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Event Segmentation and Memory Retrieval in Reading Comprehension

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RUNNING HEAD: Event Segmentation and Memory Retrieval

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Abstract

Comprehending text involves the convergence of top-down, expectation-driven processes and bottom-up, stimulus-driven processes. The precise nature of this convergence, however, is not well understood. The current study used narrative time shifts and shifts in protagonist goal, both hypothesized to encourage event-segmented memory representations, to investigate the interaction between automatic and constructive memory processes during reading. The addition of time and goal shifts was found to have no effect on the automatic retrieval of information from memory. The results are interpreted as support for the bottom-up account of retrieval of information during reading, and for the idea that the top-down account is best applied to the integration of information after retrieval.

Event Segmentation and Memory Retrieval in Reading Comprehension

Text comprehension can be understood as both a top-down process, where high-level expectations and control processes drive understanding, and as a bottom-up process, where understanding emerges from the compilation of various automatic, low-level processes (Long & Lea, 2005). Significant bodies of research have accumulated from both perspectives, but there is much work left to be done regarding their integration.

Research from the top-down perspective has tended to focus on the role of expectations and world knowledge in narrative comprehension. Zwaan (1994), for example, found that readers allocate processing resources differently depending on the genre of the text in question. The constructionist approach (Graesser, Singer, & Trabasso, 1994) also emphasizes the role of external information in the process of understanding text. In this account, textual input is used to fill in schemata, sets of expectations about familiar situations. Furthermore, the situation models which are constructed are constantly checked against world knowledge to maintain coherence (van den Broek, Risden, & Husebye-Hartmann, 1995).

Recent research into narrative comprehension indicates that readers may construct representations of situations described in texts by breaking them down into discrete units. According to the Event-Indexing Model (Zwaan, Langston, & Graesser, 1995), these discrete units, or events, may be related on any of five dimensions: time, space, protagonist, causality, and intentionality. Changes along any of these dimensions result in the creation of event boundaries in readers' situation models. Information is less accessible across event boundaries than within events, and more accessible between more related events than between less related events.

Manipulation of even a single one of these dimensions has been shown to lead to the formation of event boundaries, and to affect the accessibility of information. Zwaan (1996) demonstrated that reading times increased on lines of a narrative which included a time shift (e.g., "an hour later"). Furthermore, the same study showed that information from a previous event was less accessible when followed by a narrative time shift than when no such time shift occurred. Such results imply that the accessibility of information will depend on narrative features of the situation models constructed by readers, allowing for predictions based on such situational features of a text.

A more recent body of research has extended the findings which prompted the development of the Event-Indexing Model. This newer account of event-based processing, Event Segmentation Theory (henceforth EST), proposes several additional narrative features which may result in boundaries between events, including changes in protagonist goal (Zacks et al., 2007; see Kurby & Zacks, 2008 for a more recent review). Like other top-down accounts, Event Segmentation Theory portrays a prominent role for expectation in narrative comprehension. Readers, in its view, generate event boundaries when their predictions about the immediate future fail to a sufficient extent (Zacks et al., 2007). These predictions are influenced by prior knowledge; for example, baseball fans are more likely than their compatriots to successfully predict the occurrences of a baseball game, which may affect their segmentation of events.

Predictions from event-based models are divergent from those made by a body of research which approaches discourse comprehension from a bottom-up perspective, that of memory-based text processing, which has investigated the access of information from long-term memory during reading comprehension (e.g., Myers et al., 1994; Gerrig & McKoon, 1998; Myers & O'Brien, 1998; see Lorch, 1998 for a brief review). According to the latter theory, accessibility of information from long-term memory depends on the strength of the trace in memory and the overlap, termed "resonance" by Myers et al. (1994), between that trace and whatever cues recall, rather than high-level features like those that make up readers' situation models (e.g., Lea et al., 1998). Therefore, event boundaries should affect memory trace accessibility only when they have an effect on one of these two features.

Albrecht and Myers (1995) demonstrated that short phrases (e.g., "leather sofa") could serve as contextual cues during reading to reactivate an unsatisfied goal which rendered a text globally incoherent, even after the unsatisfied goal had been backgrounded while reading a relatively lengthy text. In their study, reading times increased while reading lines which were inconsistent with the unsatisfied goal, but only if the goal had been reactivated by the appearance of a contextual cue. Their results were consistent with the memory-based account of reading comprehension.

In the current research, three experiments were carried out to investigate the interaction between event segmentation and the reactivation of information from long-term memory via the resonance process. Experiments 1 and 2 were performed by Brooke Lea, Matthew Olson, Debra Long, and David Rapp and presented as a poster at the 49th annual meeting of the Psychonomic Society (Lea et al, 2008). They are discussed here in the context of their role in motivating the present research. The methods and results presented here are those for Experiment 3 of the study, a followup to the previously completed experiments.

Experiment 1 added narrative time shifts to the intervening episodes in the passages used in the study by Albrecht and Myers (1995) discussed above, as shown in Table 1, allowing the effect of event boundaries between backgrounded information and contextual cue to be investigated. Time shifts were chosen due to their ubiquity in natural texts, and the extent to which they can be manipulated independently of other features of a narrative.

Consistent with Zwaan's (1996) findings, reading times were found to increase for lines which included a time shift, providing evidence that event boundaries were indeed being constructed by readers. In the unsatisfied goal condition, reading times also increased for the globally incoherent lines after the reactivation of the goal by the appearance of a contextual cue, but in the time shift condition, this reading slowdown was delayed until two sentences after the cue, rather than the sentence immediately following the cue, as found in the no time shift condition (and by Albrecht and Myers).

The results of Experiment 1 did not make clear whether the delay in reading slowdown was due to a delay in the reactivation of the backgrounded goal, or whether the goal was immediately reactivated but the time shift caused readers to take longer to notice the contradiction. In Experiment 2, readers were probed both immediately before and immediately after the contextual cue with a recall task for a word which had appeared textually close to the first instance of the cue word (see Table 1). Response times were found to be significantly faster after the reappearance of the contextual cue than before it, but this difference in activation did not interact with the presence or absence of a time shift in the passage. These results indicated that the delay in reading slowdown was somehow related to a delay in the integration of the contradictory information, and not due to a slowdown in the process of goal reactivation via resonance.

In the present study, shifts in protagonist goal, indicated as a possible herald of event boundaries by EST (Zacks et al., 2007), were added to time shifts to create “high-distance” versions of each passage, in the hopes that their combined effects would yield stronger results and shed some light on the details of the results from Experiments 1 and 2.

Method

Participants. Thirty-seven psychology students at Macalester College participated for partial course credit. All were native speakers of English.

Materials. The experimental stimuli consisted of 24 brief narratives. These passages were modified versions of those used by Albrecht and Myers (1995). Each passage was modified so that it fit either a “low-distance” or a “high-distance” template.

Each passage comprised three sections, as seen in Tables 2 and 3: an opening section, an intervening episode, and a conclusion. The opening established the situation and introduced the protagonist. An initial goal was also established during this section, followed by one instance of the target word, textually close to an instance of the cue word. The contents of the intervening episode depended on the distance condition. For low-distance passages, the first goal was left unsatisfied, and a subordinate goal was introduced and also left unsatisfied. In the intervening episode of high-distance passages, the first goal was satisfied, a subordinate goal was introduced, a time shift occurred, and then the subordinate goal was also satisfied. Finally, the conclusion of each passage contained a second instance of the cue word, then wrapped up the story in such a way as to maintain global coherence.

Eighteen filler passages were also included to obscure patterns of stimuli. Each passage was followed by a comprehension question concerning the story's plot. Four different stimulus lists were constructed such that each one contained one version of each story.

Participants were seated in front of computers running E-Prime software (E-Prime, 2000) in sound-attenuated rooms. A response box, which was used to record participant responses, was placed on the desk in front of them in easy reach.

Procedure. Participants were randomly assigned to one stimulus list, and instructed to read at their own pace and to press the "continue" button on the response box when they had read and understood the line on the screen. The passages appeared on the computer monitor one line at a time. The box also had two equally accessible buttons labeled "yes" and "no." Participants were asked to keep their fingers on all three buttons at all times.

At some point in each story, the words "GET READY" appeared for 500ms, followed by a word in all capital letters (e.g., SHOES). Participants were asked to press the "yes" button if the word had previously appeared in the passage and the "no" button if it had not. Accuracy and response time feedback were provided, after which the story resumed. In the experimental passages, the probe appeared either immediately before or immediately after the reappearance of the cue word in the story's conclusion, as marked in Tables 2 and 3.

The experiment followed a 2 (distance: high vs. low) X 2 (probe position: before vs. after) X 4 (stimulus list) design, though no effects of stimulus list were predicted.

Results

The data consisted of response times for correct responses to word recognition probes.. In both high-distance and low-distance conditions, response times were substantially faster after the contextual cue than before, but as seen in Table 4, means did not differ across distance conditions. A two-way factorial ANOVA confirmed that there was a significant main effect of probe position: $F\,(3,36) = 13.96$, $MSe = 339391$, $p < .01$. It revealed no main effect of distance condition, nor was there a significant interaction (*F's* < 1). Paired samples *t*-tests confirmed that the effect of probe position was significant for both low-distance and high-distance passages: $t(36) = 2.07$, $p = .046$ for low-distance; $t(36) = 2.19$, $p = .035$ for high-distance. The response time data indicate that availability was affected by the presence of a contextual cue, but not by distance condition.

General Discussion

The current research represents an attempt to shed light upon the extent to which reading comprehension can be characterized as a top-down, expectation driven process versus a bottom-up, automatic process. In Experiment 1, the insertion of time shifts between contradictory statements was shown to delay the reading time slowdown which occurred upon encountering the global coherence break. Experiment 2 demonstrated that there was no equivalent slowdown on reaction times in a probe recognition task, indicating that the results of Experiment 1 were not the result of a delay in reactivation from before the time shift. The present study added shifts in protagonist goal to strengthen the psychological distance effect. It still found no evidence of an effect of psychological distance on the reactivation of items from long-term memory via resonance. Taken together, these results constitute support for the bottom-up characterization of reading comprehension, and suggest that the effects of expectation-driven processes like event segmentation are likely to operate on some post-reactivation stage of the comprehension process.

The various accounts of memory access during reading agree that reactivation of items in memory will be affected by some sort of psychological "distance." In resonance theory (Myers & O'Brien, 1998), this is the concept described as "resonance." Where they differ fundamentally is in their predictions about what features of a text will determine that distance. Resonance theory makes a strong prediction high-level memory structures like event-segmented situation models should have no such effect. Given past findings about the effects of event boundaries on memory availability (Zwaan, 1996), one might expect the insertion of textual features heralding event segmentation to contradict that prediction and directly affect psychological distance. However, the present findings do not support such a conclusion. Instead, consistent with bottom-up accounts like memory-based text processing, high-level features of a text like shifts in time and protagonist goal had no effect on the reactivation of information in memory.

This conclusion was first supported by the result of Experiment 2. Top-down accounts of memory reactivation would have predicted an interaction between probe position and time shift condition: the facilitation effect on the recognition task found in the after-cue condition would have been weakened in the time shift condition, compared to the no shift condition. However, no such interaction obtained. The present research provides additional support in that the addition of shifts in protagonist goal was hypothesized to make event segmentations more likely in the intervening text, which should have strengthened the interaction if there was one to be found. The fact that there was still no effect of distance condition on probe reaction time provides additional evidence against the possibility that Experiment 2's failure to find results was because it was an insufficiently sensitive task, allowing for a more confident assertion that event boundaries do not affect the reactivation of information in long-term memory via the resonance process, although the evidence still comes from a null result.

This conclusion leaves an open question: If the delayed slowdown on reading times from Experiment 1 cannot be accounted for by a delay in reactivation of the coherence-breaking information, what can account for it? The presence of an event boundary must cause a delay in some post-reactivation process, but how should this process be characterized?

One possibility is suggested by the Construction-Integration model (Kintsch, 1988), which incorporates both top-down and bottom-up characterizations of discourse processing. According to this account, initial processing of textual input is strictly bottom-up, yielding a collection of propositions generated from the text. This initial stage is "dumb," resulting in an incoherent and inconsistent set of propositions, some of which may contradict one another. However, this process is followed by a spreading of activation throughout the initial network of propositions, which makes reference to such high-level features as world knowledge. This second process is repeated until activation of the various propositions stabilizes, resulting in a coherent, consistent, and integrated account of the content of the text.

This second process, that of "integration," may be where the answer to Experiment 1's delayed contradiction effect lies. Rather than affecting the automatic processes that govern the reactivation of information from long-term memory, high-level features of comprehension like event segmentation guide the integration of already-activated information into a coherent situation model. This conclusion provides further support for the idea that top-down accounts of reading comprehension are best applied to the evaluation and integration of activated information in working memory (Long and Lea, 2005). However, without empirical data, the characterization of exactly when and how top-down processing guides the analysis of previously activated information must be left to future research.

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Table 1. Example Passage Used in Experiments 1 and 2.

Opening	
The cruise was coming to an end and the ship would soon dock. The captain sat in his office, trying frantically to finish some paper work. He had to do an inventory of the ship before he could begin his shore leave. He had been heavily fined for not completing the inventory on an earlier cruise. He pulled up his **chair** and sat down at his **large desk**.	(contextual cue)
Intervening Episode	
Immediately after he completed the inventory,	(goal-satisfied condition)
However, before he could start the inventory,	(goal-unsatisfied condition)
some passengers arrived to report a theft. He would have to complete the inventory later. He left his desk covered with the inventory forms and began an investigation in order to catch the thief. He carefully reviewed each of the complaints.	
After a few minutes, he was sure the thief	(no time shift condition)
Two hours later, he was sure the thief	(time shift condition)
was a staff member who had access to a master key to the passengers' cabins. This greatly reduced the number of suspects. After questioning a few of the crew members,	

(Table Continues)

he was sure the thief was the ship's purser.	
Within minutes, the purser was locked up.	
Conclusion	
The captain returned to his office	
and sat down at his ^ **large desk**. ^	(recognition probe: CHAIR)
He was happy to be done with the cruise.	(target line 1)
He was ready to start his shore leave.	(target line 2)
As he left the ship, he talked with one of the crew members. Then he walked to his car and went home.	(target line 3)
Comprehension Question	
Was the cruise almost over?	

Table 2. Example Low-Distance Passage Used in Experiment 3.

Opening	
The cruise was coming to an end and the ship would soon dock. The captain sat in his office, trying frantically to finish some paper work. He had to do an inventory of the ship before he could begin his shore leave. He had been heavily fined for not completing the inventory on an earlier cruise. He	(introduction of first goal)
kicked off his **shoes** and sat down at his **large desk**.	(target and cue words)
Intervening Episode	
However, before he could start the inventory, some passengers arrived to report a theft. He would have to complete the inventory later. He left his desk covered with the inventory forms and began an investigation in order to catch the thief. He carefully reviewed each of the complaints. After a few minutes, he shook his head. There just wasn't enough evidence to be found in the complaints. There would have to be a full investigation. It would probably take several hours. The captain sighed, thinking of all the	(introduction of subordinate goal)

(Table Continues)

paperwork the investigation would mean for

him. It was always one thing or another.

Conclusion

The captain returned to his office and sat down at his

^ **large desk**. ^ He wished the cruise was over. (recognition probe: SHOES)

He was ready to start his shore leave.

Comprehension Question

Was the cruise almost over?

Table 3. Example High-Distance Passage Used in Experiment 3.

Opening	
The cruise was coming to an end and the ship would soon dock. The captain sat in his office, trying frantically to finish some paper work. He had to do	(introduction of first goal)
an inventory of the ship before he could begin his shore leave. He had been heavily fined for not completing the inventory on an earlier cruise. He kicked off his **shoes** and sat down at his **large desk**.	(target and cue words)
Intervening Episode	
Immediately after he completed the inventory, some	(satisfaction of first goal)
passengers arrived to report a theft. Fortunately,	(introduction of subordinate goal)
he had already completed the inventory. He left his desk covered with the inventory forms and began an investigation in order to catch the thief. He carefully reviewed each of the complaints.	
Two hours later, he was sure the thief	(time shift)
was a staff member who had access to a master key to the passengers' cabins. This greatly reduced the number of suspects. After questioning a few of the crew members,	

(Table Continues)

he was sure the thief was the ship's purser.

Within minutes, the purser was locked up. (satisfaction of subordinate goal)

Conclusion

The captain returned to his office and sat down at his

^ **large desk**. ^ He was happy to be done with the cruise. (recognition probe: SHOES)

He was ready to start his shore leave.

As he left the ship, he talked with one of the crew

members. Then he walked to his car and went home.

Comprehension Question.

Was the cruise almost over?

Table 4. Means and Standard Deviations for Response Times to Recognition Probes.

Condition	Mean RT (ms)	Std. Dev.
High-distance, before cue	1089.34	412.93
High-distance, after cue	976.07	336.81
Low-distance, before cue	1057.90	353.77
Low-distance, after cue	979.62	345.56