

# Inferences and Text Comprehension

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## SITUATION-BASED INFERENCES DURING NARRATIVE COMPREHENSION

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### I. Introduction

We are interested in how readers go beyond explicitly stated information in order to understand narratives. To do this, readers have to make inferences, that is, they activate and use implied but unmentioned information to understand the narrative. This article emphasizes a situation-based view of inference. We begin by distinguishing this view from a text-based view of inference.

Much of the prior research in psychology and text linguistics has taken a text-based view of inference. Readers are likely to draw text-based inferences when representing the meaning of the text in a propositional text base, as in a hierarchically organized list of propositions (Kintsch & van Dijk, 1978). Readers draw such inferences to link together explicitly stated propositions, thereby forming a referentially coherent text base. While background knowledge about described objects and actions is required to make these inferences, readers only use this knowledge as it is needed to connect explicitly stated propositions (e.g., Lesgold, Roth, & Curtis, 1979).

Text-based inferences are "backward directed" in the sense that readers apparently do not draw these inferences at the time they are invited by a sentence; rather, the inferences are only drawn later when they are

required to connect together subsequent sentences into a coherent text base (McKoon & Ratcliff, 1986; Singer & Ferreira, 1983). Consider the following example:

*The toddler knocked over the vase.  
The glass scattered all over the floor.*

According to the text-based approach, readers infer that the toddler broke the vase only when reading the second sentence, when the inference is needed to relate the two sentences into a coherent sequence. In short, readers draw backward-directed, text-based inferences as they are building a coherent propositional representation of the text's meaning.

In contrast, the situation-based view argues that readers primarily draw inferences when focusing on situations described by the text. Thus, readers draw inferences not only to construct a propositional text base, but also to represent the described situations in a situation model. While the text base represents the text's meaning, the situation model represents the situations that the text refers to. Drawing inferences is an integral part of building the situation model. It is a primary means by which readers elaborate the text using their background knowledge about the described places, objects, and actions (Johnson-Laird, 1983; van Dijk & Kintsch, 1983). Thus, situation-based inferences are similar to the elaborative inferences previously discussed by Harris and Monaco (1978).

Situation-based inferences differ from text-based inferences in at least two ways. First, besides aiding text coherence, situation-based inferences are used to understand the writer's intended situations. That is, readers are likely to use background knowledge whenever they assume the writer intended them to use this knowledge to understand the situations. In other words, background knowledge is used as a first rather than a last resort when it is a salient part of the common ground between reader and writer (Clark, 1983). Second, situation-based inferences are directed "forward" rather than "backward" because readers tend to draw them as these inferences are implied as relevant to the described situations, rather than later as they become necessary for coherence.

The situation approach suggests that readers are most likely to make situation-based inferences when background knowledge is highly relevant to the described situations, is a salient part of the common ground between reader and writer, and is readily available. Its availability allows readers to efficiently construct the situation model on-line despite limitations imposed by attention and memory.

Support for this approach comes from research on script-based narratives. With these narratives, background knowledge that is highly relevant

to the described situations is packaged in readily available memory schemes called "scripts." Recent studies show that readers make script-based inferences during comprehension in order to construct a situation model. For example, readers activate central script concepts even if they are not mentioned in the text (Sharkey & Mitchell, 1985; Walker & Yekovich, 1987). Thus, with *John went into a restaurant*, readers activate *table* because it is central to the restaurant script. Additional support for the situation approach comes from research on domain knowledge in text understanding. Experts have an extensive knowledge base that should be readily available for inferring when reading texts about their domain of expertise. According to Fincher-Kiefer (1987), experts use their knowledge to make global inferences that organize situation models, while novices are often restricted to making only local inferences that link sentences into a propositional text base.

Our research examines inferences based on specific spatial knowledge rather than script knowledge. Previous research has shown that readers make spatial inferences to construct a situation model, even when the inferences are not required to construct a coherent text base (Black, Turner, & Bower, 1979; Bransford & Johnson, 1973; Mani & Johnson-Laird, 1982). In our experiments, readers used knowledge about a house or building layout in order to understand narratives. Our experiments show that readers infer layout information when it is relevant to the narrative protagonist, the main character. We describe three experiments that follow the same general procedure. Subjects first learned about the spatial layout of a setting and then read narratives describing events in that setting. We are interested in how they combine the new text information with the prior layout information in order to create the situation model. We expected readers to make inferences based on implicit layout information because this information was readily accessible and also a salient part of the common ground between reader and writer.

## II. Experiment 1: Spatial Inferences in Situation Models

The first experiment investigates spatial inferences readers make in constructing a situation model from motion sentences (Morrow, in press). Subjects read short passages that described a character moving through the house depicted in Fig. 1. The described path always included an unmentioned room. For example, to understand the sentence *John was walking from the kitchen to the bedroom* with respect to the house layout, readers will infer that John walked through the living room to reach the bedroom. While this inference is not required by a propositional represen-

events still in progress, with John on the path, walking from the kitchen or hall and heading toward the goal. For *walking from/past the kitchen to the bedroom*, John was in the middle of the living room, the exact location depending on the path set up by the prepositions *from* and *past*.

These results show that readers made systematic location inferences while interpreting the motion sentences in terms of the house layout. The resulting situation model often located the character at a path location that was not mentioned in the text. This suggests that readers use implicit information to elaborate sentences, even when these inferences are not required by a propositional representation of the sentence's meaning.

### III. Experiment 2: Spatial Inferences and Referent Choice

Experiment 2 examines whether the spatial inferences in Experiment 1 help to organize narrative understanding (Morrow, 1985b). We will try to show that implicit locations help readers update the situation model by guiding the interpretation of ambiguous referring expressions such as *the chair*. For example, if the sentence *John was walking from the kitchen to the bedroom* is followed by *He bumped into the chair*, the question is which chair John bumped into. If readers interpret the second sentence in terms of the situation described by the first sentence, they will think John bumped into a chair in the unmentioned living room. They are especially likely to focus on implicit locations when interpreting new information if these locations are associated with the narrative protagonist, since readers typically interpret narratives by focusing on the protagonist and interpreting situations from that character's perspective (Anderson, Garrod, & Sanford, 1983; Bower, 1978; Morrow, 1985a). Thus, readers in this experiment should choose objects from implicit locations of the protagonist as referents for target referring expressions.

Subjects memorized the house layout presented in Fig. 2. They then read narratives that included motion sentences such as those in Experiment 1. The critical motion sentence was followed by a sentence with a definite noun phrase (the target). Figure 3 presents an example narrative and shows where the motion sentence locates the protagonist in the house (based on the location judgments from Experiment 1). The motion sentence in the example locates Kathy in the unmentioned hallway that connects the kitchen and bedroom. After each critical sentence, subjects wrote down the referent of the target phrase.

We will consider the results for the motion sentences examined in

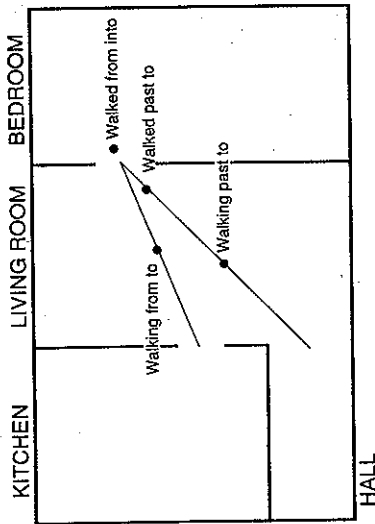


Fig. 1. House layout and location judgments for motion sentences in Experiment 1. Adapted from Morrow (in press), with permission of Ablex Publishing Corporation.

tation of the sentence meaning, it is needed to understand the described situation.

Subjects read 3-sentence narratives containing a motion sentence as the second sentence. They indicated on the layout where the character was located at the moment described by the motion sentence. This procedure produced a cluster of location judgments for each sentence. The study included location judgments from the following sentences.

*John walked from the kitchen into the bedroom.*

*John walked past the kitchen to the bedroom.*

*John was walking past the kitchen to the bedroom.*

*John was walking from the kitchen to the bedroom.*

Depending on the prepositions and motion verb in the sentence, readers should locate John either in the explicitly mentioned bedroom (goal) or in the unmentioned living room (path).

Figure 1 presents the mean location for the clusters of judgments produced by the four sentences as well as the typical paths. Subjects thought the sentences with *walked into* and *walked to* described complete events with John walking from the kitchen or hall and arriving at the bedroom, or goal. For *walked from the kitchen into the bedroom*, John was inside the goal; but for *walked past the kitchen to the bedroom*, John was in the living room, near the goal entrance. Thus, John was at rather than in the goal. On the other hand, subjects thought the sentences with *walking to* described

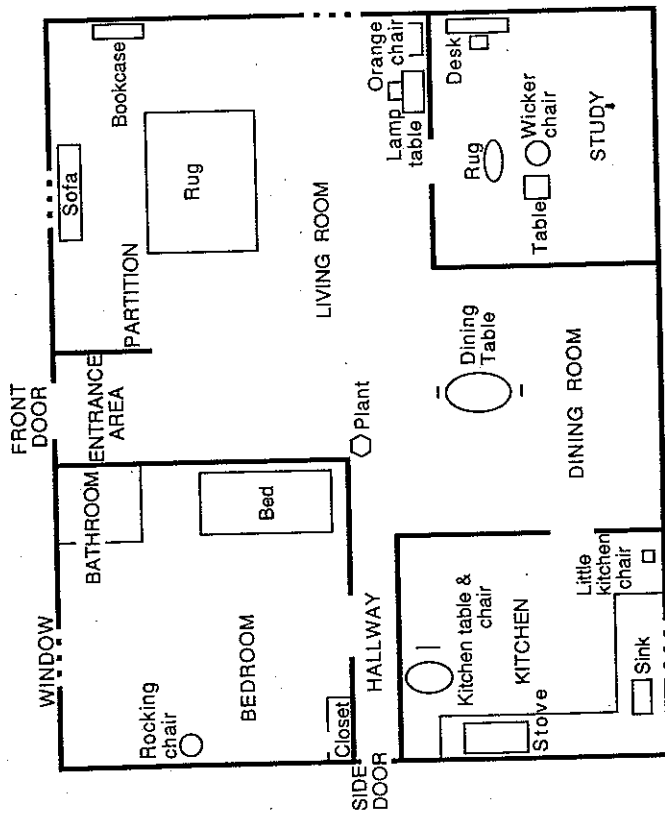


Fig. 2. House layout from Experiment 2. From Morrow (1985b), with permission.

Experiment 1. Table 1 shows that after *walked into* sentences, readers chose objects from the goal room (e.g., they thought Kathy noticed a bedroom rug). After *walked past to* and *walking from/past to* sentences, readers chose path objects, and these objects were most often from rooms not mentioned in the narrative (e.g., they thought Kathy noticed a hallway rug). Thus, readers usually chose objects near the protagonist as referent, presumably because they were interpreting the target sentence in terms of the protagonist.

Experiments 1 and 2 show that readers use unmentioned layout information to update their situation model when reading motion sentences in narratives. They do this by completing or "filling in" the motion event with the implicit path. Moreover, the model is centered on this implicit location, which guides the interpretation of the next sentence in the narrative.

Kathy finished drinking coffee in the kitchen. Then she remembered that she had promised Bill to wash the windows. She didn't think he had cleaned up the house, so she didn't want to do her work. Instead, she looked for something else to do. She was walking from the kitchen to the bedroom. She noticed the rug was dirty.

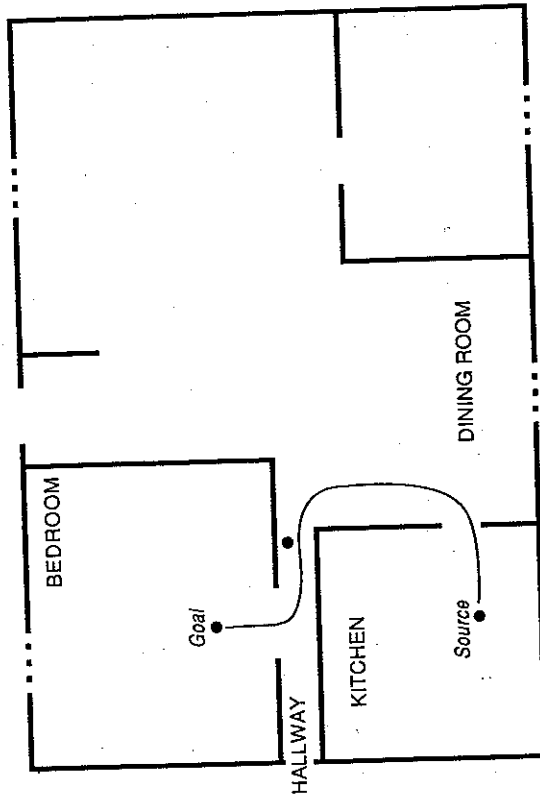


Fig. 3. Example narrative from Experiment 2. Adapted from Morrow (1985b), with permission.

TABLE I  
PERCENTAGE OF READERS CHOOSING REFERENTS FROM GOAL, MENTIONED PATH, UNMENTIONED PATH, AND OTHER ROOMS IN EXPERIMENT 2<sup>a</sup>

Sentence	Goal	Mentioned path/source	Unmentioned path	Other
Walked from kitchen into bedroom	77	0	21	2
Walked past kitchen to bedroom	21	23	50	6
Walking past kitchen to bedroom	9	31	59	1
Walking from kitchen to bedroom	33	4	63	0

<sup>a</sup> Adapted from Morrow (1985b), with permission.

### IV. Experiment 3: Spatial Inferences and On-Line Comprehension

The final experiment explores whether readers make spatial inferences even when these inferences are not needed to connect sentences into a coherent propositional text base (Morrow, Bower & Greenspan, 1989). We also examine when these inferences are made during comprehension.

In the situation examined by Experiment 3, the protagonist moves from an explicitly mentioned source room into an explicitly mentioned goal room via an implicit path room. For example, in the sentence *John walked from the conference room into the laboratory*, John passes through an unmentioned library to reach the laboratory. We tested whether readers inferred that the protagonist passed through the implicit path room by probing the accessibility of information from the path, source, and goal rooms. We probed accessibility after subjects read the critical motion sentence but before they read the next sentence in the narrative.

Readers first memorized the layout of a research center (part of the layout is shown in Fig. 4). Next they read narratives presented one sentence at a time on a computer screen. They were probed with a test question after reading critical motion sentences. At these points, we used a same/different question to probe accessibility of object locations. That is, readers were presented a pair of object names and they responded whether the objects were from the same room or from different rooms of the building. They were told to respond as quickly and accurately as possible. Thus, accessibility was measured by judgment latency. Figure 4 presents an example sentence and illustrates the four kinds of same-room probes: the goal, the implicit path, the source, and an other room that was neither mentioned nor relevant to the narrative. The path and other rooms were equidistant from the goal.

According to the situation-model account, information accessibility depends more on the information's relevance to the protagonist than on its mention in the text. This suggests that readers draw inferences when they are relevant to the situation. This approach predicts that the goal should be most accessible because it was the protagonist's current location and the reader's focus of attention. The implicit path should be next most accessible because the protagonist had just been in the room. The source should be less accessible than the path because more time had passed since the protagonist was in this room. The other room should be least accessible because it was not relevant at all to the protagonist's thoughts and actions. On the other hand, the text-based account predicts that accessibility depends more on mention of information than on relevance to the situation. In this view, readers draw inferences only when necessary for text coherence. The approach predicts that the source should be more accessible

Willbur walked from the conference room into the laboratory

1. Goal room (scales; computer)
2. Implicit path room (copier; shelves)
3. Source room (table; chair)
4. Other room (dock; litter)

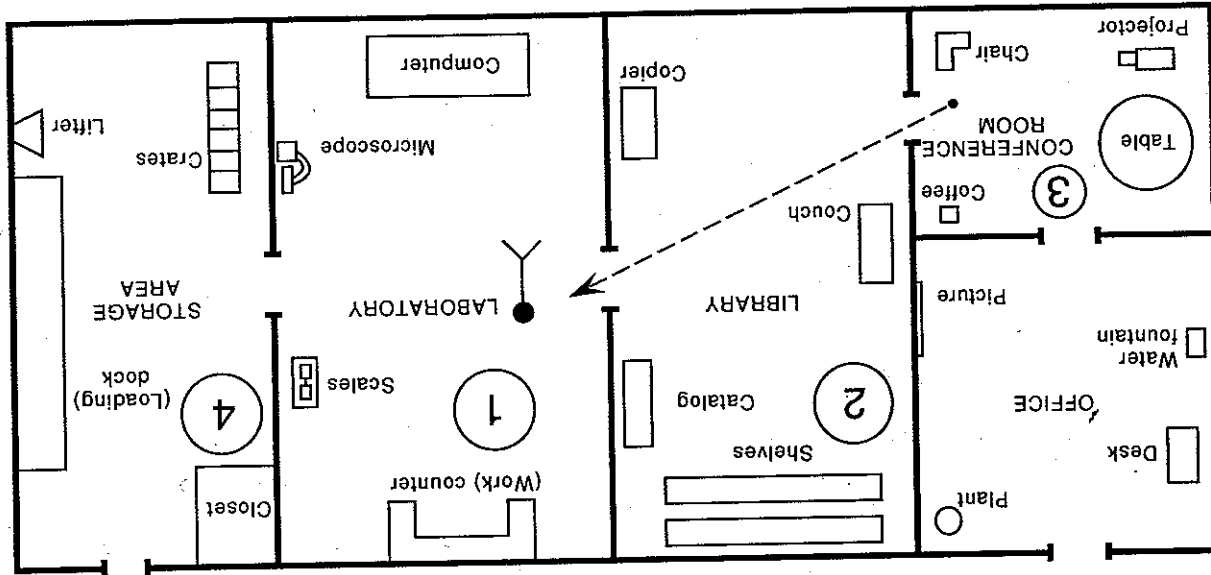


Fig. 4. Research center layout and same-room probes types from Experiment 3. Adapted from Morrow, Bower, and Greenspan (1989), with permission.

than the unmentioned path or other room, and the latter rooms should not differ in accessibility.

In addition to the same-room probes, we examined three kinds of different-room probes: The goal-other probe presented one object from the goal room and one from another room; the path-other probe presented one object from the implicit path and one from another room; and the source-other room presented one object from the source room as well as one from another room.

Table II presents the mean reaction time (RT) for the same-room and different-room probes. The RT increased linearly from goal to source room probes. The goal probe was answered more quickly than the other probes. Notably, the implicit path probe was significantly faster than the other-room probe and was marginally faster than the source-room probe. The different-room probes tell the same story as the same-room probes since RT increased across goal-other, path-other, and source-other probes.

The results show that readers focused more on the implicit path than on the source room because of the path's momentary relevance to the protagonist. They did not focus on the other room because it was not relevant to the protagonist. This suggests that readers inferred that the protagonist passed through the path room. It is important to note that the inference

TABLE II

MEAN REACTION TIME (SEC) AND  
PERCENTAGE ERRORS FOR SAME-ROOM  
AND DIFFERENT-ROOM PROBES IN  
EXPERIMENT 3<sup>a</sup>

Probes	Reaction time	S.D.	Errors
Same room			
Goal	2.53	.62	4.6
Path	2.71	.61	5.2
Source	2.88	.78	5.2
Other	2.94	.93	4.0
Different room			
Goal-other	2.46	.56	1.9
Path-other	2.63	.77	5.6
Source-other	2.77	.72	6.5

<sup>a</sup> Adapted from Morrow, Bower, and Greenspan (1989), with permission.

about the path was not required to construct the propositional text base. First, the inference was not triggered by particular words in the critical sentence as might occur for verb case inferences (for example, *sweep* implies *broom*). Second, the inference was not logically required since the protagonist could have chosen a different, if more roundabout, path to reach the goal. Third, it was not required to connect the critical sentence with the following sentence since the latter did not refer to the path room or to the act of passing through this room. Instead, readers made the inference to integrate the actions described by the text with the layout information in a situation model.

The experiment also suggests that readers made the spatial inferences while reading the critical sentences rather than waiting for later text to force the inferences. In this sense, these spatial inferences are "forward directed" compared to "backward-directed" text-based inferences. This evidence is consistent with the view that readers make the inferences on-line in order to update their situation model.

We have also conducted other, similar probe experiments that show that readers focus on a room because it is relevant to the protagonist's thoughts and actions and not simply because it is mentioned incidentally in the narrative (Morrow *et al.*, 1989; Morrow, Greenspan, & Bower, 1987). For example, readers continue to focus on the protagonist's location even though a less relevant room is mentioned incidentally just before the probe. On the other hand, readers shift their attention to a room other than the location room if that other room is more relevant because the protagonist is thinking about it (see Morrow *et al.*, 1989). These experiments also show that the accessibility of the implicit path in Experiment 3 was not simply due to its being repeatedly probed. In all of these experiments, the rooms of interest are probed equally often, yet their accessibility reflects their relevance within the situation model. Thus, the implicit path room was accessible because readers inferred that the protagonist passed through this room.

## V. Discussion

The three experiments show that readers of these narratives made situation-based inferences during comprehension. With these inferences, they elaborated the text according to their prior knowledge about the setting in order to update their situation model. In Experiment 1, readers elaborated motion sentences into a situation model organized around the unmentioned location of the protagonist. In Experiment 2, they used the

inferred location as a reference point for interpreting the next sentence in the narrative. Finally, in Experiment 3, readers made spatial inferences about path rooms even though the inferences were not needed to construct a coherent propositional text base.

Our experiments appear to have been more successful than previous studies (e.g., McKoon & Ratcliff, 1986; Singer & Ferreira, 1983) in showing that readers make situation-based inferences during comprehension. Several factors may have encouraged readers in the previous studies to construct propositional representations, but not situation models. First, subjects in those prior studies read a large number of texts covering different topics, so they had to continually access new knowledge domains, and they may have had little prior knowledge about some of the topics. Therefore, compared to readers in our studies, subjects in the earlier studies may have had an impoverished knowledge base for creating a situation model. Moreover, continually shifting topics across texts may have discouraged them from creating a situation model. Second, the texts in the previous studies were often shorter than those in our experiments. Thus, readers had less text information as well as less prior knowledge about the referent situation for constructing a situation model. Finally, the memory tasks in previous studies encouraged subjects to read the texts more superficially than in our experiments. For example, the word-recognition probe task, used by McKoon and Ratcliff (1986) may have encouraged readers to focus on the text itself more than the situations described by the text.

In short, limited prior knowledge about the referent domain, the brevity of the texts, and surface memory tasks may have encouraged readers in previous studies to construct a propositional representation of the text but not a situation model. In doing so, they made text-based inferences. On the other hand, readers in our experiments were encouraged to construct a situation model because prior knowledge was readily accessible, was a salient part of their common ground with the writer, and was important for the experimental task. Thus, they made situation-based inferences. Our experiments suggest that readers draw those inferences that best serve their goals in reading a text (Harris & Monaco, 1978). The experiments also underline the importance of situation-based inferences for understanding narratives.

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