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Effects of Familiarity on Inferential Comprehension:
Evidence for Strategy Differences Between
Good and Poor Inferencers

by

Stephanie A. Fortin, B.A.

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of

Master of Arts

Department of Psychology

Carleton University

Ottawa, Ontario

1992 May 11

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**"EFFECTS OF FAMILIARITY ON INFERENTIAL COMPREHENSION:
EVIDENCE FOR STRATEGY DIFFERENCES BETWEEN
GOOD AND POOR INFERENCERS"**

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MAY 19, 1992

Abstract

The purpose of the present study was to investigate strategy differences in fast and slow readers who were either good or poor inferencers. A moving-window method was used to collect word reading times for familiar and unfamiliar expository texts. Multiple regression method of data analysis was used in order to examine the contribution of reading time of words in specific locations in the sentence to overall reading time. It was predicted that readers 1) would spend less time at the end of the sentence for familiar vs. unfamiliar texts, 2) there would be an interaction between familiarity and inferencing ability; good inferencers would spend more time at the end-of-sentence for unfamiliar text than poor inferencers and 3) fast readers would be faster at elementary visual processing than slow readers. All predictions were supported. Subject profiles of fast and slow readers who are either good or poor inferencers are postulated. Directions for future research are discussed.

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Effects of Familiarity on Inferential Comprehension:
Evidence For Strategy Differences Between
Good and Poor Inferencers

Reading is a complex mental activity that involves a variety of cognitive skills and abilities. Because it is such a complex mental activity, reading performance may vary along many dimensions and each of these dimensions may show a large amount of variability across individuals. Further, reading performance may vary with the material being read, assessment procedures (i.e., online processing vs. recall or comprehension tests) or the reading process under investigation (i.e., word recognition vs. reading for meaning). Although the various components of "reading skill" have been researched extensively, very little attention has been focussed on how readers of varying skill levels process different types of texts. The purpose of the present study then, was to measure on line reading processes using readers of differing skill levels in order to assess 1) whether topic familiarity will impact on readers processing strategies, and 2) whether readers of various skills will employ differing strategies.

Examination of the cognitive operations involved in reading performance is problematic because of large individual differences among skilled adult readers. There are many possible sources of individual differences in reading skill, from feature recognition of letters to working memory capacity. Furthermore, any definition of "reading skill" can be questioned because the

definition depends upon the particular aspect of reading that is being studied. For example, readers are often classified as "more skilled" or "less skilled" based on either reading rates or some measure of comprehension ability. Previous research (Jackson & McClelland, 1975, 1979; Palmer, MacLeod, Hunt, & Davidson, 1985; Dixon, LeFevre, & Twilley, 1988; LeFevre & Dixon, 1988) has indicated that reading rate and comprehension ability represent two distinct skills that are subserved by quite different cognitive operations. Reading rate seems to be affected by more elementary (letter and word recognition) processes, whereas comprehension seems to be affected by processes which require the manipulation of meaning (Palmer et al., 1985). Skill on either of these dimensions may result in different patterns of performance across different texts. If readers differ in their capacity to perform the cognitive operations necessary to read quickly or to comprehend successfully, then it is possible that any observed differences are a result of divergent reading strategies.

One strategy that was of interest in the context of the present study involved readers actively using their prior world knowledge combined with text information to assemble a mental representation of the text (i.e., a schema) (Rumelhart, 1975, Whitney, 1987). Schema development is an active process where readers use their prior knowledge combined with new text

information to make plausible inferences about the subject matter at hand. Further, because schemas originate from readers' previous knowledge store, familiarity affects schema assembly in that the more previous knowledge a reader has about a text (or the information in that text), the easier it is to make text-based inferences, and assemble a coherent schema. And finally, based on previous research (Aaronson & Scarborough, 1976; Just & Carpenter, 1980; Just & Carpenter & Wooley, 1982; Daneman & Carpenter, 1983), I propose that the inferencing process necessary for successful comprehension occurs at the end of the sentence, where text information and prior knowledge are integrated. There are many types of inferences that readers must make throughout the reading of a text, I am proposing that end-of-sentence inferences are specific to the overall concept or theme of a given passage.

To assess these hypothesis about schema-assembly, readers in the present study read familiar and unfamiliar text. Reading times of individual word were measured and end-of-sentence processing was examined. The subject pool was composed of fast and slow readers who were either good or poor inferencers. This population was of interest because I wanted to examine individual differences in inferencing ability and schema assembly in order to propose profiles of readers who varied on the reading rate and inferencing dimensions.

In the next sections, I will present an overview of the Schema-Assembly Model, including reading as an active process and the role of working and semantic memory in schema-assembly, in order to delineate the theoretical standpoint that is being adopted for the present research. The role of end-of-sentence processing will then be discussed. Finally, I will outline the details of how individual differences in reading rate and comprehension have been found to affect reading performance.

Background

Reading as an Active Process. Reading can be viewed as an active process in which the reader interacts with the text (Corbett & Doshier, 1976). Langer (1985) describes the interactive reading process as an envisionment, which is the total understanding that has been reached at any point in time during the reading of a particular text. The envisionment (a) is established after reading any portion of the text, (b) is affected by the interpretation of previous events in the text, and (c) continues to change and develop as the text unfolds. One implication of this perspective is that the reader is an active participant in comprehension, using his or her experience and world knowledge to interpret the text. Furthermore, because no text can ever be fully explicit, readers must make plausible inferences as they integrate their own knowledge with cues from the text. Thus, this active comprehension process, which

combines world knowledge with text information, may result in inferential comprehension in that the reader's constructed representation of the text goes beyond the actual content of the text.

The Schema-Assembly View. According to Whitney (1987), comprehension is always a dynamic schema-assembly process in which schemas are constructed to fit current demands. In this view, new information is integrated into the knowledge base of the reader as part of the schema construction process. The knowledge base can be viewed as a network of concepts in semantic memory. Schemas are groups of associated nodes in the network. Inferential comprehension is driven by spreading activation from these nodes that are primed via information that is encoded from another node. Activation of a node or a set of nodes occurs when a baseline threshold is reached. The baseline strength for any node is determined by how often that node is activated. The definition of familiarity in this model therefore, is that the more often a node or set of nodes is activated, the faster and more efficient the assembly of that schema becomes. Thus, according to the schema-assembly model, reading speed and comprehension would be affected by the familiarity of a text; a difficult, unfamiliar text would be read at a rate much slower than an easy, familiar text, and readers would recall less of an unfamiliar text than a familiar

text.

Research supports the notion that unfamiliar texts are processed more slowly than familiar texts, and that recall is more difficult for unfamiliar than familiar texts. Bransford and Johnson (1973) found that subjects had much better recall of a text when they were familiar with the material in the text than when it was unfamiliar. Similarly, Graesser, Hoffman, and Clark (1980) found that subjects read familiar texts faster than unfamiliar texts. Therefore, congruent with this research, familiarity results in fast and efficient processing of reading material. According to the schema-assembly model, the familiarity effect occurs because the pre-existing related concepts that are made available through node activation can be quickly assembled, and used as a guide for comprehension. Although processing of unfamiliar text requires the same type of assembly operation, fewer concepts would be activated, and consequently, processing would be slower and less efficient. Because the schema-assembly process utilizes both semantic and working memory, it is important to now briefly delineate their roles in this model.

The Structure of Semantic Memory. Semantic memory is the part of memory that contains a reader's set of understood or defined concepts, and as such, forms the semantic representation of that reader's knowledge base. It is structured as a network

of connected nodes that are activated in particular combinations that are relevant to the text being processed (Abbott, Black, & Smith, 1985; Sharkey & Mitchell, 1985). Nodes in semantic memory are concepts that can be inter-connected. According to van Dijk (1977), concepts are imaginable properties and they derive their meanings from each individual's realm of experience. The organization of semantic memory constitutes an entire network of these related concepts. When a node is accessed, related concepts are immediately activated, and the assembly process begins.

The Role of Working Memory. After the nodes are activated in semantic memory they must be brought into working memory and assembled into a loose framework (Just & Carpenter, 1980; Kintsch & van Dijk, 1978). Working memory can be described as a general workspace where external information is integrated with activated nodes from semantic memory (Just & Carpenter, 1980). Activated nodes are brought into working memory in order to construct a text representation. This is accomplished by integrating knowledge from semantic memory with new information from the text. Thus, the schema-assembly model allows for adaptation and flexibility in the assembly process.

Summary of Schema-Assembly Model. In the schema-assembly view, reading is an active process in which comprehension develops as readers use their world knowledge to construct a

framework of what is written. The building blocks of the framework originate from the readers' previously stored knowledge, and the comprehension process combines elements of this knowledge with new information from the text. More familiar topics would activate more concepts and therefore, comprehension should be a fairly simple process of bringing those concepts into working memory and building the framework by filling in a few ambiguous or unknown "spaces". Unfamiliar texts, on the other hand, should be much more difficult to process because the framework has many more unknowns. Readers, therefore, should process familiar texts faster and more efficiently than unfamiliar texts (Adams & Perfetti, 1989; Graesser & Riha, 1984; LeFevre, 1988).

Where Inferences Occur: End of Sentence Processing

The next question that arises is how missing nodes or concepts are instantiated in order to assemble a coherent schema. Because schema-assembly results from a consideration of both previous knowledge and text information, and because no text is fully explicit, readers presumably make inferences to fill in the missing concepts (Kintsch & van Dijk, 1978; Johnston, 1983). The question of when the instantiations occur during reading is somewhat more complicated. Previous research has indicated that readers require extra time to process words at the end of sentences as compared to other parts of the sentence suggesting that the

inferencing and integration process occurs at those locations.

Research supports the view that sentence boundaries mark the processing units in working memory. Jarvella (1979) used interrupted discourse to show that word recall was as efficient for seven words back as for four words back, providing it was in the same sentence. In contrast, words from previous sentences were much more poorly recalled, regardless of how far they were from the interruptor. Similarly, Perfetti and Goldman (1976) found that target words were recalled 50% of the time within the same sentence, but only 30% of the time from a previous sentence. These studies support the assumption that readers integrate at the end of the sentence. In accord with this assumption, Haberlandt and Graesser (1985), and Haberlandt, Graesser and Schnieder (1989), found that number of new concepts in a sentence had a positive linear relationship with end-of-sentence reading times, suggesting that the more concepts that have to be integrated at the end of a sentence, the longer the end-of-sentence reading times.

In summary, according to the schema-assembly view, assembly takes place in working memory, where world knowledge and text information are integrated. This integration process involves inferential comprehension. Sentences compose the units of ongoing analysis, and fuel the schema development process. Because integrative processing occurs at the end of the

sentence, and because integrative processing results in inferential comprehension, it seems plausible that inferential comprehension occurs at the end of the sentence.

In the Schema-Assembly model, the building blocks of the assembly process are derived from the readers' previous knowledge store. The reader starts to activate the relevant previous knowledge, and using text information, assembles the schema. As Langer (1985) suggests, the schema develops and changes throughout the processing of the text. The development of the schema is highly dependent upon the readers' ability to make the necessary inferences. In the present study, ease of schema development was varied by using texts on familiar versus unfamiliar topics. The texts were constructed to be very similar in all respects (e.g., number of words) other than familiarity (i.e., the amount of previous knowledge required to understand them). Because inferential comprehension is assumed to occur at the end of the sentence, where the integration process takes place, subjects should have faster end-of-sentence processing times for familiar versus unfamiliar texts.

It is important to understand that in the schema-assembly model of reading, although unfamiliar text will be read more slowly than familiar text, the extra time should be specific to the ends of sentences. Because fewer concepts are activated for unfamiliar versus familiar texts, the assembly of the schema and

the resulting integration and inferencing process should be more difficult.

Individual Differences

The Schema-Assembly model of reading can also be used to predict differences between good and poor comprehenders. If readers have a more elaborate previous knowledge store, then they should have more concepts to activate, and they would be better comprehenders than readers who have an impoverished schema. The larger the reader's information base, the better chance he or she has of making the necessary inferences and successfully understanding the material. Of course, readers must have the basic tools of text processing (i.e., letter recognition, word decoding and so on) before they can access their knowledge base through the written word, but assuming text decoding ability, successful comprehension should be highly related to reader knowledge (Golinkoff, 1975-76).

In previous research, connections have been found between readers' domain-specific knowledge, and their comprehension of material in that domain. Adams and Perfetti (1989) used high-skill readers (as identified by their score on the California Achievement test) to examine comprehension differences in a domain-specific (football) text. Half of the subjects were football "experts" and the other half were football "novices". It was found that good readers who were unfamiliar with the

topic made fewer text-based inferences than good readers who were familiar with the topic. Therefore, in domain-specific texts, making inferences may be more related to domain-specific knowledge than to global aspects of reading skill. Adams and Perfetti, however, interpreted their findings in a different way; they suggested that lack of knowledge of a topic disrupts the comprehension processes of good readers. Regardless of the interpretation, the evidence from this study indicates that a good comprehender must be defined to some extent by how well they comprehend a specific texts. By this argument, the more world knowledge that readers have, the better chance they have of being good comprehenders.

Another aspect of reading skill that is important in the context of the present study is reading speed. Reading ability is often defined by how fast a person reads, as evidenced by speeded tests such as the Nelson-Denny Reading Test (Brown, Bennett, & Hanna, 1981) that purport to measure overall "reading skill". Previous research (e.g., Palmer, MacLeod, Hunt, & Davidson 1985; Graesser, Hoffman, & Clark, 1980) has shown that reading speed was related more to elementary reading processes (processes which require identification of visual symbols) than to higher level processes (processes which require manipulation of meaning). Therefore, the higher level constructs under investigation in the present study should not have been

influenced by reading speed. However, the reading speed component was included in the selection of subject groups because it was important to examine the impact of overall reading speed on end-of-sentence processing.

In the present study, individual differences in inferential comprehension ability were examined by dividing the subjects into four discrete skill groups. The use of inferential comprehension score in choosing skill groups is directly relevant to the constructs under investigation. Because I was interested in how previous knowledge is organized and utilized in order to make the inferences necessary to understand text material, it was important to examine how individual differences in inferencing ability impacted on end-of-sentence processing and overall reading performance.

The subject groups for the present investigation were determined by a "components of reading" pretest battery with which inferential comprehension ability and reading speed were assessed. Results found by Dixon, LeFevre, and Twilley (1988), LeFevre (1988), and correlations performed on the "components of reading" pretest used for subject selection in the present study (Thibodeau, Varymowich, Chernecki, & Fortin, 1990) indicated that inferential comprehension ability and reading speed were two distinct abilities. However, Fortin (1990) found that reading speed and inferential comprehension scores were

significantly correlated. These conflicting findings could be indicative of more diverse skill groups than a simple division into "fast or slow readers" and "good or poor comprehenders". Fast readers who are good comprehenders may be using a different strategy than fast readers who are poor comprehenders. Alternatively, slow readers who are good comprehenders and slow readers who are poor comprehenders are probably not using the same strategies. The assumption that good and poor comprehenders differ on their ability to use strategies has been supported by previous research.

Kletzien (1991) examined strategy use by good and poor comprehenders on texts of varying difficulty. The subjects used in her study were high school students who were classified as "good" or "poor" based on their performance on the California Test of Basic Skills. Subjects read three expository passages of increasing difficulty levels; independent level (easy), instructional level (mid-difficulty) and frustration level (difficult), and were asked to fill blanks left by deleted content words (cloze task). They were also asked to describe their reasoning processes for the cloze responses and the responses were recorded and analyzed.

Results showed that good and poor comprehenders used the same type of strategies in completing the cloze task, and that the groups did not differ in strategy usage for easy texts.

However, the differences between good and poor comprehenders became apparent in their ability and persistence in trying a variety of strategies on more difficult texts. Good comprehenders continued to try various strategies on more difficult texts, whereas poor comprehenders had a severe decline in both the variety of strategies and in number of times strategies were used on more difficult texts.

Consistent with Kletzien (1991), Zabrocky and Ratner (1989) examined good and poor readers' processing of inconsistent stories, and found that although poor readers detected inconsistencies, they were less likely than good readers to reread. Zabrocky and Ratner concluded that poor readers simply ignore problematic text information, and maintain or accelerate their reading speed, whereas good readers decrease their reading speed on more difficult material.

The evidence from these studies suggests that good comprehenders are more flexible in their strategy usage; they slow down or reread more difficult or unfamiliar material. Conversely, poor comprehenders stop trying any strategies when faced with difficult or unfamiliar material and start skimming the text. The various strategies that these skill groups are using may be related to their schema assembly abilities. For example, a fast reader with poor comprehension abilities may stop trying to assemble a schema, and just skim the words,

whereas a slow reader with a good comprehension abilities may assemble an elaborate schema even though their elementary processing may be slower and more methodical (Palmer et al., 1985).

Based on the cited previous research, I predicted an interaction between comprehension level and the familiarity manipulation; good comprehenders should spend more time on an unfamiliar text at the end of the sentence than they do on a familiar text, whereas poor comprehenders should spend less or the same amount of time on an unfamiliar text as they do on a familiar text. Poor comprehenders presumably spend less time on end-of-sentence processing in unfamiliar texts because they abandon their reading strategies and skim the texts. Therefore their ability to make the inferences necessary to answer inferential comprehension questions is compromised. Conversely, good comprehenders spend more time at the end of the sentence to ensure their understanding of the material and to make the necessary inferences.

Further, as was previously mentioned, because reading speed is assumed to be related more to elementary processing than to higher level processing, it was predicted that there should be little or no effect of overall reading speed on inferential comprehension.

In order to examine whether reading speed is more closely

connected to elementary processing than the higher level process of inferential comprehension, the elementary process of length of word (number of letters) was analyzed. Although this issue is not of central importance to the model under investigation (except for comparative purposes), I was interested in looking at how reading speed affects elementary processing in the four skill groups included in this study. Based on previous research (e.g., Palmer et al. 1985), I predicted that there would be an effect of reading speed, but not of comprehension level, on length of word.

Another aspect of physical text variables that reading speed may influence in the present study involves fast and slow readers differentially integrating text information at either the end-of-lines or the end-of-sentences. Haberlandt et al., (1989) studied reading patterns at the word, line and sentence level for fast and slow readers. They used a moving-window method of text presentation to collect word reading times, and they found that fast readers integrate new-arguments at the end-of-lines, while slow readers integrate new arguments at the end-of-sentences. Based on Haberlandt et al. (1989) research, differences may be found between fast and slow readers on their treatment of lines and sentences in the present study.

In order to examine the end-of-sentence effect, a method of measuring individual word reading times was used. In the

present study, the Moving Window paradigm was chosen as a economical and practical alternative to eye-fixation methods.

Moving Window Paradigm

Reading times of individual words can be used to assess on-line reading processes. It is important to assess on-line reading processing during reading because of the assumption that the amount of time spent reading a word reflects the amount of time it takes to process that word, from elementary to higher level processing (Just & Carpenter, 1980; Haberlandt & Graesser, 1985, Graesser, Haberlandt, & Koizumi, 1987; Haberlandt et al., 1989). Just and Carpenter have termed this assumption the immediacy hypothesis. The moving window paradigm is a method of computer text presentation that allows the researcher to record the amount of time it takes the subject to read each word (Just, Carpenter & Wooley, 1982). In this method, the entire video screen is filled with dashes and spaces corresponding to the actual layout of the text. When the subject presses a key, one word of the text is presented and the previous word is replaced with dashes (see Figure 1). The computer records the reading time of each word.

Insert Figure 1 about here

There are a number of advantages and disadvantages to this

method of text presentation. First and foremost, it provides a simple and economical alternative to eye tracking techniques, with fairly comparable results (Daneman & Carpenter, 1983; Just et al., 1982). Further, unlike eye tracking equipment, the moving window methodology allows free movement of the head during reading, which more closely resembles a natural reading situation. Reading time is slower overall with word-by-word presentation than eye tracking because of button pressing latencies, however the reading time of the word still reflects the amount of time it takes to process and comprehend it (Daneman & Carpenter, 1983; Dixon, 1984). Dixon (1984) has pointed out that one disadvantage of the Moving Window method is that it may force subjects to "read at a more uniform rate, or they may fixate words that they would otherwise skip" (p. 113). Nevertheless, the word-by-word moving window methodology being used in this study does not substantially alter the reading process (Daneman & Carpenter, 1983; Just et al., 1982).

Summary

The Schema-Assembly model is based on the assumption that readers' semantic representations of their previous world knowledge are organized in semantic memory as connected or related concepts. When a reader begins a new piece of text, concepts are activated and brought into working memory. The schema assembly process occurs in working memory, as readers

constructs a representation of the text using their world knowledge and textual information. The successful integration of textual information and world knowledge involves inferential comprehension. Familiar texts are easier to process because the building blocks of the schema come from stored knowledge, and the more familiar a reader is with a text, the more concepts are available to be activated. Unfamiliar texts, on the other hand, are more difficult to process because fewer activated concepts are available to construct the schema. Sentences compose the units of processing for the schema, and previous research has indicated that the integration of previous knowledge and text information occurs at the end of sentences (as evidenced by slower reading times). Because inferential comprehension is a result of the integration process, inferences are presumably made at the end of sentences throughout the text.

Present Research

The purpose of the present study was to examine the hypothesis that reading time at the end of sentences would be faster for familiar texts than unfamiliar texts, because a more elaborate schema would facilitate the integration and inferencing process. Four groups of subjects were used, based on their performance on a reading skill pre-test, in order to examine how topic familiarity affects individuals with varying levels of reading skill. The four groups were divided based on

their inferential comprehension scores (good/poor) and reading rate (fast, slow). The subjects were required to read four expository passages (two familiar, and two unfamiliar), rate their familiarity with each passage, and answer corresponding multiple choice questions. Individual word reading times were collected for each passage, in order to examine how long subjects spend on each word in a sentence. It was predicted that end-of-sentence reading times would vary as a function of familiarity: unfamiliar texts would produce slower end-of-sentence processing for good comprehenders. It was also predicted that reading time per letter (word length) would vary as a function of reading speed; fast readers would spend less time per letter than slow readers.

Method

Pretest

Materials. The pretests consisted of a working memory task (Daneman & Carpenter, 1980; 1983), an inferential comprehension test (Dixon, LeFevre & Twilley, 1988; Fortin, 1990), a lexical decision task (Dixon et al., 1988), and the Nelson-Denny Reading Comprehension test (Brown et al., 1981). The first minute of Nelson-Denny was used to obtain a reading rate score, but the subjects were not required to complete the comprehension questions. Subjects were chosen based on reading rate and inferential comprehension score (from the Inference Test). Scores from the lexical decision and working memory tests were not used. The Inference Test is a fairly new instrument for assessing inferential comprehension, but preliminary validity analyses have indicated that its internal validity is high ($\alpha = .76$). It consists of one practice story and two experimental stories. After each story, the subjects answered inferential comprehension questions that required them to combine text information with their own previous knowledge. The Inference Test is presented in Appendix 1. There was no time limit on the test.

Subjects. Two hundred and forty-seven introductory psychology students participated in the pretest battery for course credit. Fifty subjects were disqualified from the selection pool because either they did not finish the reading battery or English was not their first language. Consequently,

there were 197 subjects to select from in the final pool. The descriptive statistics for the subject selection pool are presented in Table 1. The correlation between reading rate and inferential comprehension score was not significant ($r = .04$), which indicates that these two variables are orthogonal.

Insert Table 1 about here

Experimental Task

Subjects. The selection criteria and descriptive statistics for the four groups of subjects that were selected from this pool are presented in Table 2. I chose 18 prospective subjects from the extremes of each quadrant of the inferential/reading rate plot, which resulted in four groups: high inference score, low reading rate, high inference score, high reading rate, low inference score, high reading rate, and low inference score, low reading rate.

Insert Table 2 about here

The division of subjects into these skill groups allowed examination of individual differences in processing of familiar versus unfamiliar texts, as well as a comparison between groups on inferential comprehension scores. There were 12 subjects in each skill group; with an approximately equal split of male and

female subjects. Subjects were either paid for their participation or received course credit.

Apparatus. The reading texts and questions were presented on a monochrome monitor controlled by an IBM-type computer. A moving window method was used to present the passages one word at a time. A three-button response panel connected to the computer was used by subjects to control presentation of the texts.

Reading materials. The reading materials that were used in this study are multi-paragraph expository texts, constructed by LeFevre (1988). The Carleton University text was constructed by the author, using the same text criteria as LeFevre (1988). The passages were set up in pairs, varying in familiarity, but of comparable difficulty, length, and complexity. The goal of writing these passages was that the unfamiliar passages would differ from the familiar passages only in the amount of prior knowledge available to the subject (e.g., The Canadian Constitution versus the Indian Constitution). There were four pairs of passages; each passage in a pair had the same number of sentences, and a similar number of words. For each passage, five multiple choice, pencil-and-paper, questions were constructed and used to ensure that the subjects were actually reading and processing the texts. The texts and the multiple choice questions are presented in Appendix 2.

Design. A 2 (text type: familiar, unfamiliar) X 2 (reading

rate: fast, slow) X 2 (inferential comprehension level: good, poor) design was used with repeated measures on the first factor. The texts were partially counterbalanced with presentation order (complete counterbalancing was not possible because it entitled using too many subjects), so that four combinations of the familiar and unfamiliar texts were used (the last two counterbalances were repeats of the first two in each set of six). This method of counterbalancing resulted in 12 sets of reading materials (see Appendix 2). The orders that were chosen involved alternating the familiarity (either familiar, unfamiliar, familiar, unfamiliar or unfamiliar, familiar, unfamiliar, familiar) because presenting two unfamiliar or two familiar texts first may have resulted in a practice effect.

Procedure. Subjects were tested individually in one hour sessions. They read the texts one word at a time on the computer screen. Subjects initiated the text presentation by pressing a "new paragraph" button on the response panel. The texts were presented one paragraph at a time, as a series of dots and dashes corresponding to the actual layout of the text. The subjects then pressed the "forward" button on the response panel, which presented the text, one word at a time, while the previous word was replaced by dashes. There were two practice texts, followed by two familiar and two unfamiliar texts.

After subjects finished reading each text, the experimenter gave them the paper-and-pencil multiple choice comprehension

questions. Subjects rated their familiarity with the text that they had just read and then answered 5 multiple choice questions. These questions assessed their literal (text information) comprehension. No time limits were imposed. After reading all texts, the subjects completed Form F of the Nelson-Denny Reading Test (Brown et al., 1981) for the prescribed time of 20 minutes. All subjects were debriefed at the end of the session.

Results

Order Effects

Before discussing the results of the main analyses, it is important to mention the order effects that were found in the present study. Many of the analyses of both the manipulation checks and the coefficients resulted in main effects and interactions with order. Order refers to the order in which the texts were presented to the subjects, and the order effect means the first pair of texts compared to the second pair of texts, collapsed across familiarity. Depending on the counterbalance slot for each subject, they read either a familiar or unfamiliar text first (see Appendix 3). Upon examination of the means for each variable, it was discovered that the significant order effects that were found were attributable to the subjects simply getting better (faster) at using the moving-window. As such, these effects are not of great interest or import to the constructs under investigation, but the significant order effects will be included at the end of each section.

Manipulation Checks

Reading Speed. First, the reading times of each word from the four texts was averaged for each subject, and analyzed in a 2 reading rate (fast, slow) x 2 inferential comprehension level (good, poor) x 2 familiarity (familiar, unfamiliar) ANOVA, with repeated measures on the last factor. This was done in order to ascertain the success of the familiarity manipulation. The means are presented in Table 3.

Insert Table 3 about here

Subjects spent more time reading unfamiliar texts than familiar texts (365 vs. 384 ms), $F(1,44) = 8.19$, $p < .01$; indicating that the familiarity manipulation was successful. Fast readers spent less time on each word than slow readers (344 vs. 406 ms), $F(1,44) = 6.33$, $p < .02$. This result validates the original group division from the pretest; fast readers read the experimental texts faster than slow readers (see Figure 2).

Insert Figure 2 about here

There was also a significant main effect of order, $F(1,44) = 23.35$, $p < .00$, such that subjects read the last passages of each type of text (familiar or unfamiliar) faster than the first passage of each type (391 vs. 364 ms).

Familiarity. The texts used in this study were judged to be familiar or unfamiliar based on independent ratings by volunteers (LeFevre, 1988). However, in order to establish whether the texts were actually familiar or unfamiliar to the subjects in the present study, subjects were asked to rate their familiarity with each text. Means are presented in Table 4.

Insert Table 4 about here

The rating scale ranged from 1 (very unfamiliar) to 7 (very familiar). There was a significant main effect of familiarity (5.0 vs 2.6), $F(1,44) = 87.93$, $p < .00$; subjects judged the familiar texts to be significantly more familiar than the unfamiliar texts. Interestingly, good inferencers tended to rate all texts as more familiar than poor inferencers (3.9 vs 3.6), $F(1,44) = 4.68$, $p < .04$. This result supports the Schema-Assembly Model in that good inferencers may have more prior knowledge of material in these texts.

The familiarity rating analysis was included in order to examine the degree to which the subjects were familiar with the material in the texts. The results indicate that the familiarity manipulation was successful; therefore it can be assumed that the texts used in this study were tapping subjects' prior knowledge store.

There was a significant interaction between speed and order, $F(1,44) = 5.19$, $p < .03$, such that fast readers found the first pair of texts more familiar than the second pair of texts (3.3 vs. 4.0), whereas slow readers rated both pairs as equally familiar (4.0 vs. 3.8).

Comprehension Questions. The subjects were also asked to

answer 5 multiple choice questions about each text that they had read. The questions were literal in content (answers could be found in the text), and as such, they were not intended to measure inferential comprehension or schema-assembly processing, but were included in order to ensure that the subjects were actually reading and attempting to process the texts. Comprehension scores are presented in Table 5.

Insert Table 5 about here

Subjects scored significantly better on comprehension questions from familiar texts than from unfamiliar texts (3.1 vs. 2.9), $F(1,44) = 5.98$, $p = .019$, indicating that text familiarity affects subjects' ability to answer literal comprehension questions. Good inferencers were not better at literal comprehension than poor inferencers (3.0 vs 3.0), whereas fast readers were better at literal comprehension than slow readers (3.4 vs 2.7), $F(1,44) = 8.41$, $p = .006$. If literal and inferential comprehension skills represent two distinct abilities, then the former result is not surprising, since the subjects were grouped according to their inferential (not literal) comprehension scores. More difficult to interpret is the fast/slow reader dichotomy, although the Nelson-Denny Reading Test (Brown et al., 1983) which contains literal and

inferential comprehension questions, is correlated with speed. This finding will be further discussed in the next section, where it is compared with results of the Nelson-Denny correlations.

Nelson-Denny Reading Test. The subjects recorded their reading rate from Form E of the Nelson-Denny Reading Test in the pretest battery. In the experimental session, Form F of the Nelson-Denny Reading Test was administered the prescribed time of 20 minutes. The Nelson-Denny comprehension questions are divided equally into literal and inferential comprehension. They are also ordered so that if a subject only finishes a portion of the test (because of time constraints), they will have had the chance to answer approximately equal numbers of literal and inferential comprehension questions. Literal and inferential comprehension scores from the Nelson-Denny were calculated and correlated with the post-test reading rate, the pretest reading rate, and the pretest inferential comprehension score (from the Inference Test). These correlations are presented in Table 6.

Insert Table 6 about here

The pretest reading rate and the post-test reading rate were highly correlated. Most interesting however, is the

correlation between reading rate and literal comprehension score, reading rate is significantly correlated with literal, but not with inferential comprehension on the Nelson-Denny. This result supports the literal comprehension finding in the present study; literal (but not inferential) comprehension is related to reading speed. Perhaps reading quickly allows readers to map on to certain words in the text, and pick up "surface" literal information to answer literal comprehension questions correctly, but readers must slow down to do the work required (make inferences) to answer inferential comprehension questions correctly. The inferential score from the Nelson-Denny was correlated with the Inference Test score, which is a good indicator of the convergent validity of the Inference Test.

Multiple Regressions

Each subject read 2 familiar and 2 unfamiliar passages. The reading times for each subject and each text were analyzed with a multiple regression analysis in order to separate and examine the contribution of specific components of the sentence to overall reading time.

Multiple regression analysis generates an equation of predicted sentence reading times that optimally match the obtained reading times (Graesser & Riha, 1985, Graesser, Haberlandt, & Koizumi, 1987). Each predictor variable has its own slope coefficient in which the effect of all other variables

in the equation have been partialled out. Lorch and Myers (1990) recommend this method of data analysis because it "... clearly represents the logic of the test of each predictor variable" (p. 153). Multiple regression was used because it allowed the reduction of variance that was due to lower level processing (such as word length) and presentation aspects of the text (such as first word in the paragraph).

There were two possible limitations of the multiple regression methodology. First, because the same subject read each word, the reading times are probably not independent from each other, which violates an assumption of the multiple regression technique. As shown in Appendix 4, however, calculation of the Durbin-Watson statistic for two randomly selected regressions suggests that autocorrelation is not a serious problem for the data collected in this study. Second, multiple regression can be compromised if there are correlations among the predictor variables. The correlations among the predictor variables for one familiar and one unfamiliar text were examined. As shown in Appendix 4, all intercorrelations are small (less than .20). Thus, it seemed reasonable to proceed with the multiple regressions.

A list of the variables that were included in the multiple regression analysis and their codings are presented in Table 7. The paragraph variable was included in the regression in order

to account for variance that was due to the position of the paragraph in each text. The line and sentence variables were included in order to account for extra time spent reading words in various positions in the texts. The "first word" variable was included in order to account for extra time spent reading the first word in each paragraph. "Length of word" variable was included in order to measure word (lower) level processing.

Insert Table 7 about here

By using the slope coefficients instead of raw data in the analyses of variance, we were able to eliminate superfluous variance and find a "purer" measure of individual word reading times.

Analyses of Coefficients

The reading time coefficients from the regression were analyzed in 2 reading rate (fast, slow) x 2 inferential comprehension (good, poor) x 2 familiarity (familiar, unfamiliar) ANOVAS, with repeated measures on the last factor. The results of each ANOVA will be considered separately.

End-of-Sentence Processing. Subjects were expected to have faster end-of-sentence reading times for familiar than for unfamiliar texts. Readers should spend more time at the end-of-sentence on unfamiliar texts because the assembly process for a

familiar text would be easier and faster than the assembly process for an unfamiliar text. On familiar texts, readers have more knowledge with which to provide a schema, which should facilitate processing. Mean end-of-sentence coefficients are presented in Table 8.

Insert Table 8 about here

In the present study, mean end-of-sentence reading times across the four groups did indicate that generally, readers spend more time at the end-of-sentence for unfamiliar than for familiar texts (91 vs. 108 ms), $F(1,44) = 3.17$, $p < .082$. However, this difference held only for good inferencers (83 vs. 109 ms); poor inferencers spent about the same amount of time at the end-of-sentence for unfamiliar texts as they did for familiar texts (100 vs. 106 ms) (see Figure 3).

Insert Figure 3 about here

The comprehension x familiarity interaction approached significance, $F(1,44) = 3.15$, $p < .083$, in support of the view that poor and good inferencers are using different types of strategies on unfamiliar texts. This finding is consistent with Kletzien (1991) and Zabrocky and Ratner (1989) in that poor

inferencers seem to stop using strategies when faced with more difficult or unfamiliar material, whereas good inferencers increase their strategy usage on difficult material. Perhaps the difference between good and poor inferencers is that good inferencers are more flexible in their use of strategies; the more difficult the text, the harder they work at trying to understand it.

Further, this finding has implications for the obtained word reading times previously described (see Table 3). Both good and poor inferencers are spending more time reading unfamiliar texts. For good inferencers part of the extra time that they are spending on unfamiliar texts is allotted to end-of-sentence processing. Poor inferencers, however, spend approximately the same amount of time at the end-of-sentence for both types of texts (see Figure 3). This means that the differences found between good and poor inferencers' processing at the end-of-sentence could be affecting their schema assembly and resulting inferential comprehension. That is, the reason that good inferencers are spending more time at the end-of-sentence in unfamiliar texts is that they are working at assembling a more comprehensive schema than poor inferencers and the result of that extra work is reflected in their inferential comprehension scores.

There was also a significant main effect of order, $F(1,44)$

= 5.41, $p < .025$, subjects spent less time on end-of-sentence processing on the second pair of texts than on the first pair (109 vs. 94 ms).

Beginning-of-Sentence Processing. Beginning-of-sentence reading times were analyzed in order to compare them to end-of-sentence reading times. The mean beginning-of-sentence coefficients are presented in Table 9.

Insert Table 9 about here

Interestingly, whereas end-of-sentence reading times analysis resulted in differences between good and poor inferencers, beginning-of-sentence reading times analysis resulted in differences between fast and slow readers. Again, although the effects were marginal, there was a trend in the data that suggested a speed x familiarity interaction, $F(1,44) = 3.18$, $p < .082$. Fast readers spend approximately an equal amount of time at the beginning-of-sentence for unfamiliar texts as they do for familiar texts (24 vs. 27 ms), while slow readers spend less time at the beginning-of-sentence for unfamiliar texts than familiar texts (59 vs. 37 ms) (see Figure 4).

Insert Figure 4 about here

Although the significance of the interaction is not clear, one possible explanation for this result is that beginning-of-sentence reading times reflect some type of strategy differences between fast and slow readers. Specifically, slow readers may be starting to process new arguments at the beginning of the sentence in familiar texts and that processing is discarded in unfamiliar texts (possibly because it is too difficult). Fast readers, on the other hand, may just skim the beginning-of-sentence in both types of texts, and use another location in the sentence to integrate new ideas or arguments. Haberlandt et al. (1989) did find integration differences between fast and slow readers in their study; fast readers integrated new arguments at line boundaries, whereas slow readers integrated new arguments at sentence boundaries. Whatever the strategy, the results of this analysis indicate that fast and slow readers are differentially processing information at the beginning-of-sentence in familiar and unfamiliar texts.

There was a speed x order interaction, $F(1,44) = 3.77$, $p < .059$, fast readers spent about the same amount of time at the beginning-of-sentence on the first and second pair (23 vs. 29 ms), slow readers had longer beginning-of-sentence reading times on the first than on the second pair of texts (57 vs. 38 ms).

Beginning- and End-of-Line Processing. Beginning-of-line and end-of-line coefficients were analyzed in order

to compare line reading times to sentence reading times. As was mentioned previously, Haberlandt et al. (1989) found that fast readers buffer and integrate new arguments line boundaries, whereas slow readers buffer and integrate new arguments at sentence boundaries. Accordingly, a main effect of speed was expected at the end-of-line in the present study. However, there were no significant main effects or interactions from this analysis (see Table 10), other than a significant order effect (18 vs. 10 ms) $F(1,44) = 5.77, p < .021$.

Insert Table 10 about here

There was a significant beginning-of-line main effect of familiarity, $F(1,44) = 3.76, p < .059$, subjects read the beginning-of-line faster on familiar as compared to unfamiliar texts (see Table 11).

Insert Table 11 about here

The results of the line analyses did not support Haberlandt et al., (1989); subjects in the present study did not seem to be using line-based buffering, especially since the effects of beginning-of-line and end-of-line are much smaller than the

sentence effects, and there do not seem to be individual differences of interest.

There was a significant familiarity $\times$ inference $\times$ order interaction for beginning-of-line, $F(1,44) = 4.73$, $p < .035$.

Length-of-Word. According to Palmer et al. (1985) and Graesser et al. (1980) length-of-word processing should reflect elementary visual activity as opposed to the higher level processing involved in reading for meaning. It was expected that length-of-word would differentiate fast and slow readers, but not good and poor inferencers. The means for length-of-word coefficients are presented in Table 12.

Insert Table 12 about here

There was a marginal main effect of familiarity, $F(1,44) = 3.87$, $p < .055$, such that subjects spent less time per letter on words from familiar passages than they did on words from unfamiliar passages (5.9 vs 6.9 ms). The length-of-word coefficient measures time per letter, and the 1 ms difference between familiar and unfamiliar texts is fairly small. But, words from an unfamiliar text are probably somewhat less familiar to the readers, and therefore they spend more time reading them.

As predicted, there was a significant main effect of speed,

$F(1,44) = 5.45, p < .024$, such that fast readers spent less time per letter on words than slow readers (4.2 vs. 8.9 ms). The inference main effect was not significant. This result supports the notion that reading speed is more related to elementary visual processing than to the higher level processing required for inferential comprehension (see Figure 5).

Insert Figure 5 about here

Summary of Results

The manipulation checks were successful; subjects read familiar texts faster than they read unfamiliar texts, and they were rated as more familiar. Good inferencers rated all texts as more familiar than poor inferencers, suggesting that good inferencers have more prior knowledge of the topics of the texts used in this study. All subjects scored better on literal comprehension questions from the familiar texts, and fast readers scored better than slow readers on these questions. Nelson-Denny Reading Test results indicated that fast readers score better than slow readers on literal comprehension questions, suggesting that literal, but not inferential, comprehension is related to reading speed.

As predicted, good inferencers spent more time at the end-of-sentence for unfamiliar than for familiar texts, whereas poor

inferencers spent about the same amount of time at the end-of-sentence for both types of texts. This result suggests that good and poor inferencers are using different strategies for schema-assembly on more difficult texts; good inferencers slow down or reread more difficult text, whereas poor inferencers spend about the same amount of time on difficult texts as they do on easier texts. Fast and slow readers seem to be using different strategies for line versus sentence boundaries, although the results of these analyses were not quite clear.

As expected, fast readers spent less time per letter in words than slow readers, indicating that reading speed is strongly related to elementary visual processing, but not to higher level constructs like inferential comprehension.

Discussion

The purpose of the present study was to investigate the effects of familiarity on inferential comprehension by using subjects with differing skills and skill levels. I was particularly interested in examining the strategy differences of good and poor inferencers on familiar and unfamiliar texts, in order to propose a model that could account for these differences (the Schema-Assembly Model). A secondary purpose of the present study was to look at the effects of reading speed on higher and lower level processing, in order to discover whether reading speed is more related to word recognition processes than to reading comprehension processes. End-of-sentence reading times were used as a measure of inferential processing and schema-assembly, and reading time spent per letter was used as a measure of elementary word processing. The specific hypotheses tested were that end-of-sentence processing would 1) be faster for familiar versus unfamiliar texts, 2) differentiate good and poor inferencers; good inferencers would increase their strategy usage on unfamiliar over familiar texts, whereas poor inferencers would use equivalent strategies for both types of texts, and that 3) fast readers would be faster at elementary visual processing than slow readers. All three hypotheses were supported, and will be considered in more detail in the following sections.

Individual Differences

Both good and poor inferencers spent more time reading

unfamiliar texts. For good inferencers part of the extra time that they are spending on unfamiliar texts is allotted to the end-of-sentence. One possible explanation for these results is that readers have more prior knowledge of the material in familiar texts, and therefore, they can make the inferences necessary to understand the text faster and more efficiently for familiar topics.

Regardless of reading speed, good inferencers spent less time at the end-of-sentence than poor inferencers for familiar texts, presumably because good inferencers are more skilled in making the inferences necessary for schema-assembly. There are two possible reasons for the observed differences between good and poor inferencers; either (a) they have more prior knowledge or (b) they make better use of their prior knowledge (i.e., use more strategies).

A consideration of the differences between good and poor inferencers in unfamiliar texts point toward the second possibility as the most plausible alternative. End-of-sentence reading times for good inferencers were actually slower than for poor inferencers reading unfamiliar texts. If strategy use reflects an increase in cognitive load (and therefore an increase in reading time), then the reason that good inferencers increase their reading time in unfamiliar texts is that they increase their cognitive load by using more strategies. Conversely, poor inferencers do not increase their use of

strategy in unfamiliar texts and their reading time stays approximately the same for both types of texts. If good inferencers simply had more prior knowledge, then there would be a main effect of inferencing ability. instead of the obtained interaction between text familiarity and inferencing ability.

Previous research has indicated that the difference between good and poor comprehenders is that poor comprehenders focus on different types of information than good comprehenders (Yuill & Jocelyne, 1988). Further, poor comprehenders have no conception of what good reading entails (Garner & Kraus, 1982), they see word decoding as the most important function in reading. Therefore, although poor comprehenders may be able to make inferences, their problem lies in their lack of awareness for the need to make inferences or their inability to use the strategies necessary to make inferences (Oakhill, 1982). Hare and Borchart (1985) found that the poor comprehenders in their study were disrupted most by "hard" vocabulary, rather than overall comprehension difficulties; it seems poor comprehenders concentrate on word by word reading, at the expense of comprehension of larger textual units.

The emerging picture of a poor comprehender then, is a reader who is unable to "grasp the big picture" because they are focusing almost exclusively on decoding and vocabulary difficulties. In the present study, poor comprehenders must have given up on inferencing and schema-assembly in unfamiliar

texts, and simply skimmed over the words. Good comprehenders, in adapting their reading speed and style to the more difficult material, slowed down their reading speed in unfamiliar texts and worked harder at inferencing and schema-assembly.

The predicted relationship between reading speed and familiarity was supported; readers do spend more time per letter in unfamiliar texts. This is probably attributable to unfamiliar texts containing more unfamiliar words than familiar texts. Fast readers also spent less time per letter than slow readers, indicating that fast readers are good at recognizing and processing letters quickly. Fast readers were also better at answering literal comprehension questions than slow readers, suggesting that literal information in the text somehow maps on to elementary processing. In line with this assumption, Miller and Smith (1985) argue that literal questions demand recognition of similarities between words in the question and words in the text, so perhaps there are key words that fast readers recognize in the text and questions. Slow readers are probably concentrating on different aspects of the passage, and they miss the textual cues.

The emerging picture of fast and slow readers then, is that there is a discernible difference in their strategy use as well. Fast readers process surface textual information quickly, and slow readers who are good inferencers process on a more global level.

Consistent with this interpretation, van Oostendorp (1991) found that the difference between fast and slow readers in his study was that slow readers instantiated schemas and integrated arguments, whereas fast readers used a context-evaluation strategy. A context-evaluation strategy assumes that readers monitor, and very quickly evaluate the semantic relatedness between concepts present in working memory. Inferences are only instantiated when the relatedness between the new argument and the theme of the text is low. In the context-evaluation strategy, readers confine themselves to estimating the degree of semantic relatedness between concepts, and omit activating more accurate previous knowledge. It can be assumed then, that the activation of previous knowledge is a time consuming process, and fast, careless readers opt for the easier strategy of context-evaluation. Slow readers who are poor inferencers seem to experience difficulties at both the global and textual levels.

Taken together, the findings of the present and previous studies produce a picture of at least four different types of readers. Good inferencers who are fast readers are flexible and able to adapt their use of reading strategy to the task at hand; the more difficult the text, the more strategies they employ in order to successfully understand the material. Poor inferencers who are fast readers map on to letter and word identification and use easily recognizable breaks in the text for integration

(Haberlandt et al, 1989), perhaps to the detriment of grasping the overall meaning of a passage. Good inferencers who are slow readers spend a fair amount of time on elementary word processes, and therefore do not seem to notice surface textual information, but they are able to use their extra processing time to make the inferences necessary to build a coherent schema, and understand the text. Poor inferencers who are slow readers may be using a word by word reading strategy, because when faced with more difficult texts, they seem to abandon inferencing attempts, and perhaps focus on decoding or vocabulary problems.

Schema-Assembly Model

The Schema-Assembly Model offers a plausible cognitive framework for the observed findings in the present study. In terms of the Schema-Assembly Model, readers are required to combine text information with prior knowledge in order to make the inferences necessary to construct a coherent schema, and understand the text. Further, inferential processing occurs at the end of the sentence, where the integration of prior knowledge (contained in the schema) and text information takes place. Schema assembly should be easier and faster for more familiar topics, simply because readers have more prior knowledge with which to furnish the schema. Results indicated that readers do spend more time reading unfamiliar texts, and one location in the sentence that receives that extra time is

the end of the sentence. Therefore, it can be postulated that readers do assemble schemas, and make the inferences necessary to make the schema more complete at the end of sentences.

Readers differ on their schema-assembly abilities however; good inferencers are able to use their previous knowledge combined with text information to assemble a coherent schema, and successfully understand the text. Poor inferencers lack the ability to use inference to assemble a coherent schema, and therefore their understanding of the text is compromised.

Limitations and Directions for Future Research

It is impossible to know just how much inferencing was performed by the subjects because there was no measure of inferential comprehension. Future research would benefit from including both inferential and literal questions in the measure of comprehension. This study may also have been limited by the fact that the more difficult texts may have contained more difficult vocabulary. Again, future research would benefit from including a variable to code "new arguments" and "special terms" in the regressions.

Order effects should be examined more thoroughly by use of more subjects (and thereby more orders) because it is of interest to know how order is affecting reading ability with the Moving-Window method of text presentation. It may be causing legitimate order-effect problems (i.e., subjects getting faster at pushing buttons) that need to be resolved.

And finally, most of the research in this area has been with elementary school students, and although developmental issues have certain merit, more research in the area of reading processes of the mature reader is in order.

Summary and Conclusions

The primary intention of the present study was to use familiarity to compare fast/slow reader profiles to good/poor inferencer profiles, and to propose a model that could account for the observed differences. Prior research in the area of reading processes has generally grouped subjects in to either fast and slow readers or good and poor comprehenders. The present study represents an advance over previous research because it allowed examination of different reader types based on both reading rate and comprehension level. This examination resulted in the discovery that there are at least four different types of readers, as opposed to the fast/slow or good/poor distinctions found previously. Further, the use of coefficients in the ANOVAS enabled me to examine the four groups according to different measures of reader efficiency (Haberlandt et al., 1989) and to propose different reader profiles based on their performance on the predictor variables.

In examining the data collected from the four groups, two factors are immediately obvious; fast and slow readers can be differentiated by how quickly they can recognize letters and words in a text, while good and poor inferencers can be

differentiated by their use of strategy in understanding text. The implication of these findings is that reading speed and inferential comprehension represent two very distinct levels of processing, and readers vary on their ability to perform these functions.

Although the focus of the study was not lower level processing per se, I included reading speed in my subject selection because, regardless of extensive previous research to the contrary, researchers and educators may still think that fast readers are good readers. I propose that there are "good" fast readers, but more importantly, there are also "good" slow readers and further, that "good" only refers to the specific skill that is being examined. In this study, fast readers were good at recognizing letters and extracting literal information from the text, and skilled inferencers were good at being flexible in their strategy usage on texts of varying difficulty.

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Table 1

Descriptive statistics for pretest group (n=197)

Variable	Mean	SD	Min.	Max.
Inference score	8.5	4.1	0	16
Reading rate*	252	71	112	553

*words per minute

Table 2

Selection criteria and descriptive statistics for skill
groups (n = 12 per group)

	<u>Good Inferencers</u>		<u>Poor Inferencers</u>	
	<u>Slow</u>	<u>Fast</u>	<u>Slow</u>	<u>Fast</u>
RATE	< 220	> 285	< 230	> 230
Mean	181	330	203	322
SD	29	47	34	79
INFER.	> 10	> 10	< 5	< 5
Mean	13	13	4	3
SD	1.4	1.5	2.7	1.2

RATE - reading rate (words per minute)

INFER. - inferential comprehension test score

Table 3

Mean word reading times (ms)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	342	28	392	32	327	12	399	38
Unfamiliar	362	32	404	26	344	12	427	35

Table 4

Mean familiarity ratings (1 - Unfamiliar 7 - Familiar)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	4.9	.55	5.4	.33	4.7	.44	5.2	.38
Unfamiliar	3.1	.32	2.8	.46	2.2	.35	2.3	.40

Table 5

Mean literal comprehension scores (max. 5)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	3.5	.22	2.9	.24	3.1	.27	2.9	.34
Unfamiliar	3.0	.37	2.4	.34	3.9	.36	2.6	.37

Table 6

Correlations from the Nelson-Denny pretest, the Inference
pretest and the Nelson-Denny post-test.

	<u>Reading Rates</u>		<u>Nelson-Denny Comprehension</u>	
	<u>Pretest</u>	<u>Posttest</u>	<u>Literal</u>	<u>Inferential</u>
Reading Rates				
Posttest	.92**			
ND Comprehension				
Literal	.43*	.46**		
Inferential	.29	.30	.78**	
<u>Inference Test</u>	.00	.01	.21	.37*

* = .01

* = .001

Table 7

Variables used in the multiple regression equation

<u>Variable</u>	<u>Description</u>	<u>Coding</u>
Predictor Variables		
Paragraph	position of paragraph in text	1(1st)-n(last)
First word	RT of the first word in each paragraph	1=1st word:paragraph 0=otherwise
Line	position of line in paragraph	1(1st)-n(last)
Beginning of line	RT of first word in each line	1=1st word:line 0=otherwise
End of line	RT of last word in each line	1=last word 0=otherwise
# of letters	length of word	1-n
Beginning of sentence	RT of first word in each sentence	1=1st word:sentence 0=otherwise
Comm.	RT of the last word before a comma	1=last word:comma 0=otherwise
End of sentence	RT of the last word in sentence	1=last word:sentence 0=otherwise
Dependent Variable		
Reading time	time spent on each word	ms/word

Table 8

Mean slope coefficients for end-of-sentence reading times

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	66	22	100	34	89	31	124	34
Unfamiliar	85	28	132	43	77	30	136	39

Table 9

Mean slope coefficients for beginning-of-sentence reading
times (ms)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	<u>Fast</u>	<u>SE</u>	<u>Slow</u>	<u>SE</u>	<u>Fast</u>	<u>SE</u>	<u>Slow</u>	<u>SE</u>
Familiar	18	12	59	29	31	12	61	17
Unfamiliar	21	11	36	17	34	16	39	14

Table 10

Mean slope coefficients for end-of-line reading times (ms)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	15	4	19	17	15	6	19	8
Unfamiliar	20	7	14	9	8	9	5	8

Table 11

Mean slope coefficients for beginning-of-line reading times (ms)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	9	4	4	11	5	5	10	8
Unfamiliar	14	11	8	6	6	5	28	15

Table 12

Mean slope coefficients for length-of-word reading times (ms per letter)

	<u>Good Inferencers</u>				<u>Poor Inferencers</u>			
	Fast	SE	Slow	SE	Fast	SE	Slow	SE
Familiar	4.8	2.2	6.1	2.4	2.4	.7	10.5	3.0
Unfamiliar	5.5	2.4	7.5	1.9	3.4	1.5	11.2	3.1

Figure 1

Example of a Moving-Window Text

-----, -----
 -----.
 . ----- (---), -----
 -----, -----:
 ----- Marriage -----.
 -----.
 -----,
 -----.

Figure 2.
Mean word reading times for
fast and slow readers

Figure 3.
Mean end-of-sentence slope coefficients
for good and poor inferencers

Figure 4.
Mean beginning-of-sentence coefficients
for fast and slow readers

Figure 5.
Mean length-of-word slope coefficients
for fast and slow readers

Appendix 1
Inference Test

INSTRUCTIONS

In this task, we would like you to read two stories and answer questions about them. The questions require you to think about and understand what is going on in each story, so you should read the stories carefully.

If you need to, feel free to look back at the story when answering the questions. After you have finished the questions for the first story, go on to the second story, and answer the questions for it.

The Flex-Wing Project

As Ian pushed open the door to his office building, he absentmindedly read the sign on the door "Evans Aeronautics Corporation Engineering and Design Division." All in all, not a bad place to work, he reflected, as he often did, gazing with satisfaction around the comfortable lobby. He'd been with the company almost 20 years now, and he'd gotten his share of just desserts: good salary, periodic promotions, interesting projects to work on. And now, with a little luck, he could very well end up being a vice-president! Things were going well for him, he surmised, and with a little help, everything would be just about perfect.

The key at this stage of the game was the new flex wing project. Ian would get most of the credit if that project panned out, and that would make him particularly visible when the current vice-president of engineering retired next spring. Besides, who else was there with enough seniority and experience to take the job? Nobody, he told himself. Well, perhaps Roy could handle it. But Roy was nominally his subordinate, and it would be really outrageous for him to be promoted over Ian. Anyway, after the flex wing project there wouldn't be any doubt. All he had to do was to smooth out these last few problems, and they'd be on their way.

He recalled the meeting the design team had had last week with the vice-presidents. The big issue that time had been low-

speed stability. No one doubted the wing would work well at near supersonic speeds; it was the low end that had caused all the fuss. He thought he could have avoided the issue entirely, if Roy hadn't chimed in with his objections. It was really aggravating. Didn't Roy see what he was doing? He was undermining the confidence in the whole project, plus creating a lot more work for the two of them. They had had to spend almost a full week working up new wind tunnel tests and putting together a report. Ian really didn't understand the man's motivation. After all, if the project went smoothly and Ian was promoted to vice-president, Roy was almost certain to get the chief engineer position Ian held now.

As he walked down the hall to his office, he saw Roy talking with a couple of the technicians from the wind tunnel lab.

"Good morning," Ian offered amiably. Roy just nodded neutrally. Roy was like that: he was not overtly hostile, but he always seemed to be on the verge of saying something snide or insulting. He remembered that joke Roy had told yesterday about Ian padding expense accounts. Ian was used to being the brunt of Roy's jokes, but that one had seemed excessive. He didn't like the suggestion that he was dishonest, even if it was supposed to be a joke. Occasionally though, Roy would do something decent despite himself. Take the wind tunnel report for instance. Roy had volunteered to work on it, even tabulated and analyzed the results personally, before turning them over to Ian. And now Roy was going to let Ian take all the credit for the report, didn't even insist that his name appear on it. Ian thought that it was rather strange of Roy to let him take all the credit, but he felt that Roy was making sure of his chances to get promoted to chief engineer.

Ian sat down at his desk and pulled the wind tunnel report from a drawer. A nice piece of work he told himself, and it answers all the questions that were raised at last week's meeting. In fact, the results were much better than he had expected. He had anticipated some hint of instability at low speed, especially with the sheer forces; that was one of the disadvantages of the flex wing design. But the results were quite clear: The instability was less than 5%. The report had already been distributed, but Ian thought he would go over the tables one more time. They were everything they had hoped for: low-speed stability, low drag, and good high-speed performance. In fact, the engineer who had worked on the latest redesign had been surprised that the results had turned out so well. In some ways, the results were too good.

On an impulse Ian stepped out of his office to look for Roy.

There were a couple of questions he wanted to ask him about the data analysis. But Roy was no longer lounging around with the technicians, nor was he in his office. He checked with Roy's secretary:

"Ann, did you see where Roy went to?"

"I think he and Carl went upstairs to see the vice-president." Carl was one of the technicians Roy had been speaking to earlier.

Ian frowned.

"That's odd. Do you know what the meeting's about?"

"I think it would be better if you talked to Roy about that," Ann replied frostily. Ian was taken aback by Ann's tone and returned to his office deep in thought.

Questions

1. Why didn't Roy want his name to appear on the report?
2. Why did Roy volunteer to do the wind tunnel analysis?
3. Why did Roy make that joke about Ian?
4. What did Roy want to get?

The Burglar

I've always regarded my insomnia as a really annoying problem, but this time it was something of a blessing. Otherwise I probably wouldn't have known anything about what was going on. As it happens, I awoke about 3 in the morning and couldn't get back to sleep. As long as I wasn't going to get any rest, I figured I

might as well get some work done, so I went downstairs to find the reading I was supposed to have finished by tomorrow. I wouldn't have noticed that anything was amiss except that the front door had been left ajar. That was pretty unusual. Did I not close it properly? It seemed unlikely; I usually was pretty conscientious about locking the door before I went to bed. As I started to close the door, I became even more alarmed. The wood around the lock was splintered and cracked, rendering the lock quite useless. Someone had forced his way in, and might still be in the house!

With some trepidation, I began to make a systematic check of the house, working from the front to the rear of the house. In each room I turned on the lights, decided that everything was okay, and then moved to the next room. Perhaps because of my nervousness I began talking out loud to myself: "Nope, nobody in here...nothing seems to be missing in here...". After checking the living room and dining room I started to feel a little calmer. Surely the burglar (if there was a burglar) had already left. Suddenly I heard a loud crash. It sounded like something large and heavy had been smashed or broken, and seemed to come from the study at the rear of the house. The crash was followed by a number of smaller breaking noises. Now I definitely was scared. I ran quickly to the study, but it was several seconds before I could steel myself to open the door. The noises continued: there were some scuffling and scurrying noises, several quick, light steps, and then silence. With my heart pounding, I finally managed to open the door. There was no one there.

But someone had been there. On one side of the room, next to the gas fire, a large ceramic statuette lay smashed into small pieces. It had been originally about a meter tall, but was now distributed fairly evenly over several square meters. On the other side of the room a chair had been drawn up next to the bookshelf. About two meters off the ground, a space among the books on the top shelf indicated where the statuette had originally stood. Nothing else in the room seemed to have been touched. I checked my desk where I had a chequebook and some important papers. They were still there, not even disturbed. I was starting to be relieved, despite the fact that my hand was trembling. I noticed I was sweating, even though there was a cool breeze from the open window.

It was too bad about the statuette though. I had bought it in Mexico a couple of months ago. It had been a very nice piece, good workmanship and an interesting design. And it had been a tremendous bargain, even for Mexico, where one is accustomed to good deals on artwork. It would be impossible to find anything here at that price that would be nearly as nice. Perhaps I would be able to get another piece from the same man I bought this one from. After all, he said he was coming to Canada in a few weeks

and would be trying to set up shop here. In fact, he had gone out of his way to get my address. "In case I find something else you might be interested in," he said. Well, if he came up with a statuette like the last one, I'd definitely be interested.

Questions

1. What was the burglar after?
2. What did the storyteller discover in the study that would indicate that the burglar was short?
3. Why did the seller of the statuette want the buyer's address?
4. What, in your opinion, was the burglar's occupation (when he wasn't being a burglar)?

Appendix 2

TEXTS

THE CANADIAN CONSTITUTION

Canada is an independent federal parliamentary state. Since 1867, the main document of the Canadian Constitution has been the British North America (BNA) Act. The original set of resolutions, agreed upon by Canadians but made law by the Parliament of the United Kingdom, created a new nation out of three colonies, New Brunswick, Nova Scotia, and Canada (what is now Ontario and Quebec). The BNA Act defines the most important elements of the federal system, including the major institutions of Parliament and the Provincial Legislatures, and the powers to be exercised by Canada's federal and provincial governments. The original BNA Act is, however, only a part of the complete constitution. Over the years the British Parliament has made more than 20 amendments to the act, usually at the request of the Canadian Parliament, and these became part of the Canadian Constitution. A number of purely Canadian laws touching on constitutional matters and contributing to the political evolution of our country have also become part of the overall Constitution. These include the Canada Elections Act, and the federal statutes that created the provinces of Manitoba, Saskatchewan, and Alberta.

The strange situation of having our Constitution an Act of a foreign government remained a nagging problem. Although a fully independent nation in other respects, Canadians could not amend their own Constitution without approaching the British Parliament. Efforts to correct this situation began over 50 years ago, when Britain recognized the independence of Canada and other dominions with the passage of the Statute of Westminster in 1931. Two federal-provincial conferences, held in 1927 and 1931, failed to establish a formula that allowed all constitutional changes to be made in Canada. So, our Parliament asked Britain to keep its authority to amend the BNA Act. There were more attempts in the years that followed, and on two occasions the eleven governments came close to agreement, but the breakthrough remained elusive.

Finally, new talks began in the summer of 1980 at the time of political commitments by the government to constitutional reform. agreement was reached between the federal government and nine of the ten provincial governments on the terms of patriation. In December of 1981, the House of Commons and the Senate approved a Joint Address to Her Majesty the Queen requesting patriation of the Canadian Constitution. In the United Kingdom, the British Parliament passed the Canada Act on March 25, 1982. It did two things. First, it ended Britain's power to legislate for Canada, and second, at the same time it included our Constitution, the Constitution Act 1982. Its proclamation in Canada was the final step in the patriation process.

The BNA Act however is not dead. The Constitution Act 1982 states clearly that the BNA Act is still part of our constitution

and it adds some important new provisions. These include the Canadian Charter of Rights and Freedoms, new powers over natural resources of the provinces, and a written commitment to the well-established principle of making federal equalization payments to the less wealthy provinces.

THE CANADIAN CONSTITUTION

How familiar were you with the material in this passage:

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

- The constitution of Canada is distinguished because it is:
 - modelled solely on the U.S. constitution.
 - very comprehensive
 - the longest written constitution in the world.
 - the only orally transmitted constitution in the world.
 - none of the above.
- The BNA Act united the colonies of:
 - Ontario, New Brunswick, and P.E.I.
 - Ontario, New Brunswick, and Nova Scotia.
 - Canada, New Brunswick, and Nova Scotia.
 - Ontario, Quebec, and New Brunswick.
 - Canada, New Brunswick, and Quebec.
- In addition to the BNA Act, the Canadian constitution before patriation also included:
 - the Canada Elections Act.
 - the statutes that created Manitoba, Saskatchewan, and Alberta.
 - amendments to the BNA Act by the Canadian parliament.
 - both a and b.
 - a, b, and c.
- Efforts to patriate the constitution began:
 - with the passage of the Statute of Westminster.
 - shortly after Canada was created by the BNA Act.
 - in the summer of 1980.
 - both a and b.
 - none of the above.
- The Canada Act:
 - is an Act of the Canadian Parliament.
 - ended Britain's power to legislate for Canada.
 - included the Constitution Act.

- d. both a and c.
- e. a, b, and c.

THE INDIAN CONSTITUTION

India is a sovereign democratic republic. The constitution of India, which came into effect on January 26, 1950, is the lengthiest written constitution in the world. It contains much that in other countries is to be found in statutory rather than in constitutional law, partially because of the attempts of the people responsible for the constitution to account for all possible situations. It was promulgated on the day that India was proclaimed a republic, the first republic to achieve membership in the Commonwealth and the first to acknowledge the British monarch as head of that organization. This arrangement has undergone several revisions. Changes or amendments to the constitution usually occur following landmark decisions by India's supreme court. The constitution has been described as a quasi-federal document providing for a unitary state and having subsidiary federal features, rather than a federal constitution with subsidiary unitary features. This form was thought to provide the best arrangement for India's particular combination of loosely connected regions, that differ on many dimensions.

India's constitution derives from several sources, but was mainly influenced by the British concept of parliamentary government. The US constitution of the federal supreme court was adopted, and the American definition of certain presidential powers also influenced the final document. The Indian president, however, functions more as a constitutional sovereign, primarily a ceremonial figurehead, than as the chief executive of the government. Other sources for the constitution included the Canadian constitution, upon which India based its quasi-federal system, and the Irish constitution, to which its directing principles owe much. The constitution was an attempt to incorporate the best of the existing systems. However, the basic framework of the Indian constitution comes from the Government of India Act, which was enacted in 1935 by the British Government.

The India Act actually contained no constitutional principles, rather, it was primarily a lengthy collection of administrative details. The Act created an elaborate federal structure in an attempt to unite the disparate regions in an equitable way. It was designed as the last installment of British influence before the assumption of full self-government which some British politicians expected would occur very soon. This process was delayed by the outbreak of World War II and it was not until the Japanese began to pose a threat that the Indian situation again held Britain's attention. Independence for India was hampered by a number of factors. Because India is composed of a very diverse collection of

various linguistic and religious groups, agreement on a unity policy was difficult. For instance, the creation of Pakistan and India, rather than one country, seemed the only alternative to civil war.

India is a federal union of states. It has a strongly centralized national government, run by the prime minister and Cabinet who are elected representatives. Broadly, the distribution of powers between the centre and the states follows the accepted principle that the centre administers those matters which concern all of India, such as defense and foreign affairs, and other matters such as the police, public health, and education are administered by the individual states.

THE INDIAN CONSTITUTION

How familiar were you with the material in this passage:

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

- The constitution of India is distinguished because it is:
 - modelled solely on the U.S. constitution.
 - very comprehensive
 - the longest written constitution in the world.
 - the only orally transmitted constitution in the world.
 - none of the above.
- India is unique because it:
 - was the first republic in the commonwealth.
 - is the only republic with a sovereign as head of state.
 - was the only commonwealth republic that was created peacefully.
 - both a and b.
 - a, b, and c.
- The Indian constitution was described as:
 - providing for a strong federal state with subsidiary unitary features.
 - providing for a unitary state with subsidiary federal features.
 - providing for a strong unitary state with strong federal features.
 - quasi-federal and weakly unitary.
- Why was the Indian constitution created as described in the previous question?
 - because of a relatively homogenous population.

- b. because of the diversity among regions.
 - c. because of the lack of agreement among British officials.
 - d. both a and c.
 - e. none of the above.
5. The responsibilities of the Indian president are most like those of:
- a. the Governor-General.
 - b. a chief executive.
 - c. a prime minister (Canadian).
 - d. a prime minister (British).
 - e. the American president.

MICROWAVE OVENS

Defrosting, reheating, and cooking food can be easily and quickly accomplished by modern microwave ovens. A microwave is simply an insulated box that subjects food to high energy waves, sometimes called superhigh frequencies. These waves are termed 'micro' because of their extremely short wave lengths, shorter than radio waves but longer than infrared. The microwaves penetrate the food and increase the overall energy level of each individual molecule, causing them to vibrate at a higher rate. In spite of the simplicity of the basic process, microwaving is complicated by such concerns as: optimal energy levels, length of treatment, rotation, or stirring of food. The correct combination of factors should be sufficient to adequately cook just about anything. Browning food is probably the only thing the average microwave does not do well.

The designers of a new microwave must decide what functions to give the oven. Usually, they would start with the most basic functions, such as time or energy level, and continue adding more complicated ones that are consistent with the oven's intended use and performance requirements. Because the basic functions are so simple, small microwaves are sold for quite low prices. This simplicity also makes them easy to use. The simplicity does create problems however, in that it limits the usefulness and flexibility of the microwave, making it an addition to an already fully-equipped kitchen. This view of a microwave as an 'extra' and therefore unnecessary can be addressed in a number of ways. The most common include first, re-education (that is, teaching full use of the oven's capabilities) and second, loading the oven with features, allowing it to be used for just about everything.

The first technique for increasing the profile of microwaves, re-education, involves replacing people's current cooking methods and beliefs about cooking with new ones. The result may be a different and perhaps healthier cooking style. Vegetables, for instance, can be cooked quickly, neatly, and with minimal loss of

flavour in a microwave. In some ways, microwave cooking allows both greater freedom and more control over cooking and is a boon for the busy working couple. Heating up of leftovers or of precooked food becomes painfully simple. Re-education into the art of microwave cooking may have a profound impact on the eating habits of Western society.

The other method of increasing the appeal of microwave cooking has been to add numerous extra features. Ovens that combine both traditional convection (that is, hot air) cooking and microwaves have been developed. Such ovens can, for instance, be used either as a regular oven, as a microwave, or a strange mixed beast, in tandem or in series. These newest products become multipurpose appliances, especially when a variety of other features are added. The goal here is to make the microwave central to kitchen operations.

Both these methods are widely used. For day-to-day purposes however, it seems unlikely that microwaves (even the super-deluxe models) are replacing the traditional oven. Most houses still boast a traditional oven, whereas microwaves are considered to be an extra or a luxury. Unless some major change in available resources or lifestyles occurs, the microwave will probably never completely replace the traditional oven. The added convenience of a microwave will continue to make them popular sellers, however. In other words, most people who can afford it will buy a microwave, but they are unlikely to throw out their traditional oven.

MICROWAVE OVENS

How familiar were you with the material in this passage:

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

- The simplicity of microwave cooking is complicated by concerns about:
 - optimal energy levels.
 - length of treatment.
 - original temperature of food.
 - both a and b.
 - a, b, and c.
- The average microwave probably would not be useful for cooking:
 - cookies.

- b. casseroles.
 - c. frozen meat pies.
 - d. cruciferous vegetables.
 - e. fudge.
3. One method of re-education involves:
- a. selling microwaves to certain segments of the population (e.g., Yuppies).
 - b. stressing the low price.
 - c. pointing out the usefulness for defrosting and reheating foods.
 - d. teaching new techniques.
 - e. all of the above.
4. The other method involves:
- a. adding a variety of functions.
 - b. stressing the low price.
 - c. teaching new techniques.
 - d. pointing out the usefulness for defrosting and reheating foods.
 - e. special deals on new ovens
5. The theme of this passage is:
- a. microwaves are wonderful.
 - b. everyone needs a microwave, whether they know it or not.
 - c. microwaves complement the well-equipped kitchen.
 - d. acceptance of new methods depends on changing attitudes.
 - e. cooking is a dying art.

THE MICROLINE POINT PLOTTER

Display of complex images can be easily and quickly accomplished by a GBX-64K Microline point plotter. This point plotter is simply a specialized circuit board designed to store images and transfer them to a display unit. The point plotter has a buffer where the coordinates of one or more three-dimensional arrays of points can be stored. The points are moved through digital-to-analog converters to an oscilloscope at high speed without the intervention of the main computer. Because of the simplicity of the basic process, the points can be plotted and refreshed at the rate of 20,000 per a ten millisecond cycle, which is extremely fast. The correct combination of point plotter, oscilloscope, and a computer produces optimal results. Plotting images and even producing animation become simple and efficient.

The designers of systems used in vision research are faced with a number of issues. Usually, speed of plotting must be optimized, although the resolution of the image that is produced and the complexity of the image are also important to maximize within the intended use and performance requirements. A simple, inexpensive system consisting of a microcomputer and a television

or video screen does not optimize resolution, complexity, or speed. However, simple systems are inexpensive and easy to use. Larger computers constitute one way of addressing the speed, complexity, resolution issue because they make the speed of processing (and therefore plotting) much faster. The cost of large computers is a problem however, and the use of a television screen will rarely be satisfactory. An oscilloscope has many more possible screen plotting locations (4096 to the television's 525) resulting in a resolution that is 8 times better.

Thus, replacing the standard video screen with an oscilloscope will improve resolution, and using a larger computer will increase speed of plotting. This combination does not solve the complexity issue though. The display hardware and the computer needed are still expensive, because speed of plotting is limited by the processing speed of the computer. If the image must be displayed for an extended period of time without flicker then the image points must be replotted frequently. This requirement limits the total number of points that can be plotted in one cycle. Thus, the complexity of the images that can be presented is greatly reduced.

The method used in the GBX-64K device to overcome these problems is to increase the plotting speed by using a digital electronic circuit board. The board makes the display of complex images possible with much less expensive computers. The point plotter has a buffer that stores the coordinates of an image array, and can in fact store up to three images at the same time. As was mentioned, the point plotter can transfer these stored points to the oscilloscope much more quickly than the computer can. The goal here is to provide a high-speed interface between the computer and the display.

The buffer method has not been widely used. However, for certain vision research purposes, it seems to be the ideal solution to the speed, complexity, resolution issue. Images can be produced that are comparable to (or better than) those done with an expensive high speed computer that does not have the GBX-64K interface. The device is specially designed to take advantage of the timing requirements of certain vision research paradigms. The time between image presentations can be used to transfer the next plot to the buffer, from which it is easily and quickly plotted. In other words, the GBX-64K Microline point plotter provides a simple and relatively inexpensive way to accomplish sophisticated image processing tasks.

THE MICROLINE POINT-PLOTTER

How familiar were you with the material in this passage:

PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT

PRECISIONSM RESOLUTION TARGETS

PROPERTIES IN METHYLENE BLUE TESTING SINCE 1974

Micro-D
SYSTEMS, INC.

¹ KIRK : 26 1/2 400 " BURBANKVILLE MINN 55317 USA
 1 36 1 1/2 4 1/2 4 1/2 7500" 1 1/2 5 1/2 10000000

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

1. The GBX-64K device can be briefly described as:
 - a. a computer
 - b. an oscilloscope attached to a computer
 - c. a buffer attached to an oscilloscope
 - d. an interface
 - e. a high-speed number cruncher
2. Probably the most important aspect of plotting visual images is:
 - a. optimizing plotting speed
 - b. optimizing image resolution
 - c. optimizing image complexity
 - d. both b and c.
3. Which of the following components of a complete image processing puts the greatest limits on the complexity of the image that can be plotted:
 - a. the computer
 - b. the GBX-64K device
 - c. the display device
 - d. both a and b define the limits.
4. What is the main advantage of the GBX-64K device:
 - a. it allows any computer and any display device to be used
 - b. it increases the total number of points that can be generated.
 - c. it can plot points more quickly than the computer.
 - d. both a and c.
 - e. both b and c.
5. Which issue is not addressed by using a large computer and an oscilloscope (instead of a T.V. screen):
 - a. resolution
 - b. complexity
 - c. speed
 - d. both a and b.

WESTERN MARRIAGE

Marriage, the joining together of a male and a female into some relatively permanent union, varies considerably in form and customs from one culture to another. Although similarities exist at a global level, there are legal, cultural, and ceremonial components that differ greatly. In Canada and the United States, weddings are often large formal affairs, and the recent revival

of this custom has created a large entrepreneurial wedding industry. Legally, marriage in North America involves three steps. First, the interested parties (that is, the groom and the bride) agree in principle to the marriage, and then fix the date for the wedding. The next step is to obtain the marriage license from the local government offices. In essence, for a nominal fee, they are registering their intent to form a legally binding union. The acts of getting engaged, buying an engagement ring and all the attendant rituals are purely cultural, not legal, events.

The next step of the legal contract involves the marriage ceremony itself, conducted by a marriage commissioner or clergyman. The clergyman, the bride and groom, and two witnesses sign the marriage license and the union is official, legal, and binding. The accompanying ceremonial aspects and rituals, although certainly linked to the legalities in the minds of the participants, are quite optional in terms of the law.

In North America, the full-fledged wedding rituals vary somewhat with the culture of the participants. In general, after the engagement is announced to the family, the parents may publish a formal statement in the newspaper, and the preparations begin. Arrangements are made for the actual ceremony (usually performed in a church), a hall is reserved, and guest lists are compiled. Next, engagement parties, pre-wedding showers, and other events are held, special outfits purchased, and invitations are sent. On the big day itself, the bride and groom prepare separately, meeting at the altar where the bride is delivered by her father into the keeping of the groom. The exchange of rings, the post-nuptial reception, and the bride's adoption of her husband's last name are all quite optional.

A marriage that excluded the traditional rituals would be considered legally binding, given that the afore-mentioned legal steps had been accomplished. However, in the eyes of the family and friends of the nuptial pair, the rituals serve to publically establish their new status. The marriage rituals link the couple into a vast network of beliefs, traditions, and expectation that forms the cultural fabric of their lives.

WESTERN MARRIAGE

How familiar were you with the material in this passage:

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

1. Which of the following might be considered optional components:
 - a. deciding on the date.
 - b. buying an engagement ring.
 - c. obtaining a license.
 - d. both a and b.
 - e. all of the above.
2. The definition of marriage used by this passage was:
 - a. a legal definition.
 - b. joining together two people into some relatively permanent union.
 - c. a cultural definition.
 - d. a contractual definition.
3. Wedding rituals common to North America that were mentioned in the passage include:
 - a. a honeymoon.
 - b. engagement parties and showers.
 - c. purchasing and sending invitations.
 - d. both b and c.
 - e. a, b, and c.
4. What is the function of the cultural rituals?
 - a. to make the marriage legally binding.
 - b. primarily religious.
 - c. to publically establish the new status of the couple.
 - d. both a and b.
 - e. a, b, and c.
5. The revival of the traditional 'white wedding' is probably most heartening for:
 - a. the moral minority.
 - b. traditional ministers and priests.
 - c. entrepreneurs.
 - d. parents.
 - e. none of the above.

BANTU MARRIAGE

Marriage, the joining together of a male and a female into some relatively permanent union, varies considerably in form and customs from one culture to another. Although similarities exist at a global level, there are legal, cultural, and ceremonial components that differ greatly. The Bantu of Southern Africa, whose currency is mainly in the form of cows, are an example in which the legal and symbolic aspects of marriage have become almost inseparable. Legally, marriage among the Bantu involves three steps. First, the interested parties (that is, the groom and his family, and the bride's family) meet, agree in principle to the marriage, and then fix the bride-price or lobolo.

Interestingly, this dowry is quite different from that commonly found in some other cultures. Among the Bantu, the groom pays for the bride, rather than the bride bringing a dowry into the marriage with her. Because the Bantu are polygamous, this practice tends to insure that only men who can afford numerous wives will actually acquire them.

The next step of the legal contract involves the delivery of the lobolo, usually a specified number of cows and the final step is the delivery of the bride to the groom's kraal. When these steps are completed, the marriage, or customary union in the white-imposed legal terminology, is official, legal, and binding. The accompanying ceremonial aspects and rituals, although certainly linked to the legalities in the minds of the participants, are quite optional in terms of the law.

Bantu customs require that, before the bride leaves her ancestral kraal, a cow is sacrificed and a feast is held. The blood of the sacrifice is sprinkled over the bride and she is adorned with the bladder of the sacrificial animal. This procedure symbolizes the bride's severance from her own family or ancestral tree. Next, the woman is 'twaaled' or formally abducted (according to specified customs) and spirited away to the groom's kraal. There, another cow is sacrificed and the bride is again adorned with the bladder to symbolize her union with her new family. Another feast is held, and afterwards, the bride changes her dress and puts on a head scarf, indicating to the world that she is now a married woman.

A marriage that excluded the traditional rituals would be considered legally binding, given that the afore-mentioned legal steps had been accomplished. However, in the eyes of the family and friends of the nuptial pair, the rituals serve to publically establish their new status. The marriage rituals link the Bantu couple into a vast network of beliefs, traditions, and expectation that forms the cultural fabric of their lives.

BANTU MARRIAGE

How familiar were you with the material in this passage:

1	2	3	4	5	6	7
Very Unfamiliar			Somewhat Familiar			Very Familiar

QUESTIONS

- Which of the following might be considered optional components:
 - fixing the bride-price.

- b. slaughtering a cow.
 - c. delivering the bride.
 - d. deciding on the lobolo.
 - e. all of the above.
2. The definition of marriage used by this passage was:
 - a. a legal definition.
 - b. joining together two people into some relatively permanent union.
 - c. a cultural definition.
 - d. a contractual definition.
 3. Wedding rituals common to the Bantu that were mentioned in the passage include:
 - a. ritual kidnapping.
 - b. an extended honeymoon.
 - c. sacrifice of a cow.
 - d. both a and c.
 - e. a, b, and c.
 4. What is the function of the cultural rituals?
 - a. to make the marriage legally binding.
 - b. primarily religious.
 - c. to publically establish the new status of the couple.
 - d. both a and b.
 - e. a, b, and c.
 5. The important difference between a Bantu bride-price and that common to some other (e.g., especially European cultures) is:
 - a. the Bantu pay in cows.
 - b. the Bantu parents and the groom agree on the price.
 - c. the European dowry is paid to the husband.
 - d. the European dowry is nonrefundable upon divorce.
 - e. none of the above.

CARLETON UNIVERSITY

Carleton began in 1942 as a non-sectarian, private, part-time college to meet the needs of the many men and women who came to Ottawa to serve the country's war effort. The first campus was a few rented classrooms in a high school. Full time programs were offered for the first time in 1945. Carleton then moved to its own building in downtown Ottawa the following year. At this location, Carleton awarded its first degrees in 1946 in Journalism and Public Administration. Its first graduate diploma was awarded in 1954 in Public Administration. As the university expanded, it became necessary to plan and develop a new campus, located on a picturesque site, between the Rideau River and the Rideau Canal.

The faculties of Arts, Sciences, Social Science, Engineering and the school of Computer Studies offer many diverse programs. These programs lead to bachelor degrees and are offered in architecture, arts, commerce, computer science, engineering, industrial design, music and public administration. Certificates are offered in public service studies, teaching english as a second language, law enforcement, English and French language and composition and music studies. Courses in english as a second language and a variety of other services are available through the Centre for Applied Language Studies. More than 18,500 full and part time students attend Carleton. It is staffed with more than 670 full time instructors and many part time instructors. Carleton has grown from modest beginnings to a fairly large, diverse institution.

The academic reputation Carleton has established in these areas is complemented by exciting interdisciplinary programs. There is Canadian studies, computer science, criminology and criminal justice, film studies, international affairs, public policy and East European studies, to name a few. The faculty of Graduate Studies and Research offers 34 master's degree and 14 doctoral degree programs in arts, business, computer science, engineering and journalism. There is a graduate diploma in public administration.

A broad spectrum of recreational, cultural and leisure time activities are available to Carleton university students. The multi-purpose university centre has coffee house, a pub and a gamesroom. The athletics complex provides facilities for physical recreation in a wide range of activities from individual fitness programs to team competition. Accommodation for more than 1,300 students is provided in Carleton's 5 residence buildings.

The Parliament Buildings and the National Arts Center are just two of the many resources available to Carleton's students, thanks to the University's location in the national capital. Museums, art galleries, libraries, embassies, national associations and organizations are all available to the students. The Rideau Canal, always popular for boating in the summer, has gained great wintertime fame in recent years as the worlds longest skating rink. One end of that rink is at Carleton's front door, the other end, eight kilometers away, is at the National Arts Center. The Ottawa area has cultural and recreational facilities to suit every taste, and Carleton is part of that community. It is a university old enough to have an established reputation, yet young enough to combine its tradition with innovation in ways to meet the diverse needs of modern students.

CARLETON UNIVERSITY

How familiar were you with the material in this passage:

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

- The Second world war had what sort of effect on Carleton's beginnings?
 - none.
 - small.
 - moderate.
 - large.
 - not enough information.
- Carleton awarded its first degrees in:
 - Law and Public Administration
 - Journalism and Public Administration.
 - Architecture and Journalism.
 - Journalism and Law.
 - none of the above.
- Which faculties that lead to degrees are not included Carleton's offerings?
 - Architecture.
 - Engineering.
 - Law.
 - Computer Studies.
 - all are included.
- Accommodation for more than _____ students is provided in Carleton's _____ residences.
 - 2000; 5
 - 2200; 6
 - 1600; 5
 - 1800; 5
 - 1900; 6
- What is Ottawa famous for that is adjacent to Carleton's "frontyard".
 - boating on the Rideau Canal.
 - skating on the Rideau River.
 - The Parliament Buildings.
 - skating on the Rideau Canal.
 - The National Arts Centre.

UNIVERSITY OF ALBERTA

The University of Alberta is a large, publicly supported,

coeducational institution that was authorized by the province in 1906. The sponsor of the bill was A. C. Rutherford, Alberta's premier and first Minister of Education. Classes opened in September of 1908 in what is now Queen Alexandra School with 45 students and a faculty of 5. The first building on campus was Athabasca Hall, which opened in 1911. Athabasca served as a residence for staff and students, included classrooms, laboratories, the library, a gymnasium, and the administration offices. The student body of the fledgling institution grew rapidly up until 1914, when the first World War broke out. The University sent 438 of its staff and students to the armed forces.

After the War, the University expanded rapidly. Many departments (that have since become faculties) such as Agriculture, Accounting (now Business), Pharmacy, and Home Economics were added around this time. During the depression, enrollment held steady but the budget actually decreased, making it a difficult time financially. During the second World War, the University geared up to contribute to the war effort. Medicine, Dentistry, and Education offered accelerated courses and Engineering offered special courses to members of the armed forces. After the war, enrollment swelled with the flood of returning veterans, from 2,000 to about 5,000. Accommodation in classrooms, labs, and libraries was pathetically inadequate, and there was also a shortage of staff. Growth continued, but more slowly, during the fifties.

In the sixties, enrollment had reached about 17,000, and this huge population necessitated the rapid construction of many new buildings, including the Lister Hall residence complex, Cameron library, the Physical Education building, the Education building, the Physical Sciences building, Tory Lecture, and the present Student's Union building. Recently, growth and expansion have slowed in these difficult economic times. However, the University is still one of the largest in Canada.

The University of Alberta is a collection of various faculties that offer undergraduate degrees and (often) graduate training. For instance, the Faculty of Education trains teachers (BEd), Faculty of Science awards the BSc., and the Faculty of Arts the BA. In many cases though, students in one faculty take courses offered by other faculties as part of their degree requirements, for example, Engineering or Nursing students may take courses in the faculties of Arts (such as English)/ or Science (such as Psychology). Students in the general BSc or BA programs are not usually allowed to take courses from other faculties when those courses are part of the requirements for quota degrees.

Like other institutions, the University of Alberta has its own traditions and official symbols. In addition to the school motto (Quaecumque Vera), a crest, and a coat of arms, the university has official academic costumes (that is, the gowns worn at Convocation) for the various degrees. These costumes (gowns and hoods) were once required apparel at universities like Oxford or Cambridge. The official university colours, green and gold, were suggested by the autumn colours of the river valley below the campus. The green represents 'wide stretches of prairie flanked by spruce forests' and symbolizes hope and optimism. The gold represents 'golden harvest fields' and symbolizes the light of knowledge. The University of Alberta is a well-established university with a tradition of excellence and scholarship, whose alumni people the ranks of Canadian politicians, scientists, educators, and professionals.

THE UNIVERSITY OF ALBERTA

How familiar were you with the material in this passage?

1	2	3	4	5	6	7
Very			Somewhat			Very
Unfamiliar			Familiar			Familiar

QUESTIONS

- The first World War had what sort of effect on the operation of the U of A?
 - none.
 - small.
 - moderate.
 - large.
 - not enough information.
- During World War II, the faculties of Medicine, Dentistry, and Education:
 - offered special courses to members of the armed forces.
 - offered accelerated programs.
 - closed down because of the shortage of students.
 - both a and b.
 - none of the above.
- What is the main difference between being in a quota faculty (such as Engineering) and being in a nonquota faculty (such as Science) that was mentioned in the passage?
 - stricter admission requirements.
 - smaller size.
 - students in quota faculties can take courses in nonquota

- faculties, but the reverse is not usually true.
- d. Engineering is a job-oriented faculty, whereas Science is oriented towards providing a liberal education.
 - e. all of the above were mentioned.
4. The official university colours, green and gold, symbolize:
- a. learning and achievement, respectively.
 - b. hope and optimism and the light of knowledge.
 - c. achievement and the light of knowledge.
 - d. the autumn colours of Alberta.
 - e. all of the above.
5. One similarity between present conditions on campus on those that existed after World War II include:
- a. growth of student population.
 - b. abundance of funds.
 - c. overcrowding in classrooms and laboratories.
 - d. both a and b.
 - e. both a and c.

Appendix 3
Counterbalance

1. C _f E _u M _f U _u	7. M _u U _u C _u E _f
2. U _f C _u E _f M _u	8. E _u M _f U _u C _f
3. M _f U _u C _f E _u	9. C _u E _f M _u U _f
4. E _f M _u M _f U _u	10. U _u C _f E _u M _f
5. C _f E _u M _f U _u	11. M _u U _f C _u E _f
6. U _f C _u E _f M _u	12. E _u M _f U _u C _f

C - constitution texts
E - equipment texts
M - marriage texts
U - university texts

f - familiar
u - unfamiliar

Appendix 4
Correlations Among Predictor Variables: University Texts

Carleton University (Familiar)

	EOS	NLET	BOS	BLINE	ELINE	FRWORD	LINE
EOS	-						
NLET	.12	-					
BOS	-.05	-.09	-				
BLINE	.05	.05	-.07	-			
ELINE	.05	.08	-.02	-.01	-		
FRWORD	-.02	-.04	-.02	-.02	-.02	-	
LINE	.06	.04	.00	.00	.00	-.14	-
PARA	.00	-.03	.00	-.01	-.01	.01	-.15

University of Alberta (Unfamiliar)

	EOS	NLET	BOS	BLINE	ELINE	FRWORD	LINE
EOS	-						
NLET	.09	-					
BOS	-.05	-.02	-				
BLINE	-.03	.16	-.04	-			
ELINE	.08	.01	.07	-.11	-		
FRWORD	-.02	-.07	-.02	.28	-.03	-	
LINE	.08	.01	.02	.01	.01	-.15	-
PARA	-.03	-.02	-.03	.00	.00	.00	-.15

EOS - end of sentence
NLET - number of letter per word
BOS - beginning of sentence
BLINE - beginning of line
ELINE - end of line
FRWORD - first word in paragraph
LINE - line in paragraph
PARA - paragraph in text

Example Regression Results

Subject # 118, Slow Reader; Poor Inferencer
Carleton University Text (Familiar)

	B	SE B	Beta	T
EOS	12.88	6.10	.094	2.11 *
NLET	.61	.47	.059	1.30
BOS	1.76	6.41	.012	.28
BLINE	10.95	4.60	.107	2.38 *
ELINE	7.31	4.39	.072	1.66
FRWORD	55.55	14.31	.176	3.88 **
LINE	-.35	.39	-.039	-.90
PARA	1.86	.86	.092	2.16 *

* $p < .05$

** $p < .01$

$R^2 = .09$: $F(9,503) = 5.45$, $p < .001$

Durbin-Watson Statistic = 1.54

Residuals : 10 out of 513 data points

Subject # 228, Slow Reader; Good Inferencer
University of Alberta Text (Unfamiliar)

	B	SE B	Beta	T
EOS	50.99	19.27	.111	2.65 **
NLET	3.59	1.53	.102	2.34 *
BOS	45.24	20.87	.090	2.17 *
BLINE	26.25	14.89	.078	1.76
ELINE	5.87	14.07	.017	.42
FRWORD	-11.11	47.44	-.010	-.23
LINE	-1.25	1.25	-.042	-1.00
PARA	-9.56	2.82	-.140	-3.39 **

* $p < .05$

** $p < .01$

$R^2 = .07$: $F(9,547) = 4.49$, $p < .001$

Durbin-Watson Statistic = 1.93

Residuals : 10 out of 557 data points

END

21.12.92

FIN