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# The accessibility of spatial information: Two competing views

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# THE ACCESSIBILITY OF SPATIAL INFORMATION: TWO COMPETING VIEWS

BY

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ABSTRACT

THE ACCESSIBILITY OF SPATIAL INFORMATION: TWO COMEPTING VIEWS

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The experiments reported in this thesis were designed to investigate factors involved in the reactivation of spatial information. Participants read passages that described a protagonist and a target object in a spatial location. In Experiment 1, naming times demonstrated that the target object was active immediately after reading the introduction whereas the target object was no longer active in memory after reading filler information that did not remention the target object. In Experiment 2, participants were asked to read a cuing sentence immediately following the filler information. The results showed that this cue served to reactivate the target object. In Experiment 3, the protagonist spatially moved away from the previous location. The results indicated that even after the situation model shifted, the cuing sentence still reactivated the target object. The overall pattern of results suggest that contextual cuing rather than spatial information determined accessibility of objects during reading.

# INTRODUCTION

When reading a text, it is generally assumed that readers will "fill in the gaps" between information that has been explicitly stated, and what the complete message was intended to convey. Within all theories of reading comprehension there is the assumption that readers take in information and connect it with previously read information and there are five types of event indices that readers keep track of: temporality, spatiality, protagonist, causality, and intentionality (Zwaan, Langston, & Graesser, 1995). However, models differ in predictions concerning which types of information becomes available and how this information becomes activated. The goal of this thesis is to explore further the conditions under which spatial information is activated and to what extent spatial information plays a role in reading comprehension.

In the sections that follow, I will discuss several models of reading comprehension with specific emphasis on the assumptions relevant to the activation of spatial information. Chapter one through two will focus on different models of reading comprehension. Two competing views of memory that can explain how inferential information becomes activated will also be reviewed in chapter three. This is followed by a review of literature concerning the accessibility and availability of spatial information in chapter four.

The experiments are presented in chapter five. Recent research has found that readers attend to spatial information in written text (e.g., Albrecht & O'Brien, 1992; Hakala, 1999; De Vega, 1995). The experiments in this thesis extend the literature on the

accessibility of spatial information by exploring different conditions under which it may become activated. The spatial information and contextual cues that are presented in a passage are manipulated to investigate whether or not it will affect the accessibility of a target object in a spatial environment. That is, does spatial information, contextual cues, or both facilitate the activation of spatial information? The results of this thesis will be discussed in the context of processing and representation assumptions of both the explanation-based view of text processing and the memory-based view of text processing.

# CHAPTER I

## TEXT-BASED MODELS OF READING COMPREHENSION

One of the most influential theories of reading comprehension is the Kintsch and Van Dijk (1978) model. A basic assumption of this model is that text is represented as a series of hierarchical connected propositions in which importance is reflected by height in the hierarchy. There are two primary assumptions of the model: first, each proposition is connected to another proposition through argument overlap; and second, because of limited capacity constraints, the propositions from the text are processed over a series of cycles, with only a subset of propositions processed during each cycle. During the first cycle, several propositions enter working memory. A superordinate proposition is then selected from the initial set of propositions. This proposition is selected to represent the general topic of the text. The remaining propositions are then connected based on argument overlap. Once all of the propositions have been connected, a subset is selected to be retained in the short-term memory buffer. The short-term memory buffer is a portion of short-term memory that is reserved for a small set of propositions from one cycle to the next. This is done so that on each new cycle, the incoming propositions can be connected to the established representation. Short-term memory is then emptied and a new set of propositions is input. Furthermore, the propositions that are no longer in short-term memory are now stored in long-term memory on a probabilistic basis determined by the number of cycles in which a proposition has been held in short-term memory.

Virtually every model of comprehension holds the same basic processing assumptions of the Kintsch and Van Dijk model. That is, the reader has limited capacity for information that can be held in active memory at one time. Due to the limited capacity, the reader will maintain a small subset of information in active memory, which is connected to a richer representation in long-term memory. This highlights the importance of maximizing what is available in memory so the reader is able to integrate new information with what came before. The complete representation is comprised of a structure that is built over each cycle.

Even though these basic assumptions permeate current models of comprehension, a major weakness of the model proposed by Kintsch and Van Dijk is that it primarily focuses on the representation of the text itself rather than the representation of what the text is about. Models that follow Kintsch and Van Dijk have mostly focused on the latter part of the representation (i.e., what the text is about).

Trabasso and Sperry (1985) proposed a causal model in which the representation of text contains all possible causal connections. That is, when judging the importance of a proposition, the reader takes into account the relation the proposition has with other parts of the text. This includes antecedents, consequences, and implications of a statement. Readers can evaluate the relation between a particular statement and other statements by assessing how the statements are linked. Those statements that are linked by successive causes and consequences are said to be part of a causal chain and considered to be more important than events that are not in the chain. Also, the reader can evaluate the number of direct, operative links a statement has to other statements. The model essentially states that comprehension involves a search for causal links in a text

that connect the different parts of the story. Unlike, the Kintsch and Van Dijk (1978) model, connections between propositions are not solely based on referential overlap, but on causal relatedness.

The representation system by Trabasso and Sperry (1985) highlighted the importance of causal relations in comprehension processes. However, a major weakness of this causal model is that it is simply a representational system and not without any processing assumptions that explain how a representation is constructed. In response to this concern Fletcher and Bloom (1988) developed a processing model that could explain how readers identify causal relations, the Current State Selection Strategy. According to this strategy, readers select the proposition that comprises the end of the causal chain of events in the text. During this two-stage process, the reader must first identify the most recent state from the text that has preceding antecedents but no consequences. During the second stage, the reader must select the propositions from the state selected in the first stage, that is, those propositions whose removal would result in the loss of a causal connection. The selected propositions are then maintained in short-term memory until they can be connected to their causal consequences. This strategy parallels the assumptions of the Leading Edge Strategy (Kintsch & Van Dijk, 1978) in that it assumes a limited capacity system as readers can only hold a limited amount of information in active memory. In order to connect up previous information with new information, the reader keeps the most recent causal antecedent active in memory to identify the causal relations.

However, the processing assumptions leave open a large gap between the number of causal connections that can occur within the Current State Selection Strategy and the

number of causal connections that can occur within Trabasso and Sperry's causal model. Van den Broek (2002) has argued that the actual number of causal relations is directly tied to standards of coherence. Standards of coherence "reflect a reader's knowledge and beliefs about what constitutes good comprehension as well as readers' specific goals for reading the particular text" (Van den Broek, Virtue, Everson, Tzeng, & Sung, 2002, p 137). These standards will influence the types of coherence (e.g., referential, causal, spatial) as well as the strength of the coherence that a reader aims to maintain. Moreover, the standards depend on the goals, expectations, working memory resources, perspective and various contextual variables such as text genre, presentation rate, and task variables (Van den Broek, Fletcher, & Risden, 1993; Van den Broek, Lorch, Linderholm, & Gustafson, 2001). In other words, the higher the standards of coherence, the greater the number of connections a reader will attempt to make.

# CHAPTER II

## SITUATION MODELS

The models of reading comprehension that have been discussed in the previous chapter primarily focused on the text-based level of representation. However, in order to fully comprehend text the reader must be able to continuously integrate what they are currently reading with what came before. This process allows them to develop a full representation of an entire text independent of length. Most current models assume that readers develop not only a text-based level of representation, which is a representation of the text itself but also a situation model, which is a representation of what the text is about. Van Dijk and Kintsch (1983) recognized this and proposed a model to extend and correct some of the limitations in the earlier model. It makes many of the same processing assumptions in the development of the text-based level of representation. The primary focus of the Van Dijk and Kintsch model is on processes leading to the development of the situation model level of representation. It includes the events, actions, characters, and situation described in the text. In other words, the reader develops a representation of the described situation that is almost image-like.

Subsequent to this, research focused more on how to define what is represented in a situation model (e.g., Zwaan & Radvansky, 1998, Glenberg, Meyer, & Lindem, 1987, Bransford, Barclay, & Franks, 1972). Early evidence for the existence of a situation model comes from Bransford, Barclay, and Franks (1972). They asked participants to

read two sentences that described different situations but were similar in syntactic structure. For example:

1.) Three turtles rested beside a floating log, and a fish swam beneath them.

2.) Three turtles rested on a floating log, and a fish swam beneath them.

By changing only one word, the situation described by each sentence is changed. In particular, the first sentence described a fish swimming beneath the turtles but not the log, whereas the second sentence described a fish swimming beneath the turtles and the log. When asked to identify which sentence they had read previously, participants incorrectly identified those sentences that were semantically but not propositionally similar to sentences they had seen. Consider the following sentences:

1.) Three turtles were sitting on a log and a fish swam under it.

2.) Three turtles were sitting on a log and a fish swam under them.

When presented with the first sentence, participants reported seeing the sentence when they had actually read the second one. In contrast, participants were able to differentiate those sentences that were syntactically similar. Consider the following two sentences:

1.) Three turtles were sitting beside a log and a fish swam underneath them.

2.) Three turtles were sitting beside a log and a fish swam underneath it.

Participants could tell the first sentence was new when they had previously read the second sentence.

Glenberg, Meyer, & Lindem (1987) provided additional evidence that readers create situation models to represent what the text is about. The authors had participants read text in which the main character was either spatially associated with the target object or spatially dissociated from the object. Consider the following example:

1.) After doing a few warm up exercises, John put on his sweatshirt and went jogging.

2.) After doing a few warm up exercises, John took off his sweatshirt and went jogging.

In the first example, the object of interest (e.g., the sweatshirt) is spatially associated with the character while in the second example, the object is spatially dissociated. If the reader's situation model includes the spatial structure of the events, the associated object should become part of the reader's representation of the text. In each passage, the protagonist (i.e., John) was foregrounded throughout while the object (i.e., the sweatshirt) was never repeated. Following each passage, the reader was presented with an item recognition test. Glenberg et al. (1987) showed that those items that were associated with the character were responded to quicker than those objects that were dissociated from the character. The authors suggested that the faster response time was because readers had kept the spatially associated objects active in their representation of the text.

In a classic series of studies examining whether readers track spatial information, Morrow, Greenspan, & Bower (1987) (see Morrow, Bower, & Greenspan, 1989; Rinck, Hahnel, Bower, & Glowalla, 1997; Rinck, Williams, Bower, & Becker, 1996) asked participants to memorize spatial layouts of a research center. Next, participants were asked to read narratives about the character moving through the research center (e.g., Wilburg walked from the storage area, through the library, on his way to the wash room).At some point in the narrative, participants were presented with a pair of objects and were required to decide if the objects came from the same or different room. Morrow et al. (1987) identified three types of rooms: a source room, which was the original

location of the protagonist (e.g., storage area); a path room, which was the room that the protagonist walked through (e.g., library); and the goal room, which was the final destination of the protagonist (e.g., wash room). The results of the study showed that response times to objects from the room where the protagonist was located (i.e., the goal room), and objects from the path room, were faster than response times to objects from a previously visited room (i.e., the source room). For example, in the previous sentence, the objects from the wash room and the library were most accessible. Morrow et al. (1987) argued that the accessibility of information depends on the described situation, not the surface structure of the text. In another experiment, Morrow, Bower, and Greenspan (1998) demonstrated that readers shift their attention to rooms that are relevant to goals and actions of the protagonist. For example, if the protagonist was in the laboratory but thinking about the experiment room, response times were faster for objects from the room the protagonist was thinking about, or in this case, the experiment room. Thus, Morrow et al. (1987) concluded that readers adopt the perspective of the protagonist.

However, O'Brien and Albrecht (1992) stated that having participants memorize maps may force them to focus more on the spatial layout than they usually would while reading text. In this experiment, they asked participants to read passages in which a critical sentence violated information about the protagonist that was presented earlier in the text. Consider the following example:

1.) Kim stood inside/outside the health club

2.) She decided to go outside the health club

When the first sentence stated that Kim was inside the health club, the second sentence was consistent with the stated location whereas when the first sentence stated that Kim

was outside the health club, the second sentence was inconsistent with the protagonist's stated location. O'Brien and Albrecht (1992) found that readers slowed down their reading pace when the second sentence was inconsistent with the original location because they noticed an inconsistency in the text. Nonetheless, in a second experiment the authors were unable to detect differences in reading times when a second character moved in a direction that was either consistent or inconsistent with the protagonist's perspective. For example:

1.) As Kim stood inside/outside the health club she felt a rush of excitement.

2.) She was getting anxious to start and was glad when she saw the instructor come in the door of the health club.

When the first sentence stated that Kim was standing inside the health club, the instructor is moving in a direction that is consistent with the perspective of the protagonist. However, when the first sentence stated that Kim was standing outside the health club, the instructor is now moving in a direction that is inconsistent with the protagonist's perspective. The absence of a difference in reading times on the second sentence suggests that although readers may be sensitive to information that is relevant to the protagonist, they do not adopt the perspective of the protagonist.

## Focus Model

As noted earlier, full comprehension requires connecting up earlier information with incoming information. In Garrod and Sanford's (1990) Focus Model they argue that referential processes are critical to any complete account of text comprehension, as reference is necessary in achieving a cohesive and coherent representation. These

referential processes in reading take place against a complex and dynamic representational background. That is, readers focus their attention on information about the protagonist and the situations a protagonist is in. In order to attain these two aspects of attentional focus, the reader must be able to identify the protagonist itself as well as the situation they are in. To capture this kind of relation between referential processes and the attentional state of the reader, Sanford and Garrod (1981) proposed a memory frame work which includes two dynamic systems operating in parallel, that is, explicit and implicit focus. Together, explicit and implicit focus represent the reader's current working model of the text. The capacity of the explicit focus system is limited while the capacity of the implicit focus system is not. The representation of a discourse in memory can be broken down into two focused partitions: explicit focus and implicit focus. Information that is currently in working memory is assumed to be in explicit focus, whereas information that is not directly in focus but is relevant to the contents of working memory is maintained in implicit focus. Garrod and Sanford (1988) argued that readers maintain the protagonist in explicit focus, while scenario-based information, such as the characteristics of a protagonist, would be maintained in implicit focus. Incoming information is mapped onto information that is currently active in memory, that is, in explicit focus, as well as onto information that is relevant to the currently active scenario, that is information in explicit focus. Moreover, Glenberg and Langston (1992) proposed that information in explicit focus may be connected to information in implicit focus through discourse pointers. These pointers connect tokens representing the protagonist in explicit focus to characteristics or a general profile of the protagonist in implicit focus. Whenever the reader encounters a reference to the protagonist, a fuller description of the

protagonist is primed through a resonance process and becomes readily available. The purpose of discourse pointers is to direct the reader to relevant backgrounded information. Therefore, by definition, these discourse pointers must restrict the activation stage and should only reactivate information that is relevant to the current contents of working memory (e.g., Garrod, O'Brien, Morris, Rayner, 1990; O'Brien, Rayner, Albrecht, & Rayner, 1997).

## Event-Indexing Model

Zwaan, Langston, and Graesser (1995) proposed an Event-Indexing Model that states that events and intentional actions of protagonists are the focal point of situation models. When reading text, readers monitor and update the current situation model on a number of indices including temporality, spatiality, protagonist, causality, and intentionality. Incoming information is checked against the existing situation model and updated if some inconsistencies on any of the above described situational dimensions are detected. For example, when the incoming event takes place in a different spatial location, the spatial index needs to be updated. If an incoming event involves a different protagonist, the protagonist index needs to be updated. Thus, a discontinuity on any of the five dimensions causes the reader to deactivate the current node and activate a new node (e.g., a new spatial index) or reactivate an old node. As a result, processing of new information is more effortful when situational discontinuities occur than when there are no situational discontinuities. Zwaan and colleagues found that reading times increased as a function of the number of situational dimensions that convey discontinuities. Furthermore, they claimed that the strength of the link between two memory nodes

coding for an event is a function of the number of shared situations. That is, events that take place during the same time frame and spatial location are more strongly linked than events that occur in distinct time frames and spatial locations. Hence, the structure of the situation model that results from the comprehension process depends on the number of indices that events have in common.

One assumption of this model is that readers are unable to actively monitoring all pieces of information in situation models because it is unlikely that they can keep track of all mentions. Furthermore, it is not clear whether readers maintain all this information in active memory or simply have easy access to the information when necessary. For example, Cook, Guéraud, Was, & O'Brien (in press) asked participants to read passages in which a critical sentence violated information that was presented earlier in the text about an object that was in possession of the protagonist. For example, in one passage, Dorothy loves her skates and always brings them to the park. This information was backgrounded for a few sentences, which was followed by a critical sentence and a spillover sentence. For example:

1.) Her boyfriend had recently given her a pair of customized ice skates that Dorothy always took to the park with her. Dorothy got the skates from her closet and tossed them over her shoulder on her way out the door.

3.) Dorothy wished she had a pair of skates. She decided to go to the rental booth/ Dorothy eagerly put on her ice skates. She tied her laces and went to the rink.

When the critical sentence stated that Dorothy wished she had a pair of skates, the previously provided information was inconsistent with the critical sentence. However, when the critical sentence stated that Dorothy eagerly put on her ice skates, the

previously provided information was consistent with the information stated in the critical sentence. Cook et al. (in press) found that reading times for the critical sentences were slowed down when they contained information that was inconsistent with the previously provided information about the target object. However, the authors noted that it was not clear whether readers noticed the contradiction because the information about Dorothy being in possession of the skates was held in an active portion of memory or if the second mentioning of the skates triggered reactivation of the information.

In the next section, I will discuss two current competing views of the comprehension process – the explanation-based view and the memory-based view of text processing. The explanation-based view assumes that readers continuously search after meaning in the text and update outdated information if necessary whereas the memory-based view assumes that readers maintain very little information in active memory, but make extensive use of contextual cues to reactivate information when necessary.

# CHAPTER III

## CURRENT VIEWS

While many researchers (e.g., Fletcher & Bloom, 1988; Kintsch & Vipond, 1979; Trabasso &Sperry, 1985) agreed on the contribution of the text itself to the comprehension process, others (e.g., McKoon & Ratcliff, 1988; 1995; Singer, Graesser, & Trabasso, 1994; Van den Broek & Sue, 1989) began to ask questions about how information already stored in memory from previous experience (e.g., general world knowledge) affects comprehension. As a result, new memory theories started to develop that focused on the reader's use of general world knowledge. This led to the development of two competing views: the explanation-based view and the memory-based view.

### The explanation-based view of text processing

According to the explanation-based view, readers are actively involved in the reading process and they attempt to "construct" meaning out of the text while reading. Readers always seek explanations and attempt to fully integrate current information with all relevant prior information. Readers are actively engaged in searching memory for relevant information, making every effort to ensure full integration at both local and global levels. The representation that would result from such an active process has been best captured by the early work of Trabasso and his colleagues (e.g., Graesser, Singer & Trabasso, 1994; Singer, Graesser, & Trabasso, 1994).

According to the explanation-based view, there are two important processes that take place during reading: search after meaning and the active construction of inferential information. The reader continuously searches after meaning because they feel the need to understand the motives for an action to be able to comprehend the text via the "need to know node." In order to search after meaning, the reader actively searches memory to find possible causes and connections within the text. More specifically, readers organize text into goals, attempts, outcomes, and actions, which is a recursive process. In other words, the "need to know node" drives the reader to continuously engage in an active search of all memory (e.g., what is currently available in short-term memory as well as information from general world knowledge). In this way, readers are continually maintaining both local and global coherence. Readers actively follow the causal chain of events in a story by interpreting events, goals, and outcomes to their best ability to be able to understand what will happen next. Driven by the "need to know node" readers will actively engage in generating inferences during reading based on what they read before.

Proponents of the explanation-based view argue that there are three assumptions in this model that explain why readers search for meaning in the text and engage in the active construction of inferential information. First, the readers are motivated by their own goals. The second assumption is that readers are motivated to maintain both local and as global coherence. Finally, readers are motivated to explain information that has been mentioned in the text. In order to satisfy these three assumptions the reader must activate certain inferences while reading because not all necessary information is

explicitly stated in the text. Consider the following excerpt (adapted from Trabasso, Secco, & van den Broek, 1984):

> The fox and the bear ran quickly to a nearby farm where they knew chickens lived. The bear climbed upon the henhouse roof to stand guard. The fox then opened the door very carefully. He grabbed a chicken and killed it. Just as he was about to carry it out of the henhouse, the roof fell in.

In this example, it is likely that readers infer that the roof caved in because the bear was standing on it because they seek the causes of physical changes of state, such as why the roof of the henhouse collapsed (Trabasso et al., 1989).

Furthermore, the concept of "search after meaning" arose, in part, because it appeared to its proponents that simple memory mechanisms could not account for a sufficient range of inferences. Active inferential processes require directed searches of long-term memory to locate specific types of information.

The availability of inferential information: The explanation-based view

Because not all necessary information is explicitly stated in the text, the reader must activate certain inferences during reading to satisfy their own reading goals, to maintain both local and global coherence, and to explain the information that has been mentioned in the text earlier. According to the explanation-based view, there is an active search that continually takes place in both short-term and long-term memory. Driven by a search after meaning, readers will actively draw inferences based on information from earlier in the text. These active inferential processes are strategic and involve a direct (i.e., search after meaning), resource-demanding search of long-term memory to locate

specific pieces of information. Search after meaning is defined as a memory-retrieval mechanism and predicts that information from long-term memory should be activated only when it is relevant to the developing text representation.

The explanation-based view focuses on the active components of the comprehension process; that is, the reader actively searches memory for related information and on the reader's attempt to construct inferences that will facilitate comprehension processes. In contrast, the memory-based view focuses on passive aspects of comprehension, that is, it does not require any strategic processes and it focuses on the passive reactivation from long-term memory as well as passive activation of information that leads to the reactivation of inferences.

One of the issues that remains for the explanation-based view is to develop in some detail a processing mechanism that would need to be involved in the active construction of inferences. This would likely require some appeal to "procedures" or "production rules" that are common components and theories of problem solving (e.g., Lovett, 2002; Glaser, 2001; Seifert, 1999)

## The memory-based view of text processing

The memory-based view provides an alternative view of text processing. It rejects the notion of any active search process. Furthermore, although there is an acknowledgement that an inferencing process takes place, within the context of the memory-based view there is an attempt made to explain the availability of inferential processing without any strategic process.

According to the memory-based view, the discourse representation is created by the reader but is not contingent upon special strategies. A basic assumption of the memory-based view is that information that a reader has encoded can be affected by information from earlier portions of the text and general world knowledge. Whenever a reader encodes information a signal is sent out to all of memory and related information resonates in response to this signal with the most active information returning to memory and affecting comprehension. Thus, any information that is related to the current contents of memory can affect the comprehension process independent of whether or not it interferes or facilitates comprehension.

The resonance process, which is a core concept of the memory-based view was first conceptualized by Ratcliff (1978). Ratcliff describes memory retrieval as a process that is influenced by how much a concept is activated in memory. According to this model, the likelihood that a concept will be reactivated is determined by how much the concept in memory activates or resonates with a current idea from the text. In other words, the more features a concept has in common with a current idea from the text, the greater the likelihood for activation. Similar models of memory have described current concepts in text as probes that emanate a signal to all of memory (see also Gillund & Shiffrin, 1984; Hintzman, 1986).

Myers and O'Brien, 1998 proposed a resonance model to explain the activation process during reading (see also O'Brien & Myers, 1999). The fast-acting passive resonance process is based on the assumption that concepts derived from the sentence currently being processed, or concepts residing in working memory as a result of reading earlier portions of the text, serve as signals that are sent out to all of memory in parallel

(both the episodic memory trace and general world knowledge). The intensity of these signals depends on the degree of attention given to concepts currently in focus, but the signal proceeds autonomously and is unrestricted. Concepts from earlier portions of the discourse representation as well as general world knowledge resonate as a function of the degree of overlap with the input. This match depends on the overlap of both semantic and contextual features among concepts. Memory elements that are contacted by the initial signal sent out a signal to other memory elements. Concepts in long-term memory that share features in common with the contents of working memory will "resonate" in response (see Ratcliff, 1978), and those concepts that resonate the most are most likely to be incorporated into working memory. During this resonance process, activation builds and when the process stabilizes, the most active elements enter working memory. A critical aspect of the resonance process is that it is "dumb." In other words, information that resonates sufficiently is returned to working memory independent of whether that information will ultimately facilitate or hinder comprehension.

Albrecht and O'Brien (1993) provided evidence that readers routinely maintain local and global coherence. They presented participants with text in which a main character was introduced, followed by an elaboration section that described some characteristic of the main character. Participants were then presented with information about the main character that was not always consistent with the elaborated characteristic from earlier in the text (see sample passage Table 1). Specifically, participants were presented with a final sentence that was consistent with the immediately preceding text

Table 1.

Sample Passage used by Albrecht and O'Brien (1993)

*Introduction:*
Today, Mary was meeting a friend Joan for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

*Consistent Elaboration:*
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week. Mary never worried about her diet and saw no reason to eat nutritious foods.

*Inconsistent Elaboration:*
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, had been a strict vegetarian for 10 years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything that was fried or cooked in grease.

*Neutral Elaboration:*
This was Mary's favorite restaurant because it had a nice and quiet atmosphere. Mary frequently ate at the restaurant and had recommended it to all of her friends. She especially liked the cute tables and the country style cloths on them. It made her feel right at home.

*Filler:*
After about 10 minutes, Mary's friend Joan arrived. It had been a few months since they had seen each other. Because of this Mary and Joan had a lot to talk about and chatted for over a half hour. Finally, they signaled the waiter to come and take their orders. They checked the menu one more time. May and Joan had a hard time deciding what to have for lunch.
*Critical Sentences:*
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

*Closing:*
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.

but either globally consistent, inconsistent, or neutral with the earlier elaborated character trait. For example, when readers were presented with the information in the inconsistent condition about Mary ordering a cheeseburger and fries reading times were slowed because presumably the target sentence reactivated the earlier presented elaborated information about Mary's eating habits through the resonance process. The reactivated information about Mary being a vegetarian slowed reading time because a global coherence break occurred. Thus, readers attempted to maintain coherence for the character at the global level even when the information was locally coherent.

In order to provide evidence that the resonance process was both unrestricted and dumb, O'Brien, Albrecht, Rizzella, and Halleran (1998) conducted a series of experiments that demonstrated that readers use general world knowledge to maintain a globally coherent representation of a protagonist while reading text. Across a series of experiments, the authors included a qualified condition in which the inconsistent elaboration was written to make it clear to the reader that Mary was no longer a vegetarian or that Mary had never been a vegetarian ( see sample passage Table 2). Comprehension should not be disrupted if readers actively search earlier portions of the discourse for relevant information (i.e., the passage makes clear that Mary no longer is or never was a vegetarian). However, if memory activation is a dumb process, then disconfirmed or false information should resonate and become active simply because it is related to information in the target sentence. Consistent with the memory-based view, the reading times on the target sentence continued to be slow in the qualified conditions, but not as slow as the inconsistent conditions (with the overt contradiction). Thus, memory

Table 2.

Passage used by Albrecht and O'Brien (1993) and O'Brien, Rizzella, Albrecht, and Halleran (1998)

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*Introduction:*
Today, Mary was meeting a friend Joan for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

*Consistent Elaboration:*
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week. Mary never worried about her diet and saw no reason to eat nutritious foods.

*Inconsistent Elaboration:*
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, had been a strict vegetarian for 10 years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything that was fried or cooked in grease.

*Neutral Elaboration:*
This was Mary's favorite restaurant because it had a nice and quiet atmosphere. Mary frequently ate at the restaurant and had recommended it to all of her friends. She especially liked the cute tables and the country style cloths on them. It made her feel right at home.

O'Brien et al. (1998) Experiment 5: Qualified elaboration
Mary remembered that at a recent party, Joan played a joke by telling people that Mary had been a strict vegetarian for 10 years. Joan told everyone that Mary's favorite restaurant had fantastic health food. She said that Mary was a health nut and wouldn't eat anything that was fried or cooked in grease. She also claimed that Mary's favorite food was cauliflower.

*Filler:*
After about 10 minutes, Mary's friend Joan arrived. It had been a few months since they had seen each other. Because of this Mary and Joan had a lot to talk about and chatted for over a half hour. Finally, they signaled the waiter to come and take their orders. They checked the menu one more time. May and Joan had a hard time deciding what to have for lunch.

*Critical Sentences:*
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

Table 2 continued.

*Closing:*
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.

processes cannot assess truth value. Although the inconsistent characteristic was not true, the information continued to be activated and affected reading time.

Cook, Halleran, and O'Brien (1998) extended the findings of O'Brien et al. (1998) by presenting participants with passages in which the protagonist engaged in an action that was inconsistent with the general profile of a second character. That is, the passage elaborated on critical characteristics of the protagonist's friend (e.g., Mary's friend Joan is a vegetarian) and directly tested the premise that the memory activation process is unrestricted. The authors rewrote the elaboration section so that the secondary character was described as a vegetarian instead of Mary. Reading times on the target sentence (e.g., Mary ordered a cheeseburger and fries) were not slowed when Joan was described as a vegetarian; however, a subsequent probe study showed that the target sentence led to the reactivation of the characteristics now ascribed to Joan. This finding is consistent with an unrestricted reactivation process; that is characteristics associated with a secondary character are reactivated because they share features in common with actions taken by the primary character. It is difficult to imagine a conscious, intentional search mechanism that would access information about a character not in focus, especially when the information was not relevant (see also, Long & Chong, 2001; Guéraud (2003) for evidence of reactivation of irrelevant information that does not affect comprehension).

Thus far, we have seen that ordinary memory processes can explain how information within texts attains renewed accessibility as a function of the reader's current focus. However, the memory-based processing view also encompasses the mechanisms that allow a reader's general world knowledge to be activated in parallel with information

from earlier portions of the discourse. The memory-based approach to activation of general world knowledge leads us to the topic of inferences.

The availability of inferential information: Memory-based view

O'Brien and Albrecht (1991) demonstrated that the resonance process is not restricted to the episodic memory trace and that all of memory, including information from general world knowledge is searched. In other words, any concept regardless of how current it is in memory, can resonate with another concept that is active in memory as long as they share features in common. To test whether with supporting context, concepts not even present in the representation of a passage become active during antecedent search O'Brien and Albrecht (1991) wrote passages that contained either low or high context (see sample passage Table 3). In the high context version, information was presented so that it was strongly related to an elaborated concept (i.e., in the sample passage, "skunk" is the concept or antecedent that should be inferred). In the low context version on the other hand, there was less elaboration for the target concept (i.e., skunk) and other possible antecedents could be inferred (e.g., cat). Participants were asked to either name the highly elaborated concept aloud (e.g., skunk) or an alternative concept (e.g., cat).

The results of the study indicated that not only was a highly elaborated target more active in memory but so were concepts that were associated and similar to the target as related concepts also resonated in response to elaborated text. That is, participants that read the high context version, named "skunk" faster than "cat"; however, associated

Table 3.

Sample Passage used by O'Brien and Albrecht (1991)

*High-Context Version:*
Mary was driving in the country one day when she smelled a terrific odor. Suddenly a small black (skunk/cat) with a white stripe down its back ran in front of her car. Mary knew she couldn't stop in time. However, she hoped she had managed to miss the animal and continued on her way. After a while, she noticed she was low on gas. While at the gas station, the attendant asked her what had run in front of her car.

*Low-Context Version:*
Mary was driving in the country one day and she gazed at the setting sun as she went. Suddenly a small black (skink/cat) with a long furry tail ran in front of her car. Mary knew she couldn't stop in time. However, she hoped she had managed to miss the animal and continued on her way. After a while, she noticed she was low on gas. While at the gas station, the attendant asked her what had run in front of her car.

concepts such as "cat" were still named faster than non-related concepts. Participants that read the low context version named the target concept "skunk" and the alternative concept "cat" equally fast because there was no elaborated context that led to additional activation of either one of these concepts. A subsequent experiment showed that the activation of concepts not mentioned in a passage can be sufficiently high that subjects will produce them in a speeded-recall task. Participants produced the word "skunk" even though it was never mentioned in the passage. These findings support the premise that concepts absent from a passage, but having a strong semantic association to both the theme of the passage and an anaphoric phrase, were activated by the anaphoric phrase, and on some occasions they were instantiated in response to an anaphoric phrase.

The results are consistent with the basic assumptions of the resonance process; that is, a signal is sent out to all of memory and what comes back is unrestricted. Therefore, when a signal is sent out to all of memory all contextual information and general world knowledge imply "skunk" even though the passage stated "cat." Overall, these findings are consistent with the resonance process and demonstrate that when reactivation occurs, it activates both the episodic memory trace as well as general world knowledge. Furthermore, the current study showed that when both the episodic memory trace and general world knowledge get activated, the reader may assume that what came back to them was actually something that they read while in fact they did not (e.g., skunk gets activated when the animal that was mentioned was a cat) (also see Rizzella and O'Brien, 2002).

In line with the memory-based view, several researchers have studied the conditions that will lead to the activation of predictive inferences. Murray, Klin and

Myers (1993) showed that the activation of inferences was heavily determined by the immediately preceding context. They presented participants with passages that contained highly elaborative descriptions of a character or events so that they were strongly predictive of an action or event. Murray et al. (1993) hypothesized that the context of the passage and the length of elaboration would increase the likelihood that a predictive inference becomes activated. Consider the following passage:

> Carol was fed up with her job waiting on tables. Customers were rude, the chef was impossibly demanding, and the manager had made a pass at her just that day. The last straw came when a rude man at one of her tables complained that the spaghetti she had just served was cold. As he became louder and nastier, she felt herself losing control. Without thinking of the consequences, she picked up the plate of spaghetti, and raised it above the rude man's head.

Murray et al. (1993) found that when presented with the phrase "raised it above the rude man's head" after reading the elaboration about Carol, participants were significantly faster to name the concept "dump" aloud in this predictive context. Murray et al. (1993) argued that although the inference "dump" becomes activated by the immediately preceding context (without thinking of the consequences, she picked up the plate of spaghetti, and raised it above the rude man's head), it is also facilitated by the elaboration on Carol from earlier in the text; that is, the reader is given strong context that Carol is fed up with her job as a waitress and is led to believe that she will act irrationally if confronted with another difficult situation (see also Klin, Guzman, & Levine, 1999; Klin, Murray, Levine, & Guzman, 1999; McKoon & Ratcliff, 1992; McDaniel, Schmalhofer, & Keefe, 2001).

Moreover, Cook, Limber, and O'Brien (2001) were interested in whether or not predictive inferences are encoded into the representation of long-term memory. Most research on predictive inferences had concluded that the activation of predictive inferences depends on the immediately preceding context. However, Cook et al. (2001) argued that in addition to the immediately preceding context, earlier portions of the discourse also played an important role.

The authors wrote passages in which they either presented context that was high or low in relation to a predictive outcome (see sample passage in Table 4). After reading either the high or low context version of the passage, participants were required to name the inference concept aloud (e.g., dent). Participants named the concept significantly faster in the high context condition than in the low context condition indicating that predictive inferences may become activated on the basis of contextual features contained within the situation model. In a subsequent study, after a delay the inference was no longer encoded in memory as a specific word. These results suggest that predictive inferences are initially activated in the text but after a delay they are no longer represented as specific lexical item in long-term memory. For example, instead of interring the specific lexical item "dent" when Jimmy throws a rock at the car door, it may be that the reader encodes a general change in state (e.g., smash, scratch, ruined) and that this memory can be represented by several lexical items. Furthermore, Cook at al. (2001) showed that not only the immediately preceding context leads to inference activation but inference activation can come from both the immediately preceding context as well as earlier portions of the discourse representation.

Table 4.

Sample passage used by Cook, Limber, & O'Brien (2001)

*Introduction:*
Jimmy was the new kid on the block. Although his parents urged him to go meet the other kids in the neighborhood he was shy and hadn't made any new friends. One Saturday morning, his mom asked him to go to the store for her. While he was walking home, Jimmy ran into some of the kids from the neighborhood. They asked him if he wanted to play with them.

*Low context:*
Jimmy was delighted and ran across the street to play with them. They taught him a fun game that involved throwing Nerf balls at a target to get points.

*High context:*
Jimmy was delighted and ran across the street to play with them. They taught him a fun game that involved throwing rocks at a target to get points.

*Continuation section:*
Jimmy and his friends were having a great time. Jimmy even won the game once or twice. He stepped up to take his turn and aimed at the target.

*Implicit Inference-Evoking:*
He missed, though, and accidentally hit the door of a new car.

*Explicit Inference-Evoking:*
He missed, though, and accidentally hit the door of a new car and dented it.

*Background:*
Jimmy was late for dinner so he said goodbye to his new friends and ran home. He couldn't wait to play with them again the next day. He happily told his mom that he had finally met some of the other kids in the neighborhood and had a great time. He told her about the game they played.

*Critical sentence:*
He told her about denting the car door.

*Closing:*
His mother told him that he should tell the owner of the car what happened. Jimmy promised to do it first thing the next day.

Peracchi and O'Brien (2004) further assessed the effects of context on predictive inferences. More specifically, they were interested in whether or not the elaboration of a particular character profile presented prior to an inference-evoking sentence would lead to the activation of a predictive inference and whether or not context in the discourse model can have enough of an effect to override the immediately preceding context. The authors wrote passages in which a specific outcome had either a high or low likelihood of occurring based on constraining text about the character (see sample passage in Table 5). For example, in the inconsistent trait elaboration condition, Carol the waitress was described as being meek, mild and someone who would go out of their way to avoid confrontation. The authors predicted that when the inference-evoking sentence (e.g., Carol lifted the spaghetti above his head) was presented following the inconsistent elaboration, readers would most likely not activate the inference "dump." However, when Carol is described as someone who is short-tempered, irrational and often acts without thinking, it is likely that the inference evoking sentence (e.g., Carol lifted the spaghetti above his head) will activate the inference "dump."

The findings of the study indicated that the inconsistent condition was not sufficient to activate the inference "dump" after reading the inference-evoking sentence whereas in both the neutral and the consistent condition, naming times of the inference were fast because the predictive inference had been activated. This is an indication that not only the inference-evoking sentence (i.e., the immediately preceding context) but the entire passage served to activate the inference "dump" thus showing that the context in the discourse model can in fact have enough of an effect to override the immediately preceding context. In particular, in the consistent elaboration the characteristics that

Table 5.

Sample Passage from Peracchi & O'Brien (2004)

*Introduction:*
Carol was a single mother with two young children. She had to work two jobs to make ends meet. She worked full-time as a teacher and part-time as a waitress. She hated not having much free time.

*Consistent Trait Elaboration:*
Carol was known for her short temper and her tendency to act without thinking. She never thought about the consequences of her actions, so she often suffered negative repercussions. She refused to let people walk all over her. In fact, she had just gotten a ticket for road rage. She decided she would never put up with anyone that was not nice to her. One particular night, Carol had an extremely rude customer. He complained about his spaghetti, and he yelled at Carol as if it was her fault.

*Inconsistent Trait Elaboration:*
Carol was known for her ability to peacefully settle any confrontation. She would never even think to solve her problems with physical violence. She taught her students and her own children how to solve problems through conversation. She believed this was an effective way to stop the increasing violence in schools. Carol also helped other parents learn to deal with their anger. One particular night, Carol had an extremely rude customer. He complained about his spaghetti, and he yelled at Carol as if it was her fault.

*Neutral Trait Elaboration:*
Carol loved her kids and would do whatever it took to keep them. She was thankful that she was granted sole custody after the divorce. She didn't know what she would have done if she lost her children. She tried to make the time that they had together meaningful. They ate dinner together every night and she always planned a fun event for the weekend. One particular night, Carol had an extremely rude customer. He complained about his spaghetti, and he yelled at Carol as if it was her fault.

*Target Sentence:*
Carol lifted the spaghetti above his head.

*Target Sentence for Baseline Condition:*
She lifted the spaghetti and walked away.

*Probe:*
Dump

described Carol's personality were most likely encoded into memory and then facilitated the activation for a predictive inference at the end of the passage.

To extent these findings, Guéraud, Tapiero, & O'Brien (in press) designed a study that assessed whether the context from the discourse model can override immediate context to the point of leading to a very different inference. The authors adapted the materials used by Perrachi and O'Brien (2004). Each passage began by introducing a protagonist. For half of the passages, the introduction was followed by an alternative character-trait elaboration in which Carol was described as someone who just had shoulder surgery and would become uncomfortable anytime she had to raise something. For the remaining half, no character-trait information was presented. Following the inference-setting information and either an inference-evoking sentence or a baseline sentence, participants were asked to name a predictive inference that was either consistent or inconsistent with the character-trait elaboration that they had read (e.g., "dump" or "pain") (see sample passage Table 6). The results demonstrated that the trait descriptions were sufficient to produce activation of only one specific inference; this occurred even though the immediately preceding context in isolation led to the activation of a very different inference. That is, when the alternative trait information is absent time to name the high context inference (e.g., pain) was faster following the inference-evoking sentence than following the baseline sentence.

The resonance process is useful in that it provides a model for how information becomes activated and applied during reading. Information in memory can be activated regardless of whether it is stored in short-term memory or long-term memory making the distinction between local and global coherence obsolete. According to the resonance

Table 6.

Sample Passage from Guéraud, Tapiero & O'Brien (in press)

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*Introduction:*
Carol was a single mother with two young children. She had to work two jobs to make ends meet. She worked full-time as a teacher and part-time as a waitress. She hated not having much free time.

*Primary Character- Trait Elaboration:*
Carol was known for her short temper and her tendency to act without thinking. She never thought about the consequences of her actions, so she often suffered negative repercussions. She refused to let people walk all over her. In fact, she had just gotten a ticket for road rage. She decided she would never put up with anyone that was not nice to her.

*Alternative Character-Trait Elaboration:*
Carol was known for her ability to peacefully settle any confrontation. She would never even think to solve her problems with physical violence. She taught her students and her own children how to solve problems through conversation. She believed this was an effective way to stop the increasing violence in schools. Carol also helped other parents learn to deal with their anger.

*Inference-setting Information:*
One particular night, Carol had an extremely rude customer. He complained about his spaghetti, and he yelled at Carol as if it was her fault.

*Inference-Evoking Sentence:*
Carol lifted the spaghetti above his head.

*Baseline Sentence:*
She lifted the spaghetti and walked away.

*High-Compatibility Probe:*
Dump

*Low-Compatibility Probe:*
Pain

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model when a signal is sent out to all of memory any and all related information can resonate and become active in memory. Current research on predictive inferences indicates that with sufficient context predictive inference can in fact become activated. The goal of this thesis is to further assess how readers keep track of object in spatial environments and how this information becomes available or accessible to readers. More specifically, do readers maintain spatial information in memory, or do readers continually actively search memory for spatial information, or does spatial information become reactivated through a passive resonance process.

# CHAPTER IV

## THE ROLE OF SPATIAL INFORMATION IN COMPREHENSION

As outlined earlier, both the explanation-based view as well as the memory-based view assume that spatial information is being attended to during the reading process. However, both views have different assumptions about the availability of information in active memory.

The explanation-based view is best captured by the *snapshot analogy*, which is much like a visio-spatial representation of what the text currently describes. According to the snapshot analogy information in the snapshot is more available than information that is not, spatial location information remains available until there is some shift to a new snapshot, and readers need sufficient information to update the situation model but do not require contextual cues to reactivate spatial information.

Because readers can potentially encode many different details (e.g., character goals, temporal sequences of events, spatial relations between locations) a considerable amount of research has been devoted to examining which dimensions readers encode into situation models. According to the event-indexing model readers maintain mental indices for the passage of time, the organization of space, the relations and intentions of characters and objects, and causal structure of event in narratives. Zwaan et al. (1995) designed a series of experiments that attempted to test this hypothesis. The materials

consisted of four short narratives that were adopted from Graesser (1981). Each participant received a booklet with the narratives in a random order. Each narrative was followed by a page that showed a list of 10 verbs from the narrative, plus a column of seven boxes. Participants were instructed to write down in the same box verbs that they thought belonged together based on their memory for the narratives (memory condition). Participants subsequently received the booklets again and were allowed to look over the narratives while performing the clustering task (text-present condition). The five dimensions pertained to the situational representation included: temporal relatedness indicated whether or not two events occurred in the same time frame, spatial relatedness indicated whether or not two events occurred within the same spatial region, protagonist identity indicated whether or not two events involved the same agent, causal relatedness indicated whether or not two events were directly related causally, and intentional relatedness indicated whether or not two actions were part of the same plan.

Two proximity scores were computed for each verb pair, one set of proximity scores pertained to the memory condition, whereas the other set pertained to the text-present condition. A proximity score indicates the proportion of subjects who had placed the two verbs in the same category. In the memory condition, the lexicon and all five situational variables were reliable predictors of verb relatedness. In the text-present condition, all five situational variables were reliable predictors. However, none of the individual textual variables reached significance in the memory condition indicating that surface and textbase memory traces decay rather rapidly. The situation model variable was stronger in the text-present condition than in the memory condition. Hence, the presence of the text may help to make an already strong situational representation even

stronger. These findings showed that the different situational dimensions were not highly intercorrelated in stories and each dimensions made an independent contribution to predicting verb-clustering scores. The results also supported the assumption that three types of memory representations function as sources for verb relatedness and situational representations in episodic text memory. Across both conditions, all three types of memory representations made reliable contributions toward explaining variance in verb relatedness judgments.

Morrow and his colleagues (e.g., Bower & Morrow, 1990; Morrow, 1994; Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987; Wilson, Rinck, McNamara, Bower, & Morrow, 1993) also examined the role spatial information played in the development of a situation model. The authors presented participants with narratives after they had memorized a map of a spatial layout. The layout was composed of rooms that all connected and in each room was a set of objects. After the participants had memorized the rooms and the objects in the rooms, they were presented with narratives that involved a protagonist from a source room, through an unmentioned path room, to a goal room (e.g., Wilbur walked from the library to the laboratory). Immediately following this sentence, reading was interrupted, and a pair of probe words was presented on the screen. The participants had to determine whether or not the probe words were located in the same or a different room in the previously memorized map. Response times varied based on the location of the protagonist. That is, objects located in the goal room or path room were responded to more quickly than objects in the source room. Morrow and his colleagues argued that participants developed a spatial model and used the information to focus on specific information within the text. More specifically,

they were focused on the current "snapshot" of the protagonist, including information such as the character's physical location and the location of objects with respect to the protagonist's location. Because the reader was more focused on spatial information, it was more accessible than other, nonspatial information, as well as information that was not currently the focus of the snapshot (see also Haenggi, Kintsch, & Gernsbacher, 1995; Rinck & Bower, 1995).

Although previous research has shown that readers pay attention to spatial information after they had to memorize maps, the question still remains as to how important spatial information is during other reading situations. In other words, do readers typically focus on spatial information? To test this, Wilson et al. (1993) presented participants with maps to memorize in the same way as Morrow and his colleagues except that they did not include a probe that involved the protagonist and an object (e.g., Wilbur –Scales). As a result of dropping this type of probe, they failed to replicate the pattern of results consistently found by Morrow and his colleagues. This suggests that in previous work participants might have adopted a strategy that maximized their performance on the probe task. For example, when the probe that contained the protagonist's name was part of the experiment, participants presumably focused more on the spatial location than they usually would. When the probe that contained the protagonist's name was not included, focusing on spatial information was not efficient and was therefore not done.

The memory based view, on the other hand, describes situation models as *integrated networks* that contain explicitly stated text and information that readers bring to bear from general world knowledge. According to this view, the amount of

information active in memory is quite limited, only the information that is continuously referenced throughout the text remains active in memory. Moreover, spatial information has no special status and only remains available if the text focuses the reader's attention on it. Although spatial information is encoded, it is not typically held in active memory but can be readily reactivated with appropriate cuing.

Previous research has shown that readers attend to spatial information in written text. For example, O'Brien and Albrecht (1992) showed that readers remain sensitive to the location of the protagonist and are able to detect inconsistencies about the protagonist's location. The authors presented participants with passages in which an initial sentence placed a protagonist in a particular location (e.g., inside or outside a building). After several background sentences, participants read a second sentence that was either consistent with or inconsistent with the initially stated location of the protagonist. The passages were written so that the second location sentence could be integrated with the immediately preceding text without making reference to the initially stated location of the protagonist (i.e., the second location sentence was locally coherent but globally incoherent). Consider the following passage:

> As Kim stood inside the health club she felt a rush of excitement. She was getting anxious to start and was glad when she saw the instructor go in the door of the health club. Kim really liked her instructor. Her enthusiasm and energy were contagious.

On the text-based level, readers will have no problem with this passage because each of the idea units connect up with the ones that came before. However, when considering the representation of the situation model, that is the situation described by the

text, the reader will detect the inconsistency that the protagonist cannot watch the instructor go in the door of the health club if she is standing inside.

O'Brien and Albrecht (1992) found that when the second location sentence violated the initially stated location of the protagonist, participants experienced comprehension difficulty even though the second sentence was locally coherent. These findings demonstrated that readers remain sensitive to the location of the protagonist as well as to information that is spatially relevant to the main character of a text (see also Glenberg et al., 1987; Morrow et al., 1989; Morrow et al., 1989). Although it is clear that readers remain sensitive to the protagonist's location, it is not clear whether they maintain spatial information in active memory or whether current information about the location of the protagonist is checked against where they know the protagonist to be from earlier portions of the text.

De Vega (1995) demonstrated that readers only update a situation model to accommodate spatial information when prompted by the text demands. De Vega (1995) presented participants with passages that described a protagonist moving through a spatial environment (see sample passage in Table 7). The environments consisted of either an inside-outside layout (e.g., inside or outside a building) or a top-down layout (e.g., upstairs or downstairs). The protagonist was described as interacting with an object (observing, admiring, etc.) that was either consistent or inconsistent with the protagonist's current location. The author found that reading times increased when the character was interacting with an object that was not in the same location as the protagonist. Furthermore, when the text prompted the reader to integrate the spatial

Table 7.

Sample Passage from De Vega (1995)( Translation from Spanish)

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*Introductory Sentence:*
Carmen likes to walk around in the museum area.

*Layout Description:*
The museum has a free entrance so that people can explore the past. The museum has a famous room with very well preserved Egyptian mummies. In the street, just on front of the museum, many pigeons came, because people use to feed them.

*Biasing Sentence:*
Carmen went into (went out of) the museum

*Filler:*
and she walked a few steps.

*Last Sentence:*
She approached the mummies (pigeons) quietly.

---

information into the situation model, spatially related information was more available to the reader, as shown by faster response times. However, unless participants were cued to update the situation model to accommodate spatial information, availability of spatial information did not differ as a function of location of the protagonist.

To extent these findings, Hakala (1999) examined the conditions under which readers focus on spatial information other than simply the location of the protagonist under relatively natural reading conditions. To test this hypothesis Hakala (1999) generated ten passages describing a protagonist moving through a spatial environment (see Table 8). Each passage began with an introduction that described the initial spatial location of the protagonist and a spatial description of the particular target locations followed by filler material and a relocation sentence that shifted the protagonist back to a target location without explicitly rementioning the location. Following each passage, participants were presented with a probe word to be named. The probe was either the final spatial location of the protagonist or a neutral word that was close to the spatially associated probe in the text's surface structure but did not contain spatial information. Prior to the start of the experiment, half the participants were told that, while reading each text, they were to pay attention to the spatial details of the text while the remaining half were told that answering the comprehension question was the most important component of the experiment.

The mean naming times of the probe words were significantly faster when participants had been instructed to focus on spatial information than when they were not instructed to do so. When reading for comprehension, readers did not appear to focus

Table 8.

Sample Passage from Hakala (1999)

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Tony had just been transferred to Minnesota and was busy getting settled into his new apartment. After he finished unpacking, he decided to go to the supermarket and pick up some groceries. He got into his car and drive downtown to the supermarket. As soon as Tony entered, he noticed a large bakery off of his right that had been set off from the rest of the store by a large partition. It appeared to be its own separate shop within the supermarket. In fact, there was a door between the bakery and the rest of the store. Tony went through the door and looked around. He saw that inside were all different kinds of pastries and baked goods to choose from. He also noticed a large juice rack in the corner that contained all the juice sold in the store. Tony quickly glanced at the rack, but decided to wait and see if he had enough money left over after he had purchased everything he needed. However, while there, Tony picked up a package of muffins and bagels. He left and walked out to the main store's dairy case for some eggs and milk. Tony also really enjoyed cold cereals, so he went to the cereal aisles and grabbed three boxes. At the opposite end of the store, Tony found the deli, where he picked up cold cuts for sandwiches. After he left the deli, Tony added up his grocery bill and realized that he still had enough money left over to buy juice. He quickly headed back to the juice rack and grabbed a bottle.

*Associated probe:*
Bakery

*Neutral probe:*
door

---

specifically on spatial information, and this spatial information was not more available at the end of the text than other, neutral material. Thus, Hakala (1999) showed that readers can keep track of spatial information, but only under specific conditions, such as when they are explicitly instructed to focus on spatial information or when the understanding of the text requires such a processing. Moreover, this study revealed that readers do in fact encode spatial information so it can be reactivated later when it is needed for comprehension. Therefore, the research to date suggests that spatial information clearly plays a role in comprehension but it is unclear what governs its accessibility.

The explanation-based view and the memory-based view have different predictions concerning the availability and accessibility of spatial information. Hakala (1999) found that readers can keep track of spatial information, but only under specific conditions, while Zwaan et al. (1995) argued that readers maintain mental indices for several dimensions at all times. Thus, the extent to which spatial information would be activated is unclear and once again, no mechanism for the activation has been proposed. The goal of this thesis is to determine what factors govern the availability of objects in a spatial environment.

# CHAPTER V

## EXPERIMENTS

The present set of experiments was designed to further examine the availability of spatial information. Specifically, the current series of experiments was designed to further explore the availability of spatial information, its role in text comprehension and to show that spatial information is encoded and under appropriate conditions can become available for comprehension. In order to establish a baseline, participants in Experiment 1 were asked to say the probe word (e.g., lamp) out loud immediately following the mentioning of the target object. Consider the passage in Table 9. Each passage describes a spatial location of a protagonist and the object of interest (e.g., lamp). In this case, Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table next to her. In one of the two conditions, this context is followed by three filler sentences that forgrounded Lisa but doesn't reference the lamp or any object that might cue the word "lamp." At the end of each passage, participants were presented with the probe word (e.g., lamp) and were required to name it aloud.

## Experiment 1

In Experiment 1, participants read 24 narrative passages and 10 filler passages. Following each passage, participants were asked to name a probe word out loud. Time to name the target object should be faster when following the introduction than when presented with the introduction plus the filler information because the readers will have just read the target object and it is highly likely that the word "lamp" will still be active in memory.

### Methods

Participants. Participants were 24 University of New Hampshire undergraduates who received course credit for their involvement in the experiment.

Materials The materials consisted of 24 narrative experimental passages and 10 filler passages. A full set of materials used in Experiment 1 appears in Appendix A.

Each passage began with an introductory section that served to describe a spatial location of a protagonist and the target object (e.g., lamp). This section contained a mean ranged from of 76-81 words with a mean of 78.83 words. This was followed by three filler sentences that continue the same topic but do not reference the target object or any cues that might reactivate the target object for three sentences. The filler section range from 50-54 words with a mean of 52.63 words. Each passage was followed by a comprehension question to ensure that participants were reading the passages carefully. Questions focused on information from the passage which was not about the target object. There were an equal number of "yes" and "no" comprehension questions. In addition to 24 experimental passages, each participants read 10 filler passages that included probes from varying points of the passages so participants could not guess the

Table 9.

Sample Passage for Experiment 1.

---

*Introduction:*
Lisa loved to travel to different places around the world. On her current trip Lisa was in Rome and she was enjoying all the historic sites the city had to offer. Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table right next to her.

*Filler:*
As she was waiting for her friend she got involved in a conversation with a man who was sitting next to her. He was also American and as it turned out they both came from the New England area. They talked about how different life was in the U.S. in comparison to Italy.

*Probe:*
lamp

---

to-be-probed item. No data were recorded for the filler passages. Two material sets were constructed. Each set contained 12 passages that appeared in each of the two conditions. Across the two material sets, each passage appeared only once in each of the two conditions.

Procedure Participants were randomly assigned to one of the two material sets. Each participant was run individually in a session that lasted approximately one hour. All materials were presented on a video monitor controlled by a Dell 386 microcomputer.

Participants were instructed to rest their right thumbs on a line-advance key, their right index finger on a "yes" key, and their left index finger on a "no" key. Each trial began with the word "READY" in the center of the screen. When participants were ready to read a passage, they pressed the line-advance key. Each press of the key erased the current line and presented the next line. Each participant was instructed to read at a comfortable, normal reading pace. Following the last line of each passage, a cue "XXX" appeared for 500 milliseconds. The cue was then replaced by a probe word. Participants were instructed to name the probe word aloud as quickly as possible. When the word was named, a voice key triggered, the probe word was erased from the screen, and the naming time for the word was recorded. After the probe word disappeared, the cue "QUESTIONS" appeared in the middle of the screen for 2000 milliseconds. This was followed by a comprehension questions to which participants responded by either pressing the "yes" or the "no" key. There were an equal number of "yes" and "no" comprehension questions. On the trials where participants made errors, the word "ERROR" appeared in the center of the screen for 750 milliseconds. Before beginning

the experimental passages, participants read three practice passages to ensure that they were thoroughly familiarized with and understood the procedure.

Results and Discussion.

In all analyses reported, $F_1$ always refers to tests against error terms on participants variability, and $F_2$ always refers to tests against an error term based on items variability. All analyses were significant at the standard alpha level of .05, unless otherwise indicated.

The mean naming times for the target object for Experiment 1 appear in Table 10. Time to name the probe was significantly faster after reading the introduction than when reading the filler information in addiction to the introduction, $F_1(1, 22) = 13.561$, MSe = 201.600; $F_2(1, 22) = 10.702$, MSe = 310.456. This indicated that the target object was no longer active in memory after reading three filler sentences that continued the same topic but did not mention the target object or any cues that alluded to it.

Although Experiment 1 demonstrated that the target object was no longer active in memory immediately after reading the filler information, it does not address whether spatial information can become reactivated from long-term memory with appropriate cuing. Earlier studies have suggested that readers do not keep track of spatial information unless they are instructed to do so or it is needed for comprehension (De Vega, 1995; Hakala, 1999). This suggests that readers encode spatial information but the experimenters of these studies did not test the accessibility of spatial relational information among objects. Experiment 2 is designed to determine whether or not readers encode spatial information and to provide evidence that spatial information can become reactivated with appropriate cuing.

Table 10.

Mean Naming Times for Probe in Experiment 1

| Introduction Only | Introduction and Filler |
|---|---|
| 463.030 | 479.669 |

## Experiment 2

Experiment 1 provided evidence that readers only hold the object of interest in active memory immediately following the mentioning of the object; however, testing if the target object is not available after reading the filler information is not really a strong test because one might argue that the current snapshot could have degraded. Previous work has shown that cuing can sometimes increase the accessibility of information in the current snapshot. Experiment 2 will address what kind of information must be in these cues in order to reactivate the target object in memory. Specifically, it was designed to determine whether spatial information or contextual cues would be necessary to reactivate the target object (.e.g., lamp). A sentence that either contained spatial information, spatial information plus contextual cues, or only contextual cues were presented after reading the introduction and three filler sentences.

In Experiment 2, participants read the same introduction and filler sentences as in Experiment 1 in addition to one of three sentences. A control condition, in which participants will have to say the probe word out loud immediately following the introduction and filler information will serve as a baseline for the three cuing conditions. Consider the sample passage in Table 11. The filler section was followed by one of three types of critical sentences: spatial cues only (e.g., Lisa stayed where she was but started looking around for her friend so they could go to dinner), spatial cues and contextual cues (e.g., Lisa stayed on the couch next to the table but started looking around for her friend), or contextual cues only (e.g., Lisa noticed that the couch and the table matched perfectly as she was waiting for her friend). The sentence that provides spatial information only highlights the spatial information without direct cues to the target object, the sentence

Table 11.
Sample Passage for Experiment 2.

---

*Introduction:*
Lisa loved to travel to different places around the world. On her current trip Lisa was in Rome and she was enjoying all the historic sites the city had to offer. Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table right next to her.

*Filler:*
As she was waiting for her friend she got involved in a conversation with a man who was sitting next to her. He was also American and as it turned out they both came from the New England area. They talked about how different life was in the U.S. in comparison to Italy.

*Probe:*
*Lamp*

*Spatial cue but no contextual cue:*
Lisa stayed where she was but started looking around for her friend so they could go to dinner.

*Spatial cue and contextual Cue:*
Lisa stayed on the couch next to the table but started looking around if her friend was coming.

*Contextual cue only:*
Lisa noticed that the couch and the table matched perfectly as she was waiting for her friend.

*Probe:*
lamp

---

that provides spatial cues and contextual cues highlights the spatial information and also has contextual cues; that is, the couch and the table, and the contextual cue only sentence contains contextual cues only but no spatial information.

The explanation-based view predicts that reminding the reader of the snapshot, in other words, providing spatial information, should reactivate information about objects that are in the snapshot. Therefore, the first and second sentence, which contain spatial information should reactivate the probe. Time to name the probe would be faster following the first and second sentence than in the baseline condition. Time to name the probe after reading the third sentence should not differ from the baseline condition.

In contrast, the memory-based view predicts that there will be no reactivation of the target object unless there are contextual cues alluding to it. Therefore, the second and third sentence, which contain contextual cues should reactivate the probe and time to name the probe should be faster in those two conditions than in the baseline condition whereas time to name the probe following the first sentence should not differ from the baseline condition.

Method.

Participants. Participants were 60 University of New Hampshire undergraduates enrolled in psychology courses, who had not participated in Experiment 1. Participants received course credit for their involvement in the experiment.

Materials. The materials are the same 24 passages as those in Experiment 1 in addition to either one of three cuing sentences. First, the participants read the same introductions and filler sentences from Experiment 1. Following the introduction and the filler sentences, participants either had to say the probe word out loud immediately after

the filler information or they read one of three cuing sentences. The cuing sentence contained either spatial information only, spatial information and contextual cues, or contextual cues only. The cuing sentences had a mean of 79 characters, with a range of 78-82 characters. As in Experiment 1, each passage was followed by a comprehension questions to ensure that participants were reading the passages carefully. Questions focused on information from the passage which was not about spatial information or any of the contextual cues. There were an equal number of "yes" and "no" comprehension questions.

Four material sets were constructed. Each set contained eight passages that appeared in each of the four conditions. Across the four material sets, each passage appeared only once in each of the four conditions. A full set of materials used in Experiment 2 appears in Appendix B.

Procedure. The procedure for Experiment 2 was the same as in Experiment 1.

Results and Discussion.

The mean naming times for the target object for Experiment 2 appears in Table 12. There was an overall effect of cuing condition, $F_1(3, 168) = 13.732$, MSe = 437.554; $F_2(3, 60) = 4.416$, MSe = 317.472. Planned comparisons revealed that naming times for the target object were faster in the contextual cue condition than in either the baseline condition, $F_1(1, 56) = 50.871$, MSe = 649.815; $F_2(1, 20) = 15.473$, MSe = 451.402; the spatial condition, $F_1(1, 56) = 21.482$, MSe = 795.580; $F_2(1, 20) = 7.079$, MSe = 779.66; or the spatial and contextual cue condition, $F_1(1, 56) = 16.680$, MSe = 988.459; $F_2(1, 20) = 4.702$, MSe = 667.935.

Table 12.

Mean Naming Times for Probe in Experiment 2

| Baseline | Spatial Cue | Spatial & Contextual Cue | Contextual Cue |
|---|---|---|---|
| 520.98 | 514.39 | 514.09 | 497.51 |

These findings are consistent with the memory-based view of text processing. That is, there was no reactivation of the target object unless there were contextual cues alluding to it. However, when participants received either spatial cues or spatial and contextual cues, time to name the target object was not significantly different from the baseline condition. This indicates that contextual cues facilitate the activation of the target object while spatial information does not.

To provide an even stronger test of the two competing views, Experiment 3 will determine what happens when the protagonist spatially moves away from the target object, that is, the snapshot changes.

## Experiment 3

Experiment 2 showed whether the object of interest becomes reactivated through spatial information, contextual cues, or both. To provide an even stronger test of the two competing views, the third experiment will require participants to read the introduction and filler information and an additional sentence in which the protagonist spatially moves away from the target object, that is, the snapshot shifts to a new spatial location. Again, a control condition will serve as the baseline for the two cuing conditions.

In Experiment 3, participants read the same introduction and filler sentences as in Experiment 1 and 2 in addition to one of three cuing sentences. A control condition, in which participants will have to say the probe word out loud immediately following the introduction and filler information will serve as a baseline for the two cuing conditions. Consider the sample passage in Table 13. The filler section was followed by one of two

Table 13.

Sample Passage for Experiment 3.

---

*Introduction:*
Lisa loved to travel to different places around the world. On her current trip Lisa was in Rome and she was enjoying all the historic sites the city had to offer. Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table right next to her.

*Filler:*
As she was waiting for her friend she got involved in a conversation with a man who was sitting next to her. He was also American and as it turned out they both came from the New England area. They talked about how different life was in the U.S. in comparison to Italy.

*Probe:*
*lamp*

*No contextual cue:*
Lisa stood up and walked across the lobby to see if her friend was coming so they could go to dinner.

*Contextual cue:*
Lisa stood up and moved away from the couch next to the table to see if her friend was coming yet.

*Probe:*
lamp

---

types of cuing sentences: No contextual cue (e.g., Lisa stood up and walked across the lobby to see if her friend was coming so they could go to dinner) or contextual cues (e.g., Lisa stood up and moved away from the couch next to the table to see if her friend was coming). The sentence that contains no contextual cues shifts to a new snapshot and provides no contextual cues whereas the second sentence also shifts to a new snapshot but contains contextual cues.

According to the explanation-based view, the target object will no longer be in active memory because the information of the old snapshot is no longer available as the situation model has shifted. Therefore, the time to name the probe would be the same for both cuing conditions as for the baseline condition. In contrast, the memory-based view must predict that the probe word gets reactivated for the second sentence because it contains contextual cues. Therefore, the time to name the probe would be faster for the second cuing condition compared to either the baseline or the first cuing condition.

Method.

Participants. Participants will be 30 University of New Hampshire undergraduates enrolled in psychology courses, who had not participated in Experiment 1 or 2. Participants received course credit for their involvement in the experiment.

Materials. The materials are the same 24 passages as those in Experiment 1 and 2 in addition to either one of two cuing sentences. First, the participants read the same introductions and filler sentences from Experiment 1 and 2. Following the introduction and the filler sentences, participants either had to say the probe word out loud

immediately following the introduction and filler information or they read one of two cuing sentences. The first cuing condition shifted to a new situation model (i.e., new snapshot) and contained no contextual cues while the second condition also shifted to a new situation model but contained contextual cues. The cuing sentences had a mean of 79 characters, with a range of 78-82 characters. As in Experiment 1 and 2, each passage was followed by a comprehension questions to ensure that participants were reading the passages carefully. Questions focused on information from the passage which was not about spatial information or any of the contextual cues. There were an equal number of "yes" and "no" comprehension questions.

Two material sets were constructed. Each set contained twelve passages that appeared in each of the two conditions. Across the two material sets, each passage appeared only once in each of the two conditions. A full set of materials used in Experiment 3 appears in Appendix C.

Procedure. The procedure for Experiment 3 was the same as in Experiment 1 and 2.

Results and Discussion.

The mean naming times for the target object for Experiment 3 appears in Table 14. There was an overall effect of cuing condition, $F_1(2, 54) = 10.455$, MSe = 297.966; $F_2(2, 42) = 9.382$, MSe = 310.180. Planned comparisons revealed that naming times for the target object were faster in the contextual cue condition than in the baseline condition, $F_1(1, 27) = 16.201$, MSe = 408.973; $F_2(1, 21) = 12.937$, MSe = 601.913; or in the spatial cue condition, $F_1(1, 27) = 20.436$, MSe = 558.731; $F_2(1, 21) = 16.697$, MSe =

573.784. This indicated that the target object from the "old" snapshot only became reactivated when the cuing sentence contained contextual cues.

These findings are consistent with the memory-based view of text processing. That is, contextual cues will reactivate the probe even if the protagonist spatially moves away from the target object in the old snapshot. On the other hand, the probe did not become reactivated if the snapshot shifts to a new spatial location and no contextual cues alluded to the target object.

Table 14.

Mean Naming Times for Probe in Experiment 3

| Baseline | Spatial Cue | Contextual Cue |
|---|---|---|
| 482.02 | 486.67 | 467.16 |

# CHAPTER V

## GENERAL DISCUSSION

The experiments in this thesis further explored the conditions under which objects that are part of the situation model become activated with appropriate cuing and, to what extent spatial information plays a role in the availability of these objects. Previous research has shown that readers keep track of spatial information in written text, including objects that are relevant to the main character (e.g., O'Brien & Albrecht, 1992; Glenberg et al., 1987; Morrow et al., 1989). In the present set of experiments, each passage described a spatial location with a protagonist and a target object. Three main issues were addressed. First, will target objects remain active in memory as long as the spatial location remains the same even after reading three filler sentences that forgrounded the protagonist but do not re-mention the target object? Second, if a target object is no longer active after reading the filler information do they become reactivated with appropriate cuing? Third, what sorts of cues will lead to the target object's reactivation after the protagonist moves to a new spatial location and the situation model shifts to a new snapshot?

Experiment 1 tested whether or not the target objects decayed in working memory as a function of distance in text. In the first condition, readers only read the introduction section in which the protagonist was introduced in a spatial location with several objects

around him/her. In a second condition, three filler sentences were added that forgrounded the protagonist but did not re-mention the target object. Under the assumptions of the explanation-based view as well the memory-based view the time to name target objects should be faster following the introduction than when presented after the introduction in and filler information. When the target word was presented immediately following the introduction it is highly likely that it is still active in memory. On the other hand, after the protagonist has been foregrounded without re-mentioning the target object it is likely that the target object will no longer be active in memory. The results supported this assumption, that is, the target object was named more quickly after reading only the introduction than when filler information foregrounded this target concept in text.

These results fit nicely with previous findings by O'Brien, Duffy, and Myers (1986). In this study the researchers introduced the reader to a new topic prior to reinstatement of a target anaphor, the new topic was designed to bump the antecedent out of working memory. Including a condition that tested for the availability of the target anaphor allowed them to demonstrate that the target anaphor was responded to more quickly following the reinstatement than just prior to reinstatement. This illustrated that the antecedent was no longer active in working memory when the reinstatement sentence was encountered. Similarly, including a baseline condition (i.e., foregrounding the protagonist without re-mentioning the target object) in the current study ensured that the target object was no longer active in working memory right before the reader encountered either one of the cuing sentences in the following experiments.

Experiment 2 tested whether the target object could become reactivated with appropriate cuing. More specifically, Experiment 2 addressed what kind of cuing

information would lead to the reactivation the target object. The same introduction and filler sentences were used as in Experiment 1. One of three cuing conditions was used: spatial information cues, spatial information plus contextual cues, or contextual cues alone. If the target object was named more quickly after reading the sentence that contains spatial information then reminding the reader of the current snapshot would be sufficient to reactivate the target object. However, if the target object (e.g., lamp) was named more quickly after reading the sentence that contains contextual cues (e.g., coach and table) then simply reminding the reader of the current situation model would not be sufficient to reactivate the target object because contextual cues were necessary. Lastly, if the target object was named more quickly after reading the sentence that contained both spatial information plus as contextual cues then reminding the reader of the current situation model in addition to providing the reader with contextual cues would be necessary to reactivate the target object.

The results supported the hypothesis that contextual cues were necessary to reactivate the target object and reminding the reader of the current situation model was not sufficient to reactivate the target object. That is, time to name the target object after reading the sentence that contained only contextual cues was faster than either the baseline condition, spatial cue condition, or spatial plus contextual cue condition.

These results fit in nicely with the memory-based view of text processing. One of the basic assumptions of the memory-based view is that information that a reader has encoded can be affected by information from earlier portions in the text and general world knowledge. Whenever a reader encounters new information in the text a signal is sent of to all of memory and related information resonates in response to this signal with

the most active information returning to working memory. In other words, when the reader encounters contextual cues (e.g., coach and table) it sends a signal to all of memory and all previous information that shares features in common with these contextual cues will resonate in response to it. This includes information about other objects that are part of the spatial location of the protagonist. For the cuing sentence that only provided spatial information (e.g., Lisa stayed where she was but started looking around for her friends so they could go to dinner) no information regarding the target object (e.g., lamp) was activated because the spatial information provided in the sentence was not sufficient to activate the target object.

Now consider the cuing sentence that provided both spatial information plus contextual cues. The results indicated that the time to name the probe after reading this cuing sentence was not faster than in the baseline condition. Therefore, providing the reader with both types of cues; that is, spatial information plus contextual cues, did not facilitate the activation of the target object. This finding was somewhat surprising because contextual cues appeared to facilitate the activation of the target object in the third condition; however, when contextual cues were presented in addition to spatial information they did not lead to activation of the target object.

One explanation for this finding is that providing the reader with spatial information plus contextual cues lead to the activation of multiple pieces of information thereby reducing the ability to detect activation of the target object. Proponents of the memory-based view have argued that any information that is related to the current contents of memory can become reactivated through the resonance process independent of whether or not it will help or hinder comprehension (Myers & O'Brien, 1998; O'Brien

& Myers, 1999). It is therefore possible that both the spatial information as well as the contextual cues sent out a signal to all of memory and because too much information was returned it took participants longer to respond to the probe because they needed to consolidate the information that was returned first. In a series of experiments Myers, O'Brien, Balota, and Toyofuku (1984) showed that the time required to search memory increased with the number of facts learned about the propositional subject. The more information associated with a concept, the more time required for activation to a particular association. A number of studies (e.g., Anderson, 1974; Reder & Anderson, 1980) support this prediction, which is often referred to as the "fan effect." The findings of the current study support this hypothesis because when the target object had multiple associations (i.e., spatial information as well as contextual cues) the time to name the probe increased. In other words, the time to activate the target object increased as a function of the number of cues in memory.

Ratcliff (1978) described memory retrieval as a process that is influenced by how much a concept is activated in memory. One of the original assumptions of the resonance process is that the extent to which concepts become active during reading is a direct function of the degree of featural overlap. In other words, as the contextual cues in the second condition sent out a signal to all of memory, the probability that a specific lexical item (e.g., lamp) becomes reactivated increases. Moreover, as the level of contextual support increases, the degree of specificity of a target object also increases. However, if both contextual cues plus spatial information are presented to the reader, the spatial information will also sent out a signal to all of memory and will return a broader range of concepts (e.g., Lisa was waiting for her friends so they could go out to dinner). The

Table 15.

Table of Type of Cuing Sentence and Activation of the Target Object in Experiment 2.

| TYPE OF CUING SENTENCE | ACTIVATION OF TARGET OBJECT |
|---|---|
| Spatial information cues | no |
| Spatial information and Contextual cues | no |
| Contextual cues | yes |

spatial information does not support one specific lexical item whereas contextual cues allude to the target object (e.g., lamp). Because only few concepts receive sufficient activation to enter working memory, the concept "lamp" might not have become reactivated because the signal has been divided between other perhaps more relevant concepts (e.g., Lisa and her friends are going to dinner) when the reader is presented with both spatial information and contextual cues. Due to the limited capacity of working memory the reader can only hold a few lexical items in working memory at any given point in time. If the context does not restrain the number of concepts that become reactivated, one particular concept (e.g., lamp) is less likely to have become reactivated.

Experiment 3 tested under what conditions the target object becomes reactivated when the situation model shifts to a new spatial location. This experiment provided an even stronger test of the two competing views, that is, the explanation-based view and the memory-based view of text processing, because the protagonist spatially moves away to a new situation model. According to the explanation-based view, because only information in the current snapshot is active in memory, the target object should have degraded and is no longer active in memory. However, the memory-based view predicts that the target object would still be activated on the basis of contextual cues even after the protagonist moves to a new spatial location.

The results of Experiment 3 are consistent with the memory-based view of text processing. That is, time to name the probe was faster for the second cuing condition, (i.e., contextual cues condition), than for either the first condition (i.e., spatial information condition), or the baseline condition. When readers were presented with the cuing sentence that contained contextual cues they triggered a signal to be sent out to all

of memory and all concepts that shared features in common with the contextual cues (e.g., coach and table) became reactivated in memory.

These findings are inconsistent with the findings of Morrow and his colleagues (e.g., Bower & Morrow, 1990; Morrow, 1994; Glenberg, Meyers, Lindem, 1987) that readers only focus on the "current snapshot" of the protagonist, including information such as the protagonist's physical location and the location of objects with respect to the protagonist's location. The current experiment demonstrated that the target object could become reactivated with appropriate cuing even after the protagonist had moved to a new spatial location and the information from the "old snapshot" that contained the target object had degraded.

In conclusion, as stated earlier, all theories of reading comprehension assume that readers attend to and keep track of spatial information to some degree. However, the explanation-based view and the memory-based view have different assumptions about the availability of information that is active in memory at any given point in time. The present results help to define the conditions under which information contained in the situation model become reactivated after they have decayed. The results also provide additional evidence that while contextual cues serve to reactivate target objects in the situation model spatial information does not. Moreover, providing the reader with contextual cues facilitates the activation of the target object whereas providing both spatial information plus contextual cues interferes with their ability to reactivate the target object. Future work should continue to explore the conditions under which information in the situation model becomes reactivated when the protagonist moves around in a spatial location.

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# APPENDICES

# APPENDIX A

The passages used in Experiment 1 are presented in this Appendix. Each participant only saw one of the two conditions of each passage.

*Introduction:*
Lisa loved to travel to different places around the world. On her current trip Lisa was in Rome and she was enjoying all the historic sites the city had to offer. Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table right next to her.

*Filler:*
As she was waiting for her friend she got involved in a conversation with a man who was sitting next to her. He was also American and as it turned out they both came from the New England area. They talked about how different life was in the U.S. in comparison to Italy.

*Probe:*
lamp

*Introduction:*
Joshua decided to take his dog to the park because it was a beautiful spring day. Joshua enjoyed walks in the park because it gave him a chance to relax after a long day at work. He was standing by the pond in the park and looked at the cherry trees around him that were in full bloom. As Joshua was standing by the pond, he started feeding the baby ducks with bread crumbs that he had brought from home.

*Filler:*
As he was enjoying the warm spring breeze, his dog started barking and running towards another dog. At first Joshua was worried because the other dog was much bigger than his dog but they seemed to get along just fine. The dogs chased each other through the grass and had a great time playing together.

*Probe:*
ducks

*Introduction:*
Memorial Day weekend had finally arrived, and Sherry was looking forward to a long and hopefully relaxing weekend. The weather was beautiful and she was planning to go hiking with a group of friends in a nearby park. She was standing in the hallway of her house and couldn't wait for her friends to get there. She was waiting in the hallway by the wooden door looking out the window to see if her friends were there yet.

*Filler*
As she was waiting for her friends to arrive Sherry looked at the clock on the wall and remembered that it stopped a couple of days ago. She had been meaning to get a new battery but she still hadn't gotten a chance to go to the store. She figured she could do it tomorrow.

*Probe:*
*door*

*Introduction:*
Today was the first day of summer vacation and Hannah's mother promised to take her to the swimming pool. It was the first time this season that Hannah was visiting the pool with her mom. When they walked towards the stairs of the pool, Hannah and her mother decided to go into the water right away. As Hannah was standing on the stairs of the pool she put down her inflatable raft and her mom applied some sunblock to her skin.

*Filler:*
While she was waiting for her mom, Hannah watched the other kids buying ice cream from the ice cream stand. Hannah loved the taste of strawberry ice cream with sprinkles. She was certain that her mom would treat her to an ice cream later because she hadn't had one in long time.

*Probe:*
raft

*Introduction:*
Annie was excited because she was going out for dinner at a Thai restaurant with some of her friends. They hadn't been out in a long time, so they had a lot of different things to talk about. Annie was looking for the patio of the restaurant so she would be able to see her friends coming. Because it was still early, she decided to take a seat on the patio where little birds were playing in the water of a fountain.

*Filler:*
As she was waiting she noticed the large billboards advertising a new musical. Annie loved musicals so she decided to try to check the availability of tickets online as soon as she came home that night. She had never seen that particular musical so she was looking forward to it.

*Probe:*
birds

*Introduction:*
Tom and his wife had been house hunting for several weeks when they finally found a house they both liked and could afford. They were moving today and they had been busy all day to make sure that everything was running smoothly. Tom and his wife walked into the kitchen so they could start unpacking their things. They stood in the kitchen surrounded by moving boxes and several pieces of furniture but they didn't know where to start.

*Filler:*
Suddenly Tom remembered that his credit card payment was due the next day and he had been meaning to pay it for days. He quickly picked up his cell phone and called the credit card company. Fortunately, he was able to make the payment just in time to avoid paying a late fee.

*Probe:*
boxes

*Introduction:*
Jessica loved to spend time at her grandparent's house. She was on summer vacation from school and was looking forward to staying over at their house for a couple of days. Jessica was helping her grandfather plant raspberry bushes in the yard so they could make fruit jam in a couple of weeks. Jessica was standing in the yard watching her grandfather dig holes with a small shovel so they could plant the bushes into the ground.

*Filler:*
As she was watching her grandfather, two kids from the neighborhood came by to talk to Jessica. They asked her if she wanted to come ride bikes with them later in the afternoon. Jessica had become quite good friends with the children in the neighborhood although she only saw them during the summer.

*Probe:*
shovel

*Introduction:*
Mark liked New England in the Fall because the leaves on the trees changed colors and the days got shorter. He asked his younger brother if he wanted to go to the nearby park. Mark was in the garage and went through his father's tool box to look for something he could use to fix his bike. As Mark was standing in the garage he noticed the huge scratch that he had accidentally put into his parent's car with a wrench.

*Filler:*
As he looked up he saw his neighbor standing in the driveway. Their next door neighbor also had two sons and they had become good friends over the years. His neighbor invited him to a dinner party next weekend and Mark told him that he would ask his parents if they could come.

*Probe:*
scratch

*Introduction:*
Gavin was doing an internship at an advertisement company in Boston this summer. He enjoyed living in the city because there was always so much to do. Gavin and his friend had agreed to meet in front of the aquarium by the benches at 2pm that afternoon. Gavin decided to sit down on one of the benches that were right by the parking meters so he could see his friend's car when he arrived.

Filler:
As Gavin was waiting for his friend he saw two guys starting a fight. They were yelling at each other but Gavin wasn't able to understand what they were saying but he saw one of them fell down and hit his head on the pavement. Luckily, the police came and broke them up quickly.

Probe:
meters

*Introduction:*
Nina was at the grocery store to pick up some food for dinner. She looked into her shopping cart to check if she had gotten all the ingredients she needed to make lasagne that night. She was waiting at one of the registers to pay and it seemed like the line was moving very slowly. As Nina was standing in line she threw a pack of flavored mints into her cart and started flipping through a magazine to pass time.

Filler:
As Nina was waiting her cell phone rang and she was surprised to see that her boss was calling her. He told Nina that the meeting with the company's business partners in San Francisco had been pushed forward. Nina knew that they would have to work on the proposal first thing in the morning.

*Probe:*
mints

*Introduction:*
Ben was going on a business trip to New York but his flight was delayed. He was worried that he was going to be late to his meeting. Ben sat down on one of the chairs in the waiting area realizing that there was nothing he could do. As Ben was sitting on a chair at the gate, he took out his new phone to check his messages before he started working on his laptop.

*Filler:*
Suddenly Ben recognized one of his old friends from college. They started chatting about how long it had been since they had last seen each other. Ben and his old college friend talked about old times and how they should get together soon so they could have dinner and catch up.

*Probe:*
phone

*Introduction:*
Denise was helping her son's first grade teacher with the Halloween party this year. She and the teacher had decided that it would be fun to have the children decorate cookies. Denise stood by the counter in the school's kitchen holding up pictures of what the cookies were supposed to look like once they were done. Denise leaned over the counter and handed the kids colored candy to decorate the cookies while she spread icing on another one.

*Filler:*
When Denise looked up she saw that the child right next to her was about to fall off his chair because he had been bouncing around. She quickly grabbed him so he wouldn't hurt himself. Even though she saved him he started crying and Denise had a hard time consoling him.

*Probe:*
candy

*Introduction:*
Neil was on a date with his girlfriend and they had agreed to see a comedy because Neil didn't like romantic movies. Neil was annoyed because their discussion had taken so long that they arrived late and the only seats left were in the first row. To make the best out of the situation, Neil stretched out in his seat and drank some of his refreshing soda and started to munch on the popcorn that he had just bought.

*Filler:*
Although the previews had already begun, Neil and his girlfriend started talking about their plans to go camping next weekend. They had decided to go up into the mountains and sleep in tents outside. They talked about how exciting it will be to live without modern technology for a couple of days.

*Probe:*
soda

*Introduction:*
David went to visit his uncle at his cabin in Maine over the break. His uncle loved hunting and he had promised David to teach him how to track animals. It was a cold winter night and they had just finished eating dinner when they sat down by the fireplace so they could warm up. As they were sitting by the fireplace David picked up an old book from the side table next to him and started reading.

*Filler:*
Suddenly David noticed that there were two deer standing in his uncle's backyard and he had never seen deer so close up. They were digging around in the snow trying to find something edible. Nobody in the city would believe him when he told them that he had seen a real deer.

*Probe:*
book

*Introduction:*
Sara had just bought a new home and she knew it was going to take a lot of time and energy to make the place look nice. She was excited about the changes she wanted to make. She had spent the morning cleaning up weeds in the garden because the previous owner had not taken good care of the lawn. She was standing in the garden next to a white fence and was working on cutting back some of the bushes.

*Filler:*
As she was busy doing things her neighbor from across the street approached her. They started talking about two robberies that had occurred only a few blocks away from their neighborhood in the past couple of weeks. They decided to bring up the issue at the next community meeting to come up with a plan.

*Probe:*
fence

*Introduction:*
Charlotte was at the mall with her friend because they both loved shopping. She needed to buy a dress and shoes for a wedding that she was invited to. Charlotte and her friend were standing at a snack bar because they both felt hungry from having been to so many stores in the mall. Shortly after they placed an order at the snack bar, the clerk put a slice of hot pizza on the counter and got their order of lemonade.

*Filler:*
As Charlotte searched for her lip balm in her purse, she noticed that there was a hole in the lining. She reached into the hole and realized that several items that she had been looking for had fallen through the hole. She was relieved to find a bracelet that she had been missing.

*Probe:*
pizza

*Introduction:*
Elliot was a lawyer and he was at a lunch meeting with one of his new clients. They had gone to his favorite Italian restaurant because Elliot thought the food there was excellent. He couldn't wait to get a table and to order his meal because he hadn't eaten anything all morning. As soon as they were seated at a table, they were served warm bread and butter by a waitress that also took their drink orders.

*Filler:*
As they were waiting for their lunch to come, Elliot noticed the large fish tank that was right behind him. It reminded him of the one that he had when he was younger. He and his brothers had spent hours watching the fish and identifying the family each new fish belonged to.

*Probe:*
bread

*Introduction:*
Kevin was a freshmen in college and he was going to his first class today. He was nervous because his first class was a statistics course and he was never really good at math. He didn't know anybody so he sat down at a desk that was all the way in the back of the room. To get ready for class, Kevin reached underneath the desk and pulled out his mechanical pencil from his book bag so he could take notes.

*Filler:*
As Kevin was waiting for the class to start, the person right next to him started talking to him. He told him that there was going to be a party tonight to welcome all the new students. Kevin was excited because his parents had always been strict and didn't let him go out much.

*Probe:*
pencil

*Introduction:*
Rob hated going to the dentist ever since he was a child. He dreaded his annual check-ups weeks in advance because he was afraid that the dentist would have to do work on his teeth. Rob looked over to the waiting room as he gave the receptionist his health insurance information. After he was finished, he entered the waiting room and sat down on a leather chair so he could read the newspaper that he had brought from home.

*Filler:*
As he was waiting he started reading a journal article about global warming. The article said that the first part of the Earth to show dramatic effects from the heating are the oceans. As the ice recedes farther each year many polar bears will drown because it takes them much longer to reach the land.

*Probe:*
chair

*Introduction:*
Emma was a senior in college and it was only a few weeks before graduation. She started applying for jobs weeks ago because she knew it would take some time to find a job. She traveled to New York and had just arrived at the main lobby of the marketing company to go to a job interview. After she took a seat in the main lobby, she asked the receptionist for chilled water before she started to fill out one of the questionnaires.

*Filler:*
As she was waiting she thought about what it would be like to live in New York. She grew up in a rural area of New Hampshire and had never lived in a large city. She was looking forward to visiting all the sites in New York and being able to enjoy all the different restaurants.

*Probe:*
water

*Introduction:*
Brian had stayed home from work today because he was feeling sick. He had a terrible cold and felt very congested and achy. He was lying in bed at home hoping that he would feel some relief from the pain killer that he had just taken twenty minutes ago. He sat up in his bed and blew his nose before he reached for the hot soup that his wife had just put on the night stand.

*Filler:*
Brian turned on the TV because he wanted to watch the five o'clock news. He couldn't believe his eyes when he saw that the local bank had been robbed earlier that afternoon. The burglars had been able to secure several hundred thousand dollars in loot before they escaped in an unidentified vehicle.

*Probe:*
soup

*Introduction:*
Karen had decided that she would use her free time in the summer to clean out and reorganize her entire house. She had a habit of saving almost everything because she thought that she might need it again someday. Karen was sitting on the floor in the living room looking through piles of paper documents that she had saved for years. The entire floor was covered with old bills and receipts that she now realized she would never need again.

*Filler:*
As she went through all the clutter she found an old baby picture of her daughter. She remembered back when her children were still young and she had her hands full with taking care of them. They used to have so much fun and the house was always filled with laughter.

*Probe:*
bills

*Introduction:*
Julie was at the day spa with her two girl friends. She liked going to the spa at least once a month because it helped her to get away from all the daily hassles. Julie decided to go to the quiet area where she could relax in an armchair and forget about everything. Before Julie lied down on one of the armchairs she spread out her soft towel on it and put down her drink right next to her.

*Filler:*
Suddenly Julie noticed that an elderly woman on the other side of the room tumbled out of her chair and collapsed. One of the staff members immediately came to help her up and took her to another room. Julie thought that she must have gotten dizzy from taking a steam bath too long.

*Probe:*
towel

*Introduction:*
Andy decided to have a yard sale so he could sell of some of his clutter. Andy thought it would be great to make some extra cash by selling some of his old toys. He got up early and started setting up his things on the grass at his house. Because he didn't want his things to sit on the bare grass he spread out a large sheet and put price tags on each toy that was for sale.

*Filler:*
While he was setting up his things his school friend stopped by with his new puppy. It was a golden retriever and he was only a few weeks old so he looked adorable. Andy and his friend petted the puppy and watched him chew on the squeaky toy that he carried around.

*Probe:*
sheet

# APPENDIX B

The passages used in Experiment 2 are presented in this Appendix. Each participant only saw one of the three conditions of each passage.

*Introduction:*
Lisa loved to travel to different places around the world. On her current trip Lisa was in Rome and she was enjoying all the historic sites the city had to offer. Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table right next to her.

*Filler:*
As she was waiting for her friend she got involved in a conversation with a man who was sitting next to her. He was also American and as it turned out they both came from the New England area. They talked about how different life was in the U.S. in comparison to Italy.

*Probe:*
lamp

*Spatial cue but no contextual cue:*
Lisa stayed where she was but started looking around for her friend so they could go to dinner.

*Spatial cue and contextual Cue:*
Lisa stayed where she was on the couch next to the table but looked to see if her friend was coming.

*Contextual cue only:*
Lisa noticed that the couch and the table matched perfectly as she was waiting for her friend.

*Probe:*
lamp

*Introduction:*
Joshua decided to take his dog to the park because it was a beautiful spring day. Joshua enjoyed walks in the park because it gave him a chance to relax after a long day at work. He was standing by the pond in the park and looked at the cherry trees around him that were in full bloom. As Joshua was standing by the pond, he started feeding the baby ducks with bread crumbs that he had brought from home.

*Filler:*
As he was enjoying the warm spring breeze, his dog started barking and running towards another dog. At first Joshua was worried because the other dog was much bigger than his dog but they seemed to get along just fine. The dogs chased each other through the grass and had a great time playing together.

*Probe:*
ducks

*Spatial cue but no contextual cue:*
Joshua stayed where he was and noticed that there was a lot of pollen in the air because of the trees.

*Spatial cue and contextual Cue:*
Joshua stayed put by the pond and tossed bread crumbs as he noticed all the pollen in the air.

*Contextual cue only:*
Joshua watched the bread crumbs floating in the pond as he noticed all the pollen in the air.

*Probe:*
ducks

*Introduction:*
Memorial Day weekend had finally arrived, and Sherry was looking forward to a long and hopefully relaxing weekend. The weather was beautiful and she was planning to go hiking with a group of friends in a nearby park. She was standing in the hallway of her house and couldn't wait for her friends to get there. She was waiting in the hallway by the wooden door looking out the window to see if her friends were there yet.

*Filler:*
As she was waiting for her friends to arrive Sherry looked at the clock on the wall and remembered that it stopped a couple of days ago. She had been meaning to get a new battery but she still hadn't gotten a chance to go to the store. She figured she could do it tomorrow.

*Probe:*
door

*Spatial cue but no contextual cue:*
Sherry stayed put but started to get impatient because her friends still hadn't arrived yet.

*Spatial cue and contextual cue:*
Sherry got impatient as she stayed put by the window in the hallway waiting for her friends.

*Contextual cue only:*
Sherry noticed that the windows in the hallway needed a cleaning as she was waiting for her friends.

*Probe:*
door

*Introduction:*
Today was the first day of summer vacation and Hannah's mother promised to take her to the swimming pool. It was the first time this season that Hannah was visiting the pool with her mom. When they walked towards the stairs of the pool, Hannah and her mother decided to go into the water right away. As Hannah was standing on the stairs of the pool she put down her inflatable raft and her mom applied some sunblock to her skin.

*Filler:*
While she was waiting for her mom, Hannah watched the other kids buying ice cream from the ice cream stand. Hannah loved the taste of strawberry ice cream with sprinkles. She was certain that her mom would treat her to an ice cream later because she hadn't had one in long time.

*Probe:*
raft

*Spatial cue but no contextual cue:*
Hannah stayed close to her mom as she was watching the older kids glide through the water.

*Spatial cue and contextual cue:*
Hannah stayed close to her mom on the stairs waiting for the sunblock to dry as she looked around.

*Contextual cue only:*
Hannah stayed on the stairs waiting for the sunblock to dry while she watched the other kids.

*Probe:*
raft

*Introduction:*
Annie was excited because she was going out for dinner at a Thai restaurant with some of her friends. They hadn't been out in a long time, so they had a lot of different things to talk about. Annie was looking for the patio of the restaurant so she would be able to see her friends coming. Because it was still early, she decided to take a seat on the patio where little birds were playing in the water of a fountain.

*Filler:*
As she was waiting she noticed the large billboards advertising a new musical. Annie loved musicals so she decided to try to check the availability of tickets online as soon as she came home that night. She had never seen that particular musical so she was looking forward to it.

*Probe:*
birds

*Spatial cue not no contextual cue:*
Annie was still waiting for her friends when she realized that she was getting pretty hungry.

*Spatial cue and contextual cue:*
Annie was still waiting on the bench looking at the fountain when she realized how hungry she was.

*Contextual cue only:*
Annie realized she was getting hungry as the fountain splashed water onto the bench she sat on.

*Probe:*
birds

*Introduction:*
Tom and his wife had been house hunting for several weeks when they finally found a house they both liked and could afford. They were moving today and they had been busy all day to make sure that everything was running smoothly. Tom and his wife walked into the kitchen so they could start unpacking their things. They stood in the kitchen surrounded by moving boxes and several pieces of furniture but they didn't know where to start.

*Filler:*
Suddenly Tom remembered that his credit card payment was due the next day and he had been meaning to pay it for days. He quickly picked up his cell phone and called the credit card company. Fortunately, he was able to make the payment just in time to avoid paying a late fee.

*Probe:*
boxes

*Spatial cue but no contextual cue:*
Tom stayed where he was and thought about how he could clean up in as little time as possible.

*Spatial cue and contextual cue:*
Tom stayed put in the kitchen next to the furniture when he thought about how he would clean up.

*Contextual cue only:*
Tom tried to figure out where to put all the furniture from the kitchen so the house would look nice.

*Probe:*
boxes

*Introduction:*
Jessica loved to spend time at her grandparent's house. She was on summer vacation from school and was looking forward to staying over at their house for a couple of days. Jessica was helping her grandfather plant raspberry bushes in the yard so they could make fruit jam in a couple of weeks. Jessica was standing in the yard watching her grandfather dig holes with a small shovel so they could plant the bushes into the ground.

*Filler:*
As she was watching her grandfather, two kids from the neighborhood came by to talk to Jessica. They asked her if she wanted to come ride bikes with them later in the afternoon. Jessica had become quite good friends with the children in the neighborhood although she only saw them during the summer.

*Probe:*
shovel

*Spatial cue but no contextual cue:*
Jessica stayed put while she called for her grandmother to bring them freshly made lemonade.

*Spatial cue and contextual cue:*
Jessica stayed put in the yard holding onto the bushes while she called for her grandmother.

*Contextual cue only:*
Jessica looked through the yard holding onto the bushes while she called for her grandmother.

*Probe:*
shovel

*Introduction:*
Mark liked New England in the Fall because the leaves on the trees changed colors and the days got shorter. He asked his younger brother if he wanted to go to the nearby park. Mark was in the garage and went through his father's tool box to look for something he could use to fix his bike. As Mark was standing in the garage he noticed the huge scratch that he had accidentally put into his parent's car with a wrench.

*Filler:*
As he looked up he saw his neighbor standing in the driveway. Their next door neighbor also had two sons and they had become good friends over the years. His neighbor invited him to a dinner party next weekend and Mark told him that he would ask his parents if they could come.

*Probe:*
scratch

*Spatial cue but no contextual cue:*
Mark stayed where he was but he started looking for his younger brother to give him a hand.

*Spatial cue and contextual cue:*
Mark stayed where he was in the garage holding the wrench when he called for his brother's help.

*Contextual cue:*
Mark looked through the garage still holding the wrench when he called for his brother for help.

*Probe:*
scratch

*Introduction:*
Gavin was doing an internship at an advertisement company in Boston this summer. He enjoyed living in the city because there was always so much to do. Gavin and his friend had agreed to meet in front of the aquarium by the benches at 2pm that afternoon. Gavin decided to sit down on one of the benches that were right by the parking meters so he could see his friend's car when he arrived.

*Filler:*
As Gavin was waiting for his friend he saw two guys starting a fight. They were yelling at each other but Gavin wasn't able to understand what they were saying but he saw one of them fell down and hit his head on the pavement. Luckily, the police came and broke them up quickly.

*Probe:*
meters

*Spatial cue but no contextual cue:*
Gavin stayed put but was hoping that his friend would get there soon so they could go inside.

*Spatial cue and contextual cue:*
Gavin stayed put on the bench hoping that he would see his friend's car when he was pulling up.

*Contextual cue only:*
Gavin positioned himself on the bench so he could see his friend's car when he was pulling up.

*Probe:*
meters

*Introduction:*
Nina was at the grocery store to pick up some food for dinner. She looked into her shopping cart to check if she had gotten all the ingredients she needed to make lasagne that night. She was waiting at one of the registers to pay and it seemed like the line was moving very slowly. As Nina was standing in line she threw a pack of flavored mints into her cart and started flipping through a magazine to pass time.

*Filler:*
As Nina was waiting her cell phone rang and she was surprised to see that her boss was calling her. He told Nina that the meeting with the company's business partners in San Francisco had been pushed forward. Nina knew that they would have to work on the proposal first thing in the morning.

*Probe:*
mints

*Spatial cue but no contextual cue:*
Nina stayed where she was and looked to see if there were fewer people at the other checkouts.

*Spatial cue and contextual cue:*
Nina stayed put in line but put away the magazine and checked if there was a shorter line elsewhere.

*Contextual cue only:*
Nina put away the magazine and checked if there was a shorter line anywhere else in the store.

*Probe:*
mints

*Introduction:*
Ben was going on a business trip to New York but his flight was delayed. He was worried that he was going to be late to his meeting. Ben sat down on one of the chairs in the waiting area realizing that there was nothing he could do. As Ben was sitting on a chair at the gate, he took out his new phone to check his messages before he started working on his laptop.

*Filler:*
Suddenly Ben recognized one of his old friends from college. They started chatting about how long it had been since they had last seen each other. Ben and his old college friend talked about old times and how they should get together soon so they could have dinner and catch up.

*Probe:*
phone

*Spatial cue but no contextual cue:*
Ben stayed where he was and kept on checking the flight information display for any updates.

*Spatial cue and contextual cue:*
Ben stayed put on his chair and worked on his laptop as he kept checking the information display.

Contextual cue only:
Ben leaned the laptop on the side of his chair as he checked the information display for updates.

*Probe:*
phone

*Introduction:*
Denise was helping her son's first grade teacher with the Halloween party this year. She and the teacher had decided that it would be fun to have the children decorate cookies. Denise stood by the counter in the school's kitchen holding up pictures of what the cookies were supposed to look like once they were done. Denise leaned over the counter and handed the kids colored candy to decorate the cookies while she spread icing on another one.

*Filler:*
When Denise looked up she saw that the child right next to her was about to fall off his chair because he had been bouncing around. She quickly grabbed him so he wouldn't hurt himself. Even though she saved him he started crying and Denise had a hard time consoling him.

*Probe:*
candy

*Spatial cue but no contextual cue:*
Denise stayed where she was but started looking around for her son's teacher to help her out.

*Spatial cue and contextual cue:*
Denise stayed put by the counter holding the icing in her hands as she looked for her son's teacher.

*Contextual cue only:*
Denise put the icing down on the counter as she started looking for her son's teacher for help.

*Probe:*
candy

*Introduction:*
Neil was on a date with his girlfriend and they had agreed to see a comedy because Neil didn't like romantic movies. Neil was annoyed because their discussion had taken so long that they arrived late and the only seats left were in the first row. To make the best out of the situation, Neil stretched out in his seat and drank some of his refreshing soda and started to munch on the popcorn that he had just bought.

*Filler:*
Although the previews had already begun, Neil and his girlfriend started talking about their plans to go camping next weekend. They had decided to go up into the mountains and sleep in tents outside. They talked about how exciting it will be to live without modern technology for a couple of days.

*Probe:*
soda

*Spatial cue but no contextual cue:*
Neil stayed put when the lights were finally dimmed and the previews started to play on the screen.

*Spatial cue and contextual cue:*
Neil stayed put in his seat and he put down his popcorn when the previews finally started to play.

*Contextual cue:*
Neil leaned back in his seat and put down his popcorn when the previews finally started to play.

*Probe:*
soda

*Introduction:*
David went to visit his uncle at his cabin in Maine over the break. His uncle loved hunting and he had promised David to teach him how to track animals. It was a cold winter night and they had just finished eating dinner when they sat down by the fireplace so they could warm up. As they were sitting by the fireplace David picked up an old book from the side table next to him and started reading.

*Filler:*
Suddenly David noticed that there were two deer standing in his uncle's backyard and he had never seen deer so close up. They were digging around in the snow trying to find something edible. Nobody in the city would believe him when he told them that he had seen a real deer.

*Probe:*
book

*Spatial cue but no contextual cue:*
David stayed where he was and watched his uncle clean up the dishes and the food from dinner.

*Spatial cue and contextual cue:*
David stayed put next to the side table near the fireplace watching his uncle wash the dishes.

*Contextual cue only:*
David rested his hand on the side table while he enjoyed watching the fire go in the fireplace.

*Probe:*
book

*Introduction:*
Sara had just bought a new home and she knew it was going to take a lot of time and energy to make the place look nice. She was excited about the changes she wanted to make. She had spent the morning cleaning up weeds in the garden because the previous owner had not taken good care of the lawn. She was standing in the garden next to a white fence and was working on cutting back some of the bushes.

*Filler:*
As she was busy doing things her neighbor from across the street approached her. They started talking about two robberies that had occurred only a few blocks away from their neighborhood in the past couple of weeks. They decided to bring up the issue at the next community meeting to come up with a plan.

*Probe:*
Fence

*Spatial cue but no contextual cue:*
Sara stayed put but started looking around to see what else she needed to do before the barbeque.

*Spatial cue and contextual cue:*
Sara stayed put in the garden next to the bushes wondering what else she needed for the barbeque.

*Contextual cue only:*
When Sara finished with the garden and the bushes she thought of other things she needed to do.

*Probe:*
fence

*Introduction:*
Charlotte was at the mall with her friend because they both loved shopping. She needed to buy a dress and shoes for a wedding that she was invited to. Charlotte and her friend were standing at a snack bar because they both felt hungry from having been to so many stores in the mall. Shortly after they placed an order at the snack bar, the clerk put a slice of hot pizza on the counter and got their order of lemonade.

*Filler:*
As Charlotte searched for her lip balm in her purse, she noticed that there was a hole in the lining. She reached into the hole and realized that several items that she had been looking for had fallen through the hole. She was relieved to find a bracelet that she had been missing.

*Probe:*
pizza

*Spatial cue but no contextual cue:*
Charlotte stayed where she was and thought about which dress she should buy for the wedding.

*Spatial cue and contextual cue:*
Charlotte stayed put by the snack bar drinking her lemonade thinking about which dress to buy.

*Contextual cue only:*
Charlotte drank her lemonade from the snack bar thinking about which dress to get for the wedding.

*Probe:*
pizza

*Introduction:*
Elliot was a lawyer and he was at a lunch meeting with one of his new clients. They had gone to his favorite Italian restaurant because Elliot thought the food there was excellent. He couldn't wait to get a table and to order his meal because he hadn't eaten anything all morning. As soon as they were seated at a table, they were served warm bread and butter by a waitress that also took their drink orders.

*Filler:*
As they were waiting for their lunch to come, Elliot noticed the large fish tank that was right behind him. It reminded him of the one that he had when he was younger. He and his brothers had spent hours watching the fish and identifying the family each new fish belonged to.

*Probe:*
bread

*Spatial cue but no contextual cue:*
Elliot stayed where he was and continued to talk to his client about their upcoming law suit.

*Spatial cue and contextual cue:*
Elliot stayed put as he leaned over the table to reach for the butter while he talked to his client.

*Contextual cue only:*
Elliot reached across the table for the butter as he continued to talk to his client about the case.

*Probe:*
bread

*Introduction:*
Kevin was a freshmen in college and he was going to his first class today. He was nervous because his first class was a statistics course and he was never really good at math. He didn't know anybody so he sat down at a desk that was all the way in the back of the room. To get ready for class, Kevin reached underneath the desk and pulled out his mechanical pencil from his book bag so he could take notes.

*Filler:*
As Kevin was waiting for the class to start, the person right next to him started talking to him. He told him that there was going to be a party tonight to welcome all the new students. Kevin was excited because his parents had always been strict and didn't let him go out much.

*Probe:*
pencil

*Spatial cue but no contextual cue:*
Kevin stayed put but checked the time because he was anxious to meet his new statistic professor.

*Spatial cue and contextual cue:*
Kevin stayed put at his desk and reached into his book bag as he waited for his statistic professor.

*Contextual cue only:*
Kevin put his book bag next to the desk as he was anxiously awaiting his new professor's arrival.

*Probe:*
pencil

*Introduction:*
Rob hated going to the dentist ever since he was a child. He dreaded his annual check-ups weeks in advance because he was afraid that the dentist would have to do work on his teeth. Rob looked over to the waiting room as he gave the receptionist his health insurance information. After he was finished, he entered the waiting room and sat down on a leather chair so he could read the newspaper that he had brought from home.

*Filler:*
As he was waiting he started reading a journal article about global warming. The article said that the first part of the Earth to show dramatic effects from the heating are the oceans. As the ice recedes farther each year many polar bears will drown because it takes them much longer to reach the land.

*Probe:*
chair

*Spatial cue but no contextual cue:*
Rob stayed put but he started to feel increasingly anxious because he had to wait for so long.

*Spatial cue and contextual cue:*
Rob stayed put in the waiting room and read the newspaper hoping it was almost his turn to go in.

Contextual cue only:
Rob flipped through the newspaper in the waiting room hoping it was almost his turn to go in.

*Probe:*
chair

*Introduction:*
Emma was a senior in college and it was only a few weeks before graduation. She started applying for jobs weeks ago because she knew it would take some time to find a job. She traveled to New York and had just arrived at the main lobby of the marketing company to go to a job interview. After she took a seat in the main lobby, she asked the receptionist for chilled water before she started to fill out one of the questionnaires.

*Filler:*
As she was waiting she thought about what it would be like to live in New York. She grew up in a rural area of New Hampshire and had never lived in a large city. She was looking forward to visiting all the sites in New York and being able to enjoy all the different restaurants.

*Probe:*
water

*Spatial cue but no contextual cue:*
Emma stayed put but started to get impatient because her interview was supposed to start already.

*Spatial cue and contextual cue:*
Emma stayed put in the main lobby filling out the questionnaire as she waited for her turn.

*Contextual cue only:*
Emma greeted the other people in the main lobby before she started to fill out the questionnaire.

*Probe:*
water

*Introduction:*
Brian had stayed home from work today because he was feeling sick. He had a terrible cold and felt very congested and achy. He was lying in bed at home hoping that he would feel some relief from the pain killer that he had just taken twenty minutes ago. He sat up in his bed and blew his nose before he reached for the hot soup that his wife had just put on the night stand.

*Filler:*
Brian turned on the TV because he wanted to watch the five o'clock news. He couldn't believe his eyes when he saw that the local bank had been robbed earlier that afternoon. The burglars had been able to secure several hundred thousand dollars in loot before they escaped in an unidentified vehicle.

*Probe:*
soup

*Spatial cue but no contextual cue:*
Brian stayed where he was but started feeling nauseous because of the medicine he had just taken.

*Spatial cue and contextual cue:*
Brian stayed put in bed and picked up the medicine from the night stand so he would get better.

*Contextual cue:*
Brian rolled over in his bed and reached for the medicine on his night stand so he would get better.

*Probe:*
soup

*Introduction:*
Karen had decided that she would use her free time in the summer to clean out and reorganize her entire house. She had a habit of saving almost everything because she thought that she might need it again someday. Karen was sitting on the floor in the living room looking through piles of paper documents that she had saved for years. The entire floor was covered with old bills and receipts that she now realized she would never need again.

*Filler:*
As she went through all the clutter she found an old baby picture of her daughter. She remembered back when her children were still young and she had her hands full with taking care of them. They used to have so much fun and the house was always filled with laughter.

*Probe:*
bills

*Spatial cue but no contextual cue:*
Karen stayed where she and surveyed how many more boxes she would have to sort through today.

*Spatial cue and contextual cue:*
Karen stayed put on the floor sorting through the receipts when she looked at all the other boxes.

*Contextual cue:*
Karen noticed that there were still receipts left on the floor even after going through six boxes.

*Probe:*
bills

*Introduction:*
Julie was at the day spa with her two girl friends. She liked going to the spa at least once a month because it helped her to get away from all the daily hassles. Julie decided to go to the quiet area where she could relax in an armchair and forget about everything. Before Julie lied down on one of the armchairs she spread out her soft towel on it and put down her drink right next to her.

*Filler:*
Suddenly Julie noticed that an elderly woman on the other side of the room tumbled out of her chair and collapsed. One of the staff members immediately came to help her up and took her to another room. Julie thought that she must have gotten dizzy from taking a steam bath too long.

*Probe:*
towel

*Spatial cue but no contextual cue:*
Julie stayed put and closed her eyes trying to shut out everything that was going on around her.

*Spatial cue and contextual cue:*
Julie stayed put on the armchair and took a sip from her drink as she was trying to relax a bit.

*Contextual cue:*
Julie reached for the drink next to her armchair as she tried to forget everything around her.

*Probe:*
towel

*Introduction:*
Andy decided to have a yard sale so he could sell of some of his clutter. Andy thought it would be great to make some extra cash by selling some of his old toys. He got up early and started setting up his things on the grass at his house. Because he didn't want his things to sit on the bare grass he spread out a large sheet and put price tags on each toy that was for sale.

*Filler:*
While he was setting up his things his school friend stopped by with his new puppy. It was a golden retriever and he was only a few weeks old so he looked adorable. Andy and his friend petted the puppy and watched him chew on the squeaky toy that he carried around.

*Probe:*
sheet

*Spatial cue but no contextual cue:*
Andy stayed where he was when his mother brought out some cookies and juice for him and his friend.

*Spatial cue and contextual cue:*
Andy stayed where he was on the grass and adjusted the price tags when his mom brought them cookies.

*Contextual cue only:*
Andy picked up a price tag that had fallen into the grass when his mother brought them cookies.

*Probe:*
sheet

# APPENDIX C

The passages used in Experiment 3 are presented in this Appendix. Each participant only saw one of the two conditions of each passage.

*Introduction:*
Lisa loved to travel to different places around the world. On her current trip Lisa was in Rome and she was enjoying all the historic sites the city had to offer. Lisa was sitting on a couch in the hotel lobby waiting for her friend to come downstairs so they could go out to dinner. The lobby had been recently renovated and Lisa was sitting on the couch admiring the beautiful lamp that was on the table right next to her.

*Filler:*
As she was waiting for her friend she got involved in a conversation with a man who was sitting next to her. He was also American and as it turned out they both came from the New England area. They talked about how different life was in the U.S. in comparison to Italy.

*Probe:*
lamp

*No contextual cue:*
Lisa stood up and walked across the lobby to see if her friend was coming so they could go to dinner.

*Contextual cue:*
Lisa stood up and moved away from the couch next to the table to see if her friend was coming yet.

*Probe:*
lamp

*Introduction:*
Joshua decided to take his dog to the park because it was a beautiful spring day. Joshua enjoyed walks in the park because it gave him a chance to relax after a long day at work. He was standing by the pond in the park and looked at the cherry trees around him that were in full bloom. As Joshua was standing by the pond, he started feeding the baby ducks with bread crumbs that he had brought from home.

*Filler:*
As he was enjoying the warm spring breeze, his dog started barking and running towards another dog. At first Joshua was worried because the other dog was much bigger than his dog but they seemed to get along just fine. The dogs chased each other through the grass and had a great time playing together.

Probe:
ducks

*No contextual cue:*
Joshua walked over to where the dogs were because he noticed all the pollen that were in the air.

*Contextual cue:*
Joshua tossed the last bread crumbs and walked away from the pond as he noticed all the pollen.

*Probe:*
ducks

*Introduction:*
Memorial Day weekend had finally arrived, and Sherry was looking forward to a long and hopefully relaxing weekend. The weather was beautiful and she was planning to go hiking with a group of friends in a nearby park. She was standing in the hallway of her house and couldn't wait for her friends to get there. She was waiting in the hallway by the wooden door looking out the window to see if her friends were there yet.

*Filler:*
As she was waiting for her friends to arrive Sherry looked at the clock on the wall and remembered that it stopped a couple of days ago. She had been meaning to get a new battery but she still hadn't gotten a chance to go to the store. She figured she could do it tomorrow.

*Probe:*
door

*No contextual cue:*
Sherry walked over to the kitchen to check if she had packed enough water bottles for her trip.

*Contextual cue:*
Sherry walked away from the window in the hallway to check if she had packed enough water bottles.

*Probe:*
door

*Introduction:*
Today was the first day of summer vacation and Hannah's mother promised to take her to the swimming pool. It was the first time this season that Hannah was visiting the pool with her mom. When they walked towards the stairs of the pool, Hannah and her mother decided to go into the water right away. As Hannah was standing on the stairs of the pool she put down her inflatable raft and her mom applied some sunblock to her skin.

*Filler:*
While she was waiting for her mom, Hannah watched the other kids buying ice cream from the ice cream stand. Hannah loved the taste of strawberry ice cream with sprinkles. She was certain that her mom would treat her to an ice cream later because she hadn't had one in long time.

*Probe:*
raft

*No contextual cue:*
Hannah walked to the other side of the pool and jumped in so she could practice her swim strokes.

*Contextual cue:*
Hannah leaped off the stairs after the sunblock had dried so she could practice her swim strokes.

*Probe:*
raft

*Introduction:*
Annie was excited because she was going out for dinner at a Thai restaurant with some of her friends. They hadn't been out in a long time, so they had a lot of different things to talk about. Annie was looking for the patio of the restaurant so she would be able to see her friends coming. Because it was still early, she decided to take a seat on the patio where little birds were playing in the water of a fountain.

*Filler:*
As she was waiting she noticed the large billboards advertising a new musical. Annie loved musicals so she decided to try to check the availability of tickets online as soon as she came home that night. She had never seen that particular musical so she was looking forward to it.

*Probe:*
birds

*No contextual cue:*
Annie stood up and walked toward the street when she saw one of her good friends get out of a cab.

*Contextual cue:*
Annie walked by the fountain as she walked off the patio when she saw her friend arrive in a cab.

*Probe:*
birds

*Introduction:*
Tom and his wife had been house hunting for several weeks when they finally found a house they both liked and could afford. They were moving today and they had been busy all day to make sure that everything was running smoothly. Tom and his wife walked into the kitchen so they could start unpacking their things. They stood in the kitchen surrounded by moving boxes and several pieces of furniture but they didn't know where to start.

*Filler:*
Suddenly Tom remembered that his credit card payment was due the next day and he had been meaning to pay it for days. He quickly picked up his cell phone and called the credit card company. Fortunately, he was able to make the payment just in time to avoid paying a late fee.

*Probe:*
boxes

*No contextual cue:*
Tom got up and walked through the house because he was excited about how great everything looked.

*Contextual cue:*
Tom tripped over some furniture when he walked out of the kitchen to look around his new house.

*Probe:*
boxes

*Introduction:*
Jessica loved to spend time at her grandparent's house. She was on summer vacation from school and was looking forward to staying over at their house for a couple of days. Jessica was helping her grandfather plant raspberry bushes in the yard so they could make fruit jam in a couple of weeks. Jessica was standing in the yard watching her grandfather dig holes with a small shovel so they could plant the bushes into the ground.

*Filler:*
As she was watching her grandfather, two kids from the neighborhood came by to talk to Jessica. They asked her if she wanted to come ride bikes with them later in the afternoon. Jessica had become quite good friends with the children in the neighborhood although she only saw them during the summer.

*Probe:*
shovel

*No contextual cue:*
Jessica walked over to the kitchen window to ask her grandmother to bring them fresh lemonade.

*Contextual cue:*
Jessica walked across the yard by the bushes to ask her grandmother for freshly made lemonade.

*Probe:*
shovel

*Introduction:*
Mark liked New England in the Fall because the leaves on the trees changed colors and the days got shorter. He asked his younger brother if he wanted to go to the nearby park. Mark was in the garage and went through his father's tool box to look for something he could use to fix his bike. As Mark was standing in the garage he noticed the huge scratch that he had accidentally put into his parent's car with a wrench.

*Filler:*
As he looked up he saw his neighbor standing in the driveway. Their next door neighbor also had two sons and they had become good friends over the years. His neighbor invited him to a dinner party next weekend and Mark told him that he would ask his parents if they could come.

*Probe:*
scratch

*No contextual cue:*
Mark walked up the stairs into the house because he wanted to see if his brother could help him.

*Contextual cue:*
Mark walked out of the garage still holding the wrench in his hands while he called for his brother.

*Probe:*
scratch

*Introduction:*
Gavin was doing an internship at an advertisement company in Boston this summer. He enjoyed living in the city because there was always so much to do. Gavin and his friend had agreed to meet in front of the aquarium by the benches at 2pm that afternoon. Gavin decided to sit down on one of the benches that were right by the parking meters so he could see his friend's car when he arrived.

*Filler:*
As Gavin was waiting for his friend he saw two guys starting a fight. They were yelling at each other but Gavin wasn't able to understand what they were saying but he saw one of them fell down and hit his head on the pavement. Luckily, the police came and broke them up quickly.

*Probe:*
meters

*No contextual cue:*
Gavin walked towards the street corner because he thought his friend might be waiting there.

*Contextual cue:*
Gavin stood up from the bench and walked to the street corner hoping he would see his friend's car.

*Probe:*
meters

*Introduction:*
Nina was at the grocery store to pick up some food for dinner. She looked into her shopping cart to check if she had gotten all the ingredients she needed to make lasagne that night. She was waiting at one of the registers to pay and it seemed like the line was moving very slowly. As Nina was standing in line she threw a pack of flavored mints into her cart and started flipping through a magazine to pass time.

*Filler:*
As Nina was waiting her cell phone rang and she was surprised to see that her boss was calling her. He told Nina that the meeting with the company's business partners in San Francisco had been pushed forward. Nina knew that they would have to work on the proposal first thing in the morning.

*Probe:*
mints

*No contextual cue:*
Nina drove her shopping cart to the other side of the store hoping the line would move faster there.

*Contextual cue:*
Nina got out of line and put the magazine into her cart before she went to the other register to pay.

*Probe:*
mints

*Introduction:*
Ben was going on a business trip to New York but his flight was delayed. He was worried that he was going to be late to his meeting. Ben sat down on one of the chairs in the waiting area realizing that there was nothing he could do. As Ben was sitting on a chair at the gate, he took out his new phone to check his messages before he started working on his laptop.

*Filler:*
Suddenly Ben recognized one of his old friends from college. They started chatting about how long it had been since they had last seen each other. Ben and his old college friend talked about old times and how they should get together soon so they could have dinner and catch up.

*Probe:*
phone

*No contextual cue:*
Ben got up and walked towards the information counter to check if they had updated the flight time.

*Contextual cue:*
Ben stood up from the chair and put down the laptop before he walked over to the airline counter.

*Probe:*
phone

*Introduction:*
Denise was helping her son's first grade teacher with the Halloween party this year. She and the teacher had decided that it would be fun to have the children decorate cookies. Denise stood by the counter in the school's kitchen holding up pictures of what the cookies were supposed to look like once they were done. Denise leaned over the counter and handed the kids colored candy to decorate the cookies while she spread icing on another one.

*Filler:*
When Denise looked up she saw that the child right next to her was about to fall off his chair because he had been bouncing around. She quickly grabbed him so he wouldn't hurt himself. Even though she saved him he started crying and Denise had a hard time consoling him.

*Probe:*
candy

*No contextual cue:*
Denise walked out of the room to see if her son's teacher was around so she could give her a hand.

*Contextual cue:*
Denise put the icing down on the counter and walked to the other room to find her son's teacher.

*Probe:*
candy

*Introduction:*
Neil was on a date with his girlfriend and they had agreed to see a comedy because Neil didn't like romantic movies. Neil was annoyed because their discussion had taken so long that they arrived late and the only seats left were in the first row. To make the best out of the situation, Neil stretched out in his seat and drank some of his refreshing soda and started to munch on the popcorn that he had just bought.

*Filler:*
Although the previews had already begun, Neil and his girlfriend started talking about their plans to go camping next weekend. They had decided to go up into the mountains and sleep in tents outside. They talked about how exciting it will be to live without modern technology for a couple of days.

*Probe:*
soda

*No Contextual cue:*
Neil stood up and left the movie theater so he could use the restroom before the movie started.

*Contextual cue:*
Neil got out of his seat and put down the popcorn to go to the restroom before the movie started.

*Probe:*
soda

*Introduction:*
David went to visit his uncle at his cabin in Maine over the break. His uncle loved hunting and he had promised David to teach him how to track animals. It was a cold winter night and they had just finished eating dinner when they sat down by the fireplace so they could warm up. As they were sitting by the fireplace David picked up an old book from the side table next to him and started reading.

*Filler:*
Suddenly David noticed that there were two deer standing in his uncle's backyard and he had never seen deer so close up. They were digging around in the snow trying to find something edible. Nobody in the city would believe him when he told them that he had seen a real deer.

*Probe:*
book

*No Contextual cue:*
David stood up and walked into the kitchen so he could help his uncle clean up the dishes from dinner.

*Contextual cue:*
David stood up and walked past the fireplace and the side table to the kitchen to help his uncle.

*Probe:*
book

*Introduction:*
Sara had just bought a new home and she knew it was going to take a lot of time and energy to make the place look nice. She was excited about the changes she wanted to make. She had spent the morning cleaning up weeds in the garden because the previous owner had not taken good care of the lawn. She was standing in the garden next to a white fence and was working on cutting back some of the bushes.

*Filler:*
As she was busy doing things her neighbor from across the street approached her. They started talking about two robberies that had occurred only a few blocks away from their neighborhood in the past couple of weeks. They decided to bring up the issue at the next community meeting to come up with a plan.

*Probe:*
fence

*No Contextual cue:*
Sara started walking towards the house to see what else she needed to prepare before the barbeque.

*Contextual cue:*
When Sara finished cutting the bushes she walked from the garden into the house to prepare the food.

*Probe:*
fence

*Introduction:*
Charlotte was at the mall with her friend because they both loved shopping. She needed to buy a dress and shoes for a wedding that she was invited to. Charlotte and her friend were standing at a snack bar because they both felt hungry from having been to so many stores in the mall. Shortly after they placed an order at the snack bar, the clerk put a slice of hot pizza on the counter and got their order of lemonade.

*Filler:*
As Charlotte searched for her lip balm in her purse, she noticed that there was a hole in the lining. She reached into the hole and realized that several items that she had been looking for had fallen through the hole. She was relieved to find a bracelet that she had been missing.

*Probe:*
pizza

*No contextual cue:*
Charlotte walked over to one of the stores that she had been to earlier so she could buy her dress.

*Contextual cue:*
Charlotte threw away the lemonade as she walked away from the snack bar towards one of the stores.

*Probe:*
pizza

*Introduction:*
Elliot was a lawyer and he was at a lunch meeting with one of his new clients. They had gone to his favorite Italian restaurant because Elliot thought the food there was excellent. He couldn't wait to get a table and to order his meal because he hadn't eaten anything all morning. As soon as they were seated at a table, they were served warm bread and butter by a waitress that also took their drink orders.

*Filler:*
As they were waiting for their lunch to come, Elliot noticed the large fish tank that was right behind him. It reminded him of the one that he had when he was younger. He and his brothers had spent hours watching the fish and identifying the family each new fish belonged to.

*Probe:*
bread

*No Contextual cue:*
Elliot got up and walked to the lobby because he realized he left his coat in the entrance area.

*Contextual cue:*
Elliot put the butter on the table and went to the lobby to look for his coat in the entrance area.

*Probe:*
bread

*Introduction:*
Kevin was a freshmen in college and he was going to his first class today. He was nervous because his first class was a statistics course and he was never really good at math. He didn't know anybody so he sat down at a desk that was all the way in the back of the room. To get ready for class, Kevin reached underneath the desk and pulled out his mechanical pencil from his book bag so he could take notes.

*Filler:*
As Kevin was waiting for the class to start, the person right next to him started talking to him. He told him that there was going to be a party tonight to welcome all the new students. Kevin was excited because his parents had always been strict and didn't let him go out much.

*Probe:*
pencil

*No contextual cue:*
Kevin stood up and walked across the room to say hello to somebody that he had met the other day.

*Contextual cue:*
Kevin got up from his desk and put down his book bag to say hello to someone he had met the other day.

*Probe:*
pencil

*Introduction:*
Rob hated going to the dentist ever since he was a child. He dreaded his annual check-ups weeks in advance because he was afraid that the dentist would have to do work on his teeth. Rob looked over to the waiting room as he gave the receptionist his health insurance information. After he was finished, he entered the waiting room and sat down on a leather chair so he could read the newspaper that he had brought from home.

*Filler:*
As he was waiting he started reading a journal article about global warming. The article said that the first part of the Earth to show dramatic effects from the heating are the oceans. As the ice recedes farther each year many polar bears will drown because it takes them much longer to reach the land.

*Probe:*
chair

*No contextual cue:*
Rob stood up and walked to the receptionist's desk to ask how much longer he would have to wait.

*Contextual cue:*
Rob put down the newspaper and left the waiting room to check how much longer he would have to wait.

Probe:
chair

*Introduction:*
Emma was a senior in college and it was only a few weeks before graduation. She started applying for jobs weeks ago because she knew it would take some time to find a job. She traveled to New York and had just arrived at the main lobby of the marketing company to go to a job interview. After she took a seat in the main lobby, she asked the receptionist for chilled water before she started to fill out one of the questionnaires.

*Filler:*
As she was waiting she thought about what it would be like to live in New York. She grew up in a rural area of New Hampshire and had never lived in a large city. She was looking forward to visiting all the sites in New York and being able to enjoy all the different restaurants.

*Probe:*
water

*No contextual cue:*
Emma walked to the reception in the other room to see if it was almost her turn to be interviewed.

*Contextual cue:*
Emma walked through the main lobby to the receptionist's desk to drop off her questionnaire.

*Probe:*
water

*Introduction:*
Brian had stayed home from work today because he was feeling sick. He had a terrible cold and felt very congested and achy. He was lying in bed at home hoping that he would feel some relief from the pain killer that he had just taken twenty minutes ago. He sat up in his bed and blew his nose before he reached for the hot soup that his wife had just put on the night stand.

*Filler:*
Brian turned on the TV because he wanted to watch the five o'clock news. He couldn't believe his eyes when he saw that the local bank had been robbed earlier that afternoon. The burglars had been able to secure several hundred thousand dollars in loot before they escaped in an unidentified vehicle.

*Probe:*
soup

*No contextual cue:*
Brian got up and walked into the bathroom because he felt sick from the medicine he had just taken.

*Contextual cue:*
Brian bumped into the night stand as he got out of bed and went to the bathroom because he felt sick.

*Probe:*
soup

*Introduction:*
Karen had decided that she would use her free time in the summer to clean out and reorganize her entire house. She had a habit of saving almost everything because she thought that she might need it again someday. Karen was sitting on the floor in the living room looking through piles of paper documents that she had saved for years. The entire floor was covered with old bills and receipts that she now realized she would never need again.

*Filler:*
As she went through all the clutter she found an old baby picture of her daughter. She remembered back when her children were still young and she had her hands full with taking care of them. They used to have so much fun and the house was always filled with laughter.

*Probe:*
bills

*No contextual cue:*
Karen stood up and walked into the kitchen to see how many more boxes she needed to reorganize.

*Contextual cue:*
Karen got up from the floor and put the receipts on the table in the kitchen to get a better overview.

*Probe:*
bills

*Introduction:*
Julie was at the day spa with her two girl friends. She liked going to the spa at least once a month because it helped her to get away from all the daily hassles. Julie decided to go to the quiet area where she could relax in an armchair and forget about everything. Before Julie lied down on one of the armchairs she spread out her soft towel on it and put down her drink right next to her.

*Filler:*
Suddenly Julie noticed that an elderly woman on the other side of the room tumbled out of her chair and collapsed. One of the staff members immediately came to help her up and took her to another room. Julie thought that she must have gotten dizzy from taking a steam bath too long.

*Probe:*
towel

*No contextual cue:*
Julie stood up and walked away from the quiet area because she wanted to check up on her friends.

*Contextual cue:*
Julie finished her drink and walked away from the armchairs in the quiet area to look for her friend.

*Probe:*
towel

*Introduction:*
Andy decided to have a yard sale so he could sell of some of his clutter. Andy thought it would be great to make some extra cash by selling some of his old toys. He got up early and started setting up his things on the grass at his house. Because he didn't want his things to sit on the bare grass he spread out a large sheet and put price tags on each toy that was for sale.

*Filler:*
While he was setting up his things his school friend stopped by with his new puppy. It was a golden retriever and he was only a few weeks old so he looked adorable. Andy and his friend petted the puppy and watched him chew on the squeaky toy that he carried around.

*Probe:*
sheet

*No contextual cue:*
Andy stood up and walked towards the garage because he remembered another toy he could sell.

*Contextual cue:*
Andy got up from the grass and took a price tag to get another toy in the garage that he could sell.

*Probe:*
sheet

# APPENDIX D

For all experiments reported in this thesis, approval for use of human subjects was obtained from the University of New Hampshire Psychology Department Internal Review Board. Forms demonstrating proof of approval are included in this Appendix.

**University of New Hampshire**
**Institutional Review Board for the Protection of Human Subjects in Research**
**Departmental Review Committee Exemption Classification Sheet**

**Name:** Jennifer Stiegler **IRB #:** 7
**Dept:** Psychology **Reviewer:** _____
**Study:** The Accessibility of spatial information

**Exempt Review**

46.101(b)(1) ✓ Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:
(i) research on regular or special educational instructional strategies, or
(ii) research on the effectiveness of or comparison among instructional techniques, curricula, or classroom management methods.

46.101(b)(2) _____ Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and
(ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to subjects' financial standing, employability, or reputation.

46.101(b)(3) _____ Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under category (b)(2) if:
(i) the human subjects are elected or appointed public officials or candidates for public office; or
(ii) federal statute(s) require(s) without exception that confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

46.101(b)(4) _____ Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

46.101(b)(5) _____ Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

46.101(b)(6) _____ Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) or if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration, or approved by the Environmental Protection Agency, or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

✓ **Protocol is approved as presented in the category checked**
_____ **Protocol is approved with the following contingencies/comments (attach sheets if necessary)**
_____ **Protocol is referred to the IRB for Expedited or Full Board review**
_____ **Protocol cannot be approved as presented (cite reasons on separate sheet)**

**DRC Reviewer:** John Lumber **Date:** 9/23/06

# University of New Hampshire
## Institutional Review Board for the Protection of Human Subjects in Research
## Departmental Review Committee Exemption Classification Sheet

**Name:** Jennifer Stiegler **IRB #:** 2

**Dept:** Psychology **Reviewer:**

**Study:** The accessibility of spatial information

**Exempt Review**

46.101(b)(1) ✓ Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:
(i) research on regular or special educational instructional strategies, or
(ii) research on the effectiveness of or comparison among instructional techniques, curricula, or classroom management methods.

46.101(b)(2) ____ Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and
(ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to subjects' financial standing, employability, or reputation.

46.101(b)(3) ____ Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under category (b)(2) if:
(i) the human subjects are elected or appointed public officials or candidates for public office; or
(ii) federal statute(s) require(s) without exception that confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

46.101(b)(4) ____ Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

46.101(b)(5) ____ Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

46.101(b)(6) ____ Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) or if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration, or approved by the Environmental Protection Agency, or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

✓ **Protocol is approved as presented in the category checked** (with Letter of Human Subjects)

____ **Protocol is approved with the following contingencies/comments (attach sheets if necessary)**

____ **Protocol is referred to the IRB for Expedited or Full Board review**

____ **Protocol cannot be approved as presented (cite reasons on separate sheet)**

**DRC Reviewer:** John Lundy **Date:** 8/28/06

# University of New Hampshire
## Institutional Review Board for the Protection of Human Subjects in Research
## Departmental Review Committee Exemption Classification Sheet

**Name:** Jennifer Stiegler **IRB #:** 8

**Dept:** Psychology **Reviewer:** _____

**Study:** The accessibility of spatial information

### Exempt Review

46.101(b)(1) ✓ Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:
(i) research on regular or special educational instructional strategies, or
(ii) research on the effectiveness of or comparison among instructional techniques, curricula, or classroom management methods.

46.101(b)(2) _____ Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and
(ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to subjects' financial standing, employability, or reputation.

46.101(b)(3) _____ Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under category (b)(2) if:
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(ii) federal statute(s) require(s) without exception that confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

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46.101(b)(5) _____ Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

46.101(b)(6) _____ Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) or if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration, or approved by the Environmental Protection Agency, or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

✓ **Protocol is approved as presented in the category checked**

_____ **Protocol is approved with the following contingencies/comments (attach sheets if necessary)**

_____ **Protocol is referred to the IRB for Expedited or Full Board review**

_____ **Protocol cannot be approved as presented (cite reasons on separate sheet)**

**DRC Reviewer:** John Lindsey **Date:** 2/05/07