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The use of context for word recognition : a comparison between college dyslexic students, college normal readers, and reading age control group.

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THE USE OF CONTEXT FOR WORD RECOGNITION: A COMPARISON BETWEEN COLLEGE DYSLEXIC STUDENTS, COLLEGE NORMAL READERS, AND READING AGE CONTROL GROUP

A Dissertation Presented

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ABSTRACT

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COLLEGE NORMAL READERS, AND READING AGE CONTROL GROUP

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This study compared the use of context for word recognition by readers of the same chronological age with different reading abilities and by readers of different chronological age with the same reading level.

The research sample was comprised of three groups: one experimental group and two control groups - one for chronological age and one for reading-age. The experimental group was comprised of 20 college dyslexic students (DYS) with an average I.Q. scores and achievement scores below the 40th percentile on the WRMT-R. The chronological age control group (CA) was comprised of 20 college normal readers. The reading age control group (RA) was comprised of 20 younger normal readers matched on the basis of WRMT-R word identification sub-test scores with the dyslexic group.

All subjects were administered tasks assessing listening and reading comprehension, word attack skills, and the use of context for word recognition.

On both comprehension tasks the level of performance for the DYS group was about the same as for the CA group and significantly higher than for the RA group.

Word attack skills were discussed in terms of the dual-route model of word recognition. The DYS group displayed the lowest performance level in reading nonwords suggesting difficulties in using the "indirect route". However, their "regularity effect" was similar to that of the RA and CA groups, suggesting that their utilization of the indirect route in real word reading was intact and comparable to the normal readers. This pattern is in conflict with the predictions of the dual-route model.

The use of context for word recognition was inferred from the analysis of the oral reading tasks and sentence context experiment and indicated that all readers are capable of using context to facilitate word recognition. Difficulties in the use of context are attributed to task difficulty rather than to characteristics of the reader. These results were discussed in terms of qualitative vs. quantitative differences between DYS and RA groups and suggested that findings of a lack of difference between these two groups can not always be interpreted as developmental lag.

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CHAPTER I

INTRODUCTION

In a natural reading situation readers encounter words in a contextual environment. One might want to distinguish different aspects of this contextual environment, such as syntax, semantic relatedness of individual words or higher order variables such as the readers' schemata. No matter which aspect is taken, the common feature is that words are not encountered in isolation. As such, an understanding of the role of context in the identification of words is important, and not surprisingly, has long been of interest to reading researchers.

Three broad views concerning the role of contextual information in reading have emerged in the literature: top-down models of the reading process, bottom-up models and interactive models.

Investigators working within the framework of the top-down models of the reading process, (Goodman, 1976; Smith, 1971), have assumed that contextual information can speed ongoing word recognition during reading because contextual redundancy reduces the number of visual features that must be extracted from each word. Furthermore, these researchers have suggested that younger and poorer readers may not be using contextual information to the same degree as adults.

The fluent reader, according to this theory, is less reliant on visual cues because of his efficient use of contextual redundancy. Good readers should then, process words faster since their use of redundancy lightens the load on their stimulus-analysis mechanisms. The less skilled readers, on the other hand, are not as able to use contextual information. They make incorrect hypotheses and are forced to rely more on the visual features of the text in order to recognize a word, and thus read slowly.

In contrast, advocates of the "pure" bottom-up models of the reading process such as Gough (1972) suggest that context will not have any effect on word recognition; rather, it will be the efficient decoding mechanism which will determine reading efficiency.

The third view, and the one that most theorists support, is that word identification in reading is based upon an interplay between the features of individual words and context cues (Rumelhart, 1976; Stanovich 1980).

Investigators with different theoretical backgrounds use different methodologies and techniques and study different population to support their claims. Researchers that represent the top-down models of the reading process use mainly oral reading analysis methods and focus mainly on school age population subjects. These theorists perceive the errors produced in oral reading as "windows" to the unseen reading process. The main strength of this method comes from its' "natural" characteristics; it was usually studied on school-age subjects who received complete stories from instructional material, and took place in educational settings. However, there are some weaknesses in this research method as well: First, from a theoretical point of view, reading aloud involves additional levels of processing to the word recognition level. Thus it is difficult to make clear statements with regard to the interaction of word identification level and context use. Secondly, there are important methodological issues. In most oral reading analysis studies there is no systematic definition of error categories (Weber, 1970; Cohen, 1974-1975), neither there is a distinction between multiple-source type errors and single type errors. The effect of the relative difficulty of the reading passages used in each study on the type of errors produced also gained very small attention in most studies.

Two other experimental paradigms, eye movement research and reaction time methods, were used mainly by cognitive psychology researchers working within the interactive-models of the reading process. These methods were used with various age groups, and across different reading abilities groups. The rationale behind these methods of studying the reading process is as follows: due to the mental characteristics of the reading processes they can not be directly observed. Yet, it takes time to perform them. Based on measuring the different times people required to perform various tasks, psychologists can make inferences about what internal representation and operations are like (Rayner & Pollatsek, 1988). The main critique of this approach by its' opponents is that these methods of studying the reading process are artificial in nature and do not reflect real life situations (Goodman, 1976).

A brief examination of the literature then, points to a diversity in the perception of the role context plays in reading, as well as confusion in interpreting the results across different studies. It seems that due to the complexity of the reading process, the different approaches taken to study it, and the fact that all experimental techniques contain some flaws, systematic biasing of results can be precluded only when trends hold across several research techniques, each with it's own different strengths and weaknesses.

Empirical results based on eye movement methods and reaction time studies support the hypothesis that all readers use contextual information to facilitate word recognition in reading. This is contrary to the direction that was predicted by the top-down theorists. The developmental trend observed in these studies is that as reading fluency develops, contextual effects on ongoing word recognition appear to diminish. This is because the reader becomes more proficient at automatic word processing. Why is there so much confusion and contradicting evidence on such an important question? One possible explanation was suggested by Stanovich (1980), who distinguished between two types of contextual processing. One is the use of context for comprehension, and the other is the use of context for facilitation of word recognition. He suggested that part of the confusion might be due to the fact that these differences between these two types of contextual processing had not been clearly defined, addressed, or analyzed in many reading studies.

Statement of the Problem

An increasing amount of research provides accumulating evidence to support the notion that the relative importance of individual reading skill is located at the context-free word recognition skill level rather than in the use of context to facilitate word recognition. Nevertheless, there are researchers as well as educators who believe the contrary. Such a difference in the understanding of the role of context in the development of the reading process, leads to different reading and reading remediation methodologies. If reading instruction and remediation is based on false assumptions and understanding of the reading process, it may lead to inappropriate teaching of reading.

There is a need to provide more data in order to assure more effective reading instruction and practice in our society. A possible way to do so is by conducting additional studies concerning word identification strategies and the use of context to facilitate word recognition. Attention should be given, as suggested by Stanovich (1980), to differentiate between tasks that tap the use of context for comprehension and tasks that tap the use of context for improving word recognition.

The use of context for word recognition by college-age dyslexic readers has never been studied. This is an important area, and we may be able to address some of the confusion around the use of context by comparing the reading performance of college-age dyslexic students to the reading performance of younger normal readers and adult skilled readers. This information will help to differentiate between reading performance attributed to reading level and reading performance attributed to general cognitive development and general background knowledge associated with adults.

Purpose of the Study

The purpose of this study was to compare the use of context for word recognition by readers with similar reading abilities but with different age and by readers with the same chronological age and with different reading abilities. The study aimed specifically at college age dyslexic readers, in an attempt to clarify the following questions: (1) Do college age dyslexic readers display as much contextual effects as younger normal readers who have reached the same grade equivalent for context-free word decoding? (2) Is there a difference in the pattern and degree of the use of context for word recognition by college age dyslexic readers and college age normal readers?

To clarify these questions the study was designed to use a variety of experimental paradigms, rather than the exclusive use of one method. Results that will converge across the different paradigms, will provide more powerful basis for conclusion.

In addition the issue of differences between listening and reading comprehension was addressed in order to eliminate the possibility of general language comprehension difficulties encountered by the dyslexic subjects rather than specific difficulties with reading.

The study also compared single word reading strategies of college-age dyslexic readers with strategies employed by younger normal readers and college-age adequate readers in an attempt to clarify the relationship between word reading strategies and functional oral reading.

Results of this study will provide data and add information on the issue of the interrelations of decoding, context use and reading abilities, across the dimension of reading skill and chronological age.

It is the hope of this researcher that a better understanding of the relative strengths and weaknesses in the use of contextual information sources in reading will result in practical suggestions for reading instruction and remediation methodologies.

Hypotheses

This study was designed for the purpose of investigating the questions described in the previous sections. In order to obtain this information, specific questions will be presented in a more formal way, and will be grouped under specific areas of interest.

A. Listening and reading comprehension

1. There are no significant differences between college-age dyslexic readers (DYS), college-age normal readers(CA) and reading-age matched control subjects (RA) in mean percentage of correct answers given to listening comprehension questions.

$H_0 \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \; p < .05$

2. There are no significant differences between DYS, RA and CA groups in mean percentage of correct answers given to reading comprehension questions.

$H_o \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \; p < .05$

3. Within each reader group, there are no significant differences between mean percentage of correct answers given to listening and reading comprehension questions.

$H_o \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu \; ; \; p < .05$

B. <u>Word attack skills</u>

1. There are no significant differences between DYS, RA and CA groups in mean reaction time taken to read real words and matched nonwords.

$H_o \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \; p < .05$

2. There are no significant differences between DYS, RA and CA groups in mean percentage of errors committed in reading real words and matched nonwords.

$H_o \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \; p < .05$

3. Within each reader group, there are no significant differences between mean reaction time taken to read real words and matched nonwords.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \; p < .05$

4. Within each reader group, there are no significant differences between mean percentage of errors committed in reading real words and nonwords.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \ p < .05$

5. There are no significant differences between DYS, RA and CA groups in mean reaction time taken to read regular than matched irregular word lists.

$H_o \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \ p < .05$

6. There are no significant differences between DYS, RA and CA groups in mean percentage of errors committed in reading regular than irregular word lists.

$H_o \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \ p < .05$

7. Within each reader group there are no significant differences between mean reaction time taken to read regular than irregular type words.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \ p < .05$

8. Within each reader group there are no significant differences between mean percentage of errors committed in reading regular than irregular type words.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \ p < .05$

C. <u>Use of context for word recognition</u>

(Experimental paradigm - oral reading analysis)

1. There are no significant differences between DYS, RA and CA groups in the mean number of words read per second in coherent paragraphs and randomly presented paragraphs.

$H_o \quad : \mu_1 = \mu_2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \; p < .05$

2. There are no significant differences between DYS, RA and CA groups in the mean percentage of errors committed in reading either coherent or randomly presented paragraphs.

$H_0 \quad : \mu_1 = \mu 2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \; p < .05$

3. Within each reader group there are no significant differences between mean number of words read per second in reading either coherent paragraphs or randomly presented paragraphs.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \; p < .05$

4. Within each reader group there are no significant differences between the mean percentage of errors committed in reading coherent and randomly presented paragraphs.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \; p < .05$

D. <u>Use of context for word recognition</u>

(Experimental paradigm - reaction time method)

1. There are no significant differences between the

DYS, RA and CA groups in mean reaction time to target words in congruous, incongruous and neutral context condition.

$H_0 \quad : \mu_1 = \mu 2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \ p < .05$

2. There are no significant differences between the DYS, CA and RA groups in the mean percentage of errors committed in reading target words in congruous, incongruous and neutral sentence context conditions.

$H_0 \quad : \mu_1 = \mu 2 = \mu_3$

$H_1 \quad : \mu_j \neq \mu_{j'}; \ p < .05$

3. Within each reader group there are no significant differences between facilitation and inhibition scores.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \ p < .05$

4. Within each reader group there are no significant differences between the overall context effects in the easier and more difficult context conditions.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \ p < .05$

E. <u>Oral reading error classification</u>

1. Within each reader group there are no significant differences between proportion of errors classified as multiple-source than single type errors.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \ p < .05$

2. Within each reader group there are no significant differences between the proportion of self-corrected multiple-source type errors and the proportion of self-corrected single type errors.

$H_0 \quad : \mu_1 = \mu_2$

$H_1 \quad : \mu_1 \neq \mu_2; \; p < .05$

Definition of Terms

The following is a list of terminology specific to this study. Definitions were complied from several sources and are cited accordingly.

College-age dyslexic readers: college-age students who have a long documented history of dyslexia. All students have a full I.Q. score of 90-125 as measured by Wechsler Adult Intelligence Test (WAIS-R), and a score at or below the 40th percentile on the Woodcock Reading Mastery Tests-Revised (WRMT-R). All subjects were native speakers of English, and did not present gross physical disability or profound emotional problems.

Context: As used in this study, context refers to such aspects as syntax, semantic relatedness of individual words, or higher order variables such as the reader's schemata (Rayner & Pollatsek, 1989).

Word recognition: A process that involves "getting into the right location in memory"--"activating some kind of long-term memory representation that contains experientially established information about the particular string of letters that is currently available of that was most recently available to the senses" (Carr & Pollatsek, 1985, p. 53). The terminology used in this definition does not suggest literate physical entities correspondent to each step in the process. Rather, they are abstract concepts that try to represent complex information processing systems.

Direct route: This is a theorized process for word recognition in which the reader uses orthographic representations of the whole words to retrieve lexical meaning or post-lexical phonological representations. A phonetically regular word might be pronounced by this route. An "irregular" word must be pronounced by this route, but nonwords can not be pronounced by using this route (Baron, 1986.)

Indirect route: This is a theorized process for word recognition in which the reader obtains access to the lexical meaning of the word by the mediation of the pre-lexical phonological representations assembled through the application of grapheme-to-phoneme correspondence rules. A nonword must be pronounced using this route. A phonetically regular word might be pronounced this way, but a real orthographically irregular word cannot be pronounced by the use of this route (Baron, 1986).

Nonword: Letter string which is not a word, but is sometimes pronounceable based on its correspondence to graphic to phoneme correspondence rules.

Regular-irregular words: Regular words are words whose pronunciation conforms to spelling sound rules (e.g. cave, gave, pave, save and wave). In contrast, the pronunciation of the word "have" does not conform to this pattern and becomes an exception to the general rule. It is therefore considered an "irregular" word (Aaron & Phillips, 1986).

Semantic errors: Errors which are semantically acceptable up till the point the error is generated (e.g., text: they rode the bus downtown, error: into the city).

Syntactically similar errors: Errors that reflect use of syntactic information in reading (e.g., text: we do not know how to prevent, error: why to prevent)

Graphemically similar errors: Errors that matched more than one letter of the target word (e.g., text: find a horse, error: find a house). (coding system was adapted and modified from FRI, Wiederholt, 1987).

Multiple-source type errors: Errors that can fit into more than one classification (e.g., text: they waved goodbye, error: they said goodbye.

Limitations of the Study

For the purposes of this study, the following limitations should be recognized. Any inferences drawn from this investigation should be limited to research paradigms, data collecting methodologies, and population similar to those described in this study.

1. Conclusions drawn from this experiment are applicable to students similar to those in this study, described as college age students having an I.Q. score no lower than 90 and no higher than 125 on WAIS-R, and a score at or below the 40th percentile on the WRMT-R.

2. Any reading instructional suggestions resulting from this study will need further empirical research to study their effectiveness.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The role that context plays in the reading process has long been of interest to reading researchers, as a thorough understanding it may reveal clues to the very nature of the reading process. In addition, concrete empirical data with regard to the use of context in the reading process will result in better educational practice of reading instruction and reading remediation.

The literature analyzes the use of context in reading from a variety of view points. For example: the developmental point of view compares the use of context by adult skilled readers and younger normal readers. The reading proficiency point of view compares the use of context by skilled readers and poor readers.

The intention of this research effort is to extend the experimental findings that support the notion that the use of context to facilitate word recognition is a function of context-free word recognition efficiency. Analysis of the reading performance and the use of context for word recognition by college dyslexic readers compared to younger normal readers who have achieved the same context-free word identification grade equivalent as the DYS students, can help substantiate this claim.

The literature review which provided the background for this research is presented next, organized in six sections.

The first section reviews studies that used the reading-match design as an alternative way to study reading. The limitations as well as the advantages of this research design will be discussed.

The second section highlights the main models of the reading process, and discusses the role that context plays in reading according to these models.

The third section provides an overview of the definitions and methodologies used to study the use of context for word recognition according to each model.

The fourth section provides a brief overview of single word attack skills of dyslexic readers.

The fifth section, reviews the empirical on the use of context by different readers. The relationship of the data to the theory of the reading process is discussed.

The last section reviews some findings on reading performance of college dyslexic students.

The literature review is considered a select compilation of research findings concerned with the intent of this research project. By nature of the vast amount of research available dealing with the use of context in reading, several aspects were deleted. Processes as context use for comprehension, and context use to disambiguate ambiguous words were omitted because of limited applicability to this study.

Reading Level Design

The reading level design model matches reading-disabled children with younger normal readers at the same level of reading achievement, and then compares their levels and patterns of performance on various neuropsychological, psycholinguistic, and reading tasks. This research design is advocated by several reading researchers including Backman, Mamen and Ferguson (1984), Bryant and Goswami (1986), Stanovich, Nathan and Zolman (1988), as an alternative method for the traditional approach which matches reading disabled children with chronological age controls. In traditional chronological age control studies (CA), differences between groups have been interpreted as casual factors responsible for the reading failure of the disabled readers. However, the main disadvantage of this design is that discrepancies between groups do not necessarily reflect causality for reading failure. They might be attributed to different reading abilities and differences in exposure to the successful reading experience.

The reading level design attempts to overcome some of the difficulties associated with the CA design. It allows to test the hypothesis that reading disabled children actually perform at a lower level or in a manner different from that predicted by their level of reading achievement. Backman et.al (1984), argued that a pattern of results in which no differences are found on the variables measured between reading-disabled readers and reading-age (RA) controls supports the notion that reading disabled children are not qualitatively different from younger normal readers, but simply delayed in their reading and related skills. In contrast, a pattern of lower performance exhibited by reading disabled as compared to RA subjects indicates that disabled readers are qualitatively different from younger normal readers in the sequence and rate of their development.

The most basic reading level design involves a target group, such as reading disabled children, and younger normal controls matched on some aspect of reading ability. A more complex design is a three-group design in which there are two control groups in addition to the target group. One group controls for reading level (RL), and one for chronological age (CA). This paradigm allows not only comparison of children of different chronological ages with the same reading level, as in the two group approach, but also comparison with the same chronological age and across reading levels (Backman,Mamen & Ferguson, 1984).

Although this research design is relevant to evaluating developmental theories of individual differences in reading, and therefore an important advance in reading research representing potential approaches to overcome some of the difficulties in interpreting results of traditional studies, and, there are number of methodological considerations and limitations that should be taken into account:

1. The choice of the criterion for matching the groups: Given the complexity of reading and the heterogeneity of reading-disabled population it seems unrealistic to expect that one could match reading level in any absolute way. Such attempt would require an extremely complex reading battery and may be impractical or impossible. Results from studies using this design may vary depending on whether the matching is done with a reading comprehension test or with a word recognition test. Furthermore, within the comprehension tests, or word recognition tests, there is a wide variability in the tests' demands. Some tests for example, will allow a child unlimited time to read and respond, whereas others limit the time allowed for reading. Untimed tests may lead to performance of disabled readers that is not so far behind grade level when just accuracy is assessed. However, when a more sensitive measure which

incorporates response time is considered, more profound differences would be revealed. Selection of the criterion test will therefore affect not just the subjects selected for the target group but also the actual reading skill, chronological age, and grade level of the reading level matches.

2. Qualitative versus quantitative differences: Concerns with regard to interpretation of results as reflecting qualitative vs. quantitative differences were raised by Bryant and Goswami (1986). The interpretation of qualitative vs. quantitative differences in reading performance on experimental tasks between reading-disabled students and reading-age controls is not always very clear. It is possible that extreme and accumulated quantitative difficulties can cause qualitative differences. Furthermore, differences between reading-disabled students and RA controls could indicate a quantitative difference in one case, in which the reading-disabled are placed at the extreme end of a skill, whereas it is also possible to interpret it as qualitative difference because it differentiate between them and other readers, but not between average and superior readers.

Despite these methodological and theoretical concerns, this experimental design has potential power in revealing variables that are related to the reading process. This design can be used even more powerfully when testing actual reading and spelling processes, in which it can be demonstrated that reading-disabled groups and younger control groups are equivalent on some overall aspects of the experimental tasks, yet still differ in some potential important ways.

However, the concerns raised previously should not be ignored. Researchers who use this paradigm should be clear as to what tool was used for comparing the groups, and what implications such a choice make. Furthermore, the target population should be described precisely. Attention to these issues will provide appropriate framework for interpretation of results, as well as enable replications of studies.

Models of the Reading Process

Since the focus of this review is on context effects in reading, it is much beyond the scope of this section to present a thorough analysis of theories of the reading process. Yet a real understanding of the role that context plays in reading necessitates some understanding of the theory of the reading process. Thus, I shall briefly present three broad classes of the models of the reading process: Top-down models, Bottom-up models, and Interactive models. Each will be discussed in terms of their main characteristics and, at the same time, attention will be paid to the specific assumptions about and implications of the role of context in reading, as well as the different use of it by readers with different reading abilities as each of them suggests.

However, even before going into this discussion, it is necessary to look first at a broader conceptual framework. Namely: "Cognitive psychology." By so doing, we will be able to better understand the concepts as well as the terminology used in these models of the reading process. Cognitive psychology is "the study of knowledge and how people use it." For this reason cognitive psychology is also called "information-processing psychology." (Glass and Holyoak, 1985, p. 2). Cognitive psychology is aimed at studying mental abilities such as perception, memory, language. Since reading calls into play virtually every aspect of the cognitive processes, it is an excellent example of human information processing and has attracted many researchers to the study of the reading processes. Thus, concepts and terminology that are used in different studies of mental abilities will be applicable to reading as well.

Obviously, a major difficulty for the experimental investigation of cognitive operations is the inaccessibility of the phenomena being studied. The only observable events are the stimulus or input end and the response or output end. Thus, conclusions are necessarily inferential in nature and results of even the best designed experiments need to be interpreted.

The information processing theory attempts to represent human thought as "the flow of information through specific components that perform certain operations" (Hood, 1980, p. 22). A metaphor that is used in order to explain these operations is a "computer metaphor." Thus, many of the concepts that are used to describe cognitive structure and operations are borrowed from computer technology and terminology. However, the terms and the claims made in cognitive psychology are not a direct claim about the structure of the brain. Rather, they are convenient abstractions that are useful in accounting for certain empirical phenomena. The blocks and arrows that are used in many "information processing charts" are not in the brain in any literal sense. Nor are the flow diagrams intended to provide or reflect how neurons or nerve tracts transmit messages through the brain. To put it in other words, information processing models do not represent a claim about physiological structure. "It is rather a set of concepts that aid in the understanding of cognitive events" (Hood, 1980, p. 11). The computer analogy then represents a level of abstraction that in spite of differences in physical structure, similar general principles emerge.

In his introduction to cognitive psychology Cohen (1983) made the statement that "At this level of abstraction, differences in the hardware, whether electronic or neurophysical, are irrelevant" (Cohen, 1983, p. 11).

Generally speaking, cognitive psychologists claim that "it is possible and necessary to study mental representations without investigating the nervous system directly; they are primarily study codes rather than media" (Glass & Holyoak, 1985).

It seems than, that while one focuses specifically on the processes of reading, understanding the background and the philosophy behind the terms used to describe the different models may help to clarify the models themselves.

Bottom-up models

The names "Bottom-up" and "Top-down" models of the reading process are based on the metaphorical conception of "information processing as involving hierarchical layers of recoding, with sensory analysis of the input at the bottom of the hierarchy and the abstract semantic representation at the top" (Glass & Holyoak, 1985, p. 21). Bottom-up information processing models tend to be linear and to have a series of non interactive processing stages. Each stage does its work independently and transforms its production to the next higher stage. The information flows along in one direction and there is no way that what is contained in a higher stage can influence the processing of a lower stage.

A model which is associated with this approach and which I intend to describe in more detail is the model proposed by P. Gough (1972): This model gives a description of how text is processed from the time the eye first looks upon the printed words to the time the meaning is derived from the visual input. According to Gough's model, graphic information enters the visual system and is registered first in an icon and then transforms from a character level representation to phonic representation, lexical representation and finally to deep structural representation. Thus, the input is sequentially transformed to higher level processing. The reading processes as viewed by Gough are strict letter by letter, word by word analysis of the input string. In order to get the meaning of a sentence, one should proceed from left to right and understand the word serially. But, until the individual words can be organized into larger units in order to be meaningful, they first must be stored. According to Gough, the primary memory builds lexical items along with its phonological, syntactic and semantic information until the item can be understood. Once the contexts are understood, they move on, the area is "cleared" and new items can be entered.

This model clearly implies that context will not have any affect on word recognition; rather, it will be the efficient decoding mechanism which will determine the reading efficiency. Gough, in his model, is trying to account for what happens in "one moment of reading." He does not deal with reading difficulties, nor does he explain reading development. However, a logical extension of his model more likely will imply that one first must master decoding skills in order to proceed to higher levels of reading. Or, that higher levels are already in place from spoken language. However, models similar to Gough's model fail to account for findings in the reading research literature such as the perception of letters being more rapid and more accurate in words than in isolation as well as the perception of syntax being dependent on the semantic context in which the string appears. These findings suggest that a performance on a lower step in the hierarchical organization is influenced by a higher one-- thus, contradictory to strictly "Bottom-up" models.

Top-down models

These models have been termed "Top-down" models because they conceptualize the reading process as "hierarchical organization." In this hierarchical organization sensory analysis of the input considered to be at the bottom and the abstract and semantic representation at the top. A model in which the output of a lower step is influenced by a higher one is called a "Top-down" model. Associated with these models is the work done by Goodman (1976) and the work done by Smith, F. (1971). Their works imply a contradictory role for context as opposed to the one suggested by Gough. Smith's hypothesis is that because the good reader is sensitive to the redundancy afforded by the sentences, he/she develops hypotheses about upcoming words and is then able to confirm the identity of a word by sampling only a few features in the visual display. Thus, it implies that the good reader should process words faster because his/her use of redundancy lightens the load on the stimulus analysis mechanism.

Smith stated,

> "Guessing in the way I have described is not just a preferred strategy for beginners and fluent readers alike, it is the most efficient manner in which to read and learn to read" (Smith, 1979, p. 67).

Along much the same line of thinking, Goodman (1976) argued that,

> "skill in reading involves not greater precision, but more accurate first guesses based on better sampling techniques, greater control over language structure, broader experiences, and increased conceptual development" (Goodman, 1976, p. 504).

The reading model proposed by Smith and Goodman suggests that the beginner reader as well as the fluent reader is actually involved in the same process: guessing. Thus, in terms of reading development, their model will suggest that the better reader you are, the better guesser you are. The beginner reader starts out by guessing; the more skilled he becomes, the more he improves in his guessing techniques and his control over language.

The "Top-down" models were often attacked and criticized on the grounds of vagueness in their conceptualization as well as lack of empirical evidence to support their claims.

While the "Top-down" and "Bottom-up" models of the reading process contradict one another in almost every aspect, they do share one belief with regard to reading: namely, the goal of reading is deriving meaning from the printed word. What is different is the relative importance of the different components used in order to achieve that goal.

Interactive models of reading

The third class of reading process models is the interactive models. These models emerged on the grounds of criticism of "Bottom-up" and "Top-down" models. These models made an attempt to provide a more accurate conceptualization of reading performance. An interactive model is one in which processing from "Bottom-up" combines with processing from "Top-down" to "cooperatively determine the most likely interpretation of the input" (Rumelhart & McClelland, 1981).

Two interactive models of word-perception that fall into this category and will be briefly reviewed are the

Morton Logogen Model (Morton, 1969) and the Rumelhart and McClelland (1981) model.

The Logogen model was developed by Morton (1969) and has been an influential conception of the process of word recognition. The basic unit of the Logogen model is termed a logogen (derived from the latin "logos" or word, and "genus" or birth). Every word which the person knows has a corresponding logogen. Morton conceptualized that no matter where the source of information about the word comes from, a similar thing happens. For example, "One sees the written word "fork." One hears a voice saying "fork" and one understands the beginning of a sentence "the table was set except someone forgot one knife and one ----" (Crowder, 1982). The similarity in all these three cases is that the word "fork" is somehow activated and made available as a response. Logogens are conceptualized as the permanent memory representation corresponding to the words in the individual's vocabulary. The logogen consists of a "feature list." Namely: features that identify the word and a "criterion" which specifies the number of matches that must be found between the features of an input and the features of the logogen before the logogen is accepted as the correct identification of the input. Relevant information for each logogen can be obtained from visual analysis, phonological analyses, and the use of context. An important property of the Logogen model is that all of these activities can proceed at least partially in parallel. The results obtained from each of the three information sources are matched simultaneously against all the logogens in the logogen system. The process continues until one of the logogens finds enough features matching its representation. At that point, when the count of matches rises above a threshold value, the corresponding response is made available.

A visual presentation might help to clarify this model, and can be found in Figure 1.

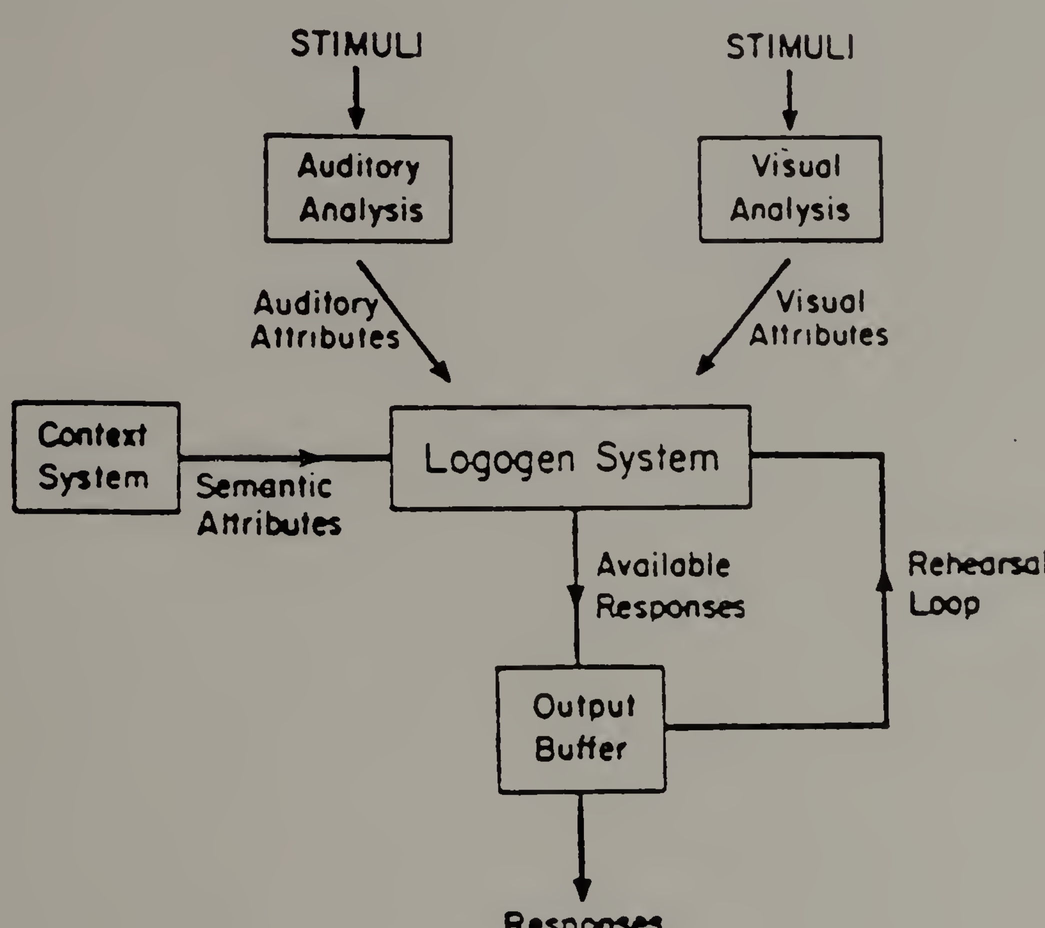

Figure 1. Flow diagram for the Logogen Model (Morton, 1969).

Rumelhart and McClelland (1981) proposed an "interactive activation" model of the logogen type. Their key assumptions are that each level of information (i.e., grapheme, phoneme, word) is separately represented in memory and that information passes from one level to the other in both directions. Communication can consist of both "excitatory" and

"inhibitory" messages. Visual illustration of the model is presented in Figure 2.

The authors describe the operation as follows:

> "...presentation of a visual stimulus initiated the process in which certain features are extracted and excitatory and inhibitory pressures begin to act upon the letter level nodes. These letter nodes will begin to send activation to those word level nodes and these will compete with one another and send excitation and inhibition back down to the letter-level nodes" (Rumelhart & McClelland, 1981, p. 46).

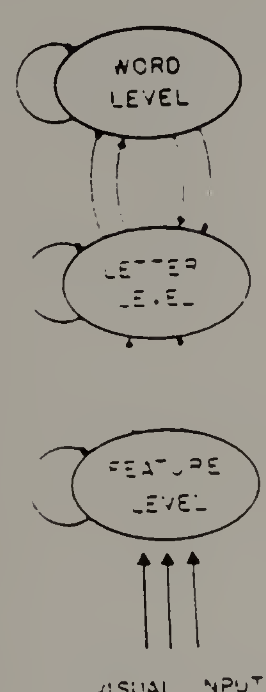

Figure 2. Levels of information of the interactive word-perception model of Rumelhart & McClelland (1981).

Crowder (1985), in his discussion of the model, gives a concrete example of how this model operates. For example: very early in processing, the letters H, E, F all would be activated if the feature level passed on that there was a vertical line bisected by a right angle horizontal line. Activation of other letters will be low. As the feature level detected a second vertical line in a certain location, the activation of H would greatly increase and the level for E and F would decrease. The same principle results in the activation of words. Thus, words having H, F, and E in this example would receive some activation that pushes them beyond their "resting level." The information travels, not just from letters to words, but also "down" from words to letters. Thus, in the previous example, at the word level, the words "OFF" and "DEN" are among those with some activation because of their having a highly activated letter in the second position. This will lead to activation of all the letters of the words although none of them except those consistent with "-" were "seen." Thus, since activation of these letters is added to that being initiated at the feature level, the final perception of the word has been speeded up. It is faster than if each letter had to be carefully identified before the words could be identified. Each code's level of activation at any given time is the algebraic sum of the excitation and inhibition it is receiving from all sources in the system.

While the Logogen Model is quite similar to the Rumelhart and McClelland model in their conceptualization of the reading process, it differs in its general assumption. Rumelhart and McClelland provide a much more specific account of how the model actually operates. Of course, these models imply a clear role for context in reading in terms of getting to the word faster while the context is present.

These three models of the reading process, imply different roles and give different weights to the use of context in reading. I have chosen these three models to represent, not necessarily the specific components of different models, but rather to outline the global trends with the different role and importance that is assigned to context in reading.

The Dual-Route Model for Word Recognition

Reading regular and irregular words

There is evidence that when single words without context must be read, there are at least two alternative routes to meaning. One is termed the "direct" route, in which the reader arrives at the meaning of the word directly from its visual appearance. The other is the "indirect route"; the reader who relies on that route uses the phonemic route in order to convert the word to its sound before getting to its meaning.

Regular type words are those words that confirm to grapheme to phoneme correspondence rules and they can be read by using either route. Irregular type words are those that are exceptions to the grapheme-phoneme conversion rules, and according to the theory can be read just by reliance on the direct route.

It is generally agreed that the ability to use both: direct and indirect access procedures is often associated with fluent reading skill, whereas reliance on only one procedure tends to be associated with a level of reading skill that is lower on the developmental continuum (Barron, 1987).

The accuracy and speed of reading regular as opposed to irregular words were also taken by Patterson, Marshall and Coltheart (1985) as indicators for sub-types of acquired dyslexia: phonological dyslexia, surface dyslexia and deep dyslexia. The different strength and weakness in reading single words by each sub-type readers have shown that selective impairment of one or other of these two routes is possible. Surface dyslexic according to this classification achieve a higher percentage of accuracy in reading orthographically regular words as compared to matched irregular words. They have selective impairment in their direct route to the lexicon. The phonemic or deep dyslexic patients, have difficulties is using the indirect route, as they experience severe difficulties in reading aloud orthographically regular nonsense words.

One study was found that studied the regularity effect in college dyslexic readers. Aaron, Olsen and Baker (1985), asked college age dyslexic readers to read a list of 36 regular and irregular words, devised by Coltheart. The reported that subjects misread both type of words equally as often. Almost all of the reading errors were substitutions of similar-looking real words. Aaron et.al, suggested that since good decoding skills may be expected to provide an advantage in the oral reading of the "regular" over "irregular" words, the performance of the dyslexic subjects indicated that they have less than adequate decoding skills. However a problem with that study is that Aaron et.al used just accuracy measure in reading the words, it is possible that incorporation of a reading time measure would provide additional information. In addition, they did not provide information regarding the performance of college age normal readers on that task.

Reading of nonwords

The ability to read nonwords requires the exclusive reliance on the "indirect" route to the lexicon. This task, is mostly used in the reading research literature as a tool to assess word decoding efficiency. It is typical finding that disabled readers are strikingly poor in their ability to read nonwords compared to populations of good readers.

Snowling (1980), compared the development of grapheme-phoneme correspondence conversion abilities in normal and reading-age matched dyslexic readers. She found that this skill increased with reading age in the normal readers, but not in the dyslexic. She concluded that dyslexic have a specific difficulty in grapheme-phoneme conversion, and that for them increase in reading age is attributable mainly to an increase in size of sight vocabulary. Pennigton, Lefly, Van Orden, Bookman and Smith (1987), report similar trends. They assessed phonological and orthographic coding skills of dyslexic and normal readers. They reported that while the phonological coding skill continued to develop in nondyslexic until adulthood, the dyslexic differed little across age in phonological skills. But, the at the same time they made linear progress in orthographic coding skill. Despite their improvement in this aspect of reading, the adult dyslexic did not close the gap between them and chronological control subjects in reading and spelling. Based on their results they suggested that the phonological coding may be a final common pathway for many etiologically heterogeneous subtypes of developmental dyslexia. Along the same line of findings Aaron and Phillips (1986) report poor decoding skills for their college age dyslexic students.

Definitions and Techniques Used to Study Context Use for Word Recognition

Four terms are being used interchangeably in the literature: word identification, word recognition, word perception, and lexical access, and there is no clear and well defined operational definition for none of them. Thus, for example, "Word identification" might be associated with decoding of a new word whereas "word recognition" might be associated with the process of recognizing a word that was already encountered in the past. Becker (1976), for example, had argued that the two aspects are needed for word recognition. He argued that processing at a level of sensory features is insufficient to afford a definitive identification for a word. Rather, what is needed is another source of information, the "lexical store," to verify the "physical features" of the stimulus. Other researchers use the term "lexical access" with the association of "getting into the right location in the lexicon" (Carr & Pollatsek, 1985), to get the available information for that specific word. ("Lexical access" and "lexical store" are terms that are used by cognitive psychologists to explain mental structure and operation. They do not imply literate physical entities corresponding to these concepts. Rather, they are abstract concepts which try to represent information processing system. Further discussion of the terminology and use of these and similar terms will be provided in a later section of the literature review).

Despite the different definitions used, it seems that most researchers will agree to a general process referred to as "lexical access." This process involves: "getting into the right location in memory--activating some kind of long term memory representation that contains experientially established information about the particular string of letters that is currently available or that was most recently available to the senses" (Carr & Pollatsek, 1985, p. 53).

Since there is no single clear operational definition of the term "word recognition," there is also no unique technique to study it. Despite the different techniques that are used in different studies, there is one common feature which transacts the various tasks and studies. Namely: researchers tend to compare reading performance in two conditions--reading words in isolation versus reading words in context. By comparing the reading performance in these two conditions they try to make suggestions about the relative role of context in the identification of words.

Studies of context effects on word recognition basically used the same techniques as those to study word perception in isolation. The most widely used are:

1. Studies in eye movements.
2. Lexical decision tasks.
3. Naming tasks.
4. T-scope tasks.
5. Oral reading error analysis.

The studies that will be reviewed will be categorized according to these different experimental paradigms. Discussion of these techniques will be provided in later sections before presenting the relevant studies.

It will be of great interest to look at the rationale for study behind each technique as well as the findings. Comparison of findings across different experimental paradigms will provide us with more insight into the process of word identification in isolation as opposed to context.

Besides the techniques used to study word recognition, it is important to specify the population that has been studied. Most studies used as their subjects skilled adult readers when studying the word-recognition process (Gough, 1972; Rumelhart, & McClelland, 1981). Others centered around different age groups (Biemiller, 1970) as well as different reading abilities (Stanovich, 1981; West & Stanovich, 1978).

In analyzing the literature on the topic, then, it is important to be clear in regard to the definition of population, definition of word recognition, and the assumption behind the technique used in each study.

Definition of the "poor readers" population is important as well. Most studies will define the poor readers based on the following criteria: school-age children, with average or above average I.Q.'s who achieve one year or more below grade level on some kind of reading test (depends on the different test used in each study). Others may fail to meet all the above criteria but still will define their subjects as poor readers (based, for example, on the teacher's rating), or others may compare sixth and second graders and define the second graders as poor readers (relative to the sixth graders).

These definitions are of great importance since they may suggest a relative value to the findings as well as provide us with an adequate knowledge in terms of our ability to generalize results as opposed to limiting them to specific studies and specific situations.

Bearing in mind the previous considerations, an attempt will be made while reviewing the studies to draw careful attention to the specific definitions used in each study.

We will turn now to some empirical evidence and look at reading strategies used by readers at different age groups and with different reading skills in reading words in isolation and in context, and try to combine these evidence with the models just discussed.

The Empirical Literature on Context Effects

Eye movement research

Before analyzing the studies used the eye movement technique to understand the reading process, it is important to present some general information regarding eye movements in reading. During silent reading, the eyes travel across a line of print in a quick movement called "saccade." Saccadic eye movements come between successive periods in which the eyes are steadily directed at a single portion. These periods are called "fixations." During a saccade, no useful information can be picked up. The information from the visual stimulus can be extracted just during the fixation. While the average fixation duration of an eye fixation is 200-250 milliseconds, there is considerable variability in the duration range from 100 milliseconds to over 500 milliseconds even for fairly simple text (Rayner & Pollatsek, 1989).

The logic behind studies that focus on recording and interpreting eye-movement patterns during silent reading is that eye-movement reflects cognitive processes during silent reading. Based on this logic many researchers used the "eye-movement" technique to study word-perception (Ehrlich & Rayner, 1984; McConkie & Zola, 1981; Rayner & Duffy, 1987, 1986; Rayner & Pollatsek, in press). Based on comparing eye-movement patterns in different text conditions such as probability of fixating on a target word in a neutral versus highly constrained and predictable context, they could make suggestions about the use of context for identifying words (Ehrlich & Rayner, 1981; McConkie & Zola, 1981).

While recording eye movement during silent reading provides accurate time measures for eye movements, at the same time there are some problematic aspects associated with it. First, one can argue that the experimental setting is not an exact replication of "reading a book" situation. Second, and even more important, is that at this point it is not clear whether eye movements reflect pure "lexical access" or deeper processes such as text integration (Rayner & Duffy, 1986).

Nevertheless, because these studies do provide accurate time measurements of eye movements "on-line," they are of great relevance and importance if one wishes to empirically evaluate the claim made by ""Top-down"" and ""Bottom-up"" theories.

One claim made by the "Top-down" models is that based upon the available context, readers should be relatively efficient at guessing the next word in a text. They suggest that the majority of time during a given fixation is spent hypothesizing about words yet to be fixated upon in peripheral vision. However, recent evidence based on eye-movement research points to the contrary.

In their review of the topic, McConkie & Zola (1981) came to the conclusion that:

> "... there currently appears to be no clear evidence that the contextual information environment exerts control over what visual information is used in reading. In fact, subjects appear to be responding to considerable visual detail of words that are almost completely constrained by their prior context." (McConkie & Zola, 1981, p. 173)

To gain more confidence in this conclusion, we can look more closely at some of the studies that led them to this statement. In a study conducted by Zola (1979), he tried to investigate contextual effects of an "on-line" reading task. He showed paragraphs in which the target word was preceded immediately either by a high constraining word or by a word neutral with respect to it. (For example, "**buttered** popcorn" - highly constrained, "**delicious** popcorn" - neutral). He had subjects read one hundred of these paragraphs while their eye movements were recorded, and analyzed them to determine the frequency with which the target word was directly fixated upon under high and low constrained conditions. Zola found that subjects made fixations on the target word over 96% of the time regardless of the level of constraint. There was no observable tendency to skip the target noun even when it was almost completely specified by the context. However, a difference was found in the average fixation time which was fourteen milliseconds shorter in the constrained condition. This difference indicated to the experimenter that there was some facilitation but not in terms of skipping the words, rather in shorter fixation duration.

One problem with Zola's study was raised by Ehrlich and Rayner (1981), namely that Zola used as his target words which were seven or eight letters long. That meant that these words would be fixated 95% of the time in any condition (Ehrlich & Rayner, 1981). Moreover, the words were highly redundant only as a result of the immediately preceding word. To improve upon these weaknesses, Ehrlich and Rayner (1981) conducted a study in which they used target words of five letters' length and in which the context for the critical target word was built up through the passage rather than from only the preceding word. They studied the probability of fixating upon the target word in a constrained and neutral context. Another point of interest in the Ehrlich and Rayner (1981) study was incorporating misspelling into the target words and thus enabling them to measure the subjects' sensitivity to factual information. They recorded eye movements of twenty-four college students, each reading thirty passages. They reported that in terms of probability of fixating the target word, readers had a lower probability of fixating on words when the context was highly predictive of the target word than when it was not; and there was a higher probability of fixating on target words when there was a misspelling. In terms of the fixation duration on the target words, they found that the average fixation duration was longer when there was a misspelling than when there was not. (Average fixation duration on the target word in the misspelling condition was 313 milliseconds versus 221 milliseconds in the control condition--a difference that reached statistical significance). Another finding was that high constrained passages in which there were no misspelled words resulted in 33 milliseconds shorter average fixation duration than did low constrained passages. When subjects were asked to report about misspelling, it was found that they had more difficulty reporting a misspelling in the high-constrained passages than in the low-constrained ones. But, the interesting results are that most of the time that subjects reported the misspelling, they also fixated on those words. It was in just 13% of the total number of cases that subjects fixated upon the target word and did not report the misspelling and the majority of these cases were in the high-constrained passages.

These results taken together with the results reported previously by Zola (1979) provide little support to the claim made by the "Top-down" theories (Goodman, 1967; Smith, 1971). The ""Top-down"" models or the "hypothesis guessing model" conceptualized the reading process as a "psycho- linguistic guessing game." Goodman (1967) assumed that the reader was minimally sampling the text in order to confirm ongoing hypotheses about words that were based on context. Smith (1971) argued that during each fixation the reader spent the major portion of the time generating a prediction of what would come next based upon what had already been read. The reader then moves the eyes and confirms the hypothesis and starts the cycle over again. However, given that the target word is highly predictable in the high constrained condition as in the previous experiments, the reader, according to the hypothesis testing model, should be able to generate accurate hypotheses which could be confirmed without ever really fixating on the word. The partial cues available from the parafovea would be sufficient for this confirmation. Yet, findings from the studies reviewed show that this was not usually the case. On the contrary, it was found that although in some cases contextual information does allow a reduction in the reader's reliance on visual information, it was still the case that misspellings were detected 75% of the time; and the target word was fixated upon 64% of the time in the high-constrained condition. With longer words, Zola found that the target word was fixated upon 97% of the time. Moreover, they found evidence that readers were highly sensitive to even minor feature manipulation in the low constraint context. Ehrlich and Rayner (1981) took these results to suggest a contextual facilitation account rather than a hypothesis testing account.

In a more recent study conducted by Balota, Pollatsek and Rayner (1985), in an attempt to investigate the interaction between context constraint and parafoveal information, they varied the context as well as the parafoveal visual information the subject had available before fixating upon the target word. The target words were either highly predicted by the prior context or less predicted but semantically appropriate. The peripheral information was varied according to five conditions: 1) visually similar non-word, 2) visually dissimilar non-word, 3) identical condition, 4) semantically related, 5) anomalous condition. Thirty college students read one hundred sentences each while their eye movements were recorded. The eye movement patterns in this study were quite similar to those reported in the previous studies. Subjects fixated on the target word in the majority of trials. However, they spent less time on the target word when it was preceded by a visually related peripheral preview and even more so when the target word was highly predictable from the sentential context. Balota et al. (1981) suggested that peripheral information primarily influences visual analyses which most likely influence the speed of lexical access. At the same time, appropriate context facilitates this process as well as the speed of integrating a word into a prior context. Thus, the "Bottom-up" peripheral information has more impact when the contextual constraint is strong than when it is weak. The results suggest that both these sources of information are used in the process of reading.

However, the parafoveal preview effect did not provide any evidence for semantic processing of parafoveal words. There was no evidence to suggest that meaning of yet to be fixated words in parafoveal vision influences the current fixation.

Balota et al. (1981) took those results as contradicting evidence to a view of reading that emphasizes expectations and predictions about coming information as the major skill in reading and visual information analysis as being just a confirmation.

Summary of eye movement research

Evidences from eye-movement studies suggest that actually contextual information does allow a reduction in the reader's reliance on visual information. This reduction is expressed in shorter fixation durations on words that are preceded by a highly constrained context. Thus, one can interpret these results as if they result from reduced perceptual analysis--the claim which is actually made by "Top-down" theories. However, no evidence has been found that shorter fixation duration reflects the use of only a small amount of the visual information needed to verify the hypothesis concerning a word. Rather, it appears that readers are responding to most of the visual details of the stimulus even under high language constrained conditions. Reduced fixation duration may reflect either that less time is needed for lexical access or that less time is needed to integrate the word that is accessed in the lexicon into the text context.

Although there is controversy concerning the issue to what extent the eye movements reflect cognitive process--and, at this point, it is not clear if they reflect lexical access or deeper processes--it is quite clear what they do not reflect. Namely: eye-movements do not reflect reduced visual analysis and thus provide no support to the "hypothesis testing" model proposed for the explanation of the reading process (Goodman, 1967; Smith, 1971).

Oral reading analysis studies

Studies based on oral reading analysis to explore the relationship between word recognition in isolation and in context can be broadly divided into two main categories:
1) studies that focus primarily on comparisons of the percentage of errors made by readers during oral reading of words in isolation and in a context condition; [based on this comparison, claims were made with regard to the strategies used by the readers in the two conditions].
2) Miscue analysis studies: The belief behind these studies is that errors are not "failure," but rather they provide us

with the "window" into the reading process in which the reader is involved. Although different studies used different definitions and classification criteria for analyzing the errors, there are two general error categories that are accepted across the studies. One category is based on the term "semantically acceptable miscue"; namely, given the language up to that point, the miscue tends to be a continuation of the sentence, although not necessarily combined properly with text not yet encountered. The observation "semantically appropriate" is taken as evidence that contextual information was used in identifying the words. The other category reflects the "graphic similarity" of the miscue to the total misread word. The degree of this similarity (which is different by definition from study to study) is taken to reflect the extent to which the subject attended to the graphic source of information in word identification.

Using the oral reading analysis to study word recognition involves several problems. From theoretical point of view, this technique may imply levels of processing beyond word recognition levels of processing. For example, hesitation and omissions might very well be some complex functions of word recognition and comprehension processes, self-corrections might in part reflect comprehension monitoring.

Another problematic point is that in those studies the subject is required to produce a spoken version that will be acceptable to the listener. An interesting point made by McConkie and Zola (1981) is that particularly older readers, when required to read aloud, produce a synonym for a word that is actually in the text. This means that while probably the visual characteristics of the word were used in getting the meaning, they were not used to select a word for pronunciation (this is a similar characteristic to that of "Deep Dyslexia," Coltheart, 1981. The most striking symptom of this disorder as described by Coltheart is "the semantic error" when the patient errs in attempting to read aloud a single word, his response is often a word which is semantically related to the stimulus.) Thus, in reading aloud, one should distinguish between what information is used to understand the language and what information seems to have been used to select the words to say.

Bearing this classification in mind, I would like to suggest that oral reading analysis should be taken with caution in regard to the information it reveals.

Despite the problems associated with the technique, these studies were taken to highlight the use of context to aid word recognition and attracted the interest of many educators in the field. Actually, there might be promise in these studies. This promise lies in the fact that these studies used school-age subjects who received complete stories from instructional materials and took place in educational settings. As such, they stand in distinct contrast to studies that use adult subjects, limit the material to word or sentence level items, and measure reaction time to isolated events in an artificial setting. It seems quite tempting to follow along the beliefs presented by this line of research. moreover, on top of the failure to provide adequate tests of the major assumptions involved in this approach, there is an additional problem of inadequate sensitivity to important methodological issues. Such as: (1) Different studies use different units of analysis (punctuation, letter, word);(2) Different definitions and calculations used for the "same" categories. For example, "graphic similarity" is calculated by a complex formula (Weber, 1970), a 5-point scale (Cohen, 1974-75), and similarity of initial letter between observed response and expected response (Biemiller, (1970); (3) In the cas of multiple-source errors, there is difficulty in distinguishing which of several information sources was used in error production; (4) There is lack of attention usually given to the effect of relative passage difficulty on error type.

In spite of these problematic aspects, much research had been done using this experimental method. Reviewing all of it will be much beyond the scope of the present section. Instead, I will review in depth some of the most influential studies and will use them as examples to highlight the strength and weakness of this approach as well as to give some suggestion for future research.

<u>Studies based on comparing error percentages made by readers in reading words in context and in isolation</u>

Studies based on comparing the errors made by poor and skilled readers in reading words in isolation as opposed to context were carried out by Allington and his colleagues. (Allington, 1978; Allington & Fleming, 1978; Allington & McGill-Franzen, 1980). Allington (1978) studied severe reading disabled children from a clinic population. Poor readers were selected based on two criteria: if they scored more than two years below their potential level as measured by the "Diagnostic Reading Scales" (Spache, 1972), and if they were orally able to read material of second- grade difficulty. Subjects were instructed to read aloud under two conditions: isolated words and coherent passages. Errors made by the subjects were recorded and an analysis of them was carried out for each subject separately. The passage used in this study was unfamiliar to the subjects and its readability level was estimated to be at a high second grade reading level. The isolated words were the same words which appeared in the passage, typed on different cards and presented serially.

An advantage of this study is that instead of looking at group means and thus possibly obscuring differences between individuals, Allington provided data on individual performance and raised questions with regard to the general correlational studies that report high correlation between reading ability in isolation and in context (Shankweiler & Liberman, 1972; Perfetti, 1985), but do not look at the specific individual. Based on individual profiles, Allington reported that the poor readers in his study were spilt into two groups: eight scored better on context and eight scored better on isolation. When looking at the errors made, he found that only 11% of the total errors were identical errors. This means that most of the errors were unique to one condition. His results suggest that when looking at individual profiles, one cannot predict performance from one condition to the other. "There are poor readers who can identify words in isolation, but fail to recognize identical stimuli imbedded in context" (Allington, 1978, p. 44). However, his study did not proceed to the next logical step -- to analyze how these words were misread as well as to provide some characteristics of the words themselves. It might be the case that some word characteristics such as frequency, length of word, etc. affected types of errors and rates to a greater degree, and had a different effect on different readers. Moreover, since neither I.Q. scores nor age were reported in this study, one cannot be certain how to interpret these results. They very well may reflect differences of I.Q. scores as well as developmental trends.

To account for the relationship between word characteristics and types of errors made, we can look at another study conducted by Allington and Fleming (1978). This time they were looking more specifically at the effects of context on the identification of high-frequency words, and comparing the performance of fourth graders, poor and skilled readers. The poor readers were defined in this study as those who scored 2-3.6 grade equivalents (on the word identification test of the Woodcock Reading Mastery Tests) and the good readers were those who scored on grade equivalents of 4.5-7 in the same test. Again, a problematic point is that no I.Q. scores were reported. Allington and Fleming (1978) reported that the significant difference between the groups was in the random condition. While the good readers' performances in the random order were similar to their performances in the context condition, the poor readers' accuracy dropped substantially in the isolated condition. Taken together with the previous study, these results suggest that poor readers can employ available language cues to reduce inaccuracy when reading. Allington and McGill-Franzen (1980) conducted a study to provide further support for these findings. They concluded that "it was the poor readers who benefitted more from the additional information" (Allington & McGill- Franzen, 1980, p. 798). They made it clear that "word identification errors elicited in tests in isolation do not constitute a solid basis for predicting errors in connected text." These results appear to be quite important from the point of view of evaluation and testing. Moreover, they were taken by these researchers as evidence to contradict the notion advocated by Shankweiler and Liberman (1972) who argued that "a child's reading of connected text tends to be only as good or as poor as his reading of individual words" (p. 298). This claim, if taken literally, suggests that those are the same words and which the reader has the same difficulty with in context and in isolation. However, the claim that was made by Shankweiler and Liberman was based on correlational study and thus should be interpreted in light of the general frame of mind of their study. As such, the high correlation between the ability of reading words in isolation and in context was taken to claim that those students whose performance on the isolated list is low most likely are the poor readers. What does not follow is that it is possible to predict the exact type and extent of the errors from one condition to the other. Yet, it is still the case that although the poor readers may perform better relative to themselves in context (Allington & McGill-Franzen, 1980) their overall achievement is lower than the skilled readers who tend to perform as well under both conditions (Shankweiler & Liberman, 1972).

One additional note of importance should be made at this time. Regarding the way "word recognition" was defined in these studies--although no clear definition was given explicitly, the intention of these researchers seemed to be of "word recognition"; i.e., a word previously learned when encountered once again will be recognized. While differences are reported between individuals, no analyses have been provided for the skills which contributed to the performances. Is it sight word vocabulary or do the children actually apply grapheme to phoneme rules? Based on these studies, one can not answer how these children attack words they have never seen before. Allington, based on the model suggested by Guthrie (1972), concluded that "poor readers in this study had neither mastered components nor integrated them into a holistic process, good readers accomplished both" (Allington, 1978, p. 414). However, a problematic aspect of this specific conclusion is that he did not provide the adequate data to support it.

Based on the same logic of comparing percentage of errors made in the two conditions as the basis for implying word identification strategy, Juel (1980) conducted a study in which he tried to control context (moderate and poor) as well as word characteristics: easy/hard decodable words and high/low frequency words. He compared reading performance of the words in isolation and in context. Context was defined in this study as a sentence preceding the target word. Juel used as his subjects 72 second and third grade students who were divided into three levels of performance: good, average, and poor readers. This classification was based on their reading groups in class, scores on the overall reading achievement in the CAT and reading abilities in a graded word list. He reported that the overall pattern of the results reveals that all readers appear to utilize context. However, the skilled readers show little benefit from context except on low frequency, hard decodable words, whereas the errors made by the low ability readers indicate that they benefit considerably from context for all word types. While this study based its interpretation on mean scores and doesn't look at individual performance, it does report the general trend. Based on a relatively large sample (n = 72), this trend looks meaningful. Taken together with studies based on individual profiles, it seems that these results fit into the same pattern and provide further evidence to the facilitation use of context for poor readers.

Along the same line are findings reported by Krieger (1981) who examined individual differences in poor readers' abilities to identify high frequency words presented in isolation and in context. Poor readers in this study were reported to do much better in the context condition which means that they increased their word identification abilities through the use of context material.

<u>Studies focused on miscue analysis</u>

Studies that based their analyses on the "miscue" notion believed that analyzing error patterns would provide us with information about the reading process. While the studies reported above were based on children aged nine and above when individual differences in reading ability were already established, researchers utilizing "miscue analysis" focused mainly on first graders' error analysis (Biemiller, 1970; Barr, 1974-75; Clay, 1972, 1982; Cohen, 1974-75; Goodman, 1977; Weber, 1970).

Based on oral reading analysis made by first graders, Biemiller (1970) identified three stages of reading development:

1. A stage of contextual dependency, defined as the stage in which the highest proportion of errors made will be contextual errors.
2. A stage of increasing attention to the graphic processing--which will be defined as a high proportion of no response errors, and decrease in a proportion of contextual errors.
3. A stage where the integration of both graphic and contextual cues occurs--an increased proportion of contextual and graphic errors will be found.

Biemiller (1970) found that no one had skipped the NR (no-response) phase. Moreover, those children who initiated the NR phases earlier in the year were those who turned out to be the more able readers at the end of the year as opposed to those who remained longer in the pre-NR phase who were uniformly the poorest readers. One should remember that the teaching instruction in these classes focused mainly on the whole word approach. Biemiller proposed the interpretation that probably it was the child's ability to grasp the notion that one specific word corresponded to one written word, and that understanding stood behind his success in mastering the reading process. This general trend of observation is very much in agreement with what is known today: the better readers can utilize both sources of information (graphic and contextual sources), while most poor readers depend mainly on contextual cues. Their deficiency in using graphic cues holds them back from becoming better and more efficient readers.

A similar analysis of errors made by first grade students during oral reading was carried out by Weber (1970). Interestingly, the result she reported replicated the same patterns that were observed by Biemiller (1970). In terms of errors which were grouped under graphic similarity, the better readers approached correct responses more closely than did the slower readers. However, in terms of grammatically acceptable errors (an error was judged acceptable to preceding grammatical context if the written sentence could be completed beyond the error in any way, not necessarily by the remainder of the written sentence), the difference between the groups was negligible. This was taken by Weber to suggest that both the strong and weak readers used the constraint of preceding grammatical context to reduce the range of responses. However, while all children were affected by context, almost all the children in the High Group had skill enough to identify words that they had never been taught while most children in the Low Group could not read new words. Since the reading instruction in this class used a basal reader which stressed the whole word approach, an appropriate question is, "What skill have the high ability readers acquired that the low ability readers seem to lack?" Since the strongest difference was centered around the use of the "graphic code" it might point to the same direction as Biemiller (1970) and more current research as well (Vellutino, 1979; Perfetti, 1985; Liberman & Shankweiler, 1979).

An important note to make regarding the previous studies is, of course, the fact that children in both studies were instructed according to the whole word approach. Thus researchers (Cohen, 1974-1975; Clay, 1972) raised the question if it is possible for a different pattern of results to emerge when observing children who come from a different instructional approach? Or, to put it in another way, "What is the relationship between the teaching instruction and the strategy used by children?"

Some data which has been accumulated toward answering this question was provided by Cohen (1974-75). She analyzed oral reading errors of fifty first graders, taught by the phonic approach. Another important aspect, which was incorporated in her study but not in the others, was using as test material non-instructed material. By so doing, Cohen still used non-artificial material, but at the same time had a better chance to gain insight into word attack skills. Other studies used instructed materials and thus one cannot be sure what strategy is used by the reader. Cohen, based on her observations, pointed to the strong relationship between teaching method and reading behavior. When early in instruction the whole word approach is the dominant one, the high proportion of errors are contextual errors. However, when the reading technique emphasizes sound letter correspondence, the NR errors are predominant. The NR errors were interpreted by her as by Biemiller (1970) to indicate awareness of this grapheme to phoneme correspondence as well as confusion about it.

Cohen looked also at the development of different strategies by poor and skilled readers. The trends she observed replicated the pattern reported by other researchers (Allington, 1978; Biemiller, 1970; Weber, 1970). Skilled readers' error trend was toward an increase in the use of those strategies which employed both meaning and graphic aspects of word identification, whereas poor readers' performances revealed that they were not aware of oral to written word correspondence. They provided a high proportion of "story" errors (gave a whole new story; for example, text: "Mr. Green and Mr. Kanda look for a chimp." Utterance: "Moon sees the cage. He wants to get away." p. 641). Another feature was that their strategies were less systematic in comparison to those of better readers.

I would like to suggest at this point that this error trend might be in accordance with the notion of compensation proposed by Stanovich (1980). While the normal reading skill may be very similar among subjects and developed through definite stages (Biemiller, 1970), when dealing with reading difficulties we may be dealing with the "compensatory model." Namely, readers compensate for the difficulty they encounter on one level by relying heavily on another skill as a source of information. While the normal readers might develop their reading skill at a comparable level of rate and success, the poor reader may encounter difficulties at different stages of the reading developments and thus develop different compensation strategies, which will differ from reader to reader. This frame of mind can help in interpreting why Cohen could not find in her study systematic strategies used by the poor readers.

The notion that the error pattern made by first graders is related to the instruction method gained additional support by Barr (1974-1975). She compared errors made by twenty-two first graders, half of them were instructed by a phonic method and half by a sight word emphasis. She found that strategies of individual children were determined to a significant degree by the class instructional method; moreover, children who initially used a different strategy than the one emphasized in class shifted toward a strategy in accordance with that used in class.

Another bulk of research findings in this area is provided by work done by Clay (1972, 1982) in New Zealand. She conducted a longitudinal study in which she analyzed oral reading behavior of 100 five years old during their first year of reading instruction. (Children in New Zealand enter school when they are five years old.) Weekly recording of observation of their reading performances yielded 10,525 errors. Children in this study were instructed by the whole language approach. She reported that 50% of error behavior of five to six years old occurred in sequence where whole stretches of text were substituted. She examined the role of the syntactical rules of grammar in the reader' selection of a response as well as the extent to which reading errors showed the influence of phoneme-grapheme learning. She found that despite the very general interpretation of the estimate of grapheme-phoneme correspondence, only 41% of the errors showed that the child might be responding to some visual characteristics of the letters. These results were relatively consistent across all levels of reading progress and they contradicted the studies that had been done in the United States that found that the better readers produced more graphic-similar errors than the poor readers. Most of the errors (72%) were syntactically and semantically appropriate for the sentences they were reading. She took these results to suggest that "the errors young children make are more often guided by the grammatical structure of the sentences read rather than by the letter-sound relationship in the words" (Clay, 1982, p. 115). Unique characteristic of the reading behavior which was recorded by her, but not by others, was the "self-correction" behavior. Self-correction behavior was seen by Clay as overt evidence of mental activity, namely, "a child has a vague awareness that he must employ self-instructions" (Clay, 1982, p. 23). Focus on this behavior has resulted in the following observation: the high ability reading group and the high-medium reading ability group made spontaneous corrections every three or four errors and were significantly different in this behavior from the low and the low-medium ability readers where the self-correction was one in eight and one in twenty errors respectively. The high correction rates were associated with high reading progress and were inversely related to error rates.

As opposed to Biemiller (1970) who proposed "stages" that the children need to pass through in order to master the reading process, Clay prefers to talk about skills that need to be integrated: "the visual perception of print, the directional learning, the special types of language used in books and the synchronized matching of spoken word units." ..."Individual differences will emerge as the fast learners master these tasks in a few weeks while the average and slow learners take much longer" (Clay, 1972, p. 75).

Analysis of some of these children in their third year of instruction showed that still was a strong trend for the substituted words to be of the same grammatical function as the text word, a trend that characterized the reading behavior of younger children as well. These results varied with the quality of reading. The best readers had 80% grammatically acceptable substitutions, the average readers 70% and the low progress readers only 62%. Meaning was also involved in reading behavior: the best readers retained meaning most often, whereas readers with low accuracy were more likely to produce an acceptable English sentence structure than to retain the meaning of the sentence. An analysis of letter-sound correspondence in single word error showed that 87% of the children's attempts involved some letter-sound correspondence. This figure is much higher compared to the 41% reported for five to six years old. No marked difference was found between progress groups.

Clay's (1972, 1982) studies point to the direction that although with reading progress, errors have more grapheme-phoneme correspondence, it is still the case that error production is dominated by language constraints rather than by visual analysis.

Additional findings based on older readers are provided by Goodman, Y. (1976). Goodman provided developmental trend for reading proficiency based on the analysis of reading miscues of six youngsters who were taped at regular intervals for a period of seven years from 1976 to 1982. In this study Goodman defined the efficient reader as one who is "able to integrate meaning while using the fewest possible cues from the graphic display (Goodman, 1976, p. 113). However, this definition is not based on any agreed upon criteria nor does it necessarily reflect any common belief that is actually proficient readings behavior. Moreover, the data provided by her in this study are based just on six children. Thus it seems more appropriate to me to state her ideas in terms of hypotheses rather than in terms of a definite statement such as, "As readers get older, regardless of developing proficiency, they produce miscues which have closer phonemic and graphic similarity to the text. This is true to all readers and does not seem related to test scores, reading methodology or reading effectiveness" (Goodman, 1976, p. 119). However, there are some problems with Goodman's conclusion: first, there is no description provided for the analysis used. Rather, there are some examples of miscues made only by one child. Based on this available information it seems unlikely to accepts statements regarding the proficient reader who "begins to make greater use of the graphic display when the going gets tough and when the semantic and the syntactic cuing is destroyed" (p. 120). While there is not enough convincing evidence for these remarks there are many studies based on large samples who point quite to the contrary. Namely: when the material gets harder, once the reader encounters difficulties in reading the words, then he will rely more heavily on context and not vice versa.

A recent study which supported the latter view was conducted by Goldsmith and Nicholich (1984). The subjects in their study were 51 average readers: fourteen children were in grade two, fifteen in grade four and twenty-two in grade six. All of them had a WISC I.Q. in the normal range and showed at least grade level achievement on the Woodcock Word Identification Passage, Comprehension, and Word Attack subtests. Each subject read two passages--one of narrative and one of science context. The passages were equal in readability and word frequency. Each child was tested individually. Analysis of the readers' errors indicated that the sixth graders produced more phonemic similarity errors than the second and fourth graders. In contrast, syntactic acceptability errors and semantic acceptability errors showed no difference between grades two and four, and four and six, but there was a difference between grades two and six. The direction of the difference was such that it indicated that younger children used more semantic strategies while the older children showed more decoding strategies when encountering difficult words. These findings are in conflict with those of Goodman(1976) and Clay (1982).

Summary of oral reading analysis studies

This section has provided a review of some of the studies that used an oral reading analysis to study reading strategies of poor and skilled readers. This review did not attempted to provide a thorough review and criticism of all the work that has been done in this area. Attempt like that will result in an entirely different project and will be much beyond the focus of the present one. Instead, my purpose was to present the logic of the technique as well as to present some of the most influential studies mentioned in the literature. However, even reviewing just a sample of the work that has been done leads to basically two contradictory patterns of findings.

One pattern of findings, based on miscue analysis, was advocated by Goodman (1976) and Smith (1978). The most prominent of their claims were that:

1. Proficient readers use more contextual information during reading than less proficient readers.

2. Proficient readers use less graphic information during reading than less proficient readers.

3. Less proficient readers should receive more frequent instruction in context-use strategies (Goodman, 1976; Smith, 1978).

On the other hand, other researchers who used an oral reading analysis made claims quite to the contrary (Allington, 1978; Biemiller, 1970; Barr, 1974-75; Cohen, 1974-75, Goldsmith & Nicholich, 1984). Their findings pointed to the direction that:

1. There is a strong influence of the teaching method on the individual's strategy employed in reading.

2. The better readers are those who can utilize both codes: graphic and contextual, whereas the poor readers' difficulty centered around "breaking the graphic code."

These contradictory results, in addition to the methodological and theoretical concerns raised above, make it impossible to arrive at any firm conclusion with much confidence.

However, a claim was made in a previous section that in the case where we are studying the unobservable structure and operations we might gain confidence from the results by looking across various experimental paradigms and settings.

Results which will tend to converge in spite of different populations and different tasks might yield to a greater confidence in regard to the conclusions based on them.

Oral reading analyses that point to the direction of "better readers can utilize both codes" is in agreement with findings based on eye-movement research, and also with findings from response-time methods (lexical decision and naming tasks). The second direction which points to the conclusion that skilled readers are those whose basic reading performance depend on context and require minimum visual analysis does not get further support from other experimental paradigms, and is highly doubtful.

Another interesting point is the link between the research and implications for instructions. While the observation might be quite similar across studies, different researchers will tend to interpret them quite the opposite to one another in terms of educational implications. Kreiger (1981) advocated context oriented method of word recognition. He stated that

> "if instruction is consistently structured to reading in context so poor readers could employ their linguistic knowledge for identifying words, their reading abilities would develop more fully" (p. 271).

On the other extreme is the suggestion made by Biemiller (1970) who advocated no-context at all.

> "The teacher should do a considerable proportion of reading training in situations providing no context at all, in order to compel children to use graphic information as much as possible. As they

> show evidence of doing so, through accurate reading without knowledge of context, they would be given contextual material to be read."

Further discussion of this issue will appear in a later section of this paper.

<u>Naming and lexical decision tasks</u>

Even though mental procedures are not directly observable, they take time to perform. Based on measuring the different times people require to perform different tasks psychologists can make inferences about what internal representations and operations are like.

"Lexical decisions" and "naming" tasks are techniques that are based on "response time" measures and have been used very often by cognitive psychologists to provide accurate time measure of "how long it takes to identify a word." In lexical decision tasks, a word is flashed on a screen and the subject is required to push the "yes" button if the string of letters is a word and the "no" button if the string is not a word. Usually, response latency and errors are measured and used for analysis.

The problem, however, with this technique is that it is not sure at all that subjects really know the meaning of a word at a moment they know it is a word. Another problematic point is that lexical decision latency may reflect post-lexical decision processes and thus do not provide a good measure of "pure lexical access" (Rayner &

Pollatsek, 1989). Another criticism centered around the claim of a lack of "ecological validity" of the task.

In naming tasks, the subject is required to read aloud as fast as possible a string of letters that appears on a screen. Some of them might be words, while others might be non-words. Reaction times and errors are recorded and analyzed. However, by measuring response time, we do not measure the isolated event of "word identification," rather we measure how long it takes the subject to say the word aloud. Thus the time measure actually reflects lexical access and response time.

In their review of the methods being used to study word identification, Rayner and Pollatsek (1989) stated:

> "In spite of everything, we do seem to be converging on an estimate. The reaction time studies demonstrated that word identification probably takes less than 400 milliseconds, the experiments with brief representations demonstrated that it takes at least 50 milliseconds and the estimate from reading suggests that a number is something like 200 milliseconds."

Thus, while not one of these techniques by itself can provide an accurate measure of word identification time; results across various tasks and various experimental paradigms do give us upper and lower time limits for word recognition process.

Researchers who based their studies on these techniques looked upon them as providing a good idea about the time needed for word recognition. Thus, for example, by comparing response time of words in isolation to words in context they could make suggestions with regard to the relative role of context in the identification of words. Studies using these paradigms were carried out on adults as well as on children, and were used also to compare between populations of different reading abilities.

The following section will review these studies with a special attempt to highlight developmental trends as well as to compare reading abilities. Then it will be of interest to compare the findings of these studies with the studies reviewed in the previous section.

Developmental changes in context use

In order to investigate the developmental changes in the influence of context in reading, West and Stanovich (1978) studied three different age groups--fourth graders, sixth graders, and college students. Each subject was involved in three separate tasks: 1) word reading task (words preceded either by congruous semantic context, incongruous, or without context); 2) word color-naming task (subjects were asked to name the color of target words as rapidly as possible under the same three context conditions described in task 2); 3) non-word color-naming task (subjects were asked to name the color of target non-words as rapidly as possible under conditions with and without the prior display of a sentence context). Context was defined as a preceding sentence, and the target always appeared last in the sentence preceded by the word "the." The subjects read the words aloud and approximately 0.5 milliseconds after the subject pronounced the last "the" in the sentence, the target word appeared. Response time then was measured. The logic behind Task 1 is clear and relates to the different influences that semantic related context has on word recognition versus unrelated semantic context. Context facilitation effect will be inferred if the response time in specific context conditions will be faster than response time to a word in "no context at all." Context inhibition effect will be inferred if response time to a word will be longer in the context condition than in "no context" condition. Tasks 2 and 3 were aimed at testing the hypothesis that context effects reflect "automatic processes." Automatic process is defined by West and Stanovich (1978) when "it can take place without attention being directed to it." Tasks 2 and 3 are based on the "Stroop effect." ("Stroop effect" was named for the psychologist J.R. Stroop who demonstrated it in 1935. In his experiments students had to name as quickly as possible the colors of the inks that color words were printed in and also name the colors of a list of color patches. Stroop found that students required an average of 63 seconds to identify colors on the color patch but an average of 110 seconds to identify the ink colors on the word list.

Apparently, students could not avoid reading the words when they tried to name their ink colors and the conflict between the name and the ink color slowed down their responses) (Glass & Holyoak, 1985).

The idea of the "Stroop effect" was extended by West and Stanovich (1978) to study whether contextual facilitation occurs via an automatic process. In Task 2, if the color-naming is preceded by a sentence context that automatically primes a response other than the relevant color, then color-naming time should be increased. Such an effect will indicate that contextual facilitation is mediated, at least in part, by "automatic process." In Task 3 subjects were asked to name the color of target nonwords as rapidly as possible under conditions with and without the prior display of a sentence context. Context effects in this task will reflect the automatic influence of context since no real word appears in the target word position.

West and Stanovich found that the speed of reading target words increased steadily from fourth to sixth grade to college students and the mean length of time required to read target words was significantly shorter in the congruous-context condition than in the no-context condition for the three groups. However, the interesting results were:

1. The size of the facilitation score (congruous context minus no context condition reaction time) did not

significantly differ between the groups; there was no evidence that the use of context increased with age and reading ability.

2. While the mean length of time required to read the target words in the incongruous context condition was significantly longer than in the congruous condition for the fourth and sixth graders, there was not such an effect for the college students (inhibition score = congruous context minus no context condition).

3. The context condition had a large influence on the color-naming task for fourth and sixth graders but did not affect the college students.

4. The mean length of time required to name the colors of the target words was significantly longer in the incongruous context condition than in the no-context condition for fourth and sixth graders but not for the college students.

5. In the non-word-color naming task, there was an interference effect when the context was present and the size of the interference effect was significantly larger for the fourth and sixth graders than for the college students.

These results indicate that the relative speed of contextual facilitation processes and automatic word processes change with age. While facilitation can be observed in each group level, inhibition can be observed only in school age children, not in college age students. These results reflect the performance on the reading task as in Task 1 and the performance on the "color interfering" task as in Tasks 2 and 3.

Worth mentioning with regard to generalizing these results is that West and Stanovich (1978), while discussing reading levels and skills, refer to reading skill as a developmental continuum. Thus, college students probably are better readers than third graders. That is not to say that the third graders are poor readers. Their relative reading ability is poorer than that of the college students. Of course, there is variability in each group, but the overall reading ability of the subjects is adequate to their chronological age (fourth graders had a mean reading ability at the 5.5 grade, the sixth graders had a mean reading ability at the 7.5 level, the college students had a level of performance at or near ceiling level with a mean score of 98 out of a possible 100. All these scores were obtained from performance on the level 1 portion of the WRAT test).

Simply said, in order to make generalizations about the results, one must carefully analyze the definitions used in each study. And specifically in this study the findings actually reflected changes across a wide age range. Keeping in mind this awareness, we can then proceed to the next questions: How can one interpret the results? Does the lack of inhibition found in the college subjects reflect their comprehension processes or does it reflect their faster word recognition mechanisms? Is the use of context a source of individual differences or rather is it the fast and efficient word recognition mechanism that will lead to "capacity free" word recognition thus leaving attention to the higher level, namely comprehension?

A possible way of answering this is to study more carefully the performance of adults. If what determines their pattern of results is their fast word recognition, then added difficulty to words may force them to rely more on context and thus to mimic the performance of children. However, if their performance reflects a difference in syntactic and semantic processes, then they are relying on context. This was the logic behind the following studies.

<u>Studies based on degrading target word</u>

Stanovich and West (1979) used a degrading stimulus condition with undergraduate psychology students. They were tested in a naming task under two conditions: normal visual conditions and degraded visual conditions. The results under normal conditions approximated the results reported by West and Stanovich (1978). However, a different pattern emerged when the degraded stimulus condition was employed. There was a higher facilitation score (43 milliseconds versus 15 in the normal condition--both statistically significant), and high inhibition score (88 milliseconds versus no significance in the normal score). This pattern was taken by Stanovich and West (1979) to indicate that when the conditions for the adults are approximately those of the children: namely a more difficult time to recognize the word, they show greater context influence in terms of facilitation as well as inhibition.

Perfetti and Roth (1981) using a similar paradigm, degraded the quality of graphic input by the deletion of letter segments. They studied fifth grade children divided into two levels of skills. In this experiment, the subjects had to listen to a story and then respond by naming a visually degraded target word that appeared on a screen. The results of this study showed that at a high level of degradation, the increased context effects for skilled readers approximated the effect of context for less skilled readers. 42% degrading caused the skilled readers to read as slowly as poorer readers do normally: and as a result, they showed comparable improvement with context. Perfetti and Roth (1981) took these results to indicate that context should be a facilitator when word level processes are slow whether they are slow because of characteristics of the reader or because of the characteristics of the word itself. There is a problem, however, with this study. Perfetti and Roth did not report on the current I.Q. scores of their subjects. Therefore, some of the results might be interpreted in terms of general intelligence, rather than reading skill.

A more natural way of studying the performance of skilled readers would be to incorporate a difficult parameter to the words instead of degrading the target word. The reason behind these studies is the same as the reason for degrading the target word. Namely, if the pattern observed is due to fast automatic word recognition, then change in the difficulty level of the word (in terms of frequency and length) will affect their performance. Thus, while facing difficult words, skilled readers will show higher reliance on context as do beginners and less skilled readers.

Studies based on manipulation of target word difficulty

Stanovich and West (1981), using the same paradigm as before and a naming task, compared the performance of undergraduate students in the naming task based on visually presented sentences followed by either easy and predictable words or by semantically appropriate but longer low-frequency and less predictable words. A word's difficulty was defined on the basis of its length and frequency. These variables are known to affect the relative ease or difficulty for word recognition. Stanovich and West (1981) reported that the mean number of letters in the easy words was 5 and the mean number of letters in the difficult words was 7. The mean frequency (according to Kucera & Francis, 1967) of the easy words was 124.3 and the mean frequency of the difficult words was 7.1. The word's "predictability" level was based on results of a pilot study in which sentence contexts were presented to 25 college students as a close task. Across all contexts the easy target word was predicted 43% of the time on the subject's first guess whereas the difficult target word was predicted only 11% of the time on the subject's first guess. They found that the more difficult the words, the larger the context effect displayed despite the fact that they were less predictable. The difficulty of the word interacted with context condition and the direction of the interaction was such that larger context effects were observed in the more difficult word condition.

In another study which incorporated a difficulty factor into the design, Stanovich, West, and Freeman (1981) conducted a longitudinal study of context effects, in younger population. They tested second-grade students in April and then again at the end of the year. In addition to the naming task, they administered three measures of reading ability to determine the children's levels of reading: Each subject completed Reading Subtest Level I of the Wide Range Achievement Test, the Reading Subtest (sections A and B) Primary Level of the Stanford Achievement Test, and a short paragraph that was read orally and was timed by the experimenter. The target words in the study were separated into two classes based on word frequency and length. The simple words were shorter, more frequent and more predictable. They found that context effects were larger for unpracticed words, for more difficult words, and during their first testing period. The recognition of difficult words was greatly affected by the presence of a prior sentence's context; easy words were much less affected. When the context effects for unpracticed easy and unpracticed difficult words were averaged, the second graders showed a 250 millisecond context effect in the first half of the year and the effect dropped to 135 milliseconds by the end of the year. Another effect was the correlation between the magnitude of the overall context effect averaged across word difficulty and practice with the measures of reading ability described above. The values of these correlations for each testing period indicated that larger context effects were associated with lower reading ability.

These results support the previous results in terms of whether the subjects are children or adults; some difficult words (of course, what is difficult will vary from subject to subject within the same age groups as well as across age groups) will show greater context facilitation.

Perfetti, Goldman and Hogboam (1979) reported similar results suggesting that context greatly reduced the effects of word frequency and word length.

Despite different paradigms used in the different studies, as well as different age groups of subjects, similar patterns of findings emerged across the variety of test conditions. To summarize:

1. Contextual effects are larger for words that are more difficult to recognize in isolation.

2. This effect occurs even when the more difficult words are less predictable from the preceding sentence context than are the easier words.

3. Contextual effects are larger when the target word is degraded.

<u>Studies based on the comparison between the use of context by skilled and less skilled readers</u>

Schvaneveldt, Ackerman and Semlear (1977) used as their subjects second and fourth grade students. The preceding context was, in their study, a word rather than a sentence and the children had to perform a lexical decision task (the words were projected by a t-scope). The unique feature of this study is that the word association that were used reflected the semantic knowledge of the children. Schvaneveldt et al. (1977) ha chosen for their study words that were taken from the subjects' first and second grade readers and from the teachers' verbal reports of recognizable vocabulary. They used associations such as "king-queen" which reflected the knowledge of the youngest (second graders) and older children and paired them according to Palermo and Jenkins' (1964) list of highly associated words for first and second grade children. Since the researchers chose words that were in the recognizable vocabulary as well as in the semantic knowledge of their subjects, they could focus on the children's use of contextual knowledge in word recognition. Besides the lexical decision tasks, the children were tested on the IOWA basic skill achievement test. These researchers reported that the absolute reaction time and the magnitude of the associated context effect appeared to decrease with increasing age. When comparing the reading scores, both second and fourth graders' reaction times decreased as test scores increased. This negative correlation between context effect and reading score suggested that poor readers used semantic context at least as much as better readers did. The importance of the study was that when the knowledge of the younger and poorer readers was assured by using simple semantic relationships, they could and did use context.

Further evidence was provided by Perfetti, Goldman and Hogboam (1979) who focused on a comparison between poor and skilled readers. They studied fifth grade children. Based on the children's scores on the reading test of the Metropolitan Achievement Test, the subjects were divided into two levels of skill. Each subject had three conditions: isolated words, list context, and story context. In the isolated word condition each word was presented via a slide projector without context. In the list context a recorded list of unrelated words was presented through headphones prior to each target word. These words were unrelated to the target word as well as to each other. In the story context a story was recorded and presented visually at unpredictable intervals varying from 3 to 14 lines of text. Perfetti et al. (1979) used an aural context followed by the visual target. They found that context actually facilitated word identification for both groups. With respect to the context, skilled readers were aided significantly by story context relative to list condition but not relative to isolated words. The importance of this experiment was that it clearly demonstrated that less skilled readers do possess the ability of taking advantage of story context. However, the context was available when it was aurally presented. The question is, what will happen when the actual reading is required to obtain the context? It might be the case that the less skilled reader will not be able to make use of it. In order to account for this problem, Perfetti et al. (1979) conducted another experiment; this time the preceding context instead of being presented aurally was read by the subjects and there were two conditions: isolated and context words. There were significant differences between the skilled and less skilled readers. These differences were obtained in all the conditions. Interesting findings were that while word length was a significant factor for less skilled readers, for skilled readers word length and word frequency were not significant factors. Thus, while both groups of readers could equally use context to facilitate word recognition, only less skilled readers showed evidence of "intrinsic word factors," i.e., word length and frequency, continuing to influence identification of words in context. The results of this study taken together with the previous results clearly indicate that less skilled readers as well as skilled readers can be helped by context.

Summary of reaction time studies

The main findings of reaction time studies are:

1. At least for the level of word processing, the claim that more fluent readers rely more on context appeared to be largely incorrect.

2. Poor readers in the studies reviewed not only used context, but they often showed somewhat larger contextual effects than did the skilled readers.

3. Context use is not strongly related to individual differences in reading ability despite its importance as an underlying factor in every child's performance.

4. Reading skill is not determined by skill at contextual prediction; but rather it is the level of word recognition skill that determines the extent to which contextual information will be relied on to complete the process of

lexical access. The slower the word decoding process, the more the system draws on contextual information.

Data based on the reaction time methods also yell to important distinctions that should be made, in order to prevent confusions in interpreting results:

1. A distinction must be made between different levels of processing--namely distinction between the context as an aid to word recognition and its use to aid comprehension processing.

2. A distinction between the nominal context (what is on the page) and the effective context (what is being used by the reader).

3. Distinction between the presence of knowledge and the use of that knowledge.

Theoretical model to explain the empirical findings

Two theoretical questions of interest are: what theoretical model can account for these findings? and what theoretical model of the reading process can predict these results?

The model that many researchers tend to subscribe to is the two-process theory of expectancy proposed by Posner and Snyder (1975). Their theory of semantic context effects is based on a distinction that is made in cognitive psychology between automatic and attentional processes (Cohen, 1983).

A process considered to be automatic when:

1. "the person may be unaware of the process";
2. "the execution of the processes is not under the conscious control of the subject, that is, that the subject's intention to perform the task may be irrelevant";
3. "the process takes "no processing capacity", that is, that it uses no resources that other mental operations might also use." (Rayner & Pollatsek, 1989).

Attentional process uses conscious control. The person is aware of the process and it takes effort. The assumption which is implicit in the above criteria is that the attention system is a "limited capacity system" meaning that conscious process will take effort and leave no room for other demanding processes during the operation of that process. The distinction between these two processes is important empirically as well as theoretically, since predictions about performance in a given task must take into account whether the processes required in the task are automatic or attentional. Based on this theoretical distinction, Posner and Snyder (1975) proposed that semantic context affects recognition via two processes that act independently and that have different properties. The "automatic spreading-activation" process is defined by the same criteria described above. It is fast acting, does not use "attentional capacity," and does not affect the retrieval of information from "memory location" unrelated to those activated by the context. This process occurs because when stimulus information activates a "memory location," some of the activation automatically spreads to semantically related memory locations that are nearly in the network. In contrast,the "conscious- attention" mechanisms respond to a preceding context by directing the "limited capacity processor" to the "memory location" of the expected stimulus. This mechanism is slow acting, utilizes attentional capacity, and inhibits the "retrieval of information" from the "unexpected location".

These theoretical models provide theoretical explanations for findings from experimental studies, and are used by Stanovich and West (1978, 1981) as well as by Perfetti and his colleagues in order to explain their findings: when the skilled reader encounters an easy word, the recognition of the word occurs so rapidly that the word can be named before the "slow- acting conscious-attention mechanism" has an inhibitory effect. This means that when the skilled reader (e.g. Stanovich & West 1978) encountered a word which was not semantically appropriate with the preceding sentence context his performance was not penalized. He read the word in this condition as fast as in the no context condition. This pattern of results was interpreted by Stanovich and West (1981), based on Posner and Snyder's (1975) model as reflecting fast word recognition process, since there was no delay in the response time to the inappropriate word. Otherwise, if the "conscious- attention mechanism" had time to operate we would observe a different pattern. It would take longer to name the target word since it would be in conflict with the meaning of the context. That is why we observe in adult skilled readers facilitation dominance performance.

However, when the word is degraded or is more difficult to decode, it takes a longer time to be recognized and thus enables the "slow mechanism" to operate and we can observe facilitation as well as inhibition when the target word is preceded by inappropriate context.

Observation of children's performance on similar tasks can be interpreted according to the same logic: the word recognition processes of children may be slow enough to allow the "conscious attention mechanism" to have an effect. This will result in contextual facilitation as well as inhibition in the reaction times of the children.

If we expand this conceptualization to the real life reading situation, the reading process for the adult skilled reader will not be guided by "conscious expectancies"; rather, most of the time it will be facilitated by "automatic spreading activation mechanism."

This trend of behavior seemed to be contradictory to the suggestion made by the Top-down theories that the skilled readers rely more on context and that their ability to use the context is what determines their reading levels. The response-time methods suggest something quite to the contrary. While there is no doubt that skilled readers have better knowledge of contextual dependencies and can use this knowledge, if they need to, simultaneously, they are less reliant on this knowledge because their context free decoding skill efficiency is so high that they are less in need of contextual support.

These results taken together with findings based on oral reading analysis suggest that those who rely heavily and benefit more from context are not the skilled readers. Rather, those are the less skilled and the beginner readers who need the context the most.

A question that comes to mind at this point is, if experimental results show that less skilled readers benefit from context as much as skilled readers do, why are there are so many complaints from teachers that those poor readers "don't use context, and don't try to understand." One approach one might suggest that it is because they are taught to emphasize the phonics of the word. While this might be true for some children, it doesn't necessarily reflect the whole truth for others. There is another possible explanation: the poor readers do not show that they use context because in real life in the classroom many times the context is really not available for them. The sole fact that it is printed on the page does not mean that it is usable. A fourth grade child, for example, whose reading skill is at the second grade level might not be able to read most of the material that he or she encounters in his/her classroom. Thus, he/she will not have the support of context to help him/her compensate for his/her weak and slow word identification process. The empirical results then, do not contradict claims made practitioners, on the contrary, they clarify them. The most important point that they highlight is that one has to differentiate between what is on the page and what is actually being used by the reader. The second question dealt with the issue of which theoretical model of the reading process can predict best this pattern of results? While it is quite clear that none of the strictly top-down or bottom-up models can do so, the interactive model can, due to its flexibility. Stanovich (1980) modified Rumelhart's interaction model by adding to it a compensatory assumption. He stated that:

> "a process at any level can compensate for deficiencies at any level."(Stanovich,1980, p. 36) "When combined with an assumption of compensatory processing, interactive models provide a better account of the existing data on the use of orthographic structure and context by good and poor readers." (Stanovich, 1980, p. 32)

Perfetti (1985) added additional aspect to the model: Interactive and asymmetric: namely, the contextual processes are limited by word "coding processes." By contrast, "word coding" processors are affected by, but not limited to contextual processors. While verbal coding can be free of context, context use must depend on "verbal coding."

Additional, realistic touch to the development of reading difficulties, on top of the theoretical conceptualization, is suggested by Stanovich (1986). He referred to this process as the "Matthew effect," - "the rich get richer and the poor get poorer" in reading. He took the position that the main difficulty most poor readers face is in breaking the spelling to sound code. Then the cycle starts:

> "...soon after experiencing greater difficulty in breaking the spelling-to-sound code, poorer readers begin to be exposed to less text than their peers.
> The combination of lack of practice, deficient decoding skills, and difficult materials result in unrewarding early reading experiences that lead to less involvement in reading-related activities. Lack of exposure and practice on the part of the less skilled reader delays the development of automacity and speed at the word recognition level." ...this process will "require cognitive resources that should be allocated to higher level processes of text integration and comprehension. Thus, reading for meaning is hindered... the downward spiral continues and has further consequences" (Stanovich, 1986, p. 364).

Findings on Reading and Reading-Related Tasks of College Dyslexic Students

Since the population studied in this study is college dyslexic students a brief review on the available literature on reading patterns of this population might provide appropriate framework for understanding the data of this study.

The literature review revealed that very little research has been done on analyzing the reading performance of dyslexic adults. Most of this published research was conducted by Aaron and his colleagues (Aaron, Olsen & Baker, 1985; Aaron, Baker & Hickox, 1982; Aaron, Baxter & Lucenti, 1980; Aaron & Phillip, 1986; Aaron, 1987). This work was done with college students who have adequate I.Q. and read at least two years below their expected level. Their performance on reading and reading-related tasks from various perspectives: psychoeducational, neuropsychological, and cognitive processing was assessed. The main findings were:

1. These students had no listening comprehension deficits as compared to that of an age control group of normal readers.

2. The linguistic competence of the dyslexic subjects was as good as the chronological control group of normal readers.

3. College dyslexic readers appeared to be competent in all aspects of processing information at the visual short-term memory level.

4. Reading error analysis of the dyslexic subjects revealed that they tended to omit, substitute, or add more function words than content words. When content words were misread the errors were primarily due to misapplication of grapheme to phoneme rules.

5. Spelling to dictation tasks reveled that more errors were committed on this task when compared to reading. In addition to spelling errors, college dyslexic students tended also to omit or substitute function words.

Aaron and his colleagues concluded that the printed language which involves grapheme to phoneme conversion process and not the oral language was the underlying causative factor of the reading difficulties experienced by this group of dyslexic readers.

Summary

This literature review was provided in an attempt to clarify the following questions:

1. Is context use a source of individual differences in reading ability?

2. Are there developmental stages in context use for word recognition?

3. To what extent do poor readers rely on and use contextual information to facilitate word recognition?

Experimental studies based on reaction time studies, eye movement studies and oral reading analysis all seem to suggest a larger use and heavier reliance on context by poor decoders and beginner readers. Skilled readers can of course use the context if they need to, but the use of context does not lie at the source of their efficient reading. Rather, it is their automatic, efficient word recognition processes that enables them to allocate capacities to higher order task demands.

While much has been written on children's reading skills and on adult skilled readers, very little research has been conducted to analyze reading strategies of adult dyslexic readers.

CHAPTER III

METHODOLOGY

The experimental procedures described in this chapter were designed to investigate the use of context for word recognition by readers in the same age group but with different reading abilities (college age dyslexic and normal readers), and by readers with the same reading abilities but in a different age group, (college age dyslexic readers and younger normal readers that were pair matched with the college dyslexic students based upon their reading level).

This chapter provides information relating to subject characteristics and selections. It is followed by a description of the experimental tasks and their administration procedures.

Population Description

Experimental group

The experimental group was comprised on 20 college dyslexic students with a mean age of 20.6 (S.D. = 2.3), mean I.Q. score of 106 (S.D. = 7.61), and below the 40th percentile achievement score on the WRMT-R. The ratio of male to female in this group was 1:1.

There were five criteria for subject selection:

1. All subjects attended college at the time of the study.
2. All subjects achieved a full scale I.Q. score of at least 90 as measured by the Wechsler Adult Intelligence Test.
3. All subjects were native speakers of English.
4. All subjects had a Woodcock Reading Mastery Test - Revised (WRMT-R) reading score which fell at or below the 40th percentile. (The mean percentile reading score was 16.48, S.D. = 12.58.)
5. All subjects had normal hearing, vision, and articulation as determined from their files and experimenter observations.

In addition to the 20 experimental subjects, there were 10 others who were referred and partially tested, but not accepted for the following reasons:

1. 3 subjects had an I.Q. score below 90.
2. 7 subjects performed on a reading level above the 40th percentile on the WRMT-R.

Subjects were recruited from four universities and colleges in Western Massachusetts. They were contacted by a Learning Disabilities Coordinator at each campus. Those who were willing to participate provided their phone numbers and were contacted directly by the experimenter. Some other students were recruited with the help of a Dyslexic Student

Organization. From a total of 20 experimental subjects, 17 were diagnosed at some point in their school history as dyslexic and at the time of the study were enrolled in special programs for learning disabilities (LD) students at their colleges. The three other experimental subjects were diagnosed in the past as dyslexic by their school districts. However, when this study was conducted, they were not involved in special programs for LD students. Rather, the help they received was in the form of untimed tests, and other adaptations for their learning deficiencies.

Control 1 - chronological age

The chronological age control group was comprised of 20 college normal readers that were matched with the DYS group on the basis of age, gender and I.Q. scores. The mean age and I.Q.scores for this group were 107 (S.D. = 8.82) and 20.9 (S.D.= 2.6), respectively. The ratio of male to female in this group was the same as in the DYS group, 1:1. Acceptance criteria for this group followed the same guidelines as for the experimental group, the only difference related to the reading score. The mean percentile reading score for this group was 63.05 (S.D = 12.82).

Subjects for the chronological age control group were recruited from undergraduate classes. The researcher presented the study to the students in their classes, and those who were interested in participating enrolled in the study. In addition to these subjects, two others were partially tested but were not continued for the following reasons:

1. One student was found not to be a native speaker of English.
2. One subject asked to stop testing during the first session.

<u>Control 2 - reading age group</u>

The reading age control group was comprised of 20 normal readers with mean age of 11.7 that was paired - matched on their word identification level as assessed on the WRMT-R with the DYS group. There were 13 girls and 7 boys in this group.

Principals of elementary, and junior high schools were contacted by the researcher, who introduced the research project. After initial approval of the building principal similar procedures were taken in the elementary and junior high level. In the junior high level the appropriate grade level consultants contacted the reading teachers to recommend normal readers at the 7th and 8th grade levels. Students who expressed interest and received their parents' permission were tested by the experimenter. At the elementary level the appropriate grade level teachers recommended normal reading students from their classrooms who had no pronounced learning, social or emotional problems. Students who expressed interest and received their parents' permission were tested by the experimenter.

Background Tests

Two tests were used in this category: The Wechsler Adult Intelligence Test - Revised (WAIS-R), and the Woodcock Reading Mastery Test - Revised (WRMT-R).

The WAIS-R is an individually administered intelligence test which yields a verbal I.Q score, a performance I.Q. score and a full-scale I.Q. score. It was administered to all adult subjects to whom it had not been previously administered. It was found that 17 out of the 20 dyslexic students had been administered the test before entering college and their scores were obtained from their files.

The WRMT-R provides an individual assessment of reading based upon current norms, and upon what its developers claim is up to date content. The test measures a wide age range of student reading levels, from kindergarten through college. Form H yields scores for word identification, word attack, word comprehension and passage comprehension. In addition it provides basic skill cluster, reading comprehension cluster, total reading - short scale, and total reading - full scale.

The raw scores can be converted to standard scores, percentile ranks, and grade level equivalents.

The WRMT-R was administered to each adult subject in the study. The Word Identification sub-test of the WRMT-R was administered to the subjects in the reading age control group.

Experimental Tasks

Experimental tasks can be grouped into three categories: (1) reading and listening comprehension tasks; (2) word attack tasks and (3) the use of context for word recognition.

Listening and reading comprehension tasks

Two tasks were employed in this section:

1. Listening comprehension.

The assessment of listening comprehension is not a simple procedure. It may be confounded by such factors as attention span, rote memory, and the subject's previous knowledge. The basic unit of listening comprehension measurement is another problem. Moreover, no test exists which possesses universally accepted norms. Thus, an informal device was employed for the purpose of this study: Four passages from the Stanford Diagnostic Reading Test (SDRT) were adopted for that purpose. Two passages were taken from the "Brown Level," which is originally intended to assess silent reading comprehension at the fifth to eight grade levels. They are about 150 words each in length. Two passages were taken from the "Blue Level" which are about 250 words in length each and originally intended to assess silent reading comprehension of students at grades nine through twelve and community college students. All passages were tape recorded by a female graduate student. Each passage was followed by comprehension questions in multiple choice form. These questions were presented at the same time via visual and auditory modalities, and the subjects were required to circle the correct answers. The passages and the questions are presented in Appendix A.

Analysis of subjects performance was based on mean correct answers given to each passage, rather than on the basis of the published norms.

2. Reading comprehension.

Although published and normed reading comprehension tests available, an informal device was employed in this study in order to provide a reading comprehension measure which is comparable to the listening comprehension device which was used in this study. For that purpose four passages from SDRT were adopted, in a parallel manner to those passages that were selected for the listening comprehension task. Thus, provided a direct measure for comparing comprehension across different modalities (both auditory and visual).

After reading the passages aloud, subjects were asked to answer comprehension questions that followed. These were multiple choice questions which followed the same procedure applied in the listening comprehension tasks. The questions and answers were simultaneously presented to the subject on paper and by tape recorder, and the subjects were required to circle the correct answer. The passages and the comprehension questions are presented in Appendix B.

Analysis of subjects performance was based on mean correct answers given to each passage, rather than on the basis of the published norms.

Word attack tasks

Two tasks were employed in this category:

1. Reading matched real and nonword lists.

Fifty words (25 in each category) were adopted and modified from Tempel (1984), and organized in five blocks. Each block contained five nonwords and five real words. Words and nonwords were randomly presented within each block with the restriction that no word and its matched nonword appeared within the same block. The experimental task was preceded by four demonstrations by the experimenter and then followed by ten trials by the subject. None of the demonstrations or trial items appeared in the experimental items. Criteria for success was determined as eight out of ten successful trials (not necessarily correct answers). The words were presented one at a time on a computer monitor in front of the subject. The subjects were required to read each word aloud into a microphone as fast and as accurately as possible. Onset of vocalization terminated the presentation of the word. When the subject pressed the keyboard, a new word would show on the screen. The target words and nonwords are presented in Appendix C.

2. Reading regular and irregular words.

Regular words are words pronounced as they are spelled. (e.g., gave, cave, save). In contrast, the pronunciation of "have" does not conform to this patterns and is an exception to the general rule. It is therefore considered as an irregular word. Thirty-nine regular and irregular words were taken from Coltheart (1979). These words were randomly presented on a computer monitor in front of the subject. Subjects were asked to read each word aloud as fast and as accurately as possible. Vocalization onset terminated the presentation of the word. Pressing the keyboard by the subject stimulated the appearance of the next word. Subjects followed in this task the same procedure as in the previous task. The list of words is presented in Appendix D.

The use of context for word recognition

Two tasks were used in order to examine the use of context for word recognition:

1. Oral reading tasks.

Subjects were asked to read aloud four passages that were presented in different contextual conditions.

Two passages were taken from the "Brown Level" of the SDRT. Each passage contains approximately 150 words. Two passages were extracted from the "Blue Level" of the SDRT and contain approximately 250 words each.

There were two contextual conditions in this task:

1. The coherent presented passages - in which the normal order and punctuation marks of the original text were kept.

2. The random order passages- which were based on the same words contained in the coherent passages however, the words were randomly ordered from left to right, and all punctuation marks were removed.

"Brown Level" passages were presented first, followed by "Blue Level" passages. Within each passage level there were two presentation orders. "Brown Level" passages, order 1: coherent passage 1, random order passage 2, random order passage 1, coherent passage 2. Order 2: Random passage 1, coherent passage 2, coherent passage 1, random order passage 2. Two passages taken from the "Blue Level" followed the same order of presentation.

Within each experimental group, half of the subjects were randomly assigned to one order of presentation and the other half to the other order. Thus, a total of 30 subjects were presented with order 1, and 30 subjects were presented with order 2. The passages in both presentation conditions are presented in Appendix B.

2. Sentence context experiment.

The experimental paradigm for this task is an adaptation and modification of the experimental paradigms used by Stanovich and his colleagues (West & Stanovich, 1978; Stanovich, West & Freeman, 1981). Stanovich developed a sentence priming paradigm based on the assumption that such a paradigm would more closely tap contextual effects at the level of word recognition. In Stanovich' (1978) study, subjects read aloud a sentence with the final word (the target word) missing. When the subject finished reading the sentence, the experimenter initiated the appearance of the target word and the subject had to name it as fast and accurately as possible. Three contextual conditions were created by manipulating the sentence context that preceded the target word. In the congruous context condition, the target word offers a meaningful completion of the sentence; in the incongruous condition, the target word does not relate to the sentence and does not provide any meaningful completion to it; and in the neutral context condition, the target word is not predicted from the context preceded it, nor does it contradict it.

The neutral condition is taken as the baseline condition. If context is indeed used to speed word recognition, then recognition times in the congruous condition should be faster than recognition times in the neutral condition. This was termed as a contextual-facilitation effect. Longer reaction time in the incongruous conditions will indicate contextual-inhibition effect. Finally, the time difference between the incongruous and congruous context conditions were termed as the "overall context effect" and served as a general index of contextual sensitivity.

The basic paradigm was adopted from Stanovich's work, with the modification that subjects in this study were required to read the incomplete sentences to themselves quietly, then press the button and initiate the appearance of the target word, which had to be read out loud. Two word lists based on the same three context conditions were kindly provided by Stanovich and parts of them were used in this study.

Sentence context and target words for list I were adapted and modified from the West & Stanovich (1978) study. Manipulation of context condition and 30 target words were counter-balanced across three presentation blocks. Within each presentation block, words were presented randomly with the stipulation that there were ten experimental items at each context condition.

An attempt was made to match target words across contextual conditions based on initial sound classification (stop, fricatives, liquids, nasals), word length, and word frequency (as determined by Kucera & Francis, 1967). Mean word frequency in the congruous, incongruous and neutral context condition was 120, 103 and 101, respectively. (These frequencies are in list 1-A and were counterbalanced at the other two presentation blocks). The mean words lengths was 4.7, 4.4 and 4.4, respectively.

List II was prepared in a similar manner. Sentence context and target words for that list were adopted from Stanovich & West (1981) and were in general at a higher level of difficulty than those employed in the previous list. There are 30 target words in this list as in the first one, and three blocks of presentation. An attempt was made to match the target words across context conditions based on initial sound classification, word frequency and word length. Mean word frequency and mean word length in the congruous, incongruous and neutral context condition (list 2-A) were 9.5;7.8, 9;7.8, and 9.6;8.5, respectively.

Experimental trials were preceded by 3 trials demonstrated by the experimenter; they were followed by 10 trials by the subjects. Criteria for success on trial items were defined as eight out of ten successful trials.

Sentence context and target words for both lists are presented in Appendix E.

Administration Procedures

Each subject was tested individually by the examiner. There were three sessions with each subject in the experimental and chronological age groups and two sessions with each subject in the reading age control group. There were usually several days interval between the sessions. Testing was done between April 1988 and December 1988.

First session

The tests administrated in the first session were The Woodcock Reading Mastery Test - Revised, and the WAIS-R. Administration time of the WRMT-R varied between the two adult groups. While it took the experimental subjects anywhere between one to one-and-one-half hours to finish the test, it took the chronological age control subjects no longer than 30-40 minutes to accomplish the task. A short break was given at this point. If the subject was not administered the WAIS-R before, as was the case with most of the CA control subjects and some of the experimental subjects, it required an additional one-and-one-half hours.

A different procedure was taken with the reading age control group; in this case the first session started with the administration of the Word Identification sub-test of the WRMT-R, which took approximately 10 minutes. If the control subject's score matched an appropriate experimental subject's score, he would qualify to continue. Then administration of the "second session" test-battery would follow.

The subjects' responses on the WRMT-R were tape recorded and played back later to assist in scoring. Scoring was carried out for the WRMT-R and WAIS-R according to the manual directions.

Second session

The second session lasted approximately 75 minutes. The order of testing was as follows: First, the listening comprehension task was administrated to all subjects. Subjects were instructed to listen carefully to a passage that was presented to them by a tape recorder. They were informed that each passage would be followed by multiple choice comprehension questions. They were allowed to listen to the passage just once. So the subjects get used to the voice and procedures, a trial passage preceded the experimental task. Subjects responded by circling the correct answer on the page in front of them.

After a short break, the oral reading tasks were administered to all subjects. At this time, subjects were instructed to read coherent and randomly organized passages as fast and as accurately as they can. They were told that after the reading of the coherent passages they would be required to answer comprehension questions. Answering the comprehension questions was followed the same guidelines as the listening comprehension task.

So that the subjects would be aware of the difference between the passages before beginning, subjects were given practice on shorter versions of the two different passage types. In addition, before each passage the subject was told if it is going to be a normal or a mixed order passage. A stopwatch measured the reading time. Timing began with the pronunciation of the first word and ended with the pronunciation of the last word. Reading was tape recorded for later analysis.

Third session

This session lasted approximately 45 minutes. Tasks were administered to all subjects. Tasks were administrated at the following order:

1. Reading of real words and matched nonwords.

Subjects were told that they have to press the keyboard, then a letter string will appear on the screen. They had to read the word aloud as fast and as accurately as possible. Subjects were told that some of the letter strings are real words, while others are not real words because they don't mean anything, but they spell like real words so they still can read them. Subjects were instructed to read the words into a microphone that they held. Onset of vocalization terminated the presentation of the word. When the subject was ready, he had to press the keyboard again for the next word. Subject's latency responses were measured by an electronic timer.

Four demonstrations were given by the experimenter. They were followed by ten trials by the subject. Then experimental tasks were administered.

2. Reading regular and irregular word type lists.

The second reaction-time task followed the same procedure, with the exception that subjects were told that this time they will not have the nonwords ; rather, they will have just real words. Subjects' responses were timed by an electronic timer.

3. Sentence context experiment.

In the sentence-context experiment, subjects were instructed to read silently incomplete sentences that will appear as a response to their keyboard press. When they got to the end of the sentence, they had to press the keyboard once again. This press initiated the appearance of the missing last word (target word). Subjects were instructed to read this last missing word as fast and as accurately as they can. They were told that they could read the sentence at a comfortable pace, and that it is just the reaction time to the last word that is measured.

All subjects saw first List I, which was followed by the presentation of List II. Response latency was timed by an electronic timer.

The experimental sentences were preceded by three demonstrations by the experimenter, which were followed by ten randomly presented trials by the subject. After the ten trials, the experimental sentences were presented.

All subjects were paid for participating in the study.

Statistical Analysis

Each major research question was first analyzed by using an overall MANOVA technique with a repeated measure design. In this design each subject was tested repeatedly under different experimental conditions. Within each experimental treatment there were one between group factor with three levels (group), and two within group factors with the number of levels varying across each condition. The MANOVA technique was used since all the variables have been obtained from the same subjects, and thus are correlated in some manner. The MANOVA procedure takes into count the correlation between variables and enables to study many dependent variables simultaneously. One basic assumption of the analysis of variance is the homogeneity of the variance. It has been shown that reasonable violations of this assumption will not seriously bias the F test (Ferguson, 1976).

If the null hypothesis of no differences between groups was rejected Scheffe' post hoc procedures were performed. Scheffe' statistics assume that the populations are normally distributed and that their variance are equal. Scheffe' uses a single range value for all comparisons, which is appropriate for examining all possible linear combinations of group means and not just pairwise comparisons. It can be used with unequal n's and to construct confidence intervals. The principal advantage of this multiple comparison procedure over Student's t test is that the probability of erroneously rejecting one or more null hypotheses doesn't increase as a function of the number of hypotheses tested. Regardless of the number of tests performed among p means, this probability remains equal to or less than α for that collection of tests (Kirk, 1978).

T-tests were used in the data analysis as well, mainly in order to detect within group differences on some experimental tasks.

CHAPTER IV
PRESENTATION OF FINDINGS AND ANALYSIS OF DATA

This chapter presents the results of comparisons between the experimental group - the college dyslexic readers (DYS), and two control groups: one group controls for chronological age (CA), and the other controls for reading age (RA).

The results are organized according to the research questions as presented in Chapter 1. First, findings are reported for the listening and oral reading comprehension tasks, followed by findings for word attack skills. The major focus of this study, the use of context for word recognition is addressed via analysis of two experimental paradigms: (1) using an analysis of oral reading rate and accuracy and (2) using a computer simulated reaction time experiment.

Listening and Reading Comprehension Data

Subjects were requested to listen to four passages presented aurally by a tape-recorder. Each passage was presented just once and was followed by comprehension questions. Subjects saw the questions in front of them and at the same time listened to them from the tape. They were requested to circle the correct answer on the answering list in front of them. Then, subjects were asked to read aloud four passages. Each passage was read just once. The comprehension questions that followed, were administrated the same way as the listening comprehension questions.

These experimental tasks were addressed to examine possible differences in listening comprehension between DYS and CA subjects, in order to try and rule out possible general language comprehension problems faced by the dyslexic students rather than specific reading difficulties. The second purpose was to examine if and how modality of presentation (auditory vs. visually) effects comprehension of readers of different reading ability.

If there are no differences between comprehension scores obtained by college age normal readers and college age dyslexic readers on the listening comprehension tasks, but there are differences in their scores on the reading comprehension tasks, it would be possible to interpret this pattern in terms of modality requirements (visually vs. auditory presented material), rather than cognitive demand (comprehension). Following the same logic, difference in scores on the listening comprehension tasks between college age dyslexic students and normal younger readers, but similarity in reading comprehension scores would support the idea of specificity of reading difficulties rather than general language comprehension.

Percentage of correct answers in each condition was calculated for each subject and was used as the basis for analysis.

A 3 (group) by 2 (modality) by 2 (difficulty level) MANOVA was performed on percentage of correct answers achieved at each condition. The analysis revealed a significant main group effect $F_{(2,58)} = 17.70$,$p < .001$, a significant material difficulty main effect $F_{(1,59)} = 185.60$, $p < .001$ and a significant modality main effect $F_{(1,59)} = 12.06$, $p < .01$. There was a significant group by difficulty level interaction, $F_{(2,59)} = 6.54$, $p < .01$, and a significant group by modality interaction $F_{(2,59)} = 8.39$, $p < .0001$. The interactions are presented in Figure 3 and Figure 4. No interaction was found between material difficulty and modality, $F_{(1,59)} = 2.74$, $p > .05$. Cell means and standard deviations for these MANOVA results are reported in Table 1.

As can be seen in Table 1, RA subjects achieved the lowest comprehension score, regardless of material difficulty or modality presentation. Scheffe' post hoc comparisons indicated that reading comprehension scores on the easier material did not differ significantly between the groups, with all groups having a high achievement level. Differences were revealed for the reading comprehension at the more difficult reading material. RA subjects scored

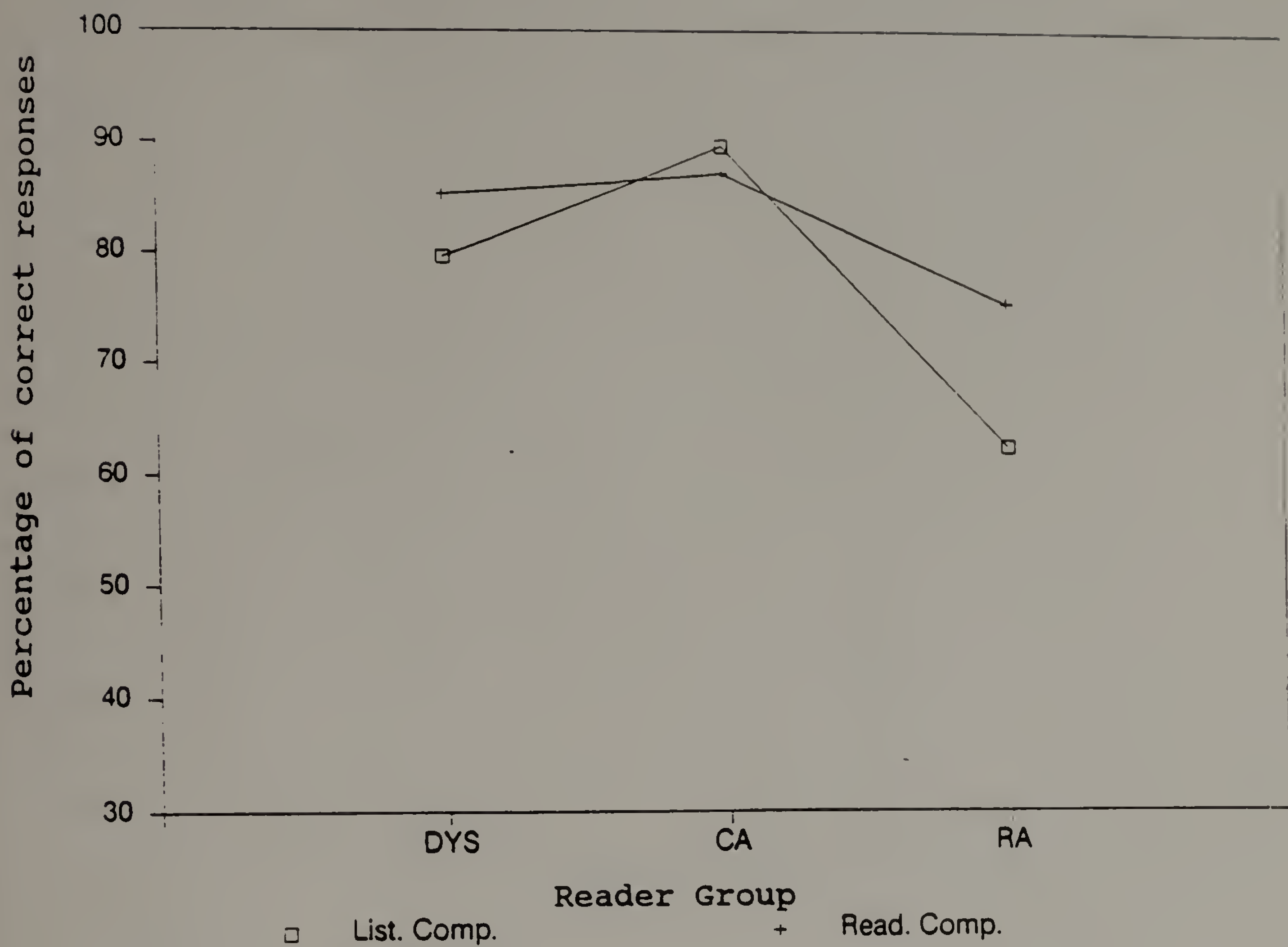

Figure 3. Percentage of correct responses as a function of reader group and modality of presentation (averaged over level of material)

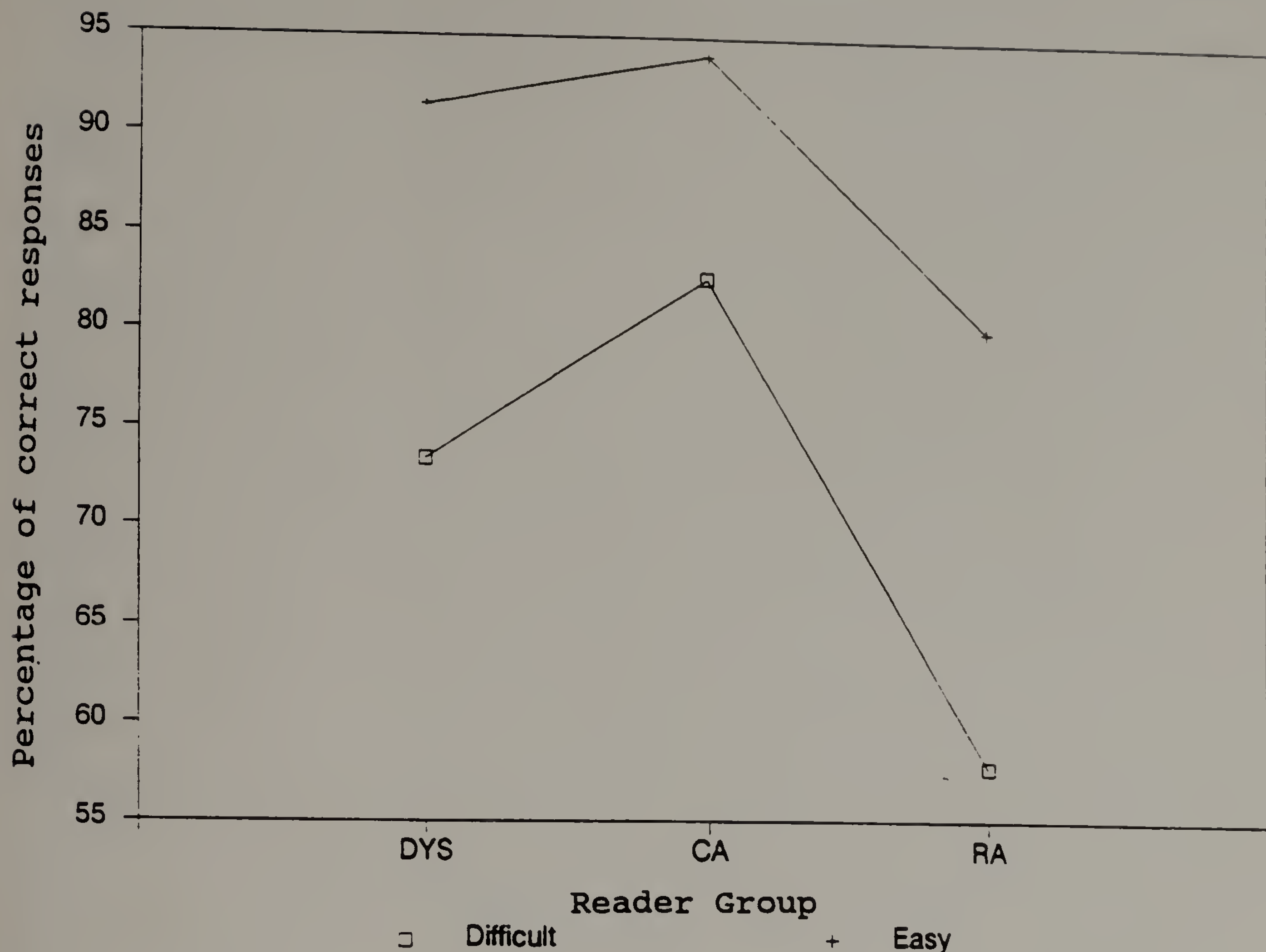

Figure 4. Percentage of correct responses as a function of reader group and difficulty level (averaged over modality of presentation)

TABLE 1

listening and reading comprehension tasks
Cell means and standard deviations

Listening comprehension

	Easy passages	Difficult passages
DYS	$\overline{x}$ = 88.31 (S.D. = 9.59)	$\overline{x}$ = 71.03 (S.D. =15.61)
CA	$\overline{x}$ = 94.62 (S.D. = 6.91)	$\overline{x}$ = 84.62 (S.D. =10.72)
RA	$\overline{x}$ = 71.00 (S.D. = 24.07)	$\overline{x}$ = 54.04 (S.D. =19.26)

Reading comprehension

	Easy passages	Difficult passages
DYS	$\overline{x}$ = 94.71 (S.D. = 94.71)	$\overline{x}$ = 75.86 (S.D.=11.71)
CA	$\overline{x}$ = 93.54 (S.D. = 6.91)	$\overline{x}$ = 80.82 (S.D. =9.77)
RA	$\overline{x}$ = 89.26 (S.D. = 24.07)	$\overline{x}$ = 61.48 (S.D.=20.90)

significantly lower than any other group, $p < .05$. The CA and DYS subjects did not differ significantly from each other. A similar pattern was observed for the listening comprehension scores in the easier level. The RA subjects achieved the lowest comprehension scores and differed significantly from the CA and DYS groups, $p < .05$. The two adult groups performed at a comparable level. In the difficult listening comprehension level, significant differences emerged between all groups, $p < .05$, with CA subjects scoring highest, followed by the DYS subjects and then by the RA subjects.

A t-test for paired data was used in order to analyze differences in comprehension scores across two difficulty levels. The test revealed that all groups had significantly higher comprehension scores on the easier level passages, $p < .0001$.

Next, a t-test was used to analyze differences in comprehension scores across different modalities. In these comparisons, comprehension scores obtained on the easy passages presented visually were higher than scores achieved on the auditory presented material, for the college dyslexic students, $t_{(18)} = -2.22$, $p <.05$, and for the RA subjects, $t_{(19)} = -3.27$, $p <.05$, but not for CA subjects. On the difficult level passages RA subjects exhibited the same pattern: higher comprehension scores on reading as compared to listening comprehension tasks, $t_{(19)} = -2.32$, $p <.05$. No differences were found for the CA subjects who obtained high scores on both tasks, (84.62% and 80.02% correct answers, on listening and reading comprehension respectively). DYS subjects scored lower than the CA group on the more difficult passages on both tasks, (71% and 75% correct responses on listening and reading comprehension respectively), with no significant differences between the two modalities.

<u>Summary</u>

On listening and reading comprehension tasks, the performance of the young normal readers was significantly poorer than the performance of the adult subjects. The two adult groups demonstrated comparable levels of performance on the easier passages. However, on the more difficult passages,CA subjects had higher comprehension scores than the DYS subjects but primarily on the listening comprehension tasks. Even in this case, the differences were not large and the groups overlapped.

As was expected, all groups had higher comprehension scores on the easier passages. However, contrary to expectations, performance on listening comprehension tasks was not greater than the reading comprehension tasks for the DYS group. In fact, both, RA and DYS subjects had higher comprehension scores on reading as compared to listening comprehension tasks.

Word Attack Skills

The literature review suggested that one major difficulty for dyslexic students is in the area of isolated word decoding. The experiment in this section was designed to examine word attack skills of college dyslexic students in comparison to chronological age controls and reading age controls and to clarify the following questions: Do college dyslexic readers display different word attack skills than younger normal readers, and from college normal readers? And what is the relationship between word identification level and word attack strategies? Subjects were asked to read as fast and as accurate as possible 25 words and 25 nonwords that were presented on a computer monitor in front of them. Results of this experiment are presented next.

Word and nonword naming

Separate 3 (group) by 2 (word type) MANOVAS were performed on the reaction time scores for each word type and on the error scores on each word type. MANOVA tables for the reaction time data are presented in Appendix F and for the error analysis data in Appendix G.

Trials in which the experimental equipment malfunctioned were dropped from the data analysis. Across all conditions attempted by the DYS group 1.87% trials were dropped from the analysis, 2.27% trials were dropped from the RA data analysis and 2.2% trials from the CA data.

Trials on which the subject incorrectly named the target word, trials on which the reaction time took longer than 2.5 S.D. above the subject's mean reaction time for that condition, and response times that were longer than 4000 msec were scored as subject errors and were dropped from the reaction time analysis. All the analyses to follow are based on the mean reaction time in each word type.

The reaction time scores revealed a significant main effect for group, $F_{(2,57)} = 16.60$, $p < .001$, a significant main effect for word type, $F_{(1,58)} = 24.46$, $p < .0001$, and a significant group by word type interaction, $F_{(2,58)} = 13.35$, $p < .0001$. Cell means and standard deviations are presented in Table 2 and a graph to illustrate the interaction in Figure 5.

As can be seen in Figure 5, the speed of reading target words increased steadily from CA subjects to RA subjects to DYS subjects. Scheffe' post hoc comparisons indicated that for the words, the mean length of reading time was significantly longer for the DYS group than for the RA group, and significantly longer for the RA group than for the CA group, $p < .05$. However, for the nonwords, the DYS subjects' reaction time was significantly longer than the reaction time of each of the other two groups. Although the CA subjects' reaction time ($\overline{x} = 564.61$) was shorter than RA subjects' reaction time ($\overline{x} = 684.71$) the difference did not reach statistical significance.

TABLE 2

Mean reaction time in milliseconds for words and nonwords

	Word Reaction Time	Nonword Reaction Time
DYS	$\overline{X}$ = 711.82 (S.D. 158.94)	$\overline{X}$ = 1326.57 (S.D. 794.54)
CA	$\overline{X}$ = 498.84 (S.D. 39.42)	$\overline{X}$ = 564.61 (S.D. 68.41)
RA	$\overline{X}$ = 606.66 (S.D. 104.79)	$\overline{X}$ = 684.71 (S.D. 131.20)

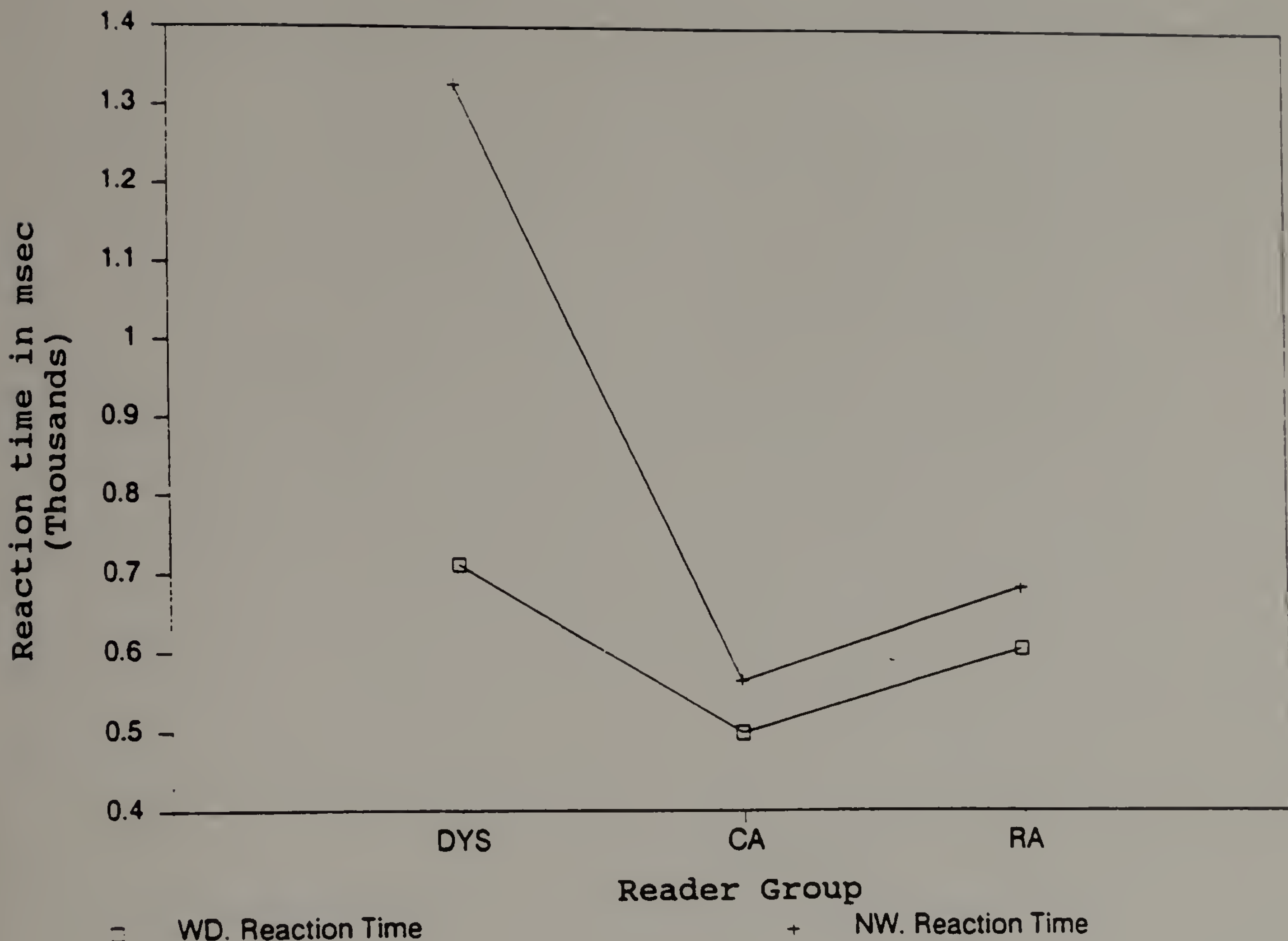

Figure 5 Reaction time in milliseconds as a function of reader group and word type

In order to examine the interaction between reader group and the reading rate on each word type, a difference score was calculated for each subject by subtracting the time taken in milliseconds to read the words from the time taken in milliseconds to read the nonwords. The difference score was analyzed with a oneway ANOVA. This test revealed a significant difference between the groups, $F_{(2,57)} = 15.47$ $p < .0001$. Scheffe' post hoc comparison indicated that while all groups were affected by the word type condition, the dyslexic subjects were affected by it the most. CA group and RA group did not differ significantly in their pattern.

In order to examine within group differences in reading rate for the two word types, a t-test was used on paired data. Results of the t-test revealed that all groups responded significantly faster in the regular word condition than in the nonword condition. The mean reaction time for the DYS subjects in the nonword condition was 1326 milliseconds, and in the word condition 711 milliseconds, $t_{(17)} = -3.95$, $p < .001$. The CA subjects' mean reaction time in the word condition was 498 milliseconds, and in the nonword condition 564 msec, $t_{(19)} = -7.22$, $p < .001$. The mean reaction time for the RA subjects were 606 msec, and 684 msec in the word and nonword condition, respectively, $t_{(19)} = -5.49$, $p < .001$. Similarly, a 3 (group) by 2 (word type) MANOVA was performed on the error percentage committed in each word type.

The following were scored as errors: target words that were incorrectly read, responses that took longer than 4000 msec, and responses that took more than 2.5 S.D. above the subject's mean reaction time for that condition. The patterns of results obtained from that analysis was virtually identical to the results obtained from the reaction time data. There was a significant group main effect, $F_{(2,57)} = 14.40$, $p < .0001$, a significant word type main effect, $F_{(1,58)} = 127.38$, $p < .0001$, and a significant group by word type interaction $F_{(2,58)} = 15.47$, $p < .0001$. Cell means and standard deviations are presented in Table 3, and a graph to illustrate the interaction in Figure 6.

As can be seen in Figure 6, all groups had a higher percentage of error in the nonword condition. The percentage of errors committed increased steadily from the CA subjects to the RA subjects to the DYS subjects. A Scheffe' post hoc comparison revealed that within the nonword condition there were significant differences between all groups, $p < .0001$. No such differences were found in the word condition, where all groups demonstrated a low error percentage.

In order to examine the interaction between reading group and reading accuracy of the two word types, a difference score was calculated for each subject by subtracting the mean error percentage committed in reading words from the mean error percentage made in reading

TABLE 3

Mean error percentage committed in reading words and nonwords

	Word condition	Nonword condition
DYS	$\overline{x}$ = 6.11 (S.D. 4.84)	$\overline{x}$ = 36.40 (S.D. 19.01)
CA	$\overline{x}$ = 4.80 (S.D. 3.74)	$\overline{x}$ = 12.27 (S.D. 8.37)
RA	$\overline{x}$ = 4.97 (S.D. 4.97)	$\overline{x}$ = 24.65 (S.D. 9.54)

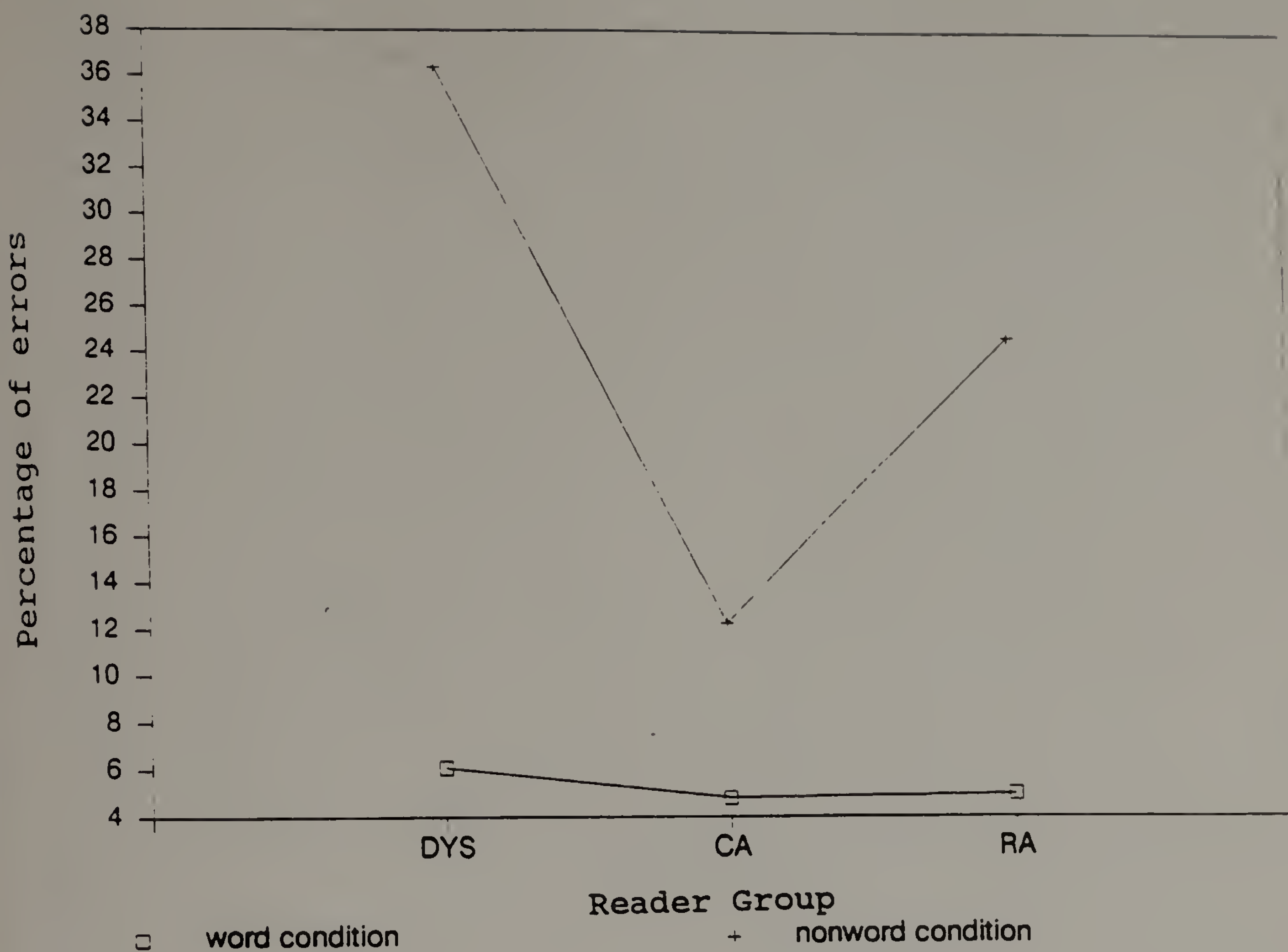

Figure 6. Percentage of errors as a function of reader group and word type

nonwords. The difference score was analyzed with a oneway ANOVA and revealed significant group differences, $F_{(2,57)} = 15.47$, $p < .0001$. Scheffe' post hoc comparisons indicated that the influence of the nonword condition increased significantly from CA subjects, to RA subjects to DYS subjects, $p < .05$. Although the between group comparison indicated that the magnitude of word condition influence differed significantly between the groups, within group comparison performed on paired data indicated that this difference was significant for each group. The percentage of errors committed by DYS subjects were 6.11, and 36.40 in the word and nonword condition, respectively, $t_{(17)} = -6.74$, $p < .001$. The CA subjects' error percentage increased from 4.80 in the word condition to 12.27 in the nonword condition, $t_{(19)} = -4.14$, $p < .001$. The RA group's mean error percentage increased from 4.97 in the word condition to 24.65 in the nonword condition, $t_{(19)} = -5.49$, $p < .001$.

In order to study the relationship between word identification level and word attack strategies, a pearson correlation analysis was used on word identification level and reading rate, and on word identification level and accuracy scores on the word and nonword lists. These correlation data are presented in Table 4. As can be seen in Table 4, significant negative correlations between word identification score on the WRMT-R and word reaction time were found for the DYS group, $r = -.87$, $p < .001$, and for

TABLE 4

Correlations between word identification level and reading rate and accuracy

	DYS	CA	RA
WI-WRT	$r = -.87$ $p < .001$	$r = .12$ $p > .05$	$r = -.49$ $p < .05$
WI-NWRT	$r = -.81$ $p < .001$	$r = -.05$ $p > .05$	$r = -.56$ $p < .01$
WI-WER	$r = -.08$ $p > .05$	$r = .09$ $p > .05$	$r = -.54$ $p < .01$
WI-NWER	$r = -.35$ $p > .05$	$r = .013$ $p > .05$	$r = -.58$ $p < .001$

* WI = word identification level
* WRT = word reading time
* NWRT = nonword reaction time
* WER = percentage of errors committed in reading words
* NWER = percentage of errors committed in reading nonwords

the RA group, $r = -.49$, $p < .01$, but not for the CA group, $r = .12$, $p > .05$. In those two groups better readers had faster responses times. Similar negative correlations were found between word identification level and percentage of errors committed in reading words for the RA group $r = -.54$, $p < .01$, and between word identification score and percentage of errors committed in reading nonwords, $r = -.58$, $p < .05$, but no such correlations were found for the CA, and DYS groups. These data can point to the direction of developmental trends observed in the RA group but not in the DYS group. Namely: for the RA group, there is a relationship between word identification level, and other skills required for fluent reading such as speed and accuracy. The better readers in this group, make an appropriate progress in reading speed and reading accuracy. The DYS students, on the other hand, do not exhibit such a relationship. The only relationship for them is apparent when time is the measure used for analysis.

Additional correlation analyses were carried out on the inner integration of the reading performance sub-skills. These correlations are presented in Table 5. As can be seen in Table 5, significant correlations were found between word reaction time and nonword reaction time for all groups, whereas significant correlation between percentage of errors committed in reading regular (WER) with percentage of errors committed in reading nonword (NWER) were significant just

TABLE 5

Correlations between reading sub-skills

	DYS	CA	RA
WRT-NWRT	$r = .87$ $p < .001$	$r = .84$ $p < .001$	$r = .87$ $p < .001$
WER-NWER	$r = .11$ $p > .05$	$r = .30$ $p > .05$	$r = .43$ $p < .05$

* WRT = word reading time
* NWRT = nonword reading time
* WER = percentage of errors committed in reading words
* NWER = percentage of errors committed in reading nonwords

for RA subjects, $r = .43$, $p < .05$. These correlations may suggest a dissimilar pattern of reading sub-skills integration within each group.

<u>Reading regular and irregular words</u>

The analysis of reading regular and irregular words will be discussed in terms of the dual-route model for word recognition. The reading of the "regular" word type may represents the use of both routes: either the use of the indirect route, in which one gets to the semantic meaning through phonological presentation, or else via the direct route. The reading of irregular words represents the use of the lexical and direct route, in which one gets to the meaning by using the orthographic representation of the whole word. The ability to use both, direct and indirect access procedure is often associated with fluent reading skill, whereas reliance on only one procedure tends to be associated with lower reading skill.

Research questions regarding reading these words was directed towards the examination of differences between groups in rate and accuracy in reading the two types of words as well as within group comparisons: shorter reaction time and smaller error percentage on regular than on matched irregular words will indicate preferable use of the indirect route for accessing meaning. Similar reaction time and error percentage across the two word types would suggest either a comparable reliance on both routes to the semantic meaning of a word, or else the preferable reliance on the direct route.

Separate 3 (group) by 2 (word type) MANOVAS were performed on reaction time scores in reading the two word lists and on the percentage of error committed on each list with reader group as between group variable and word type as within group variable. MANOVA tables for the reaction time data are presented in Appendix H and for the error analysis in Appendix I.

Trials on which an experimental malfunction occurred were dropped from the data analysis. Across all conditions attempted by the DYS group 1.39% trials were dropped from the analysis, 2.36% trials were dropped from the RA data and 0.80% trials were dropped from the CA data.

Trials on which the subject incorrectly named the target word, trials on which the reaction time took longer than 2.5 S.D. above the subject's mean reaction time for that condition, and response times that were longer than 4000 msec were scored as subject errors and were dropped from the reaction time analysis. All the analyses that follow are based on the mean reaction times for each group in each word type.

The MANOVA performed on the reaction time scores, revealed a significant group main effect, $F_{(2,56)} = 10.69$, $p < .001$, but no significant effect for word type, $F = .02$,

$p > .05$, and no significant group by word type interaction, $F = .35$, $p > .05$. Cell means and standard deviation for the reaction time data are listed in Table 6. As seen in Table 6, within each word type reaction time increased steadily from the CA group to the RA group to the DYS subjects. Scheffe' post hoc comparison revealed that the significant differences were between the DYS group and each of the other two groups. Although, in reading either word type, the CA subjects' reaction time was faster that of the RA subjects, the difference did not reach statistical significance.

Similarly, a 3 (group) by 2 (word type) MANOVA was performed on the error percentage committed in reading each word type. The following responses were scored as errors: target words that were incorrectly read by the subject, responses that took longer than 4000 msec, and responses that took more than 2.5 S.D. above the subject's mean reaction time for that condition. A different picture emerged from that analysis. There was a significant group main effect, $F_{(2,56)} = 18.71$, $p < .001$, a significant main effect for word type, $F_{(1,57)} = 114.54$, $p < 0.001$, and a significant group by word type interaction, $F_{(2,57)} = 11.23$, $p < .001$, indicating that the word type had a differential effect on each group. Cell means and standard deviations are presented in Table 7 and a graph to illustrate the interaction in Figure 7.

TABLE 6

Reading times in milliseconds for regular and irregular words
Cell means and standard deviations

	Regular Words	Irregular Words
DYS	$\overline{x}$ = 935.61 (S.D. 439.49)	$\overline{x}$ = 931.50 (S.D. 449.30)
CA	$\overline{x}$ = 516.37 (S.D 78.76)	$\overline{x}$ = 528.87 (S.D. 84.35)
RA	$\overline{x}$ = 684.45 (S.D. 173.65)	$\overline{x}$ = 680.67 (S.D. 176.45)

TABLE 7

Mean error percentage in reading regular and irregular words
Cell means and standard deviations

	Regular Words	Irregular words
DYS	$\overline{x}$ = 12.65 (S.D. 6.10)	$\overline{x}$ = 26.46 (S.D. 11.18)
CA	$\overline{x}$ = 4.61 (S.D. 2.21)	$\overline{x}$ = 8.46 (S.D. 5.21)
RA	$\overline{x}$ = 7.52 (S.D. 5.54)	$\overline{x}$ = 20.72 (S.D. 10.46)

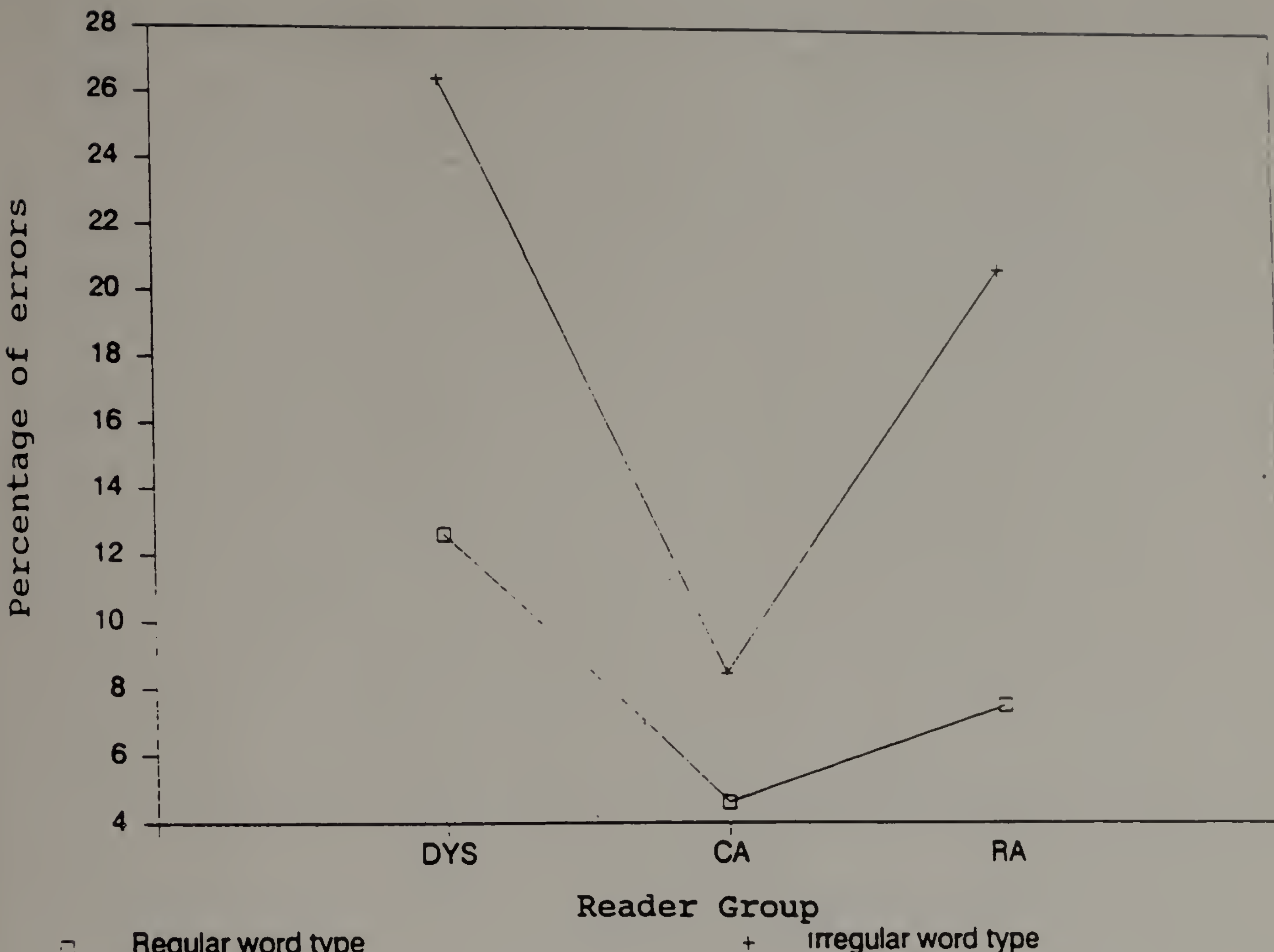

Figure 7. Percentage of errors as a function of reader group and word type

Scheffe' post hoc comparison revealed that within each word type the only group that differed significantly from the other two is the CA group, $p < .05$. Within each word type, the RA subjects committed fewer errors than the DYS subjects, but this difference did not reach statistical significant.

In order to examine the interaction between reader group and their accuracy in reading each word type, additional "difference" scores were calculated for each subject by subtracting the percentage of errors committed while reading the regular type words from the percentage of errors committed while reading the irregular type words. A oneway analysis of variance performed on the "difference" score revealed a pattern similar to those reported above. The CA subjects were less affected by word type condition than the other two groups. The amount of the "difference" score did not differ significantly between the RA and DYS groups. Within group comparisons on percentage of errors committed in reading each word type were done by using T-Test on paired data. This analysis indicated that all groups were significantly helped by the regular type words. The DYS subjects reduced their error percentage from 26.46 in the irregular word condition to 12.65 error percentage in the regular word condition, $t_{(17)} = -6.89$, $p < .001$. The CA subjects' error rate went down from 8.46 in the irregular condition to 4.61 in the regular word type, $t_{(18)} = -2.58$,

$p = .019$. The RA subject's error percentage decreased from 20.72 in the irregular word condition to 7.52 in the regular condition, $t_{(19)} = -8.84$, $p < .001$.

Summary of word attack skills

In reading either words or nonwords the DYS subjects were significantly slower than the RA and CA subjects. In reading the real words there were significant differences between all groups. The CA had the shorter reaction time, the DYS had the longer reaction time and the RA subjects fell in between. The same pattern was observed in the reading times of nonwords. The reading times for DYS and RA groups was significantly faster than for the DYS groups. It is interesting to note that the trend, longer reaction time in the nonword as compared to the real word condition was similar for each group. What differentiated between them was the magnitude of the effect rather than its existence. The nonword condition affected the reaction times of the RA and CA groups to the same degree, whereas it was much more profound for the DYS group.

Accuracy differences in reading the real and nonword target words did not differ between the groups in reading the real words. However, significant differences emerged in the nonword condition. The DYS subjects committed the higher error percentage, followed by the RA subjects and the CA subjects.

This pattern suggests that the nonword condition and the skill required to perform this task is the area in which most differences between groups occurred. The correlation data provide further support for that interpretation.

Of specific interest is the comparison between the college age dyslexic students and their reading age matched younger control group. The group of RA subjects exhibited negative correlations between word identification level (WI) and reaction time (RT), $r = -.49$, $p < .01$, negative correlations between WI and percentage of errors committed in reading words (WER), $r = -.54$, $p < .01$, negative correlations between WI and percentage of errors committed in reading the nonwords (NWER), $r = -.48$, $p < .01$, and positive correlation between NWER and WER variables, $r = .43$, $p < .05$. The only correlation observed in the group of DYS subjects was in the reading rate domain, between WI and RT, $r = -.87$, $p <.001$, but not in the accuracy field, suggesting a different pattern of reading sub-skills integration in the two reader groups. The younger normal readers improved their reading skills in accordance to their improvement in word reading, a better word reader in this group, had developed appropriate reading sub-skills. The DYS group did not present such relationship. For them, Improvement of word reading did not imply improvement in other reading sub-skills.

Considering the regular and irregular word reading results, college dyslexic readers were slower and made more errors than RA subjects, who were slower and made more errors than CA subjects, on each word type. None of the groups exhibited regularity effect in terms of reaction time. Regularity effect was demonstrated for all groups in the error rate. The regularity effect was similar for the RA and DYS groups and significantly larger than for the CA group.

In general, the reading of regular and irregular target words indicates that all groups utilize the indirect route in reading. It appears that this utilization manifests itself mainly in error rate. However, this conclusion should be taken with caution, since slow reading times were confounded with "pure" accuracy errors.

These results are in conflict with the nonword results that suggest impairment in the indirect route for the DYS group.

Oral Reading Measures

Discussion of the results in this category are divided into two sections: oral reading accuracy, and oral reading rate.

Both dependent measures, accuracy and rate in each of the experimental conditions in oral reading tasks, were analyzed in order to study the interaction between isolated word identification and the use of context for word recognition.

Oral reading accuracy

Measures of interest were between-group comparisons of accuracy level in reading coherent and randomly presented passages, and within-group comparisons with regard to those measures. The analysis based of the accuracy data was directed to answer the following research question: will there be differences among the groups in their ability to use context to facilitate word recognition, and will there be differences among the groups in the pattern of context use? A reduction in the error percentage in the coherent as compared to the randomly presented passages, would indicate use of context in reading. Larger magnitude of error reduction, if observed in the easier passages, as compared to more difficult passages, would indicate larger reliance on context in easier passages, suggesting that when the context is within accessible level, readers do use it to facilitate their reading.

The dependent measures in this analysis was the mean percentage of errors committed in reading the random (RAN) and coherent (COH) presented passages in easy and more difficult reading material.

A 3 (group) by 2 (difficulty level) by 2 (context condition) MANOVA was performed on the mean error percentage score in each context condition. The MANOVA tables of the error analysis is presented in Appendix J. The analysis revealed a significant group main effect, $F_{(2,54)} = 13.91$, $p < .001$, a significant main effect for material difficulty level, $F_{(1,55)} = 28.62$, $p < .0001$, and a significant main effect for context condition $F_{(1,55)} = 40.86$, $p < .0001$. There was a significant group by difficulty interaction, $F_{(2,55)} = 10.12$, $p < .001$, indicating that difficulty level had a differential effect on each reader group. The size of the effect was smaller for the CA subjects than for any other group, and somewhat larger for the RA group than for the DYS group. A significant group by context condition interaction, $F_{(2,55)} = 7.40$, $p < .001$, indicates that although all groups were facilitated by context (e.g. less errors), context condition had a differential effect on each group. The effect was more apparent for the RA subjects as compared to the DYS group, and in both groups when compared to the CA group. The CA group exhibited a similar pattern at the easy level, but did not exhibit this trend with the more difficult passages. Thus, it is difficult to conclude if the CA group was affected in a significantly different manner than the other two groups. No difficulty level by context condition interaction was discovered. Cell means and standard deviations can be found in Table 8, and graphs

TABLE 8

Oral reading errors
Cell means and standard deviations

	Easy passages		Difficult passages	
	Random	Coherent	Random	Coherent
DYS	$\overline{X}$ = 8.43 (S.D. 4.9)	$\overline{X}$ = 4.89 (S.D. 2.87)	$\overline{X}$ = 10.91 (S.D. 6.3)	$\overline{X}$ = 7.95 (S.D. 4.2)
CA	$\overline{X}$ = 2.57 (S.D. 2.3)	$\overline{X}$ = .86 (S.D. .68)	$\overline{X}$ = 1.68 (S.D. 1.2)	$\overline{X}$ = 1.37 (S.D. .86)
RA	$\overline{X}$ = 9.84 (S.D. 8.8)	$\overline{X}$ = 4.83 (S.D. 3.5)	$\overline{X}$ =14.45 (S.D. 11.2)	$\overline{X}$=8.03 (S.D. 7.1)

to illustrate the interactions are presented in Figures 8 and 9. As seen in Table 8, within each context condition (coherent & random) there was an increase in error percentage from CA subjects to DYS subjects to RA subjects. Scheffe' post hoc comparisons indicated that there were no differences between DYS and RA groups' error rate in any of the context condition or difficulty level material. The CA group made fewer errors than any of the other groups.

T -tests were used on paired data for each group to contrast the random and coherent passage conditions.

In the easy passages, the DYS group's error percentage decreased from 8.43 in the randomly presented passages to 4.89 with the coherent passages, (improvement of 41.99%), $t_{(18)} = -5.35$, $p < .001$, and with the difficult passages from 10.91 in the random condition to 7.95 in the coherent situation, (improvement of 27.13%), $t_{(18)} = -2.92$, $p < .01$. Similar trends were found for the RA subjects. Their error percentage rate decreased from 9.84 with the randomly presented easy passages, to 4.83 with the coherent presentation (improvement of 50.91%), $t_{(19)} = -3.60$, $p < .01$. At the difficult level there was a decrease from 14.45 in the random condition to 8.03 in coherent presented passages, (improvement of 44.42%), $t_{(19)} = -3.95$, $p < .001$. The CA subjects exhibited a somewhat different picture. At the easy level there was a significant difference in the percentage of errors made with the random (2.57) as compared

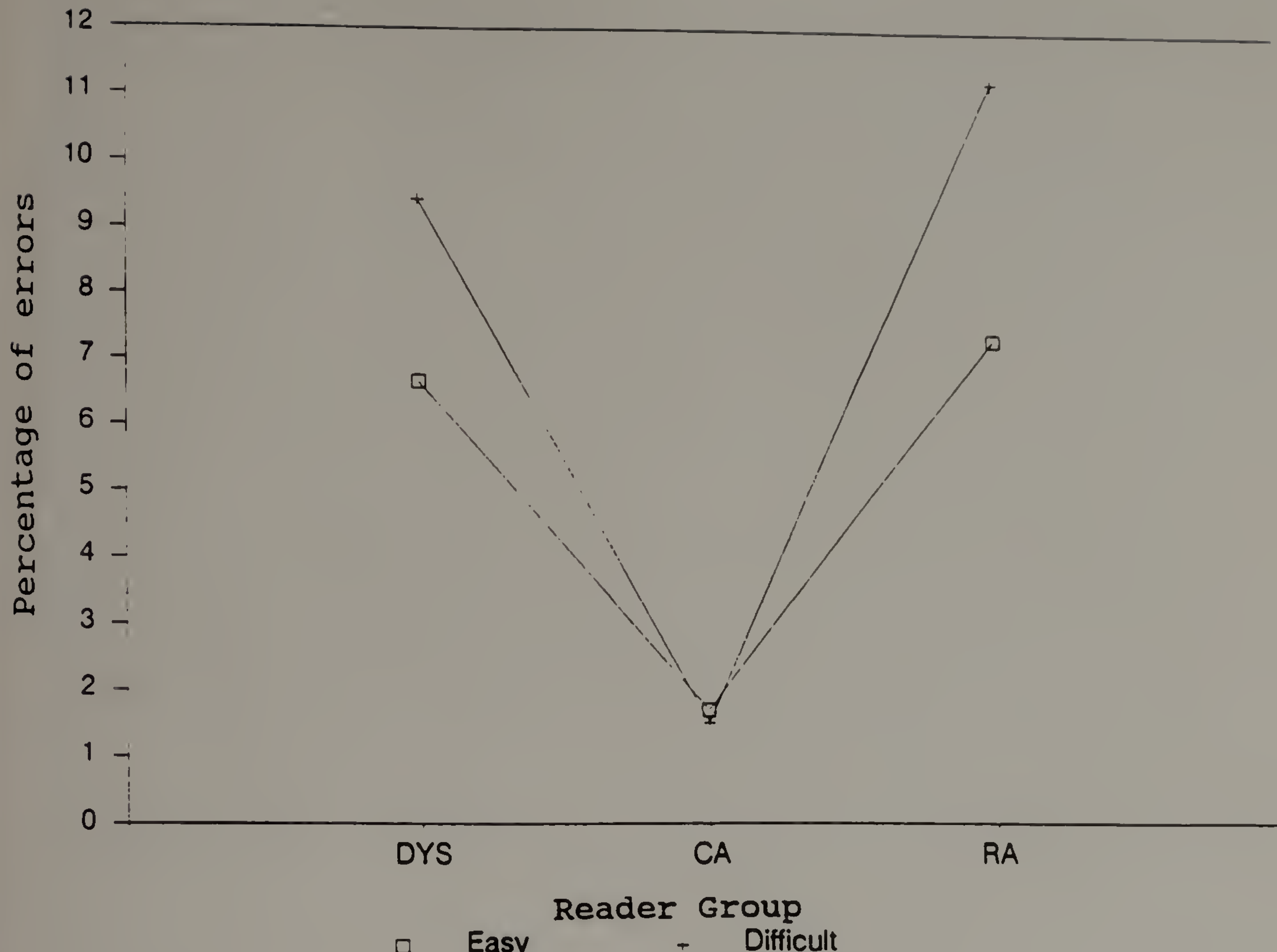

Figure 8. Error percentage as a function of reader group and difficulty level

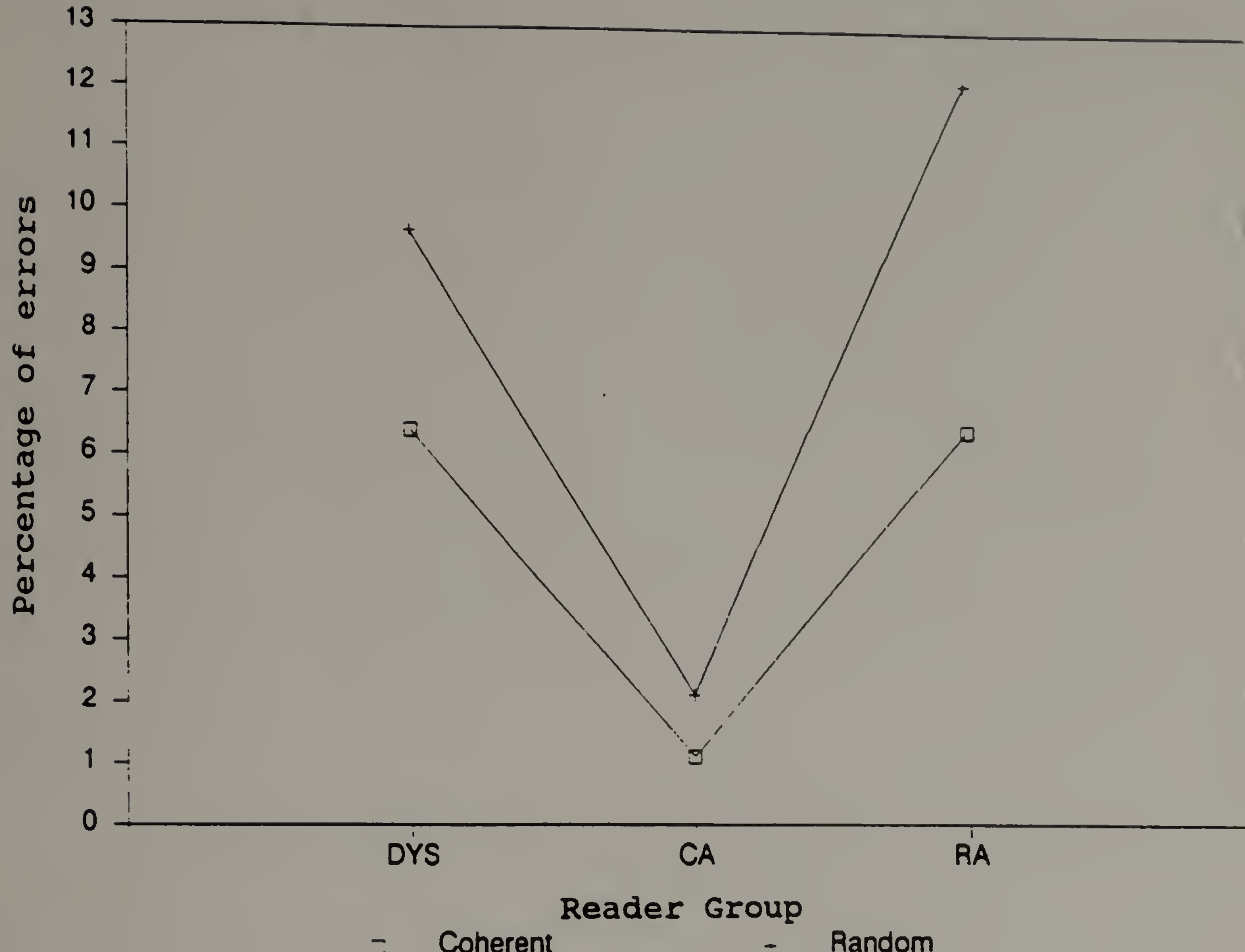

Figure 9. Error percentage as a function of reader group and context condition

to the error percentage made with the coherent (.86) passages, $t_{(19)} = -3.02$, $p < .01$. However, no such trend was observed with the more difficult passages.

These trends indicate that contextual facilitation provided by the coherent passages was greater for the easier passages than for the more difficult ones, and the effect of the level of material was more apparent for the DYS and RA groups than for the CA group.

<u>Oral reading rate</u>

The next measure for analysis was the mean percentage of words read per second. Initially, the purpose was to use the raw data for total reading times. However, it happened that some subjects skipped a few lines, so that a measure of a total reading time would obscure the real time needed for reading. Thus, a word per second score was calculated for each subject by dividing the number of total words read by the time taken to read them.

A 3 (group) by 2 (context condition) by 2 (difficulty level) MANOVA was performed on the word per second scores (WSEC). MANOVA tables for this analysis are presented in Appendix K. The results indicated a significant group main effect, $F_{(2,54)} = 25.84$, $p < .0001$, a significant difficulty level main effect, $F_{(1,55)} = 167.88$, $p < 0.001$, and a context condition main effect, $F_{(1,55)} = 409.05$, $p < 0.001$. The interactions between group and context condition,

$F_{(2,55)} = 8.91$, $p < .001$, and between difficulty level and context condition, $F_{(1,55)} = 83.46$, $p < 0.001$, were also significant. This pattern of interactions indicates that the contextual facilitation provided by the coherent passages is greater in the easy as compared to the more difficult passages and somewhat more apparent in the performance of the DYS group as compared to the RA and CA groups. The interaction between reader group and difficulty level, $F = .01$, and the three- way interaction, $F = 3.11$, $p > .05$, were not significant. Cell means and standard deviations are presented in Table 9, and a graph to illustrate the effect of context condition is presented in Figure 10.

T- Tests on paired data were used in order to analyze within group contrasts between the coherent and random conditions. All contrasts displayed at Table 9 were significant at the .001 level. Further examination of Table 9 reveals a similar pattern of facilitation to the pattern observed from the error analysis. There was a decrease in facilitation obtained by coherent context from the easy to the difficult passages, and that trend was observed for all groups. The DYS group increased their reading rate by 40% in the easy level passages, and by 20% in the difficult level. The CA group reading rate improvement when reading the coherent passages decreased from 32.46% with the easy to 27.52% with the difficult

TABLE 9

Mean number of words read per second
Cell means and standard deviations

Easy level passages

	Random passages	Coherent passages
DYS	$\overline{x}$ = 1.50 (S.D. .41)	$\overline{x}$ = 2.11 (S.D. .43)
CA	$\overline{x}$ = 2.31 (S.D. .30)	$\overline{x}$ = 3.06 (S.D. .27)
RA	$\overline{x}$ = 1.72 (S.D. .46)	$\overline{x}$ = 2.26 (S.D. .51)

Difficult level passages

	Random passages	Coherent passages
DYS	$\overline{x}$ = 1.45 (S.D. .41)	$\overline{x}$ = 1.71 (S.D. .44)
CA	$\overline{x}$ = 2.18 (S.D. .28)	$\overline{x}$ = 2.78 (S.D. .28)
RA	$\overline{x}$ = 1.61 (S.D. .46)	$\overline{x}$ = 1.94 (S.D. .53)

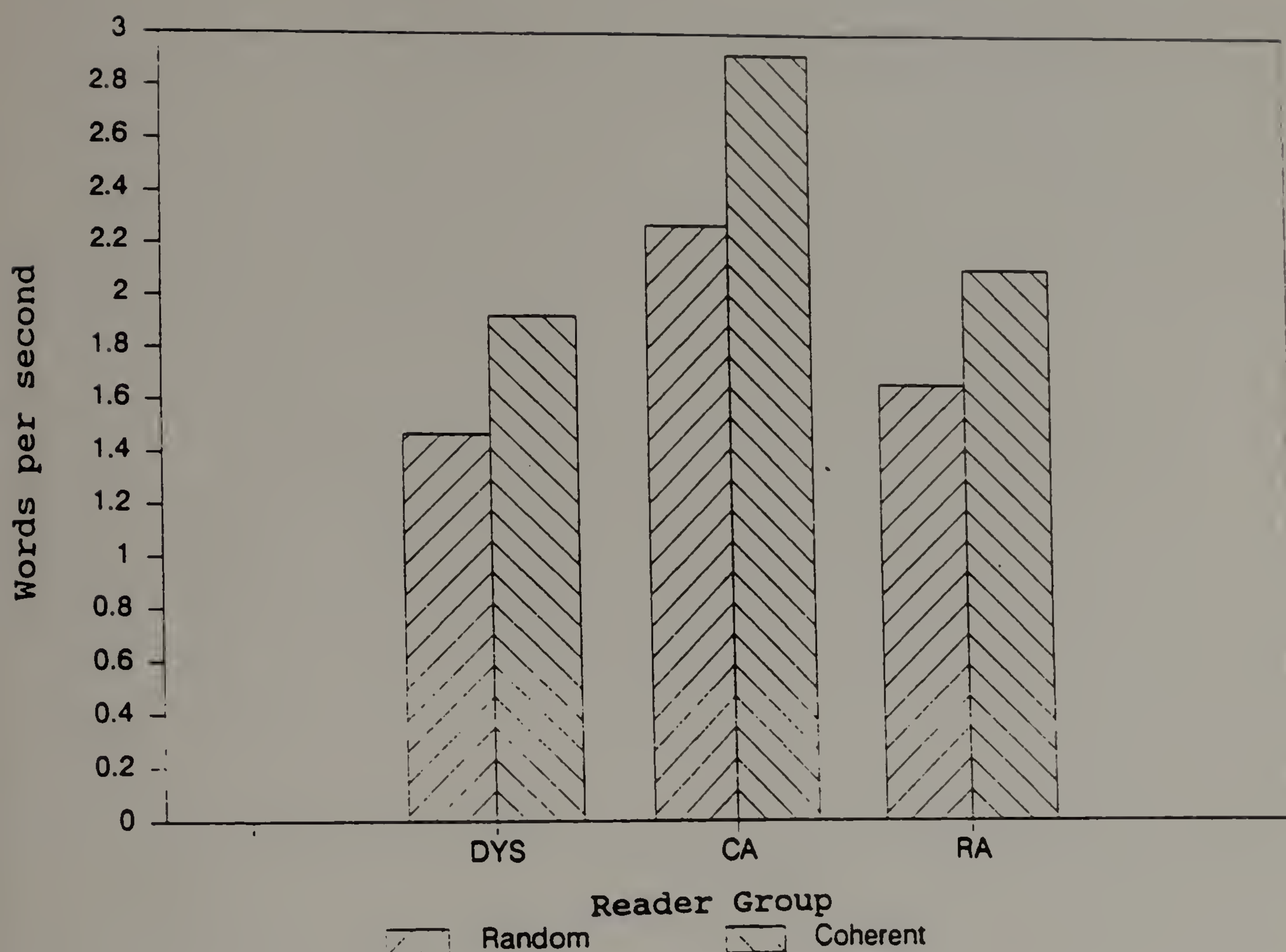

Figure 10. Words read per second as a function of reader group and context condition

passages. The RA subjects facilitation score decreased from 31.93% for the easy level, to 20.49% for the difficult level. This pattern indicates that all groups use context to facilitate reading, and to the greater extent with easier passages. However, the effect of material difficulty on the ability to use context is more profound for the DYS than for the RA group, and for both groups more than for the CA subjects.

As can be seen in Figure 10, within each context condition, there was increase in WSEC score from the DYS to RA to CA subjects. Scheffe' tests indicated that within each context condition and within each difficulty level, the CA group read significantly more words per seconds than any of the other two groups. Although the RA group's score was higher than the DYS group score, the difference did not reach statistical significance.

<u>Summary of oral reading measures</u>

Reading accuracy and reading rate were analyzed in two passage types in order to examine the use of context to facilitate reading by different reader groups, and on the basis of various reading material difficulty. Both analyses suggested similar trends.

All groups were facilitated by the coherent context condition to decrease their error rates and increase the number of words read per second. Results indicate that all groups used context to a larger extent in the relatively easy passages compared to the more difficult ones. Although all groups used context more for the easier material, the trend was stronger for the RA and DYS groups. Their ability to use context was also hindered by difficult material as compared to the CA group. The DYS group was influenced more than the RA group by difficult material.

The similar pattern of performance for the the RA and DYS groups and the greater degree of context effect for them as compared to college normal readers may suggest decoding skill is influential when determining the extent of context use rather than reading strategy.

Types of Oral Reading Errors

Error analysis with respect to error category (characteristics), rather than amount (quantity), was performed in order to determine whae cues are used or disregarded in error production or error correction.

First, results concerning error classification are presented followed by the error correction results. Both analyses were directed to answer the research question if there are differences between the groups in the sources of contextual information used or ignored during error production, and sources used or ignored during error correction.

According to the definition used in this study, an "error" is defined as any deviation from the written text.

Each error is characterized by the source of information which was used at the point of error generation and at the same time reflects the information source that was not used at this point. Given the frequency of errors committed at each category, the probability of using that information in error production can be calculated.

<u>Classification of oral reading errors</u>

Total errors committed by each subject were divided into 5 mutually exclusive categories: (1) Semantic errors (SEM)-reflect the semantic use of context but are not acceptable syntactically or graphemically; (2) syntactic errors (SYN)-reflect the use of syntactic information but not the use of graphemic or semantic cues; (3) graphemic errors (GR)-reflect the use of graphemic cues but change the semantic meaning and syntactic structure of the text; (4) multiple-source errors (MU)-reflect possible use of more than one information source; and (5) nonword errors (NW). All errors were classified just once, either as a single type error, or as multiple-source error.

Next, the percentage of errors committed in each category for that subject was calculated. A 3 (group) by 2 (difficulty level) by 5 (category type) MANOVA was performed on the percentage of error score committed for each category. MANOVA tables for this analysis are presented in Appendix N. The only significant main effect was for error type category, $F_{(4,49)} = 598.50$, $p < 0.001$, and the only significant interaction was between group and error type, $F_{(3,49)} = 3.54$, $p < 001$, indicating that the highest percentage of errors was committed in the multiple-source (MU) type error category. Cell means and standard deviations for the analysis are presented in Table 10, and a graph to illustrate the interaction is presented in Figure 11.

As can be seen in Figure 11, the greatest proportion of errors was classified as multiple - source errors. In that case however, there is possibility that the subject used only one or two sources of information for error production. Thus, it makes it impossible to separate actual from possible sources of error production. A more precise way is to show what source of information was <u>not</u> used in each multiple-source error production. The interpretation of the analysis to follow, will be based on that logic.

In order to study the inner pattern of multiple-source type error, total MU type errors committed by each subject were divided into 4 categories: (1) SESY Category-reflects possible use of either semantic or syntactic cues, or combination of both (but not the use of graphemic cues); (2) SEGR category-reflects the potential use of either semantic or graphemic cues, or combination of both, (but not the use of syntactic cues); (3) SYGR category-reflects the

TABLE 10

Proportions of errors in each category type

Easy level passages

	SEM	SYN	GR	MU	NW
DYS	$\overline{x}$=0.00 (0.00)	$\overline{x}$=13.56 (9.21)	$\overline{x}$=7.27 (8.18)	$\overline{x}$=63.70 (21.68)	$\overline{x}$=9.62 (15.96)
CA	$\overline{x}$=0.00 (0.00)	$\overline{x}$=9.25 (14.81)	$\overline{x}$=2.60 (8.94)	$\overline{x}$=76.50 (32.81)	$\overline{x}$=0.00 (0.00)
RA	$\overline{x}$=0.00 (0.00)	$\overline{x}$=14.72 (14.81)	$\overline{x}$=8.08 (9.67)	$\overline{x}$=58.20 (17.13)	$\overline{x}$=12.92 (13.68)

Difficult level passages

	SEM	SYN	GR	MU	NW
DYS	$\overline{x}$=0.00 (0.00)	$\overline{x}$=11.07 (8.67)	$\overline{x}$=9.48 (6.29)	$\overline{x}$=67.20 (13.21)	$\overline{x}$=8.48 (6.66)
CA	$\overline{x}$=0.00 (0.00)	$\overline{x}$=8.66 (10.94)	$\overline{x}$=4.89 (11.25)	$\overline{x}$=76.62 (24.08)	$\overline{x}$=1.62 (5.14)
RA	$\overline{x}$=0.00 (0.00)	$\overline{x}$=16.87 (11.69)	$\overline{x}$=10.67 (15.64)	$\overline{x}$=54.82 (16.47)	$\overline{x}$=16.22 (13.55)

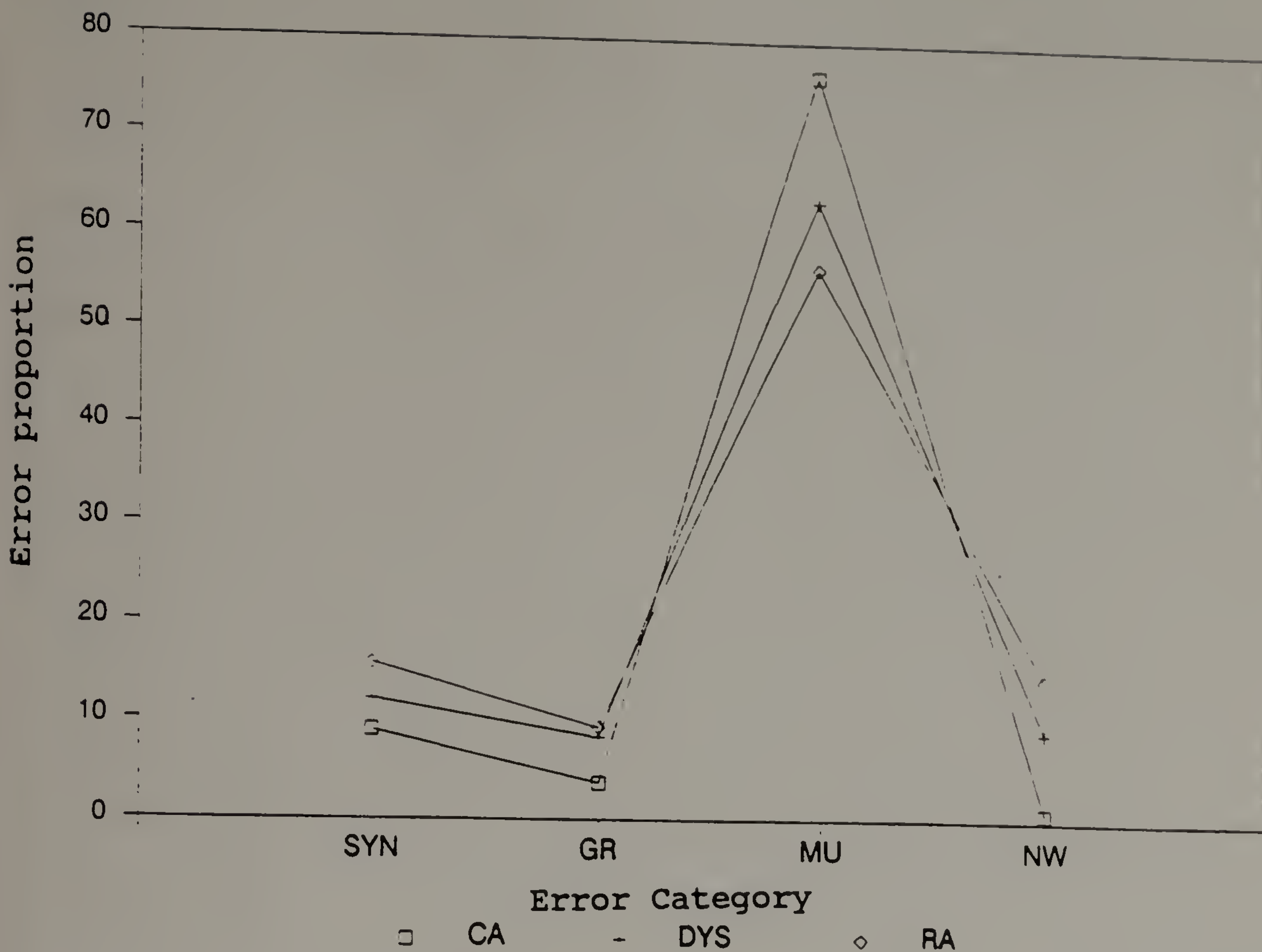

Figure 11. Proportion of errors as a function of error category and reader group

possible use of syntactic or graphemic cues (but not the use of semantic cues); and (4) MU3 category-reflects possible use of all three cues sources. In a similar manner to the procedure described above, percentage of error committed at each category type for each subject was calculated and used in the analysis. The relative weight of each category for error production represented as percentage of error committed in that category are presented in Figures 12 and 13 for the DYS group, Figures 14 and 15 for the CA group, and Figures 16 and 17 for the RA group.

In order to study the relative proportion of errors made in each of the combinations of the different categories that compose the multiple-source error type category, error categories were contrasted to each other with the use of t-test performed on paired data.

For the DYS group, the smallest percentage of error in the easy level was committed in the SEGR category and the only contrast that reached statistical significance was between that category and errors that fall under the MU3 category, $t_{(18)} = 2.84$, $p < .05$. The highest percentage of error was produced in the MU3 category, (thus, unable to make any statement with regard to cues that were not used for error production), followed by SYGR and SESY category, but none reached statistical significance. A similar but somewhat stronger trend was observed at the difficult level. The lower errors percentage was committed in the SEGR

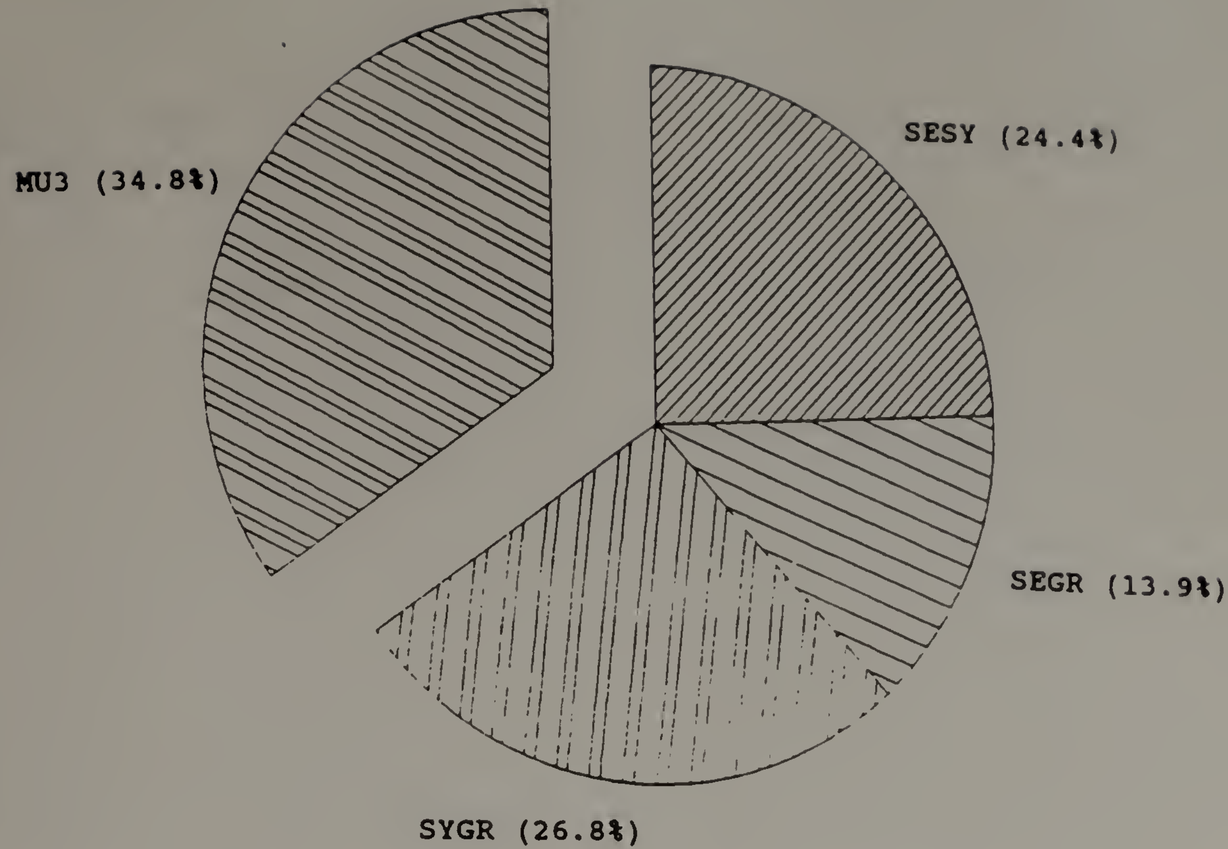

Figure 12. Multiple-Source error distribution for errors committed by the DYS group at the easy level

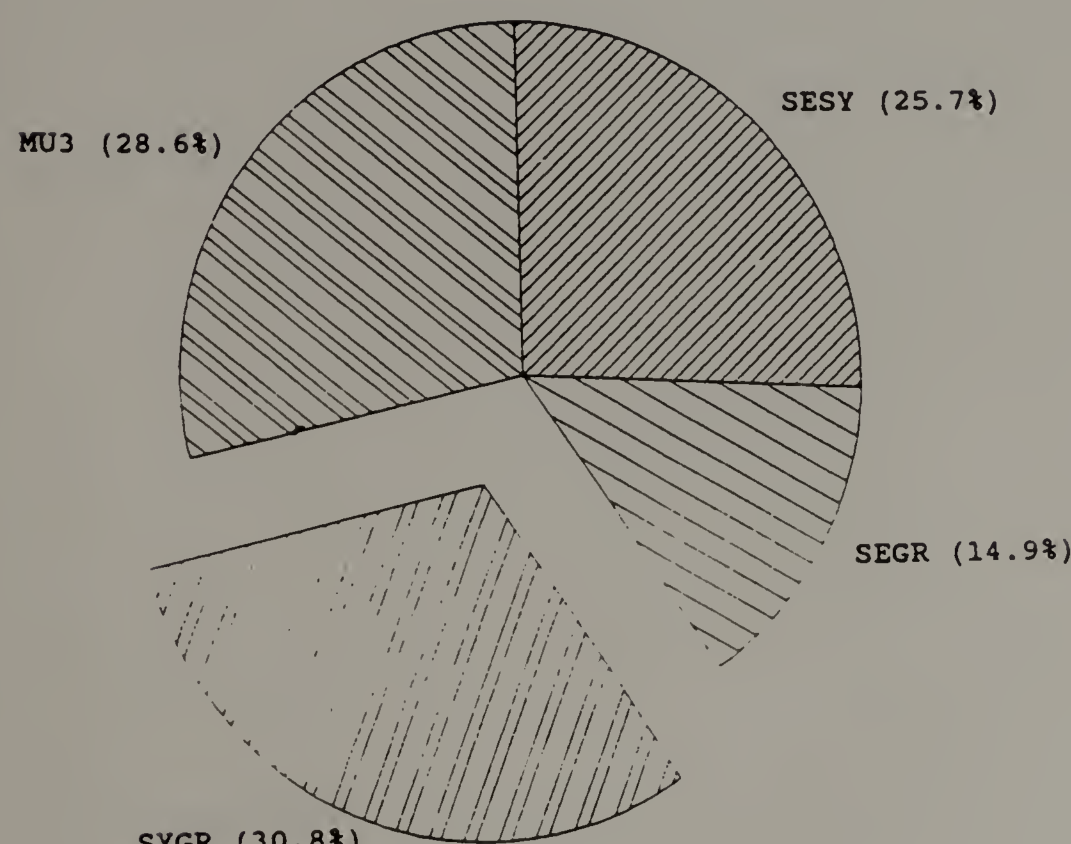

Figure 13. Multiple-source error distribution for errors committed by the DYS group at the difficult level

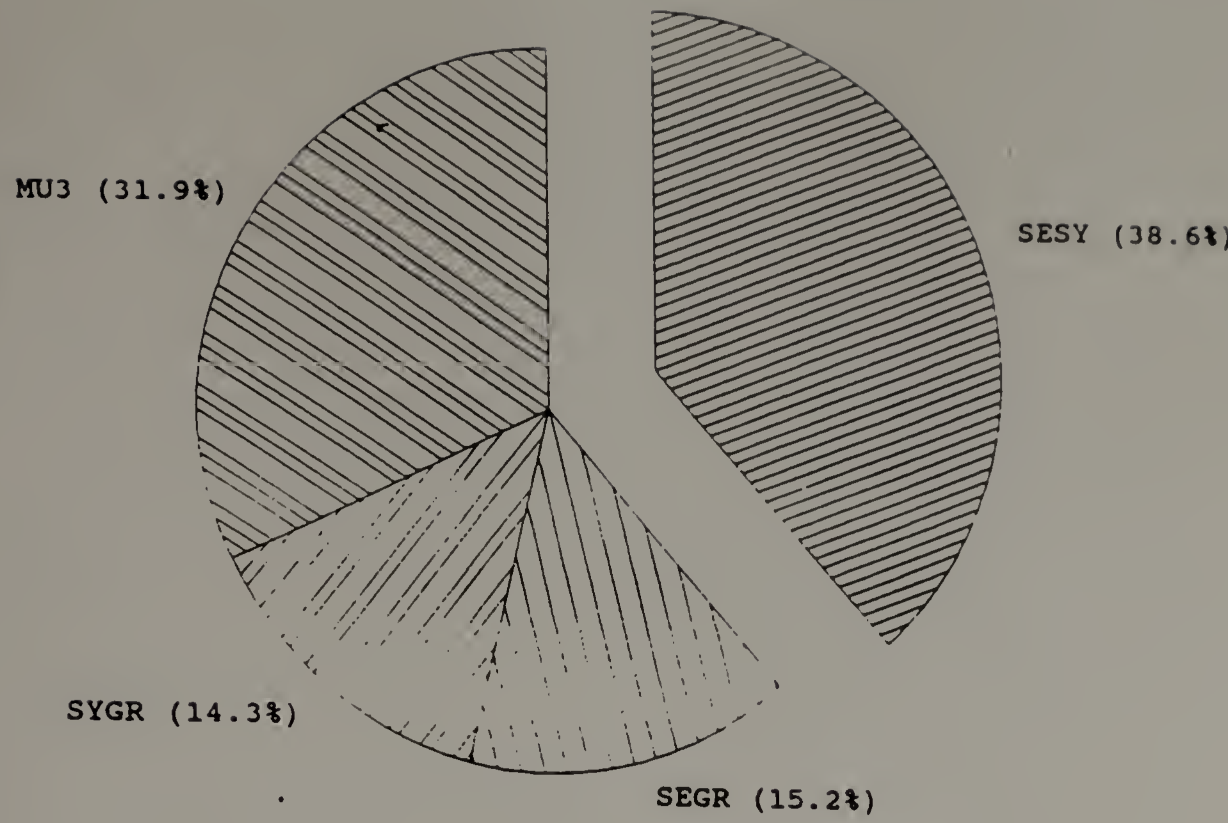

Figure 14. Multiple-Source error distribution for errors committed by the CA group at the easy level

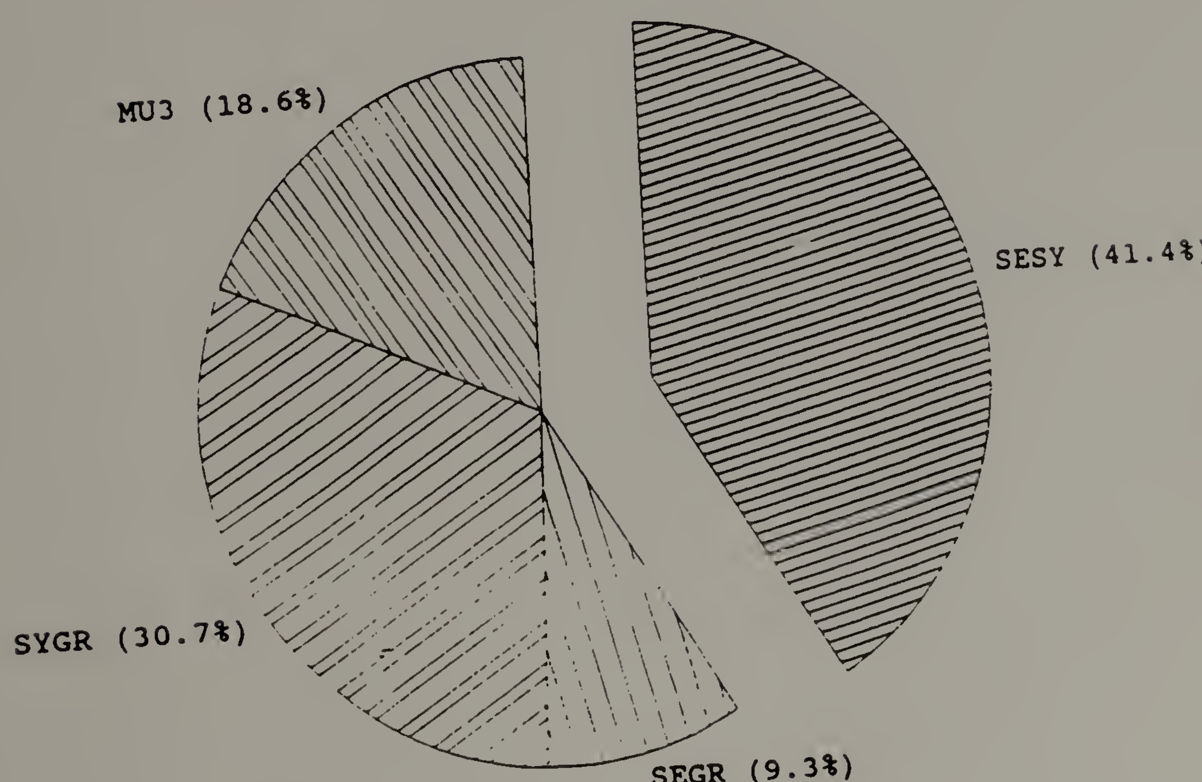

Figure 15. Multiple-source error distribution for errors committed by the CA group at the difficult level

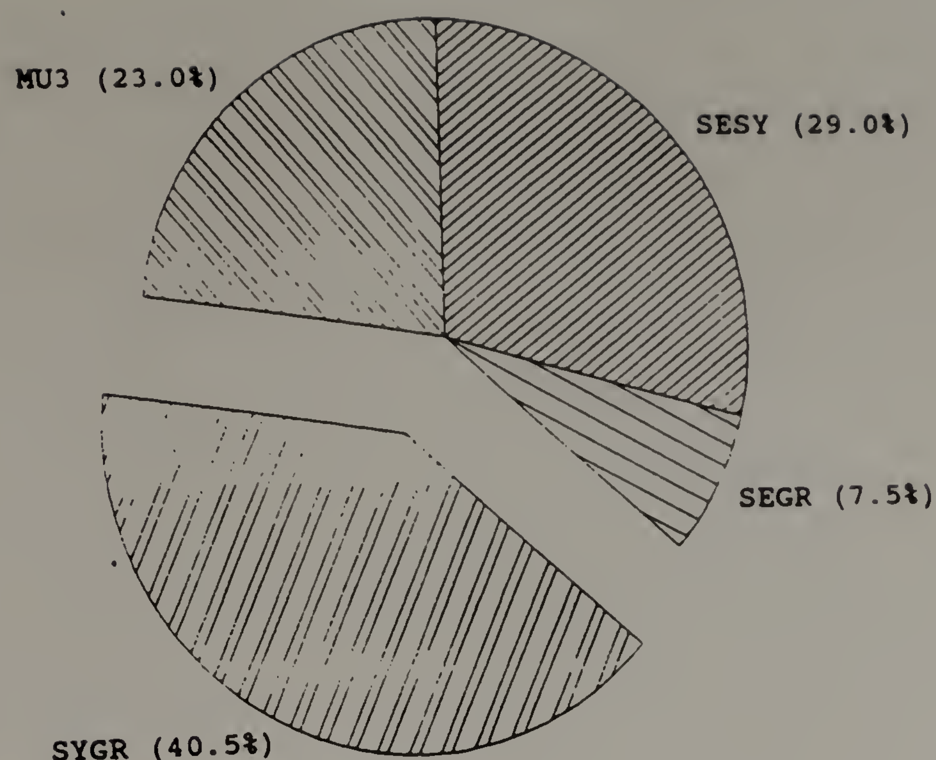

Figure 16. Multiple-source error distribution for errors committed by the RA group at the easy level

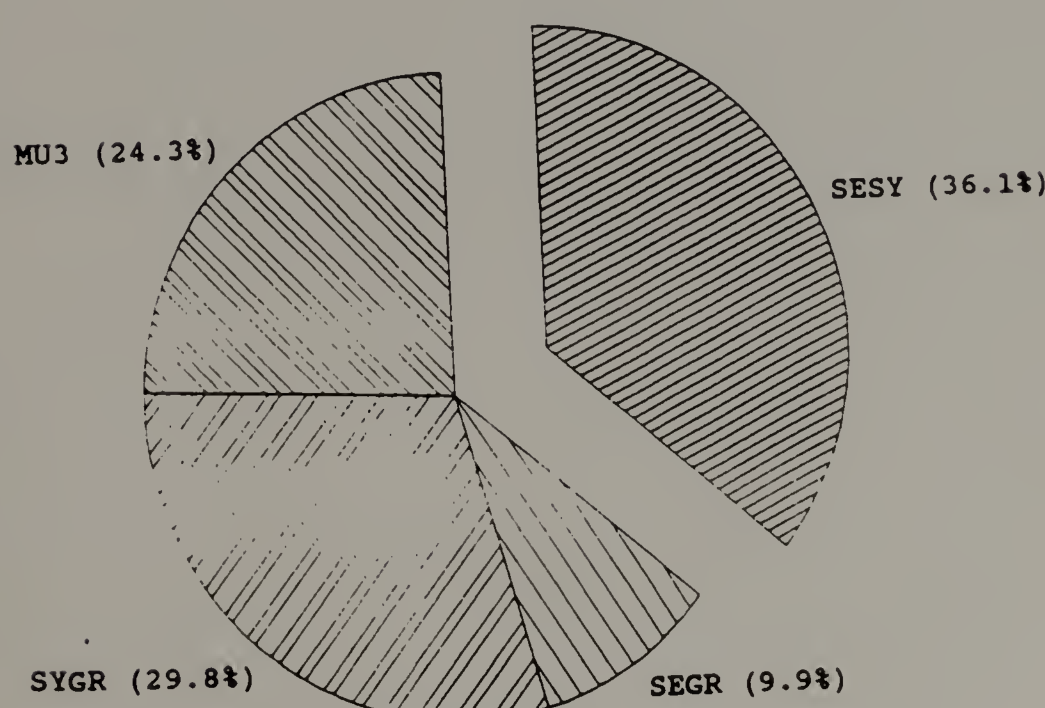

Figure 17. Multiple-source error distribution for errors committed by the RA group at the difficult level

category, and that category was significantly smaller than any other category, $p < .05$. The highest percentage of errors were those that did not reflect the use of semantic information, followed by errors in the MU3 and SESY category. However none of these differences reached statistical significance.

The greatest percentage of error committed by the CA group in the easy level was in the SESY category (reflect no use of GR information), followed by errors in the MU3, SEGR and SYGR categories. However, none of the contrasts between these categories differed significantly from each other. In the difficult level, the largest proportion of errors was at the SESY (no use of GR information) followed by SYGR and MU3 categories, and the smaller percentage of errors fall under the SEGR (no use of syntactic information). The amount of error in the SEGR category was significantly smaller than the percentage of error that did not reflect the use of GR information, $t_{(19)} = 3.18$, $p < .01$, and significantly smaller than error classified under the SYGR (no use of semantic information), $t_{(19)} = -3.03$, $p < .001$.

The RA subjects, as the other two groups, had the fewest errors with the easy level passages in the SEGR category (reflect no use of syntactic information), and was significantly smaller than any other category, $p < .01$. The greatest error percentage was in the SYGR (no use of semantic information), and differed significantly from the

MU3 category, $t_{(19)} = -3.28$, $p < .01$, but not from SESY category. In the difficult level the fewest errors were in the SEGR category and differed significantly from any other category, $p < .001$, df = 19. The largest error percentage was centered at the SESY category, followed by SYGR and MU3 categories, but none of these differences reached statistical differences.

Error self-correction analysis

Analysis of errors that were self-corrected was performed in order to examine differences in tendencies to correct errors between the reader groups. The research question was: do college dyslexic readers differ in their tendency to correct errors compared to younger normal readers and compared to chronological matched control group?

A 3 (group) by 2 (material difficulty level) by 5 (error type category) MANOVA was performed on percentage of errors corrected in each category. MANOVA tables for this analysis are presented in Appendix O. The analysis revealed significant main effect for group, $F_{(2,58)} = 10.38$, $p < .001$, difficulty level, $F_{(1,58)} = 11.43$, $p < .001$, and error category, $F_{(4,49)} = 180.56$, $p < .0001$. There were significant interactions between group and error category, $F_{(3,49)} = 2.71$, $p < .01$, and error category and difficulty level, $F_{(4,49)} = 4.66$, $p <$ 01. The interaction between group and difficulty level and the three-way interaction were not significant. Cell means and standard deviation can be found in Table 11, and a graph to illustrate the interaction is presented in Figure 18. For all groups the largest proportion of errors that was self-corrected were the multiple-source type. Within the single type errors the same pattern was observed for all groups; there was a greater tendency to correct errors that where not semantically and graphemically appropriate but did reflect the use of syntactic information than the tendency to correct errors that where graphemically appropriate but were not using the semantic and syntactic information. This suggests that the greatest tendency for correction occurred in the case when the combination of graphemic and semantic information cues were not used.

Since the majority of the errors were classified as multiple-source errors, an examination of their inner pattern was conducted. For that purpose, the total MU type errors self-corrected by each subject was divided into 4 categories according to the same criteria described at the error analysis section: SESY, SEGR, SYGR, and MU3. Similarly, the percentage of errors self-corrected at each category type for each subject was calculated, and was used in the analysis. Percentages for self corrected errors are presented in Figures 19 and 20 for the DYS group, Figures 21 and 22 for the CA group, and Figures 23 and 24 for the RA group. In order to study the relative proportion of errors

TABLE 11

Proportion of self-corrected errors
Cell means and standard deviation

Easy level passages

	SEM	SYN	GR	MU	NW
DYS	$\bar{x}$=0.00 (0)	$\bar{x}$=10.08 (16.09)	$\bar{x}$=12.62 (21.08)	$\bar{x}$=65.95 (34.32)	$\bar{x}$=1.49 (4.87)
CA	$\bar{x}$=0.00 (0.00)	$\bar{x}$=14.16 (32.11)	$\bar{x}$=0.00 (0.00)	$\bar{x}$=30.83 (44.67)	$\bar{x}$=0.00 (0.00)
RA	$\bar{x}$=0.00 (0.00)	$\bar{x}$=19.61 (35.02)	$\bar{x}$=11.11 (26.18)	$\bar{x}$=44.77 (45.64)	$\bar{x}$=1.00 (4.47)

Difficult level passages

	SEM	SYN	GR	MU	NW
DYS	$\bar{x}$=0.00 (0.00)	$\bar{x}$=15.36 (17.90)	$\bar{x}$=6.70 (11.67)	$\bar{x}$=70.52 (24.52)	$\bar{x}$=6.89 (11.41)
CA	$\bar{x}$=0.00 (0.00)	$\bar{x}$=6.25 (15.96)	$\bar{x}$=5.00 (22.36)	$\bar{x}$=63.75 (45.50)	$\bar{x}$=5.00 (22.36)
RA	$\bar{x}$=0.00 (0.00)	$\bar{x}$=16.64 (27.28)	$\bar{x}$=6.99 (15.40)	$\bar{x}$=67.11 (29.85)	$\bar{x}$=5.83 (12.11)

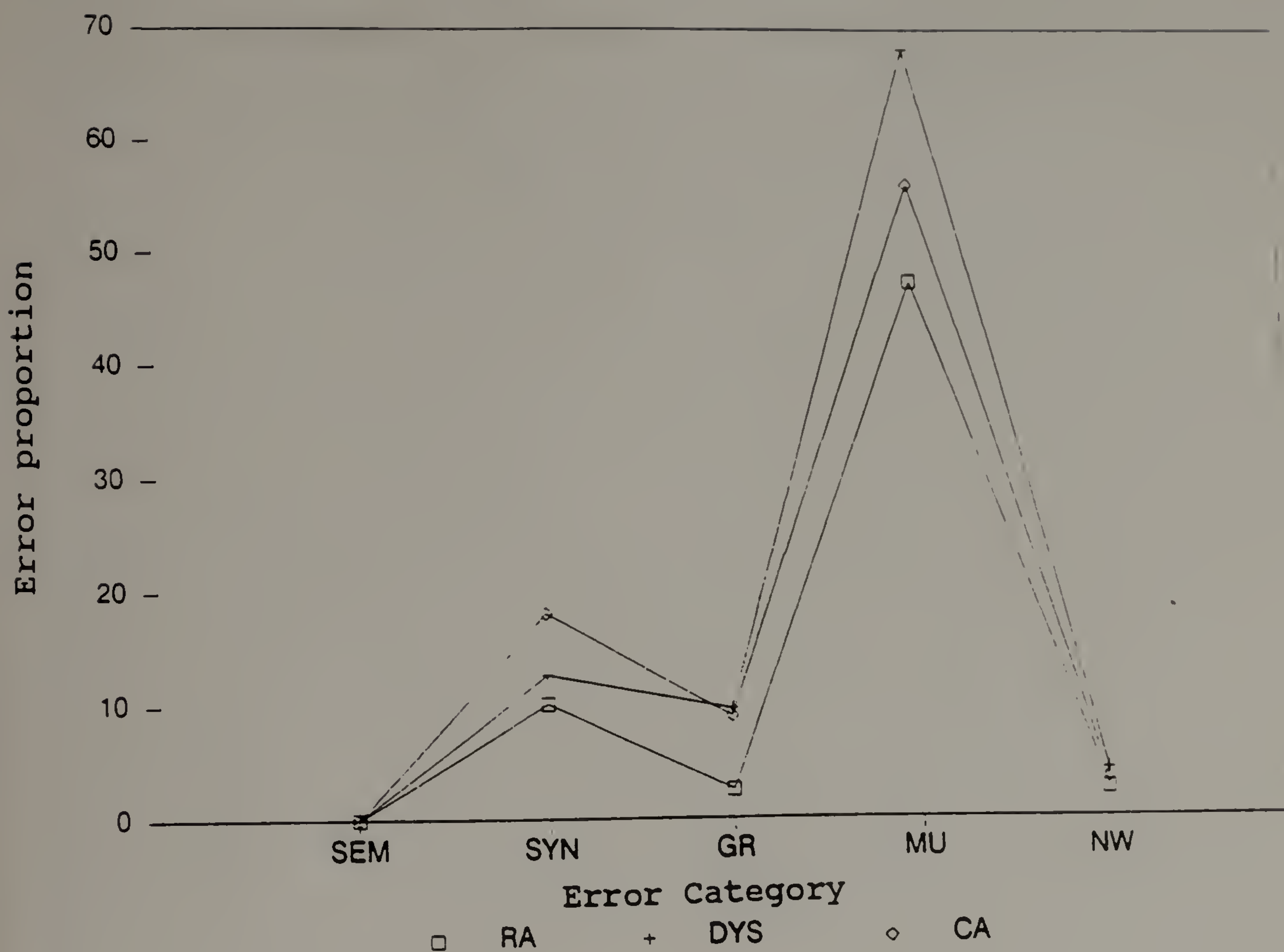

Figure 18. Error proportion as a function of reader group and error type

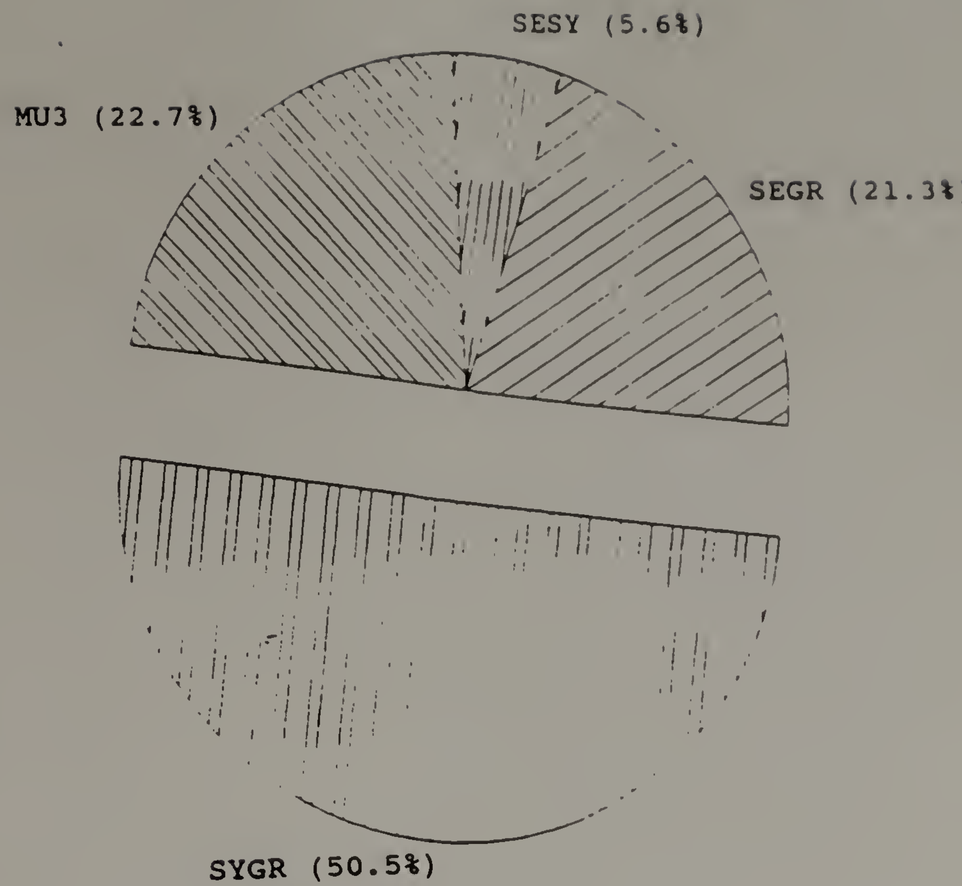

Figure 19. DYS group - self-corrected multiple-type errors in the easy level paragraphs

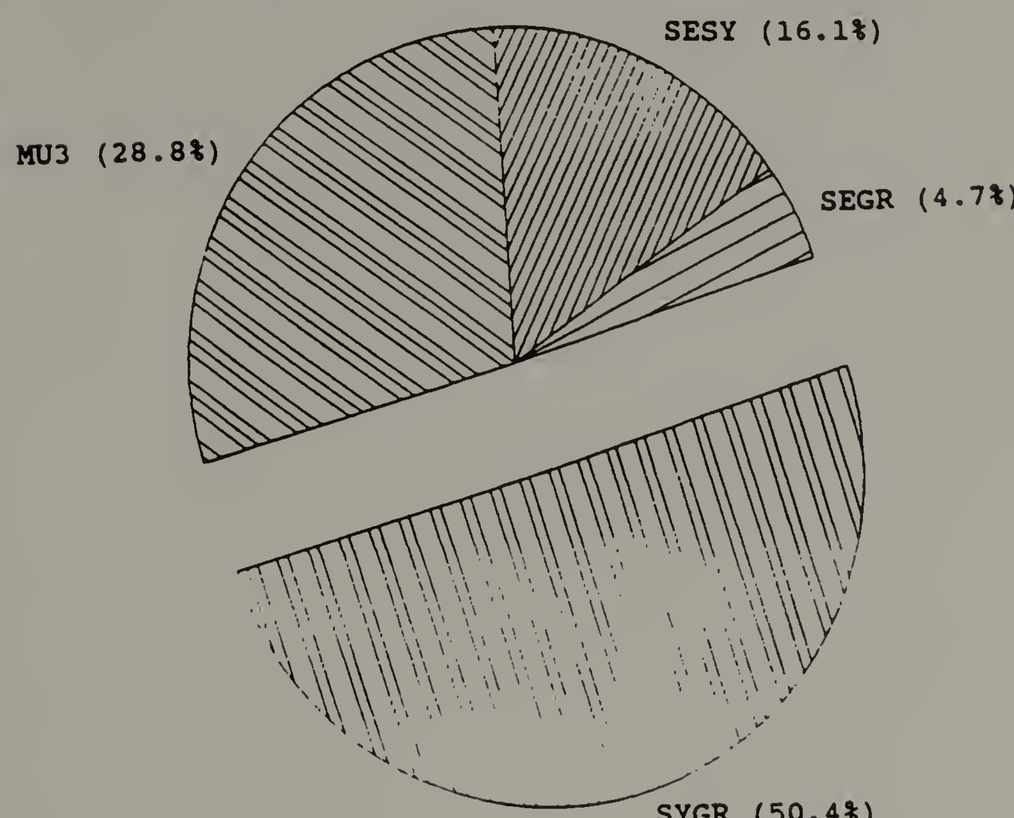

Figure 20. DYS group - self-corrected multiple-type errors in the difficult level paragraphs

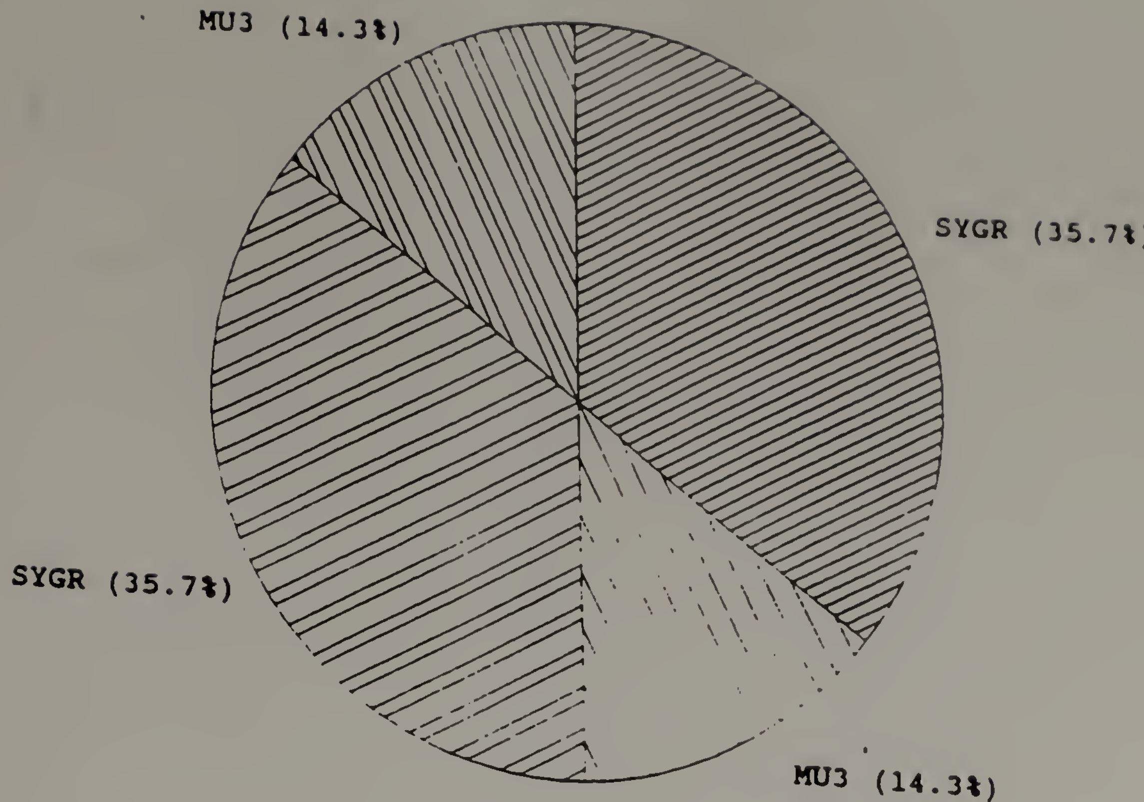

Figure 21. CA group - self-corrected multiple-type errors in the easy level paragraphs

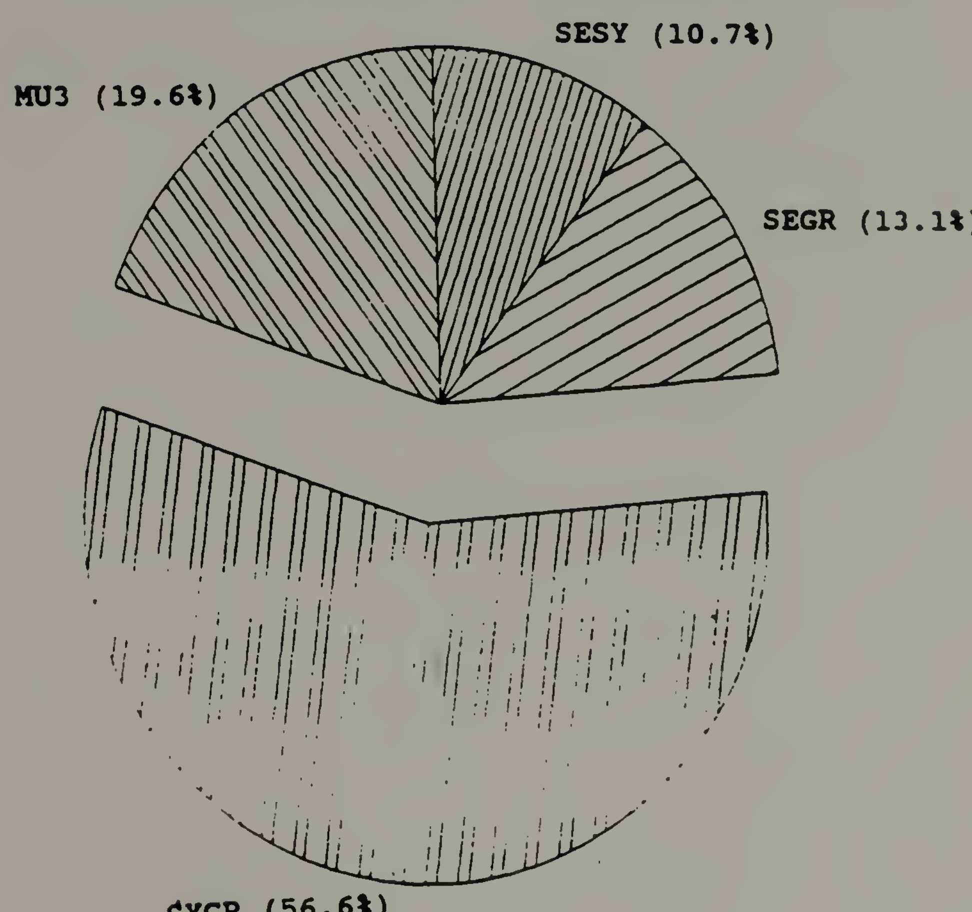

Figure 22. CA group - self-corrected multiple-type errors in the difficult level paragraphs

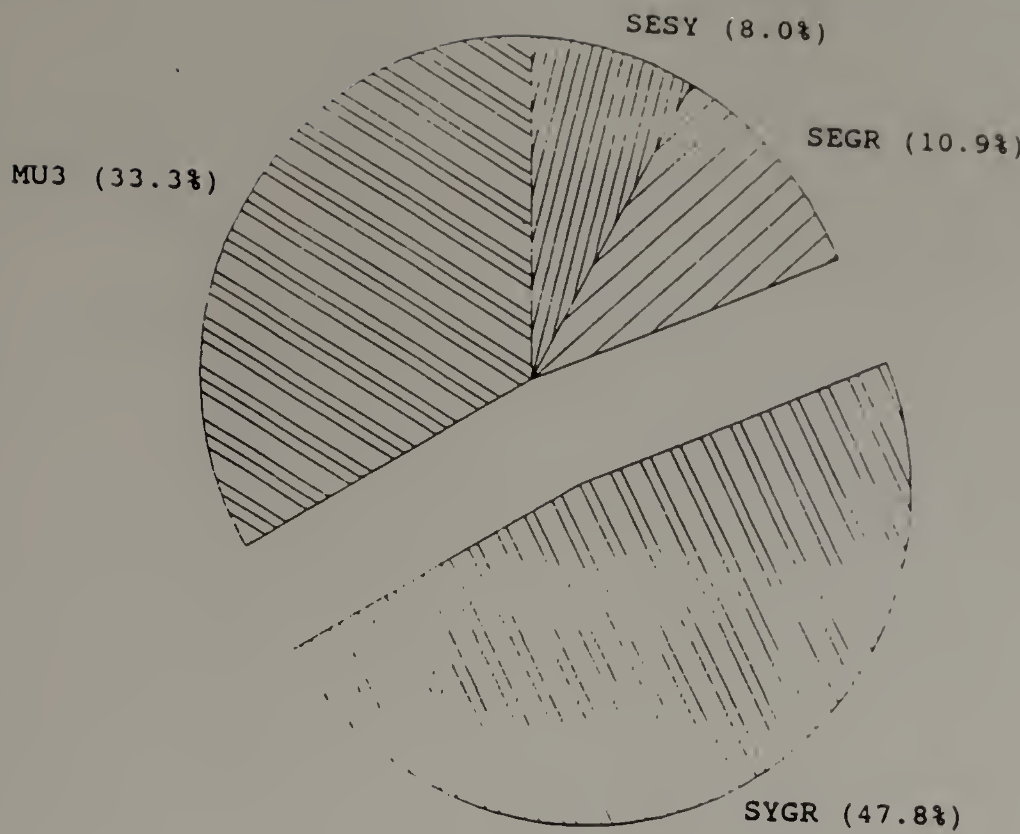

Figure 23. RA group - self-corrected multiple-type errors in the easy level paragraphs

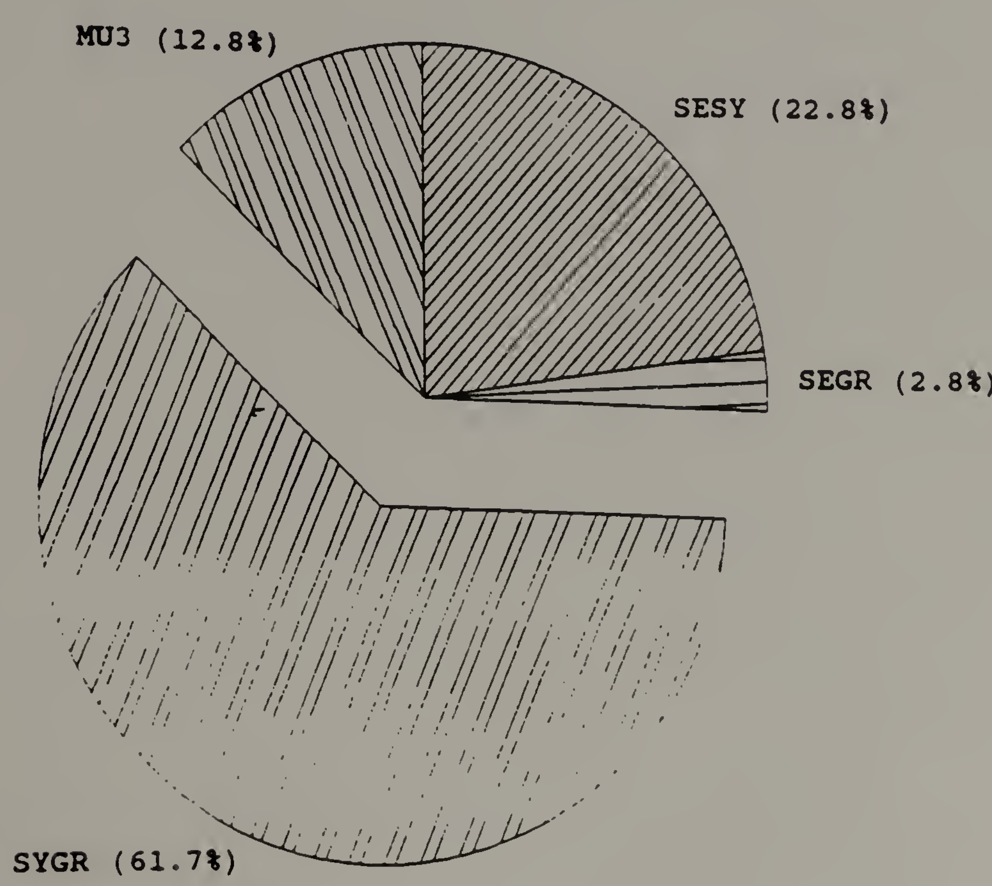

Figure 24. RA group - self-corrected multiple-type errors in the difficult level

made in each of the combination of the different categories that compose the multiple-source error type category, error categories were contrasted to each other with the use of t-test performed on paired data.

In the easy level, the majority of self corrected errors by the DYS group were in the SYGR category, thus suggesting that the tendency to correct happened when the semantic meaning of the text was disrupted. The smallest percentage of self corrected errors reflected the possible use of either semantic, syntactic, or combination of both cues, but did not reflect the use of graphemic information suggesting that when errors were acceptable semantically and syntactically without graphemic information, they were less likely corrected. These two categories were significantly different from each other, $t_{(18)} = -3.44$, $p < .01$. All the other contrasts did not reach statistical significance. A similar trend was displayed in the difficult level. The greatest tendency for correction, as in the easy level, was when the meaning was disrupted. The lowest tendency for correction was when the errors did not reflect the use of syntactic information. For the CA group, the tendency to correct errors in the easy level passages was equal when errors did not reflect the use of semantic information, as well as when errors did not reflect the use of graphemic information. These two categories were followed by the SEGR and MU3 categories, both having the same amount of self corrected errors. With the difficult level passages the greatest tendency for correction occurred when the errors disrupted the meaning of the test. The tendency for correction was higher in that category than in the case were errors were semantically and syntactically appropriate but did not reflect the use of graphemic information, $t_{(19)} = -2.62$, $p < .05$, and significantly higher than in the case were errors reflected the use of semantic and graphemic information, but disrupted the syntactical structure of the text; $t_{(19)} = -2.46$, $p < .05$. All other contrasts did not reach statistical significance.

The RA subjects tended to correct errors at the easy level mostly when meaning was disrupted. The number of errors that were self corrected in this category was significantly greater than when errors disrupted the syntactic structure of the text, $t_{(19)} = -3.40$, $p < .01$, or when errors reflected the possible use of 3 sources of information, $t_{(19)} = 2.43$, $0 < .05$. The lowest tendency for self correction was for errors that did not reflect the use of syntactic cues. A similar tendency was observed in the difficult level. The errors that were most likely to be corrected were those that disrupted the meaning of the text. The lowest tendency for correction occurred when errors either did not reflect the use of graphemic or syntactical information.

Summary of classification of oral reading errors

All groups made significantly more multiple-source than single source errors. Within the single source errors all groups made more errors that reflected the use of syntactic information than errors that reflected the exclusively use of graphemic information. No group made errors that could be classified as "pure" semantic error, (according to the definition used in this study).

Inspection of multiple-source type error reveals that all information sources and combinations contributed to error production. For the DYS subjects the largest percentage of errors committed at either difficulty level reflects the possible use of graphemic, syntactic or both information sources but disregarded the semantic information. The same pattern was observed for the RA subjects in the easy level, where the greatest percentage of error did not preserve the semantic meaning of the text. At the difficult level the SYGR category was as large as the category that did not reflect the use of graphemic information; i.e., errors that where not generated due to graphemic stimulation. Somewhat different patterns were observed in error production of CA subjects. At the easy level, the greatest percentage of multiple-source errors did not reflect the use of graphemic information but was acceptable semantically and syntactically. At the difficult level, however, there were more errors that disrupted the semantic meaning of the sentence than in the other categories.

Thus, while it is obvious that all sources have their impact at the point where the error is generated, what appears to be different among different reader groups is the relative size of each category. The general tendency for the DYS and the RA groups seems to reflect the use of graphemic and syntactical information for reading aloud, while smaller attention is given to the semantic information. The CA subjects tend to relate to semantic and syntactic information, and sometimes disregard graphemic presentation.

With regard to self-correction, more multiple-source type errors were corrected than single type errors. Within the multiple-source type errors, although all information sources were used for self correction, all groups had a greatest tendency to correct errors that were not acceptable semantically than any other error types. That trend was apparent at either material difficulty level. The CA group, however, tended also to correct errors that were not acceptable graphemically, this trend was very low in the other groups. This may suggest that the CA group does pay attention to the graphemic input and the errors made in oral reading, are not due to misperception, rather, they are output errors.

The analysis used in this section is different from the oral reading analyses reported in the literature. The main difference is the differentiation made between single and multiple-type error. It calls to attention the very high proportion of multiple-type errors and thus suggest that clear indication of what information sources are used in error production is misleading. The analysis used in this section indicates the need to improve on methodological issues in oral reading analysis.

Sentence Context Tasks

Sentence context experimental tasks were guided by the notion that although context has an effect on all readers in terms of faster processing of target words, it has larger effect on younger and less skilled reader as compared to adult adequate readers.

The purpose of the experiments in this section was to examine the use of context for word recognition by college dyslexic readers, compared to adult adequate readers and to younger normal readers. The "context" in this experiment was as a preceding sentence to the target word. There were three contextual conditions: (1) congruous context condition; (2) incongruous context condition; and (3) neutral context condition. Subjects were required to read the sentence context to themselves and then to read the target word aloud as fast and as accurate as possible. Shorter reaction times and smaller error rates in the congruous sentence context than in the neutral condition will indicate facilitation effect. Longer reaction times and higher error rates in the incongruous sentence context than in the neutral sentence condition will indicate context inhibition effect.

A 3 (group) by 3 (context condition) by 2 (difficulty level) MANOVA was performed separately on reaction time and error rate data. MANOVA tables for the reaction time data are presented in Appendix L and for the error analysis in Appendix M. Results based on the analysis of the reaction time data will be presented first and will be followed by error rate analysis.

Reaction time analysis

Trials on which some type of experimental malfunction occurred were dropped from the analysis. Across all conditions, 1.66% trials were dropped from the DYS data, 4.7% trials were dropped from the CA data and 1.24% trials were dropped from the CA data.

Trials on which the subject articulated the wrong word, had a response time longer than 4000 msec or longer than 2.5 S.D. above the subject's mean for that condition were scored as subject errors and were dropped from the reaction time analysis. The mean reaction time in each condition for each subjects was used in the analysis of variance.

Analysis of the reaction time data revealed a significant main effect for group, $F_{(2,56)} = 12.65$, $p < .0001$, difficulty level, $F_{(1,56)} = 54.25$, $p < 0.001$, and context condition $F_{(2,49)} = 5.61$, $p < .01$. There were significant interactions between group and difficulty level, $F_{(2,56)} = 11.01$, $p < .0001$, group and context condition, $F_{(1,49)} = 2.85$, $p < .05$, and between difficulty level, context condition and group, $F_{(1,49)} = 2.72$, $p < .05$. The interaction between difficulty level and context condition was not quite significant, $F_{(2,49)} = 2.95$, $p = .06$. The pattern of these interactions indicates that context had an effect on all groups but was more apparent in the performance of the DYS and RA groups than in the CA group. The difficulty level had greater impact in terms of longer reaction time on the DYS group than on the RA group, and for both groups than on the CA group. Cell means and standard deviations for the MANOVA table can be found in Table 12, and graphs to illustrate the interactions are presented in Figures 25 & 26. Also contained in Table 12 are the magnitudes of the facilitation effect (Fac. = the difference between the congruous and neutral context condition), the inhibition effect (Inh. = the difference between the neutral and the incongruous condition) and the overall context effect (Ov. =

TABLE 12

Mean reaction time in milliseconds
Cell means and standard deviations

List 1

	Con.	Neu.	Inc.	Fac.	Inh.	Ov.
DYS	$\bar{x}$=619	$\bar{x}$=659	$\bar{x}$=674	$\bar{x}$=40	$\bar{x}$=15	$\bar{x}$=55
	(93.97)	(139.26)	(106.37)			
CA	$\bar{x}$=492	x=500	$\bar{x}$=508	$\bar{x}$=8	$\bar{x}$=8	$\bar{x}$=16
	(55.20)	(54.08)	(55.61)			
RA	$\bar{x}$=590	$\bar{x}$=612	$\bar{x}$=627	$\bar{x}$=22	$\bar{x}$=15	$\bar{x}$=37
	(137.33)	(148.47)	(147.65)			

List 2

	Con.	Neu.	Inc.	Fac.	Inh.	Ov.
DYS	$\bar{x}$=955	$\bar{x}$=1176	$\bar{x}$=1422	$\bar{x}$=221	$\bar{x}$=246	$\bar{x}$=467
	(360.46)	(548.71)	(936.34)			
CA	$\bar{x}$=568	$\bar{x}$=586	$\bar{x}$=599	$\bar{x}$=18	$\bar{x}$=13	$\bar{x}$=31
	(81.28)	(78.22)	(80.00)			
RA	$\bar{x}$=842.21	$\bar{x}$=842.4	$\bar{x}$=952	$\bar{x}$=0.19	$\bar{x}$=110	$\bar{x}$=110
	(303.72)	(306.23)	(492.55)			

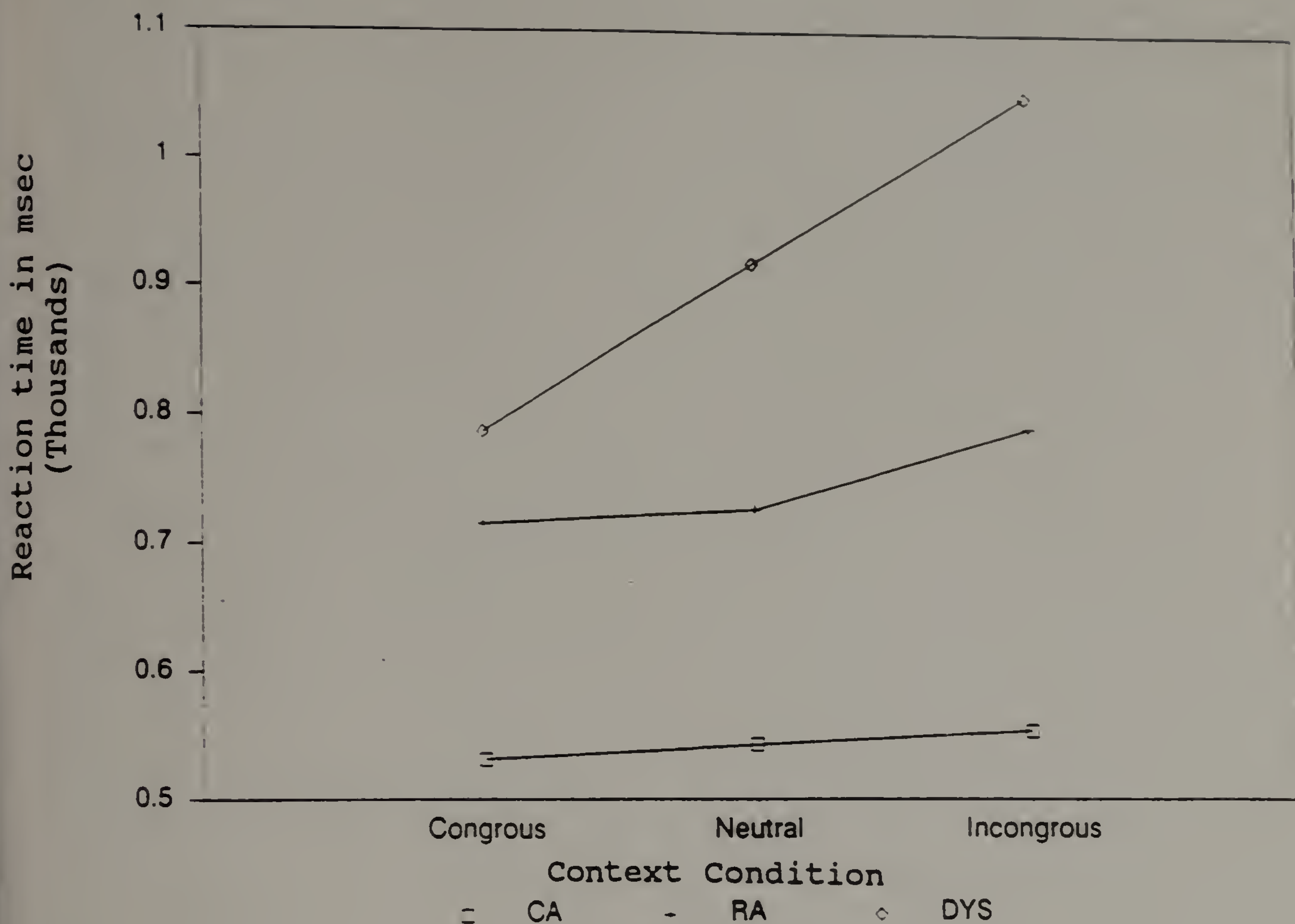

Figure 25. Reaction time in milliseconds as a function of reader group and context condition (averaged across difficulty level)

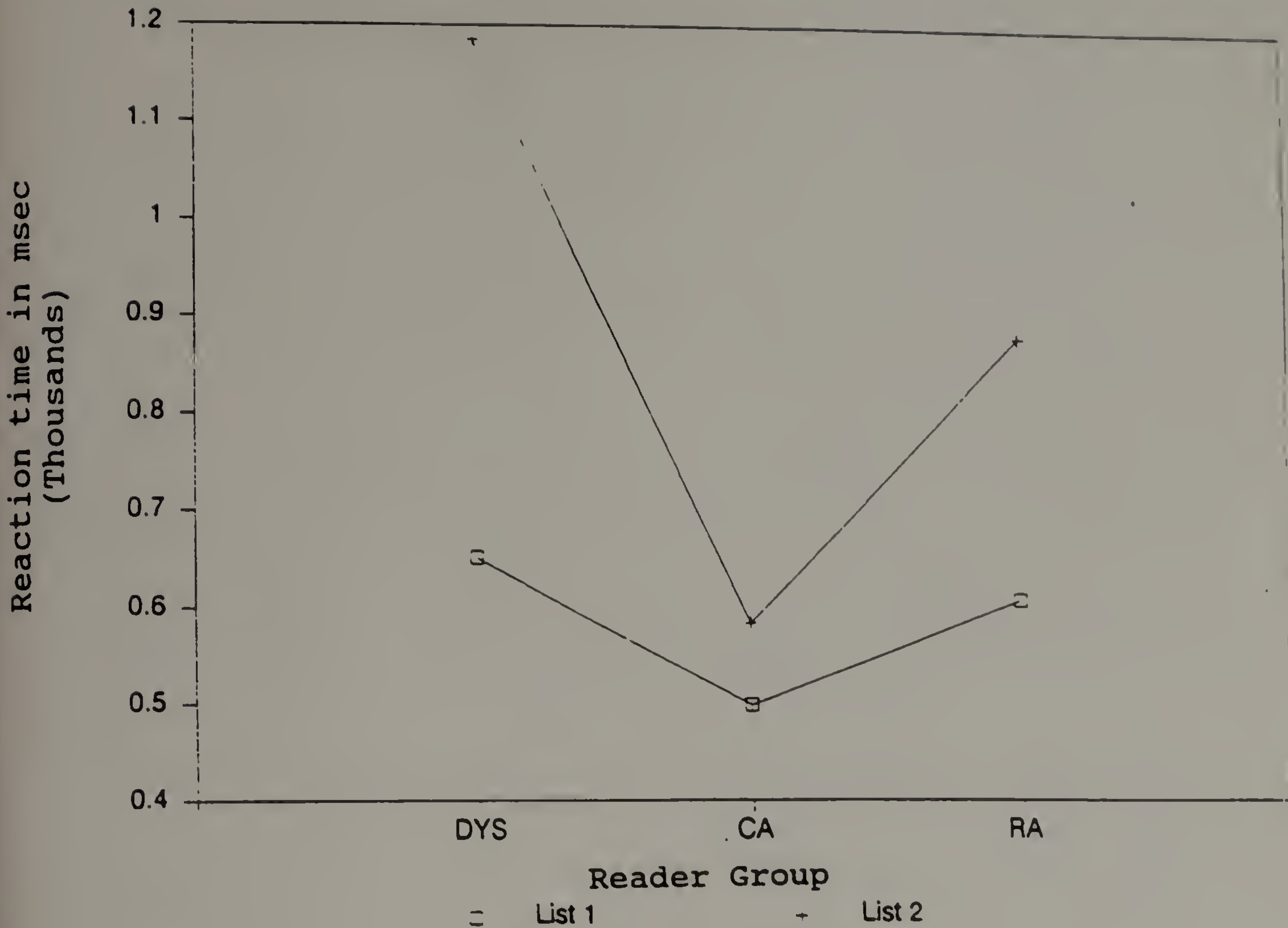

Figure 26. Reaction time in milliseconds as a function of reader group and difficulty level (averaged across context condition)

the difference between the congruous and incongruous context condition).

As can be seen in Figure 25, overall context effect averaged across difficulty levels reflects much greater use of context by the DYS group (261 msec), followed by the RA group (73.5 msec) and the CA group (23.5 msec). The DYS group exhibited identical facilitation and an inhibition effects (130.5 msec facilitation as well as inhibition effect), the RA group demonstrated mainly an inhibition effect (62.5 msec) which was much larger than the facilitation effect (11.09 msec), and the CA group exhibited small facilitation (13 msec) and inhibition (10.5 msec) effects.

Inspection of each context list separately reveals that the speed of reading target words increased steadily from DYS students to RA students to CA students. Scheffe' post hoc comparisons indicated that within each context condition the mean reading time was significantly shorter for the CA than for any other group, $p < .05$, and although it was shorter for the RA students than for the DYS students, the difference did not reach statistical significance in any of the comparison within the easy level list, but did reach significance in the more difficult list, $p < .05$.

Inspection of List 1 in Table 12 indicates that the context condition used in this experiment had some but not major influence on word reading times for all groups. The mean reaction time required to respond to target words was shorter for all groups in the congruous as opposed to the neutral condition. However, none of these differences for any group reached statistical significance. Additional analysis was carried on the size of the context effect. A facilitation score was calculated for each subject by subtracting the mean reaction time in the congruous from the neutral sentence condition. Although the trend reflected an increase in facilitation from CA (7.83 wsec) to RA (21.83 wsec) to DYS (39.52 wsec), the size of the facilitation did not differ significantly between any group. Similar results appeared in the examination of the incongruous context conditions. Although mean reaction time required to respond to target words was longer in the incongruous compared to the neutral sentence condition for all groups, none of the differences for any group reached statistical significance. The size of the inhibition score, expressed as the magnitude of the differences between the RT in the incongruous and neutral condition was about the same for the DYS (18.02 wsec) and the RA (15.17 wsec) groups and just slightly greater than for the CA group (7.9), but the difference was very small and was not statistically significant.

Although each aspect of context effect was not statistically significant by itself, overall, the context condition had influence on the word reading times. The influence was most apparent for the DYS subjects (55), followed by the RA group (37) and the smallest effect was observed in the CA group (16). Scheffe' test indicated that the differences between the DYS and CA was significant, $p < .05$, whereas the difference between RA and DYS was not. In the relatively easy list, the influence of context condition was observed in both ways: facilitation and inhibition. Although facilitation appeared to be somewhat greater than inhibition for the DYS and RA groups, none of the differences between facilitation and inhibition reached statistical significance.

In order to examine the relationship between word identification skill and the use of context a pearson correlation was used on the raw score of word identification skill on the WRMT and the overall use of context. A significant negative correlation was found between those two variables, $r = -.42$, $p < .001$, suggesting that better word readers relied less on context.

List 2 reveals more powerful trends than those observed in list 1. The mean length of time required to read target words was significantly shorter in the congruous as opposed to neutral condition for the DYS subjects, $t_{(16)} = -2.37$, $p < .05$, and although the same trend was apparent in the CA group, the difference between the two categories was not significant. No such pattern was observed in the RA group. The magnitude of the facilitation effect was the largest for the DYS subjects than for any other group, $p < .05$.

The mean length of time required to read target words in the incongruous as compared to the neutral context condition was longer for each group, however none of the comparison reached statistical significance. The size of the inhibition effect, was much larger for the DYS group (246) than for the RA group (110), and both groups exhibited greater effect than CA group (13). Despite obvious differences between the groups, Scheffe' pair-wise comparisons did not reveal any differences between the groups p >, .05, probably due to large variability within groups.

Overall, the DYS group exhibited the greatest context use (467), and the magnitude of the overall context use was significantly greater than for the CA group, $p < .05$. Although the size of context use was larger for the DYS group (467) than for the RA group (110) it did not reach statistical significance.

Context effect manifested itself in both direction: facilitation and inhibition for the DYS group, with no significant differences between those two effects, but mainly as inhibitory effect for the RA group. However, despite obvious and large differences between facilitation and inhibition effects, for the RA group, the differences were not statistically significant, probably due to large variability within scores in each context condition.

Examination of list 1 and 2 indicates an increase in context use from list 1 to list 2 by each group. The effect of the difficulty level on the extent of context use is similar to the trend observed before: largest effect observed in the DYS group, smallest effect in the CA group, and the RA group falls in between. In addition, a significant negative correlation was found (all subjects pooled) between word identification score on the WRMT-R and overall context use in the second list, $r = -.33$, $p < .01$, confirming the same trend observed in list 1; better word readers express less use of context.

Error analysis

The following types of responses were scored as errors: incorrect reading of the target word, a response that took longer than 4000 wsec, or was longer than 2.5. S.D. above the subject`s mean reaction time for that condition. All the analyses to follow are based on the mean percentage of errors committed at each context condition.

A 3 (group) by 3 (context condition) by 2 (difficulty level) MANOVA was performed on error percentage scores. The analysis indicated a significant group main effect, $F_{(2,57)} = 20.63$, $p < .0001$, difficulty level, $F_{(1,57)} = 89.51$, $p < 0.001$, and context condition, $F_{(2,50)} = 5.78$, $p < .01$. Significant interactions were revealed between group and difficulty level, $F_{(2,57)} = 17.04$, $p < .0001$, indicating that difficulty level had differential effect on the groups, and between list difficulty level and context condition, $F_{(2,50)} = 3.18$, $p < .05$, indicating that although less errors were committed in the easier list, the difficulty level had differential effect on each context condition. Cell means and standard deviations for the MANOVA table can be found in Table 13, and graphs to illustrate the interactions in Figures 27 & 28. Also contained in Table 13 are the magnitudes of the facilitation effect, (the difference between the congruous and neutral context condition), the inhibition effect (the difference between the neutral and the incongruous condition) and the overall context effect (the difference between the congruous and incongruous context condition).

As can be seen in Table 13, in each context condition, and across the two lists, the lower error percentage was made by the CA group, and it differed significantly, $p < .05$, level from errors made by any other group. The RA and DYS groups did not differ. All groups made more errors at the more difficult list. However, the difference was significant just for the DYS and RA groups, $p < .001$, but not for the CA group.

From Table 13 it is apparent that DYS and RA subjects used context to reduce their errors. The mean percentage of errors made in the congruous as compared to the neutral condition in either list was smaller for both groups,

TABLE 13

Mean percentage of errors
Cell means and standard deviations

List 1

	Con.	Neu.	Inc.	Fa.	Inh.	Ov.
DYS	$\overline{x}$=2.77 (4.60)	$\overline{x}$=8.39 (8.59)	$\overline{x}$=6.66 (5.94)	5.62	-1.7	3.9
CA	$\overline{x}$=2.00 (4.10)	$\overline{x}$=2.00 (4.10)	$\overline{x}$=2.00 (4.10)	0.00	0.00	0.00
RA	$\overline{x}$=5.72 (5.34)	$\overline{x}$=7.15 (5.31)	$\overline{x}$=5.22 (5.37)	1.43	-1.9	-0.5

List 2

	Con.	Neu.	Inc.	Fa.	Inh.	Ov.
DY	$\overline{x}$=20.0 (11.64)	$\overline{x}$= 30.55 (22.08)	$\overline{x}$=32.47 (22.14)	10.5	1.92	12.42
CA	$\overline{x}$=4.17 (5.27)	$\overline{x}$=4.12 (7.66)	$\overline{x}$=4.50 (6.86)	-.05	0.38	0.33
RA	$\overline{x}$=18.75 (18.29)	$\overline{x}$=22.86 (19.50)	$\overline{x}$=29.15 (25.80)	4.11	6.29	10.4

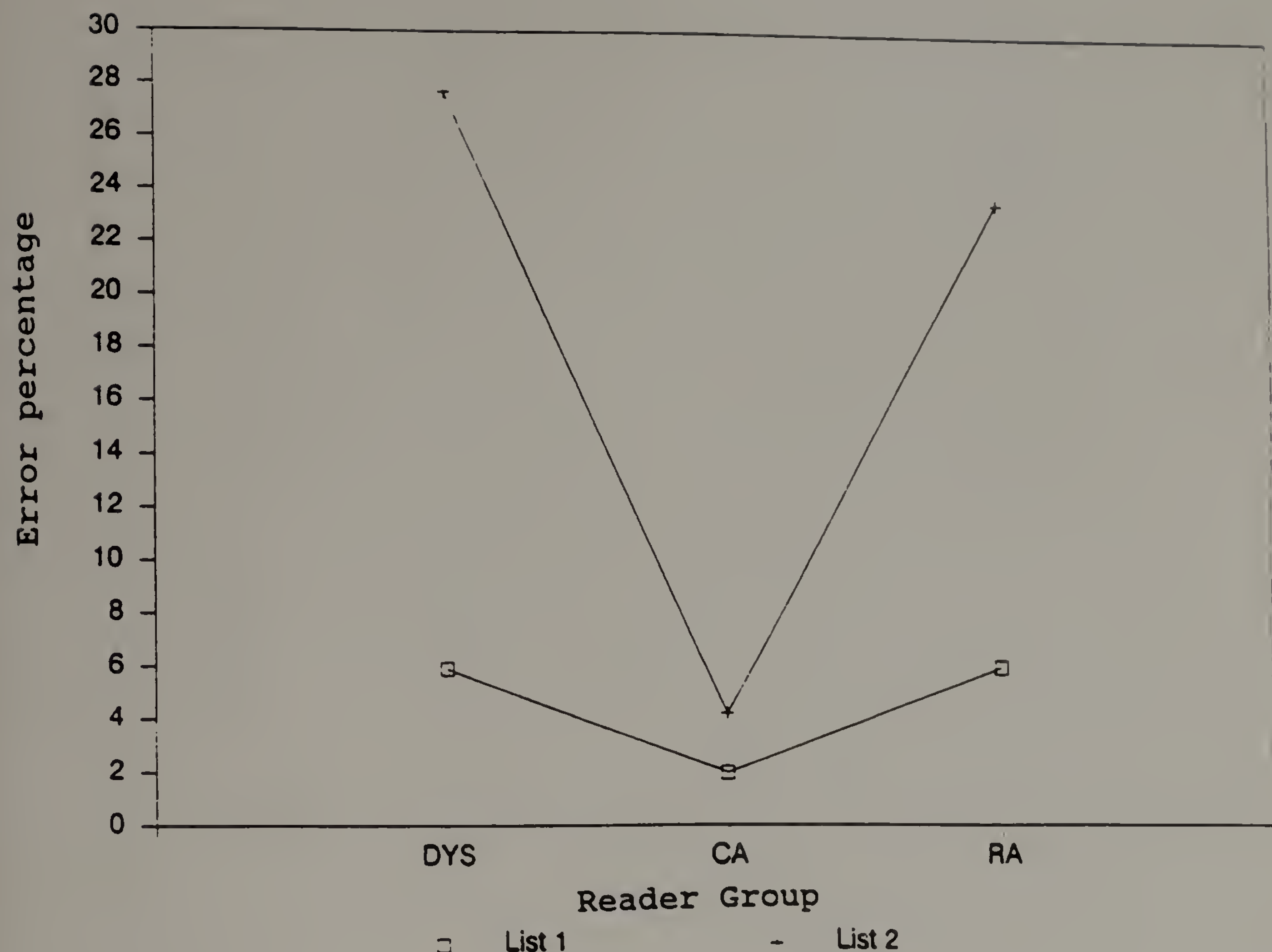

Figure 27. Error percentage as a function of reader group and list difficulty level

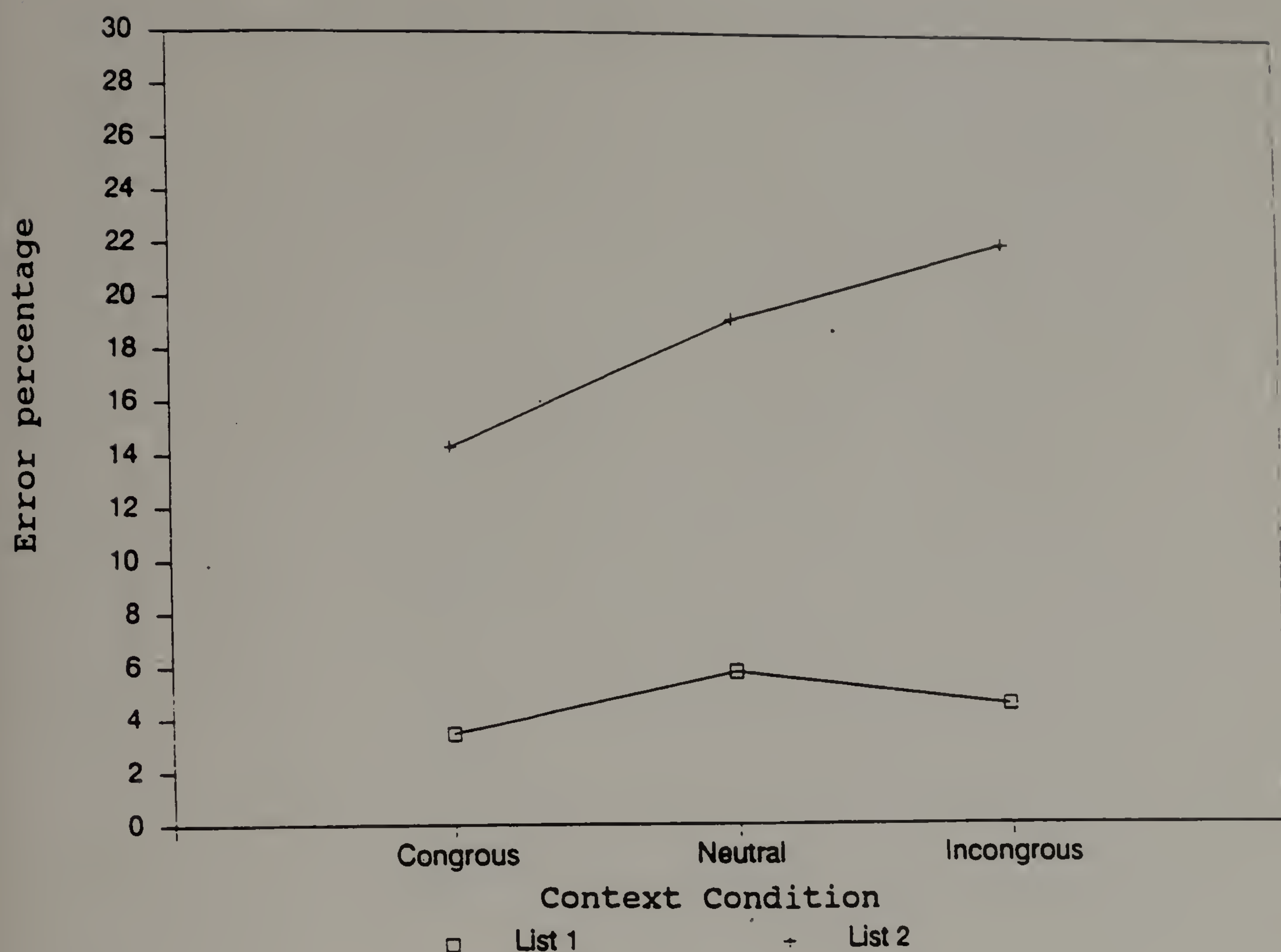

Figure 28. Error percentage as a function of list difficulty level and context condition

however the only comparison that reached statistical significance was for the DYS subjects on the easier list, $p < .01$. The CA group, had the same percentage of errors in the two conditions. The magnitude of the facilitation effect expressed as the magnitude reduction of errors in the congruous as compared to the incongruous conditions was greatest for the DYS subjects, smallest for the CA subjects, and the RA fell in between. None of the size differences however, were statistically significant.

The incongruous context condition did not interfere with reading, in terms of increase in error percentage, as compared to the neutral condition. Actually, in the easier list, the DYS and RA groups, made less errors in the Incongruous as compared to the neutral condition. The CA subjects had the same error percentage in the two conditions. None of the pair-wise comparisons of the interference scores were significant as well.

Overall, both the DYS and RA groups used context to reduce their errors, and that trend was more evident, in the more difficult list than in the easier list. The DYS group exhibited mainly facilitation effect in terms of error reduction. The interference effect was not exhibited in the List 1, and was very small in List 2. The RA group had no interference effect and a very small facilitation effect on list 1, and slightly larger facilitation and inhibition effects on list 2. The CA group was the less affected by context condition and had about the same error percentage across all conditions.

Summary of sentence context tasks

In general, the results displayed in Figures 27 and 28, indicate that all groups used context to increase their reaction time and reduce their errors. All groups tended to use more context when target words and sentences were at a higher difficulty level. The tendency to rely on context to improve reading was negatively correlated with higher word decoding ability, suggesting that less skill readers relied more on context than skilled reader. Context effect in terms of reaction time, manifested itself in both direction. Facilitation and inhibition for the DYS group in both lists and had an inhibitory effect for the RA group on the more difficult list. In terms of error production, there was decrease in the congruous context condition while a very small effect was apparent in the incongruous condition. These trends were similar for the RA and DYS group. The use of context was also apparent in the reaction times and error rates of the CA subjects, but to a much smaller degree.

CHAPTER V

DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

Introduction

The primary purpose of this study was to compare the use of context for word recognition by readers with similar reading abilities but in different age groups, and by readers with different reading abilities but with the same chronological age.

The college dyslexic reader (DYS) group was selected on the basis of having an average I.Q. score but having an achievement score below the 40th percentile on a standardized reading test (WRMT-R). The two comparison groups were college normal readers (CA) matched on the basis of gender and I.Q. to the DYS group, and younger normal readers (RA) paired-matched to the DYS subjects based upon their word identification skill. All groups were tested on various reading tasks. Dependent measures across all experimental conditions (except comprehension tasks and classification of oral reading errors) were accuracy and reading rate.

Data Summary

Reviewing the statistical data presented in Chapter IV, the following findings are summarized:

1. College dyslexic students performed at a comparable level of success to college normal readers on listening and reading comprehension tasks, while both groups achieved higher comprehension scores than younger normal readers.

2. All three groups differed in the mean reaction time required to read real single words. The DYS group had the longest reaction time followed by the RA and then the CA group. There were no significant differences among the groups in the percentage of errors committed in reading these words.

3. All groups had longer reaction times for nonwords than for real matched words. However, the difference between words and nonwords was much greater for the DYS group than for the RA and CA groups. The difference was about equal for the latter two groups. All groups made more errors in reading nonwords than in reading words. The error percentage was highest in the DYS group followed by the RA, and then CA.

4. There were no differences between regular and irregular words, using reading time as the measure, for any group. However, all groups exhibited a regularity effect

using error percentage as the measure. For both type of words, the mean naming time for the DYS group was about the same as for the RA group, and significantly longer than for the CA group. A similar pattern was observed in the error rate.

5. In oral reading of the coherent and randomly presented paragraphs, all groups read more words per second and had a lower error percentage on easier than on more difficult paragraphs and on coherent than on randomly presented paragraphs. Across all conditions, the number of words read per second increased steadily from DYS to RA to CA groups. The DYS and RA groups had about the same error percentage and much larger than the CA' error rate.

6. In the oral reading across all paragraphs all groups made more multiple-source type errors than single type errors. Different errors revealed different combinations of information sources. Within the multiple source type errors, the largest error category for the DYS and RA groups did not reflect the use of semantic information. The largest error category for the CA group did not reflect the use of graphic information at the point where the error was generated.

7. All groups self-corrected more multiple-source type errors than single type errors. All information sources in various combinations were used for self-correction. Within the multiple source type errors, all groups had a high

tendency for correcting errors when the errors disrupted the semantic meaning of the text. The CA group also tended to correct errors that did not reflect the use of graphic information while the other groups did this only to a very small degree.

8. In the sentence context experimental task all groups were affected by context in both directions when the reaction time was the measure used: facilitation in the case of congruous sentence condition and inhibition in the case of incongruous context condition with no significant differences between these two directions. However, the effect of the context was more apparent for the DYS and RA groups than for the CA group, and was stronger for the more difficult list condition than for the easier list.

9. In the sentence context experimental task the use of context was more apparent on the more difficult list when the error rate was the measure used. Context mainly had a facilitative effect for the DYS group. The RA subjects presented smaller effects than the DYS group in both facilitation and inhibition. The CA group was the least affected by context condition and had about the same error percentage across all context conditions.

Discussion

Reading and listening comprehension results

At first, the WRMT-R was administered to the CA and DYS groups. The overall score of this test is based on the subject's performance on four sub-tests: word identification, word attack, word comprehension and passage comprehension. Subjects in the DYS group obtained a score at or below the 40th percentile (mean percentile was 16.48) on this test. The mean percentile of reading score for the CA subjects on the same test was 63. Examination of the DYS' profile in each sub-test reveals a large gap between DYS's scores on the "basic skill cluster" (e.g. word and non-word sub-tests) and scores on the "reading comprehension cluster" (e.g. word and passage comprehension sub-tests). Their comprehension scores were much higher than their word attack scores. No such large difference was observed in the CA's reading profiles. This pattern suggests that the overall low reading score achieved by the DYS students is attributable to difficulties in the word attack area, rather than in comprehension difficulties. Despite the fact that the DYS subjects achieved higher comprehension scores than word reading scores, it was still the case that their comprehension scores were lower than those obtained by the CA students. Furthermore, the time taken the DYS students to perform the passage comprehension sub-test was anywhere between 20-45 minutes, while the CA on the average completed this sub-test in about 10 minutes.

Despite clear differences in the reading performance of the two reader groups on the standardized reading test, they exhibited a comparable level of performance on the reading comprehension tasks used in this study. The DYS's low performance level on the WRMT-R appeared to be a contradiction to their higher level of performance on the reading comprehension experimental tasks.

A plausible explanation for this discrepancy is that the paragraphs used for assessing reading comprehension in this study were too easy to show differences in comprehension. When the text was age appropriate, as in the case with WRMT-R, differences did emerge. Furthermore, the two tests were assessing comprehension using different methods: the WRMT-R used a cloze procedure in which the subject is required to provide the missing word, whereas in the experimental tasks the comprehension questions were presented in a multiple-choice form and the subject was requested to circle the correct answer. These two comprehension tasks demand different skills, and it is possible that on top of the differences in the difficulty level between the material used in the tests and the paragraphs used in the WRMT-R, the WRMT-R procedure requires word retrieval skills that are known to be a weak area for dyslexic students, while circling the correct answer is a relatively easy task for them.

While the CA and DYS students performed at a comparable level on the reading comprehension tasks, the DYS obtained lower scores than the CA group on the longer and more difficult listening comprehension tasks. It is possible that the longer listening comprehension paragraphs used in this study required, in addition to comprehension, a larger attention span and ability to focus for a long time on an auditory presented material. Since subjects were allowed to listen to the paragraphs just once, they would miss information if their attention wandered. On the other hand on the reading comprehension tasks, subjects were requested to read the paragraphs aloud. Thus they were actively involved in the tasks and that probably helped in keeping their attention to the material. Therefore, differences appeared on the listening comprehension task between the DYS and CA groups may not necessarily reflect real differences in comprehension, but instead, may be attributable to other cognitive skills that were involved and not differentiated in the task.

Contrary to the expectation that the DYS group should achieve higher comprehension scores on the listening than on the reading comprehension task, due to difficulties in reading that might disturb comprehension, the reverse pattern appeared: the reading comprehension scores were higher than listening comprehension scores. A plausible interpretation for that pattern is that in the reading comprehension tasks subjects were required to read the paragraphs aloud, thus it is possible that the articulation of the words provided additional reinforcement for the information, as well as helped to keep attention focused on the material, whereas in the listening comprehension task it was much harder to keep attention and be focused.

The RA group obtained the lowest comprehension scores. Within each difficulty level, the RA group had higher reading than listening comprehension scores. It is possible that for this group, as for the DYS group, the listening comprehension administration procedure required a larger attention span that they easily could lose, whereas the reading comprehension task forced them to stay focused for longer time because they were actively involved in reading aloud.

Word attack skills

Results on word attack skills will be discussed in terms of the theoretical dual-route model of word recognition (Coltheart, 1978). The classical dual-route model assumes that there are two independent routes to the lexicon. One route is termed the "indirect" route. According to this theory, word meaning is accessed through the indirect route by translation of the print to sound by application of grapheme-phoneme correspondence rules. A nonword must be pronounced using this route, a real, phonetically regular word may be pronounced using this route, but a real orthographically irregular word cannot be pronounced by the use of this route. The second route is considered to be "direct" route. Through this route, orthographic representations of the whole words are used to retrieve lexical meanings and phonological representations of the words. Words which are orthographically irregular must be pronounced by the use of this route, orthographically regular words might be pronounced by the use of this path, but nonwords cannot be pronounced using this direct route. Most dual-route theorists argue that "phonetic and orthographic routes typically operate in parallel, although task demands, word familiarity, and development differences might influence readers' relative dependence on the two paths" (Olson, 1985, p.217).

The dual-route theory will predict that if the indirect route is impaired then we should observe: (1) A large deficit in reading nonwords, (2) No or little differences between reading of orthographically regular and irregular words, and (3) If the degree of impairment varies across subjects, a large negative correlation between the difference in accuracy and speed of reading words and nonwords and the difference in accuracy and speed of reading regular and irregular words.

The data of the present study raise difficulties for this model. The DYS group exhibited extreme difficulties in reading nonwords. Difficulties in reading nonwords suggest difficulties with the indirect route. Thus, we would expect no differences in reading of regular and irregular words, presumably because both types of words are then processed almost exclusively by the direct route. However, this was not the case. The DYS group made significantly fewer errors in reading orthographically regular words, indicating better use of the indirect route, and their regularity effect was equivalent to the effect displayed by the reading-age matched controls. Furthermore, the prediction that impairment of the indirect route will result in a negative correlation between the difference in reading words and nonwords and the difference in reading regular and irregular words was not confirmed. Thus, the data of the present study are in conflict with the dual-route model of word recognition.

Most studies that addressed the issue of preferred reading route for single words by dyslexic readers tested the same subjects just on one task, either word-nonword reading, or reading of regular and irregular words, and thus no comparison between reading performance of the same subjects on both tasks was available. Furthermore, the few studies that analyzed reading performance of the same subjects on both tasks did not provide any resolution to this conflict.

Murphy (1985) reported that poor readers in her study were significantly less accurate than good readers in untimed reading of legal nonwords, indicating difficulties with the indirect route. However, these poor readers were also significantly faster in reading orthographically regular words than they were in reading the irregular words, indicating utilization of the indirect route. Murphy concluded that "it does not appear that they (poor readers) rely strictly upon direct lexical access but instead do appear to be using some type of rule-governed translation to sound" (1985, p.175).

Baddeley, Logie and Ellis (1988) compared the reading performance of dyslexic boys across a variety of word types to the reading performance of normal readers of equivalent age and to younger children of equivalent reading age to the dyslexics. They reported significant difficulties for the dyslexic subjects in reading nonwords, indicating difficulties with the indirect route. At the same time, the dyslexic readers in Baddely et.al. study also exhibited significant impairment in reading orthographically irregular words, indicating impairment of the direct route and preferable utilization of the direct route. Baddeley et.al. do not really resolve this conflict. Furthermore, they make the analogy between their dyslexic readers to acquired surface dyslexics. This comparison does not seem to be appropriate since their subjects were impaired in their ability to decode nonwords, an effect which is not said to be prominent in the pattern of reading deficiency exhibited by surface dyslexics.

Similar results to the results presented in this study are reported by Olson, Wise, Conners and Rack (in press). They found disabled readers and reading level matched controls to show an equivalent regularity effect, even though the disabled readers had a specific nonword reading problems. To resolve the conflict of possible impairment of the indirect route as presented in difficulties with reading nonwords with use of this route as expressed in the regularity effect they concluded that "the normal regularity effect for our disabled readers, along with their significant deficit in phonological coding of nonwords, implied that they did use phonological processes in reading, but they were much less accurate or efficient" (Olson et.al, in press).

This brief overview does not provide any substantial resolution to the conflict between possible impairment of the indirect route as apparent in nonword reading of the dyslexic subjects, yet, preferable use of this route as suggested by the regularity effect. I would like to suggest a plausible explanation for that conflict: Although the DYS subjects experience difficulties in reading nonwords, an indicator of impairment of the indirect route, the impairment of this route is not complete. It was still the case that the dyslexic subjects were able to read over half of the nonwords. Thus, although they had difficulties with using this route without lexical involvement as in the case of reading nonwords, they still were able to use phonological coding in reading real words when lexical information would support the phonological coding. It is possible that the indirect route works well enough to serve as a supportive system but not as a stand-alone system. If this explanation is correct it suggests that the two routes are interactive rather than parallel processes. Perhaps the most striking feature of the present data is the marked difficulties the college DYS subjects encounter in reading nonwords compared to the RA control subjects who are approximately ten years younger than the DYS subjects. Although difficulties with nonword reading for dyslexic students are often reported in the literature (Olson, 1985; Olson, 1985; Olson, Wise, Conners & Rack, in press; Seymour, 1987), the unique contribution of the present data are in the comparison between twenty-one years old college dyslexic students and younger normal readers with an age range of eight to twelve. Most of the studies that compared dyslexic students with reading age controls were based on approximately three to five year differences between the two groups. Olson et.al (in press) argue that such difficulties on the part of the dyslexic students provide strong evidence for a phonological coding deficit in most disabled readers. Furthermore, on the basis of other studies that find similar results, Olson et.al. concluded that "disabled readers do not have phonological skills which are commensurate with their attained reading level. The implication from this finding is that disabled readers have reached that level of reading through the use of alternative reading strategies". These researchers suggested that this improvement in reading is due to increase in reading experience. Along the same view Snowling (1980) suggested that an increase in word identification skill for the dyslexic students is largely due to increase in sight vocabulary size and do not necessarily involves the appropriate development and increase in the grapheme-phoneme translation strategy.

Results based on nonword reading of the present study fit with and provide further support to the hypothesis of unique phonological difficulties in dyslexic readers as proposed by Olson et.al. (in press) and Snowling (1980). However, results based on reading regular and irregular words raise difficulties for this hypothesis.

The use of context for word recognition

The use of context for word recognition will be discussed in terms of the interactive-compensatory model proposed by Stanovich (1980), and in terms of the top-down theories of the reading process as represented by Goodman (1976) and Smith (1971).

The interactive-compensatory model proposed by Stanovich is based on several assumptions underlying the interactive models' perception of the reading process: (1) information in reading is provided simultaneously from several knowledge sources such as orthographic knowledge, lexical knowledge, syntactic knowledge and semantic knowledge, (2) Each level of processing is influenced by both higher and lower level processes. Stanovich added the compensatory assumption to this model. This assumption suggests that a process at any level can compensate for deficits at any other level. Stanovich argues that the difficulties encountered by most poor readers are in their poor word decoding skill rather than inefficiency in using contextual information to facilitate word recognition.

The Goodman (1976) and Smith (1971) theory of the reading process suggests that contextual information can speed ongoing word recognition during reading because contextual redundancy reduces the number of visual features that must be extracted from each word. Furthermore, these researchers have suggested that younger and poorer readers may not be using contextual information to the same degree as adults. Fluent readers, according to this theory, are less reliant on visual cues because of their ability to use contextual redundancy efficiently. Less skilled readers, on the other hand, are not as able to use contextual information. They make incorrect hypotheses and are forced to rely more on the visual features of the text in order to recognize a word. The main difficulty of the poor readers according to this theory is their inability to efficiently use contextual information.

Both models make clear and opposite predictions in regard to context use across subjects. The interactive-compensatory model predicts that as subjects improve in reading, their improvement is mainly in word-decoding skills and therefore they use context for word decoding less. The top-down theory contends that the major component in skilled reading is improved use of context to guide word recognition and therefore better readers will use context to a greater degree than beginners and less skilled readers.

However, both models are less clear in their predictions regarding the use of context across difficulty level of material. It seems that both theories interpret "difficulty level" in a different way. Stanovich argues that sentence context are the most suitable devices to assess processes at the word level. Therefore, most of his studies with regard to context use are dealing with sentences and target words. When he discusses difficulty level he mainly refers to increased difficulty of target word due to increase in word length or decrease in word frequency. It seems that for him the major change in material is in vocabulary. He and his colleagues make the prediction that context use will be more apparent for words that are more difficult to recognize in isolation, and this effect will occurs even when the more difficult words are less predictable from the preceding sentence context than the easier words. For the top-down theory, on the other hand, the major change in material is in the ability to get context. Goodman, Y. (1976) stated that the proficient reader "begins to make greater use of the graphic display when the going gets tough and when the semantic and the syntactic cuing is destroyed" (p.120). This theory makes the prediction that the use of context will be more apparent at easier context conditions than in harder conditions. Thus, although it seems that both theories make contradictory predictions regarding the use of context across difficulty level, such a comparison is not correct due to the dissimilar use of the concept of "difficulty". Furthermore, since "difficulty level" is usually not carefully controlled it is difficult to predict in many situations whether context should be used more or less.

Another problem in comparing context use in easier vs. harder passages is the base-line for comparison. Thus, it is not always easy to assess whether the use of context is greater or less in one situation than another (e.g., the answer will be different if the use of context is interpreted in terms of percentage of improvement due to context facilitation, or in terms of absolute amount of improvement in context use).

Bearing in mind these points we can now evaluate the data of the present study. The use of context for word recognition was inferred on the basis of two experimental tasks: sentence context experimental tasks, and reading aloud of random and coherently presented paragraphs.

Results based on sentence context experimental tasks seem to be straightforward and generally supportive of Stanovich's model, but contradict the top-down theories. As was predicted by the interactive-compensatory model, there was an apparent decrease in context use as reading level increased and the influence of context was more apparent in the reading of the more difficult words than in the reading of the relatively easy words; the DYS group displayed the largest use of context followed by the RA and CA groups. These results obtained when either the reaction time or error rate was the measure used for analysis. The prediction made by the top-down theories that better readers will display larger use of context was not met. Nor was the top-down prediction that greater use of context will be more apparent for easier than for more difficult words.

Furthermore, the top-down theories would predict that since the main strategy that is used for reading is guessing then we should observe much a higher error percentage in the case of the incongruous sentence context condition than in the neutral condition. However, this prediction was not confirmed. In fact, while context played a facilitative role in the congruous context condition, the cost (in terms of an increase in error rate in the incongruous sentence context) was very small. These results contradict the notion that the main strategy used by skilled readers is guessing, instead, a more plausible interpretation of this pattern is that readers integrate both visual and contextual cues in reading as would be predicted by the interactive model.

With regard to the other measure used to assess the use of context reading aloud coherent and randomly presented paragraphs, the interactive-compensatory model makes clear prediction across subjects. According to this prediction the DYS and RA groups will benefit from context to a similar or larger extent than the CA group. However, in regard to the use of context across difficulty level the prediction will be less clear since there is no clear base-line for comparison between the difficulty level as assessed in this study and the difficulty level as studied by Stanovich. The top-down theory, on the other hand, also makes clear but contradicting prediction across subjects; better readers should exhibit according to this theory greater use of context than less skilled readers, and thus we should expect that the CA group will exhibit greater use of context than the other two groups. According to this theory the use of context should be more apparent at the easier paragraphs than in the more difficult.

Data based on reading aloud coherent and randomly presented paragraphs indicated that all groups used context to reduce error percentage and to increase reading rate. When decrease in error rate was used as the measure for analysis the CA, RA and DYS groups displayed a facilitation effect of 60%, 51% and 42%, respectively. At first glance, these results might be taken to support the Goodman and Smith theory that better readers use more context than poor readers. However, such an interpretation might be misleading. In order to infer the use of context there is a need to equate context-free word recognition level. The DYS and RA groups in this study made many more errors than the CA group in the random condition (which was taken as an indicator for context-free word recognition level). While both RA and DYS groups were much worse than the CA group in their word recognition level (the DYS made 11% errors, the RA 14%, and the CA 1%) their use of context was comparable to each other and not much worse than that of the CA group. Thus, to compare the use of context by different reader groups just on the basis of reduction in error percentage might be incorrect. What is needed is an equal base-line for comparison at the word level. An alternative explanation for these results might be that the skilled readers exhibited more use of context not because they use more context than less skilled readers, rather, because the words were more accessible to them. With a comparable level of word decoding it is possible that the less skilled readers would exhibit at least similar extent of context use, and that is actually what is reported in several studies conducted by Stanovich & West (1979), Perfetti and Roth (1981) and Stanovich and West (1981).

Although the general trend of these results is in support of the interactive-compensatory model, some aspects of the present data raise some difficulties for it. According to the interactive-compensatory model, difficulties in a particular process will lead to greater reliance on other information sources. Thus, we would expect that similar performance on word decoding will lead to a similar extent of context use, and that better word decoders will display less use of context. The present data indicate a similar pattern and extent of context use for the DYS and RA groups. However, these groups are not truly similar in their word decoding skills. The two groups were equated on their real word reading, but in reading nonwords the RA group's performance was much higher than the DYS group. Therefore we can say that the RA group actually had better word attack skills than the DYS group and thus (according to the model) should exhibit smaller use of context for word recognition. This prediction was not confirmed; the RA displayed somewhat larger use of context than the DYS group. These data raise a question as to what aspects of word recognition determine the extent of context use: Can the extent of context use be attributed mainly to sight vocabulary, or is it determined by several other aspects of word recognition such as skill in nonword reading. Further examination of the specific characteristics of word recognition that influence the use of context are needed to answer this question.

With regard to the use of context across difficulty level the data of the present experiment demonstrated that all readers use more context in the easier and shorter paragraphs than in the more difficult paragraphs used in this study. Thus, it seems that there is apparent contradiction between these data and the data based on sentence context tasks. Sentence context tasks point to the direction of greater reliance on context in the more difficult word condition. On the other hand, data based on the random and coherent tasks suggest greater use of context in the easier paragraphs. A plausible explanation for this contradiction is the differences between the two devices used for assessing the use of context. In the paragraphs, there was a comparable increase in difficulty level for words as well as for context, whereas in the sentence context tasks there was a significant increase in word difficulty level while the context difficulty level did not increase to the same degree. The mean length of the target words increased from 4.5 in the easy list to 8 in the difficult list, and the mean frequency of the target words decreased from 102 in the easy list to 9.5 in the difficult list. At the same time, the there was almost no difference in the length of the sentences in the two lists, the syntactical structure remained the same, and the mean frequency of the words in the sentence context (exclusive function words) decreased from approximately 164 in the easy list to 120 in the more difficult list. Thus, when the context remained relatively constant and the difficulty level of the target words changed, readers relied more on context to help decoding the more difficult words. However, in the paragraphs, the increase in difficulty level was comparable for both words and sentences. Thus, greater integration and reliance on context was observed in the easier paragraphs.

Qualitative vs. quantitative differences between reading performance of college dyslexic students and reading-age control subjects

The issue of qualitative vs. quantitative differences between dyslexic and reading-age controls is very complex and there is no agreed upon paradigm for how the differences will be best described. Bryant and Goswami (1986) proposed the following distinction between quantitative and qualitative differences: "A quantitative difference definitely implies a continuum..... on the other hand, a qualitative difference does not involve a continuum. The variable that distinguishes the reading disabled child from the average reader would not distinguish the average from the superior reader" (Bryant & Goswami, 1986, p.102).

Backman et.al. (1984) argue that if no differences are found between dyslexic and younger reading-age controls it would suggest that dyslexic students are not qualitatively different from younger normal readers but simply are delayed in their development. In contrast, if differences emerge between the two groups, it would suggest that disabled readers are qualitatively different from younger normal readers in the sequence and rate of their development. Results of the present study show the following differences and similarities between college dyslexic students and younger normal readers age controls: (1) Differences between DYS and RA in compre- hension tasks: the DYS group performed much better than the RA group. (2) Differences in reading nonwords: the RA group performed significantly better than the DYS group. (3) Similarity in reading regular and irregular words. (4) Similarity in the use of context for word recognition. The main difference between the two groups is in reading of nonwords. While there is a significant difference on that task between the RA and DYS groups, there is a similarity between the two normal reader groups, the RA and the CA group. The extreme difficulty that reading nonwords represents for the DYS group suggests a unique characteristic for them that can not be accounted for by limited experience with written language in comparison to the younger readers. On the other hand, the RA and DYS exhibited similar reading pattern across other experimental tasks that assess the use of context for word recognition and provide no evidence for qualitative differences between the two groups in their process of context use. The process of context use for word recognition seems to be similar for all readers and is a function of word recognition skill rather than a characteristic of a specific reader group. However, there is another possibility as well, and that is that the tasks and the material used for assessing the use of context were not sufficiently diagnostic.

A lack of difference between the DYS group and the RA group would indicate (according to Backman et.al., 1984) merely a delay in the reading performance of the DYS group. However, although no differences between these two groups were observed, to interpret it as a developmental delay seems problematic. A delay in reading performance suggests that the DYS subjects should catch up with normal readers at some point in their reading development. This assumption might be plausible when researchers are comparing reading-disabled students and reading-age controls that are few years younger. However, the DYS subjects in this study were an average of ten years older than the RA subjects, and most of them received reading remediation for several years during their school years. Thus it seems unlikely that they still can catch up.

Results of the present study suggest that a lack of difference between dyslexic and reading-age controls can not always be interpreted as developmental delay. What seems more reasonable is to interpret the results of the present study as suggesting that when reading is very easy then the DYS group will not exhibit any differences in the use of context from the RA group. However, while it is reasonable to expect that the RA group will improve their reading skills with years and reading experience and will turn to be adult skilled readers, the DYS will probably not be able to reach the same level. The difficulties that held them back in the first place most likely will inhibit them from the progress that will be observed in normal readers. The locus of these difficulties is perceived by many researchers as being in the domain of phonological skills.

Educational Implications

Although the present study did not directly address the issue of practical suggestions for the teaching of reading, it does appear to have implications for the teaching of dyslexic readers.

It is not an uncommon complaint of teachers of reading disabled students that they "just do not relate to context". Sometimes the teachers are blamed for emphasizing "word decoding strategy" too much which, according to these critics, results in an inability of their students to use context. Thee present study suggests that this is not the case. All readers are capable and do use all information sources in reading if they have an access to them. In order to get an access to the contextual source one needs to get to the word level first. Difficulties in accessing the words will result in what might be interpreted as "no use of context". Johnston's (1985) case study of three adult reading disabled males indicated that when words are not within an accessible decoding level for the dyslexic readers the subjects tend to develop inappropriate reading strategies such as guessing. He stated, "this avoidance of text-driven strategies ensures that they will not be developed and certainly will not become automatic" (p.161). Furthermore, the data from the present study demonstrated that although DYS students had much higher reading comprehension than the RA control group, it was still the case that both groups had about the same error percentage. They exhibited similar reading rates and used context to improve reading to about the same degree. This pattern suggests that higher comprehension or mere familiarity with the contextual information of a reading material will not necessarily lead to higher reading accuracy or faster reading rate. Thus, the belief that reading instruction that is focused on strategies to use context and incorporate guessing will lead to efficient reading seems to be illusive. Findings from the present study point to the need to incorporate both the use of context as well as word identification strategies in teaching reading.

Suggestions for Future Research

Based on the data and findings of this study, the following recommendations are made:

1. The study of other of reading strategies through the implementation of the reading matched design based on college dyslexic students and normal younger readers.

2. Replications of the study with an attempt to create homogenous groups in terms of word identification skill rather than groups that represent continuity of word identification skill.

3. The development of an appropriate classification methodology for analyzing single and multiple-source type oral reading errors. Such a classification system will improve the power of conclusions drawn from oral reading error analysis.

4. The replication of the sentence context experiments with more words in each context condition, and with

manipulation of the time interval between the reading of the last word in the sentence and the target word.

5. The development of more careful and diagnostic criteria for defining "difficulty" of material, in order to replicate and compare studies dealing with the use of context.

APPENDIX A: LISTENING COMPREHENSION TASKS - PARAGRAPHS AND QUESTIONS

1. Trial passage

The oldest part of the city, the medina, is surrounded by thick walls. Inside is a tangle of narrow streets and tiny shops where all kinds of wares are sold. All around, there are people-far too many people- many beggars and children in rags. The noise is deafening. There is little protection from the broiling sun, and the sharp odors are almost strong enough to make one faint. How different from the clean, wide avenues in the modern part of the city!

Comprehension questions

1. At what time of the day is the medina described?
   1. Early afternoon.
   2. Evening.
   3. Sundown.
   4. Late at night.

2. The medina is in that part of the city that is the-
   1. Most famous.
   2. Coldest.
   3. Prettiest.
   4. Oldest.

3. The medina can best be described as-
   1. An attractive village.
   2. A crowded place.
   3. A friendly place.
   4. A Shopper's dream.

4. According to the paragraph, the sounds of the medina are-
   1. Humming.
   2. Echoing.
   3. Faint.
   4. Loud.

2. Listening comprehension-"Brown level"/paragraph 1

Before there were billboards, there were signs to greet travelers on the highways. These were often painted on covered bridges, barns, or rocks by the side of the road.

Traveling sign-painters often made them, sometimes to advertise themselves. The sign-painter went from town to town with his box of paints and brushes, to be hired by whoever needed a sign. When he was tired of traveling, sometimes he would settle in town and paint signs for the local businesses and sometimes even portraits of the town's residents. William Dean Howells, in his novel, The Rise of Silas Lapham, tells about a man who painted signs on rocks to advertise his paint company.

Comprehension questions

1. According to the paragraph, signs along the highway are sometimes painted to-
    1. tell who owned the land.
    2. advertise inns.
    3. warn of danger.
    4. give a speed limit.

2. If a sign-painter grew tired of traveling,he would often-
    1. settle in town.
    2. go into another line of work.
    3. get someone else to travel with him.
    4. give up painting for a while.

3. Before there were billboards,signs were often painted on-
    1. stores.
    2. trees.
    3. houses.
    4. barns.

4. Why did Silas Lapham paint signs?
    1. To amuse travelers on the highway.
    2. To make himself rich and famous.
    3. To help roadside business get more customers.
    4. to advertise his business.

5. Sometimes a sign-painter would also paint-
    1. fences.
    2. houses.
    3. portraits.
    4. wagons.

6. Who was William Dean Howells?
    1. A sign-painter.
    2. The owner of a paint company.
    3. An author.
    4. A character in a novel.

7. Which title best tells what this paragraph is about?
   1. Famous billboard painters.
   2. How the billboard got its name.
   3. How billboards are made.
   4. Before the billboard.

3. <u>Listening comprehension-"Brown level"/paragraph 2</u>

The number of fish gathered from ocean fisheries has been rising rapidly and doubles about every ten years. However, we could get even more food from our oceans if we had as much experience in this field as we do in farming the land. For example, fencing has long been used on land to keep herds of animals together. It is only recently that this idea has been tried in the sea. Sardine fisheries in Maine are using "bubble fences" to keep fish within certain boundaries. These fences are made by forcing air through holes in pipes to form bubbles around the fish. However, because no one country owns the open sea, such fish farming is not likely to become widespread. While we are developing new forms of aquaculture, we must also find ways to share the wealth of the seas in peace and harmony.

<u>Comprehension questions</u>

1. The word "aquaculture" is used in this paragraph to describe-
   1. sea farming.
   2. special fish tanks.
   3. underwater fences.
   4. sardine processing.

2. Where are the bubble fences being used?
   1. England.
   2. California.
   3. Russia.
   4. Maine.

3. According to the paragraph, we could get more fish from the
   ocean if we had more -
   1. money.
   2. experience.
   3. ships.
   4. fishermen.

4. Bubble fences are used to-
   1. keep the water fresh.
   2. keep seaweed out of the fisheries.
   3. protect small fish.
   4. keep fish within certain areas.

5. According to the writer, one problem in starting ocean fisheries is that-
   1. no country owns the ocean.
   2. it is hard to work underwater.
   3. cold weather prevents people from fishing.
   4. the fishermen will not cooperate.

6. The writer thinks of the ocean as an important source of-
   1. water.
   2. food.
   3. fuel.
   4. air.

7. What is the main idea of the paragraph?
   1. Better bubble fences should be used.
   2. Aquaculture should not be used unless it is necessary.
   3. We should apply our experience on the land to the sea.
   4. Countries must decide which part of the ocean they want.

4. <u>Listening comprehension-"Blue level"/paragraph 1</u>

In the 1970's, it is important to consider some of the outstanding contributions made by the two previous generations during the fifty-year period between 1919-1969 which have greatly benefited the present generation. Through the accomplishments made during this period, man's life expectancy has increased by 50%. The average working day has been cut by one third at the same time, per capita output has doubled. In many respects, today's world is healthier than at any time before, and epidemics of flu, typhus, diphtheria, smallpox, scarlet fever, measles or mumps that were all known and feared in the early part of the century are no longer major threats. An out break of dreaded polio is no longer a summer expectation, and tuberculosis is almost unheard of.
Many people who lived through history's greatest depression knew cold and hunger and sadly learned what poverty really meant. Because of this experience, these people resolved that new generations would have a better life with enough food to eat, milk to drink, vitamins, warm homes, better schools and greater economic opportunity. Consequently,

today's generation is one of the healthiest, strongest and best informed of any generation to inhabit this land. While so much was accomplished, there were also some failures. No alternative for war or racial hatred was found. Hopefully, however, the oncoming generation will perfect the social mechanisms by which all men may follow their ambitions without the threat of force. Perhaps some day the earth will no longer need police to enforce the laws, nor armies to prevent some men from trespassing against others. If the new generations make as much or more progress in as many areas as these two previous generations have, it could be possible that a good many of the world's remaining ills will be solved.

<u>Comprehension questions</u>

1. For the future, the author of this passage seems to expect
   1. indifference.
   2. wars.
   3. progress.
   4. hatred.

2. The title which best describes the content of this passage is-
   1. Elimination of dreaded diseases.
   2. Accomplishments-past, present, future.
   3. Advancement in science.
   4. Future problems to be solved.

3. The author's attitude in this passage is one of-
   1. fear.
   2. optimism.
   3. pessimism.
   4. hatred

4. This author believes that one of the big failures of the last two generations was their inability to-
   1. find more medical cure.
   2. fight pollution.
   3. work for women's liberation.
   4. find an alternative to war.

5. This passage does not say that today's generation is superior in-
   1. sensitivity.
   2. strength.
   3. education.
   4. health.

6. In this passage which of the following was not mentioned as a serious problem facing people between 1919-1969?
   1. Polio epidemic.
   2. A great depression.
   3. Segregation.
   4. War.

7. The author speaks of the desirability of eliminating the need for man to depend heavily on-
   1. The country's leaders.
   2. Research findings.
   3. Nutritional laws.
   4. A police force.

8. One demand on present and future generations is to-
   1. Continue what their ancestors started.
   2. Learn to live in poverty.
   3. Perfect social mechanisms.
   4. Build a strong nation.

<u>5. Listening comprehension-"Blue level"/paragraph 2</u>

Unlikely as it may seem in the space age, there exists as a going business a wooden-wheel factory whose product is made exactly as it was in 1886 when the venture first started. Logs are hauled into the same building, put through the same processes on the same machines, and turned into the same kind of finished wheels. The wine of saws and the muffled shrieks of machines indicate that ash, oak, and hickory logs are being cut into boards, which are then cut into specific lengths for making rough hubs, spokes, and rims. Woods chips still fall, and sawdust floats toward sunny windows, as sanding wheels shape and smooth the wood, filling the air with a clean, rich aroma.

Production of these wheels, which range in size from fourteen inches to six feet in diameter, has been averaging 12,000 annually. The market these wheels ultimately reach is oddly interesting and may even be growing. They are being sent to Hollywood for use in period pictures, to the Amish country where buggies are still in use, to museums, to parks which need cannon wheels, and to restorations like Williamsburg, Virginia, which use them for chariot wheels. There is even a demand for ornamental wheels for driveways, table tops, and chandeliers.

Some years ago, the Smithsonian Institute in Washington, D.C., became interested in the wooden-wheel industry. It filmed and taped the machines, the hand-work, all the processes and shop noises, and made detailed scale drawings of the building and its various departments. If future

circumstances warrant, the whole operation could be reproduced almost anywhere.
When the superintendent of the wooded-wheel factory was asked about the future of the industry, he grinned and said, "when I first came to work here I figured the wooden-wheel business might last another two years, and that would be it. That was twenty-four years ago and the business is still rolling".

Comprehension questions

1. The passage does not say that wooden wheels are used today-
   1. For chariots.
   2. In museums.
   3. In movies.
   4. For automobiles.

2. The Smithsonian Institute in Washington, D.C., has made a thorough study of the wooden-wheel factory to-
   1. Build duplicate in Washington.
   2. Preserve all aspects of its operation.
   3. Start another business.
   4. Encourage the use of wheels.

3. In the Amish country, wheels are needed for-
   1. Table tops.
   2. Chariots.
   3. Cannons.
   4. Buggies.

4. The remark made by the superintendent of the wooden-wheel factory indicates that he expects to-
   1. Reorganize soon.
   2. Close its doors within two years.
   3. Face competition from new factories.
   4. Stay in business for some time.

5. The maximum diameter of these wooden-wheels is-
   1. 14 inches.
   2. 4 feet.
   3. 6 feet.
   4. 12 feet.

6. The passage does not say that wheel hubs are made from-
   1. Ash.
   2. Pine.
   3. Oak.
   4. Hickory.

7. One thing about the factory which is the Smithsonian Institute probably did not record is the-
   1. Noises.
   2. Aroma.
   3. Building.
   4. Machines.

8. The factory described has made wooden-wheels the same way for-
   1. An unknown period.
   2. 25 years.
   3. Over 150 years.
   4. About 90 years.

APPENDIX B: ORAL READING TASKS - PARAGRAPHS AND COMPREHENSION QUESTIONS

1. Trial passage- coherent presentation

Scientists can tell us what foods owls eat. Owls swallow every bit of their prey. Then strong juices digest all of the food except fur and a few bones.

2. Trial passage- random presentation

There other few the except of killed at rats and form help then to years nests coughed mice to prey rats and owls.

3. Oral reading-"Brown level"/paragraph 1-coherent presentation

Volcanoes have brought about fear and wonder in people for thousands of years. The crater-like tops of these cone-shaped mountains are openings in the earth's surface. They may remain quiet for centuries,and then suddenly start to smoke and rumble. Sometimes they explode, sending flaming hot rocks for miles and pouring melted stone down onto the towns below.
Long ago, people did not understand why volcanoes erupted. They thought that Vulcan, the god of fire, was angry and was punishing them. Scientists now know that there are hot rocks and gases deep inside the earth that build up pressure over time. When the gases explode through a weak spot in the earth's surface, the volcano is said to erupt. Volcanoes, however, are still a mystery. Although we now understand why they erupt, we do not know how to prevent the explosions or how to predict when they will awaken from their slumber.

Comprehension questions

1. Vulcan was the god of-
   1. Thunder.
   2. Light.
   3. Fire.
   4. Mountains.

2. According to the passage, the tops of volcanoes look like-
   1. Craters.
   2. Smokestacks.
   3. Chimneys.
   4. Needles.

3. Long ago, people thought that volcanoes erupted because-
   1. Lightning had struck.
   2. Gases had build up pressure.
   3. There was a weak spot in the earth.
   4. Vulcan was angry.

4. The word "erupt" as used in this passage means-
   1. Destroy.
   2. Interrupt.
   3. Burst forth.
   4. Melt away.

5. The title that best describes this passage is-
   1. How volcanoes were formed.
   2. The angry god.
   3. Facts about volcanoes.
   4. How the volcano got its name.

6. Volcanoes are considered to be a mystery because we don't know-
   1. What causes them to erupt.
   2. When they will explode.
   3. Where they can be found.
   4. How to describe them.

7. The expression "awaken from their slumber" suggests that-
   1. Volcanoes are quiet most of the time.
   2. Volcanoes usually erupt during the day.
   3. The god of sleep controls volcanoes.
   4. Volcanoes can destroy a peaceful town.

4. <u>Oral reading- "Brown level"/paragraph 1,random presentation</u>

fear have awaken is mystery start erupted flaming rocks they
their said for predict sending explosions and are punishing
slumber people sometimes from they melted earth's through
for wonder erupt volcanoes to and about brought was how deep
suddenly surface openings earth stone long years down these
and know smoke they hot shaped and did quiet and centuries

there not the when know understand the mountains below volcanoes miles volcano pressure that time may volcanoes erupt however pouring still or spot towns onto now them explode over we people now to Vulcan of why understand they are inside of explode for build the in like up gasses scientists the rocks thousands they the remain to rumble to angry not are a god when weak earth's that of fire how was and the gasses the prevent we a the surface ago hot will do crater cone tops the thought in then although the in why.

5. <u>Oral reading-"Brown level"/paragraph 2-coherent presentation</u>

Dust ia a serious problem in industry. When workers breath the dust-filled air, some of the dust remains in their lungs. Although breathing any kind of dust may make workers ill, the most dangerous kinds of dust are those that dome from irritating substances, such as lead or asbestos. Coal miners can get "black lung" from years of breathing coal dust. To make matters worse, the most common way of removing coal dust from the air is "rockdusting"-spreading the coal surfaces with powdered limestone.
A government report has suggested several way of removing dust from the air that workers breath: hoods should be built over dust-producing machines; as much as dust as possible should be removed by fans, vacuum cleaners, and water sprays; and workers should use masks or other devices that will protect them from the dust. All these may help to solve the problems that dust causes.

<u>Comprehension questions</u>

1. The writer discuses a danger that people face in their-
   1. homes.
   2. jobs.
   3. schools.
   4. cars.

2. Dust is dangerous because of it its effect on people's-
   1. eyes.
   2. noses.
   3. throats.
   4. lungs.

3. According to a government report, one way to reduce dust is to-
   1. install fans.
   2. slow down machines.

3. open the windows.
4. clean equipment more carefully.

4. What does the writer suggest to people who are exposed to a lot of dust?
   1. Be examined by a doctor daily?
   2. Do deep-breathing exercises.
   3. wear am mask while working.
   4. Buy a vacuum cleaner.

5. What substance is used in rockdusting?
   1. Coal.
   2. Limestone.
   3. Lead.
   4. Asbestos.

6. This passage would most likely be found in a-
   1. history book.
   2. collection of adventure stories.
   3. geography book.
   4. news magazine.

7. What is the main idea of this passage?
   1. Dust ia the main problem in industry.
   2. The government makes good suggestions.
   3. "Black lung" is very serious.
   4. Factory work is unhealthy.

6. <u>Oral reading-"Brown level"/paragraph 2-random presentation</u>

removing solve the of built the vacuum that dust the spreading that workers air cleaners the has asbestos them dust powdered dust government by report breath sprays several from lungs suggested rockdusting worse from irritating all is industry in the removed kinds causes workers any masks limestone remains filled black should workers kind or help in coal is a dust the be fans make a with problems breathing of dust will other from to water machines devices problem way producing may protect ill of much can and possible be way should of workers over should from the hoods years common matters air coal surfaces most from the substances may coal when come most lead the of breath dust air as lung such that miners serious as dangerous dust are although dust of dust as dust breathing of removing those some use these to coal make that dust or get their dust and.

7. <u>Oral reading-"Blue level"/paragraph 1-coherent presentation</u>

The bola (boleadoras in Spanish) was a strange and tremendous weapon that first streaked through the skies of South American countries in the sixteenth century. Made of one, two, or three stone balls tied together by leather thongs almost two armspans long, this primitive weapon provided the South American Indian with a tremendously powerful and effective means of fighting. Early drawings show Indians throwing the bola with such skill that, at one hundred paces, they could entangle a man and horse, or large birds, such as ducks, in flight. The Indians also used the bola to capture wild mares and subdue the fiercer animals. The Conquistadors were the first outsiders to confront the South American bolas. As they began their advance upon an Indian village, they suddenly found themselves bombarded by these bolas, which came shooting out from among clumps of brush, falling like rain. The Conquistadors thought these weapons were limestone meteors until they saw the first line of fighting Indians advancing behind the bolas. After such an experience, one early explorer warned his men that they faced an unfair enemy who not only used bows and arrows, but also threw a stone and leather weapon that could maim or kill. For the Conquistadors, the bola was one of the most awesome experiences they encountered in their history of warfare.

<u>Comprehension questions</u>

1. Conquistadors first thought the bolas were-
   1. Arrows.
   2. Bullets.
   3. Hailstones.
   4. Meteors.

2. About how long must the thongs have been?
   1. 2 feet.
   2. 6 feet.
   3. 16 feet.
   4. 100 feet.

3. Much has been learned about the use of the original bola through-
   1. Early drawing.
   2. History books.
   3. Carbon dating.
   4. Photographs.

4. This passage does not mention the use of the bola to-
   1. Fight with.
   2. Trap a man and horse.
   3. Capture wild mares.
   4. Round up cattle.

5. Which title best describes the passage?
   1. "The South American Indian".
   2. "The bola-A Mighty Weapon".
   3. "The Battle of the Conquistadors and the Indians".
   4. "Early South American Explorers".

6. According to the passage, the Conquistadors thought the use of the bola by the Indian was-
   1. Primitive.
   2. Silly.
   3. Amusing.
   4. Unfair.

8. <u>Oral reading-"Blue level"/paragraph 1-random presentation</u>

as advancing Indians upon bola entangle the ducks or Indians first century two mares limestone for maim two early show skill sixteenth in began bolas fighting a stone or kill which clumps fighting means stone through tremendous the was made capture first South advance their until meteors such warned who was encountered in suddenly subdue provided with weapon almost skies weapon of powerful came brush used not threw history one fiercer used like falling among such birds throwing tied balls an village from explorer unfair that and horse the bows leather and weapon Conquistadors experiences their awesome most thought confront Conquistadors these men his bola they warfare of countries streaked bola and three as with paces hundred the animals in man a flight out shooting drawings South the long behind an one the faced these themselves found Conquistadors bombarded Indian weapons saw experience they only arrows and could that also Indian this South that Spanish in strange a American of together one by armspans bolas early the large of tremendously a or thongs primitive American and effective that could they also the American were the outsiders bolas they to wild bola the boleadoras of the in the Indians the such at and one to they by the rain were they line first the of after an enemy but the of leather.

9. <u>Oral reading-"Blue level"/paragraph 2-coherent presentation</u>

Waves consist of the alternate rising and falling of successive ridges of water and are produced by friction between the wind and the surfaces of seas, lakes, ponds, and rivers. In spite of outward appearances, wave motion in the open ocean does not result in an actual forward movement of water. Rather, each water particle composing the wave describes a curve and returns practically to the very point from which it started. The wave form itself, however, moves on as other particles of water similarly rise and fall. The motion of ocean waves resembles a waving field of grain where the base of each moving stem is attached to the ground though wave after wave passes across the field. The motion of waves is confined to water near the surface: there is little disturbance at a depth of thirty feet, and motion becomes imperceptible at a depth of a few hundred feet. Storm waves in the open sea frequently reach a height between thirty and forty feet. The largest wave ever to be reliably reported was a towering one-hundred-twelve-foot wave that was observed by the Navy tanker Ramapo in 1933. When wind driven against the shores, the surf of broken waves has been blown to heights from one hundred to three hundred feet, exerting enough force to destroy lighthouses and rock cliffs. Waves exert tremendous erosive power, and slowly but steadily are altering coastlines of continents and islands throughout the world.

<u>Comprehension questions</u>

1. The information in this passage would most likely be found in a-
   1. Newspaper.
   2. Science book.
   3. TV commercial.
   4. Coast Guard Manual.

2. According to the passage, the power of waves is-
   1. Corrosive.
   2. Erosive.
   3. Explosive.
   4. Divisive.

3. Wave motion actually is-
   1. Backward and forward.
   2. Twisting and turning.
   3. Rolling and spinning.
   4. Upward and downward.

4. Which title best describes the content of this passage?
   1. "The continuous wave".
   2. "Water currents".
   3. "cruise of the Ramapo".
   4. "Ocean depths".

5. Ocean waves are caused by-
   1. Gravity.
   2. Temperature changes.
   3. Friction.
   4. Chemical action.

6. Wave motion is most noticeable at which of the following depths?
   1. 30 feet.
   2. 200 feet.
   3. 2 feet.
   4. 500 feet.

10. Oral reading-"Blue level"/paragraph 2-random presentation

storm towering becomes at waves as from point to hundred one tremendous continents of coastlines and lighthouses rise similarly form forward wave appearances surfaces the outward result water is there motion feet reported force heights against by a forty waves thirty in actual composing the however very produced are of consist waves ridges of particle and grain of waving attached field surface and imperceptible little motion the field to destroy erosive from surf tanker largest open the frequently wave Ramapo hundred broken of shores Navy the slowly islands world steadily cliffs feet across the started a water movement the in motion lakes practically alternate seas water of motion base where ground the depth at disturbance one to power and rock the rivers friction rising the moves itself confined after wave which describes ponds falling resembles a moving of ever reach feet in was waves throughout but been wind be height to depth a though the wave spite does ocean in between and successive wind the open the waves 1933 in hundred foot that driven blown enough exerting has altering are the particles other ocean of each is the fall a hundred a thirty water of near feet and of not each rather of an curve the returns wave and it of waves by stem is passes and wave to of the few and of a sea and when wave twelve the three to and exert on wave the between a reliably to observed the itself of.

APPENDIX C: MATCHED LIST OF WORDS AND NONWORDS ORDERED BY BLOCKS OF PRESENTATION

(adapted and modified from Coltheart, 1981)

1. <u>Demonstration words and nonwords</u>
(demonstrated by the experimenter)

glass
nelp
flass
help

2. <u>Trial words</u>

<u>Words</u>	<u>nonwords</u>
game	pame
coin	toin
dark	sark
foot	moot
verb	derb

3. <u>Experimental words</u>

<u>Block 1</u>

<u>Words</u>	<u>Nonwords</u>
floor	toble
house	nater
fine	poad
door	heam
money	mun

<u>Block 2</u>

room	schoom
child	cag
food	doy
girl	pand
woman	charch

Block 3

book	floon
street	gouse
city	fime
eye	noor
face	doney

Block 4

church	foom
hand	chold
boy	foop
car	garl
school	moman

Block 5

man	boak
head	streed
road	cimy
water	ede
table	fape

APPENDIX D: IRREGULAR AND REGULAR WORD LISTS

(Coltheart et al.,1979)

<u>Regular</u>

grill	capsule
gang	splendid
treat	strewn
dance	country
slate	spear
cult	trout
pine	free
base	horse
distress	tooth
sherry	barge
take	throng
spade	plug
turn	mile
shrug	check
save	shampoo
sort	protein
spend	stupid
kept	rub
quick	fresh
duel	
answer	

<u>Irregular</u>

gauge	shove
aunt	sword
laugh	lose
break	move
debt	yacht
pint	prove
sign	sure
mortgage	blood
castle	cough
come	bowl
glove	build
gone	biscuit
gross	subtle
bury	sew
borough	broad
steak	flood
love	trough
thorough	soul
scarce	circuit

APPENDIX E: SENTENCE CONTEXT AND TARGET WORDS

(adapted and modified from West & Stanovich, 1978; and from Stanovich & West 1981).

1. Demonstration sentences and target words

1. The cat drank from the bowl.
2. The man was convicted of the concert.
3. The next word will be class.

2. Trial sentences and target words

1. The banker locked the safe.
2. The tennis player found the ball.
3. The couple made up after the fight.
4. The man paid the area.
5. The city stored water in the rooms.
6. The man made coffee in the hunter.
7. The next word will be corridor.
8. The next word will be dictator.
9. The next word will be bacteria.

3. Experimental sentences and target words

List 1-A

Congruous sentence context

1. The plane flew above the clouds.
2. The reader opened the book.
3. The monkey reached for the banana.
4. The boy hid behind the door.
5. The horse walked along the trail.
6. The girl wrote with the pencil.
7. The ship sank beneath the sea.
8. The cat chased the mouth.
9. The boy slept during the night.
10. The horse jumped over the fence.

Incongruous sentence context

1. The man drove the cat.
2. The dog ran after the car.
3. The squirrel ran around the bone.
4. The dog hid the tree.
5. The girl drew the treasure.
6. The pirate found the picture.
7. The banker counted the sky.
8. The bird flew across the money.
9. The girl answered the milk.
10. The cat drank from the phone.

Neutral context condition

1. The next word will be closet.
2. The next word will be boy.
3. The next word will be bridge.
4. The next word will be dog.
5. The next word will be target.
6. The next word will be paper.
7. The next word will be song.
8. The next word will be music.
9. The next word will be news.
10. The next word will be food.

List 1-B

Congruous sentence context

1. The dog ran after the cat.
2. The man drove the car.
3. The dog hid the bone.
4. The squirrel ran around the tree.
5. The pirate found the treasure.
6. The girl drew the picture.
7. The bird flew across the sky.
8. The banker counted the money.
9. The cat drank from the milk.
10. The girl answered the phone.

Incongruous sentence context

1. The boat sailed under the closet.
2. The clothes hung inside the bridge.
3. The dog sat beside the song.
4. The musician played the boy.
5. The cat hid from the papers.
6. The newsboy sold the dog.
7. The arrow hit the music.
8. The girl danced to the target.
9. The paper told the food.
10. The cook burnt the news.

Neutral context condition

1. The next word will be clouds.
2. The next word will be book.
3. The next word will be banana.
4. The next word will be door.
5. The next word will be trail.
6. The next word will be pencil.
7. The next word will be sea.
8. The next word will be mouth.
9. The next word will be night.
10. The next word will be fence.

List 1-C

Congruous sentence context

1. The clothes hung inside the closet.
2. The dog sat beside the boy.
3. The boat sailed under the bridge.
4. The cat hid from the dog.
5. The arrow hit the target.
6. The newsboy sold the papers.
7. The musician played the song.
8. The girl danced to the music.
9. The paper told the news.
10. The cook burnt the food.

Incongruous sentence context

1. The reader opened the clouds.
2. The plane flew above the book.
3. The boy hid behind the banana.
4. The monkey reached for the door.

5. The girl wrote with the <u>trail</u>.
6. The dog walked along the <u>pencil</u>.
7. The cat chased the <u>sea</u>.
8. The ship sank beneath the <u>mouth</u>.
9. The boy slept during the <u>fence</u>.
10. The horse jumped over the <u>night</u>.

<u>Neutral sentence context</u>

1. The next word will be <u>cat</u>.
2. The next word will be <u>car</u>.
3. The next word will be <u>bone</u>.
4. The next word will be <u>tree</u>.
5. The next word will be <u>treasure</u>.
6. The next word will be <u>picture</u>.
7. The next word will be <u>sky</u>.
8. The next word will be <u>money</u>.
9. The next word will be <u>milk</u>.
10. The next word will be <u>phone</u>.

<u>List 2-A</u>

<u>Congruous sentence context</u>

1. The politician attended the <u>convention</u>.
2. The bartender served the <u>cocktails</u>.
3. The awards were presented at the <u>banquet</u>.
4. The interpreter knew the <u>dialect</u>.
5. The plane was buffeted by the <u>turbulence</u>.
6. The cowboy fired the <u>pistol</u>.
7. The painter fell off the <u>scaffold</u>.
8. The movie was at the <u>cinema</u>.
9. The boy was bitten by the <u>mosquito</u>.
10. We stayed until the <u>finale</u>.

<u>Incongruous sentence context</u>

1. The politician appealed to the <u>cavity</u>.
2. The dentist filled the <u>constituency</u>.
3. The train pulled into the <u>boulevard</u>.
4. The car came down the <u>depot</u>.
5. The man poured beer into the <u>tornado</u>.
6. The house was destroyed by the <u>pitcher</u>.
7. They worshipped in the <u>summit</u>.
8. The climber reached the <u>synagogue</u>.

9. The man was convicted of the <u>menu</u>.
10. The waiter handed them the <u>felony</u>.

<u>Neutral sentence context</u>

1. The next word will be <u>catalogue</u>.
2. The next word will be <u>constellations</u>.
3. The next word will be <u>bureau</u>.
4. The next word will be <u>decanter</u>.
5. The next word will be <u>trestle</u>.
6. The next word will be <u>prescription</u>.
7. The next word will be <u>strategy</u>.
8. The next word will be <u>sorority</u>.
9. The next word will be <u>mural</u>.
10. The next word will be <u>faucet</u>.

<u>List 2-B</u>

<u>Congruous sentence context</u>

1. The dentist filled the <u>cavity</u>.
2. The politician appealed to the <u>constituency</u>.
3. The car came down the <u>boulevard</u>.
4. The train pulled into the <u>depot</u>.
5. The house was destroyed by the <u>tornado</u>.
6. The man poured beer into the <u>pitcher</u>.
7. The climber reached the <u>summit</u>.
8. They worshipped in the <u>synagogue</u>.
9. The waiter handed them the <u>menu</u>.
10. The man was convicted of the <u>felony</u>.

<u>Incongruous sentence context</u>

1. It is the brightest star in the <u>catalogue</u>.
2. She observed the dress from the <u>constellations.</u>
3. The wine was served from the <u>bureau</u>.
5. The doctor gave the <u>trestle</u>.
6. The train went over the <u>prescription</u>.
7. The coed belonged to the <u>strategy</u>.
8. The general revised the <u>sorority</u>.
9. Water dripped from the <u>mural</u>.
10. The artist painted the <u>faucet</u>.

Neutral sentence context

1. The next word will be convention.
2. The next word will be cocktails.
3. The next word will be banquet.
4. The next word will be dialect.
5. The next word will be turbulence.
6. The next word will be pistol.
7. The next word will be scaffold.
8. The next word will be cinema.
9. The next word will be mosquito.
10. The next word will be finale.

List 2-C

Congruous sentence context

1. She ordered the dress from the catalogue.
2. It is the brightest star in the constellations.
3. The comb was on the bureau.
4. The wine was served from the decanter.
5. The train went over the trestle.
6. The doctor gave the prescription.
7. The general revised the strategy.
8. The coed belonged to the sorority.
9. The artist painted the mural.
10. Water dripped from the faucet.

Incongruous sentence context

1. The bartender served the convention.
2. The politician attended the cocktails.
3. The interpreter knew the banquet.
4. The awards were presented at the dialect.
5. The cowboy fired the turbulence.
6. The plane was buffeted by the pistol.
7. The movie was at the scaffold.
8. The painter fell off the cinema.
9. We stayed until the mosquito.
10. The boy was bitten by the finale.

Neutral sentence context

1. The next word will be cavity.
2. The next word will be constituency.

3. The next word will be boulevard.
4. The next word will be depot.
5. The next word will be tornado.
6. The next word will be pitcher.
7. The next word will be summit.
8. The next word will be synagogue.
9. The next word will be menu.
10. The next word will be felony.

APPENDIX F: MANOVA TABLES FOR WORD-NONWORD REACTION TIME DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	8048953.794	55	146344.614	
Constant	60521213.651	1	60521213.7	413.553*
GR	4860863.730	2	2430431.86	16.608

Within cells	3766944.130	55	68489.893	
Wordtyp	1675667.346	1	1675667.35	24.466*
GR and wordtyp	1829751.543	2	914875.771	13.358*

* p .01
** p .05

APPENDIX G: MANOVA TABLES FOR PERCENTAGE OF ERRORS MADE IN READING WORDS AND NONWORDS

Source	Sum of squares	df	Mean of squares	F
Within cells	5859.80459	55	106.54190	
Constant	24898.26104	1	24898.26104	233.69454*
GR	3069.04012	2	1534.52006	14.40297*

Within cells	4408.11862	55	80.14761	
Wordtyp	10209.75511	1	10209.75511	127.38689*
GR and wordtyp	2480.58002	2	1240.29001	15.47507*

* p .01
** p .05

APPENDIX H: MANOVA TABLES FOR REGULAR AND IRREGULAR WORDS REACTION TIME DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	7989546.43582	54	147954.56363	
Constant	572226933.67921	1	572226933.67921	386.78722*
GR	3163333.75466	2	1581666.8733	10.69022*

Within cells	130364.91990	54	2414.16518	
Wordtyp	68.02249	1	68.02249	.02818*
GR and wordtyp	1711.20171	2	955.60086	.35441*

* p .01
** p .05

APPENDIX I: MANOVA TABLES FOR REGULAR AND IRREGULAR WORDS ACCURACY DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	4585.954	54	84.925	
Constant	20200.321	1	20200.321	237.861*
GR	3178.707	2	1589.353	18.715*

Within cells	1418.713	54	26.272	
Wordtyp	3009.265	1	3009.265	114.541*
GR and wordtyp	590.136	2	295.068	11.231*

* p .01
** p .05

APPENDIX J: MANOVA TABLES FOR ORAL READING ACCURACY DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	16744.710	52	322.014	
Constant	37814.184	1	37814.184	117.430*
GR	11148.730	2	5774.365	17.311*
Within cells	2977.135	52	57.253	
Color	4135.911	1	4135.911	72.240*
GR and color	14709.078	2	735.039	12.839*
Within cells	1625.560	52	31.261	
RC	1005.057	1	1005.057	32.151*
GR and RC	330.008	2	165.004	5.278*
Within cells	429.019	52	8.250	
Color by RC	5.457	1	5.457	.661*
GR and color by RC	83.649	2	41.825	5.069*

* p .01
** p .05

APPENDIX K: MANOVA TABLES FOR ORAL READING TIMES DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	32.21100	52	.61944	
Constant	963.74278	1	963.74278	1555.82321*
GR	32.01562	2	16.00781	25.84229*

Source	Sum of squares	df	Mean of squares	F
Within cells	.76048	52	.01462	
Color	2.45499	1	2.45499	167.86646*
GR and color	.00033	2	.00016	.01124*

Source	Sum of squares	df	Mean of squares	F
Within cells	1.93847	52	.03728	
RC	15.24876	1	15.24876	409.05172*
GR and RC	.66437	2	.33219	8.91097*

Source	Sum of squares	df	Mean of squares	F
Within cells	.41735	52	.00803	
Color by RC	.66991	1	.66991	83.46779*
GR and color by RC	.04994	2	.02497	3.11141*

* p .01
** p .05

APPENDIX L: MANOVA TABLES FOR SENTENCE CONTEXT REACTION TIME DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	2803707.660	54	51920.512	
Constant	30118156.429	1	30118156.4	580.082*
GR	1314411.120	2	657205.560	12.658*

Within cells	40877912.117	54	756998.373	
Constant	41068390.155	1	41068390.2	54.252*
GR	16677510.853	2	8338755.43	11.016*

* p .01
** p .05

APPENDIX M: MANOVA TABLES FOR SENTENCE CONTEXT ERROR DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	2848.979	55	51.800	
Constant	7579.922	1	7579.922	146.332*
GR	2137.351	2	1068.681	20.631*

Within cells	59204.856	55	1075.452	
Constant	96856.640	1	96856.640	89.513*
GR	36700.108	2	18850.052	17.047*

* p .01
** p .05

APPENDIX N: MANOVA TABLES FOR ORAL READING CLASSIFICATION DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	1195.713	56	21.352	
Constant	15505.124	1	15505.124	726.167*
GR	443.536	2	221.768	10.386*

Within cells	135883.561	56	2426.492	
Constant	27737.826	1	27737.826	11.431*
GR	6494.982	2	3247.491	1.338

* p .01
** p .05

APPENDIX O: MANOVA TABLES FOR SELF-CORRECTION DATA

Source	Sum of squares	df	Mean of squares	F
Within cells	472.111	56	8.431	
Constant	20733.076	1	20733.076	2459.277*
GR	10.297	2	3.649	1.144*

Within cells	32925.092	56	587.966	
Constant	755.261	1	775.261	1.319*
GR	70.261	2	35.131	.060*

* p .01
** p .05

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