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Mental Models and Narrative Comprehension: Some Qualifications

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In a series of experiments we investigated the nature of mental representations created during narrative comprehension. Subjects learned the layout of a research center and then read a series of stories about characters performing various tasks in the center. Accessibility of information was measured by periodically interrupting the narratives with a pair of object names (object probes) or a protagonist name and an object name (protagonist probes). The subjects' task was to indicate whether the probed items were in the same room or in different rooms of the learned layout. The results indicated that the presence of protagonist probes was necessary for the construction of detailed situation models (e.g., Bower & Morrow, 1990; Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987). Therefore, it is important to consider task demands and reader goals when investigating the structure and the content of mental representations created during narrative comprehension.

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Researchers such as van Dijk and Kintsch (1983) and Johnson-Laird (1983) have proposed that narrative comprehension is supported by three types of mental representation. Readers construct a text model that represents the linguistic text itself, a propositional representation that preserves the meaning of the text, and a situation model or mental model that represents the actual situations described by the text. The focus of the present discussion is on this last type of representation, situation or mental models. In particular, we are interested in how task demands and reader

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goals might influence the structure, content, or accessibility of mental models.

A number of studies have produced results consistent with the mental model framework (e.g., Garnham, 1981; Glenberg & Langston, 1992; Glenberg, Meyer, & Lindem, 1987; Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987). The present investigations focus on a result obtained by Morrow et al. (1989). In these experiments, subjects learned the layout of a research center and then read narratives about characters performing different tasks in the center. At various points during the narratives, subjects read sentences about characters moving from one room to another room by way of an unmentioned "path" room. After reading these "motion sentences," subjects were probed with pairs of objects from the room the protagonist started in ("source" room), the room the protagonist was currently in ("goal" room), the unmentioned room the protagonist walked through to move from the source room to the goal room ("path" room), or some other room not related to the motion event ("other" room). An analysis of responses to these probe pairs revealed that accessibility of information about the rooms depended on the role of the room in the motion event. Average response times for goal, path, source, and other room probes were 2.53, 2.71, 2.88, and 2.94 s, respectively. There was a significant linear trend indicating that accessibility decreased with distance from the goal room.

According to Morrow et al. (1989), these results demonstrate that after reading the critical motion sentences, readers focused on the goal room since it defined the protagonist's current location and was thus most relevant to the "Here/Now" point of the narrative. The path room was the next most accessible part of the model, even though it was not mentioned in the narrative. The path room was more accessible than the source or the other room because of its relevance to the actions of the protagonist, who had just passed through the path room in order to reach the goal room. Thus, the accessibility of information from a situation model is directly related to its relevance to the protagonist's actions rather than mere mention in the text.

These and other results suggest that "readers construct in imagination a sort of theater stage or 'doll house' with landmarks and rooms filled with expected objects" (Bower & Morrow, 1990, p. 45). During text comprehension, readers access this model and "move" the character (i.e., a representation of the character) through the model. This movement is a function of the situation described by the text. Accessibility of information is therefore a function of the relationship between the mental model, the described situation, and the location of the protagonist.

Morrow et al.'s (1989) results are compelling. However, there are reasons to believe that readers may not always construct and access highly detailed situation models. For example, Gray (1990) was not able to replicate Morrow et al.'s results even in experimental conditions quite similar to theirs. Apparently, the learning or test conditions in Gray's experiments somehow affected the way mental models were constructed or accessed (also see O'Brien & Albrecht, 1992). The experiments reported here represent a systematic attempt to assess the effects of the experimental task and the readers' goals on the kinds of mental representations created during narrative comprehension.

Experiment 1

Subjects in this experiment memorized the layout of a research center (see Fig. 1). After memorizing the layout, subjects read a series of stories about characters doing various things in the research center. Accessibility of information was measured by periodically interrupting the narratives with the presentation of pairs of objects from the

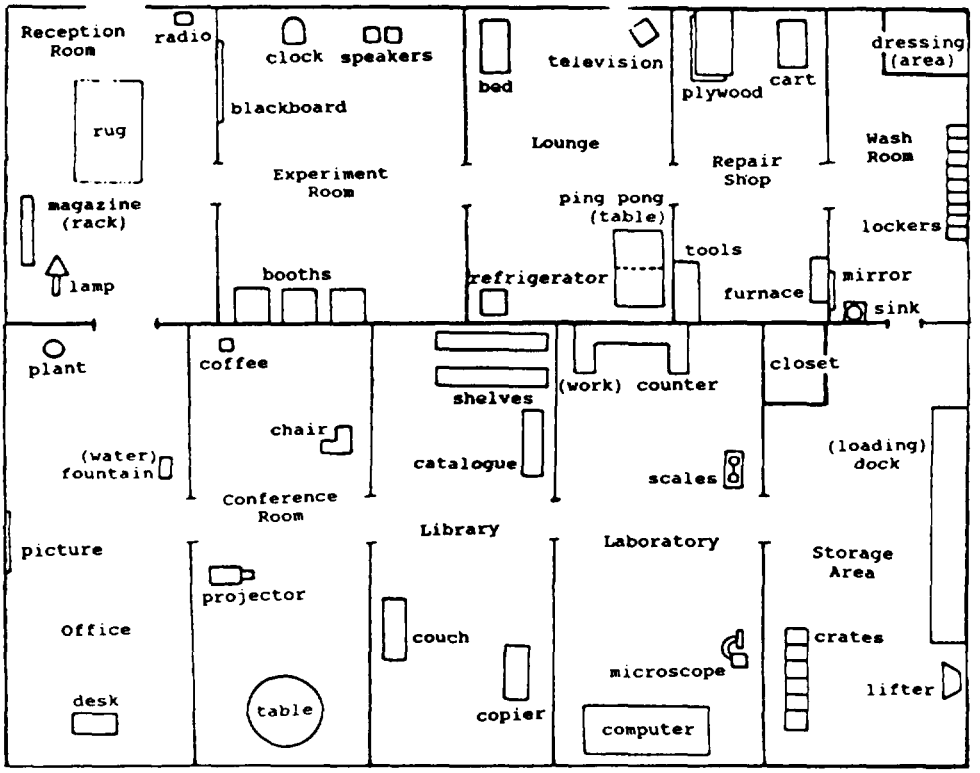

FIG. 1. Building layout from Experiments 1–3.

layout. Subjects indicated whether the two objects were from the same room or different rooms in the building. Accessibility of information was tested after sentences which described a character moving from one room to another room by way of an unmentioned path room (i.e., a room through which the character would have to move in order to complete the described motion).

If readers construct and use situation models like those proposed by Morrow and colleagues, we should find the same linear ordering of response times that Morrow et al. (1989) found. That is, after reading the sentence, "Wilbur walked from the repair shop into the experiment room," subjects should respond most quickly to objects from the Experiment Room (goal room), followed by objects from the Lounge (path room), followed in turn by objects from the Repair Shop (source room). Responses to items from any other room should be slowest since these rooms are not relevant to the motion event.

Method

Subjects. Twenty-four undergraduates at Vanderbilt University served as subjects in this experiment. Subjects were compensated for their participation in the experiment with course credit.

Layout. Subjects memorized a diagram of a research center. The diagram was adapted from Morrow et al. (1989) and was very similar to the layout used in their experiments. The diagram of the layout contained 10 rooms with 4 objects in each room (see Fig. 1).

Narratives and probes. The same 18 narratives used by Morrow et al. (1989, Experiment 1) were used. Each narrative was ap-

proximately 20 sentences long and described the actions of a character working in the research center represented by the previously learned layout (see Table 1). The first part of each narrative introduced a protagonist and described the protagonist's goal (e.g., finding misplaced notes, cleaning the research center). The second part of each narrative described the protagonist moving through the research center in order to accomplish the previously established goal. Each narrative contained three critical sentences that described the protagonist moving from a source room to a goal room by way of an unmentioned path room. Each of the first two critical sentences was followed by three sentences that described the protagonist doing something in the goal room, continuing through the goal room into the next room on the route, and doing something in this new room. This final room then served as the source room for the next critical sentence. The third critical sentence in each narrative was followed by two or three concluding sentences. One sentence in each narrative described something the protagonist had done in a previously unmentioned path room. This sentence was included to discourage subjects from concluding that the unmentioned path rooms were irrelevant to the narrative because they were not mentioned as part of a motion event. A previously unmentioned path room was only mentioned after it had already been probed in the narrative.

Each critical sentence was followed by a

TABLE 1
EXAMPLE OF NARRATIVES

Wilbur wasn't so sure he wanted to be head of the center anymore.
He had just been informed that the board of directors would be making a surprise inspection tomorrow.
He immediately called all the center's employees together in the library and told them they had less than twenty four hours to clean up the center.
He explained about the visit and said that all of their jobs were at stake.
He told everyone to spread out and clean and organize every room.
He went into the laboratory and made sure it was being cleaned, and then headed off to supervise the rest of the workers.
[Critical sentence]
He walked from the laboratory into the wash room.
[Probe of two objects]
He was pleased to see the sparkling tile floor since he knew the directors were more impressed by cleanliness than good research.
He hurried into the repair shop and yelled at the foreman for not getting those greasy machine parts out of sight.
Next he thought he'd better check to see that the researchers were getting things organized.
[Critical sentence]
He walked from the repair shop into the experiment room.
[Probe of two objects]
He made sure the experimenters would be busy conducting studies tomorrow so the directors would see how industrious they were.
As he went into the reception room, he thought about the presentation he was planning to make to the directors.
Then he remembered the television in the lounge, it had better not be on tomorrow.
[Critical sentence]
Next he walked from the reception room into the conference room.
[Probe of two objects]
Sitting down at the table, he started to write down notes for his presentation.
He imagined himself giving a high-powered talk and began to feel the visit might go well after all.

Note. From Morrow, Bower, and Greenspan (1989).

pair of probe objects. An example of each type of probe is presented in Table 2. Same-room probes contained two objects that were either from the room in which the protagonist was located at that point in the story (goal room probe), the unmentioned room that the protagonist had just passed through (path room probe), the room in which the protagonist had started the motion event (source room probe), or another room that was not mentioned in the critical sentence and was not part of the motion event (other room probe).

The different-room probes contained objects either from the goal room and some other room (goal–other probe), the path room and some other room (path–other probe), or the source room and some other room (source–other probe). Finally, each narrative also contained a probe pair which did not follow a critical sentence and contained objects from two different rooms.

TABLE 2
EXAMPLES OF PROBE TYPES

Probe type	Probed room (objects)
Critical sentence: Wilbur walked from the repair shop into the experiment room.	
Same-room probes	
Goal room	Experiment room (clock, speakers)
Path room	Lounge (television, ping-pong table)
Source room	Repair shop (plywood, cart)
Other room	Library (shelves, catalogue)
Different-room probes	
Goal–other	Experiment room–office (speakers, desk)
Path–other	Lounge–wash room (refrigerator, mirror)
Source–other	Repair shop–storage area (cart, lifter)
Protagonist probes (Experiments 3 and 4 only)	
Same	Experiment room (Wilbur, speakers)
Different	Experiment room–laboratory (Wilbur, scales)

Design and procedure. In the first part of the experiment, subjects memorized the diagram of the research center. After studying the diagram for 1 min, subjects were given a blank diagram which contained only the room walls and doorways, and were told to write down the object and room names in their correct locations. After subjects had written all they could remember, they were given 2 min to compare their layout with the original and to study the original again. Subjects were then given another blank diagram and were again instructed to fill in all they could remember. This study–test procedure was continued until subjects had correctly reproduced the entire diagram. Subjects were then given five questions that tested their knowledge of the locations of the objects in the building. On average, subjects required between 30 and 45 min to learn the layout and answer the questions.

In the second part of the experiment, subjects read 19 narratives (1 practice and 18 experimental) presented one line at a time on a CRT screen. Each line was removed from the screen before the next line was presented. The experimental narratives were the same narratives used by Morrow et al. (1989, Experiment 1). The presentation of the lines of text was self-paced. The experiment began with the message "Please press the space bar to begin the experiment." Subjects pressed the space bar to begin the experiment and to move from one line of a narrative to the next. When a probe pair appeared on the screen, subjects responded "same room" or "different room" by pressing the "m" or "z" key, respectively. Probes appeared 500 ms after the subjects pressed the space bar indicating that they had finished reading the previous line of text. Subjects were instructed to read the narratives carefully as they would be asked questions about the stories at the end of the experiment. Sub-

jects were also instructed to read the narratives at a comfortable pace and to respond to the probe pairs as quickly and as accurately as possible. Probe response times and errors were recorded by the computer.

Three different sets of 18 narratives were created. The sets differed only in terms of the order of the types of probes within each narrative. Across each set of 18 narratives, each subject saw nine instances of each same-room probe type (goal room probes, path room probes, source room probes, and other room probes) and six instances of each different-room probe type (goal–other, source–other, and path–other probes). Each narrative also contained a probe of items from two different rooms, neither of which was located along the described path (other–other probes). These probes did not follow critical motion sentences and helped to break the pattern of probes occurring only after critical motion sentences. Thus for each presentation set, each subject was presented with 36 same and 36 different probes. Assignment of probe types to probe positions was rotated across the three different sets of narratives so that each probe type occurred after each critical motion sentence position equally often. A single presentation order of the 18 narratives was used across the three different presentation sets. Objects were randomly assigned to probe conditions with the constraint that objects were not probed if they had been previously mentioned in the narrative. Each object was probed equally often across the three different presentation sets.

Results and Discussion

Subjects required an average of 4.42 trials to reproduce the entire layout correctly. Subjects answered 4.54 of the 5 object location questions correctly.

Analyses were performed on correct mean responses computed for each subject and each condition. Response times greater than three standard deviations above the mean for each subject (1.48% of the correct responses) were eliminated. Response times and error rates for same-room and different-room probes are shown in Table 3. The data for same-room probes and different-room probes were analyzed separately.

The pattern of results in Table 3 is different from that found by Morrow et al. (1989). In the present experiment, response times for goal, path, and other room probes were about the same speed and slower than response times for source room probes, but in Morrow et al.'s experiment, the conditions were ordered: goal < path < source < other. A repeated-measures ANOVA for the same-room probes revealed a marginally significant effect of probe type ($F(3,69) = 2.41, p = .07$). Pairwise comparisons indicated that responses to goal room probes did not differ from responses to path room probes ($F < 1.0$). Responses to source room probes were significantly slower than responses to goal room and path room probes ($F(1,69) = 5.77, p < .05$; and $F(1,69) = 5.01, p < .05$, respectively). Responses to source room and other room probes did not differ ($F(1,69) = 1.94$). There was no significant effect of probe type on error rates ($F(3,69) = 2.19, p = .10$).

The analysis of different-room probes revealed no effect of probe type on response

TABLE 3
MEAN CORRECT RESPONSE TIMES (S) AND ERROR RATES (%) FOR SAME-ROOM AND DIFFERENT-ROOM PROBES IN EXPERIMENT 1

	Same-room probes			
	Goal	Path	Source	Other
RT	1.93	1.94	2.09	2.00
SD	.41	.50	.48	.44
Errors	5.1	4.2	8.5	8.9

	Different-room probes		
	Goal–other	Path–other	Source–other
RT	1.97	2.07	2.00
SD	.48	.47	.46
Errors	2.8	6.4	6.9

times or error rates ($F(2,46) = 1.11$, $p = .34$; and $F(2,46) = 1.68$, $p = .20$, respectively).

The results of this experiment are generally inconsistent with the results obtained by Morrow et al. (1989). The exact same narratives, same-room probe types, different-room probe types, and a highly similar layout were used in this experiment as were used by Morrow et al. in their first experiment. Despite these similarities in materials and procedures, different results were obtained.

It appears as though subjects had a general understanding of the protagonist's spatial location in the layout and that this information influenced responding. This information was not very specific, however, as evidenced by the fact that subjects did not respond to goal room probes any faster than they responded to path or other room probes. Thus, information about the protagonist's location seems to have been integrated in a very general way with spatial information about the learned layout. In particular, information about rooms in the general vicinity of the protagonist's current location (e.g., the goal, path, and, to a lesser extent, other rooms), was more accessible than other information (e.g., the source room).

Experiment 2

The results of Experiment 1 do not support the hypothesis that readers construct situation models of the type described by Morrow et al. (1989). Rather, readers form a mental representation that includes very general spatial information about the layout and access this information based on the location of the protagonist. The information available from this mental representation is not as "fine-grained" as previous results suggest. Rather, the information available appears to be a general understanding of the character's spatial location as described by the text.

While it appears as though readers do not independently construct highly articulated situation models during narrative comprehension, this does not rule out the possibility that readers *can* construct these types of representation under certain circumstances. In Experiment 2, subjects were specifically instructed to hold an image of the research center in mind and to keep track of the protagonist's location while reading each narrative. It was hypothesized that if readers can construct detailed situation models when encouraged to do so, we might find the same pattern of results that Morrow et al. (1989) found in their first experiment.

Method

Subjects. Twenty-four students at Vanderbilt University served as subjects in this experiment. Subjects were compensated for their participation in the experiment with either course credit or monetary payment.

Layout. Subjects memorized the same diagram used in Experiment 1 (see Fig. 1).

Narratives and probes. The narratives and probes were identical to those used in Experiment 1.

Design and procedure. Subjects learned the layout of the research center using the study–test procedure described in Experiment 1. After correctly reproducing the entire layout, subjects were asked to answer five object location questions.

In the second part of the experiment, subjects were instructed to read each narrative carefully and to "try to keep an image of the building diagram in mind" as they read the stories. Subjects were also instructed to keep track of the protagonist's location as described by each narrative ("keep track of each room that the character moves into, out of, or through"). Subjects then read the same narratives used in Experiment 1. After reading each narrative, each subject was given a blank copy of the layout and asked to draw the protagonist's path as described by the story. These procedures were introduced in an attempt to encourage subjects to create a detailed sit-

uation model and to keep track of the character's location within this representation. Probe response times and error rates were recorded by the computer.

Results and Discussion

Subjects required an average of 6.17 trials to correctly reproduce the layout twice. Subjects answered 4.63 of the 5 object location questions correctly. Subjects correctly reproduced 90% of the protagonists' paths. In order for a reproduction of the protagonist's path to be considered correct, the drawn path had to move in the correct direction and both start and finish within one room of the actual beginning and end of the path described by the narrative.

Analyses were performed on correct mean responses computed for each subject and each condition. Response times greater than three standard deviations above the mean for each subject (1.38% of the correct responses) were eliminated. Response times and error rates for same-room and different-room probes are shown in Table 4. The data for same-room probes and different-room probes were analyzed separately.

Once again, the results were inconsistent with Morrow et al.'s (1989, Experiment 1) findings. A repeated measures ANOVA with type of probe as a factor was performed on the means. The analysis of same-room probes revealed a significant effect of probe type on response times ($F(3,69) = 3.74$, $p = .01$). Pairwise comparisons indicated that responses to source room probes were significantly slower than responses to goal, path, and other room probes ($F(1,69) = 5.24$, $p < .05$; $F(1,69) = 10.00$, $p < .01$; and $F(1,69) = 5.92$, $p < .05$, respectively), which did not differ (all Fs < 1.0). There was no significant effect of probe type on error rates ($F < 1.0$).

The analysis of different-room probes revealed a significant effect of probe type on response times ($F(2,46) = 3.68$, $p = .03$). Pairwise comparisons indicated that responses to goal–other probes were significantly faster than responses to path–other probes ($F(1,46) = 6.91$, $p < .05$). Responses to source–other probes did not differ from responses to goal–other or path–other probes ($F < 1.0$ and $F(1,46) = 3.59$, $p > .10$, respectively). There was no significant effect of probe type on error rates ($F < 1.0$).

The same pattern of responses to same-room probes was found in this experiment as was found in Experiment 1. Once again it appears as though readers had a very general understanding of the protagonist's location in the layout which was integrated in a very general way with spatial information about the layout.

The instructions to follow the protagonist's path may not have been strong enough encouragement for subjects to create a detailed situation model. Although subjects were quite good at reproducing the protagonist's paths, this task was quite easy. In each narrative, the protagonist moved through the layout in a counterclockwise direction. Furthermore, the protagonist's path almost always terminated one room short of the starting point. This pattern may have been relatively easy for subjects to detect. Therefore, subjects' performance on this task may not be a very

TABLE 4
MEAN CORRECT RESPONSE TIMES (S) AND ERROR RATES (%) FOR SAME-ROOM AND DIFFERENT-ROOM PROBES IN EXPERIMENT 2

	Same-room probes			
	Goal	Path	Source	Other
RT	2.45	2.35	2.72	2.44
SD	.63	.51	.98	.65
Errors	4.7	3.3	4.2	6.1

	Different-room probes		
	Goal–other	Path–other	Source–other
RT	2.47	2.77	2.56
SD	.49	.90	.71
Errors	1.4	2.1	2.9

good measure of how detailed their representations are or how well they follow the protagonist.

EXPERIMENT 3

Morrow et al.'s (1989) original experiment contained an additional probe type not used in the first two experiments reported here. In particular, each narrative in Morrow et al.'s first experiment contained one protagonist probe. In these probe pairs, the protagonist's name was paired with an object from the building. The subject's task was to determine, at the point in the narrative at which the probe occurred, whether or not the protagonist and object were in the same room.

These probes were included in order to encourage subjects to connect the probe task and the narrative comprehension task. It is possible to respond to all of the other probe types without paying attention to the narrative. That is, it is not necessary to know what is going on in the narrative in order to determine whether or not two objects are from the same room in the learned layout. However, it is necessary to pay close attention to the narrative in order to respond correctly to the protagonist probes. The inclusion of this type of probe may encourage subjects to create a situation model which combines layout and narrative information.

Method

Subjects. Thirty-six undergraduates at Vanderbilt University served as subjects in this experiment. Subjects were compensated for their participation in the experiment with course credit.

Layout. Subjects memorized the same diagram used in Experiments 1 and 2 (see Fig. 1).

Narratives and probes. The narratives were identical to those used in Experiments 1 and 2. All of the probe types used in the previous experiments were used in this experiment. However, subjects in this experiment received an additional type of probe. Each narrative in this experiment contained one probe that combined the protagonist's name with an object from the building (e.g., Wilbur-speakers). The object was either from the room the protagonist was in at that point in the narrative, or from a different room (see Table 2). The protagonist probes appeared at many different positions in the narratives, but did not follow critical sentences. Half of the protagonist probes were from the same room and half were from different rooms. Subjects in this experiment saw 9 instances of each same-room probe type, 6 instances of each different-room probe type, 18 additional probes of two objects from different rooms, and 18 protagonist probes for a total of 90 probes.

Design and procedure. In the first part of the experiment, subjects memorized the building diagram using the study–test procedure described in Experiment 1. Subjects were then asked to answer five object location questions.

In the second part of the experiment, subjects read the same narratives that were used in the previous experiments. Once again, the subject's task was to determine whether the probe items were from the same room or different rooms in the learned layout. When protagonist probes were presented, the subject's task was to determine if the protagonist was in the same room as the paired object at that point in the narrative. Probe response times and errors were recorded by the computer.

Results and Discussion

Subjects required an average of 4.42 trials to reproduce the entire layout correctly. Subjects answered 4.72 of the 5 object location questions correctly.

Analyses were performed on correct mean responses computed for each subject and each condition. Response times greater than three standard deviations above the mean for each subject (1.52% of the correct responses) were again eliminated. Re-

sponse times and error rates for same-room and different-room probes are shown in Table 5. The data for same-room probes and different-room probes were analyzed separately.

The results of this experiment more closely resemble the results reported by Morrow et al. (1989). The analysis of same-room probes revealed a significant effect of probe type ($F(3,105) = 5.76$, $p = .001$). Pairwise comparisons indicated that response times to goal room and path room probes did not differ ($F < 1.0$). Responses to goal room probes were faster than responses to source room and other room probes ($F(1,105) = 4.02$, $p < .05$; and $F(1,105) = 11.30$, $p < .01$, respectively). Responses to path room probes were also faster than responses to source room and other room probes ($F(1,105) = 4.78$, $p < .05$; and $F(1,105) = 12.56$, $p < .01$, respectively). Responses to source room probes were faster than responses to other room probes but not significantly ($F(1,105) = 1.84$).

There was also a significant effect of probe type on error rates ($F(3,105) = 3.85$, $p = .01$). Pairwise comparisons revealed that error rates on other room probes were significantly higher than error rates on goal and path room probes ($F(1,105) = 7.42$, $p < .01$; and $F(1,105) = 9.39$, $p < .01$, respectively) which did not differ ($F < 1.0$).

TABLE 5
MEAN CORRECT RESPONSE TIMES (S) AND ERROR RATES (%) FOR SAME-ROOM AND DIFFERENT-ROOM PROBES IN EXPERIMENT 3

	Same-room probes			
	Goal	Path	Source	Other
RT	2.46	2.44	2.64	2.76
SD	.86	.78	.74	.81
Errors	8.0	7.2	10.9	14.5
	Different-room probes			
	Goal–other	Path–other	Source–other	
RT	2.34	2.51	2.50	
SD	.65	.61	.68	
Errors	3.2	3.4	3.3	

Error rates on other room probes were not significantly higher than error rates on source room probes ($F(1,105) = 2.28$). The mean error rate for same-room protagonist probes was 15.5%.

The analysis of different-room probes revealed a marginal effect of probe type on response times ($F(2,70) = 2.62$, $p = .08$). Pairwise comparisons indicated that response times to goal–other probes were significantly faster than responses to path–other probes ($F(1,70) = 4.17$, $p < .05$). Responses to path–other and source–other probes did not differ ($F < 1.0$). There was no significant effect of probe type on error rates ($F < 1.0$). The mean error rate for different-room protagonist probes was 10.5%.

The results of this experiment resemble more closely the original findings of Morrow and his colleagues. Although we did not find a difference in response times between goal room and path room probes, there does seem to be a general increase in response times as distance from the protagonist increases. This pattern is also present in the error rates for same-room probes. Thus, it appears as if the inclusion of protagonist probes is critical for the formation of detailed situation models.

EXPERIMENT 4

The purpose of Experiment 4 was to test explicitly the hypothesis that the inclusion of protagonist probes is critical for the formation of detailed situation models. In addition to the same-room and different-room probes used in the previous experiments, half of the subjects in this experiment were also presented with protagonist probes. As in Experiment 3, these probes included the name of the protagonist and an object from the research center. Again, the subjects' task was to determine whether the protagonist and the object were in the same room at a given point in the narrative. By manipulating the presence or absence of protagonist probes within a single experiment it is

possible to determine the importance of these probes in the formation of situation models.

Method

Subjects. Seventy-two undergraduates at Stanford University and San Jose State University served as subjects in this experiment. Subjects were compensated for their participation in the experiment with course credit. Half of the subjects from each school were randomly assigned to 2 groups of 36. Five additional subjects were excluded from the analyses because their error rates on the protagonist probes exceeded 30%.

Layout. Subjects memorized the diagram of the research center used by Morrow et al. (1989). This diagram is only marginally different from the diagram used in Experiments 1–3. Both diagrams contained 10 rooms with 4 objects in each room. The only difference between the diagram used in this experiment and the diagram used in Experiments 1–3 is the location and size of one of the rooms.

Narratives and probes. The same 18 narratives used by Morrow et al. (1989) and in Experiments 1–3 were also used in this experiment.

A test probe naming two objects from the building occurred after each critical sentence. The subject's task was to decide whether the objects were from the same room or different rooms in the learned layout. One group of subjects in this experiment received protagonist probes as described in Experiment 3 ("with protagonist probes"). The other group of subjects received no protagonist probes as in Experiments 1 and 2 ("without protagonist probes").

Design and procedure. Subjects were tested in groups of one to three. In the first part of the experiment, subjects memorized the diagram of the research center using the study–test procedure described previously. After memorizing the diagram, subjects answered six questions about the locations of objects in the building. If subjects responded incorrectly to any of these questions, they studied the diagram again. Subjects required from 30 to 45 min to learn the diagram and answer the questions.

In the second part of the experiment, subjects read the narratives presented one sentence at a time on a CRT screen. Presentation was self-paced. Subjects held the computer's mouse in both hands and pressed both buttons of the mouse simultaneously to begin the narrative and to advance from one sentence to the next. When a probe appeared, subjects responded "same room" or "different rooms" by pressing either the left or the right mouse button. For half of the subjects in each group the left button corresponded to same and the right button corresponded to different, and vice versa for the other half of the subjects. Subjects were told to read the narratives carefully and to respond to the probes as quickly and accurately as possible. Subjects received immediate feedback about each of their answers. If a subject responded incorrectly, a request to answer more carefully was presented. Reading times of all sentences as well as probe response times and errors were recorded by the computer. As in the previous experiments, a practice narrative was presented before the 18 test narratives. Subjects required between 45 and 60 min to read the narratives and respond to the probes.

Materials were counterbalanced across experimental conditions in the same way as in Experiment 1 of Morrow et al. (1989). Across subjects, each probe type occurred equally often after each critical motion sentence position. The order of narrative presentation was also counterbalanced across subjects. Across the 18 narratives, each subject saw 9 instances of each of the 4 same-room probe types and 6 instances of each of the different-room probe types. Furthermore, 9 narratives contained an additional different-room probe after a noncritical sentence. Including all object–object probes, each subject saw 36 same

and 27 different probes. Subjects in the "with protagonist probes" group saw an additional 18 probes (i.e., one protagonist probe per narrative) presented after a noncritical sentence. Half of the protagonist probes were from the same room and half were from different rooms. Therefore, subjects in the "with protagonist probes" group received 81 test probes whereas subjects in the "without protagonist probes" group received 63 test probes.

Results and Discussion

Table 6 presents the mean correct response times and error rates for same-room and different-room probes, for both groups of subjects. Response times greater than three standard deviations above the mean for each subject (1.5% of the correct responses) were again eliminated. The data from same-room and different-room probes were analyzed separately.

TABLE 6
MEAN CORRECT RESPONSE TIMES (S) AND ERROR RATES (%) FOR SAME-ROOM AND DIFFERENT-ROOM PROBES IN EXPERIMENT 4

	Same-room probes			
	Goal	Path	Source	Other
With protagonist probes				
RT	2.04	2.17	2.23	2.33
SD	.49	.58	.58	.67
Errors	2.8	6.8	7.1	7.4
Without protagonist probes				
RT	1.90	1.87	1.87	1.89
SD	.44	.44	.45	.48
Errors	4.9	5.2	6.8	6.8

	Different-room probes		
	Goal–other	Path–other	Source–other
With protagonist probes			
RT	2.03	2.18	2.39
SD	.46	.54	.64
Errors	4.2	3.7	4.2
Without protagonist probes			
RT	1.90	1.90	1.92
SD	.40	.44	.45
Errors	4.6	2.8	1.9

The results of this experiment provide clear evidence of the influence of task demands and reader goals on the structure, content, or access of mental models. When the protagonist probes are presented, the results are fully consistent with the Morrow et al. (1989, Experiment 1) results. Without the protagonist probes, the results more closely resemble the results of Experiments 1 and 2 reported earlier.

The overall ANOVA of response times to same-room probes yielded a significant main effect of protagonist probes indicating that subjects without protagonist probes responded faster than did subjects with protagonist probes ($F(1,70) = 7.46$, $p < .01$). The interaction of protagonist probes and probe type was also significant ($F(3,210) = 5.00$, $p < .01$). For subjects who received protagonist probes, the accessibility of information depended on the role of the room in the motion event ($F(3,105) = 9.54$, $p < .001$). That is, response times increased with increasing distance between the protagonist's location and the probed objects. This pattern of results replicated the findings of Morrow et al.'s (1989) Experiment 1. Pairwise comparisons revealed that responses to goal room probes were significantly faster than responses to path room probes ($F(1,105) = 5.61$, $p < .05$), the difference in response times between path room and source room probes was not significant ($F(1,105) = 1.20$), and responses to source room probes were not significantly faster than responses to other room probes ($F(1,105) = 3.32$, $p < .10$). There was a significant linear trend ($F(1,105) = 11.98$, $p < .01$) indicating that response times increased across goal, path, and source room probes as distance from the goal increased. On the other hand, subjects without protagonist probes showed no significant differences in accessibility at all ($F < 1.0$). The longer response times to source room probes found in Experiments 1 and 2 were not found in this experiment.

Error rates partly paralleled the response

time results: although the overall interaction was not significant ($F(3,210) = 2.03$, $p < .12$), error rates of subjects without protagonist probes did not differ across probe type ($F < 1.0$) whereas subjects with protagonist probes showed increasing error rates ($F(3,105) = 2.82$, $p < .05$). These subjects made fewer errors on goal room probes than on path room probes ($F(1,105) = 4.77$, $p < .05$).

The analysis of different-room probes revealed a similar pattern. Again, subjects without protagonist probes responded faster than subjects with protagonist probes ($F(1,70) = 8.20$, $p < .01$), and the interaction of protagonist probes and probe type was significant ($F(2,140) = 5.86$, $p < .01$). Subjects with protagonist probes exhibited increased response times with increasing distance from the probed objects ($F(2,70) = 12.41$, $p < .001$). Pairwise comparisons revealed that responses to goal-other probes were faster than responses to path-other probes ($F(1,70) = 4.32$, $p < .05$), which in turn were faster than responses to source-other probes ($F(1,70) = 8.47$, $p < .01$). These results also replicate Morrow et al. (1989, Experiment 1). Subjects without protagonist probes showed no increase in response times across probe types ($F < 1.0$). There was no significant effect of probe type on error rates for different-room probes. Subjects in the "with protagonist probes" condition had a mean error rate of 10.3% on the protagonist probes.

The results of this experiment confirm the hypothesis that the inclusion of protagonist probes is critical for the formation of detailed situation models in this task. With the protagonist probes included, the results replicate Morrow et al.'s (1989) findings. Without protagonist probes, we find no evidence that subjects have detailed information in their mental model about the protagonist's spatial location.

General Discussion

The results of the experiments reported here demonstrate that readers *can* construct highly detailed situation models during narrative comprehension. Furthermore, accessibility of information from these models is a function of the relationship between the spatial representation of the layout, the described situation, and the location of the protagonist.

However, the conditions under which readers construct and access these situation models are limited. In Experiment 1, with little or no encouragement to construct a detailed mental representation of the described situation, readers failed to construct highly detailed situation models. In Experiment 2, when subjects were encouraged to hold an image of the layout in mind and follow the protagonist carefully, subjects seemed to pay more attention to the situations described by the narratives (as evidenced by longer response times than in Experiment 1). However, subjects' performance still did not reflect the construction or access of a highly detailed situation model. The demands of the task did not require subjects to form a detailed situation model and it appears that subjects did not form this type of model (also see McKoon & Ratcliff, 1992).

When subjects were forced by the task demands (i.e., protagonist probes) to follow carefully the protagonist through the learned layout, subjects did construct and access highly detailed situation models which contained fine-grained spatial information. Subjects' performance seemed to reflect a very detailed understanding of the protagonist's actions, the location of the protagonist within the layout, and the importance of information from the layout to the protagonist.

Across experiments, subjects with the same general task (i.e., reading and probe answering) and the same goal (i.e., to answer the probes correctly) built very different mental representations. Therefore, it is important to carefully consider the task, the goal of the reader, and the task demands when conducting experiments of this type. If we want to investigate the extent to which spatial information is present in mental representations created during narrative

comprehension, we must construct a task in which this information bears directly on the reader's goals.

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