Integration of Topic and Subordinate Information During Reading

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Four experiments examined how readers integrate subordinate information with relevant context as they read. Ss read texts a sentence at a time with occasional interruptions lasting 30 s. Following a distractor task, they resumed reading after being reminded of the topic sentence of the last paragraph they had read (topic cue condition), or being reminded of the last sentence they had read (local cue condition), or receiving no reminder of what they had been reading (no cue condition). Reading times on the first sentence following interruption were faster in the topic and local cue conditions than in the no cue condition (a) when the topic and local cues supplied missing referents for the target sentences, (b) when the target sentences were written to be understood as independent statements, and (c) whether the target sentences were embedded in short or long texts. Results are interpreted as demonstrating that readers integrate subordinate information with relevant topics, as well as with the immediate local context.

Although it is possible to distinguish a variety of proto-typical structures for expository texts (Meyer, 1985), a common characteristic of expository texts is their organization around a set of semantically related topics. One implication of this observation is that much of the task of comprehending an expository text can be framed in terms of processing of the text's topics. Specifically, to understand a text adequately, a reader must: (a) identify the important topics, (b) determine how the topics are related to each other, and (c) determine how subordinate information is related to the relevant topic. Consistent with this characterization, several theorists have emphasized the use of topic information to integrate text information during reading (Britton, in press; Kieras, 1981a; Kintsch & van Dijk, 1978; Lorch, Lorch, & Matthews, 1985; van Dijk & Kintsch, 1983). However, an alternative position is that most integration during reading is very local. In particular, readers are assumed to make little attempt to connect subordinate information to the relevant topic as long as the information can be related to the immediately preceding context (McKoon & Ratcliff, 1992; see also Fletcher & Bloom, 1988). The current study addresses the issue of whether readers integrate subordinate information with the relevant text topic when they read.

Studies of text memory demonstrate the central role of discourse topics in readers' text representations. Perfetti and Goldman (1975) found that cued recall of a sentence from a short text is strongly influenced by the thematic role of the noun used to cue recall. In their study, recall was much better if the noun played a prominent thematic role (i.e., was a referent of most of the text propositions) than if the noun was not thematically prominent. Other evidence of the central role of discourse topics comes from studies of memory for

texts with two competing organizations. If the topic of one of the two potential organizations is emphasized either by a title or by the initial sentence of the text, content related to the signaled topic is recalled better than is content related to the unsignaled topic (Kieras, 1981b; Kozminsky, 1977; Schallert, 1976). In addition, subjects organize their recalls with respect to the signaled topic (Kozminsky, 1977). Finally, Kieras (1978) found faster sentence reading times and better content recall if the paragraph topic was explicitly stated in the initial sentence than if the topic sentence was embedded in the middle of the paragraph.

Although studies of text memory suggest that readers use the perceived topic of a brief text as the focal point for the integration of subordinate information, recall data do not allow discrimination of whether the subordinate information is directly or indirectly related to the topic in readers' text representations. When looked at in terms of a network representation, recall data generally cannot discriminate between a text representation in which a topic is directly connected to each of its subordinate propositions versus a representation in which a topic's connection to a particular subordinate proposition is mediated by a chain of connections to intervening subordinate propositions. In either structure, topic information provides a critical access route to the text representation.

A more direct test of the role of topic information in the integration of subordinate information was provided by Glanzer, Fischer, and Dorfman (1984). In their procedure, subjects read eight-sentence texts a sentence at a time. After the fourth sentence of a text, subjects were usually interrupted and required to perform a distractor task to remove the contents of working memory. Following the distractor task, subjects resumed reading. Reading time on the fifth sentence of the text (i.e., first new sentence following the interruption) was examined as a function of whether subjects received no reminder of what they had been reading before the interruption (no cue condition), subjects were reminded of the last sentence before interruption (local cue condition), or subjects were reminded of the topic of the text (topic cue condition). In addition, there was a baseline condition consisting of no

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interruption between the fourth and fifth sentence (continuous condition). The critical results concern the reading times in the local cue and topic cue conditions. Reading times in the local cue condition were faster than in the no cue condition and nearly as fast as in the continuous condition. Reading times in the topic cue condition, however, were as slow as in the no cue condition. According to the logic of the paradigm, readers found the sentence preceding the target sentence to provide almost all of the information necessary to integrate the target sentence into their text representations. However, readers did not use information about the text topic as a context for integrating the target sentence.

The results of the Glanzer et al. (1984) study are consistent with the theoretical position that readers generally do not relate subordinate information to topics; rather, they are satisfied to integrate subordinate information only with the local context (McKoon & Ratcliff, 1992). However, there are several reasons to question the generality of Glanzer et al.'s findings. First, the target sentences in Glanzer et al.'s texts used anaphora to refer to concepts introduced before reading was interrupted. The missing referents were supplied in the local cue condition but not in the topic cue condition. Thus, it is not surprising that there were large facilitatory effects on reading in the local cue condition and no facilitation in the topic cue condition.

The following parameters of Glanzer et al.'s (1984) procedure limit the generality of their conclusions: (a) Subjects' comprehension was tested by an immediate cued-recall procedure requiring memory for factual information presented in individual sentences (i.e., did not require integration of information across sentences), (b) each text discussed only a single topic, and (c) all texts were only eight sentences long. These characteristics are all likely to inhibit integrative processing during reading (van den Broek, Fletcher, & Risden, in press). In particular, they are likely to minimize the role of topical information as a context for understanding subordinate text content.

In sum, studies of text recall do not permit us to discern whether readers directly represent the relation between subordinate propositions and their respective topics. The results of Glanzer et al. (1984) address the issue more directly but are limited in their generality. In the current study, we used Glanzer et al.'s procedure to investigate readers' integration of subordinate information in circumstances that should be more conducive to the use of topic information during reading.

Experiment 1

Subjects in the first experiment read three texts while their reading times were recorded on four target sentences embedded in each of the texts. Immediately before three of the target sentences, subjects were interrupted and required to perform addition problems for 30 s. When the distractor task was completed, subjects resumed reading after (a) rereading the initial, topic sentence of the paragraph they had been reading (topic cue condition); (b) rereading the last sentence they had read before the interruption (local cue condition); or (c) receiving no reminder of what they had been reading

(no cue condition). In the fourth condition, there was no interruption of reading before the target sentence (continuous condition). This aspect of the design of Experiment 1 was the same as that used by Glanzer et al. (1984). However, there were some important differences in procedure between Experiment 1 and Glanzer et al. (1984). First, in both the topic cue and local cue conditions of Experiment 1, the referent of the subject of the target sentence was identified in the cue. In Glanzer et al.'s procedure, this was the case only for the local cue condition.

A second important difference is that in Experiment 1 the texts were nine paragraphs long and discussed eight distinct topics. Each text discussed four attributes of two major topics and was organized by attributes. The use of longer and more complex texts was intended to make it likely that readers would both integrate text information at a meaningful level and attend to topic information as they read (cf. van den Broek et al., in press).

Finally, the third change in procedure and design was that in Experiment 1 two different comprehension tests were used following reading. In one condition, subjects performed a verification task in which they were tested for recognition of paraphrased statements from the text. As in the cued-recall procedure used by Glanzer et al. (1984), this task placed a relatively low demand on readers to integrate information across sentences. In the second condition, subjects were required to write an outline of the text after reading. Relative to the verification task, this task required more attention to topic information and more integration of information in the text.

The primary concern in Experiment 1 is the effect of the topic cue condition on target reading times. If readers do not integrate subordinate information with the relevant topic, then there should be no facilitation of reading relative to the no cue condition. If readers integrate subordinate information, then the topic cue should facilitate reading. Another concern is how the processing task might affect use of topic cues. If the outlining task promotes the strategic use of topic information to integrate text content, then topic cues might facilitate reading in the outline condition but not the verification condition. An alternative possibility is that topic cues will facilitate reading in both task conditions. This would occur if readers routinely integrate subordinate information with topic information when they read multiple-topic texts for comprehension.

Method

Subjects.   Subjects were 100 volunteers from introductory psychology classes at the University of Kentucky. The data of 4 subjects were not included in the analyses: 3 subjects failed to follow instructions appropriately (they took notes while reading), and one subject's data were lost due to experimenter error. Subjects were assigned to the verification and outline conditions at random with the restriction that an equal number of subjects participate in each condition. All subjects received credit for experiment participation.

Materials.   The materials consisted of a brief practice text and two versions of each of three experimental texts. The practice text was 25 sentences long and discussed Daguerre's discovery of a photographic development process. The experimental texts were

between 65 and 79 sentences long and were titled "The Great Apes," "A Comparison of Two Countries," and "A Comparison of Two Children's Games."

The experimental texts all had the same topic structure. A version of "The Great Apes" text is presented in the Appendix. Each text began with an introductory paragraph that gave an overview of the organization of the text. The introductory paragraph was followed by eight paragraphs discussing four attributes of each of the two major text topics. For example, "The Great Apes" text discussed the habitat, social structure, communication methods, and eating habits of chimpanzees and orangutans. All texts were organized by attributes, alternating between the two major topics. The two versions of a given text differed only in the order of discussion of the two major topics. For example, one version of "The Great Apes" text always discussed an attribute first for chimpanzees and then for orangutans; the other version always discussed orangutans first, then chimpanzees. The purpose of this manipulation was to double the number of target sentences to increase the power of tests of effects against item variability.

For each of the experimental texts, the initial sentence of each of the eight attribute paragraphs introduced the topic of the paragraph and stated the main idea (i.e., expressed the most superordinate proposition of the paragraph). One sentence in each of the attribute paragraphs was designated as a target sentence. Target sentences across the three texts were between 36 and 51 characters long, although the range of sentence lengths within the same text was no more than 8 characters. All target sentences were embedded within their respective paragraphs and were subordinate to the initial topic sentence of the paragraph. The target sentences in "The Great Apes" text are typed in italics in the Appendix.

In a given version of an experimental text, only four of the target sentences were of interest. The four critical targets in a specific text version were always the target sentences for the second-discussed topic. For example, for the text version in the Appendix that always discussed an attribute first for chimpanzees and then for orangutans, the target sentences were those associated with the four paragraphs on orangutans. Thus, across the two text versions, different sets of target sentences were examined.

In addition to the texts, sentences were constructed for the verification task. For the practice text, four true and four false statements were constructed. For each of the experimental texts, eight true and eight false statements were constructed. For the experimental texts, all statements were assertions regarding the four attributes discussed in the texts. Half of the statements paraphrased information presented in the text, and half contradicted information presented in the text. Half of the statements were about one of the major topics, and half were about the other topic. The verification sentences associated with "The Great Apes" text are presented in the Appendix. The same set of verification sentences were used for both versions of each experimental text.

Procedure. Subjects were tested individually in sessions lasting approximately 45 min. The presentation of materials was controlled by an Apple 2e computer equipped with a Mountain Hardware clock.

Subjects were instructed that they would read four short texts on different topics and would be tested after each text. Subjects in the outline condition were informed that they would write an outline after each text; subjects in the verification condition were informed that they be required to answer some true–false questions after each text. Subjects were also instructed in the procedure for reading texts and were told that they would occasionally be interrupted and asked to perform simple math problems for a short time.

When a subject understood the procedure, the practice text was presented. Each time the subject pressed the space bar, the current sentence was erased and the next sentence was presented. The computer recorded the reading time for each sentence. Immediately before the 20th sentence of the practice text, reading was interrupted and the instructions for the addition problems were presented. Pairs of two-digit numbers were randomly generated by the computer, one at a time. The subject computed the answer for each problem (use of paper and pencil was allowed), then entered the answer on the computer. Answers were typed using the numbers at the top of the keyboard and pressing the "Enter" key to record an answer. The instructions for the math problems were summarized on the screen with each addition problem that was presented. After 30 s had elapsed, the computer informed the subject that the reading task would be resumed. The subject pressed the space bar twice and received the message: "Press the space bar twice when you want to see the next sentence of the text, then continue reading as before." When the subject pressed the space bar twice, the message erased and the 20th sentence appeared. Thereafter, each press of the space bar erased the current sentence and presented the next sentence, as before.

When the practice text was completed, subjects were instructed in the testing procedure. Subjects in the verification condition were told that they would be presented a series of statements that were based on the text they had just read. They were told to decide for each statement whether it was true or false. They pressed a key marked "Yes" (the "0" key) to respond true and a key marked "No" (the "1" key) to respond false. The computer recorded response latencies and accuracy for each statement.

Subjects in the outline condition were instructed in the outlining procedure but were not asked to provide an outline for the practice text in the interest of saving time. The subjects were provided with a sample outline and asked to read it over and ask questions if they did not understand the procedure. Subjects were required to provide a handwritten outline for each of the experimental texts, and they were clearly informed of this requirement after completing the practice text.

The experimenter stayed in the room with the subjects throughout the practice text. The experimenter monitored the procedure and explained the procedure if the subject hesitated or asked questions, thus ensuring that the subjects were comfortable with the reading procedure, the procedure for the addition problems, and the verification or outlining procedure. After the practice text procedure was completed, the experimenter left the room and the subject completed the experiment.

The procedure for the experimental texts was analogous to that for the practice text except that reading was interrupted three times for each of the experimental texts. For one of the interruptions, the procedure was identical to that described for the practice text. That is, when the subject was instructed to resume reading the experimental text, no information was provided concerning what the subject had been reading at the time of interruption (no cue condition).

For another of the interruptions, the subject was reminded of the information in the last sentence before the interruption (local cue condition). For example, if the subject was reading "The Great Apes" text presented in the Appendix and was interrupted before he or she reached the target sentence in the paragraph on the orangutan's habitat, the subject was informed: "Recall that you were last reading that orangutans build nests in tall trees for protection." This message was presented after the message to press the space bar to see the next sentence of the text; that is, it was the last message the subject saw before being presented the target sentence.

Finally, for the other interruption, the subject was reminded of the topic sentence of the paragraph that was being read at the time of interruption (topic cue condition). The procedure was identical to that for the local cue condition except for the information that was presented immediately before the target sentence. For the example of the target sentence on the orangutan's habitat, the topic cue was:

"Recall that you were last reading about why orangutans find the dense rain forests a good place to live."

For a given subject and text version, one of the target sentences was assigned to the continuous condition, one was assigned to the no cue condition, one was assigned to the local cue condition, and one was assigned to the topic cue condition. Across subjects, each target of a given text version was assigned equally often to the four cue conditions using a Latin square. There were two different sets of target sentences corresponding to the two different versions of each experimental text.

Results and Discussion

The data of interest are the reading times on the target sentences in the reading task; the data from the verification and outlining tasks were not analyzed. Reading times were trimmed by first converting each reading time to a deviation from the mean of its respective condition for every subject. The standard deviation of the deviation scores was then computed, and all scores exceeding three standard deviations above zero were deleted from the data set (1.13%). The remaining reading times were analyzed. All tests were conducted against both subject (F_1) and item (F_2) variability. All reported results are significant at the .05 level unless noted otherwise.

The mean reading times are reported as a function of the cue condition and task in Table 1. These data were analyzed using a mixed-factors analysis of variance (ANOVA) with a between-subjects factor of task (verification or outline) and a within-subjects factor of cue (continuous, topic, local, no cue). In addition, planned orthogonal contrasts were computed using the Bonferroni procedure to control familywise error rate at the .05 level. Although the contrasts involved comparisons on repeated measures, the overall error term from the ANOVA was used as the basis for each error term because the sphericity assumption was satisfied (Huynh-Feldt adjustment = 1).

Table 1 shows slower reading times in the verification condition than in the outline condition, $F_1(1, 94) = 4.38, MS_e = 2.065; F_2(1, 23) = 22.30, MS_e = 0.214$. This result validates the a priori assumption that the verification task emphasizes attention to detail during reading, whereas outlining emphasizes attention to topical information at the expense of detail.

Table 1 also shows an effect of the cue on reading times, $F_1(3, 282) = 24.60, MS_e = 0.337; F_2(3, 69) = 20.38, MS_e = 0.203$. Although the magnitude of the effect appears smaller for the verification task than for the outline task, the interaction was not significant, $F_1(3, 282) = 2.36, MS_e =$

Table 1
Mean Reading Times (in Seconds) on Target
Sentences in Experiment 1

| Task | Cue | | | | |
	Continuous	Topic	Local	No cue	M
Verification	2.235	2.851	2.925	3.039	2.762
Outline	2.171	2.426	2.460	2.766	2.456
M	2.203	2.638	2.693	2.903	2.609

$0.337, p > .05; F_2(3, 69) = 1.77, MS_e = 0.244, p > .15$. Furthermore, the important observation is that the pattern of reading times across the four cue conditions was identical for the two tasks. Reading times were much slower in the three conditions involving an interruption of reading (2.745 s) than in the condition that did not involve an interruption (2.203 s), $t_1(282) = 7.92, t_2(23) = 7.40$. Within the three conditions involving interruption, reading times were faster if subjects were reminded of either the topic sentence or the last sentence preceding the interruption (2.666 s) than if they received no reminder at all (2.903 s), $t_1(282) = 3.28, t_2(23) = 3.02$. However, there was no difference in reading times for the topic cue and local cue conditions (both ts < 1).

Collapsing across the outlining and verification tasks, the findings for the local cue condition are consistent with Glanzer et al.'s (1984) findings. Readers find that the information provided in the immediately preceding sentence is an effective context for integrating new information from the sentence they are currently processing. The novel finding from Experiment 1 concerns the effect of a topic cue. In contrast to Glanzer et al., Experiment 1 demonstrates that reminding readers of the topic sentence of the relevant paragraph facilitates their attempts to resume reading. In fact, the topic cues were at least as effective as the local cues as contexts for integrating the target sentences. There are at least three possible reasons for the discrepancy in the findings between this experiment and those of Glanzer et al.

One possibility is that both the topic and local cues of Experiment 1 often supplied missing referents for the target sentences, whereas only the local cues supplied missing referents in Glanzer et al.'s (1984) procedure. The pattern of cuing effects observed in Experiment 1 cannot be entirely explained by this hypothesis, however. Most of the target sentences referred anaphorically to the subject of the sentence and both the topic and local cues supplied the relevant antecedent. However, there were several target sentences in which anaphora was used to refer to an antecedent that was supplied only by the local cue. If missing referents were the only important contextual information provided by the topic and local cues, the local cue condition should have facilitated reading of the target sentences more than the topic cue condition. However, if anything, topic cues were more effective than local cues.

Two other differences in procedure might have contributed to the discrepancy between Glanzer et al.'s (1984) findings and the findings of Experiment 1. One difference is that the texts in Experiment 1 were much longer and more complex than the texts used in Glanzer et al. Subjects reading longer texts might make more use of topic information to integrate subordinate information as they read. The other difference concerns the cuing procedure. In Glanzer et al.'s procedure, subjects were given no warning of the transition from the distractor task to the primary task. Rather, presentation of a sentence from the original text was the signal to the subjects that they had completed the distractor task. In the current procedure, the transition between the distractor and reading task was very clearly marked. Perhaps this difference in procedure contributed in some manner to the different effects observed for the topic cue conditions of the two studies.

Experiment 2 investigated whether differences in the cuing procedure or texts might be responsible for the discrepancy between Glanzer et al.'s findings and the findings of Experiment 1.

Experiment 2

Subjects in Experiment 2 read brief texts consisting of the paragraphs of the three experimental texts of Experiment 1. Reading times were recorded for a single target sentence in each paragraph (i.e., the same targets as in Experiment 1). The same four cuing conditions investigated in Experiment 1 were included in Experiment 2. If the discrepancy between Experiment 1's results and the results of Glanzer et al. (1984) is due to differences in text length and complexity across the two studies, then the results of Experiment 2 should replicate Glanzer et al.'s finding of no benefit of the topic cue condition relative to the no cue condition.

In addition to the cue variable, two different procedures were compared for switching subjects from the distractor task back to the reading task. In one condition, the procedure was identical to that of Experiment 1. This condition provided a smooth transition back to the reading task. In the alternative cuing procedure, the transition from the distractor task to the reading task was more abrupt. This cuing procedure was similar to the cuing procedure used by Glanzer et al. (1984). If the cuing procedure interacts somehow with the type of cue that is presented, we might expect to replicate Glanzer et al.'s findings in the abrupt transition condition but replicate the findings of Experiment 1 in the smooth transition condition.

Method

Subjects. Subjects were 48 volunteers from introductory psychology courses at the University of Kentucky. All subjects received credit for experiment participation. Subjects were assigned at random to the two cuing procedures with the restriction that 24 subjects participate in each condition.

Materials. The practice text was a shortened version of the practice text of Experiment 1 (i.e., 13 sentences instead of 25 sentences). There were 24 experimental texts consisting of all but the introductory paragraphs of the experimental texts of Experiment 1. The texts ranged in length between 5 and 13 sentences, with a mode of 7 and a mean of 7.29 sentences.

The 24 experimental texts were assembled into eight sets of three texts per set. Each set contained one paragraph from each of the three different experimental texts of Experiment 1, so the topic of each successive text was unrelated to the topic of the preceding text. Each of the 24 experimental texts contained a single target sentence—the same target sentence as in Experiment 1. Across subjects, each target sentence was assigned equally often to the four cue conditions.

The sentences for the verification test were the same as those in Experiment 1. The verification sentences were assembled into eight sets of six sentences each corresponding to the eight sets of texts.

Procedure. Subjects were tested individually in sessions lasting approximately 45 min. Subjects were instructed that they would read 25 short texts on different topics and would be tested after every three texts. All subjects received the verification test after each set of texts. As in Experiment 1, subjects received instructions

in the reading procedure, the addition task, and the verification task. The experimenter monitored the subject throughout the practice procedure, then left the subject alone to complete the procedure for the 24 experimental texts.

Except for the shorter texts and more frequent interruptions and verification testing, the procedure of Experiment 2 was essentially the same as that of Experiment 1. The only change concerned the procedure for returning subjects to the reading task from the distractor task. When the addition task was completed, the message to the subjects was identical for the smooth and abrupt transition conditions: "You will now resume reading the text. When you press the space bar twice, a sentence will be presented, and you should continue reading as before." The procedure after this point differed for the two conditions. Subjects in the smooth transition condition saw an additional message when they pressed the space bar: Subjects in the no cue condition were told again to press the space bar when they wanted to resume reading, and subjects in the topic cue and local cue conditions were provided with the relevant message concerning what they had been reading before the interruption. After responding to this message, subjects in the smooth transition condition were presented the target sentence. In contrast, when subjects in the abrupt transition condition responded to the initial message that the distractor task was done, they were presented with the sentence appropriate to the condition, and their reading task had resumed. In the no cue condition, the sentence was the target sentence; in the topic cue and local cue conditions, the sentence was the topic sentence or the last sentence read before the interruption (and the next sentence was the target).

Every subject read the same texts and same target sentences, but the order of texts and the assignment of targets to levels of the cue variable differed across subjects. The sets of experimental texts were divided into two groups of four sets each, and the order of presentation of the two groups of texts was counterbalanced across subjects. Furthermore, there were three different orders of texts within a set. Finally, a Latin square procedure was used to assign cues to targets such that each subject received six trials in a given cue condition and all targets participated equally often in each cue condition across subjects.

Results and Discussion

Reading times on target sentences exceeding three standard deviations above the relevant condition mean (1.48%) were deleted from all data analyses. The data were submitted to a 2 (Transition) × 4 (Cue), mixed-factors ANOVA and planned orthogonal contrasts. The mean reading times are presented as a function of experimental condition in Table 2.

The results of Experiment 2 are easily summarized. Reading times were affected by the cue condition, $F_1(3, 138) = 15.47, MS_e = 0.145; F_2(3, 69) = 14.75, MS_e = 0.152$. However, the type of transition from the distractor to the reading task had no effect, $F_1 < 1$, nor did it interact with the cue

Table 2
Mean Reading Times (in Seconds) on Target Sentences in Experiment 2

Transition condition	Cue				
	Continuous	Topic	Local	No cue	M
Smooth	2.120	2.385	2.263	2.491	2.315
Abrupt	2.235	2.476	2.264	2.846	2.455
M	2.178	2.431	2.263	2.669	2.385

variable, $F_1(3, 138) = 1.87, MS_e = 0.145, p > .10; F_2(3, 69) = 1.86, MS_e = 0.143, p > .10$. The effect of the cue manipulation was somewhat different from that found in Experiment 1. As before, reading times were considerably faster in the continuous condition (2.178 s) than in the conditions involving interruption (2.454 s), $t_1(138) = 4.35, t_2(23) = 5.17$. Also, within the three conditions involving interruption, reading times were faster if an informative cue was provided (2.347 s) than if no information was provided about where reading had been interrupted (2.669 s), $t_1(138) = 4.78, t_2(23) = 4.36$. In contrast to the findings of Experiment 1, however, there was evidence that topic cues were not as effective as local cues at helping subjects to resume reading, $t_1(138) = 2.16, t_2(23) = 2.18$ (which are reliable at the .05 level with no familywise error rate control but are marginally significant if familywise error rate is controlled at .05 for a set of three contrasts).

To follow up the apparent difference in findings for Experiments 1 and 2, the data for the verification condition of Experiment 1 were compared with the data for Experiment 2, averaged across the two types of transitions. This comparison allowed a direct test of the interaction of text length and complexity with the cue variable. In fact, the effect of the cue manipulation differed across the two experiments, $F_1(3, 282) = 5.77, MS_e = 0.258; F_2(3, 69) = 3.99, MS_e = 0.191$. Analyzing the nature of this interaction with orthogonal contrasts revealed that: (a) subjects were more distracted by an interruption of reading when reading long texts than when reading short texts, $t_1(282) = 5.05, t_2(23) = 3.89$; and (b) the relative effectiveness of topic and local cues differed for long and short texts, $t_1(282) = 2.34$, but $t_2(23) = 1.20, p > .1$.

The results of Experiment 2 clarify the discrepancy between the findings of Experiment 1 and Glanzer et al.'s (1984) findings. Specifically, when subjects are presented relatively long texts with multiple topics, they integrate subordinate information with the relevant topics (Experiment 1). However, if the text is very short and simple, they use topic information less than the local context (Experiment 2) or not at all (Glanzer et al., 1984). In fact, the results of Experiment 2 are very similar to the findings reported by Glanzer et al. As in Glanzer et al., reading times tended to be slower in the local cue condition than in the continuous condition, but the difference was not significant, $t_1(138) = 1.09, t_2(23) = 1.14$. Furthermore, local cues resulted in faster reading times than topic cues. The only discrepancy with Glanzer et al.'s findings is that topic cues did facilitate reading compared with having no cues, $t_1(138) = 3.05, t_2(23) = 2.46$. The reason for this discrepancy may be that the topic cues in Experiment 2 frequently supplied missing referents for the subjects of target sentences, whereas the topic cues used by Glanzer et al. did not supply missing referents. Experiment 3 provides a test of this hypothesis.

Experiment 3

In the first two experiments, the majority of target sentences used anaphora to refer to concepts established earlier in the text. The cues in the topic cue and local cue conditions provided many of the referents of the target sentences, but the antecedents were not supplied in the no cue condition. This difference between the informative cues and the no cue condition may have been responsible for much of the facilitation found for the topic cue and local cue conditions. Experiment 3 tests this hypothesis by replicating the verification condition of Experiment 1 with two important changes. First, the experimental texts were rewritten so that the target sentences did not use any anaphoric devices; rather, each target sentence could be understood in isolation as long as the reader had knowledge of the subject of the target sentence (e.g., that "Culatta" was the name of a fictional country). The second change was that the no cue condition was replaced by a general cue condition in which subjects were provided an informative cue consisting of the relevant superordinate topic. For example, if subjects had been reading about the habitat of chimpanzees when they were interrupted, they were reminded that they had been reading about chimpanzees before the interruption. If topic and local cues facilitated reading in Experiment 1 simply because they provided missing referents for the target sentences, then there should be no difference between the topic cue and local cue conditions versus the general cue condition of Experiment 3. If, however, the topic and local cues provide subjects with useful contexts for integrating target information into their text representations, then reading should still be facilitated in those conditions relative to the general cue condition.

Method

Subjects. Subjects were 48 volunteers from introductory psychology courses at the University of Kentucky. All subjects received credit for experiment participation.

Materials. The materials consisted of the verification sentences, the practice text, and revised versions of the experimental texts of Experiment 1. The revisions of the experimental texts consisted primarily of rewriting the target sentences so that none of them involved anaphoric reference. To accomplish this, some sentences within paragraphs were occasionally reordered. Also, a couple of target sentences were replaced with new target sentences because the original sentences could not be revised appropriately.

Procedure. The procedure was identical to that of Experiment 1 with two exceptions. First, all subjects performed a verification task after each text. Second, the no cue condition was replaced with a general cue condition. In this condition, subjects were reminded of the general topic when they were returned to the reading task from the distractor task. For example, if the subject had been reading the paragraph about the orangutan's habitat at the time of interruption, the cue in the general cue condition was: "Recall that you were last reading about orangutans." Thus, a general cue reminded the reader which of the two possible superordinate topics (e.g., chimpanzees or orangutans) was relevant. By contrast, a topic cue provided the specific topic and theme of the relevant paragraph (e.g., "Recall that you were last reading why orangutans find the dense rain forests a good place to live.").

Results and Discussion

Reading times exceeding three standard deviations above the condition mean were deleted from all analyses (0.87%). The data were submitted to a one-way, repeated measures

ANOVA and planned comparisons. The top row of Table 3 presents the mean reading times for Experiment 3.

Comparing the results in the top row of Table 3 with the verification condition results in Table 1, reading times were faster in Experiment 3 than in Experiment 1. This finding may reflect the fact that the target sentences of Experiment 3 did not use anaphoric reference, so the task of identifying antecedents of target sentence referents was easier. The important observation, however, is that the pattern of reading times across the four conditions is the same as in Experiment 1: Reading times differed reliably across the four cue conditions, $F_1(3, 141) = 12.31, MS_e = 0.277; F_2(3, 69) = 10.70, MS_e = 0.155$. Reading times were faster in the continuous condition (2.002 s) than in the conditions involving interruption (2.490 s), $t_1(141) = 5.57, t_2(23) = 5.99$. Reading times in the general cue condition were, on average, slower than in the topic cue and local cue conditions (2.636 s vs. 2.418 s), $t_1(141) = 2.35, t_2(23) = 1.53$ ($p < .1$, one-tailed, for the test against item variability). The difference between the topic cue and local cue conditions was not significant ($t < 1$). Separate comparisons of the topic cue and local cue conditions with the general cue condition showed that topic cues aided resumption of reading, $t_1(141) = 2.35, t_2(23) = 1.97, p < .05$, 1-tailed; however, the effect of the local cues was marginal, $t_1(141) = 1.71, p < .05$, 1-tailed; $t_2(23) = 1.05, p > .3$.

The results of Experiment 3 clearly establish that the informative cues—most important, the topic cues—facilitate the resumption of reading by providing readers with an appropriate context for the integration of the target information into their text representations. The facilitative effect is not due solely to the topic and local cues providing antecedents for anaphoric references in the target sentences; the target sentences contained no anaphoric references, and the general cue condition reminded readers of the relevant superordinate topic before they resumed reading.

Experiment 4

In the first three experiments, subjects were consistently faster to resume reading if they were reminded of the topic sentence or the last sentence before interruption than if they were given no information or provided only the relevant superordinate topic. These findings have been interpreted as demonstrating that subjects use the topic and local cues to facilitate the integration of the target sentence into their text representations. However, an alternative possibility is that subjects initiated the construction of an entirely new representation after each interruption, rather than integrating the

Table 3
Mean Reading Times (in Seconds) on Target Sentences in Experiments (E) 3 and 4

			Cue		
Experiment	Continuous	Topic	Local	General	*M*
E3 (Story)	2.002	2.383	2.452	2.636	2.368
E4 (List)	2.582	2.670	2.619	2.638	2.627

new information with the representation that was being constructed before the interruption (Gernsbacher, Hargreaves, & Beeman, 1989; Gernsbacher, Varner, & Faust, 1990). According to this hypothesis, comparing the topic cue and local cue conditions with the no cue and general cue conditions amounts to comparing conditions in which a context is provided for integrating the target information with conditions in which no context is provided. If this explanation is correct, then the first three experiments simply do not address the issue of how readers use topic information to construct an integrated text representation.

Subjects in Experiment 4 read the target sentences of Experiment 3 embedded in lists of unrelated sentences. As in the previous experiments, subjects either were not interrupted (continuous condition) or were interrupted before reading the target sentence. If they were interrupted, the first sentence following the interruption was either the topic sentence of the paragraph from which the target sentence was extracted (topic cue), the sentence that would have preceded the target in the original text (local cue), or a sentence that provided the superordinate topic relevant to the target sentence (general cue). In all three conditions involving interruption, the second sentence following interruption was the target sentence.

The focus in Experiment 4 was on the reading times in the three conditions involving interruption. If subjects in the first three experiments were integrating target sentences only with respect to the cues after an interruption, then the cue effects observed in the first three experiments should be observed in Experiment 4. These same cue effects should be observed because the same immediate context was provided for integration in Experiment 4 as in the first three experiments. However, if subjects in the initial three experiments were integrating the target sentences into a coherent text representation, then there should be no cue effects in Experiment 4 because subjects were not presented a coherent text to process.

Method

Subjects. Subjects were 48 volunteers from introductory psychology classes at the University of Kentucky. All subjects received credit for experiment participation.

Materials. The materials consisted of a practice text and three experimental texts. Each text was a list of unrelated sentences consisting of both factual statements (e.g., "Golf was invented in Scotland.") and statements about fictional characters, places, or events (e.g., "Winters in Pruvak are cold and windy."). The practice text was 23 sentences long and was interrupted once. The experimental texts were equal in length to the experimental texts of Experiment 3, and each was interrupted three times.

There were four target sentences embedded in each of the three experimental texts. The target sentences were identical to the target sentences used in Experiment 3, and they were embedded in their respective texts in the same serial positions as the target sentences in the texts of Experiment 3. As in Experiment 3, there were two sets of experimental texts differing only in the target sentences used (i.e., a different set of 12 target sentences was used in the two sets of texts).

Each target sentence was assigned to a cue condition. Sentences assigned to the continuous condition were preceded by an unrelated

sentence. Sentences assigned to the topic cue condition were pre-ceded by the topic sentence associated with the target in the ex-perimental text of Experiment 3. Similarly, sentences assigned to the local cue condition were preceded by the sentence that would have preceded it in the corresponding text of Experiment 3. Sen-tences assigned to the general cue condition were preceded by a sentence that asserted a category membership relation involving the topic relevant to the associated target sentence. For example, if the target sentence concerned chimpanzees, the general cue that pre-ceded it was the sentence: "Chimpanzees are a type of animal." Thus, like the general cue condition of Experiment 3, this cue pro-vided the superordinate topic to which the subsequent target sen-tence referred but did not provide any further contextual informa-tion relevant to understanding the target sentence. In all three conditions involving interruption, the first sentence presented after the distractor task was the cue sentence and the second sentence presented was the target sentence.

In addition to the texts, sentences were constructed for the ver-ification task. There were 8 sentences constructed for the practice text and 16 sentences constructed for each experimental text. Half of the sentences had appeared in the associated text and half had not appeared in the text, but the two types of sentences were otherwise indistinguishable.

Procedure. The procedure for the reading task was analogous to that of Experiment 3 except for changes in instructions because of the differences in the texts across the two experiments. Subjects in Experiment 4 were told that they would be presented lists of unrelated statements and that they were to read them in preparation for a "yes–no test of your memory for the sentences." Subjects were told not to try to memorize the sentences word for word, but to read the sentences for understanding.

All subjects performed a verification test after each text. The task was to decide as quickly as possible for each sentence whether it had appeared in the list of unrelated sentences that had just been presented. In all other respects, the procedures for Experiment 4 were identical to those for Experiment 3.

Results and Discussion

Reading times exceeding three standard deviations above the condition mean were deleted from all analyses (1.22%). Mean reading times for the four experimental conditions are presented in the bottom row of Table 3. Table 3 shows that the pattern of reading times in Experiment 4 was quite dif-ferent from that found in Experiments 1 and 3. A test of the effect of experiment (3 vs. 4) on the magnitude of the cue effect was significant, $F_1(3, 282) = 4.46, MS_e = 0.319$. Al-though there was a robust effect of the cue variable in Ex-periment 3, there was no effect of the cue variable on reading times in Experiment 4, $F_1(3, 72) < 1, MS_e = 0.255; F_2(3, 69) < 1, MS_e = 0.317$. In particular, there was absolutely no evidence that the topic and local cues facilitated reading of the target sentences in Experiment 4.

The topic and local cues facilitated reading of target sen-tences in each situation in which subjects read coherent texts (Experiments 1, 2, and 3), but not in the one situation in which subjects read an incoherent text. This pattern of findings supports the conclusion that the topic and local cues in the previous experiments facilitated subjects in their attempts to integrate the target statements into their text representations.

General Discussion

The most important finding from this study is that readers recover more quickly from an interruption of reading if rel-evant topic information is reinstated than if no information or more general information is reinstated. This result was observed both when task instructions emphasized topic in-formation (Experiment 1) and when task instructions did not emphasize such information (Experiments 1, 2, and 3). It was observed both when topic cues provided missing referents for the target sentences (Experiments 1 and 2) and when the target sentences could be understood as isolated statements (Experiment 3). It was also observed for both long texts (Ex-periments 1 and 3) and short texts (Experiment 2), although the magnitude of the effect was greater for longer texts. The only condition in which topic cues did not facilitate the re-sumption of reading was when subjects were reading an un-related list of sentences (Experiment 4). By definition, there is no topic in an unrelated sentence list.

The facilitatory effects of topic cues on the resumption of reading have been interpreted as demonstrating that readers use topic information as a context for integration of subor-dinate information. An alternative hypothesis is that readers used topic cues to retrieve the relevant local context before resuming reading, then integrated target sentence informa-tion with the local context.[1] However, two findings contra-dict this hypothesis. First, local cues should have consistently facilitated reading more than topic cues, but the trend was actually in the opposite direction in both Experiments 1 and 3. Second, the hypothesis cannot explain why the relative effectiveness of topic and local cues depended on text length and complexity across Experiments 1 and 2.

The finding that topic cues facilitated reading of the tar-get sentences appears inconsistent with the results of Glan-zer et al. (1984), but the findings of Experiment 2 suggest the likely basis of the discrepancy. Specifically, subjects in the Glanzer et al. study failed to use topical information because the texts were too brief to encourage the use of such information. The results of the present study extend the findings of Glanzer et al. by demonstrating that the topic sentence of a paragraph is an effective context for the integration of subordinate information when the text is rea-sonably long and complex. In fact, the topic sentence pro-vides a context for the integration of subordinate informa-tion that is at least as effective as the sentence immediately preceding the to-be-integrated sentence.

McKoon and Ratcliff (1992) cited Glanzer et al.'s (1984) finding that topic information did not facilitate resumption of reading as support for their position that readers do not rou-tinely integrate subordinate information with topic informa-tion. Thus, by their own reasoning, the present findings are inconsistent with minimalist theory. However, it must be noted that the distractor paradigm may not reveal how read-ers integrate information when they are not interrupted in their reading. Although the findings of the current experi-ments demonstrate that readers can integrate subordinate in-

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[1] This hypothesis was suggested by Edward J. O'Brien in his review of this article.

formation with topic information, the findings do not demonstrate that readers do such integration when their reading is uninterrupted.

The current findings are consistent with the findings of a study by Glanzer and Nolan (1986; see also Fischer & Glanzer, 1986). In their experiment, subjects read texts sentence by sentence and were occasionally interrupted by a probe statement. When a probe appeared, subjects had to verify whether it was a paraphrase of a statement appearing in the text. The critical result was an interaction of the type of information probed (topic or detail) with the distance between the probe and the sentence tested in the text (one or three intervening sentences). There was no effect of distance on response latencies to topic probes, but latencies were much slower at the longer distance than at the shorter distance when detail information was probed. This result demonstrates that topic information is maintained in working memory longer than detail information. Combined with the current results indicating that topic information is an effective context for the integration of subordinate information, these findings support the hypothesis that readers routinely use topic information as a context for integrating subordinate information (Britton, in press; Kieras, 1981a; Kintsch & van Dijk, 1978; Lorch et al., 1985; van Dijk & Kintsch, 1983).

Findings from studies of narrative texts support a similar conclusion. Using a probe procedure similar to that of Glanzer and Nolan (1986), Trabasso and Suh (in press) have demonstrated that readers are faster to verify superordinate goals when such information is relevant, as opposed to when such information is irrelevant, to understanding the sequence of events in a narrative. Using a priming verification procedure to probe readers' text representations after reading, van den Broek and Lorch (in press) have found that recognition of subordinate events is facilitated by presentation of the relevant goal even when as many as 10 sentences intervene between the goal and target sentences in the text. Thus, Trabasso and Suh's findings demonstrate that readers maintain or reinstate relevant goal information as they read narratives, and van den Broek and Lorch's findings demonstrate that readers use the goal information as a context for integrating subordinate information.

In conclusion, the findings of the present investigation contribute to a growing body of evidence that readers do not routinely do only the minimal processing necessary to construct a coherent text representation (see also Gernsbacher, Goldsmith, & Robertson, 1992; Gernsbacher & Robertson, in press; O'Brien & Albrecht, 1992). Rather, readers accord appropriate status to superordinate information (e.g., topic and goal information) and use it as context for integrating subordinate information.

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(Appendix follows on next page)

Appendix

Sample Text, Cues, and Verification Sentences for Experiment 1

Sample Text: "The Great Apes" (Version B)[A1]

Many scientists are fascinated by the great apes. One important reason for scientists' interest in apes is that it is believed that the study of apes may shed light on man's own evolution. Thus, studying the various adaptations of the great apes may provide insights into the behavior of our own ancestors. In the following paragraphs, we will compare some of the characteristics of chimpanzees and orangutans. We will begin by considering the chimpanzee's habitat, then we will look at the orangutan's habitat. Next, we will examine the societal organization of chimpanzees, and then the society of orangutans. After that, we will discuss the communication system of chimpanzees, followed by the communication methods of orangutans. Finally, we will consider the diets of chimpanzees and of orangutans.

Chimpanzees find the plains an ideal habitat. They spend their day roaming the wide open spaces. There they find plenty of food and the tall grasses hide them while they play. The chimps build nests in the trees at night. *Target 1A: The trees provide safety from most predators. (Topic Cue: Recall that you were last reading about why chimpanzees find the plains to be an ideal place to live. Local Cue: Recall that you were last reading that chimps build nests in the trees at night.)*

Orangutans make their home in dense rain forests. Most of their activities are performed in the trees. The animals rarely set foot on the ground except to cool off in the jungle streams. The trees provide the apes with food, shelter and safety. They build nests in tall trees for protection. *Target 1B: They are able to find all their food in the trees. (Topic Cue: Recall that you were last reading why orangutans find the dense rain forests a good place to live. Local Cue: Recall that you were last reading that orangutans build nests in tall trees for protection.)* And swinging through the trees is the most effective way to move about in the dense forest.

Chimpanzees live in a fairly complex society. Chimps live in groups of approximately twenty animals. Usually, a group of five or six males leads a band of females and their offspring. The males and females have different responsibilities in the band. The adult males provide protection for the group. The females are responsible for the young chimps. There is a clear social hierarchy within the band. The adult males occupy a dominant position within the group. Further, there is a hierarchy of dominance within the males. Fights occasionally occur among the males to establish which male is superior. *Target 2A: The strongest male maintains group leadership. (Topic Cue: Recall that you were last reading about the complex society of chimpanzees. Local Cue: Recall that you were last reading that chimpanzee males occasionally fight to establish which male is superior.)* The size of the group is maintained at about twenty because youths leave to form their own groups. Otherwise, the group would grow in size and its social structure would collapse.

Orangutans are not particularly social animals. Adult orangutans are solitary creatures. *Target 2B: Adult males and females usually nest separately. (Topic Cue: Recall that you were last reading about the society of orangutans. Local Cue: Recall that you were last reading that adult orangutans are solitary creatures.)* The only time they nest together is during mating. The males travel alone through the forests, while the females spend their time with their dependent infants. Preadolescent orangutans are more social than the adults. These young apes learn by playing and feeding together. However, when they grow older, they go their separate ways.

Chimpanzees communicate mainly with hand signals. Since chimps live in open spaces, this system is the safest way to communicate. One reason for this is that hand signals are silent. If a predator is spotted, the apes can signal each other without making noise. *Target 3A: They then take cover to avoid being discovered. (Topic Cue: Recall that you were last reading that chimpanzees communicate using hand signals. Local Cue: Recall that you were last reading that if chimps spot a predator, they can signal each other without making noise.)* Hand signals are not only used to warn of danger, however. Scientists studying chimps have also identified gestures for food and affection.

Orangutans communicate primarily by vocalizations. This is a good way to communicate in the forest. Vocalizations carry for miles, but do not reveal the exact location of the caller. This is an advantage in keeping the orangutan protected from predators. The vocal repertoire of orangutans includes an assortment of signals. They communicate with a variety of growls, hoots and howls. Orangutans use these signals not only to warn each other of danger, but also to communicate their social intentions. For example, males emit a bellowing call to warn away other males. *Target 3B: The call also alerts females to their availability. (Topic Cue: Recall that you were last reading about how orangutans communicate with one another by vocalizations. Local Cue: Recall that you were last reading that male orangutans make a bellowing call to warn away other males.)*

The chimpanzee diet includes many types of food. Meat is an important part of the diet. Adults procure insects and small animals for the group. Of course, chimps also feed on fruits. They are also known to eat blossoms and roots. Meals are generally a communal activity. Each adult male takes enough food to feed his immediate family. The family then shares in that amount of food. The infants do not join in the meal. *Target 4A: Rather the young are nursed by their mothers. (Topic Cue: Recall that you were last reading that the chimpanzee diet includes many types of food. Local Cue: Recall that you were last reading that chimpanzee infants do not participate in the family meal.)* However, the infants do enjoy the social aspects of the meal.

The orangutan diet consists primarily of fruit. In fact, orangutans are the largest of all fruit-eaters. They eat many types of fruits, bark and flowers. *Target 4B: Meals are a solitary activity for the orangutans. (Topic Cue: Recall that you were last reading that the orangutan diet consists almost entirely of fruit. Local Cue: Recall that you were last reading that orangutans eat many types of fruits, bark and flowers.)* There is a very good reason for this: If a group of orangutans fed on the same tree, the tree would be stripped of fruit before the animals were satisfied.

Verification Sentences for "The Great Apes" Text

Orangutans live in rain forests.
Chimpanzees live on the plains.
Orangutans are solitary animals.
Chimpanzees live in groups.
Orangutans communicate by vocalizations.

[A1] Target sentences are indicated by italics. The "A" and "B" designations refer to the text version in which the sentence served as a target.

Chimps communicate with hand signals.
Orangutans eat mostly fruit.
Chimps eat a variety of foods.
Orangutans spend most of their time on the ground.
Chimps live in the jungle forests.
Orangutans live in large groups.
Chimpanzees live in pairs.
Orangutans are carnivorous.

Chimps do not have a communication system.
Orangutans are silent animals.
Chimpanzees are never aggressive.

Search Opens for Editor of New APA Journal

The Publications and Communications Board has opened nominations for the editorship of a new journal, *Psychological Methods*, for the years 1996–2001. Candidates must be members of APA and should be prepared to start receiving manuscripts early in January of 1995 to prepare for issues published in 1996 and beyond. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. To nominate candidates, prepare a statement of one page or less in support of each candidate. Submit nominations to

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Psychological Methods will be devoted to the development and dissemination of methods for collecting, understanding, and interpreting psychological data. Its purpose is the dissemination of innovations in research design, measurement, methodology, and statistical analysis to the psychological community; its further purpose is to promote effective communication about related substantive and methodological issues. The audience is diverse and includes those who develop new procedures, those who are responsible for undergraduate and graduate training in design, measurement, and statistics, as well as those who employ those procedures in research. The journal solicits original theoretical, quantitative, empirical, and methodological articles; reviews of important methodological issues; tutorials; articles illustrating innovative applications of new procedures to psychological problems; articles on the teaching of quantitative methods; and reviews of statistical software. Submissions will be judged on their relevance to understanding psychological data, methodological correctness, and accessibility to a wide audience. Where appropriate, submissions should illustrate through concrete example how the procedures described or developed can enhance the quality of psychological research. The journal welcomes submissions that show the relevance to psychology of procedures developed in other fields. Empirical and theoretical articles on specific tests or test construction should have a broad thrust; otherwise, they may be more appropriate for *Psychological Assessment*.

First review of nominations will begin December 15, 1993.