the to-be-remembered text.

The hypotheses regarding each dependent measure are:

(1) Recall. If prior knowledge affects only the amount of recall, then there should be a main effect of knowledge condition, with the effects of level in hierarchy on recall being similar for both knowledge groups. If prior knowledge also affects what

is recalled and how it is organized, then the various group will recall different numbers of propositions at various levels. Based on the findings of Brown et al. (1975), older subjects seem to maintain the integrity of the text cohesion when prior knowledge is imported into recalls. Younger subjects did not do this. Further, when adult subjects read a well organized text and have a high level of knowledge about the topic of the text, their subjective organization of the text is better than subjects who have little knowledge of the topic (Lewis, Note 6).

The following hypotheses are offered: Hypothesis 1(a). A group receiving prior knowledge about a passage will recall more information related to that knowledge than will control groups receiving no such knowledge. This will be manifested in recall at the levels containing concepts related to the prior knowledge. At those levels, there will be increased recall for the prior knowledge group relative to a group receiving no related knowledge. Hypothesis 1(b). This effect will be present for the younger subjects but not the older.

(2) Organization of Recall. Based upon the arguments presented for the hypothesis concerning recall, a hypothesis can be stated for the organization of recall when compared to the organization of the text itself. Hypothesis 2. For the fourth graders, the order of information appearing in recall will be more reflective of the order of information in the text for the

unrelated knowledge group than for the prior knowledge group. No difference in organization will occur between the unrelated knowledge group and the no knowledge group. No differences will occur between the groups of older subjects.

(3) Intrusions. Hypothesis 3. Again, based upon the Brown et al. (1977) study, intrusions found in the older subjects' recalls will maintain the high level of organization or cohesion of the stimulus text more so than those intrusions found in younger subjects' recalls.

(4) Probe Questions. Hypothesis 4. Based on Pace's (Note 5) findings, any advantage in providng correct answers to the questions will belong to the prior knowledge group. Further, Pace found less of an advantage of prior knowledge with older subjects. For the present study, younger subjects in the prior knowledge group will out perform their peers in the unrelated knowledge group. Older subjects in the various groups will show little if any difference in performance.

II

METHOD

Subjects

There were 45 children in each of fourth and eighth grades. Each was drawn from a school district in a rural, southeastern Wisconsin town. All children were volunteers who had received written parental consent to participate and were in the "normal" range as judged by their teachers and performance on standardized achievement tests. The average ages were 9 years 6 months (SD. 5 mos.) and 13 years 6 months (SD. 5 mos.) for the two grades, respectively. At each grade, 20 males and 25 females were tested.

Design

Each child heard and recalled a passage following one of three kinds of experiences--prior knowledge, unrelated knowledge, or no knowledge. At each grade, there were an equal number of subjects randomly assigned to each group (15). This resulted in a 3(knowledge condition) by 2(grade) between subjects design.

Treatments

In the prior knowledge treatment, the subjects heard a passage related to certain information in a target passage. In the unrelated

knowledge treatment, the subjects heard a passage unrelated to the target passage. In the third treatment, the subjects received no knowledge. Subjects in the two prior knowledge treatment conditions heard the target passage and completed memory tasks 24 hours after being exposed to the prior knowledge. Subjects in the no knowledge condition participated in the target passage tasks.

Assessment of Recall

Two memory tasks were used to assess memory for information in the target passage. Free recall of the target passage was used to measure the accessibility of information. Three measures were obtained from the recall: (1) amount of recall, (2) organization of recall, and (3) intrusions in recall. In order to measure the availability of information from the target passage, each subject was asked a series of eight probe questions.

Materials

The materials used in the present study consisted of: (1) the target passage; (2) the knowledge base, a passage containing information related to the target passage; (3) a knowledge base unrelated to the target passage; and (4) a set of questions for the target passage, the knowledge base, and the unrelated knowledge base. All materials were used in a pilot study to insure that the level of difficulty was appropriate for the age range of the subjects in

the study and to insure that the information was novel to the children. The target passage, knowledge base, unrelated knowledge base and appropriate questions appear in Appendices A-F, respectively.

The target passage and corresponding knowledge base were written so that they were related in the following manner. The knowledge base described the growth of a small midwestern town and included information about its school. The target passage described that town's demise. A secondary cause of the demise was the school. Additional information about the school was included in the target passage. The unrelated knowledge base was about a desert region and had no connection to either of the two texts. All texts were selected to assure that they would interest the children to be tested. The target passage and related knowledge base were consistent with the children's social studies curriculum and provided information about an interesting episode in their state's history.

The questions for the respective knowledge bases were written so that each major subtopic of the bases was represented. The probe questions written for the target passage were written to tap specific information. Questions 2, 3, and 8 were written so that there was a correct answer(s) from the target passage. Questions 1, 4, 5, 6, and 7 were written so that there were several plausible answers.

Analysis of the target passage proceeded as follows. First the passage was analyzed into its micropropositions following

Kintsch (1974; see also Turner & Greene, Note 1). Following this, the hierarchical analysis of the rhetorical propositions was accomplished using the rhetorical predicates identified by Grimes (1975) in his content structure. The resulting analysis yielded 82 micropropositions and 15 rhetorical propositions distributed across five levels of subordination (e.g., Micropropositions 1-10 appear at the highest level and are component parts of rhetorical proposition I: Micropropositions 11 and 36-40 occur at Level 2 and are component parts of rhetorical propositions II and VII, respectively; and so on). Appendix G shows the analysis of the target passage into the text structure. Table 3 shows the number of micropropositions and rhetorical propositions occurring at each level in the passage. The underlined terms are rhetorical predicates which serve as descriptors for the relationships between rhetorical propositions (Grimes, 1975). See Table 2 for a complete list of the rhetorical predicates following Meyer's (1975) definition.

The target passage was written so that information pertaining to the related knowledge base appeared at Levels 3, 4, and 5, the three lowest levels in the hierarchy (Micropropositions 64-70; 45-60; 52-59; and 60-63). Additionally, information about the present condition of the town and the associated causes appeared at those levels (Micropropositions 71-74; 75-76; 77-82).

Table 3

The Number of Micropropositions and Rhetorical Propositions at Each Level in the Content Structure Hierarchy of the Target Passage

	Level				
	1	2	3	4	5
Micropropositions	10	6	25	23	18
Rhetorical Propositions	1	2	5	4	3

Procedure

One group was the prior knowledge group. The other two were controls. Each of the subjects in the prior knowledge group saw the experimenter on each of two consecutive days. On the first day, each subject listened to a taped version of the related knowledge base. The tape was stopped at various intervals and the subject was asked an appropriate mastery question. This continued through the end of the tape at which time the subject was asked to again answer all of the appropriate mastery questions. If a subject failed to answer any (one or more) question(s), the tape was again played and the questions asked. Any subject who did not master the material by the third playing of the tape was dismissed and did not participate further in the study. Only two subjects in the fourth grade failed to reach criterion. On the second day, each subject listened to a recording of the target passage. Following the tape, each subject was instructed to "Tell as much as possible as you remember from the tape you just heard. Try to remember exactly, but if you can't remember exactly use your own words." The recall of each subject was recorded. When the subject hesitated, a prompt--"Can you remember any more?" was given. This continued until the subject said no more could be remembered. Following recall, the probe questions for the target passage were asked and responses recorded.

Protocol Analysis

The responses of each subject were transcribed and the free recall analyzed in the same manner as the text of the target passage. The micropropositions which appeared in each protocol were compared to those in the text analysis. A scoring criterion which allowed a recalled proposition to be scored as correct if it was semantically equivalent was adopted. The level of the text structure in which a correctly recalled microproposition appeared was noted.

Interrater agreement for the protocol analysis was obtained by having an independent rater analyze three protocols from each group for a total of 18 protocols. The independent rater was a graduate student who is familiar with Kintsch's microstructure analysis system, but blind to the group and grade of the subjects. The analysis of each protocol scored by the independent rater was compared to the analyses of that protocol done by the author. Propositions which occurred in both protocols were scored as an agreement. Using this method, an interrater agreement of 93% was obtained. All disagreements were resolved by discussion.

III

RESULTS

Recall

Frequency of recall analysis. Two planned contrasts were conducted at each of the five levels in the text structure. The contrasts of interest were: (1) prior knowledge vs. unrelated knowledge group, and (2) unrelated knowledge vs. no knowledge group. The dependent measure was the number of propositions recalled at each level.

Two series of planned comparisons were conducted at each of the five levels of subordination in the text structure for each grade level separately. The first series of comparisons was conducted to detect a practice effect. That is, the no knowledge control group should consistently perform more poorly than the unrelated knowledge group at all five levels in the hierarchy. In order to test this, one-tailed tests were conducted at each level in the hierarchy between the no knowledge control group and the unrelated knowledge group with the hypothesis:

H_1: Unrelated knowledge group > no knowledge control group

The second series of tests was conducted between the prior knowledge group and the unrelated knowledge group. Since the hypothesis regarding the recall differences between these groups was interactive, the direction of the tests at certain levels was different. For

the highest levels (Levels 1 and 2), the recall of the unrelated knowledge group should exceed that of the prior knowledge group. For the lower three levels (Levels 3, 4, and 5), the recall of the prior knowledge group should exceed that of the unrelated knowledge group. It may be recalled that information related to the prior knowledge passage occurred at these levels. The specific hypotheses can be stated for the levels of subordination in the text structure.

Levels 1 and 2: H_1: Unrelated knowledge group > Prior knowledge group

Levels 3, 4, and 5: H_1: Prior knowledge group > Unrelated knowledge group

Since the family-wise alpha for a two-way design was set at .15, each of the 10 tests was performed at the .015 level using Dunn's procedure (Kirk, 1968). The hypothesis of differential effects is limited to the fourth-grade data. Although the same tests were conducted on the eighth grade data, the overall hypothesis of this study is that the differential effect will not occur for these subjects. No direct, statistical comparisons were made between grades due to the often found difference in variability of performance. Additionally, a test for main effects of age seemed trivial since most studies have provided consistent findings that older subjects remember more than younger subjects. Although the variability of the two grade levels is similar, the more powerful design, planned comparisons at each grade, was adopted. All between grade comparisons were descriptive in nature.

A summary of the recall data appears in Table 4. The first series of comparisons conducted on the fourth grade data was conducted to determine if there was a practice effect evident between the unrelated knowledge group and the no knowledge group. To be brief, no significant differences were detected between these two groups at the fourth grade level. That is, there were no practice effects.

For the second series of comparisons (prior knowledge vs. unrelated knowledge) at the fourth grade, the prediction was, that at the most superordinate levels, the prior knowledge group would not have an advantage over the unrelated knowledge group, but at the lower levels they would. Any advantage at the highest levels would be in favor of the unrelated knowledge group. At the highest level (Level 1, Table 4), the difference in recall between the prior knowledge group and the unrelated knowledge group was significant [$t(42) = 2.30$, $MS_E = .86$]. That is, the prior knowledge group recalled significantly less than the unrelated knowledge group. For Levels 2, 3, and 4 in the text hierarchy, there were no significant differences between the prior knowledge group and the unrelated knowledge group. At Level 5, however, the prior knowledge group recalled significantly more propositions than the unrelated knowledge group [$t(42) = 2.30$, $MS_E = 7.28$].

These data indicate that prior knowledge had a specific effect on recall. The subjects receiving unrelated prior knowledge had an advantage over the subjects in the prior knowledge group in recall

Table 4

Means and Standard Deviations for the Number of Micropropositions Recalled by the Prior Knowledge (PK), Unrelated Knowledge (UK) and No Knowledge (NK) Groups at Each Level in the Content Structure Hierarchy by Subjects in the Fourth and Eighth Grades

Grade	Group		Level				
			1	2	3	4	5
4th	PK	$\bar{X}$	.47*	1.20	3.20	2.93	4.67**
		SD	1.12	1.37	2.68	2.12	3.06
	UK	$\bar{X}$	1.73	1.60	3.47	2.40	1.87
		SD	1.71	1.55	3.18	2.77	1.76
	NK	$\bar{X}$	1.60	.93	2.93	2.67	2.73
		SD	1.04	1.39	2.84	1.72	3.06
8th	PK	$\bar{X}$	1.73*	2.20	6.07	6.87	4.87
		SD	1.71	1.86	3.06	3.04	2.77
	UK	$\bar{X}$	3.20	2.60***	4.93	5.67	4.93
		SD	1.78	1.30	1.86	3.18	3.67
	NK	$\bar{X}$	1.80	1.27	5.20	4.27	3.20
		SD	1.74	1.22	3.14	3.81	2.14

* = PK < UK, $p < .015$

** = PK > UK, $p < .015$

*** = UK > NK, $p < .015$

(n = 15 per cell)

of information high in the text hierarchy. The prior knowledge group on the other hand had an advantage over the unrelated knowledge group. That is, they recalled prior knowledge-related information in the text, even though that information was low in the text hierarchy.

For the eighth grade data, when the contrasts between the unrelated knowledge group and the no knowledge group were made, the only contrast reaching significance was at Level 2 (see Table 4). At Level 2 in the text hierarchy, the unrelated knowledge group recalled more than the no knowledge group [$t(42) = 2.30$, $MS_E = 2.20$]. No other contrasts reached significance.

At the eighth grade, the effect of prior knowledge was not hypothesized to be significant at any level. When the second series of contrasts was conducted (prior knowledge group vs. the unrelated knowledge group), the difference in recall at Level 1 (see Table 4) was found to be significant [$t(42) = 2.30$, $MS_E = 3.04$]. As with the fourth grade group, the unrelated knowledge group recalled more than the prior knowledge group. No other contrasts between the prior knowledge group and the unrelated knowledge group reached significance. Although the unrelated knowledge group recalled more propositions at the highest level in the text hierarchy, the data are not consistent with the overall hypothesized effect of prior knowledge. They are more consistent with the hypothesized lack of specific effect of prior knowledge at this grade level.

By collapsing across levels in text, the overall performance of the three groups at each grade can be determined. Table 5 provides the mean number of propositions recalled by each group at each grade. Although not relevant to the specific hypotheses of the present study, a one-way analysis of variance was conducted separately at each grade level for descriptive purposes. The performance of the three groups at the fourth-grade level did not differ. At the eighth-grade level, the mean number of propositions recalled by the various groups differed significantly ($F = 4.82$, $df = 2,43$, $p < .05$). It is attributable to the poor performance of the no knowledge group relative to the others and follows from the hypothesis that the practice afforded the unrelated knowledge group would facilitate recall. The effect is a general effect, and not specific to a level in the text structure.

Ranks of proportionate recall: An alternative analysis. An alternative means of examining recall is to consider the proportion of total number of propositions recalled at each level by each subject. (Proportions have the advantage of allowing one to draw comparisons across levels in the hierarchy, even when each level has a different number of text propositions.) The proportions were rank ordered from highest to lowest (1-5). A test of concordance among rank orders (Kendall's W) was conducted on the mean ranks for each group at each grade. At the fourth grade, the rank orderings among the various groups were different ($W = .11$) and

Table 5

Mean and Standard Deviation for the Total Number of Propositions Recalled by Fourth- and Eighth-Grade Subjects in Prior Knowledge (PK), Unrelated Knowledge (UK) or No Knowledge (NK) Groups

		Group		
Grade		PK	UK	NK
Fourth	$\bar{X}$	12.47	11.07	10.87
	SD	4.58	4.53	4.90
Eighth	*$\bar{X}$	21.73	21.33	15.73
	SD	4.42	6.16	7.08

*One-way ANOVA indicated an overall difference ($F = 4.82$, $df = 2/43$, $p < .05$) between groups.

($n = 15$ per cell)

negatively correlated with each other ($\bar{r}_s = -.34$). For the eighth grade, the groups' rank orders were more similar (W = .52), and positively correlated with each other ($\bar{r}_s = .28$). This analysis yielded findings similar to the analysis of the number of propositions recalled by each group at each level in the text structure. That is, the fourth graders showed differential recall at the various levels while the eighth graders did not.

Probe Questions

Responses to each probe question were first placed into one of three categories: (1) correct, (2) incorrect, and (3) no response. Z tests of differences between percentages of subjects in each group making correct responses within grade were conducted. The tests were two-tailed since no directional hypotheses were stated. Descriptive information about the types of answers given to specific questions by each group will be presented.

Table 6 shows the percentage of subjects offering correct responses to each of the probe questions. For the fourth graders, a greater percentage of the subjects in the prior knowledge group than the unrelated knowledge group provided correct responses to Questions 2, 3, 6, and 8 ($z = 2.60, 2.40, 2.43, 3.28$, respectively, $p < .05$ in all cases). No differences were observed between the unrelated knowledge group and the no knowledge group. At the eighth grade, the only difference occurred in for Question 2. A greater proportion of subjects in the prior knowledge group answered

Table 6

The Percentage and Frequency of Subjects from the Fourth and Eighth Grades Who Answered Probe Questions Correctly in the Prior Knowledge (PK), Unrelated Knowledge (UK), or No Knowledge (NK) Group

Question	Grade					
	Fourth Group			Eighth Group		
	PK	UK	NK	PK	UK	NK
1	100(15)	80(12)	87(13)	100(15)	87(13)	87(13)
2	80(12)*	33(5)	13(2)	93(14)*	37(7)	47(7)
3	100(15)*	57(10)	87(13)	100(15)	100(15)	100(15)
4	87(13)	73(11)	73(11)	100(15)	87(13)	87(13)
5	67(10)	73(11)	93(14)	93(14)	93(14)	73(11)
6	93(14)*	53(8)	60(9)	100(15)	80(12)	80(12)
7	80(12)	87(13)	93(14)	100(15)	93(14)	67(10)
8	100(15)*	47(7)	60(9)	100(15)	80(12)	87(13)

*Prior knowledge different from unrelated knowledge, $p < .05$.

Question 2 correctly than did the unrelated knowledge group ($Z = 2.75$, $p < .05$). As in the fourth grade, no differences were observed between the unrelated knowledge group and the no knowledge group.

The quality of answers to Questions 1, 3, 5, and 6 provide additional data regarding group differences within grade. For Question 1 (How was the town different?), 53% of the fourth graders and 67% of the eighth graders in the prior knowledge group included a reference to the school in their answers--a plausible inference given the contents of the target passage by itself. Reference to the school in the answers to Question 1 appeared in 20% and 13% of the responses of the unrelated knowledge group in the fourth and eighth graders, respectively and 7% and 33% of the responses of the no knowledge group at fourth and eighth grade, respectively.

For Question 3 (For what was the building in town used?), 47% of the prior knowledge group in the fourth grade referred to the school in their answers. The other two groups in the fourth grade each referred to the school 20% of the time. At the eighth grade, the prior knowledge group referred to the school 53% of the time, the unrelated knowledge group 13% of the time, and the no knowledge group 33% of the time. Again, although reference to the school was a plausible answer, the prior knowledge group at each grade seemed more inclined to include it in their answer. Additionally, the prior knowledge group referred to the building's use as a church 53%

of the time in both the fourth and eighth grades. No one in the unrelated knowledge group at either grade did so and only one subject in the no knowledge group at both grades did so. This information was available only in the related knowledge base.

The responses to Question 5 (Why did the youngsters want better jobs?) also provide interesting data. Although not mentioned in the passage, references to the need for more money appeared in the responses at both grade levels. For the prior knowledge, unrelated knowledge, and no knowledge groups at the fourth grade, 13%, 33%, and 47% of the subjects included references to money in their responses respectively. For the eighth grade, the proportions were 7%, 47%, and 60%, respectively, for the prior knowledge, unrelated knowledge, and no knowledge groups. Although all groups at both grades had a high level of correct responses to this question, the groups with no related prior knowledge seemed to include more references to a non-text (although plausible) answer.

Question 6 (What was unusual about the school?) also elicited answers which were non-text based. That is, 40% of the subjects in the prior knowledge group at both grades referred to the fact that both blacks and whites attended the school. This response was based on the prior knowledge base. No one in the other groups included such a response in their answer.

For performance on probe questions, the difference between grades in the effects of prior knowledge observed in the recall measure are again observed. That is, with the exception of perform-

ance on a single question, no differences were observed among the groups at the eighth grade level. Several differences in performance on questions were observed at the fourth grade level. These differences are in favor of the prior knowledge group. Prior knowledge had a general, facilitative effect for the fourth graders' performance and apparently made little or no difference to the eighth graders.

ntrusions

The hypothesis as stated regarding intrusions was that the intrusion of the older subjects would be more consistent with the information contained in the text than those of the younger subjects. Table 7 shows the number of subjects whose recall included intrusions of information not in the text. As can be seen, the overall number of subjects who had intrusions is low in certain groups (prior knowledge--eighth grade and unrelated knowledge--fourth grade). This being the case, between group comparisons will not be made.

For the eighth-grade data, seven of the subjects' intrusions included errors in the name of the town (e.g., Iron Ridge or Platteville instead of Pleasant Ridge). Five subjects incorrectly stated that the quality of the school or education was poor and one subject realled that the town provided many (instead of few) jobs. It is interesting to note that all "intrusions" at the eighth grade were essentially recall of incorrect information and not intrusions of unrelated or additional information.

Table 7

Number of Subjects in Prior Knowledge (PK), Unrelated Knowledge (UK), and No Knowledge (NK) Groups Who Displayed Intrusions of Non-Text Information in Their Recalls

	Group		
Grade	PK	UK	NK
Fourth	5 (n = 15)	2 (n = 15)	8 (n = 15)
Eighth	1 (n = 15)	5 (n = 15)	6 (n = 15)

At the fourth-grade level, three subjects included errors in the town's name in their recall. One subject's recall included information from the prior knowledge base (the subject was in the prior knowledge group). The remainder of the intrusions consisted of incorrect information about the town (e.g., It was large; They built more buildings; It had one factory).

It is interesting to note that virtually all subjects (except the one subject in the fourth-grade prior knowledge group) who produced intrusions at recall did so in the form of "incorrect" information. This is consistent across grades and groups.

Organization of Recall

Since the hypothesized effect of prior knowledge is at the higher level organization or macrostructure of the text, the organization of the recall of the macrostructure by each subject was compared to the high level organization of the text. This structure is represented by the 15 high-level text units in Appendix G. A Kendall's tau statistic was used to compare the organization of each subject's protocol with that of the text. The mean Kendall tau value for subjects at each grade in each group are shown in Table 8. A one-way analysis of variance was conducted at each grade to determine if the mean Kendall tau value differed across groups. Simply put, no difference in the mean value of Kendall's tau was observed at either grade. That is, no difference in the degree of concordance between subjects' protocols and the text was observed between any groups within grade.

Table 8

Means and Standard Deviations for the Kendall tau Values for Recall by Fourth and Eighth Graders in the Prior Knowledge (PK), Unrelated Knowledge (UK) and No Knowledge (NK) Groups

Grade	Group					
	PK		UK		NK	
	Mean	SD	Mean	SD	Mean	SD
Fourth	.22	.46	.46	.53	.48	.60
Eighth	.55	.27	.71	.24	.70	.33

IV

DISCUSSION AND CONCLUSIONS

Limitations of the Study

There are two limitations in generalizing the findings of the present study. One is the use of only one passage as the stimulus. Although prior knowledge was manipulated, it is conceivable that with a passage of different style or content, the effects observed here could be altered. Clearly, these results are in need of replication with other passages of varying content and style if a broad generalization is to be made. The second limitation concerns the nature of the manipulation. The prior knowledge was related to information low in the passage hierarchy. Whether a difference in recall between knowledge conditions would be observed, when the prior information is related to other levels in the text remain an open question. Again, further study is necessary.

There is also a potential concern with "experimental-bias." If an experimenter blind to the particular knowledge condition had administered the target passage and memory tasks on the second day, a possible source of bias could have been avoided. While this limitation may present a problem to an assessment of a "pure" effect of prior knowledge, it is in fact the way in which most instruction occurs. That is, the same teacher provides day-to-day

instruction in the same room with knowledge of students' abilities and prior knowledge.

Age related differences were observed in the various measures obtained here. Before a strong affirmation of Olson and Nickerson's (Note 7) hypothesis is stated, research must be conducted with a more complete age sample. The seemingly drastic change in performance between the two grades must be examined at the intervening ages in order to establish a linear change with age.

Major Findings

Previous research and theory related to prose comprehension and recall suggested that both the structure of a text and prior knowledge about the text affect what is remembered (Kintsch & van Dijk, 1978). Two memory tasks were used to assess the interactive effects of text structure and prior knowledge on recall at two age levels, fourth and eighth graders. For one task, free recall of the passage, the measures were: the amount of recall, the organization of recall, and intrusion of information from sources other than the text. The other task consisted of a series of eight probe questions about the passage.

Amount Recalled

It was predicted that the recall of a text by younger subjects with a text-related knowledge base would differ from the recall of

the text by same age subjects who possessed no such knowledge base. Older subjects were predicted to show no such effect.

For the younger subjects, those who received a related prior knowledge base before hearing and recalling a target passage recalled qualitatively different information than subjects receiving no such information. A less consistent pattern of qualitative differences appeared for the older subjects. The prediction based on a text-structure approach was that information at the most superordinate level in a text would be best recalled while information at more subordinate levels would not be recalled as well. The prediction based on a prior knowledge effect was that information related to the knowledge base would be best recalled, no matter where it appeared in the structure of the text. Prior knowledge was purposefully structured so as to be related to low level (in a hierarchical sense) information in the target passage. This led to an interactive hypothesis. That is, at the highest level of superordination, subjects who had specific prior knowledge would recall more information than those subjects whose prior knowledge might "orient" them to information at a lower level of subordination. On the other hand, the group who received the prior knowledge should recall more information at the level of subordination containing information related to the prior knowledge. And, if that level is low in the text hierarchy, the prior knowledge group should recall more information than a group with no prior

knowledge. The principal findings of this study support such predictions.

Planned comparisons at the fourth grade between the prior knowledge group's recall and the unrelated knowlede group's recall at each level in the text hierarchy was conducted. These tests indicated that at the highest level in the hierarchy the unrelated knowledge group recalled significantly more information than did the prior knowledge group. The performance of the unrelated knowledge group is consistent with a "text structure" hypothesis. At the lowest level in the text hierarchy, the comparisons produced results consistent with a prior knowledge hypothesis. That is, the group who received text related prior knowledge, recalled more information at the lowest level in the text hierarchy than did a group receiving no such knowledge. An examination of the specific information recalled by the various groups provides a more informed basis for discussion. Table 9 shows the number of subjects who recalled information from each of the rhetorical propositions in the text at each level in the hierarchy.

The comparison of recall by the prior knowledge group with the unrelated knowledge group at each level in the hierarchy indicated that the two groups differed at the highest and lowest level in the hierarchy. At the highest level in the hierarchy (Level 1, Table 9), the recall of information from rhetorical proposition 1 (the only unit at that level) accounts for the

Table 9

Number of Fourth Graders from the Prior Knowledge (PK) and Unrelated Knowledge (UK) Groups Who Recalled Information from Each High Level Unit at Each Level of the Text Hierarchy

Text Unit		Group	
Level in the Hierarchy	High Level Unit	PK (n = 15)	UK (n = 15)
1	1	3	11
2	2	5	5
	7	5	7
3	3	1	0
	5	7	7
	8	3	5
	12	3	5
	13	9	1
4	4	5	3
	6	3	5
	9	5	5
	14	11	1
5	10	5	4
	11	8	6
	15	14	4

difference. The information at this level provides information about the lack of jobs in the town. Everything else in the passage is either a result of the lack of jobs or a further description of the town. For the unrelated knowledge group, this information most probably was important in the organization of the other information in the passage. Empirically, this is not the case for the prior knowledge group.

The other difference in free recall occurred at the lowest level in the text hierarchy (Level 5, Table 9). By examining Table 6, rhetorical proposition 15, a large discrepancy in the number of subjects who recalled information from that unit is observed. Rhetorical proposition 15 provides a description of the town as it stands presently. One reason for the high frequency of recall from this unit is that it provides closure to the history of the town. That is, rhetorical proposition 15 may have provided a conclusion-like statement to a series of events about Pleasant Ridge. If this were the case, then other statements which lead to this "conclusion" should be recalled better by the prior knowledge group. The most direct path to this conclusion includes rhetorical propositions 13 and 14, as well as 15 (Table 9). Although rhetorical propositions 13 and 14 are not at the level in the hierarchy best recalled by the prior knowledge group, there are large differences in performance on these units by the prior knowledge group and the unrelated knowledge group. The number of subjects

who recalled information from rhetorical propositions 13, 14, and 15 appears to be greater for the prior knowledge group than for the unrelated knowledge group. The information in these units states that no one returned to the town once they left it and that the town is deserted with only the cemetery remaining. (See Appendix A for the text.)

One alternative explanation for the recall of information in rhetorical propositions 13, 14, and 15 is a recency effect. This does not seem to be the case given the level of performance by the unrelated knowledge group. Another explanation is that subjects in the prior knowledge group remembered the "conclusion" to a chain of events. This would be consistent with the current research on recall of event chains in general (Warren, Nicholas, & Trabasso, 1979) as well as narratives (e.g., Mandler & Johnson, 1977) where conclusions are among the most often recalled elements. The stimulus in the present study, while written as a historic text, does conform to one description of a narrative. That is, it contains a number of temporal and causal sequences. The information in units 13, 14, and 15 provide both a temporal end point in a sequence of events and a consequent of that event sequence begun for the prior knowledge group in the knowledge base.

For the unrelated knowledge group, the event sequence, if it was treated as such, was not nearly as salient as the hierarchy established by the content structure of the passage. That is,

the levels of subordination in the target passage had more of an effect on the unrelated knowledge group than did the event structure in the passage.

Organization of Recall

One possible effect of prior knowledge is to orient the listener/reader in such a way that the organization of information in a protocol would be different than that of a subject with a different level of knowledge. For the present study, it was hypothesized that such an effect would occur for the younger subjects. That is, that the degree of concordance between the text organization and the organization of recall by subjects in the prior knowledge group would be less than the concordance between the text and the protocols of subjects in the unrelated knowledge. Such an effect did not reach significance (Table 8) for either age group. Even though the subjects in the prior knowledge group at the fourth grade level differed in the amount and content of recall, there was no significant difference in the extent to which the order of their recall was in concordance with that of the text. Other researchers have noted such a difference in free recall of texts (Clark, Note 8; Stein & Nezworski, 1979). In these cases, a random ordering of sentences from a text or varied instructional conditions produced differences between the order of information in protocols and the order of a text. The present results indicate that even when the amount and content of recall is different for groups, a text which

is structured in a somewhat typical manner will yield similar recall organization across groups.

Intrusions in Free Recall

The stated hypothesis was that the intrusions made by older subjects (eighth graders) would be more consistent with the content and organization of the target passage than those made by the younger subjects. This hypothesis was based on the findings of Brown et al. (1977). They found that prior-knowledge-appropriate information which was consistent with a text made up a majority of the intrusions, even though, the overall quantity of intrusions was quite low. The results of the present study (Table 7) are consistent with the Brown et al. (1977) study in that the overall amount of intrusions was small. Additionally, all except one intrusion (a fourth-grade subject in the prior knowledge group) consisted of incorrect information about some content from the text. One explanation for the lack of intrusions is that the target passage was an intact text. That is, in past research (e.g., Brown et al., (1977), the target passages have been purposefully ambiguous so as to allow different perspectives to operate in comprehension. The present text could "stand alone" and needed no additional information to "make sense."

Probe Questions

A series of eight probes was constructed to provide a more

in-depth measure of each subject's memory for information in the target passage. (See Appendix B for a list of probe questions.) Significant differences in performance on the questions favored the prior knowledge group at both the fourth and eighth grades. At the eighth grade, with the exception of a question about the name of the town, all groups performed at or near perfect. That is, even though free recall was far from complete for any subject, the eighth graders were able to retrieve most of the information when given an appropriate cue.

The second question was the only one which produced a significant difference between groups at both grades. This question is considered to be a manipulation check. That is, there was only one mention of the town's name in the target passage, but it occurred several times in the prior knowledge passage and was one of the mastery items. The prior knowledge group should be more likely to recall the name if they remembered the prior knowledge. The results (Table 6) indicate such an effect.

Questions 3, 4, and 8 (Table 6) also yielded significant differences in performance among the various fourth grade group. In all cases, the prior knowledge group performed better than the unrelated knowledge group. Questions 3 and 6 were directed toward information in the target passage which should be "highlighted" by the prior knowledge and as such should yield better performance by that group. This was the case. Question 8, however, is not related

directly to specific content in the prior knowledge. The question was directed toward the present state of the town. Again, in this case, performance favored the prior knowledge group. The correct response to this question came from text units appearing low in the text hierarchy. This information is the same that was freely recalled better by the prior knowledge.

The prior knowledge group not only correctly answered questions related to the prior knowledge more often but also performed better on information not directly related to the prior knowledge. This replicates Pace's (Note 5) findings.

Educational Implications

As with most research in which prose comprehension is the major concept under examination, there are questions regarding implications for educational practice. It is clearly impractical to recommend that teachers take an inventory of each pupil's prior knowledge before instruction begins. One recommendation which can be made is based on the fact that the structure of and relationships between instructional units are highly related to the manner in which learners organize and remember information from those units. In units novel to learners, critical information should be prominent in a hierarchical sense. In subsequent units, care should be taken so that the biasing effect of prior units is taken into account since subsequent accessibility is affected. Further, it might be noted any activity which provides a context for to-be-remembered

information will no doubt enhance its memorability given the proper cue.

A second implication concerns the construction of assessment tasks. That is, before the construction of the task, the objective of the assessment should be considered. In other words, if the object of the assessment is to confirm that certain information is merely stored in memory, then a probed or cued recall task is appropriate. If the objective is to determine how that information is stored and the ease with which the learner can access it, then a measure such as free recall is more appropriate. In most cases, both issues are of concern, hence, multiple measures may be best.

The last implication extends far beyond the classroom. That is that when we comprehend discourse, our expectancies and prior knowledge affect the meaning we obtain and the information we store. This is not a new finding (Bartlett, 1932) but is a re-affirmation of the power of our biases in understanding our world.

REFERENCE NOTES

1. Turner, A., & Greene, A. The construction and use of a propositional text base. Technical Report No. 63. Institute for the Study of Intellectual Behavior, University of Colorado, 1977.

2. Meyer, B. J. F., Brandt, D. M., & Bluth, G. J. Use of the author's textual schema: Key for ninth graders comprehension. Paper presented at the American Educational Research Association, 1978.

3. Meyer, B. J. F., Freedle, R. O., & Walker. Effects of discourse type on the recall of young and old adults. Unpublished Arizona State University paper, 1978.

4. Pichert, J. W. Sensitivity to what is important in prose. Technical Report No. 149. Center for the Study of Reading, University of Illinois at Urbana-Champaign, 1979.

5. Pace, Ann Jaffe. The influences of world knowledge on children's comprehension of short narrative passages. Paper presented at the Annual Meeting of the American Educational Research Association, Toronto, Canada, 1978.

6. Lewis, Jed. The effect of prior subject knowledge and text structure on the organization of text information in memory. Paper presented at the Annual Meeting of the American Educational Research Association, Toronto, Canada, 1978.

7. Olson, D. R., & Nickerson, N. Language development through the school years: Learning to confine interpretation to the information in the text. Unpublished manuscript, The Ontario Institute for Studies in Education, Toronto, Canada, 1979.

8. Clark, Charles H. Organization of prose: Its effects upon recall organization. Unpublished doctoral dissertation, University of Wisconsin-Madison, 1978.

REFERENCES

Adams, M. J., & Collins, A. A schema-theoretic view of reading. In Roy O. Freedle (Ed.), New directions in discourse processing, Volume II. Norwood, NJ: Ablex Publishing Co., 1979.

Anderson, R. C., & Pichert, J. W. Recall of previously unrecallable information following a shift in perspective. Journal of Verbal Behavior, 1978, 17, 1-12.

Ausubel, D. P. Cognitive structure and the facilitation of meaningful learning. In R. C. Anderson and D. P. Ausubel (Eds.), Readings in the psychology of cognition. New York: Holt, Rinehart & Winston, 1965.

Bartlett, F. C. Remembering. Cambridge University Press, 1932.

Bobrow, D. G., & Norman, D. A. Some principles of memory schemta. In D. G. Bobrow and A. Collins (Eds.), Representation and understanding: Studies in cognitive science. New York: Academic Press, 1975.

Bousfield, W. A. The occurrence of clustering in the recall of randomly arranged associates. The Journal of General Psychology, 1953, 49, 229-240.

Brown, A. L., Smiley, S. S., Day, J. D., Townsend, M. A. R., & Lawton, S. C. Intrusion of a thematic idea in children's comprehension of stories. Child Development, 1977, 48, 1454-1466.

Chomsky, N. A review of Verbal behavior by B. F. Skinner. Language, 1959, 35, 26-58.

Chomsky, N. Syntactic structures. The Hague, The Netherlands: Mouton & Co., 1975.

Fillmore, C. J. The case for case. In E. Bach & R. Harms (Eds.), Universals in linguistic theory. New York: Holt, Rinehart & Winston, 1968.

Flavell, J. Cognitive development. New Jersey: Prentice-Hall, 1977.

Frederiksen, C. H. Representing logical and semantic structure of knowledge acquired from discourse. Cognitive Psychology, 1975, 7, 371-458.

Grimes, J. The thread of discourse. The Hague: Mouton, 1975.

Haviland, S. E., & Clark, H. H. What's new? Acquiring new information as a process in comprehension. Journal of Verbal Learning and Verbal Behavior, 1974, 13, 512-521.

Johnson, R. E. Recall of prose as a function of the structural importance of the linguistic units. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 12-20.

Kintsch, W. On modeling comprehension. Educational Psychologist, 1979, 14, 3-14.

Kintsch, W. The representation of meaning in memory. Hillsdale: NJ: Lawrence Erlbaum Assoc., 1974.

Kintsch, W., Kozminsky, E., Streby, W. J., McKoon, G., & Keenan, J. M. Comprehension and recall of text as a function of content variables. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 196-214.

Kintsch, W., & van Dijk, T. A. Toward a model of text comprehension and production. Psychological Review, 1978, 85, 363-394.

Kintsch, W., & Vipond, D. Reading comprehension and readability in educational practice and psychological theory. In L. Nilsson (Ed.), The proceedings of the conference on memory, The University of Uppsala. Hillsdale, NJ: Lawrence Erlbaum Assoc., 1979.

Kirk, R. E. Experimental design procedures for the behavior sciences. Belmont, CA: Brooks Cole Publishing Co., 1968.

Mandler, G., & Pearlstone, Z. Free and constrained concept learning and subsequent recall. Journal of Learning and Verbal Behavior, 1966, 5, 126-131.

Mandler, J. M., & Johnson, N. S. Rememberance of things parsed: Story structure and recall. Cognitive Psychology, 1977, 9, 111-151.

Manelis, L., & Yekovich, F. R. Repetitions of propositional arguments in sentences. Journal of Verbal Learning and Verbal Behavior, 1976, 15, 301-312.

Meyer, B. J. F. The organization of prose and its effects on recall. Amsterdam: North-Holland Publishers, 1975.

Meyer, B. J. F. The structure of prose: Effects on learning and memory and implications for educational practice. In R. C Anderson, R. J. Spiro & W. E. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, NJ: Lawrence Erlbaum Assoc., 1977.

Piaget, J. The origins of intelligence in children (Translanted by Margaret Cook). New York: Basic Books, 1952 (Originally published, 1936).

Pichert, J. W., & Anderson, R. C. Taking different perspectives on a story. Journal of Educational Psychology, 1977, 69, 309-315.

Royer, J. M., & Cable, G. W. Facilitated learning in connected discourse. Journal of Educational Psychology, 1975, 67, 116-123.

Rumelhart, D. E. Notes on a schema for stories. In D. G. Bobrow & A. Collins (Eds.), Representation and understanding: Studies in cognitive science. New York: Academic Press, 1975.

Shuell, T. J. Clustering in free recall. Psychological Bulletin, 1969, 72, 353-374.

Stein, N. L. & Glenn, C. G. An analysis of story comprehension in elementary school children. In R. O. Freedle (Ed.), Discourse processing: Multidisciplinary perspectives. New Jersey, Ablex, Inc., 1978.

Stein, N., & Nezworski, T. The effects of organization and instructional set on story memory. Discourse processes, 1978, 1, 177-194.

Tulving, E., & Pearlstone, Z. Availability versus accessibility of information in memory for words. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 381-391.

van Dijk, T. A. Text and context: Explorations in the semantics and pragmatics of discourse. London: Longman, 1977.

van Dijk, T. A. Some aspects of text grammars. The Hague: Mouton, 197[illegible].

APPENDICES

APPENDIX A

TARGET PASSAGE

The small towns in Wisconsin the 1800's did not provide jobs for the youngsters growing up in them. One town like this was Pleasant Ridge. Although it was different from many other towns, all the people who lived there were farmers and there were no stores or factories in the town. For a long time the small town had only one building. All the town's meetings and parties were held in that building.

When the youngsters from the small town grew up, they moved away. They left to find better jobs. The reason that the youngsters wanted better jobs was that the town's school gave them a good education. The log schoolhouse had been built by the farmers and it was the only one of its kinds in the town. The teachers were very good and the students liked their teachers. When they finished school, they wanted to move away and find other places.

Once the youngsters moved away from the small town, they never returned. Soon, the town was deserted. The only part of the town left is a cemetery where the settlers of the town are buried.

APPENDIX B

PROBE QUESTIONS FOR THE TARGET PASSAGE

1. Why was the town different from other towns in Wisconsin?
2. What was the name of the town?
3. What was the one building in the town used for?
4. Why did the youngsters leave?
5. Why did they want better jobs?
6. Why was the school unusual?
7. What did the youngsters do when they finished school?
8. What is the town like now?

APPENDIX C

RELATED KNOWLEDGE BASE

PLEASANT RIDGE AND DISTRICT NO. 5 SCHOOL

While there were many small towns in Wisconsin in the 1800's, none was like Pleasant Ridge. Pleasant Ridge was different from the others for two reasons. One reason was that it was the first town settled by blacks in Wisconsin. These first settlers were ex-slaves from Virginia. They had traveled by riverboat and covered wagon to southwest Wisconsin. Once they arrived, they bought a piece of land and called it Pleasant Ridge. The second reason that Pleasant Ridge was different was that it had a school. Very few towns in Wisconsin had schools then.

The school was started by a man named John Greene. He was also an ex-slave and was one of the few people in the area who could read and write. This made him realize that the town needed a school. He got together with the rest of the farmers in the area and built a school. The name of the school was District No. 5 school.

District No. 5 School was perhaps the first school in the nation to have both black and white students. It also was the first school to have both black and white teachers. This made it very important to the state of Wisconsin.

Since District No. 5 School was the only building in Pleasant Ridge, it was used for many things. For a long time, the log schoolhouse was used as a church and a community center. In addition to getting a good education at District No. 5 School, people went to parties and meetings there. The youngsters from Pleasant Ridge were very lucky to have their school.

APPENDIX D

PROBE QUESTIONS FOR KNOWLEDGE BASE

1. What is the name of the town?
2. What are the two reasons why it is different?
3. Who started the school?
4. Why did he realize the town needed a school?
5. What was the school's name?
6. Why was the school important to Wisconsin?
7. What was the schoolhouse used for?
8. How many buildings did Pleasant Ridge have in it?

APPENDIX E

UNRELATED KNOWLEDGE BASE

In southwestern Africa there is a great stretch of dry land. The land is flat with no lakes or rivers. Vegetation is scarce. The plants and animals that live there have adatped to a place with little water and high temperatures. This place is called the Kalahari Desert. The Kalahari Desert covers part of South Africa.

The plants of the Kalahari have changed so that they can live in the desert weather. Most of the plants are grasses and bushes. There are a few large trees called the Baobob tree. These trees are sometimes more than 200 feet tall and have thick branches. The bark of these trees is smooth and is very thick near the bottom of the tree. The Baobob tree stores water in its soft, spongy wood and is able to live in the desert. Other plants sometimes store water in their roots underground.

Many animals that live in the Kalahari Desert eat plants. This is how the antelope, zebras, and others get their water. Other animals like lions and leopards depend on other animals for their food. For instance, lions sometimes eat antelope they can catch.

The desert is without rain for 10 months of the year. Most of the time, a hot wind blows across the desert. June and July are the coolest months of the year. During this time, frost can be seen on the grass and bushes. January and February are the months when it rains in the desert. During this time, the grasses are green and bloosoms appear on the plants.

APPENDIX F

PROBE QUESTIONS FOR THE UNRELATED KNOWLEDGE BASE

1. What is the name of the desert?
2. What country does it cover?
3. What is the name of a tree that lives in the desert?
4. How tall are the trees?
5. Where do plants store water?
6. How do zebras get some of their water?
7. Which are the coolest months in the desert?
8. When does it rain in the desert?

APPENDIX G

ANALYSIS OF TARGET PASSAGE INTO MICROPROPOSITIONS AND RHETORICAL PROPOSITIONS AT FIVE HIERARCHICAL LEVELS

Analysis of Target Passage into Micropropositions and Rhetorical Propositions