Where in the world am I?: Mental models derived from text and spatial inference.

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ABSTRACT

This study examined whether and to what extent the characteristics of mental models derived from the identical text, which is known to produce a certain type of mental model, are influenced if the subjects are given different task expectations before the reading session. Seventy-one undergraduates read one of the two text genres, descriptive or narrative, that were based on the same underlying spatial configuration and later answered three types of inference questions about spatial information. Each group was instructed to anticipate one of the three types of questions: global perspective questions, spatial orientation questions, or order inference questions. Results indicated that readers constructed a two-dimensional mental model when they anticipated global perspective questions, whereas they built a one-dimensional mental model when they expected order inference questions. The results showed similar data patterns obtained in the previous studies (Ohtsuka, 1990, 1993a, 1993b) where three text genres produced different models without any specific instructions. Therefore, the findings suggest that subjects' different task expectations, at least in part, account for the effect of genre type on mental models. Three appendixes give examples of experimental passages, lists of inference questions, and instructions. Included are one table and six figures. (Contains 13 references.) (Author/SLD)

Where in the world am I?: Mental models derived from text and spatial inference.

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Running head: Mental models and spatial inference

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Abstract

This study examined whether and to what extent the characteristics of mental models derived from the identical text, which is known to produce a certain type of mental models, would be influenced if the subjects are given different task expectations before the reading session. Seventy-one undergraduates, read one of the two text genres, *descriptive* or *narrative* that were based on the same underlying spatial configuration and later answered three types of inference questions about spatial information. The subjects were randomly distributed into one of the three instruction groups. Each group was instructed to anticipate one of the three types of questions: global perspective questions, spatial orientation questions, or order inference questions. The results indicated that the readers constructed a two-dimensional mental model when they anticipated global perspective questions, whereas they built a one-dimensional mental model when they expected order inference questions. The results showed similar data patterns obtained in the previous studies (Ohtsuka, 1990, 1993a, 1993b) where three text genres produced different models without any specific instructions. Therefore, the findings suggest that subjects' different task expectations, at least in part, account for the effect of genre type on mental models.

Where in the world am I?: Mental models derived from text and spatial inference.

When you are reading a novel, have you ever lost in the middle of long spatial descriptions? The author seems to know what she is describing but you are hopelessly confused. However, you read on since you got a rough idea bout where things are and feel that it is not essential to the understanding of the novel. This quite common anecdote highlights a subtle interaction between text genres and mental representation.

In the early eighties, researchers in the area of discourse comprehension postulated that the characteristics of a mental model that readers build from one text genre would be different from the mental models that they would form from other genres (Johnson-Laird, 1983, Brewer, 1980). According to these researchers, descriptive text written from a bird's eye perspective embodies a two-dimensional spatial array. The mental models constructed from this type of text will be based on an external coordinate system (north, south, east, west) where landmarks are distributed across the landscape. Narrative text embodies a series of events that occur in time. The mental models built from narrative text will be sequential with an internal coordinate system built with respect to the character's point of view.

The theoretical claim on the effect of text genres to the characteristics of mental models has been substantiated by Ohtsuka's studies (1990, 1993a, 1993b) with the explicit purpose of comparing different mental models derived from different text genres. Previous studies established that proficient readers successfully build an optimal representation for a given text genre (Ohtsuka, 1990, 1993a). Even in the absence of explicit instructions, proficient

readers look for the information that helps them construct an optimal representation from the text. One type of such information is a text genre.

Readers build a two-dimensional spatial model from descriptive text, whereas they build a one-dimensional model from procedural or narrative texts. Presumably, proficient readers build different mental models at least partly based on their assumption on what information is central to given text genres. Research evidence shows that even at the level where sentence information is integrated into a coherent mental model, proficient readers focus on different types of information depending on a text genre they are processing.

By presenting ambiguous pronouns and asking subjects to guess the referents, Morrow (1985, 1986) found that spatial information was predominantly used in descriptive text whereas character information was used in narratives. Readers rely on the knowledge of places or characters depending on the text genre of experimental texts when they determine ambiguous referents. If different information is used to integrate sentence-level information to a mental model, it follows logically that the prominent characteristics of mental models being generated might well be different depending on text genres.

Since we now know the characteristics of mental models are partially influenced by a text genre, the next research question is formulated as follows: How does the effect of text genre occur? How does the effect of text genre interact with readers' task expectation?

To address these questions, this study examines readers' mental models that they create when reading different text genres. The aims of the study are to examine: (a) how accurately readers build a spatial mental model from text written in different text genres; and (b) whether the characteristics of

mental models change if the subjects know the nature of questions that will follow the reading session.

Using three text genres that was all based on the same spatial model, Ohtsuka (1990) has shown that readers of procedural and narrative texts build one-dimensional mental models, whereas readers of descriptive texts build two-dimensional mental representations from the experimental texts. Furthermore, he found that the direction of order inference does not influence accuracy of the order inference questions in the descriptive text group. In the other two text groups, however, accuracy for the inference questions stated in the direction opposite to the text was significantly lower than those stated in the direction of the text. Overall, Ohtsuka's results suggest that the main characteristic of the mental model derived from descriptive texts is that it is two-dimensional. On the other hand, both procedural and narrative texts produce primarily one-dimensional mental models. He also postulated that the initial characteristic of the mental model derived from a text during the reading session can be modified into other forms as they make inferences afterwards.

In order to test the plasticity hypothesis of mental models, repeated testing of mental models was carried out. When readers were instructed to read a different text genre for the second time, the characteristics of mental models built from the text became similar (Ohtsuka, 1990b). The results were consistent with the prediction from the hypothesis concerning the plasticity of mental models.

In this paper, the plasticity hypothesis of mental models was further examined by giving instructions regarding the type of questions that the readers expect after the reading session. Specifically, two text genres, descriptive and narrative texts, which are known to produce different types of mental models, were used in the study. Each subject were randomly

assigned to one of the two text genre groups. After the reading of an experimental text, the subjects received an example of question types that they expect after the reading session. If the plasticity hypothesis is correct, readers will produce different mental models from the identical text genre, by trying to construct a mental model focused on crucial information that will be evaluated.

The Current Study

The current study uses a spatial model paradigm, which was originally used in Ohtsuka (1990). Subjects read a text from one of the two types of text genres, descriptive or narrative. These texts were designed to contain identical underlying information about the spatial layout of a fictitious town. By comparing the different mental models that readers constructed from each genre type, the study examined how genre could influence the characteristics of mental models of text information.

The descriptive text described the global configuration of a hypothetical town and the locations of various landmarks from a bird's eye perspective. This text used an external coordinate system (north, south, east, west) and landmarks were distributed neutrally in the text. It was hypothesized that readers of the descriptive text build a global spatial model as the mental representation is generated from the text.

The narrative text described the trip of a woman and her dog through the same hypothetical town and a series of events that happened along the way. The narrative text used in this study was written as a story that produces affective response in readers in compliance with the structural-affect theory of story comprehension (Brewer & Lichtenstein, 1981, 1982). The narrative text embodies a series of events organized along a time line. It was hypothesized that readers of the narrative text build an event model from the

character's point of view. This type of model derived from the narrative text is a sequential, one-dimensional model which is constructed from the protagonist's point of view.

The differences in the characteristics of the mental models generated from the three text genres were measured by asking questions about information from the underlying models that was only available from inference. To test readers' success at constructing mental models, three types of inference questions were used: global perspective questions, spatial orientation questions, and order inference questions.

Global perspective questions and spatial orientation questions represent two different ways of testing spatial information.[1] Global perspective questions are questions regarding the spatial configuration among pairs of landmarks viewed from a global perspective, for example, "Is Landmark A north of Landmark B?" One can answer global perspective questions directly by examining a two-dimensional spatial model and making spatial inferences from a global perspective.

Spatial orientation questions test the spatial orientation inferences about landmarks with respect to a given ground-level location, for example, "If you're at Location A and look south, would you see Landmark B?" One can answer this type of question by imagining oneself to be at the indicated location and then making a spatial orientation inference.

Order inference questions assess the event order inference with respect to the underlying spatial model. For this study, these questions were generated by translating the relation between a pair of landmarks into a hypothetical trip along a specified route, for example, "If you are heading south, would you see Landmark A first and then Landmark B?" By reversing the trip direction, the relations between Landmark A and Landmark B can be tested in yet another question: "If you are heading north, would you see

Landmark A first and then Landmark B?" Subjects can answer both types of inference questions by imagining a hypothetical trip along a specified route using the spatial mental model built from the text.

Response time and accuracy were the dependent variables in this study. The basic underlying methodological assumption was that any extra cognitive processing effort needed to manipulate a mental model constructed from the text requires additional processing resources. Consequently, the more steps the readers need to transform the mental model built from the text in order to answer inference questions, the longer it should take for them to answer questions and the less accurate should be the answers. According to this processing model, the closer the form of the constructed mental model from the text and the mental model required to answer the inference question, the faster and more accurate readers will be in answering the question.

In contrast to previous studies (Ohtsuka, 1990; 1993a, 1993b) , the present study attempts to elicit two different types of mental models from each of the two text genres known to produce different types of representations by providing information on the nature of expected questions.

The present study addressed the following specific hypotheses:

1. Readers normally build a two-dimensional spatial model from the descriptive text. However, it was hypothesized that the characteristics of mental models derived from text could be manipulated by providing an example of inference questions that were to be presented after the reading session. More specifically, when the readers of descriptive text expect order inference questions, they will construct a one-dimensional mental model instead of the typical two-dimensional model derived from the descriptive text. On the other hand, when they are expecting global spatial questions, the

readers will construct a two-dimensional spatial model as they normally do in the absence of explicit task information.

2. Readers normally construct a one-dimensional event model from the narrative text. However, when the reader of narrative text expect global perspective questions, they will instead construct a two-dimensional spatial model. On the other hand, when they expect order inference questions, they will construct a one-dimensional model as they normally do from the narrative text.

Method

Subjects

Seventy-one undergraduate psychology students participated in the study to fulfill a course requirement. They were required to be native speakers of English to participate in the study.[2]

Materials

Two types of passages (descriptive and narrative), each written in two forms (north to south and south to north), were constructed from the same underlying information. Each passage was designed to represent information about the same imaginary town whose map is given in Figure 1 (no subjects saw this map in the experiment).

Insert Figure 1 about here

Descriptive passages. The descriptive passages described a bird's eye view of an imaginary town. The global layout of the town was given first, followed by its large scale structure.[3] After the global information, a series of statements about specific landmarks in the town was introduced. The location of each landmark was described in terms of the relevant street names but the exact location of the landmark within a street block was not

explicitly specified. The descriptive passages described the landmarks in an orderly manner, from one end of the town toward the other end (either from North to South or South to North), so that the reader could form a coherent mental model when each statement was processed without violating the immediate integration principle. This principle states that discourse comprehension is facilitated by introducing new information in discourse in such a way that it can be integrated immediately into an already constructed underlying structure (Ehrlich & Johnson-Laird, 1982; Ohtsuka & Brewer, 1992).

Narrative passages. The narrative passages described a walk by a woman taking her dog to a veterinary hospital from her home (or taking her dog from the veterinary hospital to her home). On the way, the character loses her dog and finds it again after an anxious search. The route in the narrative passages was the same route described in the procedural passages. Examples of the passages are given in Appendix A.

Inference questions. As noted earlier, three types of questions were used to assess readers' inferences: global perspective questions, spatial orientation questions, and order inference questions. The answers for all questions were not available verbatim from the experimental passages. To answer questions, subjects had to make inferences by building a mental model. There were two different randomizations of question item order for each of the three types of questions. The global perspective questions consisted of 18 true-false statements testing the global spatial configuration among pairs of landmarks in the passage. The spatial orientation questions consisted of 18 true-false statements testing the spatial orientation inferences about the locations of landmarks with respect to a given ground level location. The question items were carefully examined to check their validity using world knowledge regarding the line of sight between the observer and the object, the

relative height of the observer's position and the object, and the visibility of the object from the distance. Items that yielded multiple answers were eliminated. The order inference questions consisted of 18 true-false statements testing order inferences when a hypothetical trip was carried out across the town described in the passage. Half of the order inference questions described the hypothetical trip in one direction while the other half described the trip in the opposite direction. Because there is more than one way to navigate from Landmark A to Landmark B, the route information has to be provided in an order inference question to determine a particular route. Most distant landmark pairs were eliminated because it was not possible to determine a route without giving more than two street names. Appendix B presents examples of the three question types.

Apparatus

An Apple Macintosh personal computer controlled the presentation of the experimental texts, the display of inference questions and the measurement of response time to answer each question. The computer programs for the experiment were written by the author in HyperTalk and incorporated the timer and video stimulus synchronization routines by Pugh (1991). The measurement was accurate to the nearest millisecond.[4]

Design and Procedure

There were two types of text genre, as between-subject factors, and three types of inference questions as a within-subject factor in a factorial design.[5] Subjects were randomly assigned to one of the experimental conditions.

Instructions and Reading session. Subjects participated in the experiment individually. They were told that they would be asked to read a passage on a computer and later to answer questions about its content. At the end of instructions, subjects were given an example of questions that they will expect after the reading session. A third of the subjects were told that

they were to answer questions regarding global perspective questions. A third were instructed that they were to answer spatial orientation questions. A third of the subjects were told that they were to answer order inference questions. Appendix C lists three instructions given to the subjects.

Once they started responding to the questions, the subjects were not allowed to look back at the text. Reading time was recorded from the onset of the experimental text presentation until the subjects started to answer the questions.

Key press practice trial. Before the question session, the subjects read brief instructions on how to press keys to respond to questions on the computer display. After the instructions, five practice questions were presented. The instruction display and the key press trials also served as the intervening task to reduce effects due to possible rehearsal of the experimental texts. The practice question items were unrelated to the content of the experimental passages or the inference questions.

Inference question session. After key press trials, the three types of 18 questions each were administered in a block format on a computer display. The order of question item presentation within each question type was randomized for each subject. Subjects were asked to verify a series of statements regarding the hypothetical town. All subjects verified all three types of inference statements. The statements were displayed on the computer screen one at a time. The subjects responded by pressing a colour-coded yes key or no key on the keyboard. They pressed the yes key with their dominant hand and the no key with their nondominant hand. The key press as well as the response time from the onset of the presentation of the statement until the key press was recorded. Subjects did not receive feedback concerning the accuracy of their answers, nor about the speed of their responses.

Results

Passage Reading Time

The average reading times for the descriptive text group and the narrative text groups were, in order, 10 min 40 s and 8 min 50 s. There was no statistically significant differences between the two groups.

Accuracy Scores

The mean accuracy scores for each of the three question types were calculated for each subject by adding correct responses. The maximum accuracy score was 18 and a chance score was 9. Percentages of correct responses were used for analysis.

Response Time Data

A logarithmic transformation was applied to normalize raw response time data. One hundred twenty-four miss key presses and outliers exceeding the means plus or minus three standard deviations, 3.3% of the total data of 3,751 responses, were removed from the analysis. Means and standard deviations were calculated for each type of question. Table 1 shows the mean accuracy scores and mean response times for each of the three types of inference questions by genre.

Insert Table 1 about here

Overall results. On the accuracy scores, repeated-measure analysis of variance (ANOVA) indicated an overall main effect of instructions on expected question type, $F(2, 65) = 3.09$, $MS_e = 0.06$, $p < .05$. There was also a statistically significant two-way interaction of expected questions and question type, $F(4, 130) = 4.20$, $MS_e = 0.01$, $p < .01$. As expected, the two-way interaction of text genre and the question type was not statistically significant.

On the response times, a two-way interaction of expected questions and question type was significant, $F(4, 130) = 149.19$, $MS_e = 0.005$, $p < .01$. In addition, there was a significant effect for question type, $F(2, 130) = 25.57$, $MS_e = 0.005$, $p < .01$, indicating a trivial effect of the average question length for each question type. There was no evidence of speed-accuracy trade off in the data.

Two-way interaction of expected questions and question type: Accuracy.

The two-way interaction of expected questions and question type on accuracy data is given in Figure 2.

Insert Figure 2 about here

When the readers expected order inference questions, their accuracy levels on global perspective questions became significantly lower, $F(1, 65) = 10.68$, $MS_e = 0.025$, $p < .01$. Similarly, when the readers expected spatial orientation questions, their accuracy on global perspective questions became significantly lower, $F(1, 65) = 5.94$, $MS_e = 0.025$, $p < .05$. Finally, when readers expected spatial orientation questions, they scored significantly higher on order inference questions, $F(1, 65) = 5.40$, $MS_e = 0.026$, $p < .05$.

Two-way interaction of expected questions and question type: Response time.

The two-way interaction of expected questions and question type on response time data is given in Figure 3. The results indicate that response times to the three question types varied according to the expected questions given in the instructions. The results clearly demonstrated that the change of task expectation results in different types of mental models derived the

identical text genre that was known to produce a certain type of mental model. Figure 3 shows contrasts between the subjects expect global perspective questions versus order inference questions.

Insert Figure 3 about here

When the readers expected order inference questions, they responded slower to global perspective questions, $F(1, 65) = 44.46$, $MS_e = 0.019$, $p < .01$, but faster to both spatial orientation questions and order inference questions, $F(1, 65) = 11.71$, $MS_e = 0.016$, $p < .01$ and $F(1, 65) = 39.98$, $MS_e = 0.01$, $p < .01$, respectively. Figure 4 presents contrasts between those who expect global perspective questions versus spatial orientation questions.

Insert Figure 4 about here

When the readers expected spatial orientation questions, they responded slower to both global perspective questions, $F(1, 65) = 5.03$, $MS_e = 0.019$, $p < .05$, and spatial orientation questions, $F(1, 65) = 23.67$, $MS_e = 0.016$, $p < .001$, but much faster to order inference questions, and $F(1, 65) = 110.79$, $MS_e = 0.01$, $p < .001$. Figure 5 shows contrasts between the subjects expecting spatial orientation questions versus order inference questions.

Insert Figure 5 about here

When the subjects expected order inference questions, they were faster in answering both spatial orientation questions, $F(1,65) = 68.27$, $MS_e = 0.16$, $p < .001$, and order inference questions, $F(1,65) = 18.33$, $MS_e = 0.10$, $p < .001$, but

were slower on global perspective questions, $F(1,65) = 19.0$, $MS_e = 0.19$, $p < .001$.

General Discussion

The overall results from this study indicate that the characteristics of mental models derived from the descriptive text or the narrative text are different depending on subjects' task expectation.

Accuracy data demonstrated that regardless of the input text genre, the subjects expecting global perspective questions and those expecting order inference questions exhibit rather different data patterns. For the group expecting global perspective questions, the accuracy of other two types of questions was significantly lower. On the other hand, both descriptive and narrative groups expecting order inference questions performed significant lower in global perspective questions[6].

The response time data followed a similar pattern observed in the accuracy data. When the subjects expected global perspective questions, they responded significantly slower to order inference questions. When the subjects expected order inference questions, they responded significantly slower to global perspective questions.

In the previous studies (Ohtsuka, 1990; 1993a, 1993b), without explicit instructions regarding question types, the descriptive text produced a similar data pattern with the readers expecting global perspective questions. Likewise, the procedural and narrative texts produced the data pattern which closely resembles to that obtained from the readers expecting order inference questions.

The results of the current study suggest that the characteristics of mental model derived from text are guided, at least partially, by readers' expectation on what type of information processing will be required after the reading session.

Furthermore, Ohtsuka (1993b) reported that the two-way interaction of text genre and question type disappeared when reading sessions were repeated. This is because the readers learn the nature of questions during the first session and construct a mental model focused on the comprehension of a spatial model for the second session. The current study further demonstrated that by providing different task expectations to the group of subjects processing the identical text genre and induced them to construct drastically different mental models. These results can be interpreted to corroborate Ohtsuka's postulation on plasticity of mental models (Ohtsuka, 1990). According to this view, the mental models built from text are not static, rigid representations. Rather readers are able to manipulate the mental models derived from text actively to make inferences based on them. Apparently, the subjects were able to construct optimal representations depending on task requirements.

The current study extended a series of previous work by showing that readers' task expectations, at least partially, contribute to the effect of text genre on mental models and influences the main characteristics of mental models derived from the text.

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Author Notes

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Footnotes

1 Thorndyke and Hayes-Roth (1982) reported that map-learning subjects were not as accurate as navigation subjects in indicating the direction of a hidden landmark. Their findings suggest that global spatial understanding and spatial orientation judgment might be two different kinds of spatial tasks in real-life spatial learning.

2 Any student who was taught in English prior to Grade 12 is identified as a native speaker of English.

3 Although the description of a grid pattern configuration in the city centre used in the experimental text better applies to American cities than Australian counterparts (Blosfelds, M., personal communication, 1992), the effect of text genres on the type of representation is not limited to a particular subgroup of the English speakers. Ohtsuka (1993a, 1993b) replicated similar data pattern by presenting a shorter set of experimental texts to Australian English speakers.

4 There was a random variance between 0 ms to 15 ms (average variance 5 ms) in measurement due to a polling rate of Apple keyboard input. There was no known method available to account for the variance.

5 The question type given in the instruction was always presented at first. No attempt was made to counter-balance the question block presentation order.

6 However, these groups showed different pattern in order inference questions.

Appendix A: Examples of Experimental Passages

Descriptive Passage (North to South)

Rebecca Jones lives in the town of Newell. Newell is located in a valley near the seaside. There are three major avenues that run north-south. First Avenue is on the west side of the town, Second Avenue is in the middle, and Third Avenue is on the east. There are three major streets that run east-west. From the north end of town to the south end, they are: Apple Street, Cherry Street, and Orange Street. The Cairn River flows from east to west on the south side of the town. Rebecca's house is on the northeastern edge of town. Her house is located on the east side of Third Avenue up on the hill. Just to the south of Rebecca's house is a beautiful fountain. Apple Street crosses Third Avenue to the south of the fountain. There is a roundabout at the intersection of Apple Street and Third Avenue. The Greenwood Department Store is located on the west side of Third Avenue in the block between Apple Street and Cherry Street. The tall department store towers over the surrounding buildings. Cherry Street crosses Third Avenue to the south of the department store. Second Avenue runs parallel to Third Avenue one block to the west. Shoppers' Paradise, the major shopping centre in Newell, is on the west side of Second Avenue and occupies the whole block between Apple and Cherry Street. St. Mary's Cathedral is located on the east side of Second Avenue between Cherry and Orange Street. Directly across Second Avenue from St. Mary's Cathedral, on the west side of the street, Picasso's sculpture of a huge bird soars towards the sky. A big banner announcing the "Corn Festival" hangs over Second Avenue to the south of the sculpture. Orange Street crosses Second Avenue to the south of the festival banner. First Avenue runs parallel to Second Avenue one block to the west. Memorial Park is located on the west side of First Avenue. The park occupies the entire block between Cherry Street

and Orange Street. To the south of Orange Street on the east side of First Avenue is a TV tower, the highest structure in Newell. There is a bridge to the south of the TV tower where First Avenue crosses over the Cairn River. The hospital is south of the river and located on the west side of First Avenue.

Procedural Passage (North to South)

Welcome to my home town, Newell. Newell is located in a valley near the seaside. My name is Rebecca Jones. Here are the directions about how to get to the hospital from my house. I live on the northeastern edge of town on the hill. You are standing in front of my house on Third Avenue. Go south on Third Avenue. You will immediately see a beautiful fountain on the east side of the street. The next street you will cross is Apple Street. The intersection you come to is Third Avenue and Apple Street, where there is a roundabout. Keep on going south on Third Avenue, you will pass the Greenwood Department Store on the west side of the street. The tall department store towers over the surrounding buildings. The next Street you come across is called Cherry Street. Turn west when you arrive at Cherry and go one block to Second Avenue. Arriving at Second Avenue, you will see Shoppers' Paradise. It is on the north side of Cherry Street and the west side of Second Avenue. Shoppers' Paradise is the major shopping centre in Newell and occupies the entire block between Apple Street and Cherry Street. Turn south onto Second Avenue away from Shoppers' Paradise. You will see St. Mary's Cathedral on the east side of the street. Across the street from the Cathedral, Picasso's sculpture of a huge bird soars up to the sky. You will pass under a big banner announcing the "Corn Festival" directly to the south of the sculpture. Continue south until you come to Orange Street, then turn west onto Orange and go one more block. You will see Memorial Park. It is on the north side of Orange Street and the west side of First Avenue. Memorial Park occupies the

entire block between Cherry Street and Orange Street. Turn south on First Avenue at First and Orange. You'll soon see the TV Tower, the highest structure in Newell, on the east side of the street. As you continue down First Avenue, you will cross the bridge over the Cairn River. Finally you will see the hospital on the west side of First Avenue.

Narrative Passage (North to South)

Rebecca and her dog, Fido, lived in Newell, a town located in a valley near the seaside. They lived on the northeastern side of town up on the hill. Rebecca's house was located on the east side of Third Avenue. Today Rebecca walked Fido to the Vet's for his vaccination. They started out walking south along Third Avenue. Immediately on the east side, they saw a beautiful fountain. They continued south and passed a roundabout at the intersection of Third Avenue and Apple Street. Then continued along Third until they came to the Greenwood Department Store. The tall department store towers over the surrounding buildings on the west side of the street. The two of them soon came to Cherry Street. They turned west on Cherry Street and walked on for one block to Second Avenue. Rebecca looked towards Shoppers' Paradise, the major shopping centre of Newell. It is on the north side of Cherry Street and the west side of Second Avenue. Shoppers' Paradise occupies the entire block between Apple Street and Cherry Street. Rebecca saw an old friend heading towards her. They became deeply involved in reminiscing about old times at the intersection of Cherry Street and Second Avenue. Suddenly Rebecca realised Fido was gone! She ran one block south where she came to St. Mary's Cathedral on the east side of Second Avenue. She walked across the street to Picasso's sculpture of a huge bird soaring towards the sky, hoping Fido might be hidden behind it. Then she passed under a big banner announcing the "Corn Festival" hanging over Second Avenue directly to the south of sculpture.

She continued along Second Avenue until she reached Orange Street and went west for one block. Then she crossed over First Avenue to Memorial Park. It is on the north side of Orange Street and the west side of First Avenue. Memorial Park extends the entire block between Cherry Street and Orange Street. Arriving at the park, she called out her dog's name but Fido did not come. Rebecca was really becoming concerned and began to continue her search south on First Avenue. The TV tower, the highest structure in Newell, on the east side was blurred by her tears. Then she crossed the bridge over the Cairn River. She wondered if Fido could have fallen into the river. After a while, she found herself in front of the Veterinary Hospital on the west side of First Avenue. Standing at the front door was Dr. Jake with a small animal in his arms. It was Fido! "He's had his vaccination," said Dr. Jake, "but the next time, don't make Fido face this all alone!"

Appendix B: List of Three Types of Inference Questions

B.1 Examples of Global Perspective Questions

1. The fountain is north of the roundabout.
2. The Greenwood Department Store is to the northeast of Memorial Park.
3. Memorial Park is southwest of Shoppers' Paradise.
4. The Greenwood Department Store is to the south of the fountain.
5. Memorial Park is south of the Cairn River.
6. The roundabout is east of Shoppers' Paradise.

B.2 Examples of Spatial Orientation Questions

1. If you're at Memorial Park and look west, you would see Picasso's sculpture of a huge bird.
2. If you're at Memorial Park and look northwest, you would see the TV tower.
3. If you're at the roundabout and look west, you would see the north side of Shoppers' Paradise.
4. If you're at St. Mary's Cathedral and look northwest, you would see Shoppers' Paradise.
5. If you're standing on the bridge over the Cairn River and look south, you would see the TV tower.

B.3 Examples of Order Inference Questions

1. When you're going from Rebecca's house to the hospital via Second Avenue, you would pass Shoppers' Paradise then St. Mary's Cathedral.
2. When you're going from the hospital to Rebecca's house via First Avenue and Cherry Street, you would pass Memorial Park then the TV tower.

3. When you're going from Rebecca's house to the hospital via Cherry Street and First Avenue, you would pass Shoppers' Paradise then Memorial Park.
4. When you're going from Rebecca's house to the hospital via Third Avenue and Cherry Street, you would pass Shoppers' Paradise then the fountain.
5. When you're going from the hospital to Rebecca's house via Cherry Street and Third Avenue, you would pass Shoppers' Paradise then the Greenwood Department Store.
6. When you're going from Rebecca's house to the hospital via Second Avenue, you would pass St. Mary's Cathedral then the "Corn Festival" banner.

Appendix C: Three instructions regarding question types

Global Perspective Instructions

The passage you will read features the fictitious town of Newell. The questions in the question section will test your understanding of the relative position of landmarks in the town. For example, if the passage featured UWA, you may be asked to verify the following statement: "The University Bookshop is north of the Psychology Building." True or false? Please keep this kind of question in mind as you are reading the passage.

Spatial Orientation Instructions

The passage you will read features the fictitious town of Newell. The questions in the question section will test your understanding of the spatial orientation of landmarks relative to your position in the town. For example, if the passage featured UWA, you may be asked to verify the following statement: "If you are outside the University Bookshop and look south-west you would see the clock-tower of Winthrop Hall." True or false? Please keep this kind of question in mind as you are reading the passage.

Order Inference Instructions

The passage you will read features the fictitious town of Newell. The questions in the question section will test your understanding of the various landmarks you may pass as you follow a particular route through the town. For example, if the passage featured UWA, you may be asked to verify the following statement: "When you are going from the Psychology Building to the Reid Library, via Social Science Building, you would pass the Refectory then the University Bookshop." True of false? Please keep this kind of question in mind as you are reading the passage.

Table 1

Accuracy Scores and Response Times for Each Question Type

	Text Genre			
	Descriptive		Narrative	
	M	SD	M	SD
Global Perspective Questions				
Accuracy (%)				
GPQ Expected	90.1	15.9	87.7	15.9
SOQ Expected	75.3	15.9	80.0	15.9
OIQ Expected	72.7	15.9	75.3	15.9
Response time				
GPQ Expected	3.79	0.14	3.84	0.14
SOQ Expected	3.88	0.14	3.93	0.14
OIQ Expected	4.06	0.14	4.10	0.14
Spatial Orientation Questions				
Accuracy (%)				
GPQ Expected	86.9	17.7	83.1	17.9
SOQ Expected	84.4	17.9	70.6	17.7
OIQ Expected	72.7	17.6	77.8	17.7
Response time				
GPQ Expected	3.86	0.13	3.92	0.13
SOQ Expected	4.09	0.13	4.04	0.12
OIQ Expected	3.74	0.12	3.79	0.12
Order Inference Questions				
Accuracy (%)				
GPQ Expected	84.3	16.2	79.1	16.3
SOQ Expected	91.3	16.3	80.9	16.3
OIQ Expected	70.1	16.3	80.2	16.3
Response time				
GPQ Expected	4.00	0.10	4.03	0.10
SOQ Expected	3.70	0.10	3.70	0.10
OIQ Expected	3.84	0.10	3.81	0.10

Note. Response time data are transformed data.

Figure Caption

Figure 1. A map of Newell.

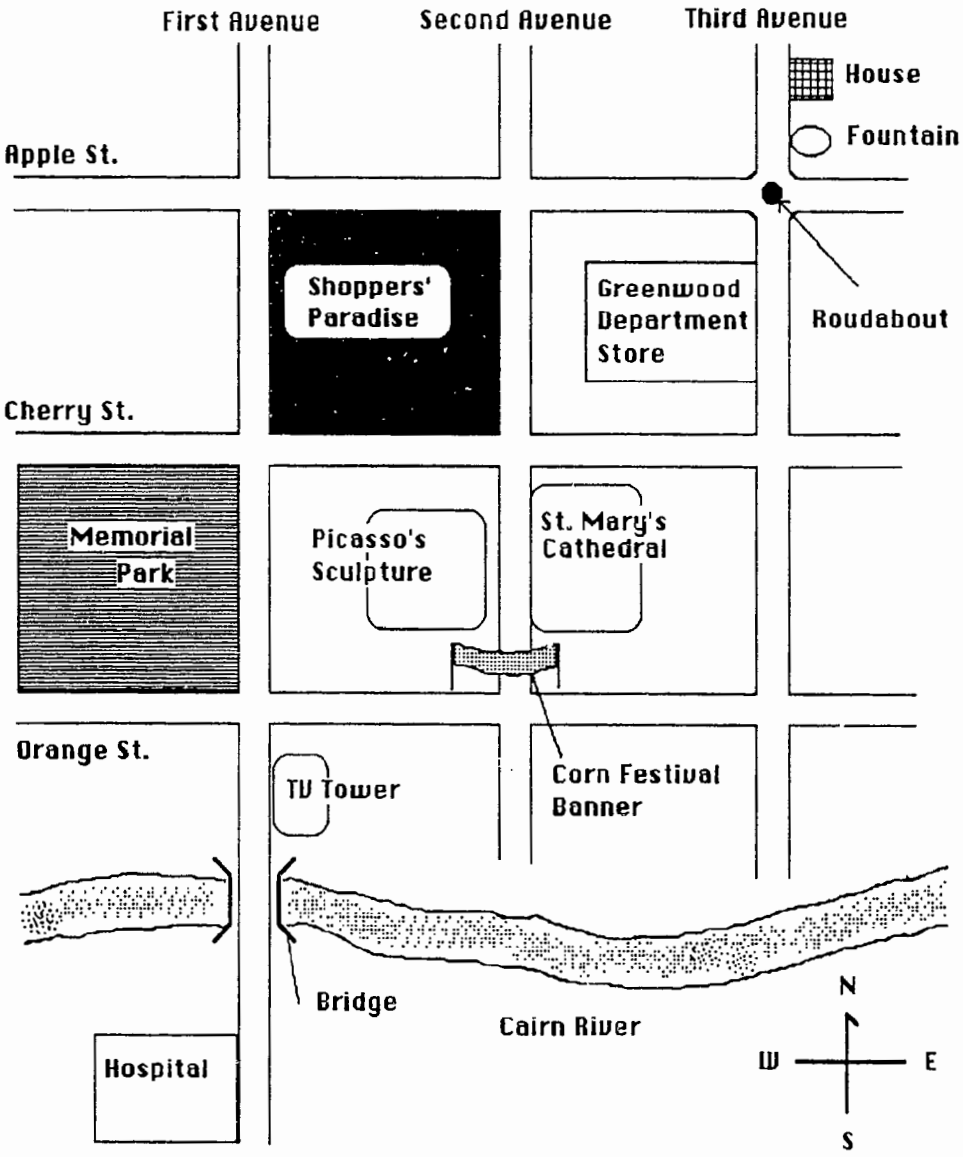

First Avenue
Second Avenue
Third Avenue
House
Fountain
Apple St.
Shoppers' Paradise
Greenwood Department Store
Roudabout
Cherry St.
Memorial Park
Picasso's Sculpture
St. Mary's Cathedral
Orange St.
TV Tower
Corn Festival Banner
Bridge
Cairn River
Hospital
N
W
E
S

Figure Caption

Figure 2. Accuracy: Two-way interaction of the anticipated question and the question type.

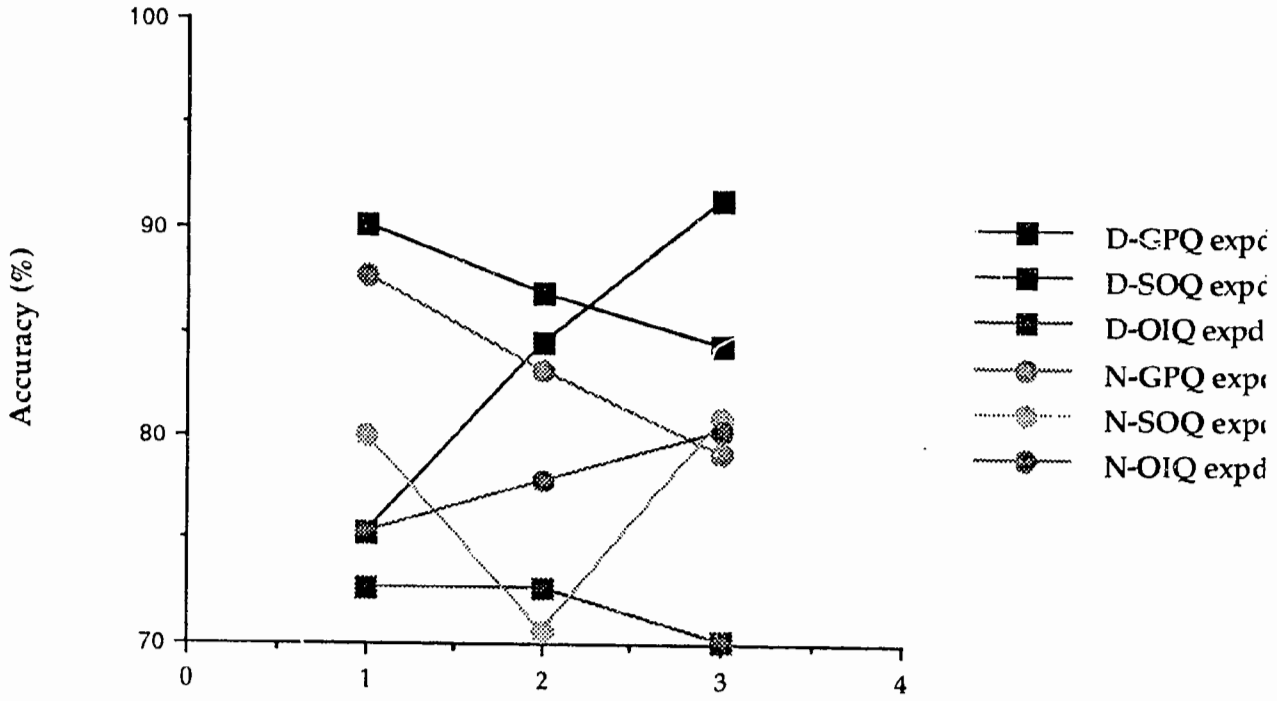

100
90
80
70
0
1
2
3
4
Accuracy (%)
Global Persp.
Spatial Orient.
Order Inf.
Question Type
D-GPQ expd
D-SOQ expd
D-OIQ expd
N-GPQ expd
N-SOQ expd
N-OIQ expd

Figure Caption

Figure 3. Response time data: Two-way interaction of the anticipated question (global perspective questions vs. order inference questions) and the question type.

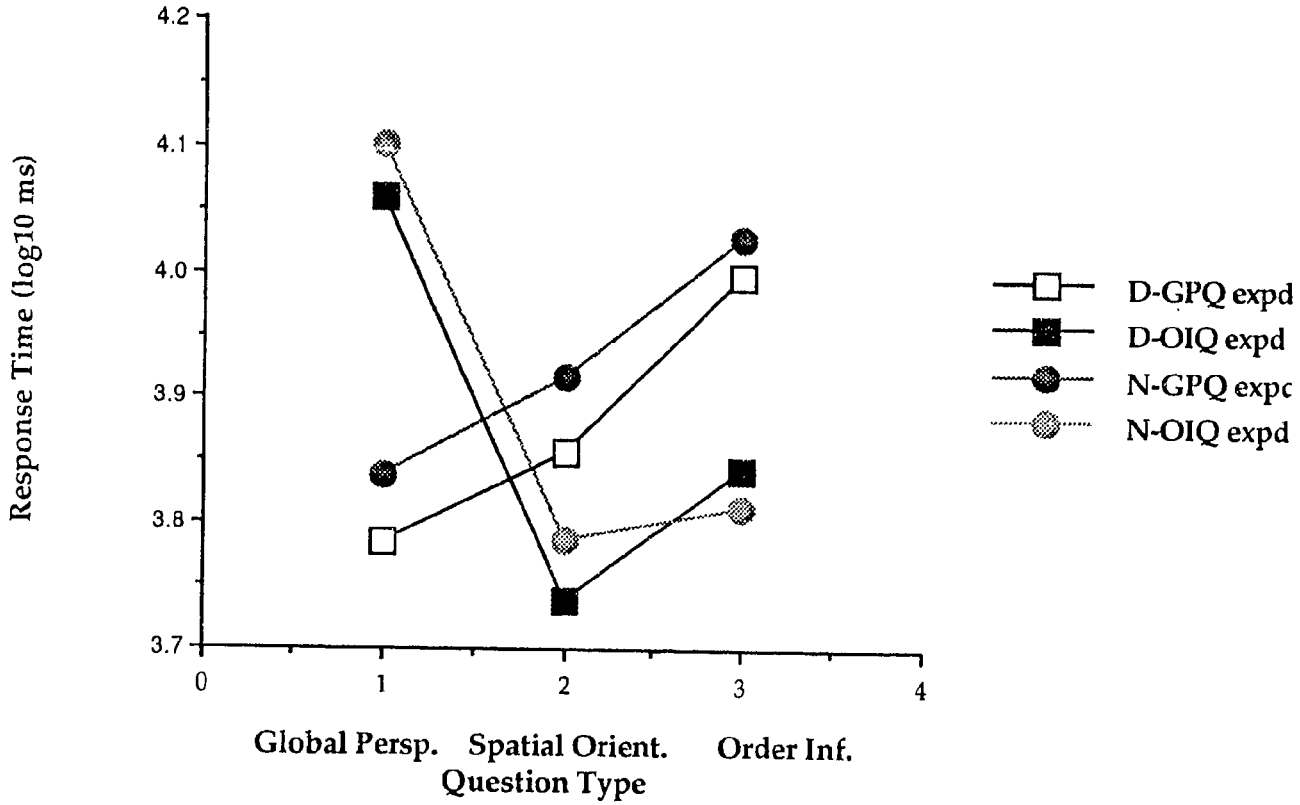

Response Time (log10 ms)
4.2
4.1
4.0
3.9
3.8
3.7
0
1
2
3
4
Global Persp.
Spatial Orient.
Order Inf.
Question Type
D-GPQ expd
D-OIQ expd
N-GPQ expc
N-OIQ expd

Figure Caption

Figure 4. Response time data: Two-way interaction of the anticipated question (global perspective questions vs. spatial orientation questions) and the question type.

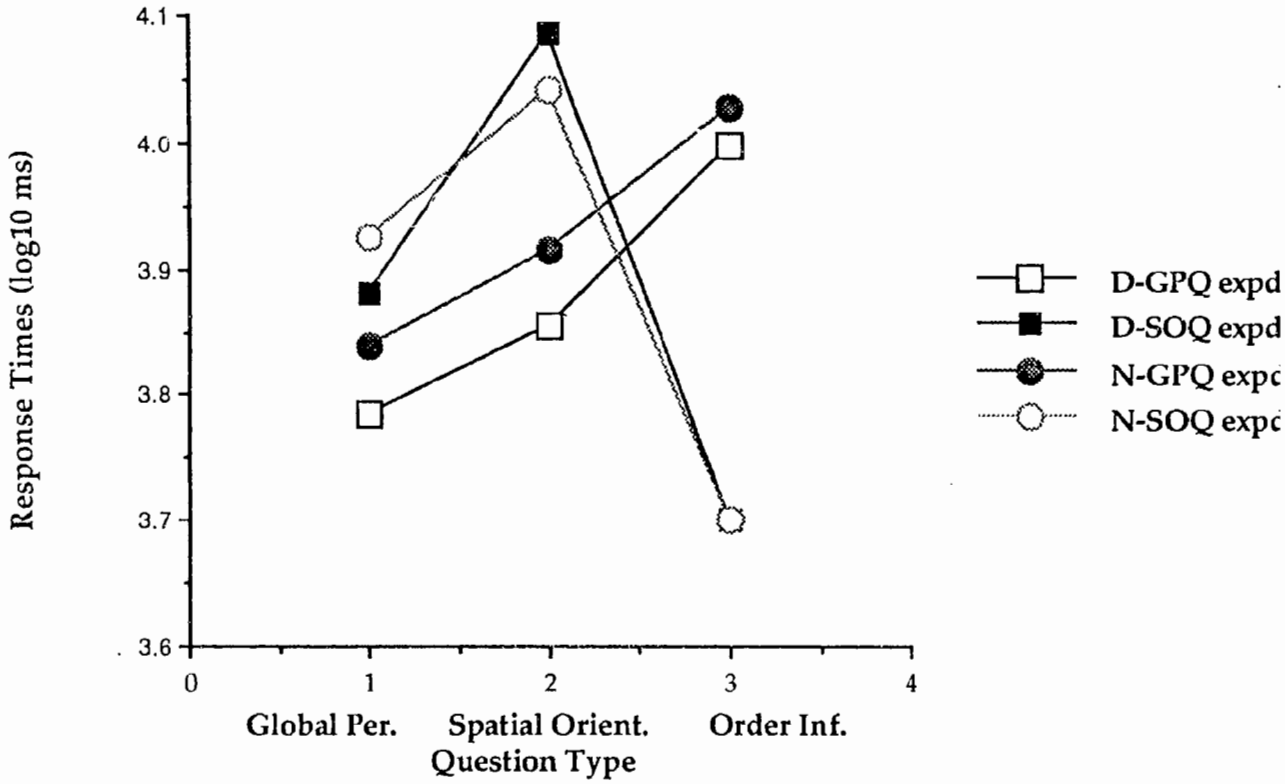
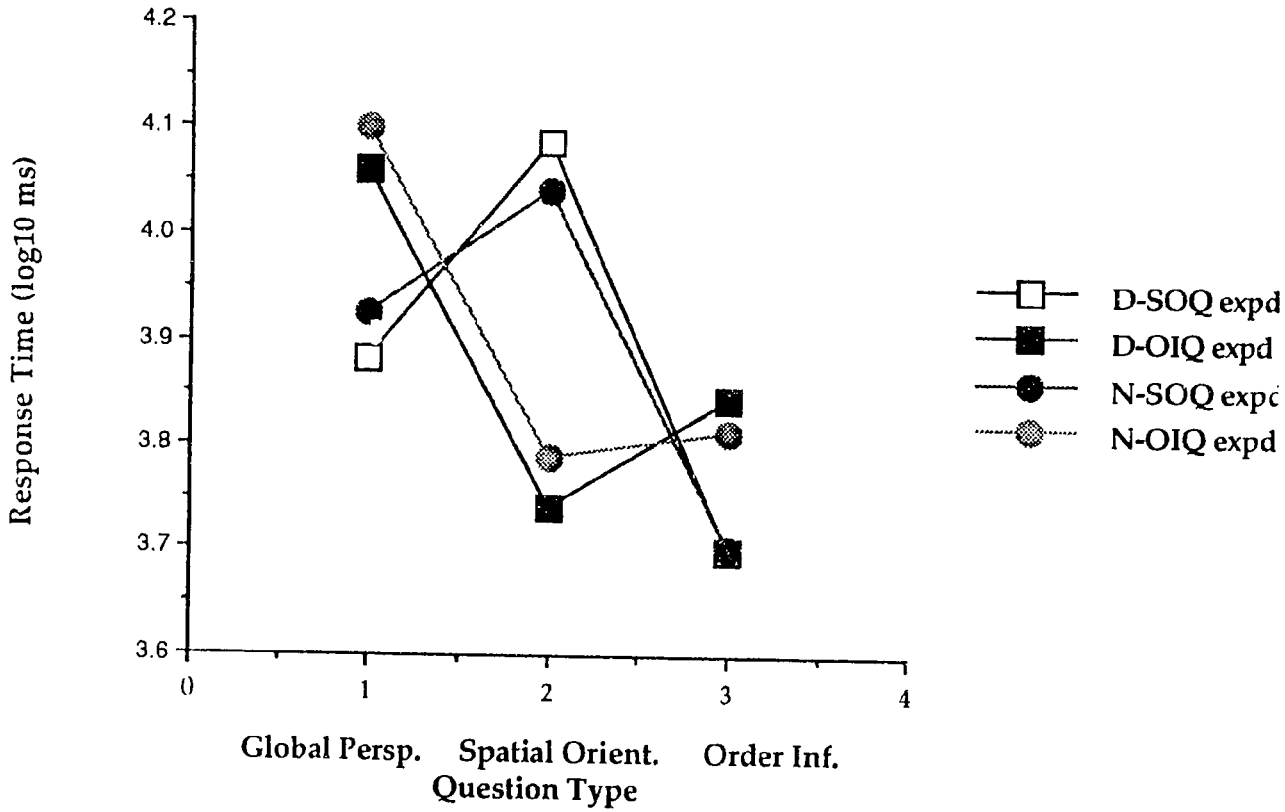

Response Times (log10 ms)
4.1
4.0
3.9
3.8
3.7
3.6
0
1
2
3
4
Global Per.
Spatial Orient.
Order Inf.
Question Type
D-GPQ expd
D-SOQ expd
N-GPQ expc
N-SOQ expc

Figure Caption

Figure 6. Response time data: Two-way interaction of the anticipated question (spatial orientation questions vs. order inference questions) and the question type.


Response Time (log10 ms)
4.2
4.1
4.0
3.9
3.8
3.7
3.6
0
1
2
3
4
Global Persp.
Spatial Orient.
Order Inf.
Question Type
D-SOQ expd
D-OIQ expd
N-SOQ expd
N-OIQ expd