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Individual Differences in Situation-based Inferencing* during Narrative Text Comprehension

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Consistent with current models of text comprehension (e.g., Gernsbacher, 1990; Kintsch; 1988), a variety of research has shown that readers integrate their previously stored knowledge with informa-

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tion provided by a text to construct a mental representation of the situation described in the text (Johnson-Laird, 1983; van Dijk & Kintsch, 1983). These mental representations, often called situational models, have been distinguished from two other levels of text representations. On the most superficial level, a surface representation captures the verbatim record of word sequences (Fletcher, 1992), and the text base represents the semantic content of a text as a hierarchically organized list of propositions (Kintsch, 1986). The third representational level, the situational model, represents the perceptible features of corresponding objects in the world, and as such it transcends both the verbal surface form and the propositional text base. Since situations described in naturally occurring texts, such as narratives, are often indeterminate, the comprehension process extends beyond the construction of a coherent text base; readers often must rely on resources such as previously stored knowledge. In other words, readers must draw inferences to fully comprehend a narrative. We propose that readers draw inferences based on the situational models they construct during comprehension. The present study investigates how readers draw inferences that are frequently drawn from naturalistic text: spatial and emotional inferences.

Although it has been suggested that emotional inferences provide the most common inferential information in naturalistic text comprehension (Miall, 1989), this class of inference has received very little attention. Some research has focused on the inferences that readers draw about temporal (Anderson, Garrod, & Sanford, 1983) and causal events and relations (van den Broek, 1990), but most studies have investigated how readers draw inferences about spatial relations. For example, in a study by Mani and Johnson-Laird (1982) subjects read short texts that were consistent with one spatial layout (The knife is in front of the spoon. The spoon is to the left of the glass. The dish is to the right of the glass.) or with two spatial layouts (The knife is in front of the spoon. The spoon is to the left of the glass. The dish is to the right of the spoon.). A recognition memory test indicated that subjects drew spatial inferences only when the texts were determinate; that is, when the texts were consistent with one spatial layout (Ehrlich & Johnson-Laird, 1982).

Other studies indicate that readers draw spatial inferences that do preserve some distance information provided by a text. For example, Morrow, Greenspan, and Bower (1987) asked subjects to memorize the spatial layout of a building. The subjects were then presented with narratives that described each character's movement through the building. A series of critical motion sentences described

the character's dislocation from a source to a goal room (for example, Wilbur walked from the laboratory into the conference room). To measure accessibility of object locations in the building, a probe occurred after each motion sentence. The probe named two objects from the building and subjects had to decide whether the two objects were located in the same room or in a different one. Objects were verified more rapidly when they were from the character's current location (for example, the conference room), and accessibility decreased as the distance between the character's location and the object pair increased. Morrow, Bower, and Greenspan (1989) showed that readers encode information relevant to a character's perspective even when this information is not explicitly mentioned in the narrative. These results indicate that subjects used their knowledge about the described situation to preserve information about distance.

Glenberg, Meyer, and Lindem (1987) presented subjects with texts, each describing an event in which a character was either spatially associated with an object (After a few warm-up exercises, John put on his sweatshirt and went jogging) or dissociated from an object (After a few warm-up exercises, John took off his sweatshirt and went jogging). Item recognition as well as reading time data indicated that readers keep a target object foregrounded in their mental representation when a character and an object were spatially associated. Glenberg et al. (1987) concluded that a reader's situational model reflects the spatial structure of a series of events rather than the structure of the text.

Consistent with this view, Miller and McNamara (1992) found longer reading times for sentences that described objects far from a central character than for sentences that described objects close to a character. However, in contrast to the results provided by Morrow et al. (1987), distance did not affect the reading times of sentences that described a character moving to either a close or a far object, indicating that a character's movement was encoded discontinuously. When target objects were primed by either close or far objects, word recognition latencies did not indicate a distance effect, suggesting that text information is represented in a spatial format only during encoding but not at the time of retrieval of a situational model.

The results of these studies suggest that readers can incorporate spatial information into their situational models. However, the conditions under which readers incorporate spatial information into their mental representations, and use those mental representations to draw inferences about spatial relations, varies with the readers' goals (and the subjects' task) and cognitive skills. Emphasis on learning spatial information (for example, learning a map) or probing (testing) for spatial information might encourage subjects to adopt strategies they do not normally use during natural comprehension. Consistent with this claim, Zwaan and van Oostendorp (1993) found that drawing inferences within a spatial situational model might not be a high-priority process of narrative text comprehension. Subjects in their experiment read a naturalistic text, the opening pages of a mystery novel describing the details of a murder scene. Low performance on a sentence-verification task indicated that subjects did not infer spatial information even when the texts were spatially determinate. Similarly, McKoon and Ratcliff (1992) have pointed out that drawing such inferences strongly depends on well-known and easily available information.

Coherent with this view, a recent study by Gernsbacher, Goldsmith, and Robertson (1992) suggests that inferences are drawn naturally when the reader's task is to comprehend one of the most frequently implied types of information in narratives: information about characters' emotional states. Investigating whether readers naturally draw inferences about fictional character's emotional states, Gernsbacher et al. (1992) designed 12 story pairs, each implying a main character's emotional state. Each story was followed by a target sentence that either matched or mismatched an emotional state. As illustrated in Table 5.1, two frames of matching versus mismatching target sentences were used. Subjects read each story, one sentence at a time, from a computer screen at their own pace, and comprehension was encouraged because the subject also had to write suitable one-line continuations for half of the stories.

Longer reading times for emotionally mismatching target sentences indicated that readers inferred a character's emotional state in their mental representations as a normal part of reading comprehension.

Given the importance of knowledge activation in situation-based inferencing, the question arises to what extent inferences are qualitatively similar across inference types in narrative comprehension. Comparing a relatively novel type of inference (emotional) with an inference type that has been investigated considerably (spatial), we examined whether readers infer emotional information as naturally and rapidly as they infer spatial information during naturalistic text comprehension. Experiment 1 examined whether readers draw inferences about emotional and spatial information to a comparable extent, and how these inference processes are related to domain-specific cognitive skills such as spatial imagery ability and emotional responsiveness as well as reading comprehension ability. To en-

TABLE 5.1
Example Stories and Target Sentences for Emotional Reading Task

Eric really wanted to go to the Senior Prom, but he didn't have a date. He was thinking of asking Shelly, a girl in his history class. Chances are she'd actually consider going with him, but he hadn't been able to ask her. He'd talked to her once when she asked him if she could borrow a pencil. He'd been wanting to say something else to her ever since, but he had little practice talking to girls—or anyone else.
Matching: He couldn't believe how shy he was.
Mismatching: He couldn't believe how confident he was.
Matching: In situations like this, he was extraordinarily shy.
Mismatching: In situations like this, he was extraordinarily confident.

"I just know I'll get this job," Ron said, as he walked up the stairs to the interviewer's office. "How could they not hire me? I had a 3.96 GPA and was Student Body President for two years," he thought. As he opened the door and was greeted by the interviewer, he immediately extended his hand and said, "Hello, I'm Ron Miller." He then began to take control of the conversation.
Matching: He couldn't believe how confident he was.
Mismatching: He couldn't believe how shy he was.
Matching: In situations like this, he was extraordinarily confident.
Mismatching: In situations like this, he was extraordinarily shy.

courage our subjects to draw inferences as they do normally occur during narrative comprehension, subjects' exposure to a text was limited to one reading at a naturally occurring rate.

The few studies on individual differences in inferencing have demonstrated strong interdependencies between cognitive skills and domain knowledge in text comprehension. For example, Spilich, Vesonder, Chiesi, and Voss (1979) showed that domain experts who read texts on familiar topics recalled more and inferred more situation-relevant information than domain novices. This result emerged even though experts and novices were matched in reading comprehension ability. In a similar study, Yekovich, Walker, Ogle, and Thompson (1990) found that groups of subjects who were high versus low in verbal ability but equally knowledgeable in a text domain drew the same kinds and quantities of inferences. In a study of reading comprehension ability, Haenggi and Perfetti (in press) found that prior knowledge, together with processes of decoding and working memory, could account for nearly 90 percent of the variance in reading comprehension. In contrast, processes related to making inferences of predictable events fared less well as a source of individual differences in comprehension.

The conclusion to be drawn from these studies is that individual differences in cognitive skills can help us to distinguish between different types of inferences such as automatic versus strategic inferences. We consider automatic inferences as primarily driven by domain knowledge. In comparison, strategic inferences operate in a more deliberate fashion and individual processing resources such as cognitive skills may have a stronger impact on comprehension. To further explore this issue, we conducted two further experiments. Experiment 2 addressed the question of whether a spatial reading time task and a spatial probe task measure the same inference processes and yield the same pattern of results. The reading task was designed to measure situation-based inferencing in naturalistic text comprehension, whereas the probe task might have induced a more strategic type of comprehension process. Experiment 3 was conducted as an extension of the second experiment and examined correlations between the spatial probe task and measures of reading comprehension as well as spatial imagery ability. We restricted ourselves to spatial inferences since there is much more related research on this type of inference and spatial imagery ability is a potentially important source of individual differences in comprehension.

THE ROLES OF DOMAIN-SPECIFIC KNOWLEDGE AND COGNITIVE SKILLS IN DRAWING INFERENCES ABOUT EMOTIONAL AND SPATIAL INFORMATION

Our first experiment examined how readers draw inferences about emotional and spatial information, and to what extent these inference processes are related to specific cognitive skills.

If readers represent the information implied by a story in their situational models as part of a normally occurring comprehension process, then target sentences that matched this information should be read faster than sentences that mismatched this information. That is, significant differences in reading time between mismatching versus matching target sentences would provide a demonstration that inferencing took place during comprehension. We can also expect a significant correlations between reading times for target sentences for emotional and spatial stories since these measures reflect a common reading speed factor. It has been demonstrated that reading speed and comprehension are not reliably correlated (Jackson & McClelland, 1979) and have different information-processing correlates (Hammond, 1987; Palmer, MacLeod, Hunt, & Davidson, 1985). We therefore subtracted the mean reading time for mismatching target sentences from the mean reading time for matching target sentences to get an effect measure of

inferencing. For a comparison of inference processes across the two story types, the difference scores between mismatching versus matching target sentences promised to be a more reliable indicator of inferencing than raw reading times. To the extent that the two types of situation-based inferences (emotional as opposed to spatial) are driven by domain-specific knowledge, the difference scores should be weakly correlated across the two sets of stories. Furthermore, both raw reading times for target sentences and effect measures of inferencing should be weakly correlated with reading comprehension ability and domain-related measures of cognitive skills such as empathy and spatial imagery. Previous studies showed that individual differences in comprehension skill can be attenuated when readers draw inferences in a familiar text domain, suggesting that domain knowledge increases both accessibility of relevant information to comprehension and availability of processing resources within the text domain (Haenggi & Perfetti, 1992, in press; Yekovich et al., 1990). In contrast, high correlations between inference effects across the two sets of stories and with measures of cognitive skills would indicate that these inferences are controlled strategically and rely on specific memory and comprehension skills. In addition to reading comprehension ability, the ability to feel emotions and empathize should be related to a reader's tendency to draw emotional inferences, and spatial imagery ability should play a significant role when a reader tends to represent text information spatially.

Fifty-six University of Oregon undergraduates were included in Experiment 1. Subjects read the set of emotional stories used by Gernsbacher et al. (1992) (see Table 5.1). A second story set implied spatial relations among characters and objects, and each story was followed by a target sentence that matched versus mismatched an implied spatial relation. A sample story pair and a set of target sentences is illustrated in Table 5.2.

Half of the subjects read the emotional stories first and the other half of the subjects started with the spatial stories. Subjects read the emotional stories before they indicated to what extent they felt a particular emotion on a modified version of the Positive and Negative Affect Schedule (PANAS) developed by Watson, Clark, and Tellegen (1988). Subjects also completed Davis's (1983) Interpersonal Reactivity Index, which differentiates among perspective taking, fantasy, empathic concern, and personal distress. The Interpersonal Reactivity Index has been found to be reliable (Davis, 1983; John, 1983) and significantly related to prosocial behavior (Eisenberg & Miller, 1987). It has been used as a instrument to assess empathic

TABLE 5.2
Example Stories and Target Sentences for Spatial Reading Task

Carol enjoyed jogging to keep in shape, but lately she hadn't been able to jog very much because she'd been so busy. On Sunday, she decided to try to jog around a new five-mile course. It was a loop course, meaning that it was one big circle. She hoped she'd be able to make it the whole five miles around the course. After she had jogged one mile, she felt okay. After she had jogged two miles, she wished she was in better shape. Still, she thought she could make it all the way around the five-mile loop. After Carol finished the third mile, her legs really began to ache. And after she had jogged four and a three-fourths miles she was truly exhausted.
Matching: So she decided to walk even though she was so close to where she wanted to finish.
Mismatching: So she decided to walk even though she was so far away from where she wanted to finish.
Matching: Although she was so close to the end, she began walking the rest of the way.
Mismatching: Although she was so far away from the end, she began walking the rest of the way.

Julia loved to cycle and today she decided to bike along a nearby river. Along the river was a great 25-mile bike path. The entire 25-mile path was well paved and convenienently marked off after every five miles. After Julia had ridden five miles, the path got steeper and she needed to pedal harder. After riding ten miles, Julia felt the path flatten. She even passed a few other bikers. But after riding 15 miles, Julia heard the chain on her bike snap. She got off her bike and inspected the chain. It was obvious that she wouldn't be able to ride the rest of the way.
Matching: So she decided to walk even though she was so far away from where she wanted to finish.
Mismatching: So she decided to walk even though she was so close to where she wanted to finish.
Matching: Although she was so far away from the end, she began walking the rest of the way.
Mismatching: Although she was so close to the end, she began walking the rest of the way.

responding to a range of settings and as such it provides a traitlike measure of empathy. In contrast, the PANAS provides a measure of emotional responsiveness to a specific situation. A modified version of Gernsbacher's Multi-Media Comprehension Battery (Gernsbacher & Varner, 1988) was also administered. This measure is related to the ability to build a coherent mental representation (Gernsbacher, Varner, & Faust 1990). In the modified version of the Multi-Media Comprehension Battery three narratives were presented at a rate of 175 words per minute on a computer screen, and each narrative was followed by 12 multiple-choice comprehension questions that covered explicit as well as implicit information. Finally, subjects completed the Card Rotation and the Cube Comparison Tests (French, Ekstrom, & Price, 1963). These two paper-and-pencil tests load on a

spatial orientation factor that can be described as the ability to perceive spatial patterns or maintain orientation with respect to objects in space (Carpenter & Just, 1986; McGee, 1979).

Consistent with our first hypothesis, target sentences that matched an emotional state implied by a story were read substantially faster (2505 msec) than target sentences that mismatched that emotional state (3273 msec). The reading time difference between mismatching versus matching target sentences was equally pronounced for spatial stories: Subjects read a spatially matching target sentence faster (3036 msec) than a spatially mismatching sentence 3871 msec), and the effects reported were statistically reliable.

Table 5.3 illustrates that the reading times for mismatching versus matching target sentences were substantially correlated between the two sets of stories and even more pronounced within each set. The PANAS was moderately related to reading times for emotional target sentences, but the measures of cognitive skills did not significantly correlate with the reading time data.

We have pointed out that high correlations between reading times for target sentences across the two story types may reflect a common reading speed factor. Similarly, low correlations between raw reading times and reading comprehension could reflect relative independence of reading speed from comprehension ability. In order to examine whether an effect measure of inferencing yielded the same pattern of results as the raw reading data, we correlated the differ-

TABLE 5.3
Correlations of Reading Times for Emotionally (E) and Spatially (S) Matching and Mismatching Sentences with the Mean Scores on the Positive and Negative Affect Scale (PANAS), The Davis Empathy Scales, The Card Rotation, The Cube Comparison, and The Reading Comprehension Tests (Comp Battery) in Experiment 1 ($N = 56$)

Measures	1	2	3	4	5	6	7	8	9
1. Match (E)	–								
2. Mismatch (E)	.79*	–							
3. Match (S)	.63*	.47*	–						
4. Mismatch (S)	.71*	.54*	.82*	–					
5. PANAS	.35*	.35*	.16	.18	–				
6. Empathy	.03	.09	–.13	–.10	.18	–			
7. Card	–.07	–.14	–.05	.05	–.31*	–.25	–		
8. Cube	–.03	.03	–.01	.08	–.28*	–.07	.56*	–	
9. Comp Battery	.07	.21	–.07	.03	–.06	–.08	.26	.22	–

*$p < 0.05$, two-tailed.

ence scores between mismatching and matching target sentences per story type with the measures of cognitive skills. An analysis of the difference scores revealed that these scores, although comparable in size for emotional (763 msec) and spatial target sentences (835 msec), were uncorrelated across the two story types ($r = 0.04$) and relatively independent of cognitive skills ($rs = -.14 - .22$).

In summary, readers did infer implied emotional and spatial information during reading narrative texts at a normally occurring rate: Subjects took 767 msec longer to read a target sentence that mismatched a character's particular emotional state implied in a story compared to a target sentence that matched this emotional state. Similarly, subjects spent an additional 835 msec to read a sentence that mismatched an implied spatial relation between a character and an object. The results further suggest that the difference between mismatching versus matching target sentences was equally pronounced but independent across the two story types. A reader who showed a large inference effect for emotional information did not necessarily show an equally large effect for spatial information and vice versa. A moderate correlation between reading times for emotional stories and the PANAS showed that subjects with a greater tendency to feel emotions needed more time to read the sentences in emotional stories. The conclusion to be drawn from Experiment 1 is that the reading time differences between mismatching and matching target sentences reflect inference effects that are primarily driven by domain-specific knowledge rather than strategically controlled or dependent on cognitive skills.

PROCESSING DIFFERENCES IN DRAWING INFERENCES ABOUT SPATIAL INFORMATION

Since other researchers have used other paradigms such as priming to examine situation-based inferences (Glenberg et al., 1987; Morrow et al., 1987), the question of whether a reading time task and a probe task measure the same process and yielded the same results emerges. To address this issue a second experiment compared subjects' performance in both a spatial reading task and a spatial probe task. As pointed out earlier, we restricted ourselves here to spatial inferences since there is much more related research on spatial compared to emotional inferences. Subjects read the same set of spatial stories that were used in the first experiment before they learned the spatial layout of a castle and read eight stories about characters moving around in the castle. Figure 5.1 displays the floor plan.

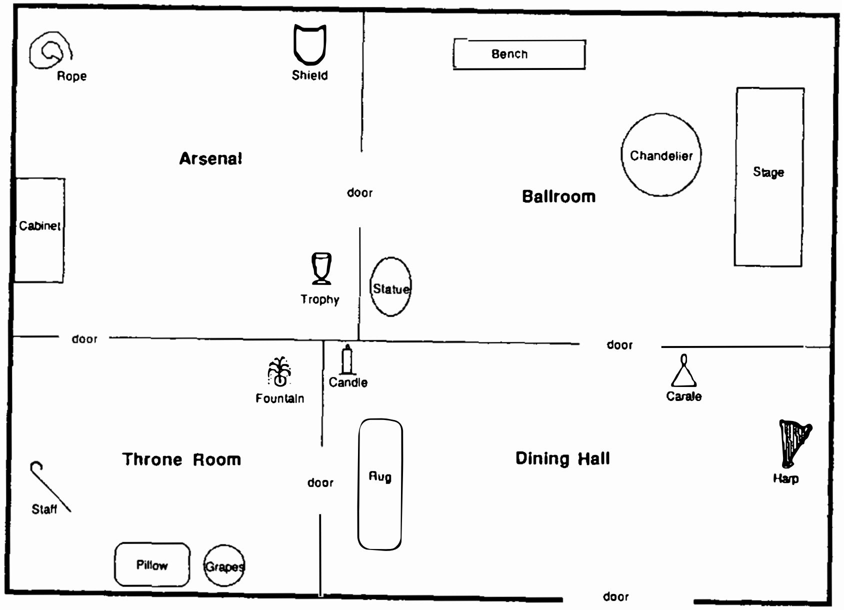

FIGURE 5.1 Floor plan of the castle that subjects had to memorize for the spatial probe task.

Similar to Morrow et al.'s (1987) materials, each story described the actions of a character, which required them to move through the different rooms of the castle. As illustrated in Table 5.4, each story contained four critical motion sentences describing a character's dislocation from one room to an adjacent goal room. After each motion sentence subjects were probed with two words either naming two objects or an object and a character. In the same-goal probes, both objects were in the same room that the character had just entered. In the same-other probes, both objects were in the same room, but this room was not currently occupied by the character. Different probes named two objects that were located in two different rooms, and character-object probes were included to control for subjects' comprehension. Presentation order of the probes was varied across two material sets, and each subject responded to eight same-goal, eight same-other, four character-object, and twelve different-room probes. Fifty-two subjects read each story, one sentence at a time, from a computer screen at their own pace. When a probe named two objects, they had to decide whether the objects were in the same or a different room as each other by pressing a key.

TABLE 5.4
Example Story and Probes for Spatial Probe Task

Wizard Bob was a favorite on the court of the King and Queen. He had in his possession many potions, ointments, and magic spells. He had been hired by the King and Queen to cure any ailments that might befall them. But he was not sure whether he could cure their most recent ailment. He had been asked by the King and Queen to stop them from aging. He knew that every wizard eventually runs into this request, but that none can comply. His only choice was to give the King and Queen the bad news and face the consequences. *He moved from the dining hall into the ballroom to begin his search for the King and Queen.*
* *GRAPES* * * *STAFF* * (same-other)
He saw that the ballroom was dark, and he heard no movement. He figured that the King and Queen must not be in the mood for dancing. *He then walked from the ballroom into the arsenal.*
* *BOB* * * *ROPE* * (same-character)
He didn't see anyone in there either, although occasionally the pair could be found there. The King and Queen were known to get into some nasty sword fights every now and then. *He moved from the arsenal into the throne room.*
* *CABINET* * * *RUG* * (different)
He saw the King and Queen sitting on their respective thrones. He told them the bad news, and they were obviously not very happy. *He quickly left the throne room and entered the dining hall.*
* *CARAFE* * * *HARP* * (same-goal)
He thought that this would be a good time for a vacation, so he vanished into the air.

As expected, target sentences that matched a spatial relation implied by a story were read substantially faster (3329 msec) than spatially mismatching target sentences (4213 msec). This replicates the results of the first experiment.

Regarding the spatial probe task, the analysis of same-room probe responses revealed longer response times (mean 2772 msec) and lower accuracy rates (88.8%) for probed objects from the same room when this room was not currently occupied by the character ("same-other") compared to object pairs that were located in the same room as the character ("same-goal," mean 2199 msec, and 97.1%, respectively).

The reading times for spatially matching and mismatching target sentences were highly correlated ($r = .76$), and response times to same-goal and same-other probes were substantially correlated, too ($r = 51$). But more important, no significant correlation between the reading and the probe response measures could be observed ($rs < .06$).

In summary, the reading time data reported in the first experiment were replicated in Experiment 2. We also replicated the spatial separation effect found by Morrow et al. (1987): Subjects took longer to respond to probed objects from the same room when this room was not currently occupied by the character and reaction times were shorter when the character was in the same room as the two objects. Furthermore, the low correlations between the reading time and the probe-response data suggest that the two tasks tap qualitatively different processes. That is, if a reading task with spatially matching versus mismatching target sentences uncovers the process of making spatial inferences, then this process is not measured by a spatial probe task (or vice versa). In particular, the memorization of the floor plan and the probe recognition task may have induced a more strategic comprehension process than occurs when reading stories including matching versus mismatching sentences at a normal rate. However, when one considers a reader who is reading a narrative about a city or other locations that she or he is highly familiar with, and there are references to landmarks in that city, the comprehension task becomes more natural, but it is still a task with a problem-solving character.

An alternative explanation regarding the faster probe-response times for same-goal compared to same-other probes should be considered here. In contrast to same-other probes, only the same-goal probes are preceded by a sentence explicitly stating the name of the target room. We could assume that the name of a room can trigger its containing objects, and thereby facilitate the judgement speed of same-goal probes. According to this view, the facilitation effect for same-goal probes is at least partly caused by learned associations rather than by forming a spatial situational model. Although we suggest, along with Morrow et al. (1987), that the data reflect situation-based inferences, the paired associate explanation cannot be ruled out without further research.

THE ROLES OF COGNITIVE SKILLS IN UPDATING SPATIAL SITUATIONAL MODELS

A third experiment is an extension of the second experiment. It examined the relationships between probe-response performance and measures of reading comprehension as well as spatial imagery ability. Since subjects rely on a previously learned spatial layout to update their situational models relative to a character's location, a significant correlation between spatial imagery ability and inferencing could be expected. Reading comprehension ability was also expected to play an important role since subjects were required to manipulate a spatial layout in their working memory. Forty subjects

TABLE 5.5
Correlations of Reaction Times for Same-Goal, Same-Other, and Different-Room Probes with The Card Rotation, The Cube Comparison, and The Reading Comprehension Tests (Comp Battery) in Experiment 3 (N = 40)

Measures	1	2	3	4	5	6
1. Same-Goal	–					
2. Same-Other	.73*	–				
3. Different	.82*	.65*				
4. Card	−.12	.10	.05	–		
5. Cube	−.64*	−.52*	−.48*	.34*	–	
6. Comp Battery	−.51*	−.44*	−.35*	.02	.46*	–

*$p < 0.05$, two-tailed.

completed the spatial probe task before they were presented with the reading comprehension, the Card Rotation, and the Cube Comparison Tests as used in Experiment 1.

As expected and replicating the spatial separation effect reported in Experiment 2, subjects responded both significantly faster (mean 2108 msec) and more accurately (96.3%) for same-goal than for same-other probes (2782 msec, and 80.9%, respectively).

Table 5.5 illustrates that the response times for same-goal, same-other, and different-room probes were highly correlated among each other. Moreover, response times for each probe type were substantially correlated with both Cube Comparison and reading comprehension but not with Card Rotation Test scores. In comparison to the latency measures, only response accuracy for same-other probes was related to comprehension (r = .46) and Cube Comparison Test scores (r = .40). The two spatial tests correlated moderately, and Cube Comparison Test performance was significantly related to comprehension ability.

Partial correlations revealed that although Cube Comparison and reading comprehension test performance shared a substantial amount of variance in probe-response time, comprehension ability was only weakly correlated with response time when Cube Comparison Test performance was accounted for.

DISCUSSION

Consistent with the view that situation-based inferences are drawn during comprehension of naturally occurring narratives, readers integrated textually implied information in their mental representa-

tions. Although the reading time difference between mismatching versus matching target sentences was equally pronounced for both emotional and spatial information, this inference effect was almost uncorrelated across the two sets of stories and relatively independent of specific cognitive skills as we saw in the first experiment. A lack of a correlation between the empathy scale and reading times for emotional sentences could reflect that this scale provided a measure of social desirability rather than emotional responsiveness. When a more state-dependent measure of emotional responsiveness such as the PANAS was considered indeed a significant relation was found. Readers with a stronger tendency to feel emotions after reading our stories took longer to read emotional target sentences.

The low correlations between subjects' additional processing time for mismatching sentences and the other measures such as reading comprehension ability and spatial imagery ability suggest that online inferencing of implied text information (spatial or emotional) is a relatively effortless process that is rather driven by familiar knowledge about emotional states and spatial relations than by cognitive abilities, such as spatial imagery ability and reading comprehension ability, or even affective-cognitive abilities such as empathy. This interpretation is consistent with the view that knowledge-driven processing is based on an automatic spreading activation process that is relatively effortless (Kintsch, 1988). As a consequence, the availability of knowledge may facilitate automaticity of naturalistic text comprehension and increase the processing resources of working memory during reading. Recent studies including prior knowledge as well as reading comprehension ability suggest that knowledge allows poor readers to compensate for their generally low reading comprehension ability in a familiar text domain (Recht & Leslie, 1988; Yekovich et al., 1990). Our results indicate that readers use situational models to draw inferences while reading narratives that describe concrete actions in highly familiar settings. The fact that the difference scores between mismatching versus matching target sentences were almost uncorrelated for emotional and spatial information in Experiment 1 further suggests that the processes of making emotional and spatial inferences, although they share the same reading speed component, seem to rely on relatively different knowledge bases.

Replicating the spatial separation effect reported by Morrow et al. (1987), we found in Experiment 2 that readers draw spatial inferences to update their situational models during narrative text comprehension. Low correlations between the reading and the probe-response times reflect that the two tasks measured two different processes. Examining correlations between probe-response times and measures of cognitive skills, Experiment 3 was conducted to further substantiate that the spatial probe task measures a different inference process than the spatial reading task. Unlike the reading time data, probe-response times were substantially correlated with both Cube Comparison and reading comprehension tests. Partial correlations identified the ability to maintain orientation with respect to three-dimensional objects in space as a significant predictor of probe-response latency. A moderate relation between probe-response time and comprehension skill further suggests that the accessibility of relevant parts of a situational model in working memory might play an important role in situation-based inferencing as well. In comparison, the inferences readers draw while they comprehend naturally occurring texts at a normal reading rate might, in addition to a basic reading speed factor, strongly rely on the activation of domain-specific knowledge and sentence mapping rather than foregrounding situation-relevant information in working memory.

The roles of knowledge activation and sentence mapping in text comprehension are emphasized in Gernsbacher's (1990) Structure Building Framework. According to her framework, subsequent information is mapped on a mental structure if it is coherent with previously represented information. Consequently, when subjects read a sentence that mismatches the information implied by a story, they have to restore coherence since the new information is inconsistent with their expectation. To resolve this discrepancy, readers might draw a coherence or backward inference (McKoon & Ratcliff, 1992), and this process might stimulate the activation of additional knowledge. We suggest that the activation of domain-specific knowledge enables a reader to map incoming text information on their representation of the situation described by the text. Our reading time data suggest that this process might be a component of naturalistic text comprehension. In addition, the probe-response data indicate that specific memory strategies might contribute more to inferencing when foregrounding situation-relevant information in working memory is required for comprehension. However, to the extent that this foregrounded information refers to a situation in the real world, this strategic process becomes a crucial element in comprehending naturally occurring text as well.

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