

DOCUMENT RESUME

ED 240 527

CS 007 518

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**TITLE** Reading as an Interactive Process.  
**PUB DATE** 8 Oct 83  
**NOTE** 66p.; Paper presented at the Annual Meeting of the Boston University Conference on Language Development (8th, Boston, MA, October 7-9, 1983).  
**PUB TYPE** Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

**EDRS PRICE** MF01/PC03 Plus Postage.  
**DESCRIPTORS** Academic Aptitude; \*Cognitive Processes; Elementary Education; Grade 3; Grade 6; Language Usage; \*Linguistics; Models; Predictive Validity; Reading Processes; \*Reading Research; Reading Strategies; \*Research Methodology; Semantics; Syntax  
**IDENTIFIERS** Interactive Reading; Protocol Analysis

**ABSTRACT**

A study examined the linguistic strategies of strong and weak readers in grades three and six within the context of D. E. Rumelhart's interactive model of the reading process. A linguistic prediction task was set up to investigate students' use of orthographic constraints, syntactic redundancy, and syntactic and semantic knowledge. A program was written for a computer so the prediction task could be presented as a progressive cloze activity. The data were examined using inferential and descriptive statistics and detailed protocols of individual performances. Contrary to prediction, inferential analyses of the data revealed no significant differences between the groups of readers. Descriptive statistics showed some of the problems underlying the application of inferential analyses. Protocol examination, comparing the performance of ideal readers with real ones, was the most revealing form of analysis as it showed the individual differences of children in using interactive processes to carry out language tasks. (Author/FL)

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READING AS AN INTERACTIVE PROCESS

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Presented at the Eighth Annual Boston University Conference on  
Language Development, October 8, 1983, Boston, Massachusetts

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### Abstract

This study examined the linguistic strategies of strong and weak readers in grades three and six within in the context of Rumelhart's (1977) interactive model of the reading process. A linguistic prediction task was set up to investigate pupils' use of orthographic constraints, syntactic redundancy, and syntactic and semantic knowledge. A program was written for the IBM 5100 desk top computer so the prediction task could be presented as a progressive cloze activity. The data were examined using inferential and descriptive statistics as well as by constructing detailed protocols of individual performance. Contrary to prediction, inferential analyses of the data revealed no significant differences between groups of readers. Descriptive statistics showed some of the problems underlying the application of inferential analyses to the data. Protocol examination, comparing the performance of ideal readers with real readers, was the most revealing form of analysis as it showed the individual differences of children in using interactive processes in carrying out the language task. An important feature of this report, therefore, is the comparison between the types of information one obtains by statistical approaches as contrasted with that obtained from qualitative protocol analyses. Such a comparison reflects the current debate on quantitative versus qualitative analysis as recently described by Light and Jillemer (1982).

## READING AS AN INTERACTIVE PROCESS

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Reading is one of the most researched topics in psychology. Many investigations have looked at how good and poor readers differ on a variety of variables. If the underlying causes of children's reading problems can be determined we assume steps to ameliorate the situation could be taken. Thus, this type of research appears to be important in a real world sense. However, given the complexity of both print processing and the acquisition of reading ability, much is still to be learned.

Early studies attempted to isolate variables believed crucial in the reading act. Tests for these components were devised and given to large groups of good and poor readers who were identified by performance on a standardized reading test. Correlation coefficients were computed to determine variables important in differentiating good and poor readers. The so-called diagnostic/prescriptive approach to teaching was one of the results of this early work. Although later work used different, and perhaps more sophisticated methods of experimentation (e.g., Davis, 1944), the emphasis on finding important components of reading continued.

It is a mistake to dismiss the relevance of early studies into reading. First, some work was ahead of its time, looking at reading as a total communication process instead of a set of discrete skills (Huey, 1908; Thorndike, 1917). Second,

exploring issues that later prove to be unproductive is part of the evolutionary process of research. For example, many early studies looked at characteristics of poor and good readers. Poor readers were found to make more regressions than good readers; they engaged in more subvocalization; and they made more reversals. We know now these manifestations are not causes of poor reading, but rather, products. Practices associated with stopping symptoms of poor reading, such as manipulating text artificially so the reader cannot regress, are diminishing.

The literature on good and poor readers is well documented (Vellutino, 1979; Samuels, 1971; Golinkoff, 1975-76). Kleiman (1982) offers a useful critique of the problems in carrying out this type of research. They include choice of tests or tasks, experimental design, sampling, and measurement. Kleiman adds to these classic issues the critical problem of individual differences. Group studies assume homogeneity within each group of readers. Wiener and Cromer (1967) hint at this problem in proposing a variety of models to account for reading disability, some appearing to assume individual differences. Applebee (1971) believes research into reading retardation must consider individual differences. This study focuses on issues raised by Kleiman, not to offer definitive answers but to explore the ramifications of proceeding in a given direction when carrying out research on good and poor readers.

#### Purpose of the Study

The purpose of this study was to explore the application of a model of the reading process to research on good and poor

readers. Specifically, we applied Rumelhart's (1977) description of reading as an interactive process. An ancillary goal was to examine the performance of the students who completed the specially devised language task using both quantitative and qualitative methods of analysis.

#### Models of Reading

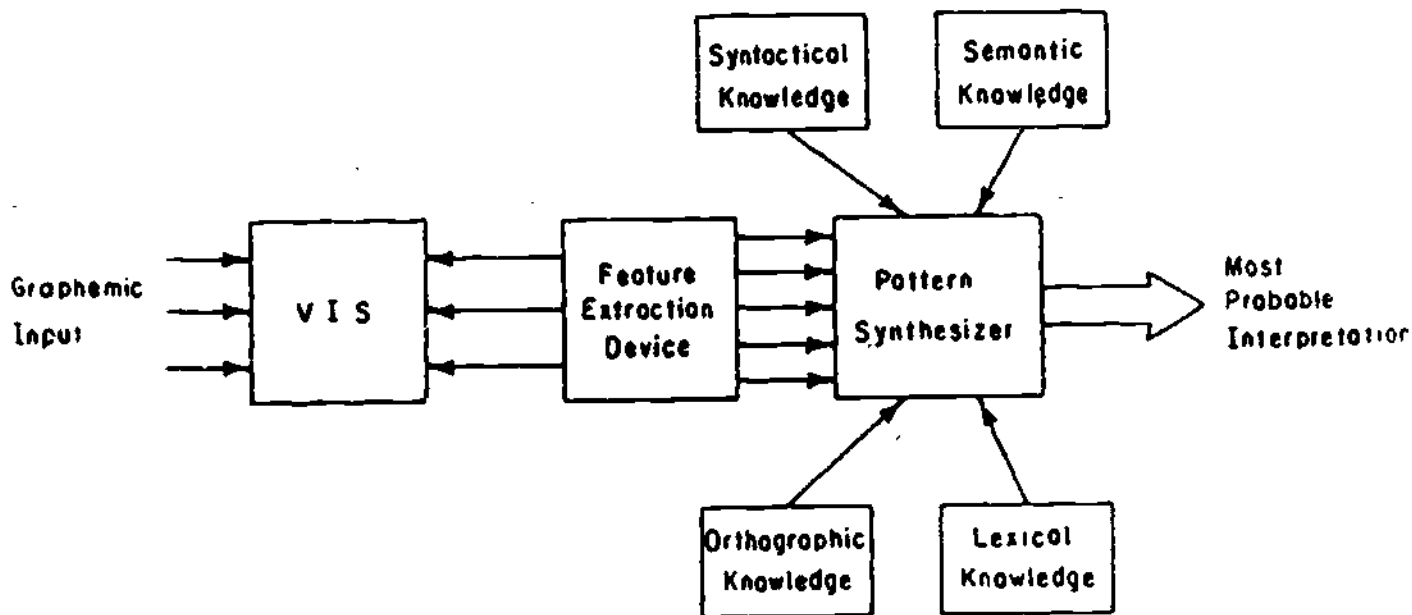
It is difficult today to pick up a journal in psychology without seeing an article entitled "Toward a Model of Reading" or "A Cognitive Model of the Reading Process". Models of reading are not new. In 1960 Gray depicted what he believed were the major aspects of the reading process. Jack Holmes, working out of Berkeley, devised his sub-strata factor theory in 1953. As well, he stimulated a gifted group of graduate students including Harry Singer, Irene Athey, and John Geyer, to think about the reading process. His correspondence with Marion Jenkinson influenced her early calls for more useful models of reading (Jenkinson, 1970). Some of her criticisms remain valid today. She believed different models may be needed to distinguish the mature and the developing reader. There is little doubt we know more about the reading processes of Psychology 100 students than any other group of readers. Whether or not the processes of these students are isomorphic with children is debatable.

Large numbers of reading models are accompanied by diversity in focus and orientation. Top-down, bottom-up and interactive are common terms applied, but there are psycho-sociolinguistic (Harste and Burke, 1978), cognitive-developmental (Marsh, Friedman, Welch, & Desberg, 1981) and psycholinguistic (Smith,

1971) descriptions of reading as well. Many terms overlap. For example, Goodman's (1970) model is described at times as both top-down and psycholinguistic. Interestingly enough, Goodman considers it an interactive model. In one sense the proliferation of models is encouraging as it demonstrates a growing understanding of the interrelationships among the multitude of variables influencing reading. Models now take into account factors within the reader as well as the text. In 1971 Mackworth keenly observed "...reading" can only be defined in terms of "who" is reading what in what state for what reason (p. 8-57)". Recent research dictates one would have to add, at least, 'in what cultural context' to this description (McDermott, 1977).

Chapanis (1963) noted some of the general values and limitations of model building. Providing researchers with a framework for experimentation is one of the prime values. As a framework for this study we adopted the interactive model proposed by Rumelhart (1977). Here, reading is described as a set of parallel, interacting processes. To some degree Rumelhart's model resembles a board meeting where all the underlings bring their reports to the chairman who then synthesizes their views and makes the best decision from the available information. The information brought to the reading board chairman, or pattern synthesizer in this instance, can be graphic, orthographic, lexical, syntactic or semantic (see Figure 1). Since Rumelhart believes lower level processes are guided by more global higher level processes it can be assumed that the

FIGURE 1



A stage representation of an interactive model of reading. From Rumelhart, D.E. Toward an interactive model of reading. In S. Dornic (Ed.), Attention and performance VI. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977, at p. 588.



stage representation depicted in Figure 1 does not capture the interrelationships among the various types of information acted on by the executor. Indeed, Rumelhart sees interaction occurring along three dimensions: position along the flow of print, levels of hypotheses, and alternative hypotheses at the same level.

#### Research Background

Rumelhart argues his model is testable using Bayesian probabilities. However, our goal was not to test the viability of Rumelhart's model. Instead, we decided to use principles based on a Rumelhartian description of the reading process to see how good and poor readers differed on a specific task.

Rumelhart's model lends itself to a form of analysis devised by Fillmore (1981) who is studying the differences in performance between ideal readers and real readers. An ideal reader "...is someone who knows, at each point in a text, everything that the text presupposes at that point, and who does not know, but is prepared to receive and understand, what the text introduces at that point (p. 253)". Although we borrowed the general idea of contrasting ideal readers with real readers our research deviated from Fillmore's work since he is interested in the ways school children interact with standardized tests of reading comprehension. Thus, his segmented text presentation format was not useful for our purposes.

One of our major problems was to determine how an ideal reader might process a text. An abstract analysis, using mathematical probabilities might be possible but it would be difficult given all the possible interacting variables. A second

problem was how to deal with low level information such as knowledge of orthographic constraints. Especially with good readers, low level information is processed at a level of automaticity. To solve this problem, Kolars (1968) used transformed text to study the reading processes of university students. His technique produced a reading in slow motion effect. However, we planned to compare our ideal reader with elementary school children. Even with such techniques it is hard to ascertain whether or not a reader is aware of, and using, orthographic redundancy. Adams (1980) points out some ways of studying the question, but these methods often entail the use of a tachistoscope.

A decision was made to use the progressive cloze technique which had been applied previously for scaling the difficulty of materials (Carroll, 1971). Following Shannon (1951), the progressive cloze procedure requires subjects to guess a text letter by letter. One member of our team had been using just such a procedure over the past several years with undergraduate students enrolled in a faculty of education. The sentence, "The large duck quacked and jumped into the Ijssel River.", was devised to demonstrate how an interactive model of the reading process might operate. Moreover, the sentence had been programmed on a computer so students could complete the exercise prior to class lecture (Burnett and Miller, 1981-82). Records of their responses, both correct and incorrect guesses, were brought to class. Thus, we had a record of the performance of approximately 200 university students. Given the simplicity of

the sentence we believed an ideal reader's performance could be constructed by examining their records.

Whenever one assessment methodology is selected over others there are tradeoffs. The progressive cloze procedure appeared to have several weaknesses, some of which were discovered as the research progressed. First, reading via a progressive cloze technique is not the same as reading a paperback novel for enjoyment or a textbook with the purpose of passing a test. As well, our task was essentially an encoding task while reading is decoding. Related to the encoding/decoding issue is spelling ability. The data may be contaminated by children's inability to spell the words. The children's classroom teachers did not believe this would be a problem. However, the research assistant who gathered the protocols was alerted to this possibility. If a spelling difficulty was perceived the research assistant was instructed to determine its nature by asking probe questions. For example, if the child guessed the letter "j" after "lar" in the word large, she would say, "What word are you thinking of?". If the child, as expected, answered "large", then the research assistant told the child that the next letter was "g", not "j". On the positive side the task did allow us to examine various aspects of the reading process including the use of orthographic constraints. Since we planned to interview the children as they worked through the sentence the slowness of the task became a virtue. The time it took to guess letters and to offer reasons for their selection were congruent. The task also allowed subjects to use language processes in an interactive manner, one

we felt had similarities to the reading process. There were other limitations and values to our choice, some of which will be discussed later in the paper.

For many years, two research paradigms have dominated research in education and the social sciences. Generally speaking, quantitative research and qualitative research have been regarded as fundamentally different. Quantitative research, where statistical results are presented on the basis of controlled experimental studies, is regarded as a different brand of research from qualitative studies that describe case studies or prototype a subject's thoughts and activities. Recently, researchers have emphasized the need to bridge the boundary between qualitative and quantitative research so the advantages of each could be emphasized. Light and Pillemer (1992) express the need to acknowledge the limitations of each approach by combining the strongest aspects of both research strategies.

Light and Pillemer identify several reasons for using qualitative information in combination with quantitative information to increase the richness of both. Some of these apply to this study. First, since there was flexibility in the procedure used with the students, quantitative analysis is difficult and may be misleading when examined alone. When treatment is idiosyncratic, Light and Pillemer claim nonquantitative information is important in two ways. Qualitative information is needed to document the process of each of the differing treatments along with the corresponding outcomes. Also, to make some sort of overall statement about the

outcomes, qualitative synthesis, taking into account differing treatments, is more valid than quantitative synthesis.

Another reason for using qualitative data is that some critical outcomes may be difficult to detect using quantitative methods (Light and Pillemer, 1982). Oversimplification of complex processes using simple numerical summary statements may result from using quantitative analyses alone. Along with the oversimplification accompanying statistical analyses, there is also the danger of "believing the figures" to the degree that the results are accepted uncritically.

Although Pillemer and Light focus on how quantitative and qualitative information can be combined effectively in literature reviews we believe many of their suggestions can be applied to individual research reports such as this one. Thus, we chose to supplement our statistical analyses with comparisons and contrasts of good and poor reader's protocols with an ideal reader.

#### Method

Subjects. Twenty-four students, twelve from grade three and twelve from grade six, were selected from a local public school. All grade three and six students in the school were included in the subject population.

The subjects were selected on the basis of their reading ability based on standardized test scores (The Gates-McGinitie Reading Tests [Canadian Edition], Levels C and D) and teacher ratings. The students' relative performance on the Gates-McGinitie, Form 1 (Comprehension Section only) was used to

rank them as high, medium or low readers. Cut-off scores were chosen so that 25 per cent of the students would be rated as high readers, 50 per cent as medium readers, and the remaining 25 per cent as low readers. These rankings were compared to the classroom teacher's assessments of the student's reading comprehension abilities. In most cases, teachers' ratings confirmed the indications of the standardized reading test. Disagreement occurred in only a few instances where a child was close to a classification border. In these cases, the teacher rating was used to rank the children's reading ability.

Once the students were ranked, a random sample comprised of two boys and two girls of each of the grades and reading levels was taken.

Apparatus. An IBM 5100 computer was used to deliver the exercise. This small, stand alone computer has a built-in screen. However, because of the small size of the screen a monitor was slaved to the computer for better viewing. Data was gathered by using a video tape recorder to record both subjects' and experimenter's comments along with the corresponding screen display.

The Language Task. The sentence used in this study was first used with university students enrolled in an introductory reading and language arts education course. The sentence, "The large duck quacked and jumped into the Ijssel River.", was created to demonstrate how reading processes operate interactively. The sentence was constructed so the role of orthographic constraints, syntax, semantics, redundancy, and pragmatics could be

demonstrated. The sentence did not appear to be too difficult for grade three and six school children. The exception, of course, is the word 'Ijssel', which neither university nor grade school children were expected to guess easily. Using this sentence allowed us to construct a portrait of how an ideal reader might solve the mystery sentence. This portrait could be compared and contrasted with real readers.

Procedure. The language exercise was presented in an office located in the school. The students were excused from regular classroom activities to participate. The order of participation was arbitrary, often affected by other school activities.

The students were presented with the following display:

??? ????? ???? ??????? ???? ?????? ???? ???? ?????? ??????

They were told to guess the sentence, letter by letter, from left to right. Students were permitted up to seven guesses for each question mark, and if the letter was not discovered in seven guesses, the correct one was given. There was a time limit of 35 minutes allowed for participation in the exercise.

Through the course of the exercise, the experimenter asked various questions. Students were frequently asked why a particular letter was guessed, or if a particular letter precipitated guessing a word. Sometimes the experimenter attempted to determine how certain a student was about the correctness of a guess before the guess was checked by the computer program. In a few cases where a student was having

difficulty concentrating on the task, a more interactive procedure was used. For instance, the student could "bet" or "exchange" letters, thereby allowing him "free" letters in situations where he might otherwise have wanted to abandon the task. As well as making the task more interesting to the student, this procedure highlighted the parts of the sentence that the student found easy or difficult. Thus, similar information was gathered from all students. The experimenter had no set list of required questions. Rather, she knew the type of information we wanted to obtain and formulated her questions accordingly.

## Results

### Quantitative Analysis

Analysis of the data arising from this study is less than straight forward. At first glance the structure for the analysis is well-defined: a 2x3 (grade x reading levels) fixed effects design with four subjects in each cell. Thus analysis of variance should be appropriate. Having defined the cells, one now proceeds to place the data in them. Here the shoals begin to emerge above the placid sea. What are the appropriate variables or dimensions for capturing the subjects' performance? At first, we can examine the total number of guesses required by each subject to complete the task - better readers should require fewer guesses. Most subjects were not able to complete the entire exercise in the time limit of 35 minutes, so the task for the purpose of statistical analysis consists of the first eight words. Even with this decision there remains a difficulty. Due



to individual differences in the way students responded to the set task, some students still failed to complete all eight words. Failure to complete the task implies fewer errors and hence an inflated performance index. To fill in the missing data with the maximum possible number of guesses is probably even more misleading since it would substantially increase the number of errors (at a rate of 7 x number of letters not yet attempted). Instead a decision was made to "increase the homogeneity of the affected cells" by substituting the average number of guesses by other subjects in that cell who had completed an attempt at the letter. A total of six out of the 24 subjects had their scores adjusted in this manner, but only two had a substantive change of having more than 10 added to their total number of errors.

The resulting means and standard deviations are given in Table 1; the corresponding 2-way ANOVA (fixed effects) is given in Table 2. The original hypothesis was that reading level would be a more important variable than age (i.e. grade level) in accounting for variability in performance on this task. Table 2 indicates that this hypothesis was incorrect. Alternatively, the results reported in Table 2 could have occurred because this analysis somehow fails to provide a good snapshot of the actual event. Pursuing this latter interpretation, we decided to explore the use of different filters (creation of derived variables, methods of analysis and presentation) to see if certain hidden features would emerge, thereby supporting the original hypothesis.

One facet of the preceding analysis may be typified as the

Table 1  
Means and Standard Deviations for Number of Errors  
by Reading Level and Grade Level

| Grade |   | Reading Level |        |       |
|-------|---|---------------|--------|-------|
|       |   | Low           | Middle | High  |
| 3     | X | 59.50         | 66.00  | 50.50 |
|       | S | 17.40         | 5.79   | 8.08  |
| 5     | X | 51.25         | 56.25  | 39.00 |
|       | S | 13.27         | 13.59  | 5.05  |

Table 2  
 Number of Errors  
 ANOVA Table

| Source              | SS     | df | MS    | F    |
|---------------------|--------|----|-------|------|
| Reading level       | 177.2  | 2  | 88.6  | 0.46 |
| Grade               | 580.2  | 1  | 580.2 | 3.04 |
| Interaction         | 658.6  | 2  | 329.3 | 1.72 |
| Error (within cell) | 3436.5 | 18 | 190.9 |      |
| Totals              | 4852.5 | 23 |       |      |

"fallacy of the IQ score". Two students may have the same total score, say 120, but one student receives an 80 on verbal and 40 on non-verbal components and vice versa for the other. To say that both students have "the same" IQ is silly. Similarly, the way in which individual students accumulated their errors across the mystery sentence varied appreciably, suggesting a finer grained analysis. To present a priori hypotheses from this point on would be deceitful, hence we shifted to descriptive statistics.

One approach is to develop detailed composite profiles. The underlying assumption is that each group should be thought of as a homogenous whole (a highly questionable assumption) and to see what differences and similarities are apparent among the groups on a letter-by-letter task performance. Tables 3 through 6 give the profiles for the high and low readers in both grades. The middle group has been omitted primarily for brevity. It is difficult enough to make statements about the extreme groups - inclusion of the middle group tends to add little information while complicating the structure and number of comparisons.

One set of comparisons focuses on the relevance of letter position within a word. Thus one might hypothesize that all students are in similar position while guessing the first letter of a word, but as the letters are progressively determined, the better readers should be able to take greater advantage of these cues and hence their error rate should improve (i.e., decrease) relative to the poorer readers. A second factor that should influence student performance with respect to letter position in

Table 3

Grade 3 Low Reader Composite Profile  
 Number of Guesses for the Group (N=4) Before Success for Each Letter

| Word          | Position of Letter in Word |           |           |           |          |          |          | Total      |
|---------------|----------------------------|-----------|-----------|-----------|----------|----------|----------|------------|
|               | 1                          | 2         | 3         | 4         | 5        | 6        | 7        |            |
| The           | 9                          | 7         | 0         |           |          |          |          | 16         |
| large         | 19                         | 2         | 21        | 15        | 1        |          |          | 53         |
| luck          | 12                         | 13        | 8         | 3         |          |          |          | 36         |
| quacked       | 22                         | 0         | 14        | 1         | 1        | 0        | 0        | 38         |
| and           | 0                          | 4         | 0         |           |          |          |          | 4          |
| jumped        | 23                         | 7         | 7         | 1         | 1        | 0        |          | 39         |
| into          | 20                         | 16        | 0         | 0         |          |          |          | 36         |
| the           | 0                          | 0         | 0         |           |          |          |          | 0          |
| <b>TOTALS</b> | <b>105</b>                 | <b>49</b> | <b>50</b> | <b>20</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>227</b> |

Table 4

Grade 3 High Reader Composite Profile  
 Number of Guesses for the Group (N=4) Before Success for Each Letter

| Word          | Position of Letter in Word |           |           |           |          |          |          | Total      |
|---------------|----------------------------|-----------|-----------|-----------|----------|----------|----------|------------|
|               | 1                          | 2         | 3         | 4         | 5        | 6        | 7        |            |
| The           | 7                          | 0         | 0         |           |          |          |          | 7          |
| large         | 22                         | 5         | 15        | 12        | 0        |          |          | 54         |
| luck          | 17                         | 14        | 10        | 0         |          |          |          | 41         |
| quacked       | 28                         | 1         | 0         | 1         | 0        | 0        | 0        | 30         |
| and           | 14                         | 0         | 0         |           |          |          |          | 14         |
| jumped        | 15                         | 4         | 6         | 0         | 0        | 0        |          | 25         |
| into          | 23                         | 1         | 0         | 0         |          |          |          | 24         |
| the           | 0                          | 0         | 0         |           |          |          |          | 0          |
| <b>TOTALS</b> | <b>126</b>                 | <b>25</b> | <b>31</b> | <b>13</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>195</b> |

Table 5

Grade 6 Low Reader Composite Profile  
 Number of Guesses for the Group (N=4) Before Success for Each Letter

| Word          | Position of Letter in Word |           |           |           |          |          |          | Total      |
|---------------|----------------------------|-----------|-----------|-----------|----------|----------|----------|------------|
|               | 1                          | 2         | 3         | 4         | 5        | 6        | 7        |            |
| The--         | 0                          | 0         | 0         |           |          |          |          | 0          |
| large         | 14                         | 1         | 16        | 3         | 0        |          |          | 39         |
| duck          | 23                         | 18        | 16        | 0         |          |          |          | 57         |
| quacked       | 28                         | 1         | 3         | 2         | 7        | 0        | 0        | 41         |
| and           | 6                          | 2         | 0         |           |          |          |          | 8          |
| jumped        | 22                         | 9         | 1         | 0         | 0        | 0        |          | 32         |
| into          | 21                         | 7         | 0         | 0         |          |          |          | 28         |
| the           | 0                          | 0         | 0         |           |          |          |          | 0          |
| <b>TOTALS</b> | <b>114</b>                 | <b>38</b> | <b>35</b> | <b>10</b> | <b>7</b> | <b>0</b> | <b>0</b> | <b>205</b> |

Table 6

Grade 6 High Reader Composite Profile  
 Number of Guesses for the Group (N=4) Before Success for Each Letter

| Word          | Position of Letter in Word |           |           |           |          |          |          | Total      |
|---------------|----------------------------|-----------|-----------|-----------|----------|----------|----------|------------|
|               | 1                          | 2         | 3         | 4         | 5        | 6        | 7        |            |
| The           | 2                          | 0         | 0         |           |          |          |          | 2          |
| large         | 11                         | 1         | 26        | 17        | 0        |          |          | 55         |
| duck          | 8                          | 11        | 2         | 0         |          |          |          | 21         |
| quacked       | 13                         | 0         | 0         | 0         | 0        | 0        | 0        | 13         |
| and           | 3                          | 0         | 0         |           |          |          |          | 3          |
| jumped        | 22                         | 5         | 7         | 0         | 0        | 0        |          | 34         |
| into          | 21                         | 0         | 0         | 0         |          |          |          | 21         |
| the           | 0                          | 0         | 0         |           |          |          |          | 0          |
| <b>TOTALS</b> | <b>80</b>                  | <b>17</b> | <b>35</b> | <b>17</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>149</b> |



a word is related to the syntactic structure of most English language words. Thus, the first letter is often a consonant and hence there are 21 potential candidates. Similarly, given that the first letter is a consonant, the second letter is often a vowel. The number of prime candidates is only five or six. Once again, the third letter has a much larger set of possibilities, although by now, with the first two letters known, there is additional syntactic and orthographic information available. Thus if one were to graph the number of errors by the position of the letter in a word, one would expect decreasing curves for all groups, with a slight rise at the third letter, and for the curves of high and low readers to diverge as the letter position increases. Figure 2 indicates that the curves clearly decrease as we expected but they converge instead of diverge. Two explanations come to mind. Perhaps these curves are artificial constructs of the particular words in our particular mystery sentence. A second more likely explanation is that a form of "ceiling effect" is operating after the first three letters.

Another set of comparisons focuses on the relevance of word position within the sentence. This is strongly related to the semantic content of the sentence. It is more difficult to predict the nature of the curve since a "difficult" word would naturally cause a spike in the curve. Keeping this in mind, the curves should decrease and there should be divergence between high and low readers. Figure 3 gives the curves for the two extreme groups: grade three low readers and grade six high readers. A few comments deserve mention. Both curves have the

FIGURE 2

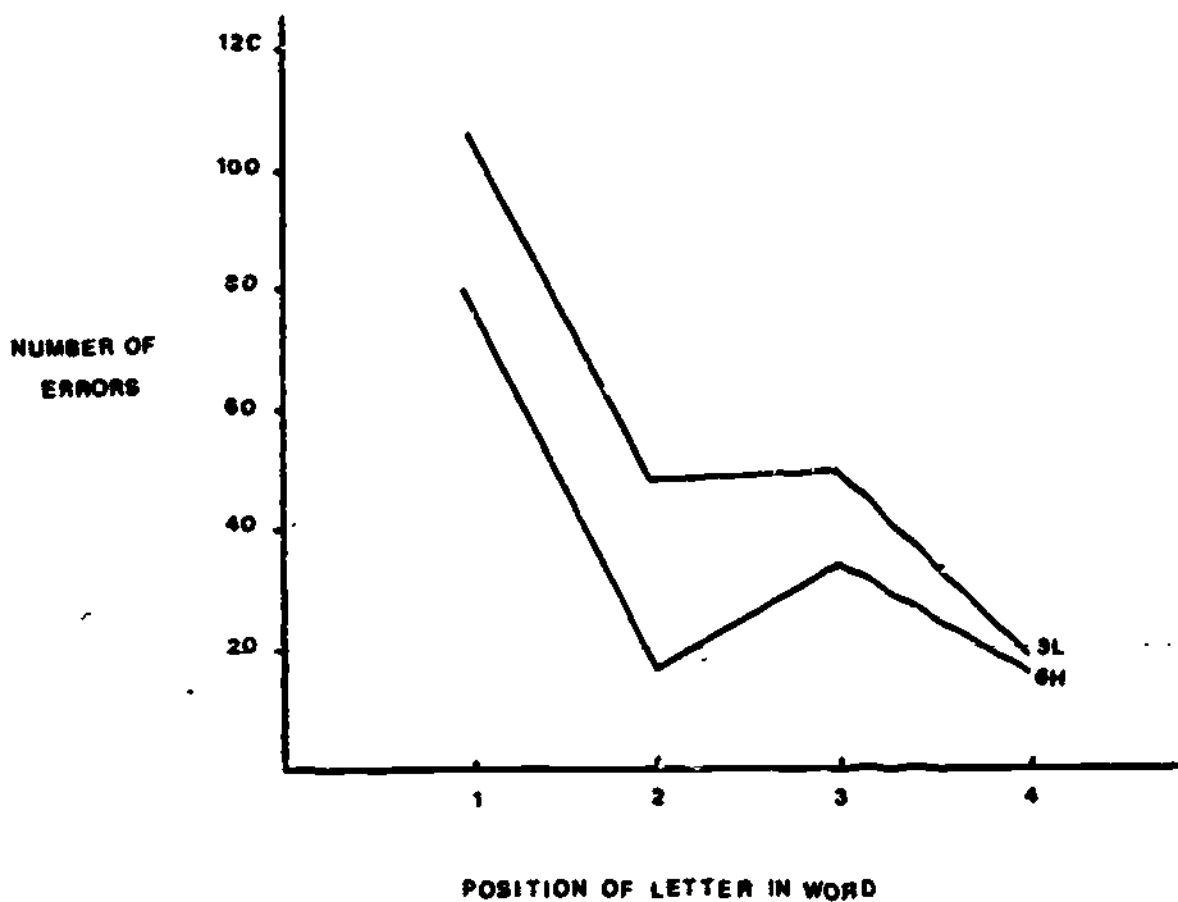
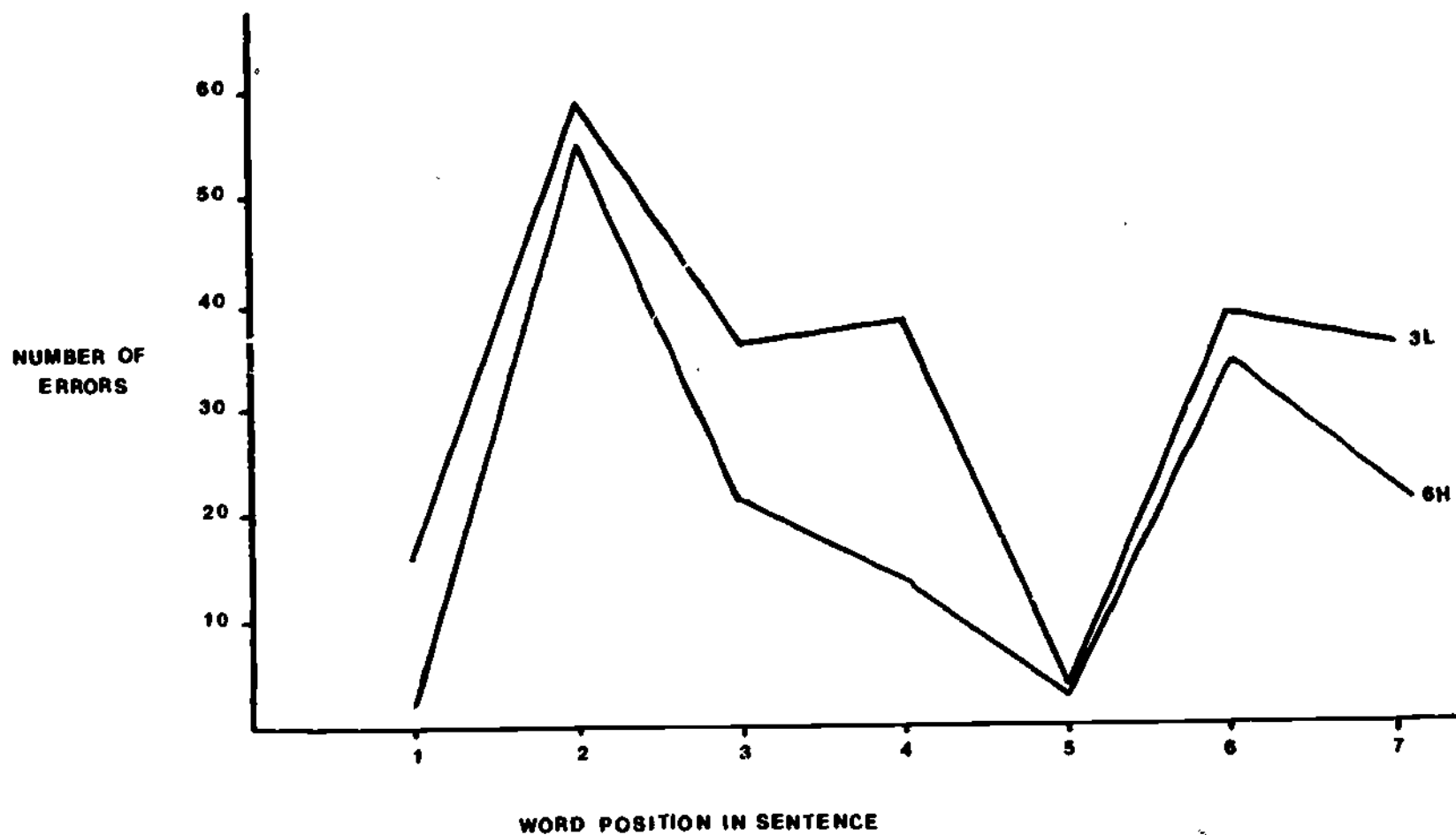


FIGURE 3



24.

sane shape, rising and falling together but the curve for the strong readers shows less variability because of the lower number of errors. Word order does not appear to be a dominant factor, the specific words in our sentence dominate whether the curve rises or falls. Thus words like 'large', 'quacked' and 'jumped' have more errors than words like 'the', 'duck', 'and' and 'into'. A confounding factor is word length although a review of Tables 3 - 6 indicates almost all errors occur during the first three letters. The one exception is the large number of errors for the fourth letter of "large", corresponding in part to the low frequency with which "g" occurs in the English language.

Before looking at a couple of individual profiles, we would like to present some of our data, embedded in the last figure, as a series of box and whisker plots (Tukey, 1977). Such plots provide a good measure of the variability in student performance. Figures 4 - 7 give the plots for the second through fifth words. Explanations that overlook this variability are clearly incomplete. Thus on the word 'large', the weak reading group shows more variation than the strong group as well as slightly better performance (!). The increase in variability in the weak group is even more pronounced for 'duck', but the strong group makes fewer errors. A similar pattern is noticeable for the other words. The larger variability for the weak readers is suggestive of the idea that there may be many more reasons for poor performance than for good performance. This may be where the heart of the matter lies with respect to future

FIGURE 4

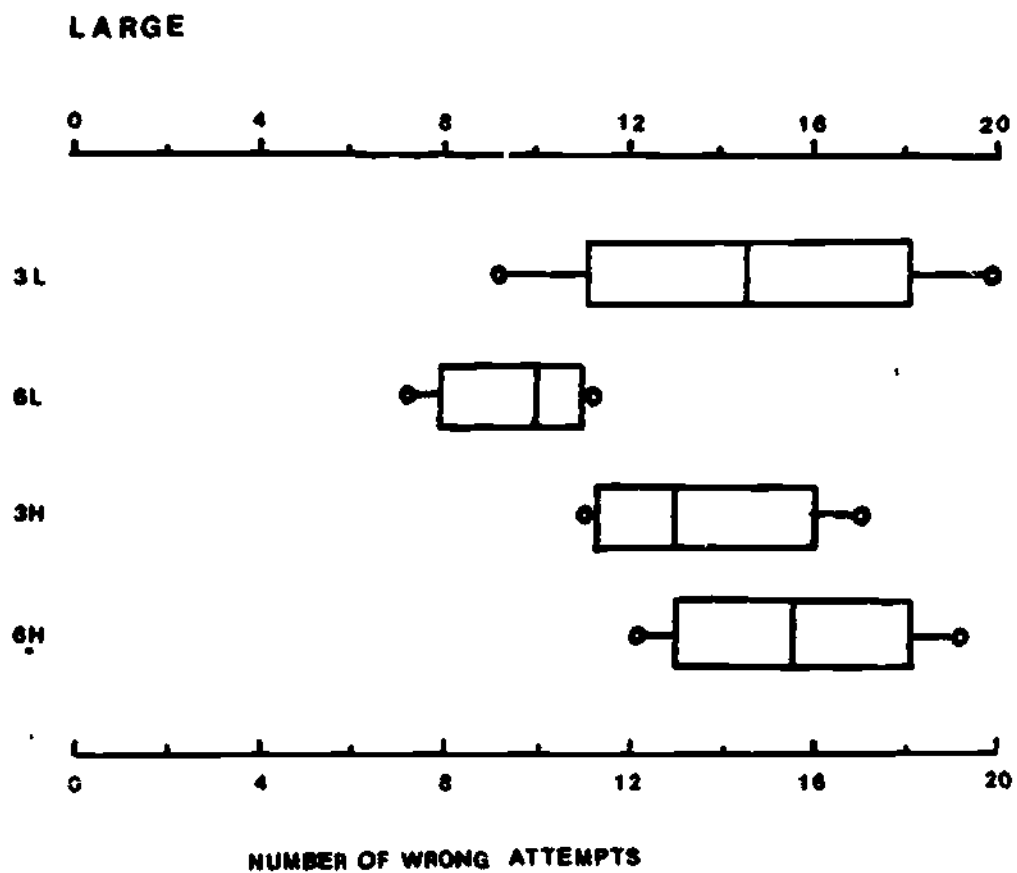


FIGURE 5

DUCK

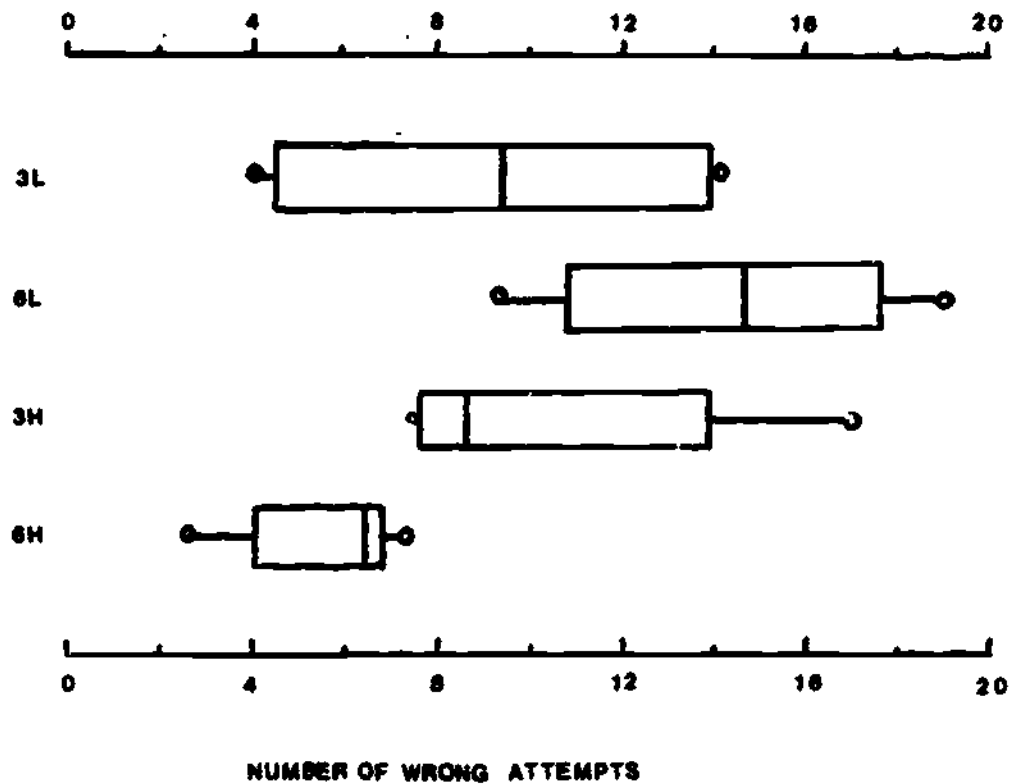


FIGURE 6

QUACKED

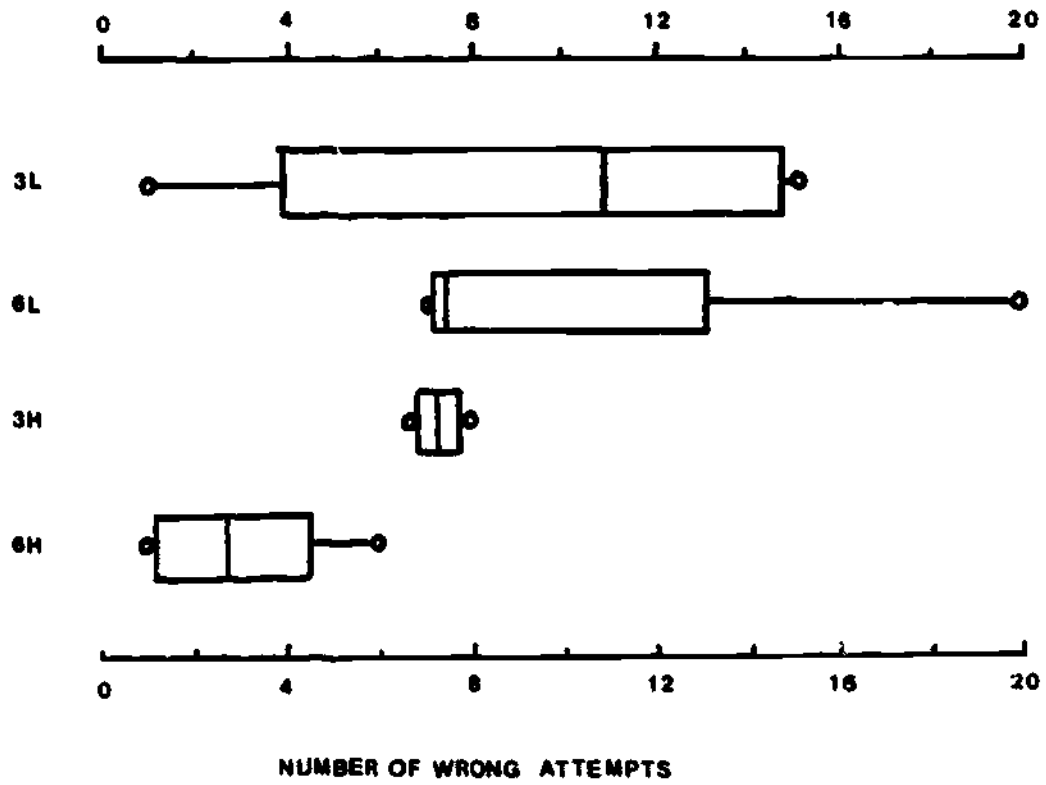
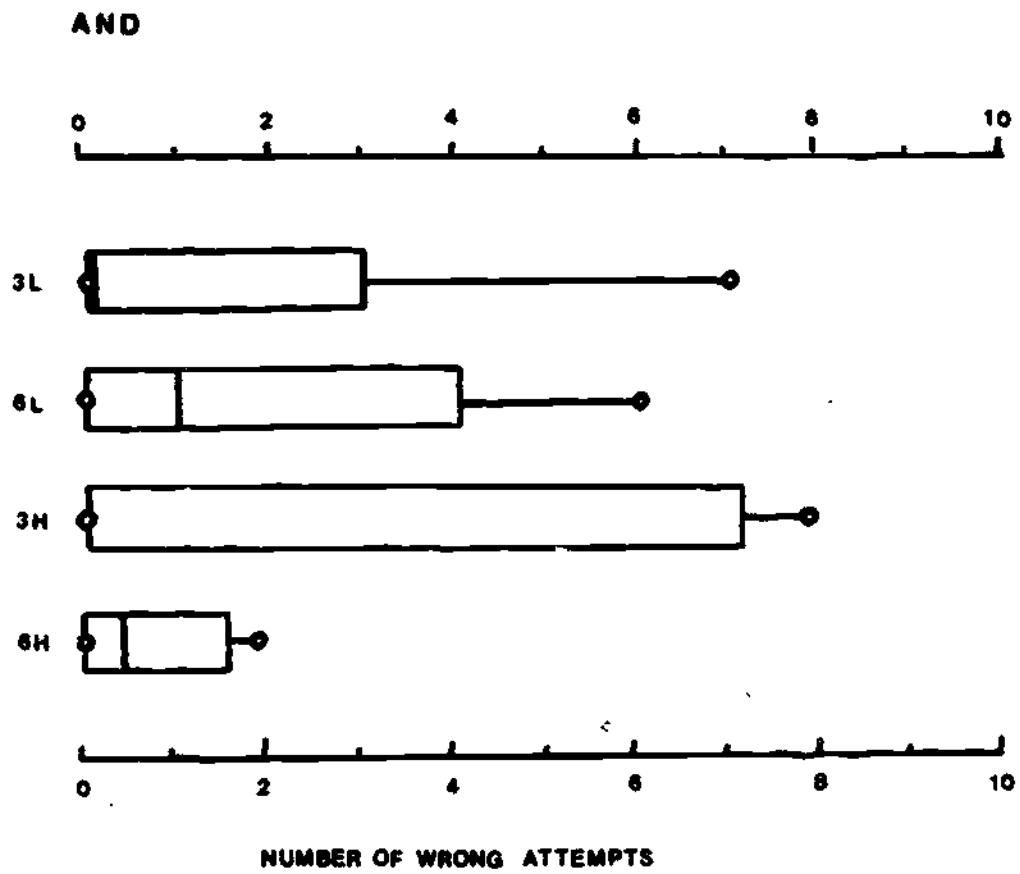


FIGURE 7





research.

### Qualitative Analysis

#### Readers: Ideal and Real

If a mature reader was asked to solve the mystery sentence how would she go about it? What strategies would be used? At what points would she work from words to letters, perhaps showing higher level processes controlling lower level processes? Would protocols indicate evidence of pragmatics influencing guesses? How would orthographic constraints assist in the solution? And most importantly, how does the mature reader use linguistic information interactively? These questions can also be asked of the elementary school students used as subjects in this study.

To supplement the quantitative analysis carried out on the data we first constructed a composite interview of an ideal reader. The composite interview was based on the responses of a large number of university students who completed the exercise on a computer or in small groups led by an instructor. The synthesized protocol was compared with those of real good and poor readers, the grade three and six children used in this study. Although all children were interviewed while they solved the sentence, only two analyses are presented here, one of high grade three readers and one of low grade three readers. Our goal is to demonstrate the potential of this type of analysis rather than to offer definitive answers as to how groups of good and poor elementary school readers differ from an ideal reader.

Consonant with the interactive model of reading, information from many sources is used to solve the mystery sentence. The

hypotheses of the university students are not always correct. However, even incorrect guesses demonstrate an attempt at the best possible answer given the linguistic context, both within the text and the reader's mind. We view this behaviour as congruent with the example given by Rumelhart where plausible words (hypotheses) compete for confirmation (Rumelhart, 1977, p. 595, Figure 10).

The following synthesized protocol, along with analytical comments, depicts how an ideal reader might solve the mystery sentence. Although the protocol is a composite, we present it in a realistic manner, as though one student is completing the task. The comments, often colloquial, are typical, and we used many quotes to retain a flavour of how students proceed through the mystery sentence. Specifically omitted are the comments of one student who struggled for approximately a half-hour, only to reach the word 'Ijssel'. About the time he guessed the second S, he rose from his chair muttering oaths and incantations about crazy professors.

Observer: Ideal reader, your task is to solve a mystery sentence. To do this you will guess the letters in each of the words, in sequence, and one at a time. The question marks on the screen tell you how many letters are in each word. No other information will be given. If your guess is correct the letter will be displayed in its proper place in the word. If the letter is incorrect, it will be displayed below the word. After seven incorrect guesses the correct letter will be given to you. Now, what is the first letter of the first word?

Ideal Reader: Mmmm, it's a three letter word that begins the sentence. Let's try T.

O.: You're right. How did you get it?

I.R.: Well, the word has three letters which doesn't seem like a lot of help at first. But this three letter word begins the sentence and...well, I don't know but the is probably the most common three letter word that starts sentences.

Comment: The strategy used by the I.R. is common. It might be considered a pragmatic strategy although the term is usually applied differently in the literature. Once the T is guessed the HE are automatic. Two other common guesses are W and I. The W guess usually indicates the reader thinks the sentence is a question that begins with 'Why' (perhaps because of the use of question marks to indicate letter position). The I guess, although rare, is meant to be the word 'I'. Even mature readers will ignore cues (such as that there are three letters in the first word) and allow other cues to rule their guess.

O.: Continue.

I.R.: The next letters are H and E. That was easy. Let's see. The next word has five letters, and it has to be a noun or an adjective. That's not much help. Let's try some consonants. T. No. S. Nope. How about B. Could be a vowel. Try E. Wrong again. C. F? How many guesses is that? One more. D. Oh, it's L.

Comment: Adults tend to begin in the most logical manner possible. However, when they see their early responses are wrong, the most linguistically sound (i.e., high frequency letters) guesses are sometimes abandoned and a more random pattern is adopted. However, even here the guesses tend to be reasonable,

that is, they may switch to vowels but Z or X are infrequent. Also, while they sense the word must be an adjective or noun the futility of trying to use this information is quickly recognized.

I.R.: The next letter has to be a vowel.

O.: Does it?

I.R.: Well, it doesn't have to be. It could be a 'llana'. (laughs). I'll try vowels. E. No. A. Got it! (I.R. begins to sound LA).

O.: What are you thinking of?

I.R.: Lamps. Mmmm. Lads, lamps, ladies...no. Try K for lakes. O.K. how about C. T.

O.: What were you thinking?

I.R.: Nothing really. Latin maybe? (nervous laugh) Maybe it is D. Is ladies spelled 'ladys' or 'ladies'?

O.: Maybe both spellings are correct.

I.R.: D. No. P. Only two more guesses. Gee The...The....lanes? N. One more. Maybe it's a vowel. O. It's R. (sounds LAR) Lard...No, only four letters. Lards. Wierd.

O.: What's the problem?

I.R.: This is a toughie. Five letters...(Begins to say LAR again and again.) Try C. Mmmm. K. I know, large! Got it! The large...(voice trails off)

Comment: The general strategy is to use top-down processing. Often students could be observed working backwards, that is, constructing an answer that was syntactically and semantically plausible. But there isn't sufficient information as yet to use this strategy effectively. The result is an interesting combination of thoughtful frustration.

O.: Next word please.

I.R.: The large...Mmm four letters. What's large and has four letters. Could be a three letter noun with an S added. Of course, it could be another adjective too. Not likely though. Try B for boys. O.K., How about R for rake. I was raking the leaves yesterday. No, D for dogs. Hey, I got it. O. Oops. Not dogs. The large (begins sounding D.....E. A.

O.: Were you thinking of a word?

I.R.: Well, it could be a lot of things. Has to be a vowel. It could be R but not likely. Try I. Gosh, maybe it is R. U. So it's U. The large (begins sounding DU). Mmmm. I know, duck. Right!. (The letters CK are filled in quickly and triumphantly).

Comment: It is typical of university students to believe initially that identifying the first two words will open up the rest of the sentence. This euphoria dissipates as they realize adjectives or nouns beginning with any letter of the alphabet could fill the next slot. Students still work backwards, that is, from words to letters, but the futility of the strategy tends to persuade them to choose words that begin with high frequency letters. Thus, in essence, it appears as though students know when to abandon a top-down strategy and focus on bottom-up processing.

Once the D in 'duck' is guessed orthographic constraints come into play. As well, students attempt to apply syntactic and semantic cues although there are still too many options to make this type of processing useful. Note the sophistication of the students in guessing vowels. Wrong answers turn out to be right. Given the linguistic context, A, E, I, etc. are better guesses than U, a low frequency vowel. Although there are other viable

words, 'duck' tends to be ascertained in three or four guesses at the most.

O.: What now?

I.R.: The large duck... What do large ducks do? Swim. No, not enough letters. It has to be seven letter word. What do ducks do that takes seven letters? Waddle. That's it! W. O.K., so they don't waddle here. Looked. Leaped? (silence)

O.: You seem to think the word is a verb.

I.R.: Yes, it has to be. Well, it doesn't have to be...but it probably is.

O.: What else could it be?

I.R.: It could be an adverb...like - The large duck happily... Of course that wouldn't be good grammar, would it?

O.: I don't know. What do you think?

I.R.: Gee, this isn't as easy as I thought. What do ducks do? Splashed. S. Nested. N. Try E.

O.: Were you thinking of a word?

I.R.: No, I could think of one though. Quack. Try quacked. Voila! (I.R. quickly types Q while laughing).

O.: Why are you laughing?

I.R.: If it's Q it's got to be U. (I.R. continues typing in letters). Must be an ED at the end.

O.: Why do you say that?

I.R.: Well, it must be S or ED, quacks or quacked. And I have two letters left.

Comment: Once again, the ideal reader believes the solution is at hand. "What do ducks do?" she asks. This is a question we hear muttered over and over as students wrestle with the word.

It is a good question as it shows the I.R. is attempting to activate her schema for the word 'duck'. However, even at this early point in a simple sentence, the I.R. is attempting to use a variety of strategies, presumably in an interactive manner, to solve the problem.

The number of letters in the word is some help but observe how the I.R. tends to ignore the specific number of letters, choosing long words instead. General word length seems to be a clue, but the reader does not focus on specifics. For example, 'splashed' has eight letters while 'nested' has six. Both answers fit semantically and syntactically.

Once the letter Q is guessed the word comes quickly. On occasion, students will guess a word other than 'quacked' that begins with QU, but this is rare.

- I.R.: The large duck quacked....three letters.  
Quacked out? No, doesn't make sense.
- O.: What type of word fits?
- I.R.: Lots.
- O.: Nouns?
- I.R.: No. Adverbs mostly. What else? Maybe conjunctions? Yea.
- O.: Anything else?
- I.R.: I suppose I could find a way to put almost anything there, but some make more sense than others. (silence) I'm thinking.
- O.: What about?
- I.R.: What could go there. Try F. The large duck quacked for his breakfast. Nope. Oh, it could be a preposition. I. Its....quacked

its head off. Gee, any other part of speech.  
What is 'its'?

O.: What do you think?

I.R.: B for but. (silence) A.

O.: Are you thinking of a word?

I.R.: (As the computer shows A to be correct.) I am now!

Comment: As the sentence progresses students may apply more strategies to the task. Numerous options limit the effectiveness of these strategies until the initial letter is guessed. This breaks the log jam of options and the word is quickly identified.

At this point, and sometimes earlier, it is common for students to attempt to complete the sentence. They are not concerned merely with local context but try to achieve closure on the entire thought.

I.R.: (Mumbles sentence to himself.) What else do ducks do? Another Q. Quacked, quacked, quacked. Sounds like a basal reader. Let's try waddled again. No W. D. C.

O.: Where you thinking of something?

I.R.: Climbed. Danced? Dancing bears but no dancing ducks. Mmmm. Let's go back to splashed. S. That was a dumb answer.

O.: Why?

I.R.: Too many letters. I didn't notice that before. Oh, it's six letters this time. What else do ducks do besides quack? N. P.

O.: Were you thinking of a word?

I.R.: No, guessing. One answer left. Try H for hopped. Do ducks hop? Guess not. I-'s J. Oh, jumped. (Types in word.)



Comment: As before, many options face the reader. Making sense of the sentence is still a goal though. Even whimsical answers such as dancing ducks are related to plausible situations. As with other words, the initial consonant, combined with syntax and semantics, are powerful clues.

We notice students seldom slow down when they come to the ED in the word 'jumped'. Their knowledge of language tells them tense should be continued so they supply this information instantly.

- I.R.: (I.R. repeats sentence up to the new word.)  
 Out. No. Jumped onto? O. Over maybe.  
 Near. N. Rats!
- O.: What's the problem?
- I.R.: Lots of words can fit.
- O.: What kinds of words?
- I.R.: Prepositions. Let's see, what else?  
 Adjectives? Adverbs? I forget. No, it must  
 be an adverb. I don't know. Who cares? Try  
I for into. Ah-ha. (Types in into.) Next  
 word -- the. It has to be 'the'.
- O.: Why?
- I.R.: It just does. It makes sense. Listen. The  
 large duck quacked and jumped into the (pause)  
 river. R. no. S. B for brook. What else  
 can ducks jump into? Maybe it's an adjective  
 first. Muddy river. M. O. It's a salt  
 water duck. Mmmm. T. My favorite guess.
- O.: Why is T your favorite guess?
- I.R.: Lots of words start with T. One more guess.  
D. (The letter I is supplied by the  
 computer.) Wow. What do ducks do that starts  
 with I? Is that a capital I?
- O.: What do you think?

- I.R.: You know, you sound like a psychologist.
- O.: Yes, it is a capital I.
- I.R.: Indian Ocean. Try N. (silence) What comes after I? V. M. This is tough. I thought it would get easier.
- O.: Why?
- I.R.: Because I have almost have the entire sentence. Try S. Island? Doesn't make sense. T. P. (Silence) I.
- O.: The next letter is J.
- I.R.: J. You've got to be kidding. (I.R. tries to sound out IJ; long silence.)
- O.: Guess a letter please.
- I.R.: Nothing makes sense. E. Maybe it's a vowel. I. O. U.
- O.: Why do you say that?
- I.R.: Because I have two consonants. Here's a wild guess...J. A. Y.
- O.: The next letter is S.
- I.R.: S? Are you sure? What is this, Russian?
- O.: What do you think?
- I.R.: Must be something foreign. Nothing is going to make sense. (silence) A. E. I. O. U.
- O.: What are you doing?
- I.R.: Playing games. It must be a vowel now. Maybe it's Norwegian. What's that funny letter they use?
- O.: A thorn? That key is not on the computer.
- I.R.: Y. One more. G.
- O.: The next letter is S.
- I.R.: 'Ijs'. Some word. J. Let's try some letters haven't used before. K. X. Z. Another S. Got one! Blind luck.

O.: Why do you say that?

I.R.: This isn't English. Since I don't know the language I don't know what is coming next. 'Ijss'. There must be a vowel now. A. I. U. E. At last, something makes sense. One more letter. T. M. D. P. (silence) G. Mmmm...into the (tries to sound out Ijssé).  
B. C.

O.: The final letter is L.

I.R.: How do you pronounce that word? (Tries pronouncing 'Ijssel'.) One to go.

Comment: Guessing the letters in 'Ijssel' is a frustrating experience. The game has been changed, but initially students are unaware of the change. Semantics rules over both word length and syntax as evidenced by common guesses such as "pond". As well, they attempt to apply the orthographic constraints of English to the word. After the first two letters are guessed, or given by the computer, they realize something is wrong. Eventually most surmise they are dealing with a foreign word. Interestingly enough, even though they realize the word is foreign they often continue to apply the orthographic constraints of English.

I.R.: (Reads the sentence up to the last word.)  
Ocean. O. Makes as much sense as Ijssel.

O.: Does it?

I.R.: Not really. But it probably is a body of water unless you have another trick up your sleeve, or computer. R for river. (The I.R. types in the rest of the word.)

Comment: Students want to use their English linguistic knowledge once again although they remain skeptical. However, most focus on 'River' before the allowed seven guesses are up.

Real Readers -- Low Grade Three

The descriptions of real readers will follow a different format from that selected for the composite of the ideal reader. Rather than describing the responses of the real low grade three readers in detail, describing responses for all of the letters in the mystery sentence, selected aspects of the protocols have been selected to illustrate differences and similarities between ideal and real readers.

Jackie. Jackie, a grade three low reader, entered the room and sat down at the computer. The experimenter tried to put her at ease so she engaged Jackie in conversation for a few minutes. After chatting about some of the school activities the experimenter described the task. Jackie said she understood and proceeded to guess the first word. By the time she guessed it her response pattern appeared as follows:

The  
gu  
ev  
ap  
wb  
bd  
ct  
c

When queried about her answers Jackie said she was thinking of the word 'air' for A, 'wind' for W, and 'cold' for C. Notice both the disregard for word length and pragmatics. Although the experimenter was becoming suspicious about Jackie's answers she continued with the second letter. Ideal readers tend to guess T in one or two guesses, with the HE being automatic. One of her guesses confirmed the experimenter's hypothesis that Jackie did not understand the task, in spite of her claims to the contrary.

Experimenter: (after the response of V.) Were you thinking of a word there?

Jackie: Yes. TV.

E.: TV? (Puzzled inflection.)

Jackie: Yea, you know, like TV.

The experimenter took time to go over the task again. However, Jackie still appears not to understand the nature of the 'game'. Once H is guessed, the final E is filled in 'the' without a miss.

Protocol analysis of Jackie's first word guesses is revealing in that it shows the raw data for what it is -- worthless for the purpose of evaluating Jackie's performance in this task situation. Jackie doesn't understand the task. This raises the issue of how many times children are asked to perform a task in school when they do not understand what is involved. The tragedy, however, is not in their ignorance of the nature of the task. It lies in the teacher's interpretation of the performance and the decisions made because of it.

Marvin. Analyzing Marvin's protocol on the word 'large' reveals some interesting differences between the performance of ideal and real readers. His guesses are as follows:

large  
h be  
z od  
ei  
dt  
pl  
cp  
mu

Marvin guessed the letter L faster than the ideal reader. However, luck may be an appropriate explanation. Look at his second guess, Z. His guess pattern appears to be random rather

than based on high frequency consonants, about the only useful strategy a reader has in this instance.

His guess of the correct vowel shows knowledge of orthographic constraints in language, a trait we noted in most of the low grade three readers although this knowledge was not applied consistently. Notice some of the guesses once LAR is identified. Some, such as P, either violate the orthographic patterns of English or the pattern is rare. What we noticed in the protocol analyses of this group was a knowledge of the more common orthographic constraints. Less common patterns were not perceived. We speculate such knowledge would not be available to these readers in a true reading situation either.

Leslie. Ideal readers demonstrate a consistent pattern in solving the word 'duck'. A typical ideal reader pattern appears as follows:

duck  
tom  
se  
gi  
pa  
w  
b

High frequency consonants dominate the guesses in the initial position as this is the only useful strategy. Orthographic constraints dictate a vowel or a highly constricted list of consonants to occupy slot two. Ideal readers guess high frequency consonants. The letter U is seldom guessed until these have been exhausted. Once the first two letters are identified the next letter is guessed quickly as orthographic constraints as

well as syntactic and semantic knowledge can be combined with the knowledge of orthographic constraints.

Leslie's pattern of guesses, typical of our grade three low readers, is depicted below:

duck  
bot  
caa  
w b  
k p  
n  
s  
m

Her guesses for the letter in the initial position are good, that is, they tend to be high frequency consonants. Once she gets D the letter U is guessed quickly. It shouldn't be! But Leslie's pattern is typical of grade three low readers. Instead of showing linguistic knowledge by not guessing U immediately they identify the correct letter within two or three guesses. Why? At first, we thought that they may be working backwards from the word 'duck'. Duck is a common word in primary books so such a strategy seemed plausible. If you look at the guess patterns for the third and fourth letters, however, this doesn't seem likely. One student actually used up all of his guesses before the computer gave him the final letter in 'duck', a sign that he did not capture the orthographic constraints ruling the response. We aren't certain what strategies low grade three readers are applying, but they are not productive. Ideal readers apply more strategies as information is revealed. As well, they apply these strategies in ever-increasing sophisticated ways. This doesn't appear to be happening with low grade three readers.

Kent. Solving 'quacked' is a lark for ideal readers. Once Q is identified, which often takes five or more guesses, a chuckle accompanies the typing in of the entire word, including the ED. For at least some low grade three readers the obvious isn't. Consider Kent's attempts on 'quacked'.

```

quacked
e t
t k
u b
c l
n o
h u
d

```

There is nothing wrong with Kent's initial guesses although an ideal reader might include more high frequency letters. Also, when we asked the low grade three readers about their guesses they often indicated a top-down strategy, that is, working backwards from a word. Indeed, one child attempted to solve the entire sentence once she discovered 'The large duck'. She gleefully exclaimed, 'The large duck swam across the ocean'. This response may show little regard for the number of words remaining or their length, but it is a sensible semantic response. Kent's justification for some of his guesses show difficulties in using syntax as a useful cue. For example, when asked if he was thinking of a word when the letter H was guessed, Kent replied, "Heavy.". Other responses ('tried' for I) showed a lack of sensitivity to word length. Once again, it seemed that more than one cue was being overlooked, applied improperly, or not applied at all.

Ideal and real low grade three readers differed distinctly on their guess patterns for the letter A in 'quacked'. Ideal



readers solve the entire word once Q is guessed. But A is not as obvious to the latter group. Kent's second guess was T for 'cute'. Notice the graphophonemic difficulties he is having here. Actually, 'cute' isn't that inappropriate, that is, like many children's invented spellings this makes sense. But it also leads him astray. For some guesses Kent could not offer a word. "Just guessing," Kent would reply when asked if he was thinking of a word. In a genuine reading situation Kent may be using up valuable attention time focussing on linguistic elements that could be processed automatically. Thus, his inefficient strategies may be interfering with comprehension.

#### Other Observations

The four excerpts presented above demonstrate some of the differences between the solving strategies of ideal and real low grade three readers. As the latter group worked through the balance of the sentence we noticed additional differences, as well as some similarities between the two groups.

Like ideal readers, most of the low grade three readers guess the word 'and' with little difficulty. But observe the pattern of one child:

and  
t  
o  
r  
l  
e  
d  
k

This child had little difficulty with 'quacked', getting the word with only one miss. In the case of 'jumped' she identified

the word with a total of only four incorrect guesses. What happened with 'and'? We don't know, but some breakdown in her processing strategies is occurring. For example, when questioned about her T guess she replied the word was 'at', a clear disregard of word length. The guess O stood for 'another', a more blatant disregard of length, not to mention spelling. Low grade three readers showed this type of pattern. When they became confused or applied a strategy incorrectly they did not see the problem or the futility of proceeding in a given direction. Ideal readers not only know when they are on the right track but quickly abandon a useless strategy.

A situation similar to 'and' arose with the word 'jumped' with other children. Three of four readers got the word almost as quickly as ideal readers, but one child's guessing pattern looked like this:

jumped  
 aaken  
 bkr  
 cwe  
 dbd  
 gew  
 tvy  
 lfi

This student had just solved 'and' using the minimum number of incorrect guesses -- zero! Notice his guesses for the second letter. Many break the rules of orthographic constraints. In most cases he was unable to offer any word as a possibility. It seemed he reverted to a bottom-up strategy just when top-down processing became highly feasible. Some of his guesses ignored both orthographic rules and syntax. For example, twice he said 'water' when asked what W stood for. When the letters in 'jump'

were revealed, he said 'pond'.

Again, it is the case of when things start to go wrong, they become a disaster. Linguistic strategies are not monitored to the degree that the child can alter his guess patterns to suit the situation. Contrary to Fillmore's definition of the ideal reader, he does not know everything up to this point and doesn't seem to be able to receive new information. It is the inconsistency of performance that is the most consistent characteristic of the low grade three reader.

The word 'into' demonstrated the inconsistency of performance another time. Two readers' patterns are similar to ideal readers, while the other two readers had difficulty with the word. One pattern of a reader demonstrating difficulty is reproduced below:

into  
ho  
ba  
me  
gr  
pu  
fl  
t

One place ideal and real low grade three readers' performance converges is in solving the word 'Ijssel'. In fact, low readers may do slightly better since they adopt random guess patterns more quickly than ideal readers who cling to English strategies as long as possible.

One of the low grade three readers in our sample attempted the word 'River'. The time allotted for the test sentence often expired on 'Ijssel'. We speculate that slow performance is a characteristic of low grade three readers, and one that inhibits

their ability to apprehend meaning from a text. The inefficient strategies, dead ends, use up valuable processing time. As well, they deter meaning resolution since the reader is pursuing cues inconsistent with the text or the rules of English (e.g., The large duck quacked and jump... - The child says 'pond'.).

### Real Readers -- High Grade Three

There are two normal routes of analysis we could pursue in examining high grade three readers. Their performance may be compared and contrasted with ideal readers or low grade three readers. Typically, investigations focus on one type of analysis only, usually the latter. However, perhaps more can be learned by expanding the analysis to include a three-way comparison, that is, compare low and high readers to each other, but also compare them to ideal readers. In such a three-way analysis the key question is not how do good and poor readers differ but how do members of each group differ from ideal readers. Once this is known, comparisons and contrasts between high and low readers take on a different perspective.

In this section we carry out the second leg of the analysis triad, a comparison of high grade three readers with ideal readers. The comparison of low grade three readers with ideal readers has been reported. A final synthesis will be presented later in the paper.

Bernice. At first glance, Bernice's profile appears similar to the ideal reader's performance. Consider her total record:

|     |       |      |         |     |        |        |     |        |        |
|-----|-------|------|---------|-----|--------|--------|-----|--------|--------|
| The | large | duck | quacked | and | jumped | into   | the | Ijssel | River. |
| w   | bin   | co   | f       | fs  | oa     | wguin  | t   |        |        |
| d   | sud   | ta   | j       | b   | m      | ocaiam |     |        |        |
| c   | t t   | fe   | s       | t   | f      | ptoaop |     |        |        |
| b   | w     | si   | p       | g   | n      | snieur |     |        |        |
| a   | h     |      | m       | n   | h      | rdeynt |     |        |        |
| s   | r     |      | t       | p   | b      | aett s |     |        |        |
| p   | p     |      | c       | j   | s      | bp r b |     |        |        |

It appears initially that Bernice, like Jackie, may not understand the task. She uses up all her guesses to identify the first letter. Her reasons for these guesses indicate differently. When questioned about the guesses Bernice said she was thinking about the word 'Why' or 'Was' for W, 'Did' for D, and 'Can' for C, etc. Bernice understands the task, and her answers indicate a top-down strategy. Moreover, she shows deeper knowledge about sentence structure, as seen in this exchange.

Experimenter: What are you thinking about? (after B was guessed)

Bernice: Well, I though, W for 'Why' or maybe 'Was'... But that's not right. It's not a question. I can't think of any other three letter words that start a question. It must be a sentence.

Bernice understands the task, and her comments indicate a thoughtful approach to solving the first word. She even speculates on sentence type. Bernice's strategy is not the same as an ideal reader though, at least in solving the initial word.

After the first word is identified, Bernice's guess pattern almost mirrors the ideal reader. She even guesses high frequency vowels prior to U in 'duck'. Like ideal readers she laughs when Q is identified in 'quacked'. Her comments reveal congruency with ideal readers in terms of strategies also. For example, when questioned about her strategy in identifying the Q in

'quacked' Bernice replies, "Just guessing letters. Ducks could be doing anything." After guessing most of the high frequency vowels for 'duck' she says, "Well, it could be a consonant blend." This metalinguistic ability seems to be a common trait of both ideal and high grade three readers, it certainly is in Bernice's case.

Hugh. How typical is Bernice's performance of high grade three readers? Our statistical analysis offered some group indications, but consider Hugh's pattern on the first three words.

|      |       |      |
|------|-------|------|
| The  | large | duck |
| sozd | bag   |      |
| w pv | cer   |      |
| h tk | rid   |      |
| g nh | hof   |      |
| d m  | x n   |      |
| d    | y m   |      |
| s    | l     |      |

Hugh used up many guesses in solving the first three words, more than ideal readers. Close examination of his pattern indicates his deviance may not be as great as first imagined. The word 'The' is guessed in the same manner as ideal readers. Likewise, his pattern for the first two letters of 'large' is not different from ideal readers. It is only when he encounters RG that difficulty arises. Protocol analysis indicates a thoughtful top-down strategy at work. When Hugh guessed V after identifying LAR he muttered, "Not larva.". Other guesses were accompanied by similar plausible words. Thus, although Hugh's pattern does not fit over the ideal reader's template his strategies indicate an attempt to apply interactive processes. Once Hugh managed to

identify 'duck' the balance of his pattern fit the ideal model.

Brandy. Brandy's pattern, although different from both Bernice and Hugh, points up the similarities between high grade three and ideal readers. When she was able to use top-down strategies Brandy applies them well. Comments such as "What do ducks do?" and "It has to be quacked." show the application of schema and orthographic constraints. Also, she demonstrates knowledge of syntactic redundancy by not pausing when she encounters ED in 'jumped'. Perhaps the key difference between Brandy and ideal readers is the time allotted to solving the task. Brandy is deliberate, taking time to work through her guesses. Ideal readers appear to instinctively apply their strategies, reflecting on their thought processes after the fact. Brandy tried out different responses, testing them for a goodness of fit prior to typing them.

Robert. In scanning Robert's response pattern there appears to be little difference from the ideal reader. The word 'The' is discovered with a minimum number of guesses; orthographic constraints are used when viable, and he applies strategies interactively. However, as with Brandy, one major difference seems to separate Robert from ideal readers -- speed. Although his pattern is similar to an ideal reader's, Robert only reached the word 'into' in the allotted time for the task (35 minutes).

#### Discussion

The purpose of this study was to explore the usefulness of

applying a model of the reading process to examine the strategies of high and low readers. Two methods of analyses were used since quantitative and qualitative approaches tend to yield different types of information. Our focus was on ways of carrying out research more than looking for definitive explanations of how high and low readers differ. Additionally, while high and low readers' performance on the language task was compared, individual profiles were also matched against the template of an ideal reader.

### Models of Reading

Are models of reading useful in examining the processing strategies of high and low readers? Specifically, what is the value of Rumelhart's model? Based on our interpretation of the literature we believe the evidence supports a model such as Rumelhart's. Although Rumelhart's interactive model is useful it is not clear yet whether it should be preferred over similar descriptions of the reading process. Our investigation did not test Rumelhart's model; we assumed it was a useful description of how the reading process worked.

One observation about the model did emerge when we constructed the ideal reader profile; the data fit the model. At first glance such a statement would appear to endorse the model. And we continue to believe it is useful. However, Rumelhart has produced a powerful model, one that may account for too much. To put it another way, it is easy to find ways of explaining different performances on our language task. We might argue that one reader was using the syntax of the sentence, or we



could speculate orthographic constraints were guiding a response. It's disturbing when so many plausible possibilities fit the model. Based on the performance of over 200 university students we constructed an ideal reader profile, one who appears to be processing in a manner congruent with Rumelhart's model. But rival hypotheses about how the ideal reader is functioning are possible.

Models of reading, as Chapanis (1963) pointed out, provide a framework for carrying out research. Research of this nature seems more productive than simply examining how good and poor readers perform on a large number of reading or reading related tasks. A model offers some indication of the relative importance of a strategy or skill prior to investigation.

#### Methodology--Quantatative and Qualitative

Kleiman's (1982) warning about comparing only groups in research into good and poor readers is supported by our findings. To pursue a straightforward 2X3 fixed effects design would have offered little insight into the question of how high and low readers in the study differed. The Rumelhartian model might predict a fewer number of overall guesses for high rather than low readers but each word offered a unique "best solution" pattern. Only when the data was presented as a series of box and whisker plots did interesting information emerge. The variability in the low readers' performance proved to be an important feature, a pattern different from high readers. It seems as though there may be many more reasons for poor performance than good performance.

The quantitative analyses offered insights into the relative performances of high and low readers. They also guided us in examining individual profiles. For example, we noted the large variability in low readers' performance through quantitative analysis. Protocol analysis then helped us gain insights into the nature of this variability. The interviews aided in understanding why the performance of low readers was more variable than good readers. Therefore, we believe the two forms of analysis do complement each other, at least in this study.

Protocol analysis complemented the quantitative analysis, thus extending our understanding of the data. However, the qualitative analysis struck out in new directions also. The comparison of the ideal reader's solving pattern and strategies with high and low reader; was not a part of the quantitative analysis. We could have carried out an ANOVA, comparing the performance of the high and low readers with the ideal readers. The data would be somewhat cooked however as one surmises the ideal reader solves the sentence the same way (perfectly, in light of the available cues) each time. Thus, certainly the low reader group's performance would differ significantly. In retrospect though, it would be interesting to see if the high readers, especially the grade six group, differed significantly.

Fillmore's (1981) idea of comparing ideal and real readers intrigued us. We used his general notion in a way different from Fillmore's original proposal which looked at how school children interact with reading comprehension tests. Whether or not our particular task was well suited for this type of analysis is not

as crucial as the nature of the analysis itself. But breaking away from comparing so-called good readers with so-called poor readers is necessary. Many critics of this type of research point out good and poor reader groups are described in a manner so incomplete synthesis studies of the literature are impossible. One study's good group may be the poor group in another study. Having a model of reading, and building a portrait of an ideal reader given that model, seems to make sense. We believe more use of this technique will emerge as its value is seen.

The protocol analysis was effective in examining the strategies used by students as well as their metalinguistic knowledge. The words a student uses to describe a task or strategy do not always lend themselves to a quantified form, but protocol analysis may capture this information. Special values of the interviews were clearly demonstrated when we discovered a child who did not understand the directions. As well, students often pronounced the word they thought fit into a slot, thus showing a top-down strategy. Simply counting their responses does not reveal the type of strategy used. Of course, at other times our suspicion of a top-down strategy was not confirmed as when a child would say, "Just guessing."

#### The Task

How useful is the language task we devised in examining the reading strategies of the children involved in this study? It has advantages, as outlined earlier. It did allow us to slow down the problem solving process. As well, it permitted us to gain insights into how these children manipulated various aspects of

reading, some within the reader and some within the text. Top-down and bottom-up strategies could be seen in guessing the letters, sometimes both simultaneously. Therefore the task seemed suited for looking at strategies in the context of Rumelhart's model. These are positive features of the task, but some changes should be made if further research makes use of our procedures.

Changing the task, as we propose here, is tied to computer speed. Our computer took too long in recording the children's answers, whether correct or incorrect. Although discussion is desired, some children became bored with parts of the task. A good example of this situation is with the word "quacked" where they want it to appear quickly since they know it. Another illustrative case is when they have three or four "good" guesses in mind. If one doesn't work, children want to get on to the next. Part of the problem can be handled in two ways, better programming and/or a more powerful machine. Speeding up machine response time leads to the possibility of changing the task in various ways.

Fast response time allows experimenters to increase the length of the text read by the subjects. Our sentence does not require understanding of intersentential constraints and relationships. More text would permit an examination of these language aspects. Another alteration would have the computer supply the word within a shorter guess period, that is, the subject would be given the letter after four or five guesses, not seven. This permits the reader to process more text although

valuable insights into processing strategies may be diminished by this format. The progressive cloze procedure could be modified to include words. Here the subject would guess whole words not letters. After so many incorrect guesses the computer supplies the word. This may be useful for looking at schema application, something not captured by our sentence as all groups had adequate schemata to apply to the task. After all, the duck only quacked and jumped. Kids knew they could do these things. As well, they knew the types of things ducks could jump into.

The modifications described leave at least one problem unresolved. The task, as described, still requires encoding. Spelling ability contamination can be removed by using a word level progressive cloze technique, but this restricts the researcher's forum for studying subjects' knowledge of orthographic constraints. This problem must be acknowledged if some form of the progressive cloze procedure is used.

#### Classroom Application

Direct classroom application of this research is not warranted, nor was it the goal of the work. Nevertheless, there are some insights into both children's behaviour in general, and language tasks in particular, that appear useful. Protocol analysis showed the logic behind children's choices. Armed with this type of knowledge a teacher is in a better situation to help the child. As pointed out previously, simply looking at responses can be misleading. This lesson is valid in both the laboratory and the classroom.

Protocol analysis revealed at least two children who did not

understand the task given the standard explanation and directions. Listening to one of these children, questioning her about responses, led to a clarification of the task. If this lack of understanding occurs in a one-to-one laboratory situation with a trained experimenter, how often does it occur in a classroom with thirty children? Perhaps a great deal, but perceptive teachers can lessen the impact of misunderstood directions by circulating after a task is assigned, ascertaining understanding. In the second case, we suspected a lack of understanding. Here, conversation with the child indicated otherwise. Indeed, rather than discovering misunderstood directions we were treated to a discourse showing sound logic and processing strategies. The key point is talking with children, looking beyond the obvious.

This key element - talk - can be applied in many other learning situations. What is behind the child's inability to solve a math problem? A conference may aid both the teacher and child. In composition instruction, the conference is gaining, or perhaps regaining, credibility as a valuable tool in developing the craft of writing. Teachers help children find topics, revise, and learn skills during these focussed conversations. In reading, strategies may be examined by listening to a child read aloud (miscue analysis). In all these situations, as with our study, talking to children adds meaning to numbers.

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