Journal of Experimental Psychology:
Learning, Memory, and Cognition
1986, Vol. 12, No. 2, 220-231

0278-7393/86/$00.75

Memory Connections Between Thematically Similar Episodes

Colleen M. Seifert
Yale University

Gail McKoon
Northwestern University

Robert P. Abelson
Yale University

Roger Ratcliff
Northwestern University

Recent theories about the representation of thematic information in memory propose that two episodes that share a theme are connected together through a thematic structure. We investigated the use of such cross-episode connections in comprehension and memory in six experiments. Experiments 1 and 2 used a priming technique; it was found that verification time for a test sentence from one story was speeded by an immediately preceding test sentence from a thematically similar story but only when subjects were given instructions to rate the similarities of the stories. In the remaining experiments, a single test sentence was presented immediately after a story was read, with timing controlled by presenting the story one word at a time. Response time for a test sentence from a previously read story was facilitated if the immediately preceding story was thematically similar, but only if the previously read story was extensively prestudied. We conclude that, during reading of an episode, thematic information may be encoded so as to lead to activation of similar episodes and formation of connections in memory between episodes, but such encoding is not automatic and depends on subjects' strategies and task difficulty.

The idea that previous knowledge is used to understand and remember new information dates, in current literature, from Bartlett (1932). Recently, work in both psychology and artificial intelligence has resulted in the development of theories to describe the structure of such knowledge and the collection of a body of empirical results that provides evidence about how such knowledge is used. Minsky (1975), Rumelhart (1980), and Schank and Abelson (1977) have proposed that related information is organized into knowledge clusters called "frames" or "schemata," and the psychological reality of these theoretical notions has been tested extensively (see Abelson, 1981; Alba & Hasher, 1983; Taylor & Crocker, 1981). In this article, we are concerned with one particular aspect of schema theories, namely the connections that they postulate between different instances of a schema. For example, "ordering" can happen both with respect to a restaurant and a catalog, and these two instances would share some of the abstract characteristics of ordering. Schank (1982) and Dyer (1983) have proposed that the abstract structure shared between the instances leads to connections between them in memory. To investigate if connections are made between different instances of the same schema, six experiments were performed; in each experiment, subjects read short stories that expressed well-known schemata. Particular attention was given to the various processes in which a schema might be involved; reading one instance of a schema might activate another already stored in memory and it might be connected to it in memory, and either of these processes might happen automatically or strategically. The conclusion from the experiments was that one instance of a schema does not automatically activate or become connected to another in memory. However, before describing the experiments in detail, recent work on schema theory and on the processing of textual information is reviewed.

This research was supported by a grant from the System Development Foundation and by National Institute of Health Grant No. 16381 to Gail McKoon and Roger Ratcliff. We would like to thank G. Collins, K. Hammond, and S. Lytinen for helpful discussions of the ideas presented in this article. M. Dyer was of great assistance in the preparation of the materials and the design of the experiments reported here.

Correspondence concerning this article should be addressed to Colleen M. Seifert, Cognitive Science Program, Yale University, P.O. Box 2158 Yale Station, New Haven, Connecticut 06520.

Theoretical Background in Schema Theory

Originally, schemata were proposed to represent knowledge of familiar events or relationships among events. The information in a schema is assumed to be organized into a structure, reflecting, for example, temporal contiguity, importance, or more abstract relations such as that between a goal and a plan for its attainment. The content of the schema and its structure define the inferences that can be made when the schema is activated in memory. Some schemata organize information in a very specific context such as a restaurant, whereas others represent much more abstract knowledge such as the role of authority or ways to avoid problems in life.

The original schema theories have several weaknesses. Among these are, first, that schemata are too rigid (Feldman, 1975) and so they cannot be adjusted to nonstereotypical situations. Second, the theories have no recovery mechanism to allow the use of partially analyzed information when an incorrect schema has been selected. Third, the theories do not capture the intuition that two stories or episodes can share common structures even though their contexts are unrelated.

To address these limitations, Schank (1982) has developed the notion of generalized schemata. For example, one kind of schema, the "script," originally represented a stereotypical sequence of events in a particular context; for example, in a restaurant script,

"being seated by the hostess" would be followed by "ordering from a menu," and so on. Scripts have been reformulated as "memory organization packets" (MOPs), which are made up of generalized clusters of events called "scenes." The MOP specifies the organization of the scenes (e.g., that *entering* comes before *ordering*) and adds the specific contextual information. But the scenes themselves are relatively abstract, so that the same scene can be used in different contexts (by different MOPs). Consequently, the same *ordering* scene can be used in a restaurant MOP and a catalog MOP.

The use of generalized scenes allows limitations on the original schema theories to be addressed. First, the system is more flexible because the scenes can be combined and recombined in any desired organization. Second, even if the wrong MOP is used to encode the episode, it may still be possible to retain the analyses of some of the scenes for use with a different MOP. Third, different MOPs or different instances of the same MOP can be connected through the scenes that they share.

MOPs represent generalizations of one kind of knowledge; they can be compared with thematic organization packets (TOPs), the kinds of schemata used in the experiments in this article. TOPs are intended to capture a level of information that is relatively content free as compared to scripts. For example, the theme of retaliation can appear in very different situations, such as a terrorist group responding to government action with bombing, or a child, feeling wronged, tattling on a sibling. A TOP is defined as an interacting pattern of goals and plans, with certain conditions attached to the pattern. In retaliation, each side has goals and plans to achieve those goals under the condition of mutual antagonism. TOPs are related to earlier versions of themes (Abelson, 1973; Schank & Abelson, 1977) and differ from other structures proposed to capture thematic information (e.g. Lehnert, 1981; Wilensky, 1983) in the emphasis on the overall pattern of goal and plan interaction, the importance of the attached conditions, and their functionality as structures in memory. Like MOPs, TOPs allow connections between episodes because of shared abstract structures.

In the experiments in this article, the main interest was in the connections that might exist in memory between different instances of the same schema. With MOPs, these connections could be at least partly the result of semantic relatedness (e.g., two stories about restaurants would share many related or identical concepts). To avoid such semantic connections, and so study the connections established by shared abstract structures, the schemata used in the experiments were TOPs.

One particular kind of TOP was examined, namely the thematic abstraction units (TAUs) proposed by Dyer (1983). TAUs are the patterns of goals and plans reflected in common adages. For example, the adage "Closing the barn door after the horse is gone" expresses the point of the following two stories:

Story 1: Academia

Dr. Popoff knew that his graduate student Mike was unhappy with the research facilities available in his department. Mike had requested new equipment on several occasions, but Dr. Popoff always denied Mike's requests. One day, Dr. Popoff found out that Mike had been accepted to study at a rival university. Not wanting to lose a good student, Dr. Popoff hurriedly offered Mike lots of new research equipment. But by then, Mike had already decided to transfer.

Story 2: Wedding Bells

Phil was in love with his secretary and was well aware that she wanted to marry him. However, Phil was afraid of responsibility, so he kept dating others and made up excuses to postpone the wedding. Finally, his secretary got fed up, began dating, and fell in love with an accountant. When Phil found out, he went to her and proposed marriage, showing her the ring he had bought. But by that time, his secretary was already planning her honeymoon with the accountant.

TAUs were chosen as structures to be used in the experiments for two reasons. First, whereas TAU structures are more abstract than structures previously investigated, they are still reasonably well defined. Second, the patterns of goal–plan interactions represented in TAUs are easily recognized, as was shown by Seifert and Black (1983). In one experiment, they gave subjects example stories that shared a common TAU (like the two stories above) and asked subjects to write similar stories. Of the stories written by subjects, 82% matched the TAUs of the examples. In a second experiment, subjects were reliably able to sort studies according to their TAU pattern. Given this evidence that people can recognize these structures, we can consider what processes might be involved and what the consequences might be for the representations of the stories in memory. Previous research with other kinds of schemata suggests that TAUs might be involved in both the encoding and retrieval of stories. This research is reviewed in the next section.

Empirical Investigations of Schemata

The use of schemata in remembering textual information has been well documented. In early work, Bransford and Johnson (1972, 1973) and Dooling and Lachman (1971; also Dooling & Mullet, 1973) demonstrated that ambiguous stories were easy to understand and recall if they were given a title that referred to appropriate background knowledge but very difficult without the title. Similarly, experts, who can provide extensive background knowledge for themselves, do better at recalling information in their area than nonexperts (Chiesi, Spillich, & Voss, 1979). Schemata have been shown to determine not only how much of a text will be recalled but which parts of a text will be recalled. If a schema is mentioned at the time a text is read, information relevant to the schema is more likely to be recalled (Pichert & Anderson, 1977) and more likely to be recognized (Graesser, Woll, Kowalski, & Smith, 1980; Schallert, 1976). Schema-relevant information is also more likely to appear as intrusions in recall protocols than schema-irrelevant information (Bower, Black, & Turner, 1979). Finally, facts that can be organized by well-known schemata seem to be more tightly connected in memory than facts that cannot be so organized (McKoon & Ratcliff, 1980b).

Much of the evidence for the psychological reality of schemata has been taken to support the hypothesis that schemata are used during encoding to determine the memory representation of a story. Some of this evidence comes from studies of recall; these studies show that the recall protocol generated by a subject for a story conforms to some combination of the schema structure of the story and the information in the text of the story. However, McKoon and Ratcliff (McKoon, 1977; McKoon & Ratcliff, 1980a, 1980b; Ratcliff & McKoon, 1978) have pointed out that

this conclusion does not necessarily follow; it may be that the schema-like nature of the recall protocol is the result of retrieval processes operating on nonschema-like memory structures. Data confirming the role of retrieval processes have been reviewed by Alba and Hasher (1983). Furthermore, Alba and Hasher note that information that does not appear in recall protocols (making the protocols seem to reflect schemata) can, in fact, be remembered when the test is recognition (cf. Alba, Alexander, Hasher, & Caniglia, 1981; Thorndyke & Yekovich, 1980).

Other evidence often cited to support the hypothesis that schemata affect encoding processes comes from studies of recognition that find a gap-filling phenomenon; statements that express script events tend to be falsely recognized (Bower, Black & Turner, 1979; Graesser, Gordon, & Sawyer, 1979; Graesser et al., 1980). The argument is that this false recognition occurs because the memory representation of a script story is the generalized script (plus any extra or unusual information). However, it could also be the case that the representation of a script story in memory is simply a list of the events in the story without any reference to the generalized script. In this case, script events would be falsely recognized because incomplete memories may combine with response biases and with cues from semantic similarity and general knowledge about the script situation to lead to incorrect guesses. Therefore, recognition results are not conclusive evidence that a story is stored in terms of the generalized script as opposed to a separate organization in memory.

Thus we argue that none of these recall or recognition results unequivocally shows the memory representation set up by encoding processes. Perhaps the best available tests for schematic organization are those that involve timed decisions; then a subject is least likely to invoke relatively slow strategic retrieval processes or guessing processes and data are most likely to reflect the structures set up in memory at the time of encoding. McKoon and Ratcliff have measured response latencies in recognition and verification in a series of experiments in which subjects were pressed to make their responses as quickly as possible. They have argued that results in these experiments do not reflect strategic retrieval processes (Ratcliff & McKoon, 1981) but instead reflect automatic retrieval processes and therefore allow inferences about the memory representation of a text set up at the time of encoding (McKoon & Ratcliff, 1980b; Ratcliff & McKoon, 1978). With respect to schematic encoding, specifically, McKoon (1977) found a topicality effect in recognition response times; important information was recognized more quickly than unimportant information. Also, using a priming technique, McKoon and Ratcliff (1980b) found that response time for a target statement from a script depended on the immediately preceding test statement; a priming statement close to the target in the script structure speeded response time for the target more than a priming statement farther away in the structure. These results demonstrate, first, that response-time procedures are sensitive to the effects of schemata, and second, that schemata may indeed affect encoding, despite the problems with data from the recall and recognition procedures that allow slower, more strategic processing.

However, these results do not represent a large body of data, and the questions of whether and how schemata determine the structure of the memory representation of a text, at the time of encoding, are still open. What is needed, then, are experiments

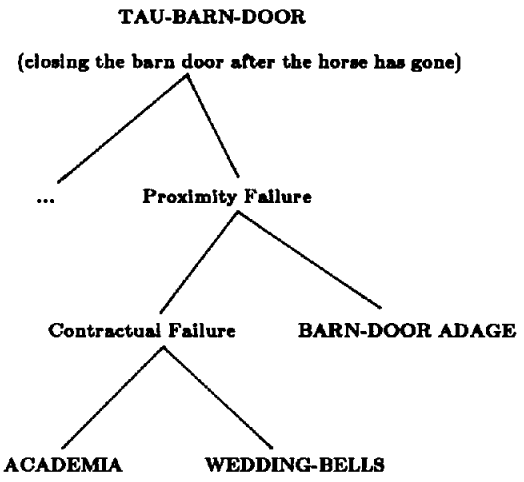

Figure 1. The memory organization of a thematic abstraction unit (TAU) structure and related episodes.

that directly examine the effects of schemata on encoding. We chose to investigate two aspects of encoding, whether the encoding processes are automatic or strategic and what kind of schematic information is used.

During encoding of a text, schematic information might be activated automatically and thus be available to organize or add to new information (Schank & Abelson, 1977). Automatic activation in this sense is illustrated in experiments by Dell, McKoon, and Ratcliff (1983). They presented subjects with stories in which there was an anaphor referencing a previously mentioned noun. The time required for subjects to recognize the noun as having been in the story was speeded when the noun was tested just after the anaphor. The speedup was present (and at its maximum) when the noun was shown only 250 ms after the anaphor, suggesting that the speedup was due to automatic processing (Posner, 1978). However, such fast automatic processing might not occur with schematic information; rather, schematic information might be made available strategically on demand when the text-comprehension system needs information not provided in the text. By strategic, we mean processes that are optionally invoked, under conscious control, and relatively slow (Posner, 1978).

Independent of the question of automatic or strategic activation processes is the question of what kind of schematic information gets activated. If schemata provide a way of connecting episodes of the same structure (Schank, 1982), then one episode of a particular schema may activate another.

For example, the stories given above might be connected in memory as shown in Figure 1 (Dyer, 1983). Related episodes, such as the story represented by the adage "Closing the barn door after the horse has gone" are connected via the same TAU structure. Then, if the Academia story is read, the Wedding Bells story might be activated. This would be an example of cross-contextual reminding (Schank, 1982): cross-contextual because the stories have relatively little in common in terms of semantic context. Experiments by Bower, Black, and Turner (1979) suggest that such cross-contextual connections may occur. They had

subjects read pairs of stories, for example, one about visiting a doctor and one about visiting a dentist, and then presented sentences for recognition. They found that sentences about events in a doctor's office were likely to be incorrectly recognized as having been read if there had actually been sentences about events in the dentist's office. Similar results were found for intrusion errors in recall. However, there are two different interpretations of these recall and recognition results. It might be that connections between the doctor and dentist stories are set up at the time of reading; for example, the stories might be connected through general scenes, such as "waiting room" (Schank, 1982). Or, it might be that the two stories are not at all connected; as mentioned above, it might be that at the time of the memory test, incomplete memories combine with cues from semantic similarity and general knowledge about visiting professionals to result in incorrect guesses about information that could have appeared in either story. Thus, given these alternative explanations of the data, there is not clear evidence that cross-contextual reminding occurs during encoding.

To summarize, the general question with which we are concerned in the research reported here is whether schematic information determines the organization of information during encoding of a text. Specifically, we ask whether the information in a text is encoded with respect to previously read episodes that have the same structure; is a previously read episode activated (automatically or strategically?) and is information from a previously read episode connected in memory to the new text?

Introduction to Experiments

In each of the experiments, subjects read stories based on TAU structures. The questions of interest all concern what happens when the story that is currently being read (e.g., the story about the graduate student) has the same TAU structure as a previously read story (e.g., the story about the secretary). The processes that might occur can be listed as follows: The current story might activate the abstract TAU structure but not the previous story. This activation might lead to a connection in memory between the current story and the abstract TAU and perhaps through the abstract TAU to the previous story. Or, the current story might activate the previous story as well as the abstract TAU; the previous story might be activated as a whole (say, by a title), or the elements might be activated one by one as the elements of the new story are read. In either case, activation might lead to connections in memory between the new and old stories.

In Experiments 1 and 2, a priming technique was used to look for memory connections between the elements of the two stories. We hypothesized that if there were such connections, then verification of an element from one of the stories would speed verification of a similar element from another story. In the first experiment, subjects were given no instructions about the themes (TAUs) of the stories; in the second experiment, we attempted to encourage strategic processing during reading by giving instructions asking subjects to rate similarities between stories.

In Experiments 3 through 6, we tested for activation by presenting a single test sentence immediately after a story was read. We thought that if the test sentence was from a previously read story with the same TAU structure as the story just read, then response time for the test sentence might be speeded because the previous story had been activated. In Experiment 3, subjects were given no instructions; in Experiment 4, they were given instructions to encourage strategic processing. In Experiments 5 and 6 some of the stories were presented for extensive study to make strategic processing during reading easier.

Table 1
Test Sentences Used in the Experimental Conditions in Experiment 1

Condition	Sentence
Same theme	Prime: Conclusion from TAU (1)—Story A Target: Conclusion from TAU (1)—Story B
Different theme	Prime: Conclusion from TAU (2)—Story A Target: Conclusion from TAU (1)—Story B
Within-story control	Prime: Setup from TAU (1)—Story B Target: Conclusion from TAU (1)—Story B
Between-story control	Prime: Setup from TAU (2)—Story A Target: Conclusion from TAU (1)—Story B

Note. TAU = thematic abstraction units.

Experiment 1

In Experiment 1, subjects were presented with a series of trials. On each trial, they read two stories and then responded to a series of test sentences about those two stories. For each test sentence, they were required to verify whether it was true according to the stories. The stories were all based on TAU structures like those shown in the Appendix.

Target test sentences were those used to test the experimental hypotheses; they all expressed the conclusions or outcomes of their stories. For example, the target test sentence for the story about the graduate student was "by then, Mike had already decided to transfer." These target test sentences appeared in four different conditions, defined according to the test sentence that immediately preceded them in the test list (the priming sentence). The priming test sentence was either from the same story as the target or from the other story read on that trial. The other story could have been based on the same TAU as the story for the target sentence or a different TAU. The four conditions are summarized in Table 1.

In the same-theme and different-theme conditions, the target and the priming test sentences came from different stories and were both conclusions of their stories. In the same-theme condition, the stories were based on the same TAU; in the different-theme condition, the stories were based on different TAUs. We hypothesized that if two stories based on the same TAU were connected in memory, then the priming sentence from one of the stories should speed response time for the immediately following target from the other story. Response time would be speeded relative to the different-theme condition.

The two other conditions of the experiment were control conditions. In these conditions, the target test sentence expressed the conclusion of its story and the priming sentence expressed

the initial elements of the TAU of a story (the "setup"). The setup test sentence for the story about the graduate student was "Popoff always denied the requests for equipment." In the within-story control condition, the priming and target sentences came from the same story. In the between-story control condition, they came from different stories (based on different TAUs). We expected that response times for the target sentences would be faster in the within-story control condition, replicating previous work (McKoon & Ratcliff, 1980b) and showing both that the elements within a story were connected to each other and that our methodology was sensitive to differences in connections in memory.

Method

Subjects. Twenty Yale University undergraduates participated in the experiment for pay or for credit in an introductory psychology course. Each subject participated in one session lasting about 50 min.

Materials. All of the 84 stories used in the experiment were based on one of nine thematic patterns (TAUs), shown by example in the Appendix. The stories averaged six sentences (80 words) in length. Forty-eight of the stories were used in the design of the experiment, five or six from each of the nine thematic types, and the other 36 were used as fillers.

For each of the stories, there were four test sentences. One of these expressed the conclusion of the story (in the experimenters' best judgments) and another expressed the setup or initiating circumstances of the story. These two were positive test sentences, that is, the correct answer was "true"; they averaged eight words in length. The setup and conclusion test sentences did not contain any content words in common. The other two test sentences were negatives, expressing clear violations of something the story had said to be true; they also averaged eight words in length.

Design and procedure. Each subject was presented with 44 study-test trials, of which the first two were for practice. Study and test list presentation and data collection were controlled by a microcomputer driven by a DEC-20 computer. Stimuli were displayed on a CRT screen and subjects made responses on the CRT's keyboard.

Each trial was initiated by the subject pressing the spacebar. Then the two stories in the study list were presented one at a time for 20 s each. After the second story, a warning signal appeared for 1 s, and then the test list began immediately. Each test list was composed of eight sentences, four from each of the two studied stories (half positive, half negative). The subject was instructed to respond to each test sentence by pressing either a "true" key ("/" on the keyboard) or a "false" key ("z" on the keyboard). A test sentence remained on the screen until a response was made; then, the next test sentence appeared after a 50-ms pause. If the subject made an error, the word "ERROR" was presented for 2 s before the next test sentence appeared. After the eight test sentences, the instruction to press the space bar to initiate the next trial appeared.

The four experimental conditions were as follows: The priming sentence for a target (the conclusion of its story) was either the setup from the same story (within-story control condition), the setup from the other studied story (between-story control condition), the conclusion from the other studied story that had the same theme (same-theme condition), or the conclusion from the other studied story that had a different theme (different-theme condition). These four conditions were combined in a Latin square design with four groups of subjects (5 per group), and four groups of stories (12 per group).

For each study list, one of the 48 target stories was chosen; it always appeared as the second of the two studied stories. Stories in the same-theme condition were paired with a filler story based on the same thematic pattern, and stories in the different-theme and between-story control conditions were paired with filler stories based on a different thematic pattern. The filler stories used in these three conditions were evenly distributed among the nine thematic types. Because the within-story control condition did not require a filler story to provide a priming test sentence, each story in this condition was paired with another target story in the within-story control condition. The serial positions of the 48 stories of the experimental design remained constant across subjects, except for slight changes required by rotating stories through the within-story control condition. In total, subjects saw 9 or 10 exemplars of each thematic pattern. The same-theme condition was the only one where two stories of the same thematic type were paired, so study lists in which the two stories had the same themes made up one fourth of the total. Otherwise, a particular thematic pattern used in a study list was separated from other exemplars of that pattern by at least three study lists.

Each test list was constructed by first placing a target test sentence in a randomly chosen position in the test list, excluding Positions 1, 2, and 8. Then, its priming sentence was placed in the immediately preceding test position. When both studied stories were in the within-story control condition, there were two target test sentences. Otherwise, there was only one target. The remaining test positions were filled by the remaining positive test sentences and negative test sentences. Two constraints on the construction of the test list were that no sentence could appear more than once, and that there could not be a sentence from the same story as a target test sentence in the position immediately preceding its priming sentence.

Results

All analyses and statistics were based on mean response times for each subject or test sentence in each condition. Mean response time for filler positives was 1,562 ms (3% errors), with a standard error of 62.2 ms. For negatives, mean response time was 1,708 ms (6% errors), with a standard error of 71.4 ms. For the four experimental conditions, only correct "true" responses preceded by correct "true" responses were included in the analyses and statistics in an attempt to ensure that both the priming and primed test sentences were in memory. Standard error for the experimental conditions was 62.0 ms.

For the control conditions, when the target conclusion sentence of a story was primed by the setup of the same story, then response time was faster than when it was primed by the setup of a different story, min $F'(1, 64) = 5.56$, $p < .05$. Mean response time was 1,436 ms (3% errors) in the within-story control condition and 1,594 ms (5% errors) in the between-story control condition. The difference in error rates was not significant, Fs < 1.

When the conclusion of a story was primed by the conclusion of another story, it made no difference whether the story expressed the same theme or a different theme: Fs < 1 for both response times and error rates. Mean response time was 1,538 ms (3% errors) in the same-theme condition and 1,516 ms (5% errors) in the different-theme condition.

Discussion

The priming effect in the within-story control condition demonstrates that the setup and conclusion parts of a story are connected in memory in a way that facilitates verification of the conclusion. This statement is subject to one qualification: Because we have no neutral priming condition in the experiment, we cannot be sure that we have observed facilitation in the within-story control condition and not inhibition in the between-story

control condition. But whichever the effect actually is, facilitation or inhibition, we would attribute the cause of the effect to connections that exist in memory among the elements within a story and that do not exist between elements of different stories. So, for simplicity of exposition, we will refer to the effect as facilitation.

With respect to the theme conditions, Experiment 1 failed to demonstrate an effect of thematic similarity on verification time. Whereas the similarities in the stories appear quite salient, especially when presented in pairs, this manipulation did not affect the time to verify the conclusion of one story primed by the conclusion of the other. Apparently, either subjects did not recognize the intended similarities or if they did, elements of similar stories were not connected to each other. In order to determine if subjects were able, in the strongest case, to make use of the thematic similarity in the story pairs, a second experiment was designed to stress the use of the themes in understanding the stories.

Experiment 2

In this experiment, an attempt was made to encourage subjects to recognize and use the thematic similarities in the story pairs. The experiment was the same as Experiment 1 except that subjects were asked to evaluate the similarity of each story pair throughout the experiment and they were given instructions to encode the stories in terms of their thematic similarity.

Method

Subjects. Twenty Yale University undergraduates participated in the experiment for pay or for credit in an introductory psychology course. Each subject participated in one session lasting about 60 min.

Materials. The same materials were used as in Experiment 1.

Design and procedure. The design and procedure were the same as in Experiment 1 with two additions: Specific instructions about the themes in the stories were given at the beginning of the experiment and a rating task was given after each test list.

In Experiment 1, it was never mentioned to the subjects that the stories used in the experiment would have obvious themes and that these themes would be repeated in different stories. In contrast, the instructions for Experiment 2 gave a description of the type of themes used in the experiment and an explicit example of a story with a particular theme. Subjects were told to think about the theme of a story as they read it and to judge how similar were the themes of the two stories in each study list. After each test list, the subjects were asked to rate the similarity on a 7-point scale (1 = *very different*, 7 = *very similar*).

Results

The data were analyzed as in Experiment 1. The mean response time for filler positives was 1,608 ms (5% errors), with a standard error of 66.5 ms. For negatives, the mean response time was 1,792 ms (11% errors), with a standard error of 65.3 ms. The standard error in response times for the experimental conditions was 72.6 ms.

For the within-story control condition, in which the prime and target sentences came from the same story, mean response time was 1,575 ms (6% errors), faster than the mean response time for the between-story control condition, 1,691 ms (13% errors). Just as in Experiment 1, this difference in response times was significant, min $F'(1, 35) = 4.84$, $p < .05$. The difference in error rates was significant with subjects as a random factor, $F(1, 19) = 6.0$, $p < .05$, and with test sentences as a random factor, $F(1, 47) = 6.4$, $p < .05$, but marginally significant with both factors random, min $F'(1, 53) = 3.1$, $p < .10$.

In contrast to Experiment 1, response time for a target test sentence was faster if it was primed by a sentence from another story with the same theme than if it was primed by a sentence from another story with a different theme. Mean response time was 1,567 ms (10% errors) in the same-theme condition and 1,649 ms (14% errors) in the different-theme condition. This difference was significant with subjects as a random factor, $F(1, 19) = 4.7$, $p < .05$, and marginally significant with test sentences as a random factor, $F(1, 46) = 3.2$, $p = .10$. The difference in error rates was not significant with subjects or test sentences as a random factor, $F(1, 19) = 2.2$ and $F < 1$, respectively.

The similarity ratings from Experiment 2 show that the subjects were able to reliably detect the intended thematic similarity in the story pairs. The same-theme condition pairs were the only ones where two stories with the same thematic pattern were presented in the same study list. In the other three conditions, the study list contained stories with different themes. The mean ratings for the study pairs reflect this pattern: For the same-theme pairs, the mean rating was 6.19; for the different-theme, within-story, and between-story pairs, the means were 2.97, 3.06, and 3.03, respectively. A contrast pitting the same-theme condition against the other three revealed a significant difference, min $F'(1, 49) = 171.41$, $p < .01$.

Experiments 1 and 2 differed only in the additional instructions given to the subjects and the additional rating task. Thus, it is possible to analyze the data from the two experiments in a between-subjects design. In Experiment 1, there was no effect of thematic similarity on response times to test sentences (1,538 ms for same-theme, 1,516 ms for different-theme), whereas in Experiment 2 there was an effect (1,567 ms vs. 1,649 ms). This difference in the two experiments is reflected in an interaction that was marginally significant with subjects as a random variable, $F(1, 38) = 3.7$, $p < .06$, but not with test sentences as a random variable, $F(1, 94) = 1.7$. In this between-experiments analysis, the interaction in error rates was not significant, Fs < 1.

The mean response time was 1,527 ms (4% errors) for Experiment 1; for Experiment 2 it was 1,608 ms (12% errors). This difference was significant with materials as a random variable, $F(1, 94) = 4.7$, $p < .05$, but not with subjects as a random variable, $F < 1$. The difference in error rates was significant, min $F'(1, 126) = 7.0$, $p < .05$. Over the two experiments, there was a 30-ms difference in mean response time between the same-theme and different-theme conditions. This main effect of similarity was not significant with subjects or test sentences as a random variable, $F(1, 38) = 1.3$ and $F(1, 94) = 2.7$, respectively. The difference in error rates (6% vs. 11%) was marginally significant with subjects as the random variable, $F(1, 38) = 3.1$, $p < .10$, but not with test sentences as the random variable, $F = 1$. The standard error of the response times in the experimental conditions for the combined analysis was 48.8 ms.

Discussion

In Experiment 2, it appears that subjects could sometimes make use of the thematic similarity in the story pairs, resulting in an effect, at least marginally significant, of the thematic connections between the stories: A conclusion sentence was verified faster when primed by another conclusion sentence from a related story than when primed by a sentence from an unrelated story. This effect obtained in Experiment 2 when subjects were instructed to consider thematic similarity while they read but not in Experiment 1 when they were not so instructed.

Intuitively, it seems that subjects must be sensitive to the thematic structures of these stories. In fact, if the thematic structure is not recognized, these stories cannot be considered to be understood correctly, as the thematic pattern is the point of the story. In addition, when the prime and target come from the same story, the within-story control condition, then there is a priming effect in both Experiments 1 and 2 showing that elements within a story are connected compared to elements that appear in the same study list but are not in the same story. These considerations argue that subjects do understand the themes in the stories even without specific instructions but that this understanding does not automatically give connections between elements in two instances of the same theme. Instead, it appears that the connections between episodes require some strategic processing during reading (as in Experiment 2). This is not to say, however, that thematic similarity does not cause activation during comprehension. It may be that elements in similar episodes are activated during reading but not connected together in the memory representation of the stories. And, because priming shows only the connections encoded into memory, the effects of thematic similarity did not appear in Experiment 1. Activation processes are investigated in the next experiments.

Experiments 3 and 4

In these experiments, each subject read a long series of stories. For some stories, the end of the story was followed by an instruction to begin the next story. For other stories, the end was followed by a single test sentence, and then the instruction to begin the next story. In order to pace subjects' reading and control the timing of the test sentence, the stories were presented word by word.

In the design of the experiments, two stories presented one immediately after the other could have either the same or different thematic structures. The second of the two was immediately followed by the target conclusion test sentence of the first. If, in the same-theme condition, reading the second story activates elements of the first, then facilitation of response time for the test sentence should result.

In Experiment 3, as in Experiment 1, subjects were given no specific instructions about the themes of the stories. In Experiment 4, as in Experiment 2, subjects were given instructions and a rating task.

Method

Subjects. Fourteen Yale University and 6 Northwestern University undergraduates participated in Experiment 3, and 14 Yale and 6 Northwestern undergraduates in Experiment 4, for pay or credit in an introductory psychology course. Each subject participated in one session lasting 50 to 60 min.

Materials. Of the stories used in Experiment 1, 28 were used in the design of Experiments 3 and 4, three or four from each of the nine thematic types, and 49 were used as fillers.

Design and procedure. Presentation of stories and test sentences was controlled by a microcomputer driven by a DEC-20 computer. All materials were presented on a CRT screen and responses were collected on the CRT's keyboard. In total, each subject was presented with 77 stories and 49 test sentences, preceded by practice on 6 stories and 5 test sentences.

The following describes the procedure for Experiment 3; additions to this procedure for Experiment 4 are described below. To initiate each story, subjects pressed the spacebar. Then the story was presented, one word at a time. Total time to present a story averaged 22 s, with 250 ms per word plus 500 ms at the end of each sentence. As each word was presented, it stayed on the screen so that at the end of the story, all the words were displayed on the screen; then, after an additional 2,000 ms, all the words disappeared. At this point, either a test sentence was presented immediately or a prompt for the subject to initiate the next story was presented. The test sentence was always from the story immediately prior to the one just presented and was either a conclusion test sentence from that story or a negative sentence based on that story. The subject was instructed to respond "true" or "false" as in Experiment 1. The test sentence remained on the screen until a response was made. If the response was incorrect, the word "ERROR" was presented for 2 s. Otherwise, the prompt to initiate the next trial appeared.

In the total list of 77 stories, positions were chosen for the 28 stories used in the experimental design. Filler stories were placed immediately following each of these 28 according to their experimental condition; stories in the same-theme condition were followed by filler stories based on the same thematic pattern, and stories in the different-theme condition were followed by fillers based on a different thematic pattern. The filler stories were always preceded by the stories of the experimental design without any intervening test sentence, and the filler stories were always followed by a positive test sentence (the target conclusion sentence of the preceding story in the design). The other 21 filler stories were placed in the remaining positions in the list of stories, and each of these was followed by a negative test sentence from the preceding story. A particular thematic pattern was separated from later exemplars of that pattern by at least 10 stories, except for stories in the same-theme condition.

The two experimental conditions in the experiment, same or different theme, were combined with two groups of subjects and two groups of stories (14 in each group) in a Latin square design. Order of presentation of stories and test sentences remained constant across subjects except for the changes in the positions of filler stories required by rotating items through experimental conditions.

For Experiment 4, there were three additions to the procedure just described for Experiment 3. First, instructions were presented that explicitly described the kind of thematic patterns in the stories. These were the same as the instructions in Experiment 2. Second, 500 ms of additional reading time was given at the end of each sentence to encourage comparison between stories; the total time added averaged 3 s per story. Third, the similarity rating task of Experiment 2 was added to the procedure. After each of the 28 target test sentences, subjects were asked to rate (on a 7-point scale) the similarity of the last two stories they had seen.

Results

All analyses and statistics were based on mean response times for each subject or each item in each condition. In Experiment 3, the mean response time for negatives was 2,015 ms (20% errors)

with a standard error of 102 ms. In Experiment 4, the mean response time for negatives was 2,268 ms (12% errors) with a standard error of 106 ms. The standard errors of the response times in the experimental conditions in Experiments 3 and 4 were 64 ms and 70 ms, respectively.

The effect of thematic similarity can be determined by comparing the time to verify the conclusion of a story when it is presented immediately following a story with a similar theme (same-theme condition) to when it is presented following a story with a different theme (different-theme condition). In neither experiment was there a significant effect. The respective means for the same- and different-theme conditions were 1,659 ms (9% errors) and 1,659 ms (7% errors) in Experiment 3 (Fs < 1), and 1,698 ms (8% errors) and 1,752 ms (8% errors) in Experiment 4. Whereas the difference in Experiment 4 was 54 ms, it was not significant, $F(1, 19) = 2.4$ (with subjects as the random variable), and for only 11 of the 20 subjects was the difference in the right direction.

Subjects in Experiment 4 were able to reliably detect the intended thematic similarity in story pairs. For same-theme pairs, the mean rating was 5.85; for the different-theme pairs, the mean rating was 2.90. These were significantly different, min $F'(1, 35) = 54.4$, $p < .01$.

Discussion

In these experiments, test sentences were presented immediately after a story was read in order to measure whether previously encoded, thematically similar information was activated. In neither experiment was there any evidence of activation, even in Experiment 4 where specific instructions were given and ratings indicated that subjects did recognize the intended thematic similarities.

At first, it appeared somewhat surprising that the additional instructions and rating task that had led to some evidence for connections between elements of thematically similar stories in Experiment 2 had no effect in Experiment 4. However, when a story is presented word by word, as in Experiments 3 and 4, it may be much more difficult for subjects to invoke either the encoding processes needed to set up the memory representation for later retrieval by a thematically similar story or the retrieval processes necessary to find such stories. In Experiments 5 and 6 we attempted to make these processes easier by giving subjects extensive study on the stories that would later need to be retrieved by thematic similarity.

Experiments 5 and 6

These experiments were similar to Experiments 3 and 4 in that subjects read a long list of stories presented word by word. However, in Experiments 5 and 6, all of the stories were followed by a single test sentence. The test sentences were based on a small set of prestudied stories. For each of the prestudied stories, subjects were asked to read it, answer questions about it, and write a summary of it.

Each of the prestudied stories was grouped in the experimental design with two of the stories that were followed by test sentences. One of these stories was based on the same thematic structure as the prestudied story; the other was based on a different thematic structure. For both stories, the test sentence was the conclusion of the prestudied story. We hypothesized that in the same-theme condition, activation of the prestudied story might lead to faster response time for the test sentence.

In Experiment 5, subjects were asked to verify whether or not test sentences were true, just as in all the previous experiments. But in Experiment 6, an identification task was used; subjects had only to press a response key as soon as they could remember which story the test sentence referred to. This task was selected as a possibly more sensitive measure of the activation of the prestudied story than the verification task.

Method

Subjects. Eighteen subjects participated in Experiment 5 and eight in Experiment 6 for pay or for credit in an introductory psychology course. Each subject participated in one 50- to 60-min session.

Materials. The eight stories used in each experimental design were based on eight of the nine thematic types shown in the Appendix and were selected from the stories used in Experiment 1. Additional fillers were written based on other thematic patterns similar to the ones in the Appendix.

Design and procedure. There were three phases to Experiments 5 and 6, a prestudy phase, a study-test phase, and a final free-recall phase. In the prestudy phase, three practice stories and eight target stories, each of a different thematic type, were given to subjects in booklet form. Each page in the booklet contained one story and four questions about the story. The subjects were instructed to read each story carefully, answer each of the questions with a short phrase, and then write a one- or two-sentence summary of the story. The subjects were given 30 min to complete the booklet (and all subjects finished).

In the study-test phase, all the stories presented for reading were new to the subject but all the test sentences referred to the target stories presented during the prestudy phase. Subjects were not tested on the stories presented during the study-test phase; however, they were instructed to attend to the stories becasue they would be tested on them in the final free-recall phase of the experiment.

In the study-test phase, presentation of the materials and data collection were controlled by a microcomputer driven by a DEC-20 computer. Subjects pressed the spacebar of the CRT to initiate presentation of each story. The story was presented one word at a time on the CRT screen. Total time for presentation averaged 22 s, with 250 ms per word plus an extra 500 ms at the end of each sentence, and 2,000 ms at the end of each story before it disappeared from the screen. After the story, a test sentence was presented immediately. The test sentence was always the conclusion sentence from one of the prestudied stories, or in Experiment 5, a negative filler from one of the prestudied stories. The test sentence remained on the screen until a response was made.

In Experiment 5, subjects were instructed, as in Experiment 1, to respond "true" or "false." If a response was incorrect, "ERROR" was presented on the screen for 2 s; otherwise, the prompt to initiate the next story was presented.

In Experiment 6, subjects were instructed to respond to a test sentence by pressing a single response key (the "z" key) "as soon as you can remember the story it refers to." After responding, they were instructed to write a one-sentence description of the story referred to and then press the spacebar to initiate the next trial.

In the study-test phase of Experiment 5, 31 stories were presented, the first 6 for practice. Of the other 25, 8 were paired with the 8 prestudied stories so as to have the same thematic pattern (same-theme condition), and another 8 were paired with the prestudied stories so as to have a

different thematic pattern (different-theme condition). A prestudied story and its same-theme pair-mate in the study-test phase were the only instances of a particular thematic type in the experiment. The test sentence for each of the 16 paired stories was the conclusion sentence of the pair-mate from the prestudy phase. (Thus, each conclusion sentence was presented for testing twice, once in the same-theme condition and once in the different-theme condition.) The test sentences for the other 9 of the 25 stories were negatives from the practice prestudied stories and from target prestudied stories that had been tested in both conditions previously in the list.

The list of stories for the study-test phase of Experiment 6 was made up in the same manner as for Experiment 5, except that the nine stories with negative test sentences were not included. The total number of stories in the study-test phase was 20, with the first 4 for practice.

Test sentences from each of the eight prestudied target stories were presented twice for each subject, once in the same-theme condition and once in the different-theme condition. For one group of subjects, four of the test sentences presented for the first time were in the same-theme condition, and four in the different-theme condition. For the second group of subjects, assignment of test sentences to conditions on first presentation was reversed. For all subjects, test sentences that had appeared in one condition on first presentation appeared in the other condition on second presentation. Order of presentation of test sentences remained constant.

In the final free-recall phase of the experiments, subjects were instructed to recall, in any order, the stories from the prestudy phase. In Experiment 5, subjects were also instructed to recall the stories from the study-test phase. They were to recall the stories by writing an identifying phrase for each story and were given 10 min (Experiment 5) or 5 min (Experiment 6) to complete this task.

Results

Data obtained in the prestudy phase (answers to questions about the stories and summaries of the stories) showed that each subject had responded adequately; the data were not analyzed further.

For the study-test phase, all analyses and statistics for the data for the test sentences were based on mean response times for each subject and each test sentence in each condition. In the same-theme condition, the test sentence, the conclusion of a prestudied story, was preceded by a story with a matching thematic structure, whereas in the different-theme condition, the same test sentence was preceded by a story with a different thematic structure. In both experiments, responses in the same-theme condition were faster than responses in the different-theme condition.

In Experiment 5 (verification), the mean response time in the same-theme condition was 2,376 ms (3% errors), and in the different-theme condition, 2,554 ms (1% errors). This difference was significant with subjects as a random variable, $F(1, 17) = 11.5$, $p < .01$, and with test sentences as a random variable, $F(1, 7) = 5.6$, $p < .05$, though min $F'(1, 15) = 3.8$, $p < .08$ was marginally significant. Standard error on these means was 88 ms. The difference in error rates was not significant, Fs < 1.

There was a main effect of order of presentation, where verification time for test sentences presented for the first time (2,742 ms, 3% errors) was greater than for test sentences presented for the second time (2,187 ms, 0% errors), min $F'(1, 12) = 26.1$, $p < .01$. The difference in error rates for first and second presentation was significant with subjects as a random variable, $F(1, 17) = 4.9$, $p < .05$, and with test sentences as a random variable, $F(1, 7) = 5.7$, $p < .05$, though the min $F'(1, 21) = 2.6$ was not. Whereas the main effect of order of presentation was strong, the interaction of order presented and relatedness was not significant: Fs < 1 for the reaction time analysis. For the first presentation, the reaction time means were 2,638 ms and 2,847 ms (same theme and different theme, respectively), and for the second, 2,115 ms and 2,261 ms, respectively. There was also no interaction of order of presentation and relatedness in the error rates, Fs < 2.0. For the first presentation, the error rates were 3% and 3% (same theme and different theme, respectively), and for the second, 0% and 0%, respectively. Mean response time for negative responses was 2,392 ms (6% errors), with a standard error of 298 ms.

In Experiment 6 (identification) mean response time in the same-theme condition was 1,253 ms and in the different-theme condition, 1,474 ms. These means were significantly different, min $F'(1, 14) = 5.4$, $p < .05$, and their standard error was 162 ms. As in Experiment 5, there was an effect of order of presentation: When presented for the first time, the identification times were significantly longer (1,491 ms) than when presented for the second time (1,235 ms), min $F'(1, 13) = 7.6$, $p < .05$. The interaction of order of presentation and same theme or different theme was not significant, Fs < 1.5. For the first presentation, the reaction time means were 1,420 ms and 1,563 ms (same theme and different theme, respectively), and for the second, 1,086 ms and 1,385 ms, respectively. After each identification response, subjects were to write a one-sentence description of the story from which the test sentence came; all subjects were able to do this for all test sentences in the experimental conditions.

In the final free-recall phase subjects were not able to generate all of the eight prestudied stories they had seen in the experiment. In both Experiments 5 and 6, they recalled 75% of the prestudied stories. In Experiment 5, subjects were asked to attempt to recall the study-test phase stories as well as the prestudied stories; in this experiment, subjects recalled 27% of the study-test phase stories. Further, the probability of recall for study-test phase stories that matched the prestudied stories in thematic structure was higher than the probability of recall for study-test phase stores that did not match, .35 versus .19. This difference is significant with subjects as a random variable, $F(1, 17) = 10.07$, $p < .01$, but not with test sentences as a random variable, $F(1, 7) = 2.45$.

Discussion

Both experiments provide strong evidence for the effect of thematic similarity in activating previous episodes. In both the verification task and the simpler identification task, response times for a test sentence from a prestudied story were faster when the story preceding the test sentence matched the test sentence's story in thematic structure. New stories appeared to activate stories already encoded in memory on the basis of their thematic similarity.

These results contrast strongly with the results of Experiments 3 and 4, where there were no apparent effects of thematic similarity. The difference in procedure between the two sets of experiments was that in Experiments 5 and 6, the old stories that were activated during reading of new stories had been extensively

studied. This could have caused the difference in results in two ways. First, prestudy could have focused subjects' attention on the prestudied stories, leading the subjects to use strategies during reading of the new stories to try to remember the prestudied stories. Alternatively, prestudy could have led to better memory for the old stories, making them easier to activate when the thematically similar stories were read later. We suspect that both of these factors played a role; whereas the results of Experiments 1 and 2 suggest that subjects' strategies can lead to activation, the results of Experiments 3 and 4 suggest that these strategies are not enough in word-by-word reading.

General Discussion

The point of the experiments in this article was to examine processes that might occur when a story currently being read has the same thematic structure as a previously read story and to attempt to obtain evidence for connections that might be made between such stories. The results of the experiments speak to current theories of thematic structure that assume episodes are connected whenever they share a common theme. Specifically, two processes were considered: One was the process of connecting elements of the story currently being read to corresponding elements of the previously read story and encoding these connections into the memory representations of the stories; the second was the process by which the previously read story was activated during reading of the current story. We assume that connections might not be encoded into memory even when activation does occur.

We were particularly concerned with investigating these processes as they occurred during reading. It appears from previous research (Seifert & Black, 1983) that subjects can activate and connect thematically related stories when they have time to do so after reading. To measure what processes occurred during reading, we used speeded verification tests. Speeded verification is more likely to measure automatic rather than strategic retrieval processes, and automatic retrieval processes are assumed to reflect the memory representation set up at the time of reading.

We also wanted to know whether the activation and connection processes that occurred during reading were automatic or strategic encoding processes. Schank (1982) has proposed that schematic information like that represented by TAUs is automatically activated and automatically connected to other schematically similar information in memory.

Our conclusions about the two encoding processes, activation and connection, were the same: A story currently being read does not automatically activate a thematically similar previously read story, nor are elements of the two stories automatically connected to each other. However, when subjects are encouraged with instructions, then there is weak evidence that the connections are made. Or, with word-by-word reading, instructions plus extensive prestudy led to the activation of thematically similar information.

We think the results of these experiments are significant in several ways. First, it appears that strategic encoding processes are required for one thematically similar episode to activate or become connected to another similar episode. When subjects in Experiment 1 were not given instructions to rate the thematic similarity of the stories, there was no reason for one story to bring to mind a similar story. But such reminding did occur when the rating task was introduced (Experiment 2), where there was a functional purpose in remembering the previous story (to rate similarity). Similarly, in Experiments 5 and 6, remembering the prestudied stories was advantageous because all of the test sentences came from those stories. Finally, it is worth reiterating that these experiments are concerned with interactions between stories and not with structures within stories. It is the connections between stories that are shown to require strategic encoding processes.

The results of the experiments in this article are reminiscent of previous work with analogies. For example, Schustack and Anderson (1979) found that recognition of facts about fictional persons was not helped by analogies with famous people unless the analogy was pointed out both at the time the facts were studied and at the time they were tested. Likewise, Gick and Holyoak (1980; 1983) have found that subjects are not likely to be able to use the analogy between a story they study that contains a solution and a problem that needs a similar solution, unless they are instructed or given more than one story to study. We think that the similarities between two thematically similar stories in our experiments are much more obvious than the similarities in either Schustack and Anderson's or Gick and Holyoak's experiments. Yet, subjects were not able to use them without aid (instructions and/or prestudy). Thus, the present experimental results extend the range of similarities or analogies that are not useful to automatic processes.

The results of these experiments also show a striking divergence between two kinds of performance. On the one hand, as just discussed, thematic similarity does not automatically help in sentence verification. On the other hand, subjects can easily sort stories on the basis of thematic similarity and they can group stories according to thematic similarity in free or cued recall. We would interpret performance in the second set of tasks as reflecting strategies used by the subjects at the time of test (sorting or recall). This would be the case because, according to our results, information about thematic similarity between episodes is not automatically encoded during reading. The divergence between the two kinds of performance brings into focus the need for further investigation of interactions between structures in memory and retrieval processes. Some kinds of information are encoded into memory in such a way as to be useful in tasks (like priming) that reflect automatic retrieval processes; other kinds of information are useful only in tasks that involve strategic retrieval processes. The challenge for future research is to understand how different kinds of information are organized in memory to allow the operation of a variety of retrieval mechanisms.

References

Abelson, R. P. (1973). The structure of belief systems. In R. C. Schank & K. M. Colby (Eds.), *Computer models of thought and language* (pp. 287–340). San Francisco, CA: Freeman.

Abelson, R. P. (1981). Psychological status of the script concept. *American Psychologist, 36,* 715–729.

Alba, J. W., Alexander, S. G., Hasher, L., & Caniglia, K. (1981). The role of context in the encoding of information. *Journal of Experimental Psychology: Human Learning and Memory, 93,* 203–231.

Alba, J. W., & Hasher, L. (1983). Is memory schematic? *Psychological Bulletin, 93,* 203–231.

Bartlett, F. C. (1932). *Remembering: A study in experimental and social psychology.* New York: Cambridge University Press.

Bower, G. H., Black, J. B., & Turner, T. J. (1979). Scripts in memory for text. *Cognitive Psychology, 11,* 177–220.

Bransford, J. D., & Johnson, M. K. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior, 11,* 717–726.

Bransford, J. D., & Johnson, M. K. (1973). Considerations of some problems of comprehension. In W. G. Chase (Ed.), *Visual information processing.* New York: Academic Press.

Chiesi, H. L., Spillich, G. J., & Voss, J. F. (1979). Acquisition of domain related information in relation to high and low domain knowledge. *Journal of Verbal Learning and Verbal Behavior, 18,* 257–274.

Dell, G., McKoon, G., & Ratcliff, R. (1983). The activation of antecedent information during the processing of anaphoric references in reading. *Journal of Verbal Learning and Verbal Behavior, 22,* 121–132.

Dooling, D. J., & Lachman, R. (1971). Effects of comprehension on retention of prose. *Journal of Experimental Psychology, 88,* 216–222.

Dooling, D. J., & Mullet, R. L. (1973). Locus of thematic effects in retention of prose. *Journal of Experimental Psychology, 97,* 404–406.

Dyer, M. G. (1983). *In-depth understanding: A computer model of integrated processing for narrative comprehension.* Cambridge, MA: MIT Press.

Feldman, J. (1975). Bad-mouthing frames. In R. C. Schank and B. Nash-Webber (Eds.), *Theoretical issues in natural language processing* (pp. 92–93). Cambridge, MA: Bolt, Beranek, and Newman.

Gick, M., & Holyoak, K. (1980). Analogical problem solving. *Cognitive Psychology, 12,* 306–355.

Gick, M., & Holyoak, K. (1983). Schema induction and analogical transfer. *Cognitive Psychology, 15,* 1–38.

Graesser, A. C., Gordon, S. E., & Sawyer, J. D. (1979). Recognition memory for typical and atypical actions in scripted activities: Tests of a script pointer + tag hypothesis. *Journal of Verbal Learning and Verbal Behavior, 18,* 319–332.

Graesser, A. C., Woll, S. B., Kowalski, D. J., & Smith, D. A. (1980). Memory for typical and atypical actions in scripted activities. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 503–515.

Lehnert, W. G. (1981). Plot units and narrative summarization. *Cognitive Science, 5,* 293–331.

McKoon, G. (1977). Organization of information in text memory. *Journal of Verbal Learning and Verbal Behavior, 16,* 247–260.

McKoon, G., & Ratcliff, R. (1980a). The comprehension processes and memory structures involved in anaphoric reference. *Journal of Verbal Learning and Verbal Behavior, 19,* 668–682.

McKoon, G., & Ratcliff, R. (1980b). Priming in item recognition: The organization of propositions in memory for text. *Journal of Verbal Learning and Verbal Behavior, 19,* 369–386.

Minsky, M. (1975). A framework for representing knowledge. In P. Winston (Ed.), *The psychology of computer vision* (pp. 211–277). New York: McGraw-Hill.

Pichert, J. W., & Anderson, R. C. (1977). Taking different perspectives on a story. *Journal of Educational Psychology, 69,* 309–315.

Posner, M. I. (1978). *Chronometric explorations of mind.* Hillsdale, NJ: Erlbaum.

Ratcliff, R., & McKoon, G. (1978). Priming in item recognition: Evidence for the propositional structure of sentences. *Journal of Verbal Learning and Verbal Behavior, 17,* 403–417.

Ratcliff, R., & McKoon, G. (1981). Automatic and strategic priming in recognition. *Journal of Verbal Learning and Verbal Behavior, 20,* 204–215.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension,* Hillsdale, NJ: Erlbaum.

Schallert, D. L. (1976). Improving memory for prose: The relationship between depth of processing and context. *Journal of Verbal Learning and Verbal Behavior, 15,* 612–632.

Schank, R. C. (1982). Dynamic memory: *A theory of reminding and learning in computers and people.* New York: Cambridge University Press.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding.* Hillsdale, NJ: Erlbaum.

Schustack, M., & Anderson, J. (1979). Effects of analogy to prior knowledge on memory for new information. *Journal of Verbal Learning and Verbal Behavior, 18,* 565–584.

Seifert, C. M., & Black, J. B. (1983). Thematic connections between episodes. *Proceedings of the Fifth Annual Conference of the Cognitive Science Society,* Rochester, NY.

Taylor, S. E., & Crocker, J. (1981). Schematic bases of social information processing. In E. T. Higgins, C. P. Herman, & M. P. Zanna (Eds.), *Social cognition: The Ontario Symposium.* Hillsdale, NJ: Erlbaum.

Thorndyke, P. W., & Yekovich, F. R. (1980). A critique of schema-based theories of human story memory. *Poetics, 9,* 23–49.

Wilensky, R. (1983). *Planning and understanding.* Reading, MA: Addison-Wesley.

Appendix

Sample stories based on the nine thematic structures in Experiments 1–4:

The Pot Calling The Kettle "Black"

Karen's swimming coach was a real slave driver. He had the team working out for many hours every day. Besides their workouts, he insisted that each player be in great shape for the season. During the pre-season training sessions, the coach would warn the players that they should avoid drinking, drugs, overeating, and especially smoking. "Everyone knows that athletes should treat their bodies with respect," the coach said as he puffed heavily on his long cigarette.

Counting Your Chickens Before They're Hatched

Ernie was really encouraged about his interview for a security guard at the new factory in town. The interview was long, and Ernie thought he had done well. He assumed his employment as a guard was imminent. He went to the shopping mall and hunted around for a dark blue security guard uniform, and finally bought several. The next day he received a phone call from the factory personnel director saying he was not selected for a security guard position. Ernie was dismayed he had wasted money on uniforms.

Every Cloud Has a Silver Lining

Burt put in long hours as a night watchman. One day, a crate accidentally fell on him and broke his shoulder. Burt was in pretty bad shape. He had to spend several months at home recovering his strength. While at home, he started reading about electronics and decided to take courses by mail. By the time he was back on his feet, Burt had qualified for and found a better-paying job in an electronics repair shop. He also had more time to enjoy himself.

Using an Elephant Gun To Kill a Fly

One morning, Alice discovered a pimple on her chin. She hadn't had any acne in years and disliked having minor blemishes on her face. Alice decided to fly to an exclusive clinic in Argentina and have her entire face pealed. The operation required that she not smile for over two weeks. The pimple is gone now, which pleases Alice, but she will have to work overtime to pay off her medical bills.

Closing the Barn Door After the Horse Is Gone

Phil was in love with his secretary and was well aware that she wanted to marry him. However, Phil was afraid of responsibility, so he kept dating others and made up excuses to postpone the wedding. Finally, his secretary got fed up, began dating, and fell in love with an accountant. When Phil found out, he went to her and proposed marriage, showing her the ring he had bought. But by that time, his secretary was already planning her honeymoon with the accountant.

Cutting Off Your Nose To Spite Your Face

Kris's school had a policy of limiting time in their photography dark room to school hours. Kris resented the policy because he loved photography. He was angry at the school, and Kris planned to strike back by ruining all the dark room chemicals. He mixed all the photographic chemicals together and wasted them. As a result, the dark room ran out of chemicals and Kris was kept waiting weeks for new supplies to develop his own photos.

Too Many Cooks Spoil the Broth

The Bradley family wanted to attend a house party. They needed a babysitter for little Lucy. They hired the 15 year-old Dexter twins, thinking that surely the two together could cope with anything that might happen. However, the twins fought most of the evening about who should have to do the work. When the Bradleys came home at midnight, Lucy was still awake. She was crying and wet, while the twins slept soundly on the couch.

The Blind Leading the Blind

Joe was worried that his business was failing. Rather than consulting a banker or another store owner, Joe asked his friend Art for suggestions. Art had owned a restaurant in a neighboring town until being forced out of business himself by poor profits. Art told Joe he should raise the price of goods so that Joe would make more profit on each item. Joe took Art's advice, but then his sales plummeted, and Joe had to go out of business.

The Cure Is Worse Than the Disease

All his life, Irving had to wear glasses to correct his vision. He could see very well with either glasses or contact lenses, but he thought of both of them as an annoying bother. He heard about a new form of surgery in which the cornea is removed, frozen, reshaped, then stitched back on the eye, with apparently little danger. Unfortunately, during the surgical procedure the surgeon's hand slipped, and Irving lost the vision in his right eye.

Received April 16, 1985
Revision received May 31, 1985 ■