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Narrative comprehension for functional survival spatial relations

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NARRATIVE COMPREHENSION FOR FUNCTIONAL SURVIVAL SPATIAL RELATIONS

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ABSTRACT

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Spatial situation models are mental representations of the relationship between characters and objects in the narrative environment. Functional spatial relationships describe an interaction (or potential interaction) between characters and objects in the narrative environment. Although functional relations tend to produce stronger representations as compared with nonfunctional ones (Radvansky & Copeland, 2000), recent data also suggest that specification of causal information, specifically, survival-based scenarios in which characters are described as in immediate danger, may contribute to the construction and maintenance of spatial situation models (Jahn, 2004). For the current study, this idea was tested by comparing reading times and comprehension for narrative texts that describe characters in either dangerous or neutral scenarios who are interacting with objects in either a functional or nonfunctional manner. Although faster reading times and better recognition scores were observed for the functional critical sentences as compared with nonfunctional critical sentences, dangerous/survival scenarios did not enhance memory, but actually led to poorer memory. These results suggest that readers' ability to comprehend spatial relationships depend more on the functionality of the objects in the narrative environment than the survival status of the character, but that

survival does contribute to readers subsequent memorial reconstruction of details described in the text.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Interactions between characters and objects in the environment are better comprehended when a functional relationship exists between story entities, as compared with nonfunctional relationships (Radvansky & Copeland, 2000; Radvansky, Copeland, & Zwaan, 2003). For example, readers better remember that a character was under a streetlight on a dark night if she was reading a map, as opposed to if she was trying to get out of the rain.

The present experiment examined comprehension for functional and nonfunctional spatial relations when characters were described as being in survival or non-survival situations. Participants read twenty original narratives, half containing context making the scenario dangerous (i.e., survival condition) and half with a neutral scenario (i.e., non-survival condition). Of those scenarios, half of each condition had a functional and half had a nonfunctional critical sentence. For example, a character may be seeking protection from a predatory animal (survival condition) or taking photos of a non-threatening animal (non-survival condition) and is subsequently described as standing behind (functional) or in front of a large tree (nonfunctional). In this example, standing behind the tree would be functional because the protagonist is either seeking protection from a predator (survival scenario) or trying not to startle the harmless animal (non-survival scenario). Conversely, standing in front of the tree would be nonfunctional because the protagonist would be seen by the predator (survival scenario) or would startle the harmless animal (non-survival). Critical sentence reading times were recorded. After reading all of the narratives, participants were then asked to identify the critical functional/nonfunctional sentence in a forced-choice recognition paradigm.

Inclusion of the critical survival context was expected to facilitate readers' attention to the critical functional/nonfunctional relation (Jahn, 2004). More precisely, comprehension of functional spatial relations could be enhanced by the presence of a threat. Additional support for this prediction comes from recent interest in the "adaptive memory hypothesis" (Nairne, Pandeirada, & Thompson, 2008; Nairne, Thompson, & Panderirada, 2007), which proposes that the human cognitive system is attuned to survival-relevant information.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Text Comprehension

The construction-integration model of text comprehension (Kintsch & van Dijk, 1978; van Dijk & Kintsch, 1983) posits that successful comprehension of narrative text requires a series of cognitive operations on the part of the reader. Primary among these operations is the act of absorbing the items from the text (i.e., letters, words, sentences, and discourse) into the reader's cognitive architecture. Naturally, these operations depend on the presentation modality, be it visual or auditory. Following brief storage in sensory memory, the symbolic contents of the text are then passed on to the short-term working memory system where they are synthesized into meaningful representations and subsequently combined with general world and linguistic knowledge stored in long term memory (Erricson & Kintsch, 1995). At a minimum, the culmination of these steps ought to result in a coherent semantic or conceptual understanding of what is being read.

It is generally agreed among psycholinguists that the mental representation of text assumes three distinct, but interdependent levels: (1) the surface form, (2) the propositional textbase, and (3) the situation model (e.g. van Dijk & Kintsch, 1983). The *surface form* is the most basic level of representation and refers to the text itself, such as the sentences, phrases, or words that are used. Conceptual and semantic information contribute to the *propositional textbase* representations. That is, the textbase refers to the ideas that are in the text, but not necessarily to the exact words used. Finally, representations of the state-of-affairs described in a given text are commonly referred to as *situation models* (Johnson-Laird, 1983; van Dijk & Kintsch, 1983; Zwaan &

Radvansky, 1998). Situation models include a combination of what is being described in the text as well as what is inferred from the text. On the one hand, situation models of narrative text may contain perceptual information, such as images, of scenes described in a text. On the other hand, they may represent technical information, for example the linguistic and mathematical contents of a word problem (Kintsch & Greeno, 1985). Thus, situation models are not static entities; the representation maintained in a situation model depends on, among other things, the nature of the text itself.

According to van Dijk and Kintsch (1983; and summarized in Zwaan & Radvansky, 1998), situation models serve multiple purposes in the reading comprehension process. First, situation models help facilitate the incorporation of items discussed in a text. This may be accomplished, for instance, by creating tokens of characters or spatial locations of events portrayed in a text. Second, situation models may be useful in integrating modality-specific information in the cognitive architecture. For example, consumers of news information may exploit both textual and pictorial accompaniments in a given feature to form a coherent representation of an event. Third, greater familiarity with the topic under consideration permits stronger representations which ultimately yields faster and greater comprehension. Military personnel would likely navigate a field manual with greater dexterity and acumen as compared with a civilian simply because the military person possesses familiarity (or prior knowledge) with the information in the manual and therefore expends less cognitive effort in comprehending the material (assuming that both readers had comparable reading skills). Finally, situation models help readers make sense of competing sources of information. Suppose two workers are telling their boss about an event that she missed. The boss may use information from both workers to construct one coherent mental representation of the event.

Although the need for situation models is nearly universal in most reading contexts, there are occasions when situation models are not required or even necessary, such as proofreading. When proofreading, the reader's goal is not to understand the deep meaning of the text; instead, the reader is solely concerned with monitoring surface information (i.e., the text itself) for errors, such as misspelled words or poor grammar. Because proofreaders do not construct situation models, it can be inferred that the construction of one is not necessarily an automatic process. However, it should be noted, that under most reading conditions, it is useful to construct a situation model, and hence, people do this.

Zwaan and associates (Zwaan, Langston, & Graesser, 1995; Zwaan & Radvansky, 1998) break down the situation model process into three general steps. First, readers create a *current model* (t_n) for a certain clause or sentence (c_n). Second, as the reader progresses in the text, new clauses and sentences (c_1 through c_n) are added to the current model which results in the creation of an *integrated model* (t_1 through t_n). The transition process from the current model to the integrated model is commonly referred to as *updating* (Zwaan & Radvansky, 1998). Once the reader has reached the conclusion of a passage, a *complete model* (t_1 through t_x) is created which represents the culmination of each current and integrated model. Whereas information pertinent to the current and integrated models likely resides in working memory, information comprising the complete model is contained in long term memory.

As implied earlier, *events*- particularly singular events - play an important role in the construction and maintenance of situation models. According to Zwaan (1999) the interpretation of an event requires the activation of both semantic and episodic knowledge. For example, the experience and act of talking may facilitate a reader's ability to follow a story line. This assumption is consistent with van Dijk and Kintsch's (1983) proposal that successful comprehension requires drawing on long term memory resources.

These ideas suggest that comprehension depends on readers' ability to draw inferences and the readers' knowledge about the world (Haberlandt, 1994). Operationally stated, the term *inference* "refers to information that is activated during reading yet not explicitly stated in the text" (Van den Broek, 1994, p.556). Despite a relatively long tradition of research dating back to the work of Bartlett in the 1930's, inferences, what they are and how precisely they may facilitate reading, has been a frequent source of controversy among researchers (Van den Broek, 1994; Graesser, Singer, & Trabasso, 1994). Guthke (1991; see also Kintsch, 1993) hypothesized that inferences draw on information held in long-term memory or on newly acquired information and this process may result from either automatic or controlled processing. In automatic processing, the reader immediately recognizes an item in a text and links the new information with older information in long-term memory. Controlled processing, however, occurs when a reader is unable to progress in a text without making an inference or when the reader has a special goal to achieve. The reader must, therefore, try to access information in memory to make the necessary connection (but see McKoon & Ratcliff, 1992).

The Event-Indexing Model and Situation Dimensions

Congruent with the construction-integration theory of text comprehension, Zwaan and colleagues have developed the *event-indexing-model* (Zwaan, Langston, & Graesser, 1995; Zwann & Radvansky, 1998) which specifies how situation models are created, updated, and used during comprehension. The model proposes that during reading an individual may decompose text information into events which are temporarily sustained in working memory. Connections between subsequently encountered elements that are relevant with the events in working memory are formed and stored in long-term memory. Associations between previously and newly encountered text elements span five general dimensions (or indices): (1) protagonist, (2) goals/intentions, (3) time, (4) causation, and (5) space. Because situation models are based on these dimensions, a discussion of each of these factors follows below. The final dimension to be discussed, space, is the focus of the current paper.

The protagonist

In a typical narrative, the protagonist can essentially be the focus, or like a guide, in the development and maintenance of situation models. Indeed, Scott Rich and Taylor (2000) argue that characters are critical to maintaining a situation model of narrative text. This section contains a description of studies that have examined how readers form a coherent representation of a protagonist within the structure of a larger text.

The situation model perspective concerning the role of the protagonist is largely inspired by the work of Sanford and Garrod (1981; see also Garrod & Sanford, 1998). The focus model and its related research provides an extensive account of the cognitive processes involved in reading and comprehending information pertaining to characters in narrative text. The model assumes, as do theories of discourse comprehension, that readers' ability to comprehend narrative text is constrained by the limited capacity of a working memory system and the rules of linguistics. Because stories typically describe an evolving series of events, readers are required to retain and combine previously learned information with evolving details and events that occur within a story. Concurrently, readers must also rely on explicitly stated information about the protagonist to comprehend implicitly stated information about other events or characters.

Therefore, it stands to reason that the main character (or "thematic subject") in a narrative serves as a point of reference for readers to attune their attention. Ancillary or secondary characters may also serve as points of reference in a story, but readers are typically more concerned with the events occurring to and around the main character. Character details, such as when and how a character is introduced in a story (i.e., proper name vs. role), can clue readers into the extent of a character's relevance (Anderson, Garrod, & Sanford, 1983; Morrow, 1985; Sanford, Moar, & Garrod, 1988). Sanford, Moar, and Garrod (1988) tested the effect of proper names (e.g., Mr. Bloggs) versus role references (e.g., the manager) in a narrative context. They reported that reading times for stories that introduced characters by name was shorter than reading times for stories that introduced characters by their roles. This is consistent with the idea that readers have primary representations of characters (e.g., based on their names) and that properties (e.g., role) are associated with them, but are not the focus in a mental model. These results therefore appear to be consistent with the specifications of the focus model concerning the importance of proper names in identifying the main character in a story.

There is also evidence that people actively monitor the introduction of new characters when reading narratives. For example, reading times tend to slow when a new character is introduced, suggesting that people are incorporating that new character into their situation model (Zwaan, Magliano, & Graesser, 1995). Along this line, the frequent recurrence of proper names in narratives, particularly when ancillary characters are involved, may also have an inhibitory effect. For example, Gordon and Scearce (1995) reported that when participants read short narratives (such as the one below), shorter reading times were observed for sentence (1a) if it contained a pronominal referent to the preceding sentences, whereas reading times for sentence (1b) were shorter if they contained a repeated name.

Bill wanted John to look over some important papers.

He had to mail him the documents by Monday.

(1a) Unfortunately, he/Bill never sent the papers. [continue]

(1b) Unfortunately, he/John never received the papers. [shift]

As a result, the whole deal fell behind schedule.

These findings suggest foremost that readers do indeed monitor and are responsive to the introduction of new characters. That is, the presence of a proper name signals that the character should be included in the readers' current situation model. Updating the current situation model with new information requires greater processing resources and, as a result, slows reading times. Moreover, these results suggest that the assimilation between the current and integrated situation models is contingent on both surface and propositional details.

Investigations of protagonist characteristics have also yielded evidence for situation model construction and updating. Some research indicates that readers are attentive to changes in a character's affective state (de Vega, León, & Diáz, 1996; Gernsbacher, Hallada, & Robertson, 1998; Komeda & Kusumi, 2006). Decelerations in participant reading times have been recorded for emotional shifts (Komeda & Kusumi, 2006) and inconsistencies (de Vega, et al., 1996) during narrative reading. Researchers have interpreted these outcomes as suggestive of online updating of situation model construction (Komeda & Kusumi, 2006; Zwaan & Radvanky, 1998); specifically, an updating of the characteristics of the protagonists.

In sum, these studies provide evidence suggesting that readers keep track of, and recall information about, characters during narrative reading. This is because readers focus their attention on protagonists during narrative reading (Sanford & Garrod, 1981). Readers rely on explicitly stated details, such as proper names, to determine a character's relevance to a story (Anderson, Garrod, & Sanford, 1983; Morrow, 1985; Sanford, Moar, & Garrod, 1988). Finally, the repeated finding that changes in characters' emotional states during narratives elicits changes in participants' reading times has been interpreted as evidence for online situation model maintenance and updating (de Vega, León, & Diáz, 1996; Gernsbacher, Hallada, & Robertson, 1998; Komeda & Kusumi, 2006; Zwaan & Radvansky, 1998).

Goals/intentionality

In Shakespeare's *Hamlet*, the protagonist endures a series of trials and tribulations, including feigning insanity and serving jail time, in order to accomplish the ultimate goal of avenging his father's murder. His quest begins when a ghost informs him that his father's untimely death was perpetrated by his uncle, Claudius. Despite his skepticism about the ghost's advice, he decides to take up the cause. Had the meeting between the hero and the ghost not occurred at the outset of the story many of the subsequent details would make little sense. For example, because he suspects that his uncle is guilty, Hamlet pays close attention to Claudius's actions during a play depicting his father's death. In any other context, this behavior might seem unusual. Thus, an understanding of the primary character's motivation is critical for successful comprehension.

This notion is consistent with the constructionist framework of narrative comprehension (Graesser, Singer, & Trabsso, 1994). The constructionist perspective stipulates that readers actively engage in a *search for meaning* during reading. More specifically, rather than focusing their attention on surface level details (i.e., letters and words; the structure of sentences), readers are more concerned with making sense of what they are reading. A crucial part of this process includes determining why characters behave as they do in a narrative. Characters' actions are often inspired by accomplishing some ultimate (*superordinate*) goal; but before that goal may be met, the individual may have to overcome a series of smaller (*subordinate*) goals. For example, Hamlet's superordinate goal is to avenge his father's death; yet, to accomplish this he must overcome a sequence of interim obstacles, or subordinate goals, created by Claudius. Forming associations between the superordinate goals of characters, subsequent actions, and the overall theme of a story requires readers to generate inferences (Graesser, et al., 1994) because some of the vital information may not be explicitly stated in the text. These inferences are likely created during on-line reading (Long, Golding, & Graesser, 1992; for an alternative perspective, see McKoon & Ratcliff, 1992), provided that the text is coherent and that the reader has followed the story through its natural course.

Much of the research on the role of intentionality in narrative comprehension has focused on the relationship between actions and goals. The accumulated evidence suggests that readers create a mental checklist of goal-relevant story details. Goals that have been satisfied are essentially checked-off and mentally discarded, whereas unsatisfied goals remain prominent in memory. Character actions are therefore evaluated in terms of their relevance to the most pressing goal. Suh and Trabasso (1993, see also Trabasso & Suh, 1993) used verbal protocols and text probes to measure participants' comprehension of stories in which primary and secondary goals were met or unmet. Results from the verbal protocols suggested that participants were more focused on unsatisfied subgoals, as compared with unsatisfied superordinate goals. Analysis of reading times for the probes indicated that participants read information about unsatisfied goals faster than probes for satisfied goals.

Explanations for why unsatisfied goal information is more accessible to readers than satisfied goal information has eluded researchers; yet the effect has been replicated on numerous occasions (i.e., Lutz & Radvansky, 1997; Magliano & Radvansky, 2001; Radvansky & Curiel, 1998; Richards & Singer, 2001). One possibility is that the level of agreement between goals and actions may have some effect on comprehension (Egidi & Gerrig, 2006; Huitema, Dopkins, Klin, & Meyers 1993). Huitema, et al (1993) found that reading times for stories vary as a function of consistency between goals and actions. Uncompleted goals can be a potential motivator of actions, whereas completed goals cannot (provided that the completion does not yield a new uncompleted goal) (Suh &

Trabasso, 1993; Trabasso & Suh, 1993). This is because readers of narratives understand that characters actions are typically inspired by a quest to accomplish some goal. Therefore, comprehension is best achieved when there is congruency between events that occur within a narrative and the motivations of the character. That is, characters actions are causally relevant to the characters goals (Trabasso & van den Broek, 1985).

In conclusion, information about goals is important for narrative comprehension because readers make sense of events that transpire during the course of a narrative by following the goals of the characters (Graesser, Singer, & Trabsso, 1994) whether they are superordinate or subordinate goals. When a text fails to clarify the relationship between a characters' described behavior and the meeting of a goal, readers generate inferences (Graesser, et al., 1994). When there is strong agreement between characters' actions and goals, readers are better able to comprehend what they are reading (Egidi & Gerrig, 2006; Huitema, Dopkins, Klin, & Meyers 1993). Finally, goals-in-progress are more easily activated than unmet goals, possibly because unmet goals provide motivation for a character's actions (Suh & Trabasso, 1993; Trabasso & Suh, 1993).

Time

Of critical importance to the successful comprehension of narrative texts is the reader's ability to follow the duration of an unfolding sequence of events (Anderson, Garrod, & Sanford, 1983; Mandler, 1984; Ohtsuka & Brewer, 1992). Studies have shown that common linguistic devices, such as verb tense (*was*, *will*, *am*), time adverbs (i.e. *before, after, now*), and verb aspect (*ate, was eating*) function as temporal markers to signal the order in which events occur (Carreiras, Carriedo, Alonso, & Fernández, 1997; Magliano & Schleich, 2000, Zwaan, 1996). Readers rely on these textual cues, in addition to general world knowledge, to form a coherent mental representation of what is being described in the text, but are limited by the amount of information they are able to process and store in working memory (Magliano & Schleich, 2000; Ohtsuka & Brewer, 1992).

Occasionally, the temporal order of events may not be specified in a given text, as demonstrated in the following sentence:

(2) Riley went to the kitchen, picked up the pineapple, and grabbed a knife.

When a narrative text fails to explicitly state the order of events via tense or adverbs, readers take for granted that the narrated sequence (i.e. Riley first went to the kitchen/ picked up the pineapple when he got there/ then grabbed the knife) is the correct order of events. The iconicity assumption (Fleischman, 1990; Hopper, 1979) states that, in the absence of clear temporal guidelines, readers generally assume that the order in which events in a story are told denotes the correct chronological order.

Dowty (1986; see also Zwaan, 1996) proposed an extended version of the iconicity assumption, the so-called "strong iconicity assumption" (or *temporal discourse interpretation principle*), which specifies that, in addition to relying on the order in which events are relayed in a story, extended time lapses within the duration of a narrative may prompt readers to create a new situation model. For example, narratives can include sudden leaps in time, flashbacks, or flashforwards, which could disrupt comprehension. Zwaan, Magliano, and Graesser (1995) reported that increases in sentence reading times were observed when readers encountered temporal discontinuities in narratives, regardless of whether readers were engaged in natural reading or reading for memory. Zwaan, Radvansky, Hilliard, and Curiel (1998) also found the same effect for temporal discontinuities when stories were presented clause-by-clause, rather than sentence-by-sentence, as in Zwaan, et al's (1995) study. In addition, using an event related potential (ERP) method, Ditman, Holcomb, and Kuperberg (2008) showed that noticeable N400 (a negative electric brainwave that occurs 400 milliseconds after the presentation of a stimulus) patterns occurred when readers encountered large, unexpected time shifts, as compared with short or moderate time shifts. The N400 pattern suggests that readers spent more time reading the longer narrative time shifts and, thus, integrating the information into their situation model.

Additional empirical support for the strong iconicity assumption comes from Zwaan (1996). Participants were exposed to short narratives in which the critical sentences featured either close (i.e., *a moment later*), intermediate (i.e., *an hour later*), or distant (i.e., *a day later*) temporal adverbials. Consistent with the strong iconicity assumption, shorter reading times and response latencies were found for stories in which there was a shorter time shift (i.e., a moment later). It appears as though larger time shifts (i.e., a day later) suggest to readers that they should construct a new situation model because the narrative is likely to now be describing a new state-of-affairs. That is, this suggests that temporal discontinuities in the story timeline may interfere with the normal maintenance of a prior situation model. When a reader encounters a narrative time shift, information that was read prior to the shift may become less accessible because it is part of the earlier situation model, while newer information becomes more prominent in memory, because it is part of the current situation model (Speer & Zacks, 2005).

Radvansky, Zwaan, Federico, and Franklin (1998) extended the findings of Zwaan (1996) by demonstrating that, regardless of whether the necessary temporal linguistic information (i.e., temporal adverbials, verb tense) is available from a text, when readers encounter inconsistent information, the current situation model may become discarded for a new one to complete the integrated model. For instance, provided that a character is not a two-headed, four-limbed being, most readers would immediately recognize the physical impossibility of an average human character simultaneously playing pinball, reading a novel, and playing piano. If one were to have read these facts during the course of a normal narrative, the conflicting new information would likely disrupt the normal updating process and interfere with any associated recall activity. However, if the text specifies that a character *contemplated* reading a novel while they were playing pinball or *thought about* playing a piano while they were reading but did not actually perform these activities simultaneously (as indicated by the requisite adverbials), then normal comprehension would not be disrupted (de Vega, Robertson, Glenberg, Kaschak, & Rinck, 2004).

The use of other inconsistency paradigms has also revealed evidence that readers use temporal information to update their situation model. One approach has been to manipulate temporal information so that it is inconsistent with subsequent information (Rink, Gámez, Diáz, & de Vega, 2003; Rink, Hähnel, & Becker, 2001). Another approach has been to manipulate temporal information in such a way that it violates readers' expectations. Therriault and Raney (2007) compared reading times for narratives comprised of events that occurred over normal or incongruent temporal durations. For example, in one passage two characters met at a restaurant and dined together for either one-hour (normal duration), seven hours (long-inconsistent duration), or five minutes (short-inconsistent duration). As with other inconsistency studies, the manipulation had a significant effect on reading times. In general, the detection of these inconsistencies shows that people actively monitor temporal information (Therriault & Raney, 2007).

Together, these studies show that temporal situation models depend on comprehension of text-level input as well as inferences derived from the readers' world knowledge. Specificity about the duration of events that occur during the course of a narrative facilitates comprehension, whereas textural inconsistencies and sudden time shifts may disrupt comprehension (Zwaan, et al., 1995; Zwaan, et al., 1998). When the duration of events is not specified in the text, readers defer to the narrated sequence, as described by the iconicity assumption (Dowty, 1986; Fleischman, 1990; Hopper, 1979; Zwaan, 1996).

Causation

A cohesive narrative must account for why characters behave in a described manner or why certain events happen so that a person can comprehend what they are reading. Comprehending causal relations requires both textual cues as well as inferences derived from the reader's world knowledge. The following section provides a bottom-up description of how readers create causal representations of narratives. First, consideration will be given to how the integration of sentence-level information, including the use of specific grammatical devices (connectives), forms a basic causal description of the text. A brief discussion will follow on the role of inferences derived from the text and world knowledge in generating higher-level representations of a narrative. The section will conclude with a short discussion about theories of higher-level representations of causal coherence.

Inspired by the work of Haliday and Hasan (1976), researchers began to explore how text-based cues (such as conjunctions) help readers comprehend narrative relations. Conjunctives (*connectives*) are grammatical devices (words, phrases) used to specify conceptually associated statements or clauses in text. There are four major types of conjunctions: (1) additive (*and*, *also*), (2) adversative (*however*, *but*), (3) causal (*as a result*, *because*), and (4) temporal (*after*, *then*). It is generally agreed among researchers that, because they reduce the linguistic ambiguity between clauses or statements in a text and therefore the need for inferences, connectives are helpful for reading comprehension (Haliday & Hasan, 1976; Haviland & Clark, 1974; Keenan & Kintsch, 1974; Lorch, 1989).

There are several lines of evidence suggestive of the facilitative effect of connectives, more specifically causal connectives, on reading comprehension. First, faster reading times have been observed for sentences containing causal connectives as compared with no connectives (Haberlant, 1982; Millis & Just, 1994), additive connectives (Sanders, 1992; Sanders & Noordman; 1998), temporal connectives (Singer, Halldorson, Lear, & Andrusiak, 1992), and diagnostic sentences (Traxler, Bybee, & Pickering, 1997). It has also been demonstrated that the presence of causal connectives promoted superior performance on other cognitive activities such as recall (Caron, Micko, & Thüring, 1988; Golding, Millis, Hauselt, & Sego, 1995; Millis, Golding, & Barker, 1995; Millis & Just, 1994; Sanders, 1992; Sanders & Noordman, 1998), verification latencies (Cozijn, 1992; Sanders, 1992; Sanders & Noordman, 1998); and probe response times (Cozijn, 1992; Millis & Just, 1994; Singer, et al., 1992).

Some scientists contend that causal connectives facilitate comprehension by enabling readers to make connections between sentence-level clauses. Millis and Just (1994) proposed a *connective integration model* of text processing, which stipulates that readers create separate representations for two clauses, each of which is held briefly in a limited capacity working memory system and subsequently combined when the end of a sentence is reached. For example, when readers encounter a sentence like "*The elderly parents toasted their only daughter at the party because Jill had passed the exams at the prestigious university*" a representation is created for the first clause in working memory, while the connective (*because*) signals the creation of an additional representation for the second clause. Upon reaching the end of the sentence, a unified, integrated representation is then created for both clauses and the reader is thus able to understand how these two pieces of information go together. Data from eye-tracking studies suggests that clause integration may occur prior to sentence wrap-up (Traxler, Bybee, & Pickering, 1997).

In addition to text-level information, people also rely on world knowledge to determine causal relations during reading. Investigations into the role of world knowledge in comprehension have been conducted by examining participants' abilities to generate inferences for causal information (Zwaan & Singer, 2003). For example, Black and Bern (1981) presented short stories to participants in which the first sentence was either causally or temporally related to the next sentence. In the following example, readers must infer that the protagonist is sad (4) either because he lost his pocketknife (3a) or for some reason not specified in the text (3b).

(3a) *Causal*: While he was sitting on a huge log he lost an old pocketknife.

(3b) *Temporal*: While he was sitting on a huge log he found an old pocketknife.

(4) He felt sad as they took a few more pictures and headed back.

Results from both cued and free recall tests indicated that causally related stories were better recalled than temporally related stories. Thus, when an explicit expression of the causal relation between story elements is available to readers, comprehension improves.

One explanation for this finding is that in the absence of an explicit causal description, readers use bridging inferences to make associations between sentences (Singer, Halldorson, Lear, & Andrusiak, 1992; Singer, Revlin, & Halldorson, 1990). Bridging inferences require that readers validate a given premise (i.e., *Dorothy poured water on the fire. The fire went out.*) with their knowledge of the world (i.e., *water extinguishes fire*). As the distance between idea units increases (i.e., *Dorothy poured gasoline on the fire. The fire went out.*), the greater the strain on working memory resources and, consequently, comprehension becomes disrupted (Singer, Halldorson, Lear, & Andrusiak, 1992; Zwaan & Singer, 2003).

Text-level comprehension and inferences generated from world knowledge ultimately aid in the creation of a cohesive representation of a narrative. Theoretical accounts of the nature of these representations derive largely from the constructionist tradition, which holds that readers are actively engaged in a “search for meaning” during reading and that attentive readers are motivated to understand what they are reading (Graesser, Singer, & Trabsso, 1994). Network models of reading, such as those developed by Trabasso and colleagues (Trabasso, Secco, & van den Broek, 1984; Trabasso & Sperry, 1985; Trabasso & Suh, 1993; Trabasso & van den Broek, 1985) are useful in helping researchers illustrate how readers mentally represent causal relations. Fundamentally, the model developed by Trabasso and colleagues specifies that the goals of the protagonist generate a sequence of causally related events (a "causal chain") that occur throughout the course of a story. The strength of the connections between events facilitates or inhibits the readers understanding of the narrative. As such, deviations from the specified goals of the protagonist will disrupt the formation of a coherent causal representation of the story. Evidence obtained from recall measures suggests that stories with strong causal chains were better recalled than stories with weak causal chains (Trabasso & van den Broek, 1985).

In sum, the formation of a causal situation model of a narrative requires both lower- and higher- level processing. At the lower level, readers must form coherent sentence level representations. Sentence representations are facilitated by textual cues, namely, causal connectives (Haliday and Hasan, 1976), and depend critically on the availability and amount of information that can be stored in working memory (Millis & Just, 1994). Texts that specify causal relationships are better remembered than texts that require the readers to generate bridging inferences (Singer, et al., 1992; Singer, et al. 1990). Textual information, inferences, and world knowledge contribute to the maintenance and updating of higher-level causal representations (Trabasso, et al., 1984; Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985).

Space

Thus far, this paper has presented a survey of four of the five dimensions central to situation model construction and maintenance: the protagonist, goals/intentionality, time, and causality. The spatial dimension is the primary focus of the study. This section will first consider research related to the spatial framework and will then examine spatial relations.

Space is one of the most widely researched dimensions of situation models (Zwaan & Radvansky, 1998). Efforts to understand spatial situation models have generally sought to determine how readers use spatial situation models and how they might interact with other situational variables. For example, one area of interest is how readers monitor the movements and actions of the protagonist in certain environments. Here, consideration will be given to evidence for the organization and monitoring of spatial information and how readers continuously update this information into a coherent situation model.

The idea that people use space as a foundation for their mental models was demonstrated by Radvansky and colleagues (Gerard, Zacks, Hasher, & Radvansky, 1991; Radvansky, 1999a; Radvansky, Spieler, & Zacks, 1993; Radvansky & Zacks, 1991; Radvansky, Zacks, & Hasher, 1996) in that they showed that readers organize spatial information by creating single or multiple spatial situation models from textual content. In these studies participants read sentences that described randomly paired objects and locations, or characters and locations. A typical set of sentences might be:

(5) The cola machine is in the hotel. The cola machine is in the public library.

(6) The cola machine is in the high school.

(7) The display case is in the city hall.

(8) The potted palm is in the city hall.

(9) The broken window is in the city hall.

Thus, in this example one object (the *cola machine*) is described as being in three spatially distinct locations (the *hotel*, the *public library*, and the *school*). These sentences also describe a single location (*city hall*) that contains multiple objects (the *display case*, *potted palm*, and *broken window*). The primary findings for these studies were that participants exhibited better recall for information about multiple objects in a single location. For example, the participants appeared to integrate that the *city hall* contained the *display case, potted palm*, and the *broken window* better than the fact that the *cola machine* was located in the *hotel*, the *public library*, and the *high school*. The latter finding is commonly referred to as the fan effect. One explanation for these outcomes is that the logical impossibility of a single object being simultaneously present in three different locations disrupted comprehension or caused processing difficulties. However, the situation model perspective for these findings is that readers create an integrated spatio-temporal representation for related pieces of information and separate representations for unrelated pieces of information. In other words, people seemed to be building situation models centered around spatial locations. By merging related information (i.e., common location) into a unified representation, readers were better able to access pertinent information and suppress irrelevant information during recall (Radvansky, 1999b; for an alternative memory-based perspective, see Anderson & Reder, 1999).

While spatial location seems to be a primary basis of organizing information, sometimes this is not a realistic option. For example, it is possible for a spatial location to be too small to realistically contain multiple objects or people (e.g., a witness stand in court or a bathroom on a Greyhound bus). Radvansky, Spieler, and Zacks (1993) showed that when spatial organization is not plausible, people will sometimes organize around a protagonist. That is, in this scenario readers exhibited better recall for information about a single character in multiple locations. However, this does seem to be an exception to the typical pattern of organizing around spatial locations.

The above point is important because even though people typically organize situation models around spatial locations, spatial and entity information can interact. For example, readers seem to monitor protagonists as they move through various locations. As discussed previously, readers are sensitive to narrative details about a protagonist, sometimes even taking the protagonist's point of view in a story (Bower, 1975; Black, Turner, & Bower, 1979; Bower & Morrow, 1990). Following the movements and locations of the protagonist creates what Morrow (1994, 1995) has termed a "Here-and-Now" perspective (or the *deictic center*, Segal & Duchan, 1997). Textural cues, such as prepositions (e.g., *The fireman walked down the street*) or verb aspect (*walk*/*walked*) help readers determine a character's present location in a narrative (Bower & Morrow, 1990; Morrow, 1985; Morrow & Greenspan, 1988). Moreover, it has been shown that readers keep track of and are attentive to inconsistencies in a protagonist's location (Black, Turner, & Bower, 1979), regardless of whether this information is explicitly or implicitly described in the text (Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987).

Perhaps one of the more intriguing findings from spatial narrative research is the effect of varying described distances between characters, locations, and important objects on comprehension. The *map-and-narrative* task originally developed by Morrow and colleagues (Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987), and subsequently modified by Rinck and Bower (1995), requires that participants first memorize a map of a fictional building with many rooms and to then read a narrative that describes a character's movement within the building and interactions with available objects (Rinck, 2005; Rinck & Bower, 1995). These narratives detail a room-by-room account of the character's movement through the building, and occasionally, as people are reading, they are probed with items that vary as to how close they are to the character's current location (e.g., same room, previous room, distant room). In general, longer reading and response times are observed as the distance between the protagonist and target items increases. This phenomenon is known as the *gradient of spatial accessibility* (Rinck & Bower, 1995). This suggests that readers mentally move through the spatial locations along with the character (but see Pylyshyn, 1981 for an alternative view of visual imagery).

While there are some circumstances when the gradient of spatial accessibility is not observed, such as when the spatial layout of the building changes during the narrative (Wolf, Hasebrook, & Rinck, 1999) or when the characters movements are non-unidirectional (Rapp, Klug, & Taylor, 2006), the gradient of spatial accessibility is a rather robust finding and has been observed under many experimental conditions. For example, a gradient of spatial accessibility has been found regardless of variations in the described environment (Rinck, Williams, Bower, & Becker, 1996), direction of spatial distance (Rinck et al., 1996), language of the narrative (Rinck et al., 1996), targeted probe items (Rinck et al., 1996), the size of the rooms of the building (Rinck, Hähnel, Bower, & Glowalla, 1997), and whether or not the location room is explicitly stated (Rinck, Bower, & Wolf, 1998). In addition, some evidence indicates parallel increases in reading and response times for the spatial accessibility and other situational dimensions, such as protagonist goals (Bower & Rinck, 1999; Rinck & Bower, 2004) and time (Rinck & Bower, 2000), suggesting an interactive effect.

Evidence for the effects of distances on spatial situation models are not necessarily task-specific and have also been observed in situations where the participants were not required to memorize a map of a location prior to narrative reading. In a classic study, Glenberg, Meyer, and Lindem (1987) had participants read short narratives in which an item was described as proximally near or distant to the protagonist. For example,

(10) John was preparing for a marathon in August.

(11a) (near) After doing a few warm-up exercises, he put on his *sweatshirt* and went jogging.

(11b) (distant) After doing a few warm-up exercises, he took off his *sweatshirt* and went jogging.

Note that in one sentence the protagonist distances himself from an object (e.g., the *sweatshirt*) by taking it off and in the other sentence a close spatial relationship is formed with the object when it is put on. Response times for probed items were faster if the item was described as being proximal to the protagonist, as compared with items that were distant from the protagonist. These results support the idea that spatial distances are important to situation models of narratives because readers clearly update information about spatial relations by monitoring the actions of the protagonist. This finding, that readers are sensitive to the described spatial distance between important objects and characters, has come to be called the *spatial distance effect.*

Spatial distance effects have been observed in non-narrative contexts as well. In a similar study that used a virtual environment instead of a narrative, Radvansky and Copeland (2006) reported that participants demonstrated better on-line recall for recently acquired items as compared with discarded items while navigating through a virtual environment. Importantly, memory for these items was most affected by a change in spatial location. That is, when there was not a change in location, objects were more accessible in memory than when there was a change in location. In two other studies, Copeland, Magliano, and Radvansky (2006; see also Magliano, Radvansky, & Copeland, 2007) reported that participants' success in a video game was related to both the spatial proximity between the player, allies, and enemies, as well as recent changes in spatial location. Thus, these studies support the narrative studies that show that people are affected by changes in spatial location.

The *spatial framework* theory (Franklin & Tversky, 1990) specifies that readers rely on their interactions and perceptual experiences with the world to comprehend spatial information. More specifically, representations of the location of (and relationship between) objects described in a narrative are interpreted relative to three asymmetric axes of the human body: a vertical axis corresponding to the head/feet and two vertical axes corresponding to the front/back and left/right perspectives. Knowledge about the fundamental laws of gravity also governs the construction of a mental representation, particularly with regard to objects that require the vertical (head/feet) perceptual senses. Work in this domain has repeatedly shown that objects requiring head/feet representations are most accessible, front/back are moderately accessible, and left/right are least accessible (Bryant & Tversky, 1992; Bryant, Tversky, & Franklin, 1992;

Franklin & Tversky, 1990). The explanation for these findings is that people assemble a mental representation of the spatial environment and important objects in the environment are matched to the relevant axis of the body (head and feet, front and back, and left and right).

Although researchers have been successful at isolating some of the relevant properties associated with spatial situation models, efforts to obtain evidence for space, as an independent dimension, has been met with mixed results. Reading times for situational inconsistencies in narratives has been the hallmark metric for testing a dimension's unique contribution to reading comprehension. To date, reports of longer reading times for spatially inconsistent narratives have emerged (O'Brien & Albrecht, 1992; de Vega, 1995; Haenggi, Gernsbacher, & Bolliger, 1994; Rinck & Hähnel, 2000), suggesting that readers do indeed monitor spatial information during reading. Given these findings, one would therefore expect that readers might observe other types of situational anomalies during the course of narrative reading.

Zwaan, Magliano, and Graesser (1995) had participants read narratives in which a character was described as being in a spatially continuous or a spatially distinct location (a spatial discontinuity). Although this manipulation produced longer second pass reading times, it had little to no effect on initial sentence reading times. This outcome was particularly striking, given that longer initial reading times were observed for temporal and causal discontinuities. Zwaan, Radvansky, Hilliard, and Curiel (1998) reported similar outcomes for sentence- and clause- reading times for situational discontinuities. Thus, while readers do appear to monitor spatial inconsistencies, they do not always show evidence of monitoring spatial discontinuities.

One explanation for these incongruent outcomes is that task instructions may have had an effect on participants' performance. In fact, Zwaan and colleagues have investigated this possibility (Zwaan & van Oostendorp, 1993; Zwaan, et al., 1995; Zwaan, et al, 1998). Participants in these experiments were instructed to either read normally or read for memory. This manipulation had little informative effect on reading times, but did produce small group differences, to the extent that those instructed to read for memory had longer times as compared with those instructed to read naturally. In addition, a recent study by Radvansky and Copeland (2010) has suggested the possibility that reading time effects may not always be observed because spatial updating may be easier than other, less natural types of updating, such as changes in time. As it stands, spatial situation model construction appears to be an integral component of the normal reading process.

Another possibility why researchers report contrasting outcomes for studies examining space as a situation model dimension may have more to do with the text used in the studies. Texts that focus readers' attention on spatial information are more likely to produce effects consistent with the situation model perspective, as compared with texts that focus the readers attention on other, or even multiple, situational dimensions (Radvansky & Copeland, 2000; Rinck, 2005; Zwaan & van Oostendorp, 1993). Early investigations into readers' memory for spatial information provide some evidence for this hypothesis.

Consider a well-known study conducted by Bransford, Barclay, and Franks (1972). For their experiment, participants listened to sets of sentences describing varying spatial arrangements, such as

(12a) Three turtles rested *on* a floating log, and a fish swam beneath *them*.

(13a) Three turtles rested *beside* a floating log, and a fish swam beneath *them*.

Note the difference in the spatial layout (*on* vs. *beside*). In sentence (12a), the referent is the turtles that are resting *on* the log, whereas in sentence (13a) the referent is the turtles that are resting *beside* the log. In both sentences, the fish is described as swimming beneath the turtles, but the fish is only swimming beneath the log in the first sentence. After the participants heard the sentence, they were administered a recognition task that included the same, as well as subtly altered constructions of the sentences, such as

(12b) Three turtles rested *on* a floating log, and a fish swam beneath *it.*

(13b) Three turtles rested *beside* a floating log, and a fish swam beneath *it*.

In these constructions, the pronominal referents are identical with respect to the original sentences, but the spatial layouts have changed, such that in both cases, the fish is described as swimming beneath the log. To reiterate, in (12a) and (12b) the fish is swimming beneath both the turtles and log. However, in (13a) the fish is swimming beneath only the turtles, while in (13b) the fish is beneath only the log.

The outcomes from this study were clear: readers do not simply create surface-level representations for text, even when they are instructed to do so; rather they form a higher-level representation of the described spatial situation. The results from the recognition tests indicated a consistent pattern: participants often confused sentences such as (12a) and (12b), yet rarely confused sentences such as (13a) and (13b). Again, the wording difference between (12a) and (12b) was the same as between (13a) and (13b); the difference, however, was that the former referred to the same spatial situation and were confusable and the latter referred to different spatial situations and were not confused. Thus, when a given text focuses readers' attention on spatial information, evidence for situational representations are more likely to be observed, as compared with texts that prompt the activation of multiple situations models.

In a similar experiment, Mani and Johnson-Laird (1982) had participants read short determinate and indeterminate descriptions of a spatial arrangement. A determinate description precisely described the physical locations of the items (e.g., *A is behind D. A is to the left of B. C is to the right of B.*)

(14) A B C
D

Indeterminate descriptions permitted alternative arrangement possibilities (e.g., *A is behind D. A is to the left of B. C is to the right of A.*).

(15a) A B C
D

(15b) A C B
D

After reading the descriptions, the participants were then presented with a diagram of the spatial arrangement, for which they were instructed to decide if the diagram was consistent or inconsistent with the text description. Finally, they completed an unexpected memory test. Results from the recall task suggested that people created a situation model for determinate descriptions, but a text-based representation for indeterminate descriptions. In other words, they remembered the gist of the determinate descriptions because those descriptions permitted only one spatial arrangement whereas the indeterminate descriptions, where it was unclear which of the possible spatial mental model arrangements was intended, people relied on their memory of the text.

In conclusion, readers form situation models for spatial information. Studies of the fan effect (Radvansky, et al., 1991; Radvansky, et al., 1993) show that readers organize information and create situation models based on spatial locations. They combine related pieces of information to form unified representations and create multiple representations for unrelated pieces of information. Readers also monitor spatial shifts in narratives and update their situation model accordingly (Morrow & Greenspan, 1988; Morrow, 1990; Morrow, 1985). Successful integration of spatial information depends on the described distances between characters and locations, as indicated by the gradient of spatial accessibility (Rinck & Bower, 1995) or the described distances between characters as objects, as indicated by spatial distance effects (Glenberg, et al., 1997). Finally, evidence for spatial situation models is strongest when other spatial descriptions are most salient and other situational dimensions are not required for comprehension (Bransford, Barclay, & Franks, 1972; Mani & Johnson-Laird, 1982).

Functionality

The creation of a coherent spatial situation model may be facilitated by the relationship between items in a described spatial array. Spatial relations may be expressed in different ways: (1) lexically (i.e. prepositions such as *over, in, above, below*), (2) in property (e.g., shoe and laces: laces are used to fasten the shoe to the foot), or (3) orientation (e.g., floor and bookshelf: the floor supports the bookshelf). Related items are assimilated in the current situation model more easily than items that are not related (Miller & Johnson-Laird, 1976). Work in the spatial cognition domain has demonstrated that the more closely associated items are, the easier it is to retrieve items from memory when required to do so, regardless of symmetry (Coventry, Venn, Smith, & Morely, 2003).

Theorists have speculated that how readers perceive the interactions between items, as well as how these items might be used, is also critical to understanding how spatial relations are comprehended (Coventry, 1997; Coventry & Garrod, 2004; Garrod & Sanford, 1989; Michotte, 1963; Vandelosie, 1984; 1991). For example, if one were presented with a cap and a tube of toothpaste, one might observe that both objects are related in property and in purpose (the cap is used to keep the toothpaste inside the tube). Of course, knowledge about the world is required to make the inference that the cap and tube are purposefully related. Stated differently then, it could be proposed that the cap and tube of toothpaste are *functionally* related. That is, the cap functions to preserve the toothpaste contained in the tube.

In a demonstration of the effect of functionality on spatial relatedness, Carlson-Radvansky, Covey, and Lattanzi (1999) had participants place pictures of located objects (e.g., a tube of toothpaste v. a tube of oil paint) above or below a referenced object (e.g., a toothbrush). Presenting the referenced items as aligned or misaligned with their respective center mass permitted a direct test of the importance of functionality on spatial relations. The key idea was that placement tended to be further from the center of mass for the referenced item when there was a functional spatial relation present. In the example, because toothpaste is applied to the bristles of a toothbrush, people located “above” to be closer to the end with the bristles. However, for the paint, “above” was closer to the physical center of the toothbrush. In short, participants naturally perceived the spatial relations between objects in terms of functionality, even when they were not prompted to do so. These findings support the notion that functional relatedness is central to processing spatial relations.

As another example, suppose a man was standing below an old bridge. While there is nothing inherently functional about a man standing below a bridge, the appropriate context can lead to a functional spatial relationship between story elements. Here, the old bridge can provide the protagonist with shelter from rain. However, if the circumstances were changed- if a sudden downpour of rain was not mentioned in the text- then the fact that the protagonist was standing under the old bridge would seem hardly relevant to the reader. For example, if instead the protagonist were attempting to read a map on a dark, moonless night, the old bridge would be of little functional significance to the protagonist, as compared with other objects in the environment, such as a streetlight.

Using narratives with spatial relations similar to the aforementioned one, researchers (Radvansky & Copeland, 2000; Radvansky, Copeland, & Zwaan, 2003) explored the effect of narrative context and functional spatial relations on readers' recall and recognition of story events. The results from these experiments indicated that stories that specified functional spatial relationships were better comprehended than stories that specified nonfunctional spatial relationships. Moreover, reading times for the critical sentences, as well as recall and recognition scores were superior for functional, as compared with nonfunctional spatial relations. That these findings were due not simply to differences in lower-levels of discourse representation (i.e., surface or textbase representations), as reported by Radvansky et al. (2003), only furthers the argument that functional spatial relations facilitate the construction of integrated situation models.

Jahn (2004) argued that causal descriptions in narratives also contribute to the comprehension of spatial relations. In his view, meaningful interactions between characters promote stronger representations of spatial relations. Consider the following example taken from Jahn (2004).

(16) Two Zebras graze next to a shrub and an antelope trots towards them.

In this example, the object (the shrub) serves as a reference point for the spatial array (e.g. the zebras are already spatially proximal to the shrub, but the antelope is not). Importantly, there is no meaningful relationship between the zebras and the antelope. One might expect that little interaction would occur between the zebras and the antelope save for perhaps a brief visual acknowledgement. Now consider a different scenario from Jahn (2004):

(17) Two zebras graze next to a shrub and a lion trots towards them.

Here, the spatial arrangement of objects and characters is identical to sentence (16), but, in contrast, the reader is likely to anticipate a meaningful interaction between the characters. That is, one assumes that the lion is described as moving towards the zebras, not to feed from the shrub, but rather to satisfy its predatory intentions towards the zebras. According to Jahn (2004), the lion's intention to attack the zebras suggests a causal relationship. In other words, the lion is trotting towards the zebras *because* it intends to attack. Therefore, functional relations in narrative spatial descriptions are necessary, but not sufficient to promote spatial representations. The causal agent in narratives is the focus of the readers' attention, rather than the functional relations between objects and characters. Consequently, the causal component of the narrative increases the likelihood of the spatial relation being encoded into the situation model representation.

Indeed, Jahn (2004) reported that participants were better at discriminating similar recognition sentences from different recognition sentences when the sentences described predator-prey relations (e.g., the zebras and the lions), as compared with sentences that described allied relations (e.g., the zebras and the antelope). As further evidence for the effect of causal relations on spatial representations, additional experiments were conducted in which participants were instructed to determine (yes/no) whether a threat was present in the description. The rationale for this manipulation was to ensure that participants observed the spatial relations and inferred the causal relations between the characters. Again, the danger manipulation had a significant effect on recognition scores and improved recognition scores for peaceful descriptions. Thus, when participants were instructed to observe spatial and causal relations, performance improved.

Jahn's (2004) findings raise a number of interesting points beyond the earlier ideas of functionality and causality improving memory for spatial relations (i.e., the causal-functional hypothesis). That readers appear to retain information of a survival flavor better than neutral stimuli is consistent with a developing body of work (e.g., Nairne, Pandeirada, & Thompson, 2008; Nairne, Thompson, & Panderirada, 2007; Weinstein, Bugg, & Roediger, 2008). Proponents of the "adaptive memory hypothesis" (Nairne, et al., 2008) propose that the human cognitive system is attuned to survival-relevant information. Work in this domain consists primarily of priming research participants to imagine themselves in particular situations (e.g., stranded in the grasslands in need of food and water) and to then rate a set of given words on their relevance to the situation. After rating the words and completing a distracter task, participants are then given a surprise recall test. Outcomes from these studies have evidenced a fairly consistent pattern in support of the adaptive memory perspective: participants who were primed to imagine themselves in a survival scenario generally exhibit better recall for words than those in the competing conditions. Thus, it seems there is a memory benefit to associating information with survival / danger situations. That is, regardless of whether participants are more focused on survival information or if the survival information may promote arousal, there appears to be a clear memory benefit. However, currently it is not clear whether survival / danger contexts improve memory for spatial relations above and beyond simple functional relations.

Summary of Literature Review

The current state of research on how people read and understand narrative text suggests a complex interaction between both low- and high-level cognitive systems, namely perceptual encoding, working memory, and long-term memory. The collective efforts of these resources culminate in the formation of three interdependent levels of mental representation for discourse: (1) the surface form, (2) propositional textbase, and (3) situation model (Johnson-Laird, 1983; van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998). Situation models are mental representations of the state of affairs described in a text and are thought to be defined by five narrative dimensions (or indices): (1) the protagonist, (2) goals/intentionality, (3) time, (4) causation, and (5) space (Zwaan, et al. 1995; Zwaan & Radvansky, 1998). Spatial situation models are mental representation of the narrative environment and how characters interact in the environment. Radvansky and colleagues (2000; 2003) showed that relationships that are functionally congruent are often better understood as compared with relationships that are functionally incongruent or nonfunctional. However, Jahn (2004) suggested that functional spatial relations also require specification of causal information. According to this perspective, causal relations are most salient when a character is facing an imminent threat. These findings appear to be consistent with a developing body of work on the adaptive memory hypothesis (e.g., Nairne, et al., 2007; 2008; Weinstein, et al., 2008), which postulates that the human cognitive system is sensitive to survival-relevant information.

The current study

The objective of the current experiment was to determine whether survival-based scenarios (as expressed in narratives that describe characters in life-threatening situations) contribute to the development and maintenance of situation models for functional spatial relations. More specifically, the focus of the current investigation was to determine whether, as Jahn (2004) suggested, causal factors inherent in survival/non-survival narratives focus readers' attention on functional/non-functional spatial relations. This study will expand on Jahn's (2004) and Radvansky and Copeland's (2000) studies by comparing the unique effects of survival context and functionality, as well as their interaction.

Participants read twenty short, original narratives that include two types of critical sentences that each can be in one of two conditions (yielding a total of four combinations): (1) *survival* or *non-survival* sentences in which the character's life may or may not be at risk and (2) *functional* or *nonfunctional* sentences that describe a contextually useful or contextually non useful relationship with an item in the spatial environment (all stories are listed in the Appendix). To reduce the likelihood that participants would detect the purpose of the study, 16 non-experimental filler stories that did not include survival/non-survival or functional/nonfunctional critical sentences were also presented. Also, to ensure that participants were reading for comprehension, two comprehension questions were answered after reading each narrative. This data was only used to exclude participants who scored below a score of 75% (i.e., participants who did not take the task seriously). Reading times for the functional/nonfunctional sentences were recorded. After reading all of the narratives, participants then responded to forced choice recognition questions for the critical sentences.

Four potential outcome patterns were considered for the critical sentence reading times. One possibility was that both survival and functionality would equally contribute to story reading times (Figure 1, Appendix). In this scenario, the fastest reading times would likely be observed for the survival-functional stories because both components, the survival aspect and the functional aspect, contribute to ease of processing. In other words, the effects of survival and functional contexts are additive here and there would not be an interaction. This outcome would be consistent with the faster reading times observed for functional sentences reported by Radvansky and Copeland (2000) and faster reading times for survival sentences reported by Jahn (2004). Accordingly, this outcome pattern would suggest that functional-survival relations should be more easily integrated into a reader's situation model. A second possibility is that survival and functional content would have equal effects on reading times (Figure 2, Appendix). Here it would be expected that the presence of either survival or functional content would be enough to speed up processing (i.e., faster reading times). Here there would be an interaction because reading times would be fast if either survival or functional content was present (or both), but not for non-survival nonfunctional content. A third possibility is that survival relations would drive the overall reading time effect (Figure 3, Appendix). In this scenario, it is not the functionality that leads to faster processing, but only the survival content. However, based on the work by Radvansky and Copeland (2000) where effects of functionality were observed, this outcome seems unlikely. Finally, a fourth possibility is that functional relations would drive the overall reading time effect (Figure 4, Appendix). For this outcome, it is not the survival content that leads to faster processing time, only the functional relations.

As with the predictions for the critical sentence reading time outcomes, four potential outcome patterns were considered for the recognition scores. One possibility is that both survival and functionality status would contribute additively to recognition scores. Evidence for this outcome would be indicated by a non-interactive effect for both conditions, with the best memory performance for content that was in the survival-functional condition (Figure 4, Appendix). This outcome would suggest that both survival and functional content are strongly integrated into the readers complete situation model. A second possibility is that survival status, functionality, or both, would equally affect recognition (Figure 5, Appendix). This outcome suggests that improved recognition memory is strongly affected by the presence of either survival or functional relations (or both). A third possibility is that only survival content would affect recognition memory performance (Figure 6, Appendix). As with the reading times, this outcome seems to be the least likely (see Radvansky & Copeland, 2000). Finally, a fourth potential outcome is that only functionality would affect recognition scores. This outcome would be consistent with work by Radvansky & Copeland (2000).

CHAPTER 3

METHODOLOGY

Participants

A total of 40 undergraduate men and women (ages 18-30 years) were recruited from the University of Nevada, Las Vegas psychology subject pool and were awarded class credit for their participation. Although there were no restrictions on the ethnic backgrounds of the recruited participants, some exclusionary criteria were implemented for the current experiment (e.g., only native English-speaking participants were permitted to participate).

Materials

Stories

Twenty original experimental and 16 filler stories were created for the experiment. The stories were loosely based on those used by Jahn (2004) and Radvansky and colleagues (Radvansky & Copeland, 2000; Radvansky et al., 2003). All 20 experimental narratives are available in the Appendix. The experimental stories were constructed so that each contained one critical sentence that conveyed a threat to the protagonist for the survival version of the stories, but a non-threat for the non-survival version of the stories. For example, in the example story from the Appendix, for the first critical sentence the non-survival version is "As he reached, he knocked over a container of water." In contrast, the survival version is "As he reached, he knocked over a large jug of rat poison." Clearly, the latter sentence is more critical toward the character's survival because rat poison is more likely to kill a person.

In addition, the stories contained one critical sentence that conveyed a functional spatial relation when a character interacts with an object in one way, but a nonfunctional relation when the object was interacted with in another way. For example, in the example story from the Appendix, the character either holds the plastic tarp *above* him (functional condition) or holds the plastic tarp *next* to him (nonfunctional condition). Here, the functional relation in the survival version of the story is that the protagonist can use an object in the environment (the plastic tarp) to protect himself from a danger, whereas in the non-survival version the plastic tarp serves as a way to keep from getting wet. Regardless of the survival condition, holding the tarp *next to him* does not serve a function.

To counterbalance the incidence of functional, nonfunctional, survival, and non-survival sentences, there were four versions of each story. Each participant read five stories containing a functional survival scenario, five stories containing a functional non-survival scenario, five stories containing a nonfunctional survival scenario, and five stories containing a nonfunctional, non-survival scenario. Across all stories, for a given reader, each condition occurred equally often at each position. All four text versions were rotated across participants. The stories were 15 sentences long, with the survival and functional critical sentences at approximately one third and two thirds of the way through each story, respectively. Each version of the critical sentences was matched for number of syllables. Included within the main experimental trials were 16 filler stories. In addition, there were two practice stories to familiarize people with the procedure; the practice stories were also filler stories.

Story ratings

A separate cohort of participants (n = 24) that did not complete the main experiment were asked to judged if the stories were equally readable (i.e., participants were asked to rate how well the story flowed and made sense). Mean ratings for the four versions of the stories were as follows (see also, Table 1 in the appendix): survival-functional (M = 5.34, SE = .08), survival-nonfunctional (M = 5.19, SE = .10), non-survival-functional (M = 5.24, SE = .11), and non-survival-nonfunctional (M = 5.15, SE = .08). A repeated measures analysis of variance (ANOVA) was conducted on the ratings for the four story conditions. Ratings for the survival and non-survival stories did not differ significantly, F (1, 19) = 1.09, $p > .311$. Ratings for the functional and nonfunctional conditions also did not differ significantly, F (1, 19) = 1.30, $p > .269$. Finally, there was no significant interaction between ratings for the survival and functional stories, F (1, 19) = .13, $p > .719$. Thus, the four versions of the stories were all rated similarly.

Stories were rated on danger and functionality by yet another separate cohort of participants (n = 10) that did not complete the main experiment. These participants read and rated versions of the experimental stories that contained either a critical sentence that described characters in a survival condition (i.e., danger was present) or a critical sentence that described characters in a non-survival condition (i.e., danger was not present). Presentation order (survival, non-survival) was counterbalanced. After reading each story, participants' were then asked to rate the level of danger described in the story on a scale from 1 to 7, where 1 = no danger present and 7 = extremely dangerous. Overall, the stories that described a survival situation (M = 4.94, SE = .19) were clearly rated as more dangerous than the stories that described a non-survival situation (M = 2.69, SE = .19), t (9) = 8.02, $p < .001$.

In addition to the danger rating task, participants were also asked to determine, from a given set of options, whether each sentence could complete the critical spatial relation (i.e., whether it was plausible that the sentence could be in that story) and to then rate the sentence options as to how well they fit. The critical sentence describing the spatial relation was omitted from the story (i.e., there was a gap where that critical sentence would appear in the story). Participants were asked to decide (yes/no) if four potential sentences could possibly fit with the story. In addition, the participants were also asked to rate how well each sentence choice fit with the story. The potential sentences that were assessed for acceptability and rated for fit included: (1) the critical sentence describing a functional spatial relation, (2) the critical sentence describing a nonfunctional spatial relation, (3) a distracter sentence describing a functional spatial relation with an object that was not mentioned in the story, and (4) a distracter sentence describing a nonfunctional spatial relation with an object that was not mentioned in the story. Ratings for each answer choice were entered on a Likert-type scale where 1= poor fit and 7 = good fit.

Mean sentence acceptability judgments are listed in Table 2 (Appendix). Sentence fit judgments (yes/no) for the functional, nonfunctional, and distracter critical sentences differed significantly from one another, χ^2 (5) = 34.93, p < .001. Pair wise comparisons of the judgments for each of the four sentence conditions (survival-functional, survival-nonfunctional, non-survival-functional, and non-survival-nonfunctional) as well as the two distracter sentences were conducted using a Wilcoxon signed ranks test. As can be seen from Table 3 (Appendix), although ratings for the four sentence conditions differed significantly from ratings for the distracter sentences (all significance values were less than .01), ratings for each of the four critical sentence conditions (i.e., the non-distracter sentences) did not differ significantly (all significance values were greater than.05).

Mean fit ratings for the critical spatial relation sentences are available from Table 2 (Appendix). Overall, the functional critical sentences were rated as having a better fit with the stories as compared with the nonfunctional sentences, F (1, 9) = 234.29, $p <$ .001. In addition, both functional and nonfunctional critical sentences were rated as being a better fit with the stories as compared with the distracter sentences, F (1, 9) = 3.89, $p < .001$. Thus, while both the functional and nonfunctional sentences were acceptable in the stories, the functional sentences were rated as a better fit with the narrative context (i.e., a better fit with the causal structure).

Forced choice recognition test

One forced-choice recognition question was created for each story based on the functional critical sentences (see Appendix). For each question, four choices were available to the participant: (1) the functional critical sentence, (2) the nonfunctional critical sentence, (3) the functional relation with a wrong object, and (4) the nonfunctional relation with a wrong object. For example, in the first story in the Appendix, the forced-choice recognition question was: “Which of the following sentences appeared in the story? (1) Earl was holding the plastic tarp above him, (2) Earl was holding the plastic tarp next to him, (3)Earl was holding the newspaper above him, (4) Earl was holding the newspaper next to him.” The order of the choices was randomized for each question.

Finally, two comprehension questions were created for each story. The questions were used to ensure that people had read the stories for comprehension. For the sample story, the questions were “Did Earl mop the floor?” and “Were there boxes in the storage room?” Overall, half of the questions were true and half were not. None of the questions asked about information in the critical sentences.

Procedure

Participants were tested individually. The texts were presented on a PC - compatible computer. The text was white on a black background in 40-column mode. People read the two practice stories first, followed by the experimental and filler texts. The practice stories were always filler stories and never included functional or survival relations. The stories were read in a different random order for each person. Reading was self-paced; the texts were presented one sentence at a time. Each of the critical items was a single sentence. After reading a sentence, the subject pressed the space bar and the next sentence appeared. The computer recorded reading times. After each story two comprehension questions were presented in red font. Participants were instructed to answer by clicking one of the two buttons on the mouse with the right hand. The left mouse button was pressed for “yes, this is true”, and the right mouse button for “no, this is false”. There was an equal number of “yes” and “no” answers.

After reading all of the stories, participants were presented with the forced-choice recognition test. Participants’ entered their responses by selecting the appropriately labeled numerical key on the keyboard (1, 2, 3, or 4). Thus, participants read all of the stories, including the filler stories, before beginning the recognition test. Recognition items were presented in a random order for each participant, and the question for each story (with the four corresponding options) was presented by itself on the computer screen. Immediately after entering their response for an item, the computer presented the next question with its choices. There were no recognition questions for the filler stories.

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CHAPTER 4

FINDINGS OF THE STUDY

The analyses were based on manipulations of functionality and survival. Thus, the experiment was a 2 (condition: survival vs. non-survival) x 2 (condition: functional vs. nonfunctional) design. Both reading time and recognition accuracy were the dependent measures

Outliers were dealt with using a procedure described by Van Selst and Jolicoeur (1994). Briefly, this procedure involves calculating a standard deviation criterion cut-off value that is based on the sample size. Although a cutoff score of 75% accuracy for the comprehension questions was set for inclusion in the analyses, all participants scored above the criterion (M = .87, SD = .08), so none of the participants' scores were removed from the analyses described below.

Recognition

Critical sentence recognition scores were submitted to a 2 (functionality) x 2 (survival) repeated measures ANOVA for both a subject and item analysis. For all results, the subscript 1 denotes a subject analysis and the subscript 2 denotes an item analysis. The main effect of functionality was significant for the subject analysis, F_1 (1,39) = 21.07, $p < .001$, $\eta_p^2 = .35$, and marginally significant for the item analysis, F_2 (1,19)=3.78, $p = .07$, $\eta_p^2 = .16$, with people accurately recognizing more of the functional than the nonfunctional spatial items.. There was also a main effect of survival, which was significant for the subject analysis, F_1 (1, 39) = 4.29, $p = .045$, $\eta_p^2 = .099$, and marginally significant for the item analysis, F_2 (1,19)=3.29, $p = .09$, $\eta_p^2 = .15$. Recognition was better for non-survival than survival stories. Finally, the two-way interaction between survival and functionality was not significant, F_1 (1,39) = 1.48, p = .231, η_p^2 = .04, F_2 (1,19)=.73, p = .40, η_p^2 = .04. As can be seen from Table 3, the effect of functionality appears to be pretty clear. Performance was high for the functional sentences for both the survival and non-survival conditions, and these two conditions did not differ from each other, F_1 (1,39) = .438., p = .51, η_p^2 = .011, F_2 (1,19) = .15, p = .71, η_p^2 = .008. While the nonfunctional items were remembered more poorly, this seemed to be the case particularly for the survival condition, which had the lowest recognition percentage. Indeed, recall for nonfunctional critical sentences was marginally better under non-survival conditions, as compared with survival conditions, F_1 (1,39) = 3.77, p = .06, η_p^2 = .088, F_2 (1,19) = 3.28, p = .09, η_p^2 =.147. Figures 9, 10, and 11 (Appendix) illustrate outcomes for the recognition data.

Reading time

As with the critical sentence recognition items, reading times were submitted to a 2 (functionality) x 2 (survival) repeated measures ANOVA based on both subjects and items. As with the recognition data, the main effect of functionality was significant, F_1 (1,39) = 4.03, p = .052, η_p^2 = .094, F_2 (1,19)=7.08, p = .02, η_p^2 = .27, with faster overall reading times for the functional critical sentences. However, in contrast to the recognition data, the main effect of survival was not significant, F_1 (1,39) = .142, p = .71, η_p^2 = .004, F_2 (1,19)= .06, p = .81, η_p^2 = .003. Nevertheless, although the majority of the variance in critical sentence reading times was explained by the effect of functionality, survival may have contributed some variance as well, as indicated in the significant two-way interaction between functionality and survival, F_1 (1,39) = 6.90, p = .012, η_p^2 = .15, F_2 (1,19) =5.24, p = .034, η_p^2 = .22.

Follow-up tests (see Table 4) showed that although reading times for the functional critical sentences did not differ between survival conditions, $F_1(1,39) = 1.90$, $p = .176$, $\eta_p^2 = .046$, $F_2 = 1.90$, $p = .184$, $\eta_p^2 = .091$ slower reading times were observed for the nonfunctional sentences under the survival condition, relative to those in the non-survival condition, $F(1,39) = 3.55$, $p = .067$, $\eta_p^2 = .08$, $F_2 = 1.89$, $p = .185$, $\eta_p^2 = .090$ although it was only marginally significant. Figures 12, 13, and 14 (Appendix) illustrate outcomes for the reading time data.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECCOMENDATIONS

The results of the present experiment suggest that narrative comprehension of spatial relationships between characters and objects in an environment depends more on the functionality of the object (Radvansky & Copeland, 2000; Radvansky et al., 2003), than the causal reasons underlying the spatial relationship (Jahn, 2004). Here, the overall effect of functionality emerged from readers' comprehension, regardless of survival status. In fact, survival status did not seem to enhance memory of the functional information, as evidenced by the similar means for the functional information from both the survival and non-survival versions of the stories.

This was surprising because it was predicted that the survival context would enhance readers' memories of the story information. First, Jahn (2004) reported that people were better at recognizing sentences that described characters in dangerous scenarios (e.g., a lion stalking a zebra), as compared with sentences that described characters in neutral scenarios (e.g., a zebra near an antelope). Second, a more recent, related body of work by Nairne and colleagues (Nairne, et al. 2008; 2007) showed that people are better at remembering information learned in a survival context (e.g., stranded in the grasslands needing food and water) as compared with memory for information learned in a neutral context (e.g., on vacation). Thus, despite the availability of evidence favoring the notion of superior memory for survival-relevant information, the results of the present experiment do not appear to neatly conform to those previous findings.

Nevertheless, survival context does seem to have some type of effect on memory and comprehension First, it seems likely that the functional sentences were likely to have been integrated into the situation model while reading. These reading times were faster, suggesting that they were more easily processed by readers. In contrast, the reading times for the nonfunctional sentences, particularly in the survival condition, were quite long. This suggests that the nonfunctional information in the survival condition was not expected when it was encountered, and was thus not easily integrated into the situation model (hence the longer times). This conclusion parallels a body of work by O'Brien and colleagues, who reported longer reading times for sentences in stories that included inconsistent information about the location of a protagonist (Hakala & O'Brien, 1995; Myers, O'Brien, Albrecht, & Mason, 1994; O'Brien & Albrecht, 1992), as well as research on the processing of other situation model dimensions, such as time (Rink, Gámez, Diáz, & de Vega, 2003; Rink, Hähnel, & Becker, 2001). Accordingly, because it was less likely to be integrated into the situation model, memory for these nonfunctional relations was worse at recognition, particularly in this survival–nonfunctional condition. It may be that people are not as likely to encode the nonfunctional information into the situation model in this survival condition, and as a consequence, during recognition people may reconstruct (e.g., Bartlett, 1932) the spatial relations to fit the survival motivation, and subsequently mistakenly pick the functional sentence.

Note that this outcome cannot be explained as an artifact of the story content or unusualness of the nonfunctional information (e.g., the von Restorff effect) because that unusualness would produce better memory for that information, when in fact, memory for nonfunctional information was worse. Also, recall that the critical functional sentences for all stories were rated by an independent sample of participants. Importantly, participants rated the both the functional and nonfunctional sentences as acceptable fits with the story, as compared with distracter sentences.

At the outset of the current experiment, four possible outcomes were predicted for the critical sentence reading times and four possible outcomes were predicted for forced-choice recognition items. Consistent with Radvansky and Copeland (2000) (and Figure 4, Appendix), regardless of survival condition, faster critical sentence reading times were observed for the functional sentences, relative to the nonfunctional sentences. Nevertheless, contrary to expectations, slower reading times were observed for the nonfunctional sentences in the survival condition. This outcome suggests that participants' integration of that story content into a coherent situation model was quite difficult. In general, better recognition scores for the functional items, relative to the non-functional items (Figure 11, Appendix), are also consistent with Radvansky and Copeland (2000). However, weaker recognition scores for the survival-nonfunctional content, relative to the non-survival-nonfunctional content, was unexpected.

The outcomes for the current experiment compliment the existing literature on functional spatial relationships. Radvansky and Copeland (2000) suggested two general requirements for the construction of a functional spatial situation model. First, for a functional relation to exist, the state of one character must (or could) be affected by their interaction with another story element (be that an object or character). Second, the interaction must be important to the reader. However, the value of the described interaction is left to the discretion of the reader; some interactions may be judged as more vital than others. Consistent with this perspective, both Radvansky and Copeland (2000) and Radvansky et al. (2003) found that functional spatial relations were read faster and better remembered than nonfunctional spatial relations.

Subsequently, Jahn (2004) argued that causality (in the form of survival situations) was a necessary prerequisite for the spontaneous construction of situation models for spatial relations because readers would be more motivated to focus on the spatial relation if danger was present. This notion was largely inspired by Bransford, Barcley and Franks' (1972) study in that some of their materials included predatory animals interacting with non-predatory animals in the sentence stimuli. Indeed, Jahn (2004) found that participants' sentence recognition was stronger for survival scenarios as compared with non-survival scenarios. Perhaps serendipitously, this report foreshadowed more recent efforts by Nairne and colleagues (Nairne et al., 2007; Nairne et al., 2008), which showed that people are better at remembering words that are relevant to survival scenarios, as compared with neutral scenarios.

While the present study is consistent with work by Radvansky and Copeland (2000; Radvansky et al., 2003), in that functional spatial relations were read faster and recognized better than nonfunctional spatial relations, they are inconsistent with ideas from Jahn (2004) and Nairne et al. (2007). That is, survival content had little to no effect on critical sentence reading time or memory for story content. Hence, as long as the information conveys a functional relation, readers spontaneously construct situation models for spatial relations while reading and do not appear to rely on additional causal information (in this case, a dangerous scenario) specified in the narrative context in order to do so. However, they may rely on elements of the story content to reconstruct their situation model during recognition, but this stipulation does not diminish the implications of the reading time outcomes observed for the present experiment.

Limitations and future directions

If human memory is specially tuned to survival relevant information (Nairne et al., 2007; Nairne et al., 2008) then why was the present sample of readers as good at recognizing functional sentences in a non-survival context as compared with functional sentences read under survival contexts? Consider the characteristics of a typical adaptive memory experiment: participants are told to imagine themselves as stranded in the grasslands, rate a list of words on their relevancy to the scenario, and are then given a surprise memory test for the words after completing a distracter task. First, whereas previous adaptive memory studies (e.g., Nairne, et al., 2007) focused on the grasslands as a setting, stories used in the present experiment described characters in a multitude of environments and situations (e.g., a worker in a messy closet). Also, both survival and non-survival situations were described in grasslands settings. It may be possible that there is something special about the grassland environment that affects memory; this point may require further examination. Second, in contrast to stimuli used by Jahn (2004), immediate threats (such as an approaching hungry lion) were not specified for all of the story stimuli used in the current study. In the present experiment some dangers could be considered less imminent. For example, in the example story the worker in the messy closet could have avoided the dripping poison by simply waiting, rather than using the tarp. Thus, even though the stories in the current study were all rated as dangerous, there might be a difference between general and immediate danger. Third, memory benefits from survival scenarios may not have been observed in the current study because the survival scenario was set up by manipulating a single sentence in the story. It is possible that this small manipulation was not strong enough to clearly convey the danger. However, this possibility seems less likely because the stories were rated as clearly more dangerous in the survival condition. Regardless, future research efforts may benefit from lengthening the stories or adding additional sentences to emphasize the danger level of the narratives.

Additional methodological distinctions between the current and typical adaptive memory experiments also merit further consideration. For example, in contrast to the typical second-person scenarios used in the adaptive memory studies (i.e., the word "you" is used to refer to the participants themselves), stories in the present experiment were written in the third-person (e.g., he or she). Hence, comparisons could be made for second- vs. third-person perspective recognition (e.g., Copeland & Houska, 2010). Also, recent evidence suggests that the future temporal perspective, in contrast to the past or present, enhances survival-based memory (Klein, Robertson, & Denton, 2010). The stories used in the current study were all framed in the past tense, or possibly interpreted as the present tense; however, they clearly were not in a future perspective. It is possible that stories written in future-oriented perspective may be more likely to show effects of survival.

Conclusion

Comprehension of narrative discourse requires readers to generate situation models of the state of affairs described in a text (Johnson-Laird, 1983; van Dijk & Kintsch, 1983; Zwaan & Radvansky, 1998). Situation models include representations of protagonists, goals/intentionality, time, causation, and space (Zwann & Radvansky, 1998;

Zwaan, Langston, & Graesser, 1995). Past research has shown that situation models for functional spatial relations between characters and objects in the environment are more easily processed and better remembered than nonfunctional spatial relationships (Radvanksy & Copeland, 2000; Radvansky et al., 2003). The goal of the present investigation was to determine if causality (as expressed in survival narrative scenarios) is a necessary prerequisite for successful comprehension of functional spatial relations, as suggested by Jahn (2004).

Consistent with the results obtained by Radvansky and Copeland (2000; Radvansky et al., 2003), outcomes for the present study suggest that readers are better at comprehending functional spatial relations as compared with nonfunctional spatial relations. However, inconsistent with Jahn's (2004) findings, danger/survival context did not enhance memory for spatial relations. In fact, there was superior recall for nonfunctional sentences that were associated with non-survival than survival context. Along this line, at first glance, the results of the present study seem to be incompatible with the adaptive memory hypothesis endorsed by Nairne and colleagues (Nairne et al., 2007; Nairne et al., 2008), which poses that human memory is attuned to survival-relevant information. However, while survival context did not enhance memory for the spatial relations, a consideration of both the recognition and reading time results suggest that people may have had good memories for the survival context itself.

APPENDIX I

STORIES USED IN THE EXPERIMENT

Story 1
Earl was cleaning the old storage room at work.
It had not been cleaned in a long time.
The storage room was a huge mess.
There were boxes everywhere.
He could hardly walk around.
He saw an old pile of things up on a shelf that was over the doorway.
But he had difficulty reaching up to them.
Plus, there were a bunch of boxes in the way.
Critical survival sentence: As he reached, he knocked over a large jug of rat poison.
Critical non-survival sentence: As he reached, he knocked over a container of water.
It was dripping down right in the doorway - right where he needed to go.
Earl needed to find something to cover himself from the drips.
He spotted a plastic tarp he could use.
Critical functional sentence: Earl was holding the plastic tarp above him.
Critical nonfunctional sentence: Earl was holding the plastic tarp next to him.
He was upset that he got stuck cleaning this storage room.
He thought that maybe he should ask for a raise.
Did Earl mop the floor?
Were there boxes in the storage room?

Story 2
Kim lay awake in her sleeping bag gazing at the stars.
She could never see this many stars back home in the city.
So far she had spotted over ten different constellations.
The most obvious was the big dipper.
The night was so clear that she could even spot Venus - it was the brightest object in the sky.
She sighed as she relaxed in her sleeping bag - she had just purchased it for this trip.
The campfire she built a few hours ago was still burning.
It produced a lot of light and heat.
Critical survival sentence: Something bit her arm; she needed to sterilize the wound.
Critical non-survival sentence: Kim was feeling cold and saw she had goosebumps on her arms.
She could hear the fire crackle.
She reached out and fumbled for the zipper on her sleeping bag.
She wiggled out of her sleeping bag and stood up.
Critical functional sentence: Kim moved and was standing next to the campfire.
Critical nonfunctional sentence: Kim moved and was standing far from the campfire.
She thought that she wasn't feeling too well.
Maybe this trip was a mistake.

Did Kim look at Jupiter?
Had Kim eaten marshmallows?

Story 3
Ted couldn't believe his luck.
Last night it was rainy when he stumbled upon a small cave.
The cave was nice because it kept him dry all night.
Because it had stopped raining today, Ted spent the whole morning hiking.
In the afternoon, though, the sky became very dark.
It wasn't long before it began to rain.
Suddenly the rain started to come down really hard.
He could feel the wind stinging his face.
Critical survival sentence: Ted saw a tornado forming in the sky and was scared.
Critical non-survival sentence: Ted remembered that he had left his raingear in the cave.
He could feel his clothes getting wetter as he weighed his options.
He quickly decided to retrace his steps and find the cave.
Luckily he remembered where it was.
Critical functional sentence: Ted was crouching quietly inside the cave.
Critical nonfunctional sentence: Ted was crouching quietly outside the cave.
The rain continued for another hour.
By the time it stopped the sun was already setting.
Did Ted hike all morning?
Did the sky become dark in the morning?

Story 4
Izzie loved to go hunting on her family's farm.
She had been hunting with her dad for as long as she could remember.
Izzie shot her first gun when she was five years old.
Someone raised in the city might find that strange, but not out here in the country.
Since her dad died, though, Izzie would have to go hunting alone.
After taking some time to grieve, Izzie decided to get back out to the woods.
This month was deer season and Izzie had her favorite gun with her - she nicknamed it Bandit.
While she was walking she came to abrupt stop.
Critical survival sentence: Izzie saw a large bobcat and had to protect herself.
Critical non-survival sentence: Izzie checked her gun and noticed she needed to clean it.
She was standing out in the open.
She looked around for a better position.
She knelt down to steady herself.
Critical functional sentence: Izzie was holding her gun in front of her.
Critical nonfunctional sentence: Izzie was holding her gun down at her side.
She knew that if she took care of her gun it would take care of her.
Her dad would be proud.
Was it deer season?

Was Izzie 3 years old when she first shot a gun?

Story 5
Beth was hiking in the outback of Australia.
She loved the openness of the desert - it gave her a sense of freedom.
The scenery all around her was simply breathtaking.
She was a little bit upset that she had forgotten to bring her camera.
It didn't matter, though, because her mind was taking in a wonderful experience.
As she walked she saw a tree that had a giant beehive hanging from it.
She noticed a swarm of bees around the hive.
For some reason, she thought about her ninth grade science class when she learned bees don't like water.
Critical survival sentence: Suddenly the swarm of bees came toward her and she ran.
Critical non-survival sentence: Having not bathed for days, she wanted to soak in water.
She looked around and saw a river.
It was about 100 yards away.
Beth moved straight toward it.
Critical functional sentence: Beth took a breath as she stood in the water.
Critical nonfunctional sentence: Beth took a breath as she stood near the water.
The water was a greenish-brown color.
Luckily the current wasn't too strong.
Was Beth hiking in Africa?
Was the water blue?

Story 6
Rick was floating on a raft down the mighty Mississippi River.
He had just quit his job because of some crazy circumstances.
His annoying ex-wife was suing him for more child support.
Because Rick couldn't handle that stress, he decided to run away from his problems.
Although, in this case, he was floating away on his raft.
While it wasn't the best raft, so far he was moving along down the water.
As he drifted he took stock of his current situation.
He noticed some jagged rocks on the shore.
Critical survival sentence: Those jagged rocks on the shore would surely destroy his raft.
Critical non-survival sentence: Rick gasped; he saw his ex-wife standing on the jagged rocks.
Rick didn't want to be anywhere near those rocks.
The sun was starting to set over the trees in the distance.
He paddled furiously to move his raft.
Critical functional sentence: Rick's raft was floating far from the jagged rocks.
Critical nonfunctional sentence: Rick's raft was floating close to the jagged rocks.
Rick wasn't sure what the future held for him.
He wasn't sure if he could ever go home again.

Was Rick floating down the Amazon River?
Was Rick accused of assault?

Story 7
It was Saturday morning.
Erika had just finishing moving across country to California.
Nothing big was going on today so she slept in.
After hitting the snooze a few times she finally woke up.
The most important part of the day was getting some coffee.
As she headed for the kitchen she walked past her favorite picture - it was a portrait with a large custom frame.
The giant frame weighed more than she did.
As she walked she noticed something strange.
Critical survival sentence: Earthquake - she needed to stand away from the heavy frame!
Critical non-survival sentence: The frame seemed crooked; she should stand back for a better view.
She took a deep breath and began to move.
She had just moved to California hoping things would go well.
This could be a bad omen.
Critical functional sentence: Erika was standing away from the frame.
Critical nonfunctional sentence: Erika was standing right under the frame.
She was sad because she had just bought the house.
She was now regretting the move to California.
Had Erika moved to California?
Was the day Saturday?

Story 8
Tyler loved digging around in an old junkyard - it was one of his favorite pastimes.
His friends told him that vicious dogs sometimes guarded the place, but Tyler never saw one.
The junkyard was filled with all sorts of stuff.
There was everything from stuffed animals to construction equipment.
But it was mostly filled with old beat up cars.
He could usually find something salvageable.
Today he needed to find a used part for his car.
He carefully searched for the small part.
Critical survival sentence: Tyler saw a big growling dog and had to find higher ground.
Critical non-survival sentence: Tyler had to get a better view from someplace higher.
He looked around to find something to help him out.
He noticed an old truck in the distance.
Without hesitating, he ran quickly towards the truck.
Critical functional sentence: Tyler was standing on top of the old truck.
Critical nonfunctional sentence: Tyler was standing right next to the old truck.

Just then he heard a loud crashing sound.
It was the owner - he must be returning from his lunch break.
Was Tyler looking for a used car part?
Did Tyler like the junkyard?

Story 9
Jason was traveling by himself in the arctic.
The place was so isolated that there was no one in sight.
All he could see was snow - everything was white.
It was so cold here in the arctic that all of the water was frozen over.
On the bright side, though, this made it easier to travel in straight paths.
Jason paused for a moment to rest.
He reached in his coat pocket for an energy bar.
Unfortunately, he didn't have any left.
Critical survival sentence: It was so cold, he needed to find shelter to survive.
Critical non-survival sentence: He wondered if anyone still lived in the igloos here.
He looked around him in every direction.
Jason saw an igloo on the horizon.
He quickly made his way to it.
Critical functional sentence: Jason was squatting inside of the igloo.
Critical nonfunctional sentence: Jason was squatting outside of the igloo.
He was impressed by the small structure.
He was convinced, though, that he wouldn't want to live here.
Was the water in the arctic frozen?
Did Jason see a polar bear?

Story 10
Robert was hiking in a forest that was very dense with trees.
The smell of pine filled the air.
He was amazed at how tall the trees were.
Some of them had to be hundreds of feet tall.
He looked to the west and saw that the sun was beginning to set.
He turned around and couldn't see the path he had taken into the forest.
To the side, though, was a dark cave.
Robert decided to check it out and went inside the dark cave.
Critical survival sentence: As he explored, he heard a bear growling, and was frightened.
Critical non-survival sentence: As he explored, it was getting late and getting darker.
Robert knew he needed to get out of the cave immediately.
He scrambled back toward the entrance of the cave.
He stopped for a moment to catch his breath.
Critical functional sentence: Robert was standing just outside of the cave.
Critical nonfunctional sentence: Robert was still standing inside of the cave.
He wanted his flashlight.
Unfortunately, he had forgotten to put it in his fanny pack.

Was the sun setting?
Did Robert find his flashlight?

Story 11
Ivan was hiking in the jungle.
It was extremely humid this afternoon.
In fact, Ivan would go so far as to say that the air felt moist.
It was so humid that Ivan was dripping with sweat all over his body.
However, despite the weather, he was glad that he took this trip.
It allowed him to get away from his life, and to forget about his bitter divorce.
The real world seemed like it didn't matter anymore now that he was in the jungle.
He stopped for a moment to tie his shoelaces.
Critical survival sentence: Ivan turned and saw a rabid wolf foaming at the mouth.
Critical non-survival sentence: Ivan felt really hungry and wanted something to eat.
Ivan quickly stood up and rubbed his eyes.
There was a tall fruit tree in his periphery; the branches were far from the ground.
He jumped up, reaching for the branches.
Critical functional sentence: Ivan was crouching up in the tall fruit tree.
Critical nonfunctional sentence: Ivan was crouching next to the tall fruit tree.
The tree was pretty sturdy.
It was filled with a whole bunch of ripe mangoes.
Did the air feel dry?
Was Ivan divorced?

Story 12
David walked along the banks of the river.
It had been raining for weeks so the river was full.
He really enjoyed the sound of the water.
He found it to be very peaceful.
He thought the view of the quiet river was amazing.
He decided to take some pictures with his new digital camera.
He wanted to capture the beauty of the river.
He scanned his surroundings looking for the perfect shot.
Critical survival sentence: From the corner of his eye he saw an alligator.
Critical non-survival sentence: From the corner of his eye he saw a tiny turtle.
He became very silent.
He didn't want to bring more attention to himself or startle it.
He started to slowly move away.
Critical functional sentence: David knelt down behind a very large rock.
Critical nonfunctional sentence: David knelt in front of a very large rock.
Except for shows on the Discovery Channel, he had never seen one of these before.
He couldn't wait to tell his friends when he got back home.
Did David take pictures with his cell phone?
Did David think the sound of the water was peaceful?

Story 13

Jen was doing some yard work on the weekend.
It was the middle of September and the weather was beautiful.
She really would like to be swimming, but these chores needed to be done first.
She preferred to do everything in one weekend, so she could get it over with.
She didn't mind doing this though.
At least she didn't have to take care of the cars - her husband took care of those.
Earlier she had been using a ladder to clean the tall windows on her house.
Right now she was pulling weeds along the side of the house.
Critical survival sentence: Jen saw some poisonous black widow spiders on the ground.
Critical non-survival sentence: Jen saw a really small cockroach scurrying across the ground.
She didn't trust her eyes at first.
When she looked again she started to freak out.
She wanted to get as far off the ground as possible.
Critical functional sentence: Jen screamed while she was on top of the ladder.
Critical nonfunctional sentence: Jen screamed while she was right next to the ladder.
At that moment she closed her eyes.
She was trying to calm down by thinking of a happy place.
Was it September?
Was Jen's husband taking care of their cars?

Story 14
Paul had been in Afghanistan for six months.
This was his second tour overseas.
Paul was relieved that so far he hadn't seen any real combat.
Today they were doing a routine patrol in their tank.
After a couple of hours the guys were bored and hot.
They stepped out of the tank to cool off and take a break.
Some of the guys lit up cigarettes.
Just then Paul spotted some people who appeared on the side of the road.
Critical survival sentence: It was an ambush and the enemy started shooting.
Critical non-survival sentence: Another unit needed to be towed behind Paul's tank.
Paul yelled to his unit as he started to move.
They all acknowledged his yell right away.
A couple of the guys followed Paul.
Critical functional sentence: Paul was standing right behind the armored tank.
Critical nonfunctional sentence: Paul was standing in front of the armored tank.
He realized that he had dropped his gloves.
He paused for a moment while he pondered whether it was worth it to go get them.
Did the soldiers light up cigarettes?
Did Paul drop his gloves?

Story 15
Mark began every morning with a brisk five mile jog.

Although it was chillier outside than usual, he did not mind.
He preferred the cool air instead of the brutal summer heat.
If he kept a solid pace, Mark might get back in time for breakfast before work.
He had almost completed his fourth mile when he turned on Main Street.
The stores were just beginning to open.
He waved at a friend sitting across the street at a café.
Mark turned and started to walk across an intersection.
Critical survival sentence: A speeding car headed toward him in the intersection.
Critical non-survival sentence: A skateboarder headed toward him in the intersection.
Mark looked up at the crossing signal.
The walk signal was still flashing.
He rushed to get across the intersection.
Critical functional sentence: Mark walked and had made it across the crosswalk.
Critical nonfunctional sentence: Mark walked and was halfway across the crosswalk.
Suddenly Mark began heaving, unable to catch his breath.
He clutched at his heart and hoped that this wasn't the end of the line.
Did Mark usually bike in the mornings?
Was it really hot outside?

Story 16
Kathy loves being outdoors and is always up for adventure.
Every month she comes up with something new to try.
This month she decided to go rock climbing at the Grand Canyon.
She chose the Grand Canyon because of the breathtaking views.
Plus she had never had a chance to come to the Grand Canyon.
She had been rock climbing before, but this time she was alone.
She knew it was risky but that made it even more exciting.
As she climbed up the rocks, she surveyed her position.
Critical survival sentence: Just then, the rope came untied and she had to save herself.
Critical non-survival sentence: She was happy because she was close to reaching the top.
Her adrenaline was rushing.
It took all of her energy but she held on tightly to the rope.
She knew all she had to do was grab the next rock.
Critical functional sentence: She was able to reach the rock above her.
Critical nonfunctional sentence: She was far away from the rock above her.
It was an adventure she would never forget.
She couldn't wait to see what her next challenge would be.
Was Kathy at Red Rock?
Was Kathy mountain biking?

Story 17
Today was day three.

Every year Dan liked to get away to the woods with his wife.
This year was no exception.
They loved to spend a week in the summer, away from the heat back home.
The temperature was at least twenty degrees cooler here.
Plus, it was nice to get away from their email and phones for a while.
Right now his wife was out looking at birds.
Meanwhile Dan stayed back at the camp because he wanted something to eat.
Critical survival sentence: Dan saw a cobra emerge that looked like it might attack.
Critical non-survival sentence: Dan was hungry and wanted to eat the steak that he cooked.
Dan quickly looked around.
He needed to find his bowie knife.
Thankfully he found it quickly and picked it up.
Critical functional sentence: Dan held his bowie knife out in front of him.
Critical nonfunctional sentence: Dan held his bowie knife down along his side.
He was glad that he brought his knife with him.
If it wasn't for his wife, he would have forgotten to bring it.
Was it cooler in the woods?
Was Dan's wife looking at birds?

Story 18
It was Jim's twenty-fifth birthday.
He woke up eager to celebrate.
Unfortunately, he had to go to work that day.
When he got to his office, he went to the top floor to say good morning to his friend, Dot.
Dot wished him a happy birthday and gave him a plate of cookies.
She had made the cookies from scratch just for him.
Dot told Jim that they were chocolate chip cookies.
Jim grabbed one and took a really big bite.
Critical survival sentence: Suddenly Jim's throat began to tighten; he was choking.
Critical non-survival sentence: Jim wanted to thank Dot, but his mouth was full of cookie.
He stopped chewing and tried to swallow.
His throat felt dry and scratchy -– he needed to drink some water.
He walked around and saw a drinking fountain.
Critical functional sentence: The drinking fountain was right in front of him.
Critical nonfunctional sentence: The drinking fountain was down the hall from him.
Jim began to cough.
Dot thought that Jim was disgusting and gross.
Was it Jim's fortieth birthday?
Did Dot make brownies for Jim?

Story 19
Every summer Chip visited his uncle on the family ranch.
His uncle always made him work hard.
He said that a boy like Chip would do good if he developed a good work ethic.

Chip thought that his uncle was old fashioned.
He'd rather be back at the house playing PS3 instead.
But, he knew his uncle wouldn't let him have dinner unless he finished the chores.
Today Chip was cleaning up and inspecting the fence and gate around the cattle.
Chip didn't care for this because the cattle could sometimes act unpredictably.
Critical survival sentence: Suddenly there was a stampede - he had to get up high.
Critical non-survival sentence: The top of the gate was dirty and needed to be cleaned.
Chip wanted to move quickly.
There was barbed wire along the fence, but none on the gate.
The gate was very tall - at least two feet higher than the fence.
Critical functional sentence: Chip climbed up so he was on top of the gate.
Critical nonfunctional sentence: Chip moved so that he was right next to the gate.
The cattle were very loud and aggressive.
Chip hated working on this ranch.
Did Chip's uncle make him work hard?
Did Chip like working at the ranch?

Story 20
Tim was at the zoo.
It was his favorite place to go on his days off from work.
Today was a beautiful day.
Some of the animals were out sunning themselves.
Tim walked towards the lion’s den.
While one lion was out in the open eating its food it looked up and growled at him.
Tim wanted to see what the lion was eating.
He leaned over the railing to get a better look.
Critical survival sentence: Tim lost his balance and fell in near the hungry lion.
Critical non-survival sentence: He saw that the lion was eating a piece of raw meat.
A wave of nausea swept over Tim.
He knew that he needed to get out of there.
He saw an exit sign.
Critical functional sentence: Tim was standing right next to the main exit.
Critical nonfunctional sentence: Tim was standing far away from the exit.
His face was dripping with sweat.
This was not a good day.
Were the animals swimming?
Did a lion growl?

APPENDIX II

RECOGNITION ITEMS

Story 1
Earl was holding the plastic tarp above him.
Earl was holding the plastic tarp next to him.
Earl was holding the newspaper above him.
Earl was holding the newspaper next to him.

Story 2
Kim moved and was standing next to the campfire.
Kim moved and was standing far from the campfire.
Kim moved and was standing next to the backpack.
Kim moved and was standing far from the backpack.

Story 3
Ted was crouching quietly inside the cave.
Ted was crouching quietly outside the cave.
Ted was crouching quietly inside the boat.
Ted was crouching quietly outside the boat.

Story 4
Izzie was holding her gun in front of her.
Izzie was holding her gun down at her side.
Izzie was holding her compass in front of her.
Izzie was holding her compass down at her side.

Story 5
Beth took a breath as she stood in the water.
Beth took a breath as she stood near the water.
Beth took a breath as she stood in the leaves.
Beth took a breath as she stood near the leaves.

Story 6
Rick's raft was floating far from the jagged rocks.
Rick's raft was floating close to the jagged rocks.
Rick's raft was floating far from the waterfall.
Rick's raft was floating close to the waterfall.

Story 7
Erika was standing away from the frame.
Erika was standing right under the frame
Erika was standing away from the clock.
Erika was standing right under the clock.

Story 8
Tyler was standing on top of the old truck.
Tyler was standing right next to the old truck.
Tyler was standing on top of the old stove.
Tyler was standing right next to the old stove.

Story 9
Jason was squatting inside of the igloo.
Jason was squatting outside of the igloo.
Jason was squatting inside of the snow bank.
Jason was squatting outside of the snow bank.

Story 10
Robert was standing just outside of the cave.
Robert was still standing inside of the cave.
Robert was standing just outside of the lodge.
Robert was still standing inside of the lodge.

Story 11
Ivan was crouching up in the tall fruit tree.
Ivan was crouching next to the tall fruit tree.
Ivan was standing up in the dense weeds.
Ivan was standing next to the dense weeds.

Story 12
David knelt down behind a very large rock.
David knelt in front of a very large rock.
David knelt down behind a very large tree stump.
David knelt in front of a very large tree stump.

Story 13
Jen screamed while she was on top of the ladder.
Jen screamed while she was right next to the ladder.
Jen screamed while she was on top of the table.
Jen screamed while she was right next to the table.

Story 14
Paul was standing right behind the armored tank.
Paul was standing in front of the armored tank.
Paul was standing right behind the old jeep.
Paul was standing in front of the old jeep.

Story 15
Mark walked and had made it across the crosswalk.
Mark walked and was halfway across the crosswalk.
Mark walked and had made it across the bridge.

Mark walked and was halfway across the bridge.

Story 16
She was able to reach the rock above her.
She was far away from the rock above her.
She was able to reach the tree branch above her.
She was far away from the tree branch above her.

Story 17
Dan held his bowie knife out in front of him.
Dan held his bowie knife down along his side.
Dan held his fishing rod out in front of him.
Dan held his fishing rod down along his side.

Story 18
The drinking fountain was right in front of him.
The drinking fountain was down the hall from him.
The copy machine was right in front of him.
The copy machine was down the hall from him.

Story 19
Chip climbed up so he was on top of the gate.
Chip moved so that he was right next to the gate.
Chip climbed up so he was on top of the horse.
Chip moved so that he was right next to the horse.

Story 20
Tim was standing right next to the main exit.
Tim was standing far away from the exit.
Tim was standing right next to the zoo gift shop.
Tim was standing far away from the gift shop.

APPENDIX III

PREDICTED READING TIME OUTCOMES

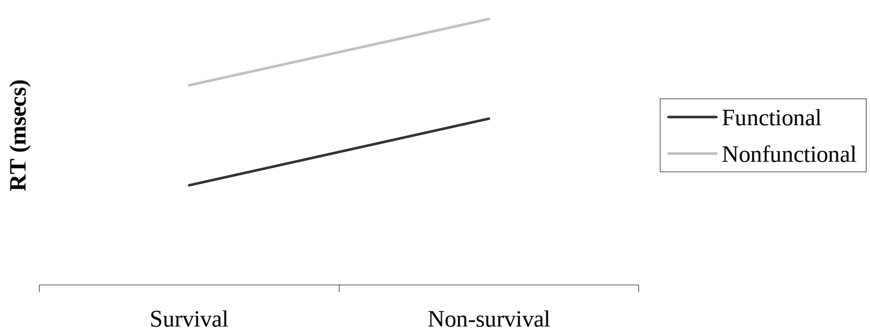

Figure 1. Possible reading time outcome where effects of survival and functionality are additive.

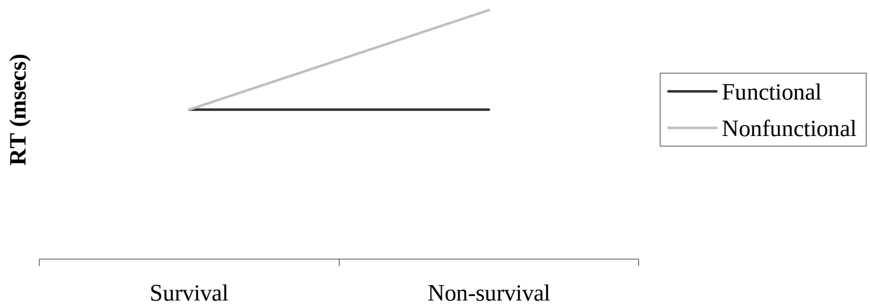

Figure 2. Possible reading time outcome where reading times are faster if sentences are either survival or functional (or both).

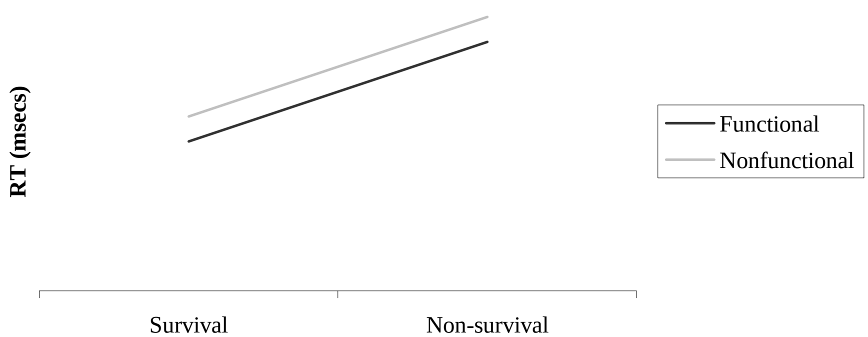

Figure 3. Possible reading time outcome if survival drives the functionality effect.

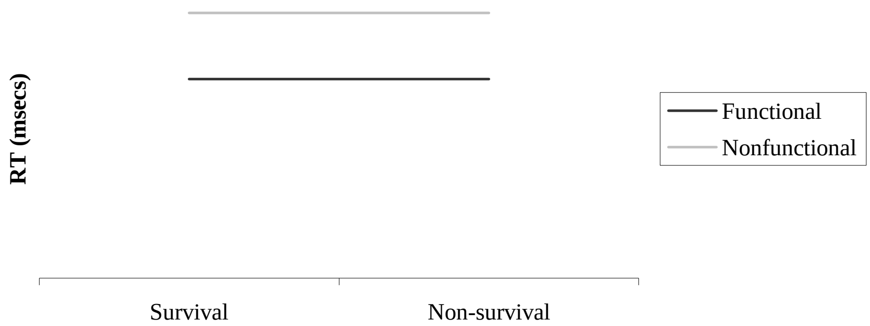

Figure 4. Possible reading time outcome where reading times are faster if sentences are functional.

.

APPENDIX IV

PREDICTED RECOGNITION OUTCOMES

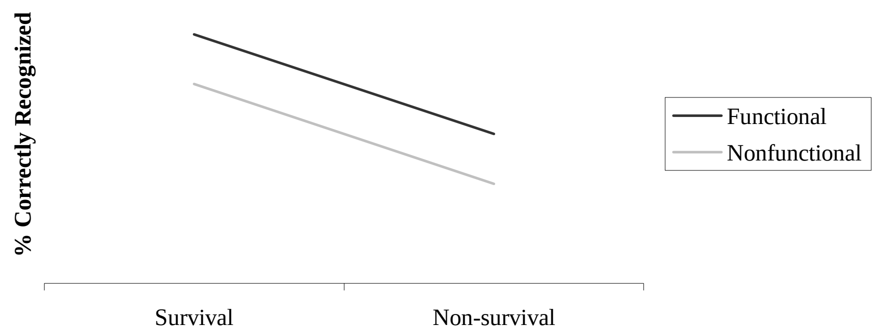

Figure 5. Possible accuracy outcome if effects of survival and functionality are additive.

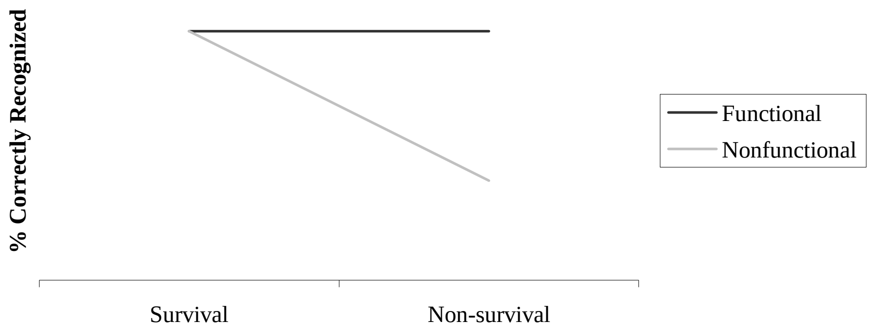

Figure 6. Possible accuracy outcome if high accuracy requires situation to either be survival or functional (or both).

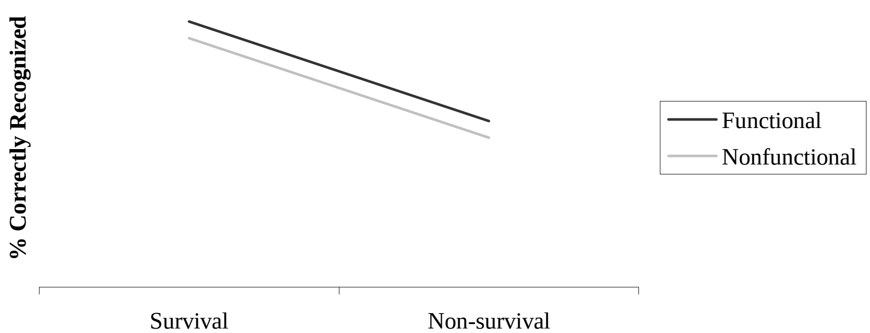

Figure 7. Possible accuracy outcome if Survival drives the Functionality effect.

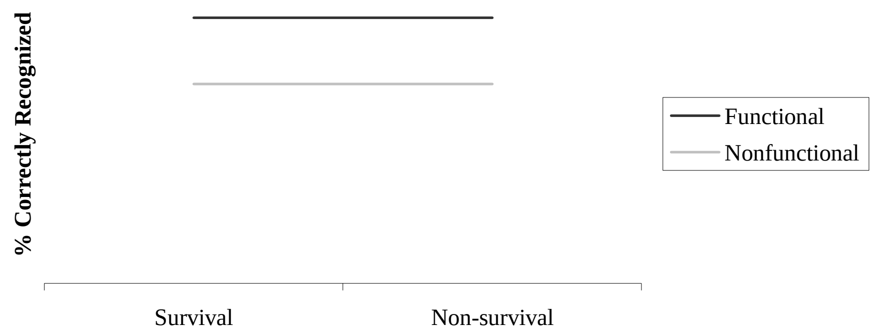

Figure 8. Possible accuracy outcome if high accuracy requires situation to be functional only.

APPENDIX V

STORY ACCEPTABILITY JUDGMENTS

Table 1. Story readability judgements.

Story condition	*M*	*SE*
Survival-functional	5.34	.08
Survival-nonfunctional	5.19	.10
Non-survival-functional	5.24	.11
Non-survival-nonfunctional	5.15	.08

Table 2. Means and standard errors for the critical spatial relations sentence acceptability judgments and ratings.

	Sentence as possible fit (yes/no)		Sentence fit ratings	
	Surv	Non-surv	Surv	Non-surv
Functional	9.50 (*.40*)	9.40 (*.31*)	6.03 (*.33*)	5.98 (*.23*)
Nonfunctional	9.30 (*.21*)	9.20 (*.33*)	4.76 (*.27*)	5.14 (*.27*)
Distracter	4.60 (*.73*)	4.30 (*.78*)	2.11 (*.09*)	2.12 (*.21*)

Table 3. Sentence acceptability judgments.

Comparison	*Wilcoxon signed ranks test* (*Z*)	*p*
Non-survival-functional vs. survival-functional	-.45	.66
Survival-nonfunctional vs. survival-functional	-.69	.49
Non-survival-nonfunctional vs. survival-functional	-1.00	.32
Survival-nonfunctional vs. non-survival-nonfunctional	-.33	.74
Non-survival-nonfunctional vs. non-survival-functional	-1.00	.32
Non-survival-nonfunctional vs. survival-nonfunctional	-.33	.74
Distracter 1 vs. survival-functional	-2.68	.007
Distracter 1vs. non-survival-functional	-2.67	.008
Distracter 1 vs. survival-nonfunctional	-2.68	.007
Distracter 1 vs. non-survival-nonfunctional	-2.67	.008
Distracter 2 vs. survival-functional	-2.68	.007
Distracter 2 vs. non-survival-functional	-2.67	.008
Distracter 2 vs. survival-non-functional	-2.67	.008
Distracter 2 vs. non-survival-nonfunctional	-2.69	.007
Distracter 2 vs. distracter 1	-7.82	.43

APPENDIX VI

RECOGNITION OUTCOME TABLE

Table 4. Means and standard errors for recognition scores.

	Survival	Non-survival
Functional	.80 (*.24)*	.82 (*.23*)
Nonfunctional	.66 (*.25*)	.75 (*.23*)

APPENDIX VII

RECOGNITION OUTCOME FIGURES

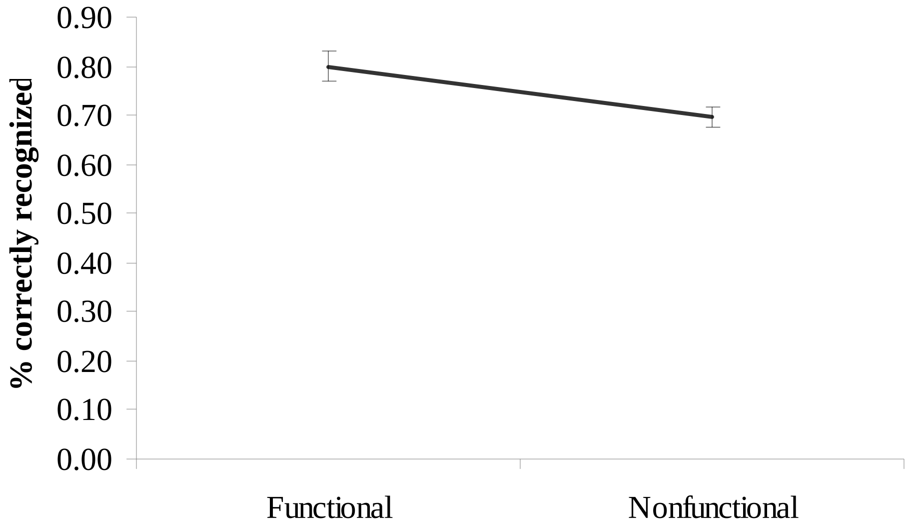

Figure 9. Effect of functionality on recognition scores.

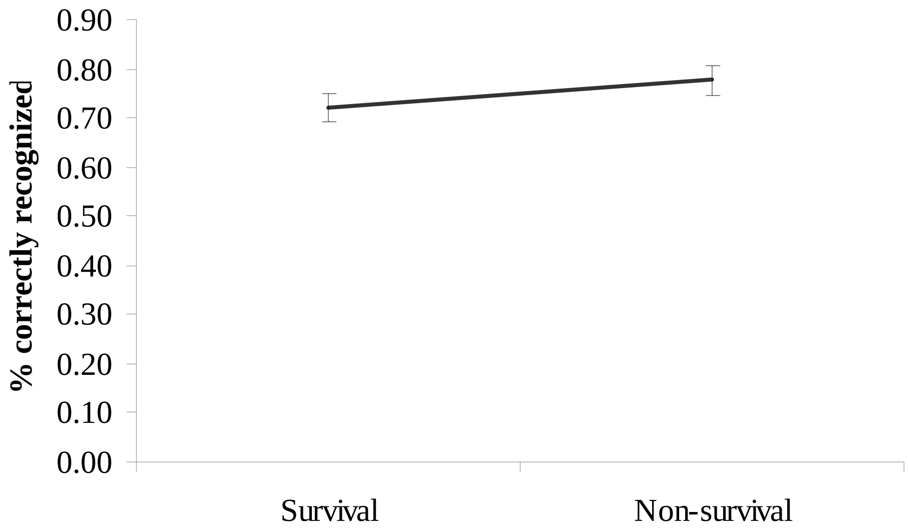

Figure 10. Effect of survival on recognition scores.

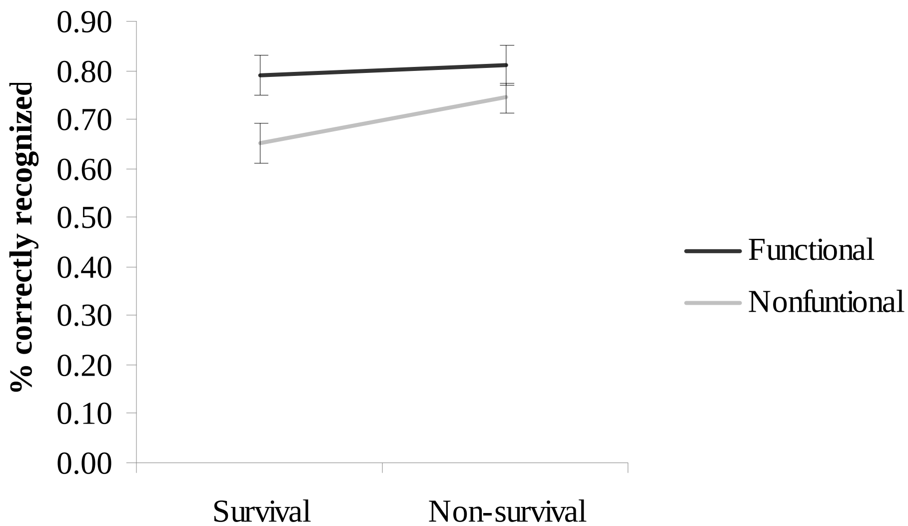

Figure 11. Interactive effects of functionality and survival on recognition scores.

APPENDIX VIII

READING TIME TABLE

Table 5. Means and standard errors for critical sentence reading times.

	Survival	Non-survival
Functional	2085.02 (*753.50*)	2209.44 (*721.60*)
Nonfunctional	2369.99 (*960.31*)	2182.44 (*701.07*)

APPENDIX IX

READING TIME OUTCOME FIGURES

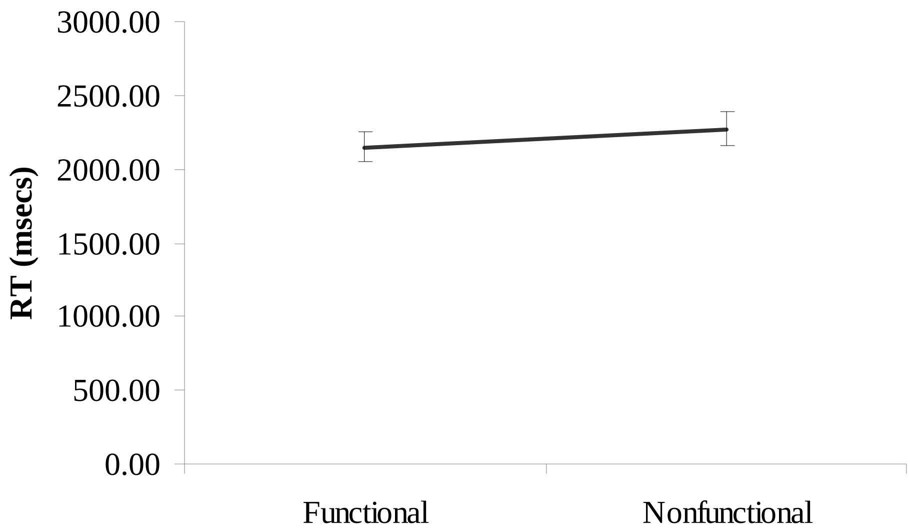

Figure 12. Effect of functionality on critical sentence reading times.

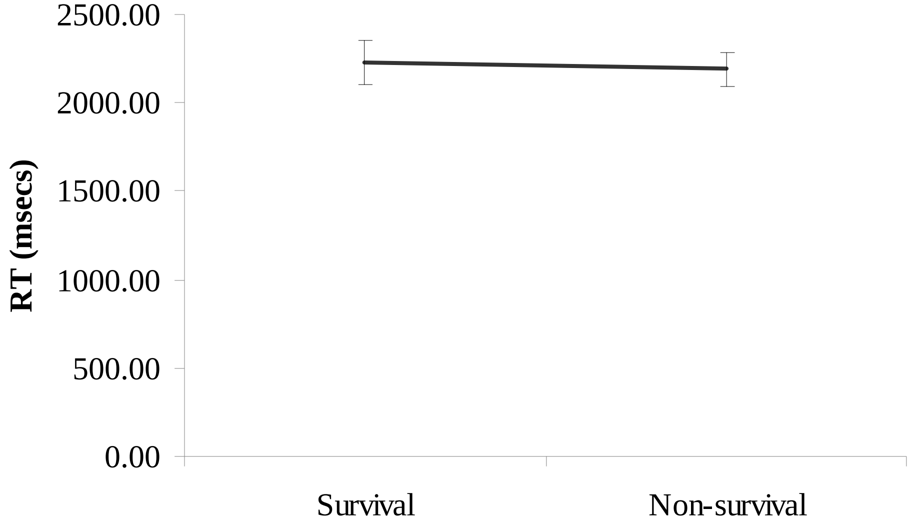

Figure 13. Effect of survival on critical sentence reading times.

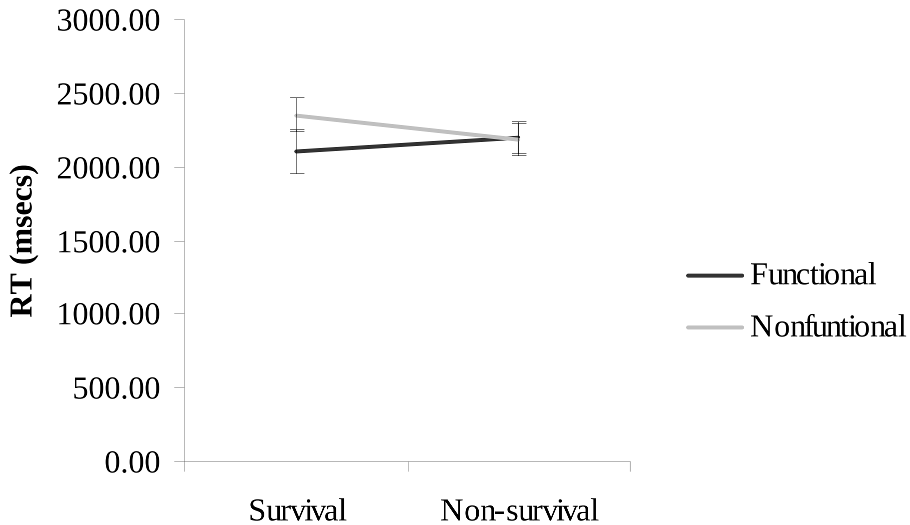

Figure 14. Interactive effects of functionality and survival on critical sentence reading times.

APPENDIX X

IRB APPROVAL FORM

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

UNLV IRB
Approved
OCT 19 2009
Expires

Social/Behavioral IRB – Exempt Review
Approved as Exempt

DATE: October 22, 2009

TO: **Dr. David Copeland,** Psychology

FROM: Office for the Protection of Research Subjects

RE: Notification of IRB Action by Dr. Paul Jones, Chair PJ/Ct
Protocol Title: Reading Stories
OPRS# 0909-3240M

This memorandum is notification that the project referenced above has been reviewed by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45CFR46.

PLEASE NOTE:
Attached to this approval notice is the **official Informed Consent/Assent (IC/IA) Form** for this study. The IC/IA contains an official approval stamp. Only copies of this official IC/IA form may be used when obtaining consent. Please keep the original for your records.

The protocol has been reviewed and deemed exempt from IRB review. It is not in need of further review or approval by the IRB.

Any changes to the exempt protocol may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a **Modification Form**.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805

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SEP 3 0 2009

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UNLV IRB Approved OCT 19 2009 Expires

INFORMED CONSENT

Department of Psychology

TITLE OF STUDY: Reading Stories

INVESTIGATOR(S): David E. Copeland and Paul J. Schroeder

CONTACT PHONE NUMBER: 702-895-5213

Purpose of the Study
You are invited to participate in a research study. The purpose of this study is to examine how different contexts described in a story affect how people read and comprehend the stories.

Participants
You are being asked to participate in the study because you are a healthy adult over the age of 18 years and can fluently speak/understand English.

Procedures
If you volunteer to participate in this study, you will be asked to do the following: Read a set of short narratives and answer questions about them. The entire process should take approximately 30 to 60 minutes.

Benefits of Participation
Although there are no direct benefits of this testing to you, most students find it interesting to see what real psychology experiments are like. You may ask questions at any time about any aspect of the procedure. Also, upon completion, you can inquire about the specific goals and expected results in this study. In addition, the results of this study will contribute to an understanding of what type of information people track and remember while they read.

Risks of Participation
There are risks involved in all research studies. This study may include only minimal risks such as fatigue. This study involves the same amount of risk as reading, working on a computer, or watching television in your normal life.

Cost /Compensation
There will not be financial cost to you to participate in this study. The study will take approximately 30 to 60 minutes of your time. You will be compensated for your time with 1 credit that can be applied to a psychology course. If you choose to terminate participation at any point, you will not be penalized. You will receive partial credit corresponding to the amount of time spent participating.

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SEP 3 0 2009

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

UNLV IRB Approved OCT 1 9 2009 Expires

INFORMED CONSENT

Department of Psychology

TITLE OF STUDY: Reading Stories

INVESTIGATOR(S): David E. Copeland and Paul J. Schroeder

CONTACT PHONE NUMBER: 702-895-5213

Contact Information
If you have any questions or concerns about the study, you may contact Dr. David E. Copeland, Assistant Professor of Psychology at the University of Nevada Las Vegas at 702-895-5213. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office for the Protection of Research Subjects at 702-895-2794.**

Voluntary Participation
Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without penalty or prejudice to your relations with the university. If you withdraw, you will still receive credit for participating. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for at least 3 years after completion of the study. After the storage time the information gathered will be shredded and deleted from the computer on which it is stored.

Participant Consent:
I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

_______________________________________ ____________________
Signature of Participant Date

____
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