Individual Differences in the Time Course of Inferential Processing

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ABSTRACT

Although less skilled readers perform poorly on tasks that require inference generation, it is difficult to know whether their performance results from deficits in inferential abilities or failure to encode accurate discourse representations. These experiments contrasted skilled and less skilled readers' ability (a) to execute a process necessary to represent the meaning of a discourse (i.e., to select the context-appropriate sense of an ambiguous word) and (b) to generate knowledge-based inferences. Ss read passages that contained homograph primes and responded to lexical decision targets. Both skilled and less skilled readers responded faster to appropriate than to inappropriate associates of homograph primes, whereas only skilled readers showed facilitation to topic-related words relative to unrelated control words. It is argued that deficiencies in basic linguistic processes alone cannot account for less skilled readers' failure to generate topic-related inferences.

The ease with which skilled readers construct a detailed mental representation of a text tends to obscure the fact that reading is an extremely complex activity. Text comprehension requires the coordination of numerous component processes. At the word level, processes are necessary to encode the printed word and access its meaning in memory. At the sentence level, processes are devoted to the formation of structures that specify the syntactic and conceptual relations among words in a phrase or a clause. These processes help in encoding propositions, abstract units that represent the meaning of a sentence. At the text level, processes are required to form connections among successive propositions in a text. Researchers generally agree that the normal execution of such processes results in a text representation comprising a set of interrelated propositions.

The processes mentioned above are primarily linguistic. They involve accessing knowledge about the language (e.g., word meanings, syntax) in order to comprehend a text. However, numerous studies have demonstrated that comprehension also involves access to knowledge about the world (Bransford & Johnson, 1973; Chiesi, Spilich, & Voss, 1979; Dooling & Lachman, 1971; Markman, 1977; Spilich, Vesonder, Chiesi, & Voss, 1979). In their classic experiment, Bransford and Johnson (1973) asked readers to comprehend and recall paragraphs that contained a number of vague referring expressions. These passages elicited low comprehension ratings and poor recall. Comprehension ratings and recall improved dramatically when readers were provided with a title that evoked relevant world knowledge. If readers are
unable to generate inferences that connect explicit information in a text to relevant world knowledge, they feel as though they do not comprehend the text and have difficulty remembering it.

Although generating inferences from world knowledge facilitates comprehension and memory for a text, considerable controversy exists over the extent to which inferential processing plays an important role as readers execute linguistic processes during reading. According to one view, readers construct a propositional representation of a text by means of linguistic processes such as word decoding and syntactic and semantic analyses (McKoon & Ratcliff, 1990, 1992; Perfetti, 1989, 1993; Perfetti & Roth, 1981). These processes are executed automatically (i.e., on-line) as a function of receiving language inputs and are not influenced by the goals and strategies of a reader. In contrast, very little inferential processing occurs automatically as readers construct a propositional representation (McKoon & Ratcliff, 1992). Inferences are generated on-line during reading only to the extent that an inference is needed to link an incoming proposition with immediately preceding propositions. Although additional inferences may be generated as they become necessary to perform a task (e.g., question answering, summarization), these inferences result from strategic, problem-solving processes that operate on the propositional representation constructed automatically during reading (McKoon & Ratcliff, 1992). Thus, inferential processing plays a limited or secondary role as readers execute more basic, linguistic processes.

According to an alternative view, a considerable amount of inferential processing occurs automatically during skilled reading (Bower & Morrow, 1990; Graesser & Clark, 1985; Long & Golding, 1993; Long, Golding, & Graesser, 1992; Schank, 1986; Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985; Trabasso, van den Broek, & Suh, 1989; van den Broek, 1988, 1990). Readers generate many more on-line inferences than are required to form local connections among propositions. These are likely to include inferences that specify (a) the real-world referents of words, (b) properties attributed to objects, (c) spatial relations among objects, (d) goals and motivations of characters in a story, and (e) causal relations among events, actions, and episodes. Thus, the ability to generate knowledge-based inferences is seen as an integral component of skilled reading.

To assess the contribution of inferential processing to reading skill, researchers have examined whether skilled and less skilled readers differ in the extent to which they generate inferences during reading. Although studies have shown that less skilled readers perform poorly on tasks that require inference generation (Garnham, Oakhill, & Johnson-Laird, 1982; Long & Golding, 1993; Oakhill, 1983, 1984; Oakhill, Yuill, & Donaldson, 1990; Singer, Andrusiak, Reisfeld, & Black, 1992; Whitney, Ritchie, & Clark, 1991; Yuill, Oakhill, & Parkin, 1989), it is difficult to know whether their poor performance is due to deficits in inferential abilities or failure to encode an accurate propositional representation of the text. For example, Long and Golding (1993) recently found that readers who failed to generate inferences that specified the goals of characters in script-based stories also exhibited poor recall for the explicit information in the texts. These readers may have performed poorly on the memory test because they (a) failed to establish an accurate propositional representation or (b) failed to generate inferences to elaborate their representation.

Several researchers have attempted to distinguish between the two possibilities described above by matching subjects on certain reading abilities and then assessing the contribution of inferential processing to comprehension performance. For example, Oakhill and her colleagues conducted several studies in which they selected subjects who were matched on tests of word recognition accuracy and reading vocabulary but differed on a test of reading comprehension (Garnham et al., 1982; Oakhill, 1983, 1984). They found that less skilled readers, compared with skilled readers, (a) were poorer at answering questions that required an inference even when the text was available during questioning (Oakhill, 1984), (b) made less use of context in the interpretation of a text (Oakhill, 1983), and (c) benefited less from referential continuity in stories.
(Garnham et al., 1982). Although these studies suggest that inference problems can occur independently of deficits in word recognition accuracy, the extent to which failure to generate inferences may be secondary to deficits in other reading abilities has not been fully assessed. For example, less skilled readers may have accurate word recognition skills but have deficiencies in syntactic or semantic processes. Alternatively, less skilled readers may have accurate but very slow word recognition processes, which limit the rate at which higher sentence-level processes can be executed (Perfetti & Roth, 1981).

It is unlikely that groups of skilled and less skilled readers can be identified who differ in comprehension performance but do not differ on a range of component reading abilities. Less skilled readers typically show deficits in multiple component processes (Perfetti, 1985, 1989). Thus, in the present study we assessed the role of inferential processing in skilled reading using a somewhat different approach. Our goal in this research was to examine the extent to which less skilled readers execute processes necessary to construct an accurate discourse representation but fail to generate knowledge-based inferences to elaborate it. Specifically, we contrasted skilled and less skilled readers' ability (a) to select the context appropriate sense of an ambiguous word, a process that is required to represent the meaning of a sentence, and (b) to generate an inference related to the topic of the discourse.

**Experiment 1**

To examine individual differences in inferential processing during reading, we replicated and extended an earlier study reported by Till, Mross, and Kintsch (1988). Till et al. investigated the effects of discourse context on the time course of sense selection and meaning elaboration (i.e., inference generation). Specifically, they examined when during processing readers (a) select a context-appropriate sense of an ambiguous word over an inappropriate one and (b) make a topical inference to elaborate the discourse meaning.

Sense selection is a process that must be executed if readers are to construct an accurate propositional representation of a sentence. In order to represent the meaning of a sentence such as "The townspeople were amazed to find that all the buildings had collapsed except the mint," readers must select the appropriate sense of the homograph mint and integrate this meaning into the preceding discourse context (e.g., mint assumes the meaning of "a building where money is made"). In contrast, topical inferences are not required for a reader to construct an accurate propositional representation. Rather, these inferences function to refine or elaborate the discourse meaning. For example, readers can use topic-related information to refine connections among propositions (e.g., the townspeople were amazed because the mint did not collapse) or to elaborate the meanings of words in the discourse (e.g., mint assumes the meaning of "the building that did not collapse in an earthquake").

In Till et al.'s (1988) experiments, sense selection and inference generation were assessed by means of a lexical decision task. Subjects read brief passages that were constructed around an ambiguous noun. The passages were presented using a rapid serial visual presentation (RSVP) procedure. A lexical decision trial immediately followed the homograph in each passage. The lexical decision targets were (a) context-appropriate associates of homograph primes, (b) context-inappropriate associates of the primes, (c) words related to the topic of the sentence, (d) words unrelated to the topic of the sentence, and (e) nonwords. Example passages and lexical decision targets appear in Table 1.

Till et al. (1988) assessed sense selection by comparing response latencies to appropriate and inappropriate associates of the homograph primes. When readers have selected the context-appropriate sense of the
homograph, they should exhibit faster latencies to appropriate than to inappropriate associates. For example, responses to the target *money* should be facilitated relative to the target *candy* in the context of Passage 1 in Table 1, whereas the opposite should be true in the context of Passage 2. Similarly, Till et al. assessed inference generation by comparing latencies to topic-related and control words. If readers generate topic-related inferences to elaborate the discourse meaning, then they should exhibit faster latencies to topic-related than to control words. For example, responses to the target *earthquake* should be facilitated relative to the target *breath* in the context of Passage 1, whereas the opposite should occur in the context of Passage 2. Till et al. assessed the time course of sense selection and inference generation by examining decision latencies to targets presented at different stimulus onset asynchronies (SOAs).

*Till et al. (1988)* found no differences in readers' responses to appropriate and inappropriate associates at short SOAs (i.e., 200 ms and 300 ms). However, subjects responded faster to appropriate than to inappropriate associates at 400-ms and longer SOAs. Topic-related inferences were not generated until later in processing. Faster response times to appropriate than to inappropriate topic words were observed only in the 1,000-ms and 1,500-ms SOA conditions. Till et al.’s results are consistent with previous studies of context effects on lexical processing. The initial stages of lexical access appear to operate independent of context but are followed by postlexical processes that function to integrate word meanings into the general discourse context (Kintsch & Mross, 1985; Onifer & Swinney, 1981; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tanenhaus, Leiman, & Seidenberg, 1979).

We extended *Till et al.’s (1988)* research by examining individual differences in sense selection and inference generation among skilled and less skilled readers. We used performance on the verbal portion of the Scholastic Aptitude Test (SAT) to assess reading skill. Although the verbal SAT score is not an explicit measure of reading ability, it is a reliable predictor of performance on a variety of reading comprehension tests (Daneman & Carpenter, 1980; Hunt, Lunneborg, & Lewis, 1975; Wood, 1982). In addition, it was practical for us to obtain verbal SAT scores from the large number of subjects who participated in these experiments. The stimulus materials and presentation procedure were similar to those used by Till et al. Subjects read short passages that contained homograph primes and responded to lexical decision targets presented at different SOAs. We examined lexical decision latencies to determine whether skilled and less skilled readers exhibited (a) different patterns of sense selection and inference generation, (b) different patterns of facilitation across SOA conditions, or (c) both.

**Method Subjects.**

Subjects were 288 undergraduate psychology students at the University of California, Davis who participated in the experiment for course credit. Data from 39 of these subjects were discarded; 31 subjects who refused to allow us to access their SAT scores and 8 subjects who had large numbers of lexical decision errors. From the remaining subjects, we identified groups of skilled and less skilled readers according to their performance on the verbal SAT (the top third and the bottom third of our subjects, respectively). Because our subject selection procedure resulted in unequal means across SOA conditions, we recruited additional subjects until we had an equal number of skilled and less skilled readers in each condition. Our final group of skilled readers had verbal SAT scores that ranged from 540 to 730 (M = 585, n = 84). Less skilled readers had verbal SAT scores that ranged from 230 to 450 (M = 394, n = 84).

**Materials.**

The materials consisted of 56 critical passages used by *Till et al. (1988)* and 42 filler passages that we constructed to be similar to the critical passages. The passages were divided into two lists, each with 28
critical and 21 filler passages. All passages were two sentences in length and were followed by a lexical decision target. Critical passages contained one sentence that ended with a homograph prime. Each prime was followed by a target item that was a word. Filler passages were followed by nonwords.

Till et al. (1988) constructed the critical passages in pairs written around an ambiguous noun that appeared in both passages (see Table 1 for an example pair of passages). The homograph appeared at the end of either the first or the second sentence of the passage, and its meaning was unambiguously specified by the context. The homographs were selected such that they had approximately equally strong associates to each of their senses. These were used as the set of associate test items. The associates were appropriate or inappropriate depending on the preceding sentence context. One passage of the pair was assigned to List A, the other to List B.

The topic test items were the modal responses made by a group of pilot subjects in Till et al.'s (1988) study who were asked to "write down a word reflecting their understanding of what the paragraph was about" (p. 286). The appropriate topic word for one passage of a pair served as the inappropriate topic word for the other passage in the pair. The characteristics of the associate and topic words (e.g., number of syllables, word frequency, response probabilities) can be found in Till et al. (p. 286).

The 28 critical and 21 filler passages were combined in each list in blocks of 7 passages such that a block contained 4 critical passages and 3 filler passages. Each critical passage was followed by (a) an appropriate associate, (b) an inappropriate associate (i.e., the appropriate associate for the other passage in the pair), (c) an appropriate topic word, or (d) an inappropriate topic word (i.e., the topic word for the other passage in the pair). The three filler passages were followed by nonwords. Two comprehension items were constructed to follow each block of seven passages. The comprehension items were true-false paraphrases based on passages in the preceding block. Subjects received both Lists A and B presented in random order. In addition, each block of seven passages and each passages within a block were randomized. Finally, a block of seven passages with associated lexical decision targets and two comprehension items was constructed for use as practice material.

Design and procedure.

The design was a 2 (skill) × 2 (appropriateness) × 2 (type) × 6 (SOA) factorial. Skill (skilled and less skilled) and SOA (200, 300, 400, 500, 750, and 1,000 ms) were between-subjects variables. Appropriateness (appropriate and inappropriate) and type (associate and topic) were within-subjects variables.

The procedure was similar to the one used by Till et al. (1988, Experiment 2). Subjects were randomly assigned to one of the six SOA conditions. It should be noted that we replaced the 1,500-ms SOA condition used by Till et al. with a 750-ms condition in order to obtain more precise information about when responses to topic words show facilitation.

Passages were presented on IBM-compatible PCs by means of an RSVP procedure. All words were presented in the center of the screen for 300 ms with one exception. In the 200-ms SOA condition, the homograph prime in each passage was presented for 200 ms. An asterisk preceded each passage for 2 s and was followed by a 1-s pause and then the first word of the passage. Lexical decision targets followed the homograph prime in each passage. The test items were distinguished from the sentence words by surrounding asterisks (e.g., ****money****). Subjects pressed a key labeled "yes" if the test item was a word, and one labeled "no" if it was not. Subjects' responses and decision latencies were recorded. Text
presentation resumed after the yes-no response.

Subjects were instructed to read the passages for comprehension and to respond as quickly and as accurately as possible to the test words. Instructions were followed by the practice material. After the practice session, subjects were allowed to ask questions about the procedure and then the experimental trials began. After the experiment, subjects were debriefed and were asked for permission to obtain their verbal SAT scores from their academic records.

**Results and Discussion Comprehension.**

A 2 (skill) × 6 (SOA) analysis of variance (ANOVA) was performed on the comprehension scores. The analysis revealed a significant main effect of skill, $F(1, 156) = 24.6, p < .05$, $MS_e = 9.85$, but no other main effects or interactions. As expected, skilled readers scored higher on the comprehension test ($M = 87\%$) than did less skilled readers ($M = 78\%$).

**Lexical decision errors.**

A 2 (skill) × 2 (appropriateness) × 2 (type) × 6 (SOA) repeated measures ANOVA was performed on the number of lexical decision errors for positive lexical decision trials. The analysis yielded a significant main effect of skill, $F(1, 156) = 12.82, p < .05$, $MS_e = 2.86$. Skilled readers made fewer lexical decision errors ($M = .92$) than did less skilled readers ($M = 1.86$). The analysis yielded no other significant main effects or interactions.

**Lexical decision latencies.**

The same analysis was performed on the lexical decision latencies. All errors and any decision latency more than 3 standard deviations from a subject's mean were replaced with a score equal to the subject's mean plus 3 standard deviations. Errors and outliers together constituted 3.1% of the data. All analyses were performed with subjects treated as a random variable ($F_1$) and again with items treated as the random variable ($F_2$). The overall analysis yielded numerous significant main effects and interactions. Although important and consistent across experiments, many of these effects are not central to our hypotheses. Therefore, we present the statistical tests for each experiment in Table 2 and discuss in the text only those effects of theoretical interest. All effects were tested at a significance level of $p < .05$. The mean latencies for Experiment 1 are presented in Figure 1.

Of particular relevance to our hypotheses was the Skill × Type × Appropriateness interaction (see Table 2). We examined this interaction by conducting separate analyses of responses to associate and topic words. With respect to the associate words, the critical Skill × Appropriateness interaction was not significant (both $F$s < 1). Both skilled, $F_1 (1, 156) = 34.87, F_2 (1, 52) = 12.36$, and less skilled, $F_1 (1, 156) = 36.96, F_2 (1, 52) = 13.66$, readers responded faster to appropriate than to inappropriate associates. Separate analyses at each prime—target SOA revealed that both skilled and less skilled readers, respectively, responded faster to appropriate than to inappropriate associates at all prime—target SOAs except 200 ms (both $F$s < 1); 300 ms, $F_1 (1, 156) = 7.58, F_2 (1, 52) = 4.55$, and $F_1 (1, 156) = 7.11, F_2 (1, 52) = 4.88$; 400 ms, $F_1 (1, 156) = 5.45, F_2 (1, 52) = 4.76$, and $F_1 (1, 156) = 10.90, F_2 (1, 52) = 6.98$; 500 ms, $F_1 (1, 156) = 6.92, F_2 (1, 52) = 4.75$, and $F_1 (1, 156) = 8.02, F_2 (1, 52) = 7.70$; 750 ms, $F_1 (1,
156) = 10.46, $F_2(1, 52) = 6.70$, and $F_1(1, 156) = 13.09$, $F_2(1, 52) = 11.44$; and 1,000 ms, $F_1(1, 156) = 14.88$, $F_2(1, 52) = 10.21$, and $F_1(1, 156) = 7.08$, $F_2(1, 52) = 4.05$. Thus, it appears that both groups constructed representations of the sentences within 300 ms of processing that were more consistent with context-appropriate than with context-inappropriate associates.

With respect to the topic words, the analysis yielded a significant Skill × Appropriateness interaction, $F_1(1, 156) = 15.29$ and $F_2(1, 52) = 5.54$. Further analyses revealed a significant appropriateness effect for skilled readers, $F_1(1, 156) = 29.52$ and $F_2(1, 52) = 10.47$, but not for less skilled readers (both $F$s < 1). Separate analyses at each SOA indicated that skilled readers responded faster to appropriate than to inappropriate topic words at SOAs of 500 ms, $F_1(1, 156) = 6.47$ and $F_2(1, 52) = 4.75$; 750 ms, $F_1(1, 156) = 10.46$ and $F_2(1, 52) = 4.91$; and 1,000 ms, $F_1(1, 156) = 14.88$ and $F_2(1, 52) = 7.80$; but not 200 ms (both $F$s < 1); 300 ms, $F_1(1, 156) = 3.29$ and $F_2(1, 52) = 1.98$; or 400 ms, $F_1(1, 156) = 2.30$ and $F_2(1, 52) = 2.01$. In contrast, less skilled readers exhibited no facilitation to the topic words in any of the SOA conditions (all $F$s < 1). Thus, these results suggest that skilled readers generated knowledge-based inferences that were consistent with the sentence topics, whereas less skilled readers did not.

The results of these analyses are consistent with the claim that inferential processing is characteristic of high reading skill. Both skilled and less skilled readers executed a process (i.e., sense selection) that is required to represent the meaning of a sentence, whereas only skilled readers generated knowledge-based inferences to elaborate their representation. However, an alternative interpretation is that less skilled readers failed to generate the topic-related inferences because they were not given sufficient processing time to do so. Perhaps these inferences would have been detected at prime—target SOAs longer than 1,000 ms. However, this possibility seems unlikely given that there was absolutely no trend toward faster responses to appropriate than to inappropriate topic words in the 1,000-ms condition.

Another interpretation of less skilled readers’ failure to generate topic-related inferences is that they have less knowledge about the sentence topics than do skilled readers. To examine this possibility, we recruited an additional group of subjects to determine whether the two groups would provide the same modal responses as topics of these sentences. We presented each passage up to the point of the prime word to a group of 85 subjects. Subjects were asked to produce a single word for the passage that described what it was about. Again, we used verbal SAT scores to identify groups of skilled and less skilled readers (the top and bottom thirds). The distribution of SAT scores among these subjects was similar to the distribution we observed in Experiment 1 ($M = 563$ and $M = 360$ for skilled and less skilled readers, respectively). We found that the two groups produced the same modal response to 41 of the 56 critical passages. Almost all of these responses corresponded to the topic words used in the experiment. In those instances in which the two groups produced different responses, (a) the modal response for one group was the second most frequent response for the other or (b) the two modal responses were roughly synonymous. Thus, it appears that differences in the pattern of facilitation to topic words exhibited by the two groups were not due to differences in their knowledge about the sentence topics.

A comparison of our results with those of Till et al. (1988) reveals an interesting difference with respect to the time course of inferential processing. Till et al. did not find an appropriateness effect for topic words until long prime—target SOAs (i.e., 1,000 ms and 1,500 ms). In contrast, our group of skilled readers exhibited a reliable effect within 500 ms of processing. One possible explanation for this difference is that Till et al.’s findings were influenced by the averaging of response times across readers of different skill levels. Some
readers (e.g., highly skilled readers) may show facilitation early in the time course of processing, whereas other readers may show little facilitation or facilitation only late in processing. To examine this possibility, we computed mean latencies to the topic words, collapsing across skill level and including those subjects who were excluded from our earlier analysis (i.e., subjects who had SAT scores in the middle third of the distribution). These means are presented in Figure 2. We performed separate analyses at each prime—target SOA and found a reliable appropriateness effect only in the 1,000-ms condition, \( F_1 (1, 262) = 4.17 \) and \( F_2 (1, 52) = 3.23 \). Thus, it seems plausible that the inconsistency between our results and those obtained by Till et al. is due to differences in the skill levels of our subjects.

In addition to information about differences in the extent to which skilled and less skilled readers generated topic-related inferences, we found an interesting Skill × SOA interaction (see Table 2). Skilled readers responded faster to target items than did less skilled readers at prime—target SOAs of 300 ms or longer. In the 750-ms and 1,000-ms SOA conditions, respectively, this effect was significant in both the subjects and the items analyses: \( F_1 (1, 156) = 6.02 \), \( F_2 (1, 52) = 198.98 \); and \( F_1 (1, 156) = 9.28 \), \( F_2 (1, 52) = 253.55 \). In the 300-, 400-, and 500-ms SOA conditions, this effect was significant in the items analysis, \( F_2 (1, 52) = 34.13 \), \( F_2 (1, 52) = 80.09 \), and \( F_2 (1, 52) = 129.43 \), respectively, but not in the subjects analysis, \( F_1 (1, 156) = 1.21 \), \( F_1 (1, 156) = 2.42 \), and \( F_1 (1, 156) = 3.60 \), respectively. In contrast, less skilled readers responded faster than did skilled readers in the 200-ms SOA condition. This latter effect was significant in the items analysis, \( F_2 (1, 52) = 36.33 \), but not in the subjects analysis, \( F_1 (1, 156) = 1.47 \).

Two aspects of the Skill × SOA interaction are particularly interesting. First, less skilled readers responded somewhat faster than did skilled readers to target words presented at the 200-ms SOA condition. Because word recognition skill is strongly associated with reading ability (Perfetti, 1985), faster responses by less skilled than by skilled readers in any of the SOA conditions are surprising. Second, the latencies exhibited by less skilled readers at long prime—target SOAs (750 ms and 1,000 ms) were very slow relative to their latencies at shorter SOAs. Less skilled readers in the 1,000-ms SOA condition responded to target items an average of 235 ms slower than did less skilled readers in the 200-ms SOA condition. Because these findings were both interesting and unexpected, we conducted two additional experiments to investigate possible explanations. In Experiment 2, we examined the hypothesis that skilled readers allocate resources to end-of-sentence integration earlier in processing than do less skilled readers, which results in delayed processing of target items presented at short prime—target SOAs.

**Experiment 2**

One explanation for the interaction between reading skill and prime—target SOA is that skilled readers are able to allocate resources to end-of-sentence integration earlier in processing than are less skilled readers. At short SOAs (e.g., 200 ms), allocation of resources to sentence integration results in delayed processing of target items. Such an effect would be consistent with a finding reported by Haberlandt, Graesser, and Schneider (1989). Haberlandt et al. examined differences in the reading profiles of fast and slow readers and found a pronounced lag in word-level processing among fast readers. Features of preceding words (e.g., word length, word frequency) influenced reading time for a current word among fast readers, but not among slow readers. Haberlandt et al. argued that the lag effect resulted from an effort by fast readers to integrate the meanings of adjacent words. A similar effect may account for the differences between skilled and less skilled readers observed in Experiment 1. If a target item is presented while skilled readers are performing integrative processing, then decision latencies may increase as a function of continued processing of the preceding context. In contrast, less skilled readers may not integrate information in a sentence until...
slightly later in processing; thus, they may have more processing resources available at 200 ms to allocate to a secondary task.

In the present experiment, we focused on differences in skilled and less skilled readers' latencies at relatively short SOAs (200—400 ms), the SOA conditions at which the interaction was most striking. We hypothesized that skilled readers experience a lag in responding to target words that is due to continued processing of the preceding sentence. We tested this hypothesis by comparing skilled and less skilled readers' lexical decision latencies when target items were preceded by two different contexts. In the text condition, we replicated the first three SOA conditions of Experiment 1 (i.e., 200, 300, and 400 ms). In the scrambled condition, we scrambled the order of the words in each sentence, with the exception of the homograph, to prevent readers from engaging in normal sentence processing. Lexical decision targets followed the homograph prime in both conditions. Although we presented both the associate and topic words used in the previous experiment, we analyzed only the associate words. The topic words are related to the discourse context, not the homograph primes; thus, they have no relationship to the preceding context in the scrambled condition.

We predicted that skilled and less skilled readers in the text condition would exhibit the same pattern of latencies to the associate words that we observed in Experiment 1. Both groups should show facilitation to appropriate, relative to inappropriate, associates within 300 ms of processing. In addition, we predicted an interaction between reading skill and prime—target SOA; skilled readers should respond faster than less skilled readers in the 300-ms and 400-ms SOA conditions, but not in the 200-ms condition. In contrast, we predicted that scrambling the sentences would eliminate both the appropriateness effect and the Skill × SOA interaction. Because skilled readers should make no attempt to integrate adjacent words in the scrambled condition, they should exhibit no differences in response latencies across prime—target SOAs.

**Method Subjects.**

Subjects were 180 undergraduate psychology students who participated in the experiment for course credit. The data from 28 subjects were discarded; 21 subjects who refused access to their SAT scores, 3 subjects who had large numbers of lexical decision errors, and 4 subjects in the scrambled condition who performed at less than chance levels on the recognition items. From the remaining subjects, we identified groups of skilled and less skilled readers according to their performance on the verbal SAT (the top third and the bottom third, respectively). Additional subjects were recruited until we had an equal number of subjects in each condition. Skilled readers had SAT scores that ranged from 500 to 690 (\( M = 560, n = 60 \)). Less skilled readers had SAT scores that ranged from 200 to 450 (\( M = 381, n = 60 \)).

**Materials, design, and procedure.**

The materials consisted of the passages and lexical decision targets used in Experiment 1. In the scrambled condition, the order of the content words in all of the sentences was scrambled with the exception of the homograph. Thus, the sentences were effectively replaced by lists, some of which ended with a homograph prime.

The design was a 2 (skill) \( \times \) 2 (appropriateness) \( \times \) 2 (context) \( \times \) 3 (SOA) factorial. Skill (skilled and less skilled), SOA (200, 300, and 400 ms), and context (text and scrambled) were between-subjects variables. Appropriateness (appropriate and inappropriate) was a within-subjects variable.

Subjects were randomly assigned to one of the six combinations of SOA and context. The procedure for
subjects in the text condition was identical to the procedure in Experiment 1. In the scrambled condition, subjects were asked to read a list of words and to respond to lexical decision targets as quickly and as accurately as possible. The list of words was presented with an RSVP procedure at the same rate as the sentences in the text condition. The lexical decision items followed the homograph prime in every list and were distinguished from the preceding list by surrounding asterisks. To ensure that subjects in the scrambled condition attended to the word lists, we gave them two recognition test items after every block of seven passages. Subjects were asked to indicate whether a target word had been in one of the preceding lists by pressing "yes" or "no." These recognition items replaced the comprehension questions used in the text condition.

**Results and Discussion Comprehension.**

A 2 (skill) × 2 (context) × 3 (SOA) ANOVA was performed on correct responses to the comprehension questions (text condition) and recognition items (scrambled condition). The analysis revealed reliable main effects of skill, $F(1, 108) = 11.84, p < .05, MS_\epsilon = 7.23$, and context, $F(1, 108) = 34.76, p < .05, MS_\epsilon = 7.23$. These effects were modified by a significant Skill × Context interaction, $F(1, 108) = 5.51, p < .05, MS_\epsilon = 7.23$. Skilled readers scored higher ($M = 85\%$) than did less skilled readers ($M = 75\%$) in the text condition, whereas the two groups exhibited no reliable difference in the scrambled condition ($M = 70\%$ and $M = 69\%$, respectively).

**Lexical decision errors.**

A 2 (skill) × 2 (context) × 2 (appropriateness) × 3 (SOA) repeated measures ANOVA was performed on the number of lexical decision errors for positive lexical decision trials. The analysis yielded a significant main effect of skill, $F(1, 108) = 6.21, p < .05, MS_\epsilon = 4.40$, but no other main effects or interactions. Skilled readers made fewer lexical decision errors ($M = 1.36$) than did less skilled readers ($M = 2.32$).

**Lexical decision latencies.**

The same analysis was performed on the lexical decision latencies to the associate words. Errors and outliers constituted 3.9% of the data and were handled by means of the procedure used in Experiment 1. The statistical tests from the overall ANOVA are presented in **Table 2**. The mean latencies appear in **Figure 3**.

The analysis yielded the predicted Skill × SOA × Context interaction (see **Table 2**). We examined this interaction by conducting separate analyses of the data in the text and scrambled conditions. The pattern of results in the text condition was similar to the pattern found in Experiment 1. Of particular interest was a significant SOA × Appropriateness interaction, $F_1(2, 108) = 5.62$ and $F_2(2, 52) = 5.24$. Both skilled and less skilled readers, respectively, responded faster to appropriate than to inappropriate associates at the 400-ms SOA, $F_1(1, 108) = 8.89, F_2(1, 26) = 4.37$, and $F_1(1, 108) = 12.56, F_2(1, 26) = 3.94$, but not at the 200-ms SOA (all $F$ s < 1). In the 300-ms SOA condition, less skilled readers showed a reliable appropriateness effect, $F_1(1, 108) = 8.35$ and $F_2(1, 26) = 8.90$, whereas skilled readers did not, $F_1(1, 108) = 1.62$ and $F_2 < 1$. The analysis also yielded the predicted Skill × SOA interaction, $F_1(2, 108) = 6.15$ and $F_2(2, 52) = 84.21$. Skilled readers responded faster to target items than did less skilled readers in the 300-ms, $F_1(1, 108) = 6.06$ and $F_2(1, 26) = 98.84$, and 400-ms, $F_1(1, 108) = 9.38$ and $F_2(1, 26) = 158.97$, SOA conditions, whereas less skilled readers responded faster than did skilled readers in the
200-ms condition. This latter finding was reliable in the items analysis $F_{2}(1, 26) = 19.81$, but not in the subjects analysis, $F_{1}(1, 108) = 1.64$.

In contrast, neither the SOA × Appropriateness interaction nor the Skill × SOA interaction was significant in the scrambled condition (all $F$s < 1). As predicted, scrambling the sentences eliminated both the influence of appropriateness and the interaction between skill and SOA.

These results support the hypothesis that skilled readers experience a lag effect at 200 ms that is due to a spill over of processing from the preceding sentence context. Skilled readers in the text condition responded slower to targets presented in the 200-ms SOA condition than to those presented in the 300-ms or 400-ms SOA conditions. In contrast, less skilled readers in the text condition showed no lag in word-level processing at 200 ms; they responded faster to targets presented at 200 ms than to those presented at longer prime—target SOAs. The patterns of latencies exhibited by skilled and less skilled readers in the scrambled condition were substantially different. When subjects were prevented from engaging in normal sentence processing, both groups exhibited similar patterns of latencies across SOA conditions. Thus, these data are consistent with the idea that skilled readers allocate resources to end-of-sentence integration earlier in processing than do less skilled readers.

In Experiment 2, we focused on differences in latencies exhibited by skilled and less skilled readers at relatively short prime—target SOAs (200—400 ms). However, the results obtained in Experiment 1 indicate that these two groups also exhibited differences in latencies at much longer SOAs. Less skilled readers’ latencies continued to increase across SOA conditions, whereas skilled readers’ latencies remained relatively stable. In Experiment 3, we examined one possible explanation for differences in the pattern of latencies exhibited by the two groups at long prime—target SOAs.

**Experiment 3**

In Experiment 1, skilled readers exhibited a large decrease in response latencies to target items across short prime—target SOAs (200—400 ms), whereas their latencies exhibited little change at longer SOAs (500—1,000 ms). In contrast, less skilled readers showed an increase in response latencies across all SOA conditions. The results obtained in Experiment 2 suggest that the increase in latencies exhibited by less skilled readers at short SOAs may be due to a delay in allocation of resources to end-of-sentence integration. Thus, they may have more resources available to respond to lexical decision targets at 200 ms than at 300 ms or 400 ms. However, this does not provide a very satisfactory explanation for the slow response times exhibited by less skilled readers at longer SOAs. It seems unreasonable to suppose that even less skilled readers require 1,000 ms to integrate information in a sentence. If allocation of resources to sentence integration alone contributed to an increase in latencies, we would expect to see a decrease in latencies at long SOAs as less skilled readers completed sentence-level integration.

Recently, Gernsbacher and her colleagues investigated a marker of less proficient comprehension skill that may help explain the performance of less skilled readers at long prime—target SOAs (Gernsbacher, 1990; Gernsbacher & Faust, 1991; Gernsbacher, Varner, & Faust, 1990; see also Perfetti & Goldman, 1976; Perfetti & Lesgold, 1977). Less skilled readers have poorer access to recently comprehended information than do skilled readers. Less skilled, compared with skilled, readers are poorer at (a) recognizing the original word order of a sentence (Gernsbacher et al., 1990), (b) recalling the word from a previously read (or heard) passage that follows a cue word from the passage (Perfetti & Goldman, 1976; Perfetti & Lesgold, 1977), and (c) recognizing the original right—left orientation of a picture (Gernsbacher et al., 1990).
We speculated that poor access to recently comprehended information would lead to an increase in lexical decision latencies at long SOAs if readers engaged in context checking at the time of test. Context checking occurs when readers attempt a comparison between a test probe and their representation of a preceding text (Balota & Chumbley, 1984; Chumbley & Balota, 1984; Forster, 1981; Potts, Keenan, & Golding, 1988). The occurrence of context checking can be influenced by (a) prime—target SOA, (b) whether subjects perceive the lexical decision task as related to the comprehension task, and (c) the speed of the lexical decision response (Keenan, Golding, Potts, Jennings, & Aman, 1990). Context checking often facilitates decision latencies by virtue of a backward association between the test word and a related prime. However, it is possible that context checking in combination with poor access to recently comprehended information could lead to an increase in decision latencies. If the preceding context is not readily accessible, it is likely that context-checking processes would take longer than normal to complete.

If context checking contributes to slow latencies among less skilled readers at long SOAs because they have poorer than normal access to recently comprehended information, then a manipulation that increases the availability of recently comprehended information may lead to faster response times. The availability of recently comprehended information may be increased by focusing readers' attention on the comprehension aspect of the task. In the present experiment, we emphasized comprehension by manipulating the frequency with which subjects were asked to respond to comprehension questions. The procedure was very similar to the one used in Experiment 1. Subjects read passages and responded to lexical decision targets (associate and topic words) presented at various prime—target SOAs. Subjects received comprehension questions after each block of seven passages (blocked condition) or after each passage (distributed condition). We assumed that answering a question after every passage, relative to after every seven passages, would encourage subjects to keep information in the immediately preceding passage readily accessible. Thus, we predicted that less skilled readers in the blocked and distributed conditions would exhibit different patterns of latencies across SOA conditions. Of particular interest was the pattern exhibited by these readers at longer prime—target SOAs (500—1,000 ms). If access to recently comprehended information increases as a function of emphasis on comprehension, then less skilled readers in the blocked condition should show an increase in latencies across these SOA conditions, whereas less skilled readers in the distributed condition should show a decrease. In contrast, we predicted no differences in the pattern of latencies exhibited by skilled readers in the blocked and distributed conditions. Skilled readers' latencies should decrease as a function of prime—target SOA.

Method Subjects.

Subjects were 480 undergraduate psychology students who participated in the experiment for course credit. The data from 32 subjects were discarded: 28 subjects who refused access to their SAT scores and 4 subjects who had large numbers of lexical decision errors. From the remaining subjects, we identified groups of skilled and less skilled readers according to their performance on the verbal SAT (top and bottom thirds). Additional subjects were recruited until we had an equal number of subjects in each condition. Skilled readers had SAT scores that ranged from 500 to 690 (M = 558, n = 156). Less skilled readers had SAT scores that ranged from 230 to 470 (M = 411, n = 156).

Materials, design, and procedure.

The materials consisted of the passages and lexical decision targets used in Experiment 1. Additional comprehension items (i.e., true—false paraphrases) were constructed, one for each critical and filler passage.
The design was a 2 (skill) × 2 (appropriateness) × 2 (type) × 2 (distribution) × 6 (SOA) factorial. Skill (skilled and less skilled), distribution (blocked and distributed), and SOA (200, 300, 400, 500, 750, and 1,000 ms) were between-subjects variables. Appropriateness (appropriate and inappropriate) and type (associate and topic) were within-subjects variables.

Subjects were randomly assigned to one of the 12 combinations of SOA and distribution. The procedure for subjects in the blocked condition was the same as the one used in Experiment 1, except for the number of comprehension items. Subjects received seven comprehension items after each block of seven passages. Subjects in the distributed condition received the same comprehension items; however, the items were interspersed in the list. When the homograph prime was in the first sentence of the passage. When the final word of the passage was the homograph prime, the comprehension item immediately followed the subject's response to the lexical decision target.

Results and Discussion Comprehension.

A 2 (skill) × 2 (distribution) × 6 (SOA) ANOVA was performed on correct responses to the comprehension items. The analysis yielded reliable main effects of skill, $F(1, 288) = 40.03$, $MSE = 39.11$, and distribution, $F(1, 288) = 85.91$, $MSE = 39.11$. These effects were modified by a significant Skill × Distribution interaction, $F(1, 288) = 4.02$, $MSE = 39.11$. Further analyses revealed a significant effect of skill in the blocked condition, $F(1, 288) = 35.51$; skilled readers performed better than did less skilled readers ($M = 88\%$ and $M = 81\%$, respectively). In contrast, we found no reliable effect of skill in the distributed condition, $F = 1.18$; skilled and less skilled readers performed similarly when comprehension questions were presented immediately after they read each passage ($M = 93\%$ and $M = 90\%$, respectively).

Lexical decision errors.

A 2 (skill) × 2 (appropriateness) × 2 (type) × 2 (distribution) × 6 (SOA) repeated measures ANOVA was performed on the number of lexical decision errors for positive lexical decision trials. The analysis yielded no reliable main effects or interactions.

Lexical decision latencies.

The same analysis was performed on the lexical decision latencies. Errors and outliers constituted 2.7% of the data and were handled by means of the procedure used in Experiment 1. The significance tests from the overall ANOVA are presented in Table 2. The mean latencies appear in Figure 4.

With respect to the hypothesis in the present experiment, we predicted a significant Skill × Distribution × SOA interaction. We expected less skilled readers in the blocked condition to show an increase in latencies across SOA conditions, whereas we expected less skilled readers in the distributed condition to show a decrease. In contrast, we expected no response differences between skilled readers in the two conditions. Although the trends in Figure 4 were as expected, the overall analysis yielded only partial support for the hypothesis. The Skill × Version × SOA interaction was significant in the items analysis but not in the subjects analysis (see Table 2). Because our predictions were specific to a Skill × Distribution interaction at longer prime—target SOAs (500—1,000 ms), we conducted an analysis in which we included data only from these longer SOA conditions. The analysis yielded a significant Skill × Distribution interaction, $F_{1}(1, 288) =$
5.02 and $F_2 (1, 52) = 112.06$. Further analyses revealed an effect of distribution among less skilled readers, $F_1 (1, 288) = 6.40$ and $F_2 (1, 52) = 134.41$, but not among skilled readers, $F_1 (1, 288) = 1.30$ and $F_2 (1, 52) = 3.12$. Less skilled readers in the distributed condition exhibited faster latencies than did less skilled readers in the blocked condition, whereas skilled readers in the two conditions performed similarly.

These findings lend some support to our rather speculative hypothesis that poorer than normal access to recently comprehended information, in combination with context checking at the time of test, contributes to slow latencies among less skilled readers at long prime—target SOAs. A manipulation that was intended to increase the availability of recently comprehended information by focusing readers' attention on the comprehension aspects of the task (i.e., by having them respond to a comprehension question after each passage) resulted in faster decision latencies among less skilled readers.

In addition to providing some support for our hypothesis, these results provide an important replication of the pattern of individual differences observed in Experiment 1. Again, we found a significant Skill × Type × Appropriateness interaction (see Table 2). Both skilled and less skilled readers executed a process that is necessary to represent the meaning of a sentence (i.e., sense selection), whereas only skilled readers generated inferences to elaborate the discourse meaning.

**General Discussion**

To conclude that inferential processing is one of the characteristics of high reading skill, one must demonstrate (a) that skilled readers generate knowledge-based inferences that less skilled readers do not and (b) that deficiencies in basic linguistic processes alone (e.g., word recognition, syntactic-processing) cannot account for less skilled readers' failure to generate these inferences. We interpret the results reported here as support for the claim that inferential processing is an important component of skilled reading. We found that skilled readers responded faster to appropriate than to inappropriate topic words within 500 ms of processing, whereas less skilled readers showed no facilitation at prime—target SOAs as long as 1,000 ms. Failure by less skilled readers to generate topic-related inferences does not appear to be due to their failure to execute lower level processes necessary to represent the meaning of a sentence. Both skilled and less skilled readers responded faster to appropriate than to inappropriate associates of homograph primes within 300 ms of processing. In addition, less skilled readers' failure to generate knowledge based inferences does not appear to be due to deficits in their knowledge about the sentence topics. When skilled and less skilled readers were asked to provide topics for the sentences, they performed similarly.

It should be noted that our interpretation of these results depends on a critical assumption. We assume that less skilled readers who exhibit facilitation to appropriate, relative to inappropriate, associates have constructed reasonably accurate discourse representations. However, this assumption is not justified if facilitation occurs by means other than sense selection. An alternative means by which facilitation may occur is lexical priming. If appropriate associates are supported by more semantic associations to individual lexical items in preceding sentences than are inappropriate associates, then appropriate associates will be facilitated relative to inappropriate ones. This will occur even if readers have not constructed an accurate discourse representation. Fortunately, we can assess the extent to which our findings were influenced by semantic associations by examining the data reported in Experiment 2. We found that scrambling the preceding discourse context to prevent readers from engaging in normal sentence processing effectively eliminated the appropriateness effect (see Foss, 1982, and Simpson, Peterson, Casteel, & Burgess, 1989, for a discussion of the use of scrambled contexts to examine sentence context effects). Thus, it appears that lexical priming alone was not responsible for facilitation to context-appropriate associates.
Additional evidence that less skilled readers constructed reasonably accurate discourse representations can be found in Experiment 3. When skilled and less skilled readers were asked comprehension questions after every block of passages, we found better performance by skilled than by less skilled readers. However, we found no reliable differences between the two groups when we asked comprehension questions after each passage. These data suggest that less skilled readers constructed representations that were sufficiently accurate to enable them to answer comprehension questions presented immediately after reading. The comprehension differences exhibited by skilled and less skilled readers at longer retention intervals may be due to factors, such as elaboration, that influence the accessibility of a discourse representation in long-term memory.

In this study, we found no differences in skilled and less skilled readers' ability to select the context-appropriate sense of a homograph. This finding appears to be inconsistent with recent evidence that less skilled readers fail to rapidly suppress the meanings of activated but irrelevant information (Gernsbacher & Faust, 1991; Gernsbacher et al., 1990). Gernsbacher et al. (1990) demonstrated differences in skilled and less skilled comprehenders' ability to reject the contextually inappropriate meanings of ambiguous words. In their task, subjects read a sentence that either did or did not end with a homograph (e.g., "He dug with the spade" vs. "He dug with the shovel"). Subsequently, they received a test word (e.g., ace) and were asked to judge whether the test word matched the meaning of the sentence. When a test word was presented immediately after the sentence, Gernsbacher et al. found that both skilled and less skilled comprehenders exhibited significant interference. That is, both groups were slower to reject the test word "ace" after reading "He dug with the spade" than after reading "He dug with the shovel." In contrast, less skilled comprehenders exhibited substantially more interference than did skilled comprehenders when a test word was presented after an 850-ms delay. Gernsbacher et al. argued that less skilled comprehenders experienced more interference than did skilled comprehenders because they have less rapid and efficient suppression mechanisms.

Although our findings appear to be inconsistent with those reported by Gernsbacher et al. (1990), we do not know the extent to which this inconsistency is due to task differences. Not only did we use a different measure of activation than they did (i.e., lexical decision versus meaning-fit judgments), we also made different comparisons. Gernsbacher et al. compared judgment times to test words that were either related to the homograph (i.e., appropriate associates) or were unrelated. In contrast, we compared decision latencies to appropriate and inappropriate associates. Because we did not compare the activation of inappropriate associates to unrelated control items, we do not know whether less skilled readers actually suppressed the homograph's inappropriate meaning. We know only that inappropriate associates were less activated than were appropriate associates. It may be that even partial activation of an inappropriate associate is sufficient to produce interference on the meaning-judgment task. Further research will be necessary if we are to determine whether our results provide evidence against Gernsbacher et al.'s (1990) suppression hypothesis.

When a lexical decision task is used to assess inferential processing, as was the case in the present study, it is necessary to consider whether the influence of postaccess processes on lexical decision latencies provides an alternative account of the findings. Considerable research has demonstrated that lexical decision latencies are influenced by both lexical access and context checking that occurs at the time of test (Balota & Chumbley, 1984; Chumbley & Balota, 1984; Forster, 1981; Potts et al., 1988). Indeed, we suggested context checking as a partial explanation for the extremely slow latencies exhibited by less skilled readers at long prime—target SOAs. With respect to the associate words, context checking may have facilitated responses to test items related to the appropriate meaning of the homograph among both skilled and less skilled readers. However, this is consistent with our claim that less skilled readers executed word- and sentence-
level processes to construct a reasonably accurate discourse representation. Even though their representation may have been less accessible over time, it was sufficiently accurate to support a backward association at the time of test.

With respect to the topic words, context checking may also have played a role. Skilled readers may not have generated topic-related inferences on-line as they comprehended the passages. Rather, presentation of a topic word may have elicited a backward association between the test word and the preceding discourse context among skilled, but not among less skilled, readers. Whether or not this provides an alternative interpretation of our results depends on why context checking facilitated responses to topic words only among skilled readers. One possibility is consistent with our claim that inferential processing is characteristic of high reading skill. Access to world knowledge during reading may increase the likelihood that the discourse representation constructed by skilled readers is compatible with the topic-related target. Consider one of the passages from our study:

1. After touching Christ, the beggar found he no longer walked with a limp.

This sentence asserts a predication (after) to connect the proposition beggar touched Christ with other propositions in the sentence. However, what is the nature of this connection? If we assume that after describes a causal relationship between "touching Christ" and one of the other propositions, did touching Christ cause the beggar to no longer limp or cause the beggar to find (notice) that he no longer limped? Access to world knowledge would suggest that the appropriate connection is a causal link between "the beggar touched Christ" and "the beggar no longer limped." If such a connection is formed, then an incoming test probe (e.g., miracle) is more likely to elicit a backward association than if some other connection is formed (e.g., touching Christ caused the beggar to notice that he no longer limped). It should be noted that access to world knowledge is necessary to construct the causal connection in this example. This can be demonstrated by contrasting Sentence 1 with the following:

2. After stepping off the curb, the beggar found he no longer walked with a limp.

Although Sentences 1 and 2 have similar constructions, a causal connection between "stepping off the curb" and "no longer limping" seems inappropriate.

Alternatively, context checking may have facilitated responses to topic-related targets among skilled, but not among less skilled, readers because skilled readers construct more accurate discourse representations against which to check an incoming target. If this is the case, then we cannot argue that inferential processing is characteristic of high reading skill. Rather, less skilled readers' failure to generate the topic-related inferences is due to deficiencies in their ability to execute basic linguistic processes. Although we cannot completely exclude this possibility, we have some evidence that less skilled readers in this study constructed reasonably accurate discourse representations. As we discussed previously, skilled and less skilled readers did not differ in (a) the extent to which they exhibited facilitation to the context-appropriate meaning of an ambiguous word or (b) their ability to answer comprehension questions presented immediately after reading each passage.

If we assume that less skilled readers in this study constructed accurate discourse representations, then we might ask why they failed to generate the topic-related inferences either during comprehension or at later test. One possibility is that working-memory constraints limit the ability of less skilled readers to engage in inferential processing. Cantor and Engle (1993) recently reported data that are consistent with this possibility. In their study, subjects with high and low working-memory spans learned lists of unrelated
sentences that varied in number of shared concepts (fan). Subjects learned the lists to criterion and then performed a verification task in which they responded to studied sentences and related foils. Cantor and Engle found that both high- and low-span subjects exhibited a positive fan effect; verification times increased as a function of fan size. In a subsequent experiment, subjects learned thematically related sentences that varied in fan size. Cantor and Engle found that low-span subjects continued to exhibit a positive fan effect, whereas high-span subjects now exhibited a negative fan effect. They argued that high-span subjects constructed a single, integrated representation (i.e., a mental model) from the list of thematically related sentences. Access to this higher order representation enhanced retrieval for the individual sentences. In contrast, low-span subjects did not construct an integrated representation; thus, the fan effect they exhibited was not influenced by the relatedness of the sentences. Low-span subjects' failure to construct an integrated representation did not appear to be due to their failure to construct an accurate representation of the individual sentences. High- and low-span subjects learned the lists to the same criterion and exhibited no differences in error rates on the recognition test. Thus, Cantor and Engle's results suggest that working-memory constraints may influence a reader's ability to form thematic connections among propositions.

In summary, our results are consistent with earlier research demonstrating that less skilled readers perform poorly on tasks that require inferential processing (Garnham et al., 1982; Oakhill, 1983, 1984; Oakhill et al., 1990; Yuill et al., 1989). It appears that skilled readers are more likely than less skilled readers either (a) to generate a topic-related inference on-line during comprehension or (b) to generate a topic-related inference to integrate a test item into a preceding discourse context. Either possibility argues that a distinguishing characteristic of skilled readers is that they engage in inferential processing that less skilled readers do not.

References


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Table 1

Table 1

*Example Passages and Target Items From Till, Mross, and Kintsch (1988)*

<table>
<thead>
<tr>
<th>Passage</th>
<th>Target items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The townspeople were amazed to find that all the buildings had</td>
<td>money</td>
</tr>
<tr>
<td>collapsed except the <em>mint</em>. Obviously, it had been built to</td>
<td>earthquake</td>
</tr>
<tr>
<td>withstand natural disasters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Thinking of the amount of garlic in his dinner, the guest asked for a</td>
<td>candy</td>
</tr>
<tr>
<td><em>mint</em>. He soon felt more comfortable socializing with the others.</td>
<td>breath</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2

Table 2

*Statistical Tests for the Three Experiments*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Subjects analysis</th>
<th>Items analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F$</td>
<td>$df$</td>
</tr>
<tr>
<td>Skill</td>
<td>13.81*</td>
<td>1, 155</td>
</tr>
<tr>
<td>Type</td>
<td>93.76*</td>
<td>1, 155</td>
</tr>
<tr>
<td>Approp.</td>
<td>68.34*</td>
<td>1, 155</td>
</tr>
<tr>
<td>Skill × SOA</td>
<td>2.37*</td>
<td>5, 155</td>
</tr>
<tr>
<td>Skill × Approp.</td>
<td>6.32*</td>
<td>1, 155</td>
</tr>
<tr>
<td>SOA × Approp.</td>
<td>5.09*</td>
<td>5, 155</td>
</tr>
<tr>
<td>Type × Approp.</td>
<td>11.43*</td>
<td>1, 155</td>
</tr>
<tr>
<td>Skill × Type × Approp.</td>
<td>8.49*</td>
<td>1, 155</td>
</tr>
</tbody>
</table>

Figure 1. Mean decision latencies for associate and topic words as a function of reading skill (Sk = skilled; L-Sk = less skilled), appropriateness (app = appropriate; inapp = inappropriate), and prime—target stimulus onset asynchrony (SOA; 200, 300, 400, 500, 750, and 1,000 ms).

Figure 2. Mean latencies for topic words (app = appropriate; inapp = inappropriate) as a function of prime—target stimulus onset asynchrony (SOA; 200, 300, 400, 500, 750, and 1,000 ms). The means were
calculated on the full data set (including those subjects who had Scholastic Aptitude Test scores in the middle third of the distribution) and were collapsed across skill level.

Figure 3. Mean decision latencies for associate words as a function of context (text or scrambled), reading skill (Sk = skilled; L-Sk = less skilled), appropriateness (app = appropriate; inapp = inappropriate), and prime—target stimulus onset asynchrony (SOA; 200, 300, and 400 ms).
Figure 4. Mean decision latencies for associate and topic words as a function of question distribution (blocked or distributed), reading skill (Sk = skilled; L-Sk = less skilled), appropriateness (app = appropriate; inapp = inappropriate), and prime—target stimulus onset asynchrony (SOA; 200, 300, 400, 500, 750, and 1,000 ms).