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WHEN COMPREHENSION DIFFICULTY IMPROVES MEMORY FOR TEXT

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The relationship between the comprehensibility of a passage and subsequent memory for that passage is neither simple nor very well understood. Some previous researchers have shown that memory performance drops markedly when texts are either very difficult or impossible to comprehend (Bransford & Johnson, 1972; Dooling & Lachman, 1971; Miller & Kintsch, 1980). Others have shown that when implicit information is stated explicitly, requiring little effort of the reader, comprehension and subsequent memory also suffer (Keenan & Kintsch, 1974). What happens, however, when a text is relatively difficult to comprehend but, with some effort, can be understood? Does memory improve or suffer relative to easier texts? Investigations of levels of processing suggest a positive relationship between effort and subsequent memorability (Eysenck & Eysenck, 1979 ; Tyler, Hertal, McCallum, & Ellis, 1979), given that the effort has been successful (Craik & Tulving, 1975). The present set of experiments is designed to explore this issue further and to show that a little comprehension difficulty might actually improve memory for prose materials as long as a reader is able to successfully employ those effortful processes necessary to overcome any difficulty.

According to the Kintsch and Van Dijk (1978) model, comprehension difficulties arise whenever the reader encounters a segment of text that does not share argument overlap with any of the current contents of the short term memory buffer. When such breakdowns of referential coherence occur, at least one, and perhaps two, resource demanding (i.e., effortful) processes must be initiated. First, the reader will attempt to establish coherence by searching long term memory for a part of the text that has some overlap with the segment just read. If this reinstatement search fails, the reader then initiates an inference process that will connect this segment of text to the current contents of the short term memory buffer. According to Kintsch and Van Dijk, both of these processes make large demands upon available resources; this results in an increase in comprehension difficulty and a possible decrement in memory performance.

In the present research we adopt a similar but more general view of comprehension difficulties and their resolution. We assume that whenever a concept is encountered that is unexpected or difficult to integrate with the present contents of short term memory, readers review earlier portions of the text in an attempt to integrate the unexpected concept into the existing memory representation. This reprocessing can vary in degree from a simple inference or elaboration to an entire restructuring of the memory representation requiring several inferences and or elaborations.

What effect does the increase in the use of these effortful processes have on the memory for a text? An implication of the Kintsch and Van Dijk model is that, if capacity is being expended for completing reinstatement searches and inferences, less capacity is available for the maintenance of information already in the buffer. This should result in poorer recall. However, an alternative position consistent with the levels of processing framework can be developed. For instance, Jacoby, Craik, and Begg (1979) have suggested that "difficult initial processing implies more extensive or elaborate analysis, and that this more extensive analysis is reflected in a richer, more distinctive memory record of the event" (p. 596). Although Jacoby et al. were dealing with single words, the extension to prose materials is straightforward. If it is assumed that much of the difficulty encountered in text processing is resolved through the use of bridging inferences (Haviland & Clark, 1974) and elaborations, recall might actually be facilitated. These inferences and elaborations may result in a richer, more distinctive memory record, and may also provide more possible retrieval routes (Anderson & Reder, 1979; Bradshaw & Anderson, 1982).

Recent evidence supporting this latter position has been offered by Cairns, Cowart, and Jablon (1981) who found an inverse relationship between processing difficulty and subsequent memory performance in sentences containing a target word preceded by one of two clauses. Consider the following example.

1) Because she was chewing so loudly in class,
   Sarah was asked to get rid of her GUM promptly.

2) Because it was annoying the others,
   Sarah was asked to get rid of her GUM promptly.

In version 1 the target word "gum" is predictable given the earlier context whereas in version 2, it is not. In a series of three experiments, Cairns et al. found that subjects took significantly longer to comprehend the word "gum" in the unpredictive case than in the predictive case. However, when subjects were probed for recognition of the word "gum" they were able to respond more quickly in the unpredictive case. Cairns et al. argued that in the predictable case, context facilitated the initial processing of "gum," allowing it to be read and comprehended quickly and easily. In contrast, in the unpredictable case, "gum" was more difficult to comprehend and therefore required additional processing in the form of elaborations necessary to integrate the concept. These additional elaborations slowed initial processing, but resulted in the concept being more salient and consequently more quickly recognized.

The experiments we will present extend the Cairns et al. research in several ways. First, we use visual as opposed to auditory presentation, thereby allowing on-line measures of comprehension through the use of reading times. Second, in response to what we considered a subtle manipulation of predictability in the Cairns et al. materials, we have used materials developed by Ehrlich and Rayner (1981) in which the predictability manipulation was much less subtle. Monitoring eye movements, they found that subjects average fixation duration and total reading time on a target word were significantly longer when the target word was unpredictable from a preceding context than when it was predictable from the same preceding context. Third, and most importantly, Cairns et al. merely demonstrated facilitation of a single word in immediate memory. By using recall measures, we are able to test our position that encountering unexpected concepts forces a reader to review earlier portions of a text in order to integrate that concept into the existing memory representation.

Our first experiment is an attempt to replicate the effect of unpredictability upon target word recognition obtained by Cairns et al. As noted, we do this in a reading task using passages previously demonstrated to provide a powerful manipulation of target word predictability. A second experiment was designed to test our position that the additional elaborative processing necessary to integrate unpredictable concepts should also facilitate the recall of concepts other than the unpredictable item.

Experiment 1

As noted, the materials for this experiment were taken from Ehrlich and Rayner (1981). Each passage contained one target word that was either predictable or unpredictable given the immediately preceding context. Subjects were asked to read each of the passages and to then make a recognition response to a series of four probe words, one of which was always a target item. It was expected that reading times would be longer in the unpredictable passages, reflecting the additional processing necessary to integrate an unpredictable target item. Also, since the unpredictable word should be the source of this additional elaboration, it should be more salient and therefore more quickly recognized than a predictable target word. Alternatively, reading time differences may be due entirely to a context priming effect which would simply yield a reduction in the threshold necessary for identification of the predictable target words (Ehrlich & Rayner, 1981). However, if this is the case, then there is no *a priori* reason to expect any difference in the saliency of target words and, consequently, no difference in recognition latency (Jacoby, 1983).

Method.

Subjects. Twenty University of Massachusetts undergraduates participated as subjects for course credit. Upon entry, each subject was randomly assigned to one of two material sets with the restriction that each set be read by an equal number of subjects.

Materials. The materials were the same 16 passages that were used by Ehrlich and Rayner; examples can be seen in Table 1. In developing the passages, eight pairs of words were chosen that differed by only

Table 1

Examples of Predictable and Unpredictable passages.

The judge had become very hard skinned over the years. He thought he had heard just about every imaginable excuse. He was disturbed by the carelessness that the visitors displayed. As he thought about the (FINES/FIRES) that would occur this year, he was sure he would hear more. strange excuses.

Probe Words

Target	Fines/Fires
True nontarget	Excuse
False related	Court
False unrelated	Bowl

The long dry summer represented a very real danger to the forest rangers. They knew that many of the tourists would be careless with matches. They thought it was inevitable that the (FIRES/FINES) would have to increase this year and were worried.

Probe Words

Target	Fires/Fines
True nontarget	Summer
False related	Trees
False unrelated	Table

a single letter (e.g. fines-fires). For each pair of words, two passages were created. The pairs of passages were written such that either word of a pair could fit in the passage without making it incomprehensible. For each of the passages, one of the words was highly predictable whereas the other word made sense but was unpredictable. For example, in the first passage in Table 1, the target word "fines" is highly predictable given the theme of the passage whereas the target word "fires" is unpredictable but certainly not anomalous. In the second passage, the opposite is true; fires is predictable and fines is unpredictable. Two sets of materials were constructed such that, within each set each member of a given pair was predictable for half of the subjects and unpredictable for the remaining half. Along with these 16 critical passages, eight filler passages were added for a total of 24 passages. For each pair of critical passages, four words were chosen to serve as probe words: two true and two false. The true probes consisted of the target item and another noun chosen randomly from the passage but with the restriction that it occur prior to the target word. False probes consisted of one false item that was consistent with the overall theme of the passage and one false item that was unrelated to the theme. Examples of each type of probe used are also presented in Table 1. For each of the critical passages, one of each type of probe appeared in a list. Consequently, each list following a critical passage required two true and two false responses; the only restriction in the ordering of probes was that the target item always appear first. The types of probes for the filler passages were randomly determined with the restriction that half of the probe word lists require three "yes" and one "no" responses and the other half require one "yes" and three "no" responses. This was done to ensure that subjects did not realize that the critical passages always contained two "yes" and two "no" responses.

Procedure. Subjects were run individually in an experimental session that lasted approximately 35 minutes. All materials were displayed on a video monitor which was controlled by a PDP 8/E computer. Subjects were instructed to rest their index fingers on two response triggers labelled "yes" and "no" and to rest their right thumb on a line-advance key. Each passage began with the word "ready" on the center of the display screen. When subjects were ready to begin reading a passage, they pressed either the "yes" or "no" key which erased the screen and presented the first line of a passage. Subjects were told to read each line and to press the line-advance key when they had understood it. Lines of a passage were presented just as they appear in table 1. Each press of the line-advance key erased the displayed line and presented the next line. Reading time for a particular line was considered to be the time between key presses. After pressing the line advance key to erase the last line of a passage, a ready cue (xxx) was presented for 1.5 seconds followed by the first word of a probe list. Subjects were instructed to respond as quickly but as accurately as possible, deciding whether each of the probes had been present in the passage or not. A maximum of 3.5 seconds was allowed for a subject to make a response. There was a .5 second delay between the response to one probe and the presentation of the next probe except on those trials on which an error had occurred. On those trials, an additional 1 second delay was added while the word "error" was presented for feedback. To ensure that subjects had read the passages carefully, each trial ended with a comprehension question. While being instructed, subjects were told that this was the most important part of the experiment and that it was critical that they read the passages carefully enough so that they could answer each question.

Results and Discussion.

Two subjects who were unable to answer two or more of the comprehension questions from the 16 critical passages were replaced. In what follows, F_1 refers to tests against an error term based on subject variability and F_2 refers to tests against an error term based on item variability.All planned comparisons used the Bonferroni t procedure (Myers, 1979) with EF = .05 and an error term based on subject variability.

Read times. The mean reading times for the line of text containing the target word and the line immediately following the target line are presented in Table 2. As can be seen, subjects took considerably longer to read the target line when it contained an unpredictable target word than when it contained a predictable target word; $F_1(1,18) = 40.20$, $p < .001$, MSe = 69,127; $F_2(1,14) = 21.21$, $p < .001$, MSe = 104,905. When considering the line immediately following the target line, this difference remained highly significant, $F_1(1,18) = 11.02$, $p <$

.01, MSe = 45,257; $F_2(1,14) = 9.35$, $p < .01$, MSe = 73,989.

Probe response times. Table 2 also contains the mean reaction times and error rates for the four types of probes. As predicted, unpredictable target words were recognized more quickly than predictable target words; $F_1(1,18) = 16.82$, $p < .001$, MSe = 6,332, $F_2(1,14) = 9.12$, $p < .01$, MSe = 9,488. For the three

Table 2

Experiment 1: Mean Read Times and Probe Response Times in Milliseconds and Error Probabilities (in Parentheses).

	Read Times	
	Predictable	Unpredictable
Target Line	2439	2967
Line After	2375	2599
	Probe Words	
	Predictable	Unpredictable
Target Word	941 (.06)	838 (.05)
True Nontarget	1012 (.12)	1088 (.18)
False Related	1252 (.30)	1288 (.44)
False Unrelated	953 (.02)	957 (.02)

remaining types of probe, none of the differences between the predictable and unpredictable conditions proved to be statistically reliable, $p > .1$. However, planned comparisons confirmed several effects of probe type. First, target probes were recognized more quickly than true nontarget probes, $t(19) = 6.37$, $p < .05$. Given that target probes were more central to the theme of the passage, this difference was not surprising. Second, since false related probes were consistent with the theme of the passage, they were difficult to reject and as a result were responded to more slowly than either target probes, $t(19) = 7.25$, $p < .05$, true nontargets, $t(19) = 4.71$, $p < .05$, or false unrelated probes, $t(19) = 4.96$, $p < .05$. Finally, since false unrelated probes are easily rejected, they were responded to more quickly than true nontarget probes, $t(19) = 3.06$, $p < .05$.

Error rates. For each of the probe types, error rates did not differ significantly as a function of whether the probe appeared in a predictable or unpredictable passage, $p > .1$. However, planned comparisons revealed that the pattern of error rates for probe type was consistent with the pattern found for response times. Subjects made fewer errors to target probes than to true nontargets, $t(19) = 3.77$, $p < .05$; this result was consistent with the notion that target words were more central to the theme of the passage. Also, since false related probes were difficult to reject, the error rate for these probes was significantly higher than for either target probes, $t(19) = 6.64$, $p < .05$, true nontargets, $t(19) = 3.77$, $p < .05$, or false unrelated probes, $t(19) = 8.43$, $p < .05$. In contrast, false unrelated probes were easily rejected and consequently the error rate for false unrelated probes was lower than for true nontargets, $t(19) = 3.84$, $p < .05$.

There are two major results of Experiment 1. First, consistent with the results of Ehrlich and Rayner, subjects required more time to comprehend a target line when it contained an unpredictable word than when it contained a predictable target word; this difference carried over to the line immediately following the target line. Second, this increased processing caused unpredictable target words to be more salient and consequently more quickly recognized than predictable target words, thereby replicating the probe word latency effect found by Cairns et al. Interpretation of these results will be considered after presenting the recall results of Experiment 2.

Experiment 2

We argued earlier that when readers encounter a concept that is unexpected given a preceding context, they will work their way back through earlier portions of a text, drawing inferences and creating elaborations in an attempt to integrate the unexpected concept. Assuming this increase in elaborative processing, Experiment 1 demonstrated that one consequence was an increase in the saliency of the unpredictable target word. We would also expect that earlier portions of the text should also benefit from this additional processing. Experiment 2 was designed to test this possibility. Such a result would go far beyond a simple demonstration that the more time spent comprehending a particular sentence the better _that_ sentence is recalled (e.g. Bransford & McCarrell, 1975). Here we propose to show that recall of prior information is also increased. The same materials and procedure were used as in Experiment 1 except that at the end of the experimental session subjects were given an unexpected free recall test. If subjects reviewed earlier portions of the passages in order to integrate unpredictable concepts, then unpredictable passages should show better recall than predictable passages. Further, these differences in recall should be limited to early portions of the passages.

Method

Subjects. Twenty two University of Massachusetts undergraduates participated for course credit. Each subject was randomly assigned to a condition with the restriction that each condition contain an equal number of subjects.

Materials and procedure. The materials and procedure were the same as in Experiment 1. The only exception was that upon completion of the initial phase of the experiment, subjects were given an unexpected free recall test. This test consisted of giving subjects a blank booklet and asking them to write down as much as they could remember about each of the passages. Subjects were instructed to use a separate page for each passage and were given unlimited time for recall.

Results and Discussion.

Three subjects could not answer two or more of the comprehension questions from the critical passages and were replaced. All planned comparisons again used a Bonferroni t procedure with an EF = .05. Reading times, probe word reaction times and error rates are presented in Table 3.

Read times. As in Experiment 1, subjects took longer to read a target line when it contained an unpredictable target than when it contained a predictable target word; $F_1(1,20) = 24.59$, $p < .001$, MSe = 170072, $F_2(1,14) = 10.81$, $p < .01$, MSe = 297518. On the line immediately following the target line, subjects continued to require more time for the unpredictable passages. However, this difference was only marginally significant in the subjects analysis, $F_1(1,20) = 3.66$, $p < .07$, MSe = 68591, and statistically unreliable in the items analysis, $p > .1$.

Table 3

Experiment 2: Mean Read Times and Probe Response Times in Milliseconds and Error Probabilities (in Parentheses).

Read Times

	Predictable	Unpredictable
Target Line	3036	3653
Line After	2863	3014

Probe Words

	Predictable		Unpredictable	
Target word	927	(.05)	823	(.05)
True Nontarget	961	(.13)	1064	(.15)
False Related	1090	(.27)	1197	(.28)
False Unrelated	912	(.03)	900	(.02)

Probe response times. The response times for the probe words were also consistent with those of Experiment 1. Subjects recognized unpredictable target words more quickly than predictable target words; $F_1(1,20) = 14.28$, $p < .005$, MSe = 8284, $F_2(1,14) = 10.61$, $p < .01$, MSe = 8873. Two differences that were marginal in Experiment 1 were statistically reliable in Experiment 2. First, true nontarget probe words were recognized more quickly when they appeared in predictable passages. This difference was statistically reliable in a subjects analysis, $F_1(1,20) = 6.10$, $p < .05$, MSe = 19161, and marginally significant in an items analysis, $F_2(1,14) = 3.55$, $p < .09$, MSe = 342495. Second, false related probe words were more quickly rejected when they were in predictable passages. This difference was highly significant in a subjects analysis, $F_1(1,20) = 8.20$, $p < .005$, MSe = 308492, and marginally significant by items, $F_2(1,14) = 3.87$, $p < .07$, MSe = 292305. There was no difference in response time for unrelated false probes, $p > .1$.

A series of planned comparisons revealed that the pattern of response times for the type of probe word also replicated the pattern of Experiment 1. Subjects responded more quickly to target probes than true nontarget probes, $t(21) = 4.68$, $p < .05$. False related probes were responded to more slowly than either target probes, $t(21) = 9.67$, $p < .05$, true nontarget probes $t(21) = 3.78$, $p < .05$, or false unrelated probes, $t(21) = 7.88$, $p < .05$. Also, false unrelated probes were responded to more quickly than true nontarget probes. Although highly significant in Experiment 1, this difference was only marginally significant, $t(21) = 2.72$, $p < .07$.

Error rates. The error rates in Experiment 2 also paralleled those of Experiment 1. There was no difference in the error rate for each of the probe types as a function of whether it appeared in a predictable or unpredictable passage p, $> .1$. The error rate for target probes was lower than for true nontarget probes, $t(21) = 3.92$, $p < .05$. False related probes had a higher error rate than either target probes, $t(21) = 7.49$, $p < .05$, true nontarget probes, $t(21) = 5.13$, $p < .05$, or false unrelated probes, $t(21) = 12.99$, $p < .05$. The error rate for false unrelated probes was lower than for true nontarget probes, $t(21) = 4.98$, $p < .05$.

Recall. Each passage was divided into a series of idea units which consisted of either individual sentences, basic semantic propositions, or phrases (e.g. Bransford & Johnson, 1972; Hasher & Griffin, 1978). We will report number of idea units recalled prior to the target word, number containing a target word, and number after the target word. Averaged over the two versions of the materials, the total possible numbers of idea units for the three sections of the passages were 38.5, 8, and 18 units respectively. We will also present the number of passages for which at least one idea unit was recalled, and the proportions of idea units recalled conditionalized upon some recall for a passage. A lenient scoring criterion was used such that an idea unit was considered to have been correctly recalled if a subject had produced a paraphrase that captured the meaning of a particular idea unit. Scoring was done by two independent judges. Interrater reliability was .96 reflecting both high agreement among the scorers and the ease with which decisions about recall of particular idea units could be made.

The first data to be presented are the total numbers of idea units recalled from all passages. These data are presented as a function of passage type and position in Table 4. Subjects recalled more total units from unpredictable passages than from

Table 4

Experiment 2: Number of Idea Units recalled as a Function of Position in a Passage.

	Idea Units Recalled	
	Predictable	Unpredictable
Idea Units Before	7.90	11.95
Idea units w/target	2.86	4.23
Idea Units After	4.04	4.36
Number of passages	3.41	5.32

predictable passages; $\underline{F}_1(1,20) = 10.18$, $\underline{p} < .005$, MSe = 838, $\underline{F}_2(1,14) = 5.90$, $\underline{p} < .05$, MSe = .5708. One source of this difference was that subjects showed better recall of idea units containing an unpredictable target word than those containing a predictable target word; $\underline{F}_1(1,20) = 10.71$, $\underline{p} < .005$, MSe = 1.91, $\underline{F}_2$ $(1,14) = 12.19$ $\underline{p} < .005$, MSe = 2.16. In addition, for those idea units that occurred prior to the target word unpredictable passages also demonstrated a recall advantage; $\underline{F}_1(1,20) = 8.43$, $\underline{p} < .005$, MSe = 21.36, $\underline{F}_2(1,14) = 9.17$, $\underline{p} < .01$, MSe = .1507. However, when considering only those idea units that occurred after the target word, subjects showed no difference in recall performance, $\underline{p} > .1$. The power to reject this null finding at the .05 level was computed using the error term was based on the appropriate MSe for the subjects analysis. The power to reject a difference as small as one idea unit was .78 and rises to .98 for a difference of three idea units.

Table 4. also shows that subjects recalled at least one idea unit from more unpredictable than predictable passages; $\underline{F}_1$ $(1,20) = 16.86$, $\underline{p} < .001$, MSe = 2.38, $\underline{F}_2$ $(1,14) = 5.93$, MSe = 3.56. Since this result could account for much of the difference in recall of idea units prior to the target word, a second analysis was performed. In this analysis, only those passages for which a subject showed some recall were

considered. Table 5 presents the proportions of possible idea units recalled per passage, averaged over those passages for which a subject recalled at least one idea unit. Overall, subjects showed no difference in the proportion of idea units recalled from

Table 5.

Experiment 2: Proportion of Idea Units Recalled as a Function of Position in a Passage.

	Proportion of Idea Units Recalled	
	Predictable	Unpredictable
Total Idea Units	.51	.54
Idea Units before	.42	.54
Idea Units After	.48	.37

predictable and unpredictable passages $p > .1$. However, when considering idea units that occurred prior to the target word, subjects recalled a greater proportion of those idea units when they occurred in unpredictable passages, $t(21) = 3.27$, $p < .05$. For idea units occurring after the target word, subjects tended to recall proportionally more of them from predictable passages. Although the size of this difference was similar to that for idea units prior to the target word, it failed to approach significance $p > .1$.

Experiment 2 maintained a consistent pattern of results. Subjects required additional time to read a target line and the immediately following line when a passage contained an unpredictable target word. As in Experiment 1, this additional processing time was accompanied by an increased saliency of the unpredictable target word: subjects recognized unpredictable target words more quickly than predictable target words. The recall results demonstrated that there was also facilitation of memory of concepts other than the target word. More specifically, concepts that appeared prior to the target word were better recalled when the target word was unpredictable.

General Discussion

The results of these experiments offer strong support for the position that increases in comprehension difficulties can force a reader to reprocess earlier portions of a passage in order to maintain coherence, and that a successful resolution of these difficulties will actually improve memory for portions of a prose passage. We will review several findings that support this conclusion. First, consider the fact that subjects spent more time reading passages that contained an unpredictable target word. Ehrlich and Rayner (1981) found that fixation time on the target word was longer when it was unpredictable. They suggested that the effect was open to two possible interpretations. It could be due to a reduction in the threshold necessary for identification of predictable target words due to a context priming effect, or to an increase in the elaborative processing necessary to integrate unpredictable words. In our Experiment 1, subjects were 528 milliseconds slower to read a target line when it contained an unpredictable target word than when it contained a predictable target word. In Experiment 2, this difference was 617 milliseconds. Although part of this difference could be due to a reduction in the threshold necessary for word identification in the predictable passages, it is unlikely that a threshold model could account for such large differences. Furthermore, read times for the line immediately following the target line were still 224 milliseconds slower in Experiment 1 and 151 milliseconds slower in Experiment 2. Again, this result is not easily explained by a reduced threshold model; such a model would predict that any additional time spent for word identification should occur only at the point of an unpredictable item. However, these results are consistent with the position that reading rate was slowed as a result of the increased difficulty encountered in integrating the unpredictable targets with the preceding text (Ehrlich, 1983). When a reader encountered an unpredictable concept, the reading process apparently continued, but at a slower rate. Presumably, this slowdown was a result of additional capacity being allocated to integrative processes (Kintsch & Van Dijk, 1978). Depending on the degree of difficulty encountered, this slowdown in reading could be quite substantial. With the present materials, there was never any obvious necessary inference, or clear point where an unpredictable concept could be integrated. It is therefore not surprising that the obtained reading time differences were so large and long lasting.

Next, consider that subjects were able to recognize unpredictable target words more quickly than predictable target words. Assuming that the increased reading time for the unpredictable passages was due in part to an increase in the elaborative processing necessary to integrate unpredictable target words, these words should be more salient and, as a result, more quickly recognized than predictable target words. In fact, in both Experiment 1 and 2 this difference was approximately 100 milliseconds, suggesting that the unpredictable targets were substantially more salient.

The pattern of response times for nontarget probes offers still further evidence that subjects were reprocessing earlier portions of the unpredictable passages. Subjects were slower to respond to true nontargets and false related probes when they appeared in unpredictable passages. Although these differences were not significant in Experiment 1, an analysis that combined the results of the two experiments revealed that true nontargets were responded to more slowly in unpredictable passages; $\underline{F}_1(1,38) = 7.62$, $\underline{p} < .005$, MSe = 22025, $\underline{F}_2(1,14) = 7.23$, $\underline{p} < .02$, MSe = 12597, while false related probes were also responded to more slowly ; a result significant in a subjects analysis, $\underline{F}(1,38) = 4.44$, $\underline{p} < .05$, but unreliable in an items analysis, $\underline{p} > .1$. That true nontargets were more slowly recognized in the unpredictable condition may reflect a diverting of attention from surface to conceptual information during the reprocessing required by encountering the unpredictable target item. Since individual lexical items are less salient in a conceptual representation than in earlier representations (Green, 1975; Caplan, 1972; Jarvella, 1971), true nontargets would be less salient when in unpredictable passages and, as a result, recognized less quickly. Although unpredictable targets are also subject to this reprocessing, they are the focus of this additional processing, the net result being an increase in saliency. Next, consider the false related probes; a similar argument can be made here. Given that subjects have reprocessed previously read information in the unpredictable passages, it should be more difficult to reject information that is conceptually consistent. This resulted in false related probes being responded to more slowly when in unpredictable passages.

The most convincing evidence supporting our position comes from the recall data of Experiment 2. We have argued that the increase in comprehension time is a function of subjects working back through earlier portions of the unpredictable passages; they draw inferences in an attempt to integrate an unpredictable concept. If this additional integrative processing is successful, then not only should the unpredictable concept benefit from these additional elaborations, but earlier portions of the unpredictable passages should also have benefited. The recall results of Experiment 2 confirmed this expectation. Not only did subjects recall an average of almost 50% more idea units from unpredictable than from predictable passages, but this advantage of unpredictable passages was focused solely on the portion of the passage preceding the target word. No difference was observed for those idea units following the target word even though reading time results indicated that more time was spent processing some of those units when they occurred in unpredictable passages. The results of the conditional analysis eliminated the possibility the unpredictable target words simply served as more salient retrieval cues, facilitating access to the unpredictable passages. It is also unlikely that this difference in recall could reflect a difference in processing during the recognition test. The overall difference in probe processing time for predictable and unpredictable passages collapsed across experiments was 9 msec while for reading times this difference was 380 msec. The hypothesis that the unpredictable target word serves as a stimulus to a reprocessing of previous material in the passage clearly provides a better account of the entire pattern of reading time, probe recognition, and recall results.

The present set of materials made it difficult to determine exactly what kinds of additional processing subjects were engaged in, or which specific concepts should have benefited most from this increased processing. Future studies should utilize materials that will allow specific predictions about the type and amount of additional processing necessary to maintain coherence. Only then will it become clear in which conditions comprehension difficulty facilitates or hinders memory performance. It should be noted that this benefit is only likely to occur if the reprocessing has been successful (cf., Bransford & Johnson, 1972). In any case, recent work has suggested that an important component of readability is the maintenance of referential coherence (Miller & Kintsch, 1980 ; Kintsch & Vipond, 1979). The present results suggest that disruptions in referential coherence can actually improve memory by forcing a reader to reprocess earlier portions of a text.

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