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Contextual Constraints on Eye Movements in Reading

Terence J. Cooper

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Abstract

Contextual Constraints on Eye Movements in Reading

Terence Cooper

Several studies have shown that linguistic and contextual constraints can influence eye movements in reading (Ehrlich & Rayner, 1981; O'Regan, 1979). The purpose of this investigation was to determine whether conceptual context, especially concepts presented in an earlier portion of a text, builds up over time to facilitate processing of a large body of text. Thirty-two subjects ranging in age from 16 to 35 years read 16 short stories edited from Reader's Digest. In half the stories, a critical word was placed near the beginning of the text, where the word was unexpected (No Context condition). In the other half, the critical word was placed near the end of the text, and the body of the text served to make this word highly expected (Context condition). Subjects were randomly divided into two groups: (a) those for which the critical word was of a high frequency in the language (High Frequency condition), (b) those for which the critical word was of a low frequency (Low Frequency condition). Subjects' eye movements while reading were monitored using a SRI Dual Purkinje Eyetracker. The main findings were: (a) high frequency words had shorter fixation durations irrespective of context, (b) the number of fixations on the critical word was the same in all conditions, (c) the probability of fixating the critical word

was the same in all conditions, (d) the magnitude of eye movements approaching high frequency words was larger in the No Context condition, and smaller in the Context condition. These results indicate that word frequency can reduce fixation durations through faster processing of high frequency words. Conceptual context, however, consistently failed to exert any influence on eye movements. This could be because conceptual context does not influence eye movements in reading, or because the manipulation used in this study was not effective. Implications of the present results for models of reading and issues concerning context effects and reading skill are briefly discussed.

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I wish to thank Dr. Melvin Komoda for his generous help throughout the course of this research project, and for many helpful comments on earlier versions of this manuscript. It is through his inspiration and encouragement that the study of eye movements in reading has become for me one of the most exciting areas of research. I would also like to thank the numerous people that have assisted me in conducting screening tests and pilot studies, preparing stimuli, analyzing eye movements, and helped with statistical analyses. I also express my sincere appreciation for those who participated in the study, and hope that their experience will encourage them to participate again in psychological research.

May the mini-hahas stay out of the PDP room!

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Contextual Constraints on Eye Movements in Reading

Models of reading can generally be classified as bottom-up or top-down, depending on the amount of influence later stages in the reading process can exert on the earlier, more perceptual stages. Strict bottom-up models view reading as a serial process, in which the output of an earlier stage forms the input to the subsequent stage. This process continues until a stage is reached at which a semantic analysis is performed, and comprehension is said to occur at this point.

Gough's (1972) model exemplifies the bottom-up model. An iconic representation is made of the visual stimulus, after which letter identification takes place. The letters are then coded into phonological form by means of grapheme-phoneme correspondence rules. The lexicon is accessed through this phonological form, and words of a sentence can be understood serially, from left to right. The information from the lexicon is placed into primary memory. The result of these operations are placed into secondary memory, and comprehension of a sentence is said to have occurred. By this time, the eye has already moved and processing of the next sentence is well under way. However, understanding the first sentence will not facilitate the processing of the second sentence. It must make its way through each of the stages.

Unlike the serial nature of bottom-up models, top-down or interactive models acknowledge the role of bottom-up processes, but

allow for feedback of later stages to influence earlier ones. One class of such models are the hypothesis testing models, which assume that the reader continuously evaluates hypotheses regarding the material being read. In this manner, words or phrases which are predictable from the context of the text or from the syntax of the sentence can be processed more quickly, or skipped over.

Examples of the hypothesis testing models are those of Hochberg (1970) and Rumelhart (1977). In Hochberg's model, cognitive search guidance (CSG) is the mechanism by which readers use their knowledge of the meaning of the text, as well as knowledge of spelling and grammar to generate hypotheses about the upcoming text. A related mechanism, called peripheral search guidance (PSG), enables the reader to make predictions about the text based on cues in peripheral vision. Thus, CSG would enable readers to skip areas of high predictability, and PSG would lead the eyes to the most informative areas of the text (Hochberg, 1970).

Rumelhart (1977) offers a more structural model. Each reader possesses a set of independent knowledge sources which contain specialized information about certain aspects of the reading process. These knowledge sources range from low-level featural and letter information to high-level syntactic and semantic information.

Another structural and dynamic component of the model is called a message center, which contains the hypotheses about the reading material provided by the knowledge sources. The knowledge sources continuously evaluate in parallel the hypotheses relevant to their specialized knowledge. If a particular hypothesis is confirmed by a

knowledge source, then it will be strengthened in relation to competing hypotheses. If it is disconfirmed, it will be removed from the message center. A new hypothesis may then replace it. This form of hypothesis testing continues until a decision is reached regarding the meaning of the text. Comprehension occurs when one hypothesis wins out over its competitors. According to this model, the relative contribution of bottom-up vs. top-down processes in reading is entirely dependent on variables related to a particular text and to a particular reader.

One method of studying the processing stages in reading that has proved fruitful is through the analysis of a reader's eye movements. It is assumed that the location and duration of fixations, as well as the magnitude of eye movements reflect these basic processes (Frazier, 1983; McConkie, 1983; O'Regan, 1984; Shebilske, 1975; Stern, 1978). Carpenter and Just (1981, 1983) clarify two assumptions that provide the basis for linking eye fixation data to reading comprehension. The first is the immediacy assumption. It states that a reader tries to interpret each word of a text as it is being read, rather than waiting until a number of words have accumulated in primary memory. The second assumption is the eye-mind assumption. It states that the reader will continue to fixate a word until all the cognitive processes which the word initiates will be completed. Although specific issues raised by these assumptions (e.g., the eye-mind lag problem) are controversial (Ehrlich, K., 1983; Ehrlich, & Rayner, 1983; Hogaboam, 1983; Potter, 1983), it is clear that bottom-up and top-down models make different predictions regarding eye movements in

reading. It is therefore possible to evaluate how well these models explain the reading process.

Bottom-up models assume that eye guidance is based only on the visual characteristics of the text. Word length, for example, may be important in determining where the eye lands as well as the magnitude of the eye movement (Rayner & Inhoff, 1981). One would expect the eye to be sent to regions containing long words since these tend to be more informative, and a short word followed by a long word may result in a larger eye movement to the long word. This does not contradict the serial nature of the processing (i.e., letter by letter, word by word), since Gough (1983) argues that unfixated words are processed in the adjacent fixations.

Fixation duration is generally agreed to reflect processing time in reading (Carpenter & Just, 1983; Ehrlich, S., 1983; Rayner & Inhoff, 1981; Shebilske, 1975). Bottom-up models would predict longer fixation durations for longer words, because of the fact that there are more letters to decode. Also, fixations in the middle of a multiletter word should be longer than fixations at the beginning or end because of lateral inhibition, and backward masking over successive fixations should produce longer fixations (Rayner & Inhoff, 1981). Words composed of hard-to-recognize letters (e.g., C, J) should have longer fixations than those composed of easy-to-recognize letters (e.g., E, R, T) (Gough & Cosky, 1977). At the level of lexical search, words of high frequency in the language should be processed faster (Dobbs, Friedman, & Lloyd, 1985; Sumby, 1963; Whaley, 1978) and therefore have shorter fixation durations than low frequency

words.

Top-down models of reading allow for syntactic context as well as semantic context at the sentence and text levels to guide the eyes to the more informative areas of the text. For example, consider the following string and assume that it comes from a treatise on genetics: "Since the unit factor of Mendelian inheritance remains the gene and not the chromosome...." Although the word "gene" is a low-frequency word in the English language (frequency = 9, based on Kucera & Francis, 1970), an expert on genetics could skip over the word based on knowledge of what the unit of inheritance is, knowledge that the text deals with genetics, and knowledge that a noun is a likely candidate to occupy that position in a sentence. Therefore, high-level knowledge directly influences the processing of the earlier stages, such that the probability of fixating a word decreases with increasing contextual constraint. Contextual constraint should also influence the magnitude of eye movements by reducing the reader's dependence on visual cues to process the text. Due to semantic preprocessing of information in the parafovea, the eye should make larger saccades approaching expected words.

Fixation duration should also reflect the influence of high-level knowledge. In the previous example, if the person does fixate the word "gene" (for example, after a very large eye movement), contextual constraint could exert its effect by reducing the fixation duration. Carpenter and Just (1983) argue that the currently fixated word (which is processed to a semantic level) can influence the time spent on that word, either by increasing the fixation duration (if the

meaning of the word is difficult to incorporate within the framework of the text), or by influencing the location of the next fixation.

In summary, bottom-up models allow for purely visual characteristics such as word length, word shape, and ease of decoding in terms of visual features and frequencies, to influence eye movements during reading. Top-down models, on the other hand, maintain that eye movements are also influenced by semantic contextual constraints, whether these operate at the level of words, sentences, or continuous prose.

There is a large body of research addressing context effects on word perception and reading. Only a selected review will be presented here. Paradigms using stimulus degradation to measure context effects (Miller, Heise, & Lichten, 1951; Sawyer, 1971), as well as those using tachistoscopic presentations (O'Neil, 1953; Rouse & Verinis, 1962) will not be reviewed, since there is growing concern that these paradigms may lead persons to rely on contextual cues to an extent that is not comparable to normal reading conditions (Gough, 1983; McConkie & Zola, 1981; Shebilske & Reid, 1979; Stanovich & West, 1983). Also, because the focus of this paper is to present information concerning contextual effects on eye movements, only studies which provide data about the main components of eye movements (i.e., saccades and fixation durations) will be included.

Linguistic Influences on Eye Movements

O'Regan (1979) provided evidence that linguistic information influences the magnitude of eye movements. Subjects were presented with sentences such as "The bear that Joe was hunting the other day

was caught", or "The bear that Joe was hunting had often been seen". It was found that subjects were more likely to skip the article "the" in the first sentence than the three letter verb "had" in the second sentence, and that the eye movement occurred earlier when the verb had a high frequency (had = 5133) as compared to when it had a low frequency (ran = 134) of occurrence in the language (frequencies are based on Kucera & Francis, 1970). It is worth noting that this is not simply a case where high frequency words were processed more rapidly than low frequency words, but that linguistic constraints (since word length prior to and including the critical word was kept constant) were able to influence the programmation of the next saccade. This latter point poses problems for bottom-up theories.

In a study investigating semantic context, Kennedy (1978) presented subjects with paragraphs consisting of three sentences each, presented one at a time. In the experimental condition, a word in the first sentence was a high associate of a word in the third sentence, whereas in the control condition, this association was not present. It was found that the mean latency to the first fixation on the critical word (from the moment it appeared) in the third sentence was significantly shorter (373 ms vs. 482 ms) in the experimental condition. Although this might indicate that the critical word was primed by the associated word presented earlier, fixation duration on the critical word was longer in this condition, making the results difficult to interpret.

The relationship of eye movements to inference processes has been studied by Just and Carpenter (1978). They provided subjects

with sentences in which one of the sentences contained a pronoun, to which its referent in the preceding sentence was ambiguous. When reading the pronoun sentence, subjects made regressive eye movements to the previous sentence over 50% of the time, and tended to fixate the referent which was the focus of the preceding sentence. These results are interpreted as indicating that some regressive eye movements are semantically driven and reflect the process of comprehension, another instance of high-level processes influencing lower ones.

Another study focussed on the relationship between a verb and its agent (Just & Carpenter, 1978). Subjects were presented with five sentences and had to judge whether each sentence contradicted any previous sentence. In one condition, the relationship between the verb and its agent (in a different sentence) was direct. For example, consider the verb "murdered":

The millionaire was murdered on a dark and lonely night.

The killer left no clues for the police to trace.

In the other condition, the relationship was indirect:

The millionaire died on a dark and stormy night.

The killer left no clues for the police to trace.

The other three sentences were simply fillers. It was found that subjects spend more time looking at the second sentence and more time looking back at the referent sentence in the condition where the relationship was less clearly delineated. These results are interpreted as evidence for the semantic control of fixation durations, and later as evidence for the immediacy and eye-mind

assumptions (Carpenter & Just, 1983).

Although these results clearly reflect semantic processes, it is less clear whether their influence is present or is as strong in a situation where a person is reading extended discourse with no task demands and where the text is continuously present. Gough (1983) clearly states that the effects of context decrease with stimulus clarity and decrease with reading ability. The subjects in the above study had to make a judgment about each sentence they read before the subsequent sentence was presented, so the strategies employed could be biased towards reviewing the sentences carefully in order to deal with the task. Another criticism concerns the text in many reading experiments, which often is not the type of continuous prose one would be likely to read in magazine articles or novels. Consider a typical "paragraph" from the Just and Carpenter (1978) study:

> The millionaire was murdered on a dark and lonely night.
> The killer left no clues for the police to trace.
> The millionaire was found in his bed by the housekeeper.
> There was no electricity in the house because of the storm.
> It was the butler who discovered the body.

Another important consideration, then, is whether studies using stimuli which differ from extended prose are studying different kinds of contextual information. To say that contextual constraints lead readers to skip high frequency words is very different from saying that the reader's knowledge of the subject matter of the text is influencing the time needed to process certain words.

Levels of Contextual Influence on Eye Movements

Shebilske and Fisher (1983) identify three kinds of contexts which are labelled situational context, linguistic context, and conceptual context. Situational context refers to the sum total of nonlinguistic external stimuli that act upon a reader. These include task demands, the purpose for which the person is reading the text, and the manner in which the text is presented. There is evidence that all these factors influence eye movements in reading (Shebilske & Fisher, 1983), but this issue will not be discussed here because these factors are usually controlled in experiments.

Linguistic context refers to the influence that a reader's prior knowledge of the language has on the expectation of regularities in orthographical, lexical, syntactic, and semantic information as the text is being read. Studies which use single words to facilitate the perception of target words (Graboi, 1974; Meyer, Schvaneveldt, & Ruddy, 1975; O'Neil, 1953; Rouse & Verinis, 1962) as well as those using single sentences to achieve similar facilitation (Miller, Heise, & Lichten, 1951; O'Regan, 1979, 1980; Sawyer, 1971; Stanovich & West, 1983; Tulving & Gold, 1963; Wanat, 1971) are manipulating the influence of linguistic context.

The third type of context is referred to as conceptual context. This is the reader's background knowledge at the moment of reading. It includes concepts presented in earlier portions of a text, the reader's prior knowledge about the topic under discussion, and the reader's general knowledge of the world. Scinto (1978) reported shorter fixation durations when subjects read portions of text in

which the information presented had already been presented earlier in the passage. Ehrlich and Rayner (1981) and Ehrlich, S., (1983) argue that this type of context builds up over time so that its constraining effects on the processing of words may not be observed if the person reads merely a sentence or two. Larger bodies of text are necessary for the reader to integrate what is currently being read with the other concepts that have appeared earlier in the text.

Although studies using extended prose are scarce in the eye movement literature, two which utilize short paragraphs are worth mentioning. The first is a study by Zola (1984), in which a target word was made highly predictable by an immediately preceding adjective. For example, the noun "popcorn" was highly constrained when the preceding adjective was "buttered" (i.e., buttered popcorn) and less so when the preceding adjective was "adequate" (i.e., adequate popcorn). Four conditions also had spelling errors of differing severity in the target word to study the relationship between level of constraint and disruption of reading due to errors. Subjects' eye movements were monitored and it was found that the target word was fixated as often in the high- as in the low-constraint condition. Furthermore, there was no interaction between level of constraint and disruption in reading due to errors. Even the minimal errors had an effect on subjects' eye movements, regardless of constraint condition. These results suggest that context does not affect the visual processing of the stimulus nor does it play a significant role in controlling saccadic eye movements. Contextual influence cannot be entirely ruled out, however, since fixation

durations were significantly shorter on target words in the high-constraint condition.

Some criticisms of Zola's (1984) study are worth mentioning. All target words were either seven or eight letters long. Rayner and McConkie (1976) showed that the probability of fixating a word increases as word length increases. With normal reading rates of 200-400 words per minute, words seven to eight letters long will be fixated 95% of the time whereas words that are five letters long, for example, will be fixated 64% of the time. This may be because more of a shorter word can fit within foveal vision when the center of fixation is not directly on that word (Ehrlich, S., 1983), or it may be an effect of word frequency in the language, or both. Most function words (e.g., the, this, that) are fairly short, and their high frequency in the language (the = 69971, this = 5146, that = 10595 according to Kucera and Francis, 1970) might make them more predictable. This is consistent with Gough's (1983) estimates of word predictability: 40% for function words and 10% for content words in single sentence presentations. Thus, by using content words seven to eight letters long as targets without taking into consideration frequency of occurrence in the language, ceiling effects may have prevented the researchers from observing important contextual influences on the saccadic control of eye movements. As a result, it could not be determined how such influences might interact with word frequency and word length. This left fixation duration as the only index of contextual influence in which, as was mentioned earlier, a significant effect was found.

Another criticism concerns the locus of contextual effects in Zola's study. Although subjects read short paragraphs of continuous prose, the amount of constraint on the target word was determined exclusively by the preceding adjective (e.g., "buttered" vs. "adequate" popcorn). The rest of the text was the same in the high-redundancy and low-redundancy versions. The manipulation, therefore, was one of linguistic context. Although the paragraphs made it more likely that subjects were using reading strategies similar to those used in reading normal text, it leaves open the possibility that contextual influences may be greatest when constraint comes from the conceptual context.

In a study which manipulated conceptual context and attempted to correct for ceiling effects due to word length, Ehrlich and Rayner (1981) worked with target words (nouns) of five letters long embedded in highly constraining or neutral passages. Constraint was a function of the word's predictability as determined by a cloze task in a pilot study. Subjects also read passages (counterbalanced) in which the target word was substituted with a word which was semantically anomalous in the context provided. This substitute word differed from the target word in all but one letter (e.g., night, right) and the difference occurred either in the first (night, right), middle (horse, house) or final (shark, sharp) letter position. In half of the cases the substitute word had the same shape as the target. Subjects' eye movements were monitored in all cases. It was found that the more constraining passages resulted in lower probabilities of fixating the target words and shorter fixation durations on those words that were

fixated. Furthermore, when subjects directly fixated a substitute word, they were aware of the substitution in all but 13% of cases and 88% of these cases were in the high-constraint passages. Another experiment was conducted in which the substitute words were not semantically anomalous but merely unexpected in the passages. Results showed that mean fixation durations and gaze durations on the target word was significantly higher for the unexpected substitute target word. The fixation following the target word was also longer in the unexpected condition.

These experiments support the hypothesis that context does affect eye movements and fixation durations during reading. One criticism of Ehrlich and Rayner's (1981) study is that in the high-constraint condition, the critical word often appeared earlier in the text. For example, in a passage in which the critical word is "shark", the phrase "sharks' teeth" appears a few lines above the critical word. Since the entire passage was very short (5 or 6 lines), there is some confusion as to whether the shorter fixation durations on the word "shark" in the high-constraint condition are due to the influence of conceptual context or due to bottom-up processes. A bottom-up explanation might be that the first occurrence of the word "shark" facilitates processing of the second occurrence since the reader is primed by the visual characteristics of the word (i.e., exactly the same organization of featural information).

The present experiment focussed on the influence of conceptual context on eye movements of readers engaged in reading prose, and the interaction of such influences with word frequency. The experimental

design was a 2 X 2 mixed design with one between-subjects and one within-subjects variable. Two levels of frequency (i.e., high and low) for a critical word embedded in a text was the between-subjects variable, and two levels of contextual constraint (No Context vs. Context) was the within-subjects variable. Given the number of texts that could be constructed, this design was preferred over a completely randomized design mainly because it provided eight replications per subject (i.e., each subject read eight texts in both Context conditions), whereas a completely randomized design would provide only four replications in each condition. Since context was the main factor of interest, it was chosen as the within-subject variable. According to Kirk (1982), the test for the within-subject variable and the between-within interaction is more powerful in this type of design.

Context was manipulated by having the critical word near the beginning of the text or near the end of the text. Only when the low frequency word occurred near the end of the text was it predictable from the conceptual context. It was expected that in the latter case, context effects should be reflected in shorter fixations on the critical word, a lower probability of fixating the critical word, and a larger saccade leading to the critical word.

If eye movements are influenced only by word frequency, this would suggest that bottom-up processes play a major role in determining fixation durations and magnitude of saccades. It is possible that eye movements may be influenced only when the text constrains the critical word and the critical word is of a high

frequency, but that conceptual context or frequency alone is insufficient to produce any effects. If this were true, then one would expect the eye movements to be influenced as above, but only in the condition where the critical word is of a high frequency and is constrained by the context of the story.

Method

Subjects

Thirty-two subjects ranging in age from 16 to 35 years whose native tongue was English were paid to participate in the experiment. Subjects came for two sessions lasting approximately two hours each. They were initially screened to determine their average reading rate and comprehension. Screening consisted of reading two texts, with 10 multiple-choice questions given after each text. The screening materials originated from Educational Developmental Laboratories, Don Mills, Ontario. The texts were taken from series IJ-6/9/16/20, and had a mean length of 1547 words (Favreau, Komoda, & Segalowitz, 1980). In order to participate in the experiment, subjects had to obtain an average reading rate of 250 wpm or higher, and an average of 7 out of 10 questions answered correctly. Subjects were also required to have good uncorrected vision (equivalent to Snellen acuity of 20/20 and normal horizontal phoria), which was determined by passing the Keystone School Vision Screening Test, developed by the Keystone View Company. Sixteen subjects (7 males, 9 females, mean age = 23.7) were randomly assigned to the High Frequency condition and the other 16 (11 males, 5 females, mean age = 21.6) to the Low Frequency condition.

Subjects with eye movement data revealing a high incidence of blinks and/or track losses were replaced until 16 subjects were found for each frequency condition. The subjects were naive with respect to the purpose of the experiment.

Text Materials

The texts consisted of 16 short stories edited from Reader's Digest, each 23 or 24 lines long, with approximately 60 characters per line. Each story was complete in itself.

There were four versions of each text. In the High Frequency - No Context version, a critical word of high frequency in the English language (based on Kucera and Francis' (1970) estimates) appeared within the 3rd to 6th line, near the beginning of the text. In the High Frequency - Context version, a high frequency word appeared within the 17th to 22nd line, near the end of the text. In the Low Frequency - No Context version, a low frequency word appeared near the beginning of the text, and in the Low Frequency - Context version, a low frequency word appeared near the end of the text.

The 32 critical words were chosen such that both the high- and low-frequency word for each text did not disrupt the continuity of the story, and both were appropriate in relation to the story as a whole. All words were adjectives, except for three nouns. Critical words ranged in length from 4 to 9 letters (mean = 6), although word length was the same within all versions of a text. Low frequency words had frequencies not exceeding 130, based on Kucera and Francis (1970). The mean frequency for low frequency words was 36. High frequency words had to be at least 100 units higher than low frequency words.

The mean frequency of high frequency words was 350.

In the context versions (i.e., where the critical word appeared near the end of the text), the body of the text constrained the low frequency word. This was determined from a pilot study in which subjects read either the first few lines of text up to but not including the critical word (No Context version), or the main body of the text up to but not including the critical word (Context version). A blank replaced the critical word. Subjects had to choose in a multiple choice task which word (the high frequency word or the low frequency word) best fit in the blank. Only those texts in which most subjects (i.e., at least 7 out of 10) chose the low frequency word in the Context version and the high frequency word (or both equally) in the No Context version were included in the experiment. The binomial probability that the subjects had chosen the low frequency word in the Context version by chance was .172. The passages were selected, then, for their ability to constrain the low frequency word, since the main interest was whether conceptual constraints could facilitate the processing of low frequency words.

The sentence in which the critical word appeared was exactly the same in all versions of a text in order to avoid local influences on eye movements (O'Regan, 1979, 1980). The only difference was in the location of this sentence (i.e., near the beginning or end of the text) and in the critical word itself (i.e., high or low frequency). The overall organization of the text was the same in the No Context and Context versions, although the specific wording sometimes differed. The texts are to be found in Appendix 1.

Apparatus

Eye movements were recorded using a SRI International Dual Purkinje Eyetracker interfaced with a Digital Equipment Corporation (DEC) PDP 11/34 computer, which controlled the experiment. The eyetracker recorded eye movements from the right eye through noncontacting, infrared illumination, so that subjects were not distracted by the illumination source. Although nonlinear over a visual field of +/- 10 deg of arc horizontally and vertically, the eyetracker has a resolution of 2 to 5 minutes of arc, a frequency response that is flat to 300 Hz and a slewing rate greater than 1000 deg/s (Crane & Steele, 1978).

The horizontal and vertical analog outputs of the eyetracker were sampled at 1000 Hz, sampling rate being determined by a real-time clock. The obtained raw eye movements were linearized on-line using a look-up table derived from calibration data. A bite bar and a forehead rest restricted subjects' head movements, and a black cardboard was placed in front of the left eye, to eliminate effects of binocular interaction or suppression.

The text was displayed double-spaced over two pages (the title plus the first 11 lines on page 1; the next 12 lines on page 2) on a DEC Model VR-17 CRT driven by a DEC Model VT-11 graphic display processor. The refresh rate was fast enough so that there was no apparent flicker. Each letter was made up of dots from a 6 X 8 matrix (4 mm wide and 6 mm high), displayed in upper and lower case as in normal text. Viewing distance was 76 cm, so that each character space subtended 18 minutes of arc horizontally. The luminance of the CRT

was adjusted to a comfortable level for the subject at the start of the session, after which it remained fixed for the duration of the experiment. The recording of eye movements was carried out in darkness. The subjects were provided with a button to change from page 1 to page 2 of the text.

Procedure

Subjects came for two sessions, lasting approximately two hours each. The first session consisted of making a bite-bar and calibrating the eye movements in order to correct for the nonlinearity of the eyetracker. The calibration procedure required subjects to fixate, as accurately as possible, a single spot on a CRT display as it moved haphazardly to 81 different points in a visual field that was 16 deg wide and 16 deg high. The data from eight such calibration trials were averaged to obtain an estimate of the nonlinearities for a given subject. The averaged calibration data were then used to construct a "look-up table" with table entries differing by 0.5 deg over a field 18 deg of arc wide, horizontally and vertically. The on-line scaling and linearization of eye movements was accomplished through the use of the look-up table and linear interpolation between the entries in the table.

Accuracy was tested by having subjects fixate different points on the CRT, while a square of .5 deg horizontally and vertically followed the eye, its position being a function of subjects' linearized eye position. All subjects had no more than .25 deg error (approximately 1 character space) which was manifest at the extreme edges of the CRT. After the calibration trials, subjects were given

one practice text to familiarize themselves with reading from the CRT and switching pages of the display.

The second session was the reading experiment proper. Subjects were presented with 20 texts, 16 experimental and 4 fillers. Each subject read only one of the versions of each text. The texts contained either high frequency or low frequency words (i.e., the between-subject factor). Context and No Context texts were alternated, and text presentation was counterbalanced. The four filler texts were presented: a) at the beginning of the session, b) after the 8th experimental text, just before a 10 minute break, c) after the break, and d) at the end of the session.

Subjects were instructed to read the text as they would normally read a novel or magazine, and that after each text they would be required to answer six multiple-choice questions based on what they had read. This was to ensure that subjects read each text for comprehension rather than quickly scanning the material. Subjects had to press a button twice during the procedure, once for switching from page 1 to page 2 of the text, and a second time to end the trial, at which point the text disappeared from the CRT. At the conclusion of the experiment, subjects were asked to fill out a questionnaire on their reading habits and interests.

Eye Movement Analysis

Eye movement analyses were carried out off-line. The beginning and end of saccades were computed using a velocity criterion of 35 deg/s. If eye velocity dropped below this criterion, it was assumed that a fixation was in progress. Velocities greater than this

criterion were taken to indicate saccades. In order to eliminate false saccades due to noise in the data, two additional criteria were imposed: a) saccadic duration could not be shorter than 6 ms, and b) the intersaccadic interval could not be shorter than 50 ms. Blinks and track losses were excluded from all analyses. Visual inspection of all eye movements was also carried out in order to eliminate the indication of false saccades.

Fixation location was determined by computing the average eye position in horizontal and vertical space respectively during a fixation. This was then converted into the row fixated and the character occupying that position in the text. Fixation on a word was defined as any fixation of a character in the word regardless of the length of the word, or a fixation on the space preceding the word (Rayner, Well, & Pollatsek, 1980). Multiple fixations on a word were counted as different fixations on that word. Fixation duration was determined by counting the number of samples between the end of the previous saccade and the beginning of the next saccade. Inasmuch as the sampling rate was 1000 Hz, durations obtained were within plus or minus one millisecond.

Eye movements were classified according to movement along the horizontal and vertical axes. Small eye movements in which the eye did not move more than half a character space horizontally and more than half a row vertically were classified as no eye movements (NOEM). Eye movements which progressed towards the end of the text were classified as forward eye movements (FWD). The majority of these consisted of moving to the right on a line of text. Eye movements

that regressed towards the beginning of the text were classified as regressive eye movements (REG). Eye movements which started at the end of a line and went to the beginning of the next line were classified as return sweeps (RET). Analyses were performed primarily on forward eye movements, in which the eye moved to the right along a line of text. This type of movement accounted for approximately 70% of eye movements in reading these texts.

RESULTS

Statistical analyses were performed on reading rates and comprehension, fixation durations on the critical word, the number of fixations on the critical word, the probability of fixating the critical word, and the magnitude of the eye movement leading towards and away from the critical word. Source tables for ANOVAs are to be found in Appendix 2.

Reading rates and comprehension

Tables 1 and 2 show the means for the screening measures and for the experimental measures of reading rate and comprehension, respectively. Reading rates from the screening test were subjected to a one-way ANOVA and showed no significant differences between the High- and Low- Frequency groups, nor was there a significant difference in reading comprehension. A 2 X 2 (Frequency X Context) mixed ANOVA showed no significant differences in the experimental reading rates nor in the comprehension scores between High- and Low-frequency groups. A one-way ANOVA yielded a significant

Table 1

Mean Reading Rate and Reading Comprehension in the Screening Test as a Function of Frequency Condition

	High Frequency	Low Frequency
Reading Rate (wpm)	325 (85)	313 (43)
Reading Comp. (% correct)	85 (7)	83 (8)

Note. Values in parentheses indicate the standard deviation.

Table 2

Mean Experimental Reading Rate and Comprehension as a Function of Frequency and Context

	High Frequency		Low Frequency	
	NC	C	NC	C
Reading Rate (wpm)	290 (66)	293 (69)	282 (42)	279 (53)
Reading Comp. (no. correct responses)	4.72 (.17)	4.70 (.16)	4.59 (.30)	4.73 (.11)

Note. Values in parentheses indicate the standard deviation.
NC = No Context; C = Context.

difference between the screening and experimental reading rates: $F(1, 62) = 4.57$, $p < .05$, reading being slower in the experimental condition (285 vs. 319 wpm).

Fixation durations

For each subject, the mean fixation duration on the critical word, regardless of the type of eye movement preceding the fixation, was computed for each text. The average of these fixation durations over eight replications then served as a subject's datum for each condition. The results for the duration of fixation on the critical word are presented in Table 3. A 2 X 2 (Frequency X Context) mixed ANOVA was performed on these means, and a main effect of frequency was obtained, $F(1, 30) = 7.78$, $p < .01$, with the low frequency condition showing higher fixation durations.

In order to correct for any confounding effect of word length on fixation durations, the mean fixation duration on words of the same length as the critical word was computed for each subject reading each text. This mean was subtracted from the mean fixation duration on the critical word itself, resulting in a difference score (i.e., fixation duration on critical word - fixation duration on words of the same length). The obtained difference scores were then averaged over the eight replications for each subject in each of the conditions, and the mean of these means was obtained for the four experimental conditions ($n = 16$ subjects per cell; see Table 4). Inasmuch as the mean fixation duration on words of the same length (other than the critical word) was longer, a larger negative value in Table 4 indicates a shorter fixation duration on the critical word. A 2 X 2 (Frequency X

Table 3

Mean Fixation Duration (ms) on Critical Words as a Function of Frequency and Context

	High Frequency	Low Frequency
No Context	209 (30)	232 (59)
Context	211 (41)	250 (35)

Note. Values in parentheses indicate the standard deviation.

Table 4

Mean Difference Scores (fixation durations on critical words - fixation durations on words of the same length) as a Function of Frequency and Context

	High Frequency	Low Frequency
No Context	-46 (18)	-28 (42)
Context	-41 (44)	-7 (35)

Note. Values in parentheses indicate the standard deviation.

Context) mixed ANOVA was carried out on the difference scores and again resulted in a main effect of frequency, $F(1, 30) = 7.99$, $p < .01$. The High Frequency condition produced shorter fixation durations on the critical word.

In order to determine whether the longer fixation durations were simply a function of page (since the critical word, being near the end of the text was always presented on the second page), a 2 X 2 X 2 (Frequency X Context X Page) ANOVA was carried out on the overall differences in fixation duration between the two pages of the text display. Mean fixation durations were obtained as previously, except that the means included all fixation durations preceding forward eye movements on a given page. Separate means were computed for each page of the display (see Table 5). The only significant effect was a main effect of page number, $F(1, 29) = 11.12$, $p < .01$. Fixation durations on page 1 were higher.

Number of fixations

Mean durations on individual fixations do not provide information about the total amount of time a reader spends looking at a word. For example, three short fixations on a critical word will result in a short mean fixation duration, although processing time is longer on that word than in a situation where there is only one short fixation. The total amount of time a reader spends fixating on a word, called gaze duration (Just & Carpenter, 1978), may reflect processing time more accurately. Alternatively, the number of fixations on the critical word should indicate the ease or difficulty in processing the word.

Table 5

Mean Fixation Durations (ms) as a Function of Frequency, Context, and Page Number

	Page 1		Page 2	
	HF	LF	HF	LF
No Context	255 (30)	260 (22)	253 (31)	257 (22)
Context	254 (17)	261 (22)	250 (28)	252 (26)

Note. Values in parentheses indicate the standard deviation. HF = High frequency; LF = Low frequency.

Table 6

Mean Number of Fixations on the Critical Word as a Function of Frequency and Context

	High Frequency	Low Frequency
No Context	1.21 (.36)	1.27 (.32)
Context	1.23 (.31)	1.21 (.26)

Note. Values in parentheses indicate the standard deviation.

The mean number of times each subject fixated the critical word (regardless of the type of eye movement leading up to the fixation) was computed for each subject reading each text and averaged across the 8 replications for each condition (No Context and Context). The mean number of fixations on the critical word was then computed for the four experimental conditions (n = 16 subjects per cell), and are presented in Table 6. A 2 X 2 (Frequency X Context) mixed ANOVA yielded no significant effects.

Probability of fixating the critical word

Analyzing the mean number of fixations on the critical word over eight replications does not provide any information about whether the critical word was skipped. Therefore, the proportion of instances that the critical word was fixated over 8 replications was computed for each subject. The proportions for each subject in each condition were then averaged, and are presented in Table 7. A 2 X 2 (Frequency X Context) mixed ANOVA yielded no significant effects.

Magnitude of eye movements

For the magnitude of eye movements leading to the critical word, a departure zone of 12 character spaces preceding the critical word was identified. If the last fixation preceding the critical word fell within the departure zone, the number of character spaces between that fixation and the next fixation was counted even if the critical word was skipped. These counts were averaged for each subject (over 8 replications) in the Context and No Context conditions (see Table 8), and the means were subjected to a 2 X 2 (Frequency X Context) mixed ANOVA.

Table 7

Proportion of Fixations on the Critical Word as a Function of Frequency and Context

	High Frequency	Low Frequency
No Context	.83 (.08)	.82 (.12)
Context	.81 (.15)	.87 (.12)

Note. Values in parentheses indicate the standard deviation.

Table 8

Mean Magnitude of Eye Movements (in character spaces) for a Departure Zone of 12 Character Spaces as a Function of Frequency and Context

	HF		LF	
	Mean	S.D.	Mean	S.D.
No Context	10.03	1.17	9.46	1.44
Context	9.31	1.42	9.19	1.64

HF = High frequency; LF = Low frequency; S.D. = standard deviation.

Table 9

Mean Magnitude of Eye Movements (in character spaces) for a Departure Zone of 15 Character Spaces as a Function of Frequency and Context

	HF		LF	
	Mean	S.D.	Mean	S.D.
No Context	10.64	1.32	9.74	1.42
Context	9.79	1.20	10.06	1.81

HF = High frequency; LF = Low frequency; S.D. = standard deviation.

The same procedure was followed for a departure zone of 15 character spaces (means are presented in Table 9). Since this data includes the counts for the departure zone of 12 character spaces, this constitutes a second ANOVA on the same set of data. In order to keep the probability of making a Type I error at .05, the significance level for each of these tests was set at .025 (Hays, 1981).

The size of the departure zones was chosen on the basis of availability of useful information in parafoveal vision, which may play a role in eye guidance. According to Rayner (1983), information about word shape and word length is available up to 12 or 15 character spaces to the right of fixation. Although O'Regan (1979) in a similar analysis used a departure zone of seven character spaces, it was not possible to carry out this analysis reliably because fixations prior to those on the critical word were usually not within this boundary. At most, only 2 measures per subject were available using this departure zone. Due to the fact that the critical words for five of the texts were located at or close to the beginning of the line, these texts had to be dropped from the analysis because departure zones could not be identified. The following results are based on the analyses of 11 texts per subject.

The ANOVA on the magnitude of eye movements in the 12-character departure zone yielded no significant effects, whereas the ANOVA on magnitude of eye movements in the 15-character departure zone produced a significant interaction between Frequency and Context, $F(1, 30) = 5.74$, $p < .025$. Post hoc Tukey tests using a conservative significance level of .01 yielded no significant differences between

the High Frequency - No Context vs. the High Frequency - Context conditions, nor was there a significant difference between the High Frequency - No Context vs. the Low Frequency - No Context condition.

Since the post hoc tests were evaluated using a rather conservative significance level, the trend towards larger eye movements in the No Context condition when approaching high frequency words was further analyzed. It is possible that this trend reflects overall larger eye movements on page 1 as compared with page 2, at least for the High Frequency group. The reason why the Low Frequency group did not show a similar effect may be simply because low frequency words tend to be fixated more often (O'Regan, 1979). For page 1 and page 2, the mean magnitude of forward eye movements over the entire page for each subject (8 replications) was averaged, and these means were then averaged for each condition (see Table 10). A 2 X 2 X 2 (Frequency X Context X Page) mixed ANOVA yielded a main effect of page, $F(1, 29) = 24.70$, $p < .001$. The magnitude of eye movements were significantly larger on page 2 of the text. A significant interaction of Frequency X Context was also found, $F(1, 29) = 4.93$, $p < .05$. There were larger eye movements over high frequency words in the Context condition, and smaller eye movements in the No Context condition. Conversely, there were larger eye movements over low frequency words in the No Context condition and smaller eye movements in the Context condition.

A 2 X 2 (Frequency X Context) ANOVA was also conducted on the magnitude of eye movements leading away from the critical word, given that the critical word was fixated. This consisted of counting the

Table 10

Mean Magnitude of Forward Eye Movements (in character spaces) as a Function of Frequency, Context, and Page Number

	Page 1		Page 2	
	HF	LF	HF	LF
No Context	9.55	9.52	9.81	9.81
	(1.01)	(1.30)	(1.00)	(1.56)
Context	9.49	9.44	10.06	9.63
	(.97)	(1.44)	(1.18)	(1.59)

Note. Values in parentheses indicate the standard deviation. HF = High frequency; LF = Low frequency.

Table 11

Mean Magnitude of Eye Movements (in character spaces) Leading Away From the Critical Word as a Function of Frequency and Context

	HF		LF	
	Mean	S.D.	Mean	S.D.
No Context	6.60	4.19	6.47	3.35
Context	6.03	6.00	7.02	3.30

HF = High frequency; LF = Low frequency; S.D. = standard deviation.

number of character spaces between the fixation of the critical word and the next fixation. Means are presented in Table 11. The ANOVA yielded no significant effects.

Discussion

The results are consistent with the idea that conceptual context did not facilitate processing of a word which was constrained by the text. This is evident from the fixation duration data, which show a trend towards longer fixations on the critical word in the context condition. Frequency, on the other hand, clearly influenced fixation duration. High frequency words had shorter fixation durations irrespective of context. These differences cannot be attributed to differences in reading rate or comprehension. Reading rate and comprehension did not differ between the two groups in the screening test nor in the experimental task.

The significant difference between the screening and experimental measures are due to differences in the reading situation. Whereas subjects were reading text under normal conditions in the screening test, the experimental texts were presented on a CRT display. The visual characteristics of the text differed from ordinary text in the sense that light characters were presented on a dark background. Also, subjects were inconvenienced by the bite-bar and the cardboard that occluded their left eye. These combined factors produced an overall decrease in reading rate, whereas comprehension remained at a high level.

Indications of poorer performance in the Context condition was not specific to fixation durations. The proportion of fixations on

the critical word was not less in the Low Frequency - Context condition. The magnitude of eye movements did not increase in the Context condition.

An overview of the results, therefore, suggests no influence of conceptual context on eye movements in reading. However, to the extent that the results of the pilot study indicated the operation of guessing, it is possible that the manipulation of conceptual context was simply not effective. Nevertheless, the processing of words is facilitated if the word has a high frequency in the language, a finding that lends support to bottom-up models of reading. To integrate the present findings with the main body of research in this area, it is worth considering each of the types of analyses in more detail.

The significant frequency effect in the fixation duration data yielded a 31 ms decrease in processing time for high frequency words. This advantage is of the same order of magnitude as that found by Ehrlich and Rayner (1981), except that in their study, the advantage was provided by contextual constraint.

As was mentioned earlier, it is possible that the contextual constraint operating in Ehrlich and Rayner's (1981) study was essentially bottom-up, since the critical word often appeared earlier in the text. It can be argued that having recently processed the first instance of the word will make the second occurrence easier to decode. Studies on the extraction of information during fixations suggest the time constraints under which such bottom-up processes may operate in order to influence fixation durations. Wolverton and Zola

(1983) report an experiment in which subjects read 30-line passages for meaning. At different times during certain fixations, lines of text were replaced with other lines (e.g., all capital Xs, lines from a different page, etc.). It was found that during the first 30 ms of the fixation, only gross changes that affected word shape and length significantly disrupted reading. It was concluded that parafoveal and peripheral information such as word shape is being extracted during the initial 30 ms of a fixation. Furthermore, it was found that only changes within the first 100 ms could influence the current fixation. It is conceivable, then, that during the second occurrence of "shark", the word is recognized by its shape and length early enough to significantly shorten the fixation duration on the word.

The memory for particular instances of any word seems to be available for some time after reading the text. This was evident in the present experiment in the multiple-choice task. Along with the five multiple-choice questions assessing comprehension, a sixth question, randomly intermixed with the other five, did not have a straightforward answer but rather asked the reader for an opinion. The question for the Convict text (see Appendix 1), for example, was: Swede can best be described as a(n) _____ person. The three choices consisted of the two critical words "simple" (frequency = 161) and "gentle" (frequency = 27), along with a third word, in this case "impatient". The purpose of this question was to determine whether the text as a whole would bias the reader in choosing the low frequency word regardless of whether the text contained the high frequency word, thus providing a measure of the effectiveness of the

context manipulation independent of the pilot study. Analysis of this measure was abandoned because many subjects reported remembering the exact word they had seen in the text. This suggests that a second occurrence of a word like "shark" within one or two lines of a first occurrence might produce facilitation in processing this occurrence due to a "repetition effect", which has to do with the frequency of the word in the text rather than its frequency in the language. Scinto (1978), in fact, provides evidence that repetition effects do occur. As was mentioned in the Introduction, shorter fixations were found when subjects read portions of text in which the information presented had already been presented before.

If one considers Zola's (1984) study, the high-constraint passage yielded a fixation duration advantage of only 16 ms for a word which was highly constrained by an immediately preceding adjective. This suggests a pattern of contextual influence in reading which runs counter to a suggestion proposed by Ehrlich and Rayner (1981). They suggested that one should find the influence of conceptual context increasing in proportion to the amount of text available which constrains the critical word. The evidence seems to suggest the contrary: in tachistoscopic presentations of single words, semantic influences are clear and reliable. For example, Meyer, Schvaneveldt, and Ruddy (1975) showed that subjects could recognize a word such as "butter" faster when it followed the word "bread" than when it followed the word "nurse." In a lexical decision task, semantic association yielded a mean advantage of 55 ms.

If we now have subjects read a passage of text in which an

adjective constrains the immediately following word, such as "buttered popcorn" as opposed to "adequate popcorn" (Zola, 1984), the advantage drops to 16 ms. Assuming that Ehrlich and Rayner's (1981) study is confounded with the repetition of the critical word, then the present study in which constraint is based on the whole nature of the text preceding the critical word rather than on any particular word suggests no advantage in processing the critical word due to contextual constraints. However, a decrease in fixation durations on the order of 31 ms is achieved by increasing a word's frequency, which probably shortens the time required for bottom-up processes to decode the word.

A puzzling aspect of the present study is that context (although context effects are not significant) tends to show worse performance in the Low Frequency condition, in which conceptual context should yield the greatest facilitation. Fixation durations are longer in the Low Frequency Context condition. This cannot be explained by the fact that the critical word in the Context condition always occurs on the second page (i.e., implying the reader becomes tired by the time he/she reads the critical word). The results of the analysis of fixation durations on page 1 and page 2 show significantly longer durations on page 1. This is consistent with the notion of a practice effect, whereby subjects find it easier to read page 2 after they have read page 1. Another possibility, however, is that the shorter durations on page 2 indicate a gross influence of conceptual context. Readers may be taking less time to process information on page 2 as long as it is consistent with the concepts introduced on the previous

page. It is impossible to determine which of these alternatives holds true for the present results because any effects due to practice are confounded with any effects of conceptual context.

The analysis of the magnitude of eye movements indicates no effect of conceptual context, although a significant interaction between Frequency and Context is present. The magnitude of eye movements approaching high frequency words was larger in the No Context condition, and smaller in the Context condition. There is no similar effect for magnitudes approaching the low frequency words. Although not significant, this trend cannot be explained by differences in overall magnitude of eye movements between pages 1 and 2 of the text, since analysis of the mean magnitudes on all forward eye movements for page 1 and page 2 indicate that the magnitudes are significantly larger on the second page by 1/3 of a character space. As was the case with fixation durations, it is possible that larger eye movements on page 2 could be due to practice effects or to a gross influence of context. As long as the material on page 2 is consistent with that on the first page, eye movements are generally longer. Like the fixation duration data, however, such global effects, if they are present, are confounded with practice.

The significant interaction between frequency and context in the 3-way ANOVA is much more difficult to explain. Collapsed over pages, there is no difference between mean forward magnitudes over the entire text in the No Context condition for the High Frequency and Low Frequency groups of subjects. However, in the Context condition, magnitudes increase for the High Frequency group and decrease for the

Low Frequency group, with an overall difference of 1/4 of a character space. Since the texts are counterbalanced over all conditions, the only difference between each condition of Frequency and Context is the critical word. Since the critical word itself cannot largely influence the mean forward magnitudes for an entire text, it is presently unclear exactly what this difference signifies. It is worth noting that 1/4 of a character space is not a huge difference, and it is difficult to see the advantage over a large body of text.

The present results raise important issues concerning reading and the variables that influence the reading process. Certain types of word may reflect influences on eye movements more easily than others. The critical word in the present experiment was an adjective, whereas Zola (1984) and Ehrlich and Rayner (1981) utilized nouns. It is possible that contextual constraints differentially affect processing time on nouns and adjectives, nouns being more highly constrained. For example, consider the critical sentence in the Convict text: "Swede was a very gentle person." If the text generally describes Swede as a gentle person, it probably constrains a class of words related to gentle rather than the specific word itself. Thus, a reader is as likely to expect words such as "kind," "good," "sweet," "friendly", or "nice, all quite appropriate in this context. However, if the critical word was the noun "person", then the string "Swede was a very gentle... " might not suggest as many possibilities. Swede may be a person, a man, or a convict, but certainly not a policeman, a doctor, or a dog. This issue could perhaps be resolved by determining whether priming effects for adjectives are equal in

magnitude to the effects that have been found with nouns.

The issue regarding reading skill is also relevant. Gough (1983) argues that skilled reading may essentially proceed in a bottom-up manner when the text is clearly and continuously visible while the eyes are moving over it. This is consistent with an active-compensatory model of reading proposed by Stanovich (1980), which states that in skilled readers, word recognition proceeds rapidly due to fast bottom-up processing. Less skilled or poor readers, however, are less able to recognize words on the basis of visual characteristics alone, and it is in this situation that top-down processes may intervene in the manner described by Rumelhart (1977) and suggested by Stanovich (1980), whereby contextual cues are used to facilitate or complement bottom-up processes. It can be argued that context effects were not obtained in the present experiment because all subjects were relatively skilled readers, reading at least 250 wpm with good comprehension. However, it should be possible to directly test this hypothesis by manipulating skill of reading by having subjects read in a second language in which they are less proficient. Using the same subjects in each group would also reduce individual differences in eye movement measures, which tend to be very large (Rayner & Inhoff, 1981). Just as contextual constraint has been shown to facilitate the processing of degraded stimuli, it may also facilitate the processing of text when bottom-up processes are not functioning in an optimal manner. As a conclusion, it is probably safe to state that although it may be possible for conceptual context to influence eye movements in reading (the evidence for this

is not overwhelming), the manipulation of conceptual context in the present study was unable to demonstrate such effects. A significant word frequency effect, however, indicated efficient bottom-up processing.

References

Carpenter, P. A., & Just, M. A. (1981). Cognitive processes in reading: Models based on readers' Eye Fixations. In A. M. Lesgold & C. A. Perfetti (Eds.), Interactive Processes in Reading. New Jersey: L. E. A.

Carpenter, P. A., & Just, M. A. (1983). What your eyes do while your mind is reading. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes.

Crane, H. D., & Steele, C. M. (1978). Accurate three-dimensional eyetracker. Applied Optics, 17, 691-705.

Dobbs, A. R., Friedman, A, & Lloyd, J. (1985). Frequency effects in lexical decisions: A test of the verification model. Journal of Experimental Psychology: Human Perception and Performance, 11, 81-92.

Ehrlich, K. (1983). Eye movements in pronoun assignment: A study of sentence integration. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

Ehrlich, K., & Rayner, K. (1983). Pronoun assignment and semantic integration during reading: Eye movements and immediacy of processing. Journal of Verbal Learning and Verbal Behavior, 22, 75-87

Ehrlich, S. F. (1983). Contextual influences on eye movements in reading. In K. Rayner (Ed.), Eye movements in reading: Perceptual

and language processes. New York: Academic Press.

Ehrlich, S. F., & Rayner, K. (1981). Contextual effects on word perception and eye movements. Journal of Verbal Learning and Verbal Behavior, 20, 641-655.

Favreau, M., Komoda, M. K., & Segalowitz, N. (1980). Second language reading: Implications of the word superiority effect in skilled bilinguals. Canadian Journal of Psychology, 34, 370-380.

Frazier, L. (1983). Processing sentence structure. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

Gough, P. B. (1972). One second of reading. In J. F. Kavanaugh & I. G. Mattingly (Eds.), Language by ear and by eye. Cambridge, Mass: MIT Press.

Gough, P. B. (1983). Context, form and interaction. In K. Rayner (Ed.), Eye movements in reading: Perceptual and language processes. New York: Academic Press.

Gough, P. B., & Cosky, M. J. (1977). One second of reading again. In N. J. Castellan, D. Pisoni, & G. Potts, G. (Eds.), Cognitive Theory, Vol 2. New York: L.E.A.

Graboi, D. (1974). Physical shape, practice and meaning in visual search. Unpublished doctoral dissertation, University of California, San Diego. (Rumelhart, D. E. (1977). Toward an interactive model of reading. In S. Dornic (Ed.), Attention and Performance VI. New York: Lawrence Erlbaum Associates.)

Hays, W. L. (1981). Statistics (Third Edition). New York: Holt, Rinehart and Winston.

Hochberg, J. (1970). Components of literacy: speculations and exploratory research. In H. Levin & J. P. Williams (Eds.), Basic Studies on Reading. New York: Basic Books

Hogaboam, T. W. (1983). Reading patterns in eye movement data. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

Just, M. A., & Carpenter, P. A. (1978). Inference processes during reading: Reflections from eye fixations. In J. W. Senders, D. F. Fisher, & R. A. Monty (Eds.), Eye Movements and the Higher Psychological Functions. New Jersey: Erlbaum.

Kennedy, A. (1978). Reading sentences: Some observations on the control of eye movements. In G. Underwood (Ed.), Strategies of Information Processing. London: Academic Press.

Kirk, R. E. (1982). Experimental Design (Second Edition). California: Brooks/Cole.

Kucera, H., & Francis, W. N. (1970). Computational analysis of present-day American English. Providence, R. I.: Brown University Press.

McConkie, G. W. (1983). Eye movements and perception during reading. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

McConkie, G. W., & Zola, D. (1981). Language constraints and the functional stimulus in reading. In A. M. Lesgold & C. A. Perfetti (Eds.), Interactive processes in reading. Hillsdale, N. J.: Lawrence Erlbaum Associates.

Meyer, D. E., Schvaneveldt, R. W., & Ruddy, M. G. (1975). Loci of

contextual effects on visual word recognition. In P. M. A. Rabbitt & S. Dornic (Eds.), Attention and performance V. London: Academic Press.

Miller, G. A., Heise, G. A., & Lichten, W. (1951). The intelligibility of speech as a function of the context of the test materials. Journal of Experimental Psychology, 41, 329-335.

O'Neil, W. M. (1953). The effect of verbal association on tachistoscopic recognition. Australian Journal of Psychology, 5, 42-45.

O'Regan, K. (1979). Saccade size control in reading: Evidence for the linguistic control hypothesis. Perception and Psychophysics, 25, 501-509.

O'Regan, J. K. (1980). The control of saccade size and fixation duration in reading: The limits of linguistic control. Perception and Psychophysics, 28, 112-117.

O'Regan, J. K. (1984). How the eye scans isolated words. In A. G. Gale, & F. Johnson (Eds.), Theoretical and Applied Aspects of Eye Movement Research. North-Holland: Elsevier Science Publishers.

Potter, M. C. (1983). Representational buffers: The eye-mind hypothesis in picture perception, reading, and visual search. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

Rayner, K. (1983). The perceptual span and eye movement control during reading. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

Rayner, K., & Inhoff, W. (1981). Control of eye movements during

reading. In B. L. Zuber (Ed.), Models of oculomotor behavior and control. CRC Press Inc.

Rayner, K., & McConkie, G. W. (1976). What guides a reader's eye movements? Vision Research, 16, 829-837.

Rayner, K., Well, A. D., & Pollatsek, A. (1980). Asymmetry of the effective visual field in reading. Perception and Psychophysics, 27, 537-544.

Rouse, R. O., & Verinis, J. S. (1962). The effect of associative connections on the recognition of flashed words. Journal of Verbal Learning and Verbal Behavior, 1, 300-303.

Rumelhart, D. E. (1977). Toward an interactive model of reading. In S. Dornic (Ed.), Attention and Performance VI. New York: LEA.

Sawyer, D. J. (1971). Intra-sentence grammatical constraints in readers' sampling of the visual display. Unpublished doctoral dissertation. Department of Education, Cornell University. (McConkie, G. W., & Zola, D. (1981). Language constraints and the functional stimulus in reading. In A. M. Lesgold & C. A. Perfetti (Eds.), Interactive processes in reading. Hillsdale, N. J.: Lawrence Erlbaum Associates.)

Scinto, L. F. (1978). Relations of eye fixations to old-new information of texts. In J. W. Senders, D. F. Fisher, & R. A. Monty (Eds.), Eye movements and the higher psychological functions. Hillsdale, N. J.: Lawrence Erlbaum Associates.

Shebilske, W. L. (1975). Reading eye movements from an information-processing point of view. In D. W. Massaro (Ed.), Understanding Language. New York: Academic Press.

Shebilske, W. L., & Fisher, D. F. (1983). Eye movements and context effects during reading of extended discourse. In K. Rayner (Ed.), Eye movements in reading: Perceptual and language processes. New York: Academic Press.

Shebilske, W. L., & Reid, L. S. (1979). Reading eye movements, macro-structure and comprehension processes. In P. A. Kolers, M. E. Wrolstad, & H. Bouma (Eds.), Processing of Visible Language, Vol. 1. New York: Plenum Press.

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. Reading Research Quarterly, 16, 32-71.

Stanovich, K. E., & West, R. F. (1983). The generalizability of context effects on word recognition: A reconsideration of the roles of parafoveal priming and sentence context. Memory and Cognition, 11, 49-58.

Stern, J. A. (1978). Eye movements, reading, and cognition. In J. W. Senders, D. F. Fisher, & R. A. Monty (Eds.), Eye Movements and the Higher Psychological Functions. New Jersey: LEA.

Sumby, W. H. (1963). Word frequency and the serial position effect. Journal of Verbal Learning and Verbal Behavior, 1, 443-450.

Tulving, E., & Gold, C. (1963). Stimulus information and contextual information as determinants of tachistoscopic recognition of words. Journal of Experimental Psychology, 66, 319-327.

Wanat, S. F. (1971). Linguistic structure in reading: Models from the research of Project Literacy. In F. B. Davis (Ed.), The literature of research in reading with emphasis on models. New

Brunswick, N. J: Graduate School of Education, Rutgers - The State University. (McConkie, G. W., & Zola, D. (1981). Language constraints and the functional stimulus in reading. In A. M. Lesgold & C. A. Perfetti (Eds.), Interactive processes in reading. Hillsdale, N. J: Lawrence Erlbaum Associates.)

Whaley, C. P. (1978). Word - nonword classification time. Journal of Verbal Learning and Verbal Behavior, 17, 143-154.

Wolverton, G. S., & Zola, D. (1983). The temporal characteristics of visual information extraction during reading. In K. Rayner (Ed.), Eye Movements in Reading: Perceptual and Language Processes. New York: Academic Press.

Zola, D. (1984). Redundancy and word perception during reading. Perception and Psychophysics, 36, 277-284.

Appendix 1

Texts and Comprehension Questions

The 16 texts and the comprehension questions for each text are presented in the following pages. The No Context version of the text is presented first, followed by the Context version. For purposes of illustration, the critical sentence contains, in parentheses, the high frequency word and the low frequency word, respectively. In the experiment, only one of these words was present in the text. The texts are not in the same format as they were presented in the experiment. Therefore, the critical word will not be in the same position in the line for each version of a text. In the experiment, the texts were presented with approximately 80 characters per line, and the critical words (as well as the sentence) were at the same location in the line for each version. The critical sentence was not underlined in the experiment.

CONVICT

My father was warden of the Kentucky State Penitentiary and after school, I sometimes did my homework in the prison administration office. One Saturday I was doing math when a convict named Swede told me to quit using a calculator to do my Grade 6 arithmetic. Swede was a very (simple / gentle) person. He told me to hand him the text and motioned me to a chair near his table. For the rest of that evening, I listened with fascination while he talked of the magic of mathematics and taught me shortcuts to squaring and multiplying. I began taking difficult assignments to Swede. With his help, I managed to get my first A in arithmetic. By this time, Swede and I were using a large empty desk in the administration office to study. My father was pleased with Swede's as well as my progress, since maximum security had initially been recommended for him. But all the time I knew him, Swede never caused an ounce of trouble. He was always kind and polite, and it pleased him greatly when he learned I was getting good marks in class. And so, my sessions with Swede continued. Until I graduated from high school seven years later, that bleak prison office, with its barred windows and improbable teacher, was a classroom as real and challenging to me as any I have attended before or since.

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My father was warden of the Kentucky State Penitentiary and after school, I sometimes did my homework in the prison administration office. One Saturday I was doing math when a convict named Swede told me to quit using a calculator to do my Grade 6 arithmetic. He told me to hand him the text and motioned me to a chair near his table. For the rest of that evening, I listened with fascination while he talked of the magic of mathematics and taught me shortcuts to squaring and multiplying. I began taking difficult assignments to Swede. With his help, I got my first A in arithmetic. By this time, Swede and I were using an empty desk in the administration office to study. My father was pleased with Swede's as well as my progress, since maximum security had initially been recommended for him. But all the time I knew him, Swede never caused any trouble. He was always kind and polite, and it pleased him very much when he learned I was getting good grades in school. Swede was a very (simple / gentle) person. All throughout the semester, my sessions with him continued. Our studies broadened as I progressed through school. My father smiled whenever he saw us at work. Until I graduated seven years later, that bleak prison office, with its barred windows and improbable teacher, was a classroom as real and challenging to me as any I have attended before or since.

1. Swede can best be described as a(n) _____ person.
   a) impatient
   b) gentle
   c) simple

2. Swede helped me with
   a) physics
   b) chemistry
   c) math

3. Swede and I studied in
   a) my father's office
   b) the administration office
   c) Swede's jail cell

4. I was in Grade
   a) 3
   b) 6
   c) 9

5. When I told Swede I received my first A, he
   a) did not care
   b) frowned
   c) was pleased

6. My father was
   a) warden of the penitentiary
   b) the prison psychologist
   c) Swede's lawyer

THE ROYAL WINNIPEG BALLET

Evelyne Bostok has always loved to dance. Inside Place des Arts, she is rehearsing for the first performance of a forty-day tour. She has been dancing and studying dance for a dozen years, and tonight, she feels (free / pain) as she spins and wheels around the stage. Later, after the practice, she will show a badly swollen ankle to Vic Zumen, the company's stage manager. She will smile, and refer to the red and purple marks as her rainbow. But it is a hurting sort of rainbow, and for the rest of the day, and tomorrow and every day thereafter until the colors fade, Evelyne will dance on it. It is all part of the life. Out on the floor, Tess Bacall, one of the company's three principal dancers, is rehearsing with a split vertebra, which, within two weeks, will force her off the stage indefinitely. Injuries are part of every tour, and dancers have to be flown in from Winnipeg to replace those seriously ill or injured. By any standards, the physical discipline involved in ballet is staggering. As she performs, Evelyne tries not to think of her rainbow, but it becomes impossible to ignore the stinging sensation in her leg. While the rewards for dancing are not great compared to those of professional athletes, few people can do what Evelyne and her colleagues do. For them, dancing is a special kind of magic.

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1. Evelyne Bostok is a

   a) ballerina
   b) dramatist
   c) jazz dancer

2. The author portrays the company as a very _____ group of people.

   a) anxious
   b) dedicated
   c) disorganized

3. What do you think Evelyne feels as she dances during the rehearsal?

   a) nervous
   b) free
   c) pain

4. The Royal Winnipeg is

   a) about to disband
   b) almost unknown
   c) very popular

5. Evelyne continues to perform despite

   a) a swollen ankle
   b) a dislocated vertebra
   c) high blood pressure

6. The rainbow refers to

   a) a performance
   b) an injury
   c) a hope

BRAIN SURGERY

Dr Long looked at the big, soft bulge at the back of Joe's head. He was certain that the tumor would be stuck to every important artery and nerve in the posterior fossa, a tennis-ball-size compartment at the base of the brain where the spinal cord emerges into the cranium. The chances that Joe would survive the operation were (limited / maximal) at this point. If he accidently cut a nerve that ran through the tumor, Joe's face could be paralyzed or he'd never swallow normally again. And then there was the brain stem, the pilot light of life. Damage a tiny artery leading to it, and something profound might happen to the connection between Joe's brain and his soul, and he would live on, and on, but never wake up. Six hours into the operation, the largest remaining chunk of the tumor started to come out. For two more hours, the tumor hung on tenaciously, giving ground reluctantly. The black tip of the Cavitron touched it and moved, leaving behind a trench. At last it finally came free, and Dr. Long was certain for the first time that Joe would pull through. He looked for any remaining speck of yellow that could grow back into a new tumor. He saw nothing. The cranial nerves lay limply across the floor of the cranium, but they were intact. It would probably take months for Joe to recover fully from the operation, but he would lead a normal life.

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1. Dr. Long was a

   a) chest surgeon
   b) neurosurgeon
   c) heart surgeon

2. Joe's recovery lasted many

   a) months
   b) days
   c) years

3. Accidently cutting a nerve imbedded within the tumor could result in

   a) heart attack
   b) respiration problems
   c) facial paralysis

4. Joe's tumor was located in the

   a) brain
   b) lungs
   c) liver

5. The tumor was stuck to

   a) veins and sinuses
   b) the Circle of Willis
   c) arteries and nerves

6. Six hours into the operation, Long knew that Joe's chances of survival were

   a) maximal
   b) minimal
   c) limited

NORTHERN LIGHTS

The aurora borealis is a geomagnetic storm known to laymen as the "northern lights". It appears as shimmering veils of green, white, and red light rippling across the northern horizon. The research on the northern lights is (available / confusing) to everybody. The phantom glows can suddenly surge in brightness, then disappear within minutes, as if propelled by celestial breezes between Earth and the stars. Despite a great amount of research, the northern lights still remain one of nature's most mysterious phenomena. Astronomers speculate that the northern lights may be related to solar flares and sunspots, areas of turbulent activity on the sun. However, there are inconsistencies to this notion. For example, a huge flare on the sun might trigger only a minor aurora, while at other times, a modest eruption will result in a fine display. Even more puzzling are reports of people being able to hear an aurora. Although incredible, these reports are so very persistent that scientists are becoming convinced that the phenomenon may in fact be real. Scientists are conducting experiments in which artificial auroras are created using a particle accelerator. It is hoped that these creations can act as a gauge for the real thing, and hence increase our understanding of the mechanism that produces them in nature.

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1. Northern lights are presumably related to

   a) temperature
   b) sunspots
   c) electrical storms

2. From the author's statements, one can conclude that research on the northern lights is certainly

   a) confusing
   b) available
   c) rigorous

3. There are reports of people _____ the northern lights.

   a) hearing
   b) feeling
   c) smelling

4. Apparently, researchers have been able to

   a) explain why northern lights occur
   b) link the appearance of northern lights with meteor showers
   c) artificially create northern lights

5. The northern lights are of greatest interest to

   a) meteorologists
   b) astronomers
   c) astrologists

6. The northern lights are also known as

   a) earthshine
   b) Magellanic Clouds
   c) aurora borealis

JUMBO

In 1880, the Barnum and Bailey circus bought a huge African elephant named Jumbo from the London Zoological Gardens, with the intent to transport Jumbo to the United States. Jumbo was a very (large / funny) elephant. When he arrived in New York, his march to Madison Square Garden was followed by an elated crowd. Thousands of spectators gathered in doorways and on rooftops, and burst into a roar of applause which almost shook the city to its foundations. Hundreds of gifts poured into the Garden from all over the country. During the time that Jumbo was on display, more than four million children and sixteen million adults went to see him. Jumbo continued to amuse children and adults alike in performances in Manhattan and on the road. A favorite trick of his was to sneak up behind his trainer and "slap" him on the back of the head with one of his large ears. Another was to steal the hats of people who came to watch him and place them on top of his own head. Many consumer products bore Jumbo's image. Shoe fasteners, soaps, liniments and laxatives were sold with his unofficial endorsement. The Williamantic Thread Company boasted that its thread was strong enough to pull the elephant. A century after his death, Jumbo remains the most beloved animal ever to have roamed the earth.

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1. Jumbo marched triumphantly to

   a) Madison Square Garden
   b) Trafalgar Square
   c) Tottenham Court Road

2. Many of the people who saw Jumbo would characterize him as a _____ elephant.

   a) large
   b) funny
   c) happy

3. Initially, Jumbo was a resident of the

   a) Boston Zoological Gardens
   b) London Zoological Gardens
   c) Kruger National Park

4. Jumbo was a(n) _____ elephant.

   a) albino
   b) Indian
   c) African

5. Jumbo would often steal peoples'

   a) popcorn
   b) umbrellas
   c) hats

6. Jumbo was part of the _____ circus.

   a) Ringling Brothers
   b) Barnum and Bailey
   c) Shriner's

LONELINESS

A growing number of mental-health professionals are studying contemporary loneliness. Studies show that feeling lonely is (basic / fatal) in some situations. It seems that people are more lonely than in the past, and the trend is expected to continue. It is not that people have become more isolated in any tangible way. On the contrary, modern communications and transportation have made it possible to stay in closer contact than ever before. Rather, there is a sense that our connections are somehow inadequate. The exagerrated expectations created by the idealized versions of life on television play a role. And because of increasing freedom and continuing mobility, ties to spouses and family tend to break more easily. Also, the physical consequences of loneliness pose greater dangers than anyone thought. There are frightening connections between lack of human companionship and heart disease. Persistent loneliness is associated with alcoholism, drug abuse and suicide. The rise of human loneliness may be one of the most serious sources of disease in the twentieth century. Furthermore, there is persuasive evidence that loneliness may have a larger impact on society than we have realized. Its impact can be assessed in the rise of self-destructive diseases like cigarette smoking and habitual drinking.

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1. Research shows that loneliness can be

   a) fatal
   b) basic
   c) beneficial

2. Loneliness has been associated with

   a) vandalism and robbery
   b) alcoholism and drug abuse
   c) depression and paranoia

3. Loneliness seems to have _____ over the years.

   a) remained the same
   b) decreased
   c) increased

4. Loneliness has a great impact on

   a) depressed people
   b) psychologists
   c) society

5. _____ plays a role in creating idealized versions of life

   a) television
   b) advertisement
   c) propaganda

6. Family ties break more easily due to increasing

   a) freedom and mobility
   b) unemployment and inflation
   c) loneliness and depression

SHEEP DOG

Nurtured amid the rigors of the wild glens and moors along the Scottish-English border, the border collie stands no higher than a man's knee, weighs about 45 pounds and has a demeanor of bashful friendliness. Considering its small size, the border collie is more (common / daring) than most other sheep dogs. It is considered to be the leading sheep dog throughout the world. No sheep is too wayward, no hazard is too great for this fleet and plucky animal. The story of Jen exemplifies its cunning when faced with difficult situations. A dozen sheep were lost in a wild blizzard that swept the hills in the Scottish border country. Tom Watson set out with his border collie, Jen, to find them. As Watson struggled through chest-high snow the dog raced up a hill and disappeared. Watson plunged onwards through the snow. Suddenly, he heard a splash. Looking up, he saw the sheep cascade from a snowdrift into the water, steered by the little collie. Not only had Jen found the sheep, she had deduced that the only escape from the hill was by the tumbling stream. She managed in herding all the sheep back to the farm. Not only is the border collie the world's leading sheep dog, it has penetrated the Iron Curtain, reached Japan, and has long been established in the Americas and in South Africa.

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1. Jen is a(n)

   a) West Highland white terrier
   b) Border collie
   c) Airedale

2. This particular breed of dog is quite

   a) common
   b) daring
   c) large

3. Jen had to find a dozen lost

   a) sheep
   b) goats
   c) cows

4. Jen led the herd through a _____ to escape the snowdrift.

   a) forest
   b) valley
   c) stream

5. Jen is a native of

   a) the Scottish border country
   b) southern Ireland
   c) Wales

6. Jen belonged to

   a) Tom Watson
   b) Percy Henderson
   c) Matilda Worth

RADIATION

Dr. Alexander Manning was on call for the Emergency Decontamination Facility (EDF), a center for the treatment of radiation accident victims, when the emergency alarm was sounded. Dr. Manning felt rather (concerned / miserable) when he left. The lead nuclear-process operator Harold Brenner was hit with 500 times the amount of radioactive material anyone should safely receive in a lifetime. The substance in question was americium-241. Without delay, Dr. Manning administered calcium DTPA, which forces americium into the body's waste products. However, a new problem developed. The huge doses of DTPA were depleting Harold's body of zinc, which could lead to fatal intestinal bleeding. The doctors then remembered that a similar compound, zinc DTPA, had been administered briefly to animals. There were some questions about its safety, for it had never been tested in humans on this continent. They tried it on Harold and to their dismay, it proved fatal. There were too many things which were not understood about this drug, too many unpredictable side effects. Until today, Dr. Manning had never lost a patient while on duty for the Decontamination Facility. Harold's death weighed heavily on his mind, even though he knew that the drug had definitely been his only chance for surviving the accident.

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1. Harold Brenner was

   a) a security guard
   b) a nuclear-process operator
   c) a medical researcher

2. Which adjective would best describe Dr. Manning's state of mind as he left the operation room?

   a) concerned
   b) miserable
   c) in shock

3. A drug which was administered to Harold Brenner was

   a) erythrityl tetranitrate
   b) calcium DTPA
   c) lithium carbonate

4. The drug had an effect on the level of _____ in Harold's body.

   a) zinc
   b) iron
   c) lead

5. Americium-241 is

   a) a radioactive substance
   b) a treatment center
   c) a decontamination facility

6. Harold Brenner

   a) was cured
   b) died
   c) was permanently impaired

PRINCE

I have memories of Prince, an old and special horse, which I shall treasure as long as I live. Prince had always been a (good / weak) horse. I first met him on a rainy morning many years ago. I had gone out to feed my daughter's mare and, behind the mare, a giant orange horse loomed in the darkness. His face was camel-like below a straw-colored forelock, and his eyes were tightly closed, as if another morning was too much for him to face. Tear streaks marked crooked paths along his nose. He walked, only when absolutely necessary, with an arthritic stiffness. We cared for Prince throughout the year, and became immensely fond of him. I returned from a trip one summer to find Prince noticeably thinner. For two months the great orange horse faded before my eyes, and nothing I could do made any difference. His tear streaks lengthened, and as I dried them with my sleeve to keep the flies away he would bow his head to allow me to scratch his forelock. One morning, Prince returned to the corral and lay down. He could not raise his head, so I called the veterinarian, and there, in the corral, Prince was put to sleep. It was all we could do. I still find it hard to believe that in the evening to come I will not see against the setting sun that lowered head, and those eyes half closed.

PRINCE

I have memories of Prince, an old and special horse, which I shall treasure as long as I live. I first met him on a gray rainy morning many years ago. I had gone out to feed my daughter's mare and, behind the mare, a giant orange horse loomed in the background. His face was camel-like below a straw-colored forelock, and his eyes, even as I approached, were tightly closed, as if another morning was too much for him to face. Tear streaks marked crooked paths along his nose. He walked, only when absolutely necessary, with an arthritic stiffness. We cared for Prince throughout the year, and became immensely fond of him. I returned from a trip one summer to find Prince noticeably thinner. For two months the great orange horse faded before my eyes, and nothing I could do made any difference. His tear streaks lengthened, and as I dried them with my sleeve to keep the flies away he would bow his head to allow me to scratch his forelock. One morning, Prince returned to the corral and lay down. He could not raise his head, so I called the veterinarian, and there, in the silent corral, Prince was put to sleep. It was all we could do. Prince had always been a (good / weak) horse. I still find it hard to believe that in the evening to come I will not see against the setting sun that lowered head, and those eyes half closed.

1. Prince's face resembled a(n)

   a) rhinoceros
   b) elk
   c) camel

2. Prince lay down for the last time

   a) in the street
   b) in the barn
   c) in the corral

3. One gets the impression from reading this text that Prince was a _____ horse.

   a) good
   b) weak
   c) intelligent

4. Prince's death was

   a) natural
   b) accidental
   c) induced

5. Prince was a _____ horse.

   a) black
   b) orange
   c) brown

6. The author of the story

   a) disliked Prince
   b) mistreated Prince
   c) was fond of Prince

THE DETECTIVE

Plainclothes Detective Robert Magone watched the afternoon crowd near New York's Grand Central Station. He noticed a young woman standing beside a counter in a bank. He could tell that she was (different / petrified) and made a mental note of it. Although she was riffling through deposit slips, she wasn't using a pen. She gestured to a man standing nearby. Two strangers, not apparently together, were signalling to each other. Magone knew he was on to something. Into this scene came a middle-aged woman. She made a withdrawal, tucking an envelope of money into her purse, and walked toward the door. Quickly, the younger woman stepped in front of her and crouched down, announcing she had lost her contact lenses. The older woman bent to help her, putting her purse down. It was then that the young lady's accomplice put his hand in her pocketbook to steal the envelope. Magone grabbed him from behind. When the young woman realized what had happened, she swore underneath her breath. Magone watched her intently. It is unfortunate that otherwise normal people, unable to find work for a variety of reasons, resort to such measures. There is probably no such thing as a new con game. But like all forms of social behavior, con games evolve with society, using the latest objects of desire as props.

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1. Robert Magone is a(n)

   a) urban policeman
   b) security guard
   c) plainclothes detective

2. What was the young woman's claim?

   a) she was forced to do this against her will
   b) she had lost her contact lenses
   c) someone had stolen her money

3. The female accomplice seemed to be

   a) petrified
   b) different
   c) hysterical

4. Robert Magone grabbed

   a) the man
   b) the woman
   c) the money

5. The crime took place in

   a) a shopping mall
   b) a bus terminal
   c) a bank

6. When did Magone first become suspicious?

   a) the woman was going through slips without using a pen
   b) the man did not seem to have any business to do in the area
   c) the woman was carrying a gun

SENILITY

Most elderly people never become senile, no matter how long they live. Usually, symptoms resembling senility are (general / genuine) and should be treated appropriately. Only five percent of those over 65 suffer from senile dementia, characterized by confusion, memory loss, disorientation, and an inability to read, write, or do any but the simplest tasks. At least half of these cases are due to a deterioration of brain cells, called Alzheimer's disease. However, these symptoms do not necessarily signal senility. The person may be suffering from a physical condition that mimics symptoms of senility. However, sometimes these conditions may simply mask a profound dementia. Jane Miller provides an example of such a case. Sometimes she would recognize her daughter, sometimes she wouldn't. Many times, she would mistake her son for her brother, who had been dead twenty years. She began yelling at her friends and neighbours, and became very stubborn. Her children were relieved when her doctor suggested that the symptoms could be the result of a renal problem. It was found that a stone which blocked the tube leading to one of the kidneys made eating painful. This led to malnutrition and eventually, the experience of memory loss and confusion. Despite prompt surgery, however, the symptoms persisted and worsened.

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1. Characteristics of senility include

   a) fainting spells and seizures
   b) confusion and memory loss
   c) indigestion and stomach cramps

2. Jane Miller's symptoms were due to

   a) senility
   b) malnutrition
   c) schizophrenia

3. Jane Miller became

   a) very docile
   b) extremely messy
   c) quite stubborn

4. Senility is often due to a deterioration of brain cells called

   a) Parkinson's disease
   b) Alzheimer's disease
   c) Huntington's disease

5. Jane often yelled at

   a) her neighbours
   b) her dog
   c) her doctor

6. Symptoms of senility are often

   a) faked
   b) very general
   c) genuine

WEATHERMAN

There is some debate as to whether forensic climatology should become a standard part of police investigations. Forensic climatology is a (young / valid) science. It makes use of weather information in criminal and civil court cases, and as such has nothing to do with prediction. It serves mainly to reconstruct weather conditions at the time and place of a crime. Take, for example, the case of a man in his garage who was working on his car. The man had taken the precaution of raising his garage door half a meter to allow the exhaust fumes to escape. What he did not know was that a high-pressure system was centered over that part of the city, causing the air to settle heavily at ground level. At the same time, a light wind was blowing directly at the garage door, trapping the deadly fumes inside. The man was found a short time later, dead. His family suspected foul play and instantly called the police. What could have been a totally inexplicable death was, as it turned out after an examination of the weather information, logically explained. The increasing demand for forensic climatologists is largely because they work with facts; information that can rarely be successfully challenged in court. Therefore, unlike weather forecasters, they can afford to be confident in their statements.

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1. In the example given in the text, a man was found dead

   a) in his home
   b) in his garage
   c) in the street

2. The main task of forensic climatologists is to

   a) reconstruct weather conditions
   b) predict the weather
   c) solve murder cases

3. In the example given in the text, a man was

   a) brutally murdered
   b) trampled by his own car
   c) poisoned by exhaust fumes

4. The controversy surrounding forensic climatology is whether it should become a standard part of

   a) television news broadcasts
   b) forensic medecine
   c) police investigations

5. Having read the text, how would you describe forensic climatology?

   a) a deceptive science
   b) a young science
   c) a valid science

6. The demand for forensic climatologists is

   a) restricted to weather forecasting
   b) increasing
   c) stable

THE STORY OF LUISHAN

In December 1956, a baby girl was born in a makeshift hut deep in the pinewoods of the Phillipines. The parents' hearts were filled with (love / fear) for the child. However, the umbilical cord was wrapped around her neck, and this was a bad omen. If the child lived, terrible things would happen to the family. Numbly following tribal tradition, the mother stuffed a sweet potato into the child's mouth. Death by suffocation should come swiftly. The baby's aunt watched, horrified. She had had no children with her husband. That meant a couple was not compatible, and that her husband must leave her. The aunt yanked out the sweet potato. Despite the protests of the mother, she would care for this infant. Her husband welcomed the child for he did not want to leave his wife. They named her Luishan. When Luishan was six, chicken-pox struck the village. The child's adoptive parents died from the disease. Now there was no dissuading Luishan's real parents that the bad things were happening. She was clearly unlucky and brought bad luck to those around her. An uncle took the bewildered little girl to the Holy Child Orphanage run by Anglican nuns in Sagada. She worked hard at the orphanage, and when she reached 18, the Christian Children's Fund agreed to sponsor her training to become a nurse.

THE STORY OF LUISHAN

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1. Luishan was brought to an orphanage run by

   a) Jesuit priests
   b) Phillipine nonks
   c) Anglican nuns

2. Luishan was brought up by her

   a) mother
   b) aunt
   c) sister

3. Luishan's parents can best be described as being

   a) superstitious
   b) uncaring
   c) neurotic

4. A sweet potato was stuffed into the child's mouth

   a) in order to feed her
   b) in order to keep her quiet
   c) in order to kill her

5. The chicken-pox epidemic

   a) turned Luishan's aunt against her
   b) reinforced the parents' superstition
   c) brought sympathy from Luishan's parents

6. The predominant feeling of Luishan's parents towards her was mainly that of

   a) awe
   b) fear
   c) love

THE WOODPECKER

On August 29, 1940, Walter Lantz and his bride had just settled into an idyllic cottage at Sherwood Lake, California, for their honeymoon when a woodpecker began to stir up an ungodly racket, trying to hammer his way through the roof. They went outside and finally spotted the bird. He was a (little / clever) woodpecker. The Lantzes named the persistent feathered intruder Woody Woodpecker and later tried to convince dubious executives at Universal Studios that a new star had been born. Universal told Walter that the woodpecker would never become popular since he was too noisy, raucus, and obnoxious. But Walter won the argument, put his pencils to work, and soon Woody appeared on the big screen. Woody Woodpecker cartoons have since been shown in the movie theaters of at least 83 countries. This frivolent bird became involved in all sorts of mischievous escapades, outwitting his opponents in ways which has the audience roaring with laughter. The children who saw Woody for the first time loved him. For kids of all backgrounds and languages, there is never a dull moment with Woody. All Woody Woodpecker cartoons are dubbed for the foreign market, but Woody's five-note wacky laugh, done for nearly 35 years by Grace Lantz, remains unchanged. Another thing that remains unchanged is his popularity.

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1. The Lantz' first met Woody

   a) in Paris
   b) on their honeymoon
   c) at the movie studio

2. Woody's wacky laugh is done by

   a) a woodpecker
   b) Walter Lantz
   c) Grace Lantz

3. The children see Woody as a _____ fellow.

   a) raucous
   b) little
   c) clever

4. Woody Woodpecker cartoons were released by

   a) Paramount Studios
   b) Universal Studios
   c) Warner Brothers

5. The original Woody was hammering away

   a) on the roof
   b) on a tree
   c) on the balcony

6. Initially, the movie studios were _____ to accept Woody.

   a) bribed
   b) eager
   c) reluctant

THE SURGEON

Paul Wilkenson was professor and chairman of surgery at the George Washington University medical center. His footsteps were (light / heavy) as he walked down the corridor. At 54, he was one of the top chest surgeons in the United States. Then, during a checkup in April 1980, his own xrays were clipped to the light box. He stared, eyes riveted on the box. In the upper lobe of his right lung there was a large, grayish spot, a shadow. It was irregular in shape, about the size of an egg. In the lateral view he saw stringlike tentacles that reached down into his lung as if grabbing at it. Looking further, he saw a wide shadow in the mediastinum, on both sides of the trachea, where the lymph nodes that drain the lungs are located. On the left side he noticed another shadow, just above the aortic arch. The thought hit him: I am looking at my own obituary. A second opinion confirmed the diagnosis: inoperable and terminal cancer. Word of Dr. Wilkenson's disease spread quickly. Soon he was overwhelmed with visitors. Orderlies, nurses, residents, and other faculty members came to cheer him up. Several of his surgical residents brought a bottle of Scotch and poured drinks all around. Old stories were told, jokes exchanged. He was touched. He hadn't realized so many people had so much affection for him.

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1. Dr. Wilkenson

   a) was feared by most of the orderlies
   b) was disliked by the nurses
   c) was liked by many people

2. After confirmation of his diagnosis, Wilkenson's footsteps were

   a) heavy
   b) light
   c) slow

3. Dr. Wilkenson was one of the top

   a) chest surgeons
   b) neurosurgeons
   c) general surgeons

4. Dr. Wilkenson's diagnosis was

   a) lung cancer
   b) brain tumor
   c) coronary occlusion

5. Why couldn't Wilkenson undergo a simple operation?

   a) he was too old
   b) the disease was too extensive
   c) he refused to undergo an operation

6. When was Wilkenson's condition clarified?

   a) when he was brought to the hospital following a stroke
   b) during a regular checkup
   c) after he suffered respiration problems

POACHERS

Hundreds of wild mammals, fish and birds have disappeared from outdoor Canada because of illegal hunting and fishing. Poachers represent a (small / dying) group of criminals. The professionals poachers have all the right equipment: four-wheel-drive trucks, snowmobiles and aircraft to reach territory once inaccessible, huge spotlights to mesmerize deer or moose feeding along a road, and the finest rifles and scopes. Due to this unacceptable situation, more judges are piling on stiff penalties for poaching, with fines and forfeiture of all hunting equipment amounting to thousands of dollars. Also, fish and game clubs are lending support to wildlife officers by launching programs to report poachers. In Ontario's Dufferin County, ordinary citizens are encouraged to report poachers. They are provided with cards containing a toll-free telephone number, space for a license number and description of the poachers, and a promise of complete anonymity. This program alone has been successful in almost eliminating poaching in that area. The key to success is education of the public. It's not that people don't care what's happening to Canada's wildlife, it's that they don't know. The eradication of poaching has to depend on the support of the average citizen and his willingness to report poachers to the proper authorities.

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1. Fish and game clubs

   a) generally encourage poachers
   b) report poachers to authorities
   c) represent a legal type of poaching

2. It would seem that poachers are a _____ group.

   a) small
   b) tough
   c) dying

3. In Ontario's Dufferin County,

   a) poaching rages rampant
   b) poaching is legal
   c) poaching has almost been eliminated

4. Poaching refers to

   a) raids on fish and game clubs
   b) illegal hunting and killing of animals
   c) the use of certain equipment such as four-wheel-drive trucks for hunting

5. Judges are helping to stop poachers by

   a) reinstating capital punishment
   b) giving stiffer penalties
   c) extending the jail term to 20 years

6. To report poachers, citizens were provided with

   a) alarm systems
   b) cards
   c) whistles

Appendix 2

ANOVA Source Tables

Source Table for ANOVA on Screening Reading Rate: High Frequency vs. Low Frequency Groups

Source	SS	df	MS	F	P
Rate	1164.03	1	1164.03	.26	
Error	135721.18	30	4524.04		
Total	136885.22	31			

Source Table for ANOVA on Screening Reading Comprehension: High Frequency vs. Low Frequency Groups

Source	SS	df	MS	F	P
Comp	50.00	1	50.00	.82	
Error	1821.87	30	60.73		
Total	136885.22	31			

Source Table for ANOVA on Experimental Reading Rates

Source	SS	df	MS	F
Between Blocks/Subjects				
Freq	1940.78	1	1940.78	.29
Error	199066.14	30	6635.54	
Within Blocks/Subjects				
Contxt	.29	1	.29	.001
Freq X Contxt	165.01	1	.96	
Error	5150.79	30	171.69	
Total	136885.22	31		

Source Table for ANOVA on Experimental Reading Comprehension

High Frequency vs. Low Frequency Groups

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Frequency	.04	1	.04	.89	
Error	1.39	30	.05		
Within Blocks/Subjects					
Context	.05	1	.05	1.46	.23
Freq X Context	.11	1	.11	2.87	.09
Error	1.13	30	.04		
Total	2.72	63			

Source Table for ANOVA on Mean Fixation Duration on the Critical Word

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	15386.01	1	15386.01	7.778	.008
Error	59343.04	30	1978.10		
Within Blocks/Subjects					
Contxt	1726.64	1	1726.64	1.033	.318
Freq X Contxt	1077.96	1	1077.96	.645	
Error	50122.37	30	1670.74		
Total	127656.02	63			

Source Table for ANOVA on Mean Difference Scores

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	10477.88	1	10477.88	7.995	.008
Error	39313.41	30	1310.45		
Within Blocks/Subjects					
Contxt	2710.74	1	2710.74	2.006	.163
Freq X Contxt	1109.99	1	1109.99	.821	
Error	40538.70	30	1351.29		
Total	94150.72	63			

Source Table for ANOVA on Mean Fixation Duration as a Function of Frequency, Context, and Page Number

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	634.49	1	634.49	.235	
Error	78008.86	29	2689.96		
Within Blocks/Subjects					
Contxt	131.15	1	131.15	1.849	.181
Freq X Contxt	2.89	1	2.89	.040	
Error	2055.90	29	70.89		
Page	610.35	1	610.35	11.120	.002
Freq X Page	43.89	1	43.89	.799	
Error	1591.70	29	54.89		
Contxt X Page	130.87	1	130.87	3.353	.074
Fre X Con X Pag	30.99	1	30.99	.794	
Error	1131.71	29	39.02		
(Residual)	4779.32	87			

Source Table for ANOVA on Mean Number of Fixations on the Critical Word

Source	SS	df	MS	F
Between Blocks/Subjects				
Freq	.006	1	.006	.058
Error	3.153	30	.105	
Within Blocks/Subjects				
Contxt	.006	1	.006	.058
Freq X Contxt	.029	1	.029	.284
Error	3.112	30	.103	
Total	6.308	63		

Source Table for ANOVA on the Proportion of Fixations on the Critical Word as a Function of Frequency and Context

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	.008	1	.008	.541	
Error	.487	30	.016		
Within Blocks/Subjects					
Contxt	.003	1	.003	.233	
Freq X Contxt	.024	1	.024	1.456	.235
Error	.502	30	.016		
Total	1.027	63			

Source Table for ANOVA on the Mean Magnitude of Eye Movements for a Departure Zone of 12 Character Spaces

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	1.89	1	1.89	.615	
Error	92.04	30	3.07		
Within Blocks/Subjects					
Contxt	3.90	1	3.90	3.808	.057
Freq X Contxt	.79	1	.79	.799	
Error	30.76	30	1.02		
Total	129.38	63			

Source Table for ANOVA on the Mean Magnitude of Eye Movements for a Departure Zone of 15 Character Spaces

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	1.60	1	1.60	.482	
Error	99.66	30	3.32		
Within Blocks/Subjects					
Contxt	1.12	1	1.12	1.201	.281
Freq X Contxt	5.36	1	5.36	5.744	.021
Error	28.00	30	.93		
Total	135.75	63			

Source Table for ANOVA on Mean Magnitude of Forward Eye Movements as a Function of Frequency, Context, and Page Number

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	.52	1	.52	.084	
Error	178.81	29	6.17		
Within Blocks/Subjects					
Contxt	.01	1	.01	.082	
Freq X Contxt	.41	1	.41	4.935	.032
Error	2.42	29	.08		
Page	3.32	1	3.32	24.696	<.001
Fre X Pag	.23	1	.23	1.733	.195
Error	3.89	29	.13		
Contxt X Page	.08	1	.08	.677	
Fre X Con X Pag	.32	1	.32	2.651	.110
Error	3.53	29	.12		
(Residual)	9.851	87			

Source Table for ANOVA on the Mean Magnitude of Eye Movements Leading Away From the Critical Word

Source	SS	df	MS	F	P
Between Blocks/Subjects					
Freq	2.97	1	2.97	.143	
Error	618.78	30	20.62		
Within Blocks/Subjects					
Contxt	.00	1	.00	.000	
Freq X Contxt	5.07	1	5.07	.293	
Error	518.92	30	17.29		
Total	1145.74	63			