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Beyond Language Comprehension: Situation models as a form of autobiographical memory

Joseph P. Magliano
Northern Illinois University

Gabriel A. Radvansky
University of Notre Dame

David E. Copeland
University of Southern Mississippi

Send Correspondence to:
Joe Magliano
Department of Psychology
Northern Illinois University
DeKalb, IL 60115

A great deal of research has examined the role of situation models in text comprehension and memory (see Zwaan & Radvansky, 1998, for a review). This research suggests that there is an isomorphism between representations of narrative and real word events. For example, narrative events are causally linked within a narrative time and space, much the way we understand real world events.

Presumably, the cognitive mechanisms that lead to understanding and memories of events operate independent of how they are experienced (Magliano, Miller, & Zwaan, 2001). As such, because they a representations of people's experiences of events in real or possible worlds, we view situation models as a form of autobiographical memory. That is, memory for encountered events, even when encountered through narratives, draws on the same cognitive machinery used to create autobiographical memories. If the same mental representations and processes are used in other circumstances where situation models are created, then they can all be viewed as a form of autobiographical memory. However, relatively little research on this idea (Thompson, Skrowonski, Larsen, & Betz, 1996; Wagenaar, 1986). While the work on situation models and text comprehension is important, it is also important to assess how well this theoretical framework can move beyond language comprehension to provide insights into cognition more generally.

Here we first provide a brief outline of situation models theory, followed by a discussion of some studies that show how this theory can be applied to areas beyond language comprehension. In particular, these areas are (a) comprehending narrative films, (b) autobiographical memory (c) comprehending virtual reality interactions, and (d) understanding strangers' goals. In general, we explore the similarities and differences in the situation models constructed from these different experiences.

Situation Models

Situation models are mental simulations of real or possible worlds (Johnson-Laird, 1983). These mental representations isomorphically capture the elements of a situation and relations among them that define it. There are a number of elements and relations that can be involved in the structure of a model, which can capture static and dynamic aspects of situations (Barwise & Perry, 1983; Wyer & Radvansky, 1998).

In terms of static components, a situation is defined and bounded by a *spatial-temporal framework*. This is the region of space that contains the situation, and the stretch of time that the situation is in force. Time is static in this sense because there is only one time period used to provide the framework to define an event. Within this spatial-temporal framework are *tokens* that represent entities, such as people, animals, objects, abstract concepts, and so forth. Associated with these entities can be various *properties*. These properties can include external physical characteristics, such as size, color, or weight, and internal properties, such as emotional state, goals, and sanity. Finally, there are *structural relations* among entities within a framework, such as spatial, social, and ownership relations. The likelihood that properties and relations are included in a situation model is a function of the degree to which they play a functional role in defining the interaction among situational elements. The more they are interacting or likely to interact, the greater the probability that they will be represented in the model.

In real or simulated situations, we are active participants. As such, the self becomes another entity in a situation model. One's internal and physical states are

incorporated into our understanding of the situation. To explore the extent that situation model theory can be applied to non-text domains, then research must assess the role of this aspect in situation model constructions.

For the dynamic component, a series of spatial-temporal frameworks may be joined by a collection of *linking relations*. These linking relations can be things like temporal and causal relations and are grounded in the entities. This is because it is the entities that are moving through time, and which have causal interactions with one another. In this case, time is dynamic because is represents the flow of changes across time in a developing situation.

There is a considerable amount of evidence consistent with the assumption that readers monitor multiple components, as specified by the event-indexing model (e.g., See Zwaan & Radvansky (1998) for an extensive review). However, within a given context, some components are monitored more closely than others. With respect to the static elements, the spatial-temporal framework is monitored closely because it provides the context that defines the static situation (e.g., Radvansky & Zacks, 1991; Radvansky, Zwaan, Federico & Franklin, 1998; Bower & Morrow, 1990). Beyond that, the entities and their structural relations are important because these provide the content for the static situation (Radvansky, Spieler & Zacks, 1993; Radvansky & Copeland, 2001). Entity properties are of less importance unless they provide information about the functional relations among entities in the situation. As such these are at the lowest end of the hierarchy. Linking relations, such as time and causality have no real definition in static situations because there is no change in time.

There is also a considerable amount of evidence that some dynamic components are monitored more closely than others. For example, during the first reading of a text, reading times increase when there are breaks in causal coherence (Zwaan, Magliano & Graesser, 1995; Magliano, Trabasso, & Graesser, 1999; Magliano, Zwaan, & Graesser, 1999) and temporal contiguity (Zwaan et al, 1995; Zwaan, 1996; Magliano, Zwaan, & Graesser, 1999; Therriault and Rinck, this volume), but not spatial contiguity (Zwaan et al, 1995; Magliano, Zwaan & Graesser, 1999; Therriault and Rinck, this volume). Readers do appear to monitor shifts in spatial contiguity when they have a specific goal to do so (Zwaan & von Oostendorp, 1993), there is a great deal of prior knowledge about the space (Rinck & Bower, 1995; Zwaan, Radvansky, Hilliard, & Curiel, 1998), or upon a second reading of a story (Zwaan et al, 1995; Magliano, Zwaan, & Graesser, 1999). Presumably, causal and temporal contiguities are monitored more closely than space because those dimensions provide stronger cues for coherence in episodic memory (e.g., Zwaan et al., 1998). Indeed, causal and temporal connectivity are strong predictors of coherence judgments (Magliano et al., 1999). Furthermore, the degree of causal connectivity among story constituents is a primary predictor of recall and summarization (see van Den Broek (1994) for an extensive review). It is important to note that both temporal and spatial relations are also indicative of the extent to which story constituents are connected in memory, but they do not carry as much variance as causal relatedness (e.g., Zwaan, Langston, & Graesser, 1995)

Some researchers have argued that situation models are structured around the narrative protagonist (Ozyurek & Trabasso 1997; Rich-Scott, Taylor, 2000). For example, Scott-Rich & Taylor (2000) found that character shifts led to decreases in (a) judgments of coherence, (b) judgments of cohesion between narrative sentences, and (c)

the accessibility of narrative entities than shifts in either time or location. They interpreted these results as indicating that narrative events are structured around the characters and they are monitored more closely than time or location. However, Rinck and Weber (in press) argued that Scott-Rich and Taylor (2000) confounded shifts in the situation components because they did not independently manipulate them across text versions. In a study to correct this, Rinck and Weber found that characters and time shifts are monitored more strongly than spatial shifts, and there was no evidence that characters were monitored more closely than time. This suggests that when the only linking relation is time, then it may not play as large of a role in the situation model relative to other components unless it has the support of a causal structure.

Isomorphism Between Situation Models and Real World Experiences

As mentioned previously, work on situation models has focused largely on the comprehension and memory of narrative texts. However, situation models should also capture events in the real world. For example, this is found in ideas about embodied cognition and perceptual symbols (Wilson, 2002; Zwaan, in press; Barsalou 1999). Before moving on, we consider the validity of such an analogical representational form.

Let's take an evolutionary view of human cognition for event comprehension and memory. Humans evolved from other species that were operating in and adapting to complex environments without the aid of human reason and cognitive complexity. Still, it is reasonable to assume that these creatures were able to mentally represent various aspects of their world, mentally manipulate that information, and store it for future use. What sort of mental representations were used?

The two most prominent candidates in current cognitive research on event comprehension and memory are abstract propositions and perceptual symbols (e.g., Barsalou 1999.). The traditional way of thinking about situation models created from text is that they are built up from a propositional textbase used as a scaffolding to create the situation model. While this is a possible scenario in some cases, it seems implausible for non-human organisms. Instead, it seems more reasonable that these creatures are creating a mental representation derived from the perceptual information that is readily available. The derivation of abstract propositions is a more highly developed process.

Given this, the situation model is the more fundamental form of mental representation, whereas an abstract propositional representation is a more complex and fragile form of mental representation that is more prone to distortion and forgetting. These characteristics of the different memory representations are well documented in the literature (c.f., Fletcher, 1994). As such, we adopt the view that the characteristics of situation models observed in narrative comprehension research should extend to other aspects of cognition where situation models can be assumed to operating. This chapter serves as a tour of some of these areas beyond language comprehension.

Beyond Language Comprehension

One test of situation model theory is to examine whether the same predictions and findings hold for events not conveyed in narratives. For example, do the components involving both static and dynamic elements of a situation (Zwaan & Radvansky, 1998)

have a similar influence in other types of experience? To this end we discuss some studies that we have conducted that address this question. The first study involves a different narrative medium, namely film. The latter studies extend to other kinds of experiences in which one is a participant. As such, the "self" becomes an entity in a situation model. A domain independent hypothesis predicts that the general influence of these components on processing is independent of medium or modality of experience (Magliano et al., 2001), although, it is possible that their relative importance may vary.

Narrative Film

Compared to texts, there is relatively little research on narrative film comprehension (Baggett, 1977; Magliano, Dijkstra, & Zwaan 1996; Magliano, Miller, & Zwaan, 2001; Schwan, Hesse, & Garsoffky, 1998; Tan, 1996). Because both narrative texts and films are event-based, theories and findings derived from work on texts should generalize to film (Magliano et al., 1996; 2001). Although there are some similarities, there may be differences regarding the prominence of situation model components. In general, the predictions are that people should parse their understanding of events along the same boundaries as they do events presented in a text.

Spatial-temporal framework. Prior research on narrative discourse has shown that readers monitor the changes along boundaries of a temporal framework of a narrative more closely than spatial framework information (e.g., Zwaan, Magliano, & Graesser, 1995). Magliano et al. (2001) assessed whether this is also true for narrative film. Given the visual nature of film, changes in spatial location are more apparent. As such, viewers may find it easier to track spatial framework information in film. Alternatively, it may be that a dominance of time over space in narrative comprehension is medium independent.

To test these possibilities, Magliano et al (2001) used an event-partonomy task (e.g., Newtson, 1973; Newtson & Engquist, 1976). People viewed feature length narrative films and made situation-change judgments by identifying points in the film that contained a change in the situation that the characters were facing. People were not told what constituted a change. One hour from each film was sampled for analyses. Each individual shot in that hour was coded, and the specific shots in which the participants made their judgments were identified. An *a priori* analysis of the film identified shifts in time, character's locations, and spatial region in the scenes. Note that this analysis of space differed from other discourse analyses (e.g., Zwaan, Magliano, & Graesser, 1995) in that it distinguished between two types of spatial shifts. One type of shift involved the movement to another location and the second involved shifts to new regions of the narrative space that did not involve the movement of prominent characters.

The large number of shots (total of 2457) enabled a full Time (shift VS no shift) X Character movement (shift VS no shift) X Spatial region (shift VS no shift) analysis. Situation-change scores were calculated by dividing the number of times a person indicated that there was a change by the total number of shots in that cell. For example, if there were 28 shots that had shifts in all three dimensions and a person indicated that there was a change in situation in 20 of these shots, the change score would be .71.

These situation change scores were submitted to a 2 X 2 X 2 repeated measures ANOVA. Consistent with situation model theory, it was found that people index film

events along multiple components. There is evidence that these components are indexed independently, but only with respect to time and character movement. Change judgments were greater for shots that contained these shifts than those that did not. However, change judgments did not increase when there was a shift to a new spatial region. A spatial region shift was only sufficient to create the impression of a new situation when it co-occurred with a temporal shift. There was also evidence for additivity, in which the more shifts that occurred, the greater the impact on the situation-change judgments.

Most importantly for this chapter, the importance of situational components may be medium independent. Shifts in time had a greater impact on perceptions that the situation had changed than either the movement of character or shifts of spatial regions. Furthermore, aspects of space that are linked to a character (i.e., movements) had a greater impact that the perception had changed than the shifts to new regions**.**

Entities, properties, and structural relations. The research in narrative film comprehension suggests that viewers do monitor and index entities, properties, and structural relations. We conducted a new analysis of the Magliano et al. (2001) data to assess whether viewers track characters in the story world. A regression analysis suggested that situation change judgments increased when new characters were introduced or established characters were re-introduced ($t(2442) = 13.801$, Beta = .22, $p < .001$). Furthermore, Magliano et al (2001) showed that once these characters are introduced, viewers monitor their movements in the narrative world. Finally, using a similar paradigm, Magliano, Taylor, and Kim (2003) also found that viewers monitor the goals of multiple characters, but this was primarily the case for those characters that are prominent in the plot. These findings are consistent with picture story narration data (Trabasso & Nickels, 1992). Obviously, more research on this aspect of situation model construction is needed in the context of narrative film comprehension.

Linking relations. One would expect that both readers and viewers infer causal relations between story events. Although, there is relatively little direct evidence for this, a study by Baggett (1979) provides some indirect evidence. She had people either read a description of a feature length film or viewed a picture flip book constructed of movie frames. Judgments of the episode boundaries were the same for both. The correspondence in the perception of these episodes entails that both readers and viewers were inferring and monitoring causal relationships between story events because these episode boundaries are determined by changes in the causal structure (e.g., Trabasso et al., 1989).

There is considerable evidence to suggest that causal relations drive story recall for narrative texts (cf. van den Broek, 1994). There is also some evidence to suggest that the same is true for narrative film. For example, Van den Broek et al (1997) had people view and then later recall a short film. They conducted a causal network analysis on a verbal description of the film. As expected, people recalled events more often that were causally central in the causal-hierarchy. Also, Magliano et al. (2003) showed that viewers monitor changes in the goal episodes of film characters, which is contingent on inferring causal relations between events, characters' internal states (e.g., goals and emotions), the actions that ensue, and the outcomes of these actions (Trabasso et al., 1989).

Autobiographical Memory

One way to view the comprehension of narrative texts is as the acquisition of vicarious autobiographical memories. This could be one of the reasons why novels and narrative films are so popular. They allow a person to have experiences what would otherwise be out of normal everyday existence. The more exciting and remote the experience, the more popular the genre of novels should be. Conversely, it is also reasonable to expect that autobiographical memory would illustrate characteristics observed with narrative texts. The narrative structure of autobiographical memory is well documented (McAdams, 2001). This arises out of a person's need to derive a coherent understanding of the many, often temporally separated, events in their lives. What is absent is an investigation of effects observed in narrative processing on autobiographical experience. As such, we have only brief comments to make about the role of spatial-temporal frameworks and entities, properties and structural relations. However, we do spend more time exploring linking relations. The predictions from situation model theory are that events should be organized by spatial dimensions (e.g., space and time), that the entities are only important in the sense that they ground causal, functional relations among the entities. As such, the linking relations of time and causality should play a prominent role in organizing and retrieving information from autobiographical memory.

Spatial-temporal framework. The use of space and time as cues to autobiographical memory is well known (Barsalou, 1988; Burt, Mitchell, Raggatt, Jones, & Cowan, 1995; Wagenaar, 1986). For example, in a study by Barsalou (1988) it was found that when people were provided with cues to help them retrieve information from autobiographical memory, spatial location and time period cues were among the most effective. That is, people recalled more autobiographical memories if they were provided with the name of a place or a period of time (e.g., New Year's Eve) than if they were given other cues, although there is some evidence that time can be a poor retrieval cue under some conditions (Wagenaar, 1986). This parallels work on situation models that also show a strong influence of these space and time dimensions on memory retrieval (e.g., Radvansky & Zacks, 1991; Radvansky, Zwaan, Federico & Franklin, 1998).

Entities, properties, and structural relations. Autobiographical memories are, by definition, structured around an entity, namely the self. However, other people may be involved, but they do not serve as effective organizational points as the self (Barsalou, 1988; Burt et al., 1995; Wagenaar, 1986). The data on the structural relations are unclear. There is some evidence that activities serve as effective retrieval cues for autobiographical memory (e.g., Barsalou, 1988). Activities serve to define the structural relations among the primary entities in a situation. However, activities are overloaded in the amount of situational information they carry. They not only provide information about structural relations, but they may also carry information about the properties of entities, the spatial-temporal location, and perhaps linking relations. For example, an activity like playing baseball not only provides information about the relations between the players and equipment, but it also about where the situation took place, the number of entities likely to be involved, and the progression of events over time.

Linking relations. Like narratives, autobiographical memory can be organized based on temporal and causal relations, and these relations can facilitate their retrieval (Brown & Schlopflocher, 1998). Although there have been a few studies directly compared autobiographical and narrative processing, we focus on a study by Radvansky, Copeland, and Zwaan (2004). This study examined both narrative and autobiographical memory using techniques from both domains. For narratives, people's memory was assessed for a novel that was read in the lab. In comparison, autobiographical memory was assessed by having people retrieve events from their own lives.

In work on narrative processing, it has been found that the linking relation of causal connectivity plays an important role in memory (e.g., Trabasso & van den Broek, 1985). As such, both narrative and autobiographical memory content was scored for causal connectivity. Consistent with prior research, causal connectivity was found to facilitate the retrieval of both narrative and autobiographical memory information.

In work on autobiographical memory, it has been observed that event information is available as a function of both the order in which various details unfolded, as well as the relative importance of those details (Anderson & Conway, 1993). Specifically, when people were asked to recall details from an event, performance is best when it is done in a forward order, as compared to a backwards order, or one based on subjective importance. In addition, during recognition, people are better able to retrieve information that corresponded to salient details of the event as compared to other details. The study by Radvansky et al. (2004) assessed performance on both the temporal and importance characteristics during both recall and timed recognition.

The result was that performance on all tasks showed a high degree of similarity between autobiographical and narrative memory. That is, people were remembering information about events similarly regardless of how they learned of those events. However, there were some small differences. Specifically, narratives appeared to rely more on temporal structure, whereas autobiographical experiences appeared to rely more on causal connectivity. However, the similarities greatly outweighed the differences. Thus, there seems to be a common representational format underlying these different aspects of memory. This format is likely to be a situation model**.**

Virtual Reality

Recently, we looked at people's performance in virtual reality situations. Of particular interest are flight and ground combat situations. In these tasks, people are asked to interact in some desktop virtual environment. Afterwards, performance was coded with respect to the components as identified by situation model theory.

In addition to looking at performance in the virtual environment, in some cases we had a second person providing assistance in the role of a coach. That is, the coach viewed the subjects' performance on a second computer monitor in a separate room and could communicate over a headphone-microphone system. These conversations were recorded along with game play to a recording device, and later scored. The coaches' comments are interesting because they can be used to help understand the processing of situation information by looking at their impact on performance, the type of information that was provided and when they occurred as the situation developed and unfolded.

In general, the more assistance that was provided by the coaches, the better was player performance. Thus, outside observers are sensitive to the on-going structure of the situation, as well as having an awareness of what information might be lacking in the player's developing situation model, and provided assistance that was useful.

Because of the structure of these situations, according to situation model theory we can expect that spatial location is going to play a more prominent role than in text comprehension. There is no real influence of temporal shifts in this case because people are moving continuously through time, and not making temporal leaps. The fact that the person is an entity in the situation should also increase the salience of entity information, although characteristics of the self are likely to be more salient. Finally, it is reasonable to expect that personal goals within the situation will have a more driving effect on the representation and processing of the situation since this is how the person is oriented with respect to the on-going events. The following results are based on looking at performance in 5 s bins. That is, within a given 5 s period, what was the state of the situation, what were the aims of the person, and what sort of assistance was provided.

Spatial-temporal framework. In our environments, spatial shifts influenced processing in the on-going event. For example, in the ground combat situation, when there was change in location, players were more likely to be hit by their enemies when they were present. Also, when looking at coaches' comments, fewer comments were given when there was a change in spatial location (e.g., the soldier entered a new room) as compared to when there were was no shift. This suggests that changing location in the virtual environment requires a person to update their mental representation, taking away mental resources that would otherwise be devoted to other aspects of situation processing. Comments provided during this time are more likely to be disruptive. Thus, the need to process a change in location is more likely to bring about a greater demand on cognitive resources, just as is seen in text comprehension work (e.g., Zwaan et al., 1995).

Entities, properties, and structural relations. An interesting component about these virtual reality situations is the inclusion of the self. The person is an active participant in the situation, rather than experiencing the event indirectly. This self-perspective is interesting because we can look at how the structure of the situation interacting with the self can affect performance.

In our simulations, people needed to monitor various aspects about their own status, such as whether they had been hit by the enemy or were running low on ammunition. Also, people needed to actively interact with the environment through some virtual representations of themselves, either as a fighter plane or as a soldier. The influence of monitoring the self in the situation was most highlighted in terms of the comments that were provided. Specifically, when the person was actively interacting with the environment, when they needed to direct more attention to their own status and to what they needed to do to accomplish their goals, people were provided with fewer comments relative to when they were less actively engaged with the environment.

In addition to the self, a person needed to also monitor other entities in the situation. In this case, these other entities could be active ones that were trying to harm the person, or were passive ones, such as targets that the person needed to destroy. In general, the more entities that a person needed to monitor, the more difficult it was to

process information about the situation, and the less effective a person was at achieving their goals. Also, the more entities there were in the situation, the less likely the coach would provide disruptive assistance. The only exception to this was that when there were increased numbers of passive entities, coaches increased the number of comments they provided that updated the person about the status of the current situation, such as whether a target had been hit or not.

Linking relations. While the virtual reality situations that we studied progressed steadily through time and involved different causal relations, because there were no clear breaks along either of these dimensions, we were not able to assess these at this point.

Inferring the goals of Strangers

In this chapter, we suggest that situation model theory is a general theory of event understanding. In this section, we provide further evidence for this by describing a study that applies situation model theory to social inferences. We assume that the same mechanisms that guide social inferences also guide narrative inference, and in particular those that involve inferring the goals of agents.

When we experience a narrative, we often encounter unfamiliar characters. Inferring the goals of these characters as they interact in the narrative world is critical to understanding. According to situation model theory, when inferring the goals of characters, readers should index a situation component, such as spatial setting, time, properties of the character, their actions, and the causal relationships between the events. This may also be true when we interact with strangers in the real world. Researchers at Northern Illinois University (Magliano, Britt, Skowronsky, Guess, & Larson) and Sandia National Laboratories (Forsythe) have conducted studies to assess the extent to which individuals index situational dimensions to infer the goals of strangers. We were specifically interested in assessing the role of different situational dimensions in providing cues that are predictive of the goals of strangers during unsolicited social interactions (i.e., the stranger initiates the interaction without an invitation to do so).

We sampled a broad range of goals, such as the solicitation of goods or services (e.g., wanting money, help jump starting a car, or to borrow an object), establishing social relationships (e.g., wants to become a friend, or wants to become a romantic partner), and harming another (e.g., rob or kill). One would expect that the static elements of the situations associated with these different categories of stranger goals would be very different across goals. For example, the time, location, characteristics of the stranger, actions of the stranger, and characteristics of oneself (e.g., dress or emotional response) would be different in situations in which we are interacting with strangers who want to become a friend or romantic partner than in situations in which the stranger wants to rob someone. Presumably, individuals develop schemas associated with various social goals that index the co-occurrence of these elements of a situation.

The first study was done to elicit the static features of the situations associated with specific stranger's goals within the categories discussed above. People were asked to imagine a scenario in which they are interacting with a stranger that has a particular goal (e.g., wants to become our friend, wants money, wants to rob us). Participants answered a questionnaire that was designed to elicit information regarding the time and location of

the interaction, as well as characteristics and actions of the stranger, and characteristics of oneself, such as “where is the interaction occurring?”, ”What time of day is it?”, “What does the stranger look like?, “What is the stranger doing?”.

The non-idosyncratic answers became situational cues that could be associated with particular strangers’ goal. For example, “at a bar” was a location cue associated with a romantic encounter goal, whereas a city street was a location cue for a mugging goal. Based on cues derived from the questionnaires, we created a cues X goals matrix, which contained the frequency that each cue was produced for each goal. Each of these cues differed in the degree to which they are informative of a stranger’s goal. The presence of some cues would be highly indicative of a goal (e.g., the presence of a gun is indicative of harming goals, such as mugging someone), whereas some cues would only be weakly associated (e.g., city street is weakly associated with mugging). We conceptualized the informativeness of a cue to be a combination if it’s strength and uniqueness of association with that goal using the equations below:

Equation 1: Strength of association (SA) = (Freq of cue_i for $goal_n$)/(total number of participants who considered $goal_n$)

Equation 2: Uniqueness of associations (UA) = (Freq of cue_i for $goal_n$)/(Sum of the frequencies for cue_i for goals $_{110}$)

Equation 3: Dignosticity score = SA + UA

We then created a diagnosticity matrix by replacing the frequencies in Cue X Goal matrix with diagnosticity scores. Strangers’ goals should be distinguishable to the extent that they differ in the situational cues that are associated with them and, thus, have different vectors in the diagnosticity matrix. Conversely, goals that are conceptually similar should share situational cues and have similar vectors of diagnosticity scores. A multi-dimensional scaling analysis was conducted on the matrix of diagnosticity scores to assess the extent to which the cues elicited validated these assumptions.

For this analysis, six goals were chosen. Specifically, two goals where selected that involved establishing social relationships (establish either a platonic or romantic relationship), two goals were chosen that involved recruitment (recruiting to either fill out a survey or religious conversion), and two goals were chosen that involved harming (either robbing or killing). Figure 1 depicts the results of this analysis, which shows the estimated Euclidean distance between the goals in a two dimensional space. As can be seen in Figure 1, goals that are conceptually similar are closer in the space than goals that are dissimilar. Furthermore, this analysis suggests that knowledge of these goals is indexed according to the situation cues associated with them.

The cues in the matrix were classified into different situation model components: location, time of day, strangers characteristics (e.g., facial expression, dress, object that are in the stranger’s possession), characteristics of oneself, and stranger’s actions. Location and time are aspects of the spatial-temporal framework. Characteristics of the stranger and self are parts of the entity dimension. The questionnaires did not directly tap linking relations. However, stranger’s actions could be thought of as an aspect of the linking relations in this domain to the extent that they are inferred to be causally related to goals. This assumption is supported by theories of causal reasoning in the context of narrative episodes (Suh & Trabasso, 1993; Trabasso et al., 1989). That is, we have implicit knowledge that actions are typically causally motivated by a goal and routinely make this inference (see Graesser, Singer, & Trabasso, 1994, for a review).

Presumably, some cues are more predictive (i.e., diagnostic) of a stranger's goal than others. To assess these differences, a second experiment was done in which people made predictability judgments for cue-goal pairs. People considered situations in which a stranger would have a particular goal (i.e., any given participant was asked to consider only one goal in the experiment). They were presented one cue at a time and asked to judge how likely a stranger would have that goal given the presence of the cues. People made judgments for all the non-idiosyncratic cues that were elicited across all the goals in Study 1. As such, some cues should be predictive of a given goal, whereas others should not. For each goal, a distinction was made between those cues that were elicited in Study 1 (i.e., diagnostic of the goal) and those cues that were not (i.e., not diagnostic of the goal) based on the diagnosticity matrix. Low diagnostic cues had a diagnostic score of 0 for a particular goal. High diagnostic had an average diagnostic score of .69. For each participant, average predictability judgments were calculated for the diagnostic and non-diagnostic cues within each category.

A three way ANOVA was conducted on the mean predictability judgments in which the independent variables were Diagnostic value (diagnostic vs. not diagnostic), Situational Cue (Location, Time, Stranger, Stranger Actions, vs. oneself), and Goal Type (Social relationship, Recruitment, vs. Malice). Table 1 contains the mean predictability judgments. Most importantly, the ANOVA revealed a significant 3-way interaction, which indicated that the cues are differentially diagnostic of a goal for the different goal categories ($F(2,78) = 3.08$, $p = .051$). Posthoc analyses were conducted (TUKEY) to reveal these differences. This analysis was used to determine if high diagnostic cues were different than low diagnostic cues for each cue category within each goal category. Table 2 shows this breakdown. Characteristics of oneself was diagnostic when the stranger's goal involved establishing a social relationship, but not when the goal involved recruitment or malice. Time was only diagnostic for the malice goals. These goals almost always occurred at night in the situations describe in Study 1, whereas the others occurred at different times of day. Strangers' locations, characteristics, and actions were diagnostic of their goals across all goal categories.

To further assess the relative importance of the situational cues, means for the diagnostic cues were calculated. The means for self, location, time, stranger, and actions were .87, 1.34, .89, 1.46, and 2.42, respectively. A one way ANOVA revealed that there were differences in the diagnostic value for the situational cues ($F(4, 320) = 145.33$, $p < .01$). A post-hoc analysis (Tukey) revealed that a stranger's actions were more diagnostic than any other situational cue. Both characteristics of the stranger and location were equally diagnostic and significantly more so than time or self characteristics.

Spatial-temporal framework. In his seminal work in ecological psychology, Barker argued that the environment constrains the goal-directed behaviors (Barker, 1968; Barker & Wright, 1955). He argued that the behaviors (and goals) of a group of people within a social setting vary less than the behaviors across settings. For example, the goals and actions of a person in a bar would vary greatly from when that same person was attending a lecture. However, the person's goals and behaviors within these two settings are likely to be highly similar. As such, location and time should greatly narrow the possible goals of a person and facilitate the ability to infer the goals of a stranger.

For the stranger's goal study, reconsider the multidimensional scaling analysis shown in Figure 1. One can surmise that the distance between the goal categories (i.e., social relationships, recruitment, and malice) is, in part, driven by the differences in the locations and times in which these goals occur. However, the analyses of predictability judgments clearly indicated that locations were more predictive than time. Highly diagnostic locations led to an increase in predictability judgments for all three goal categories, whereas time was only significant for goals of malice. This suggests that when understanding social interactions in the world, people monitor more closely where they are than what time of day it is.

This is in contrast to understanding narrative texts, in which readers monitor shifts in time more closely than space (cf., Zwaan & Radvansky, 1998). This difference between the relative importance of location and time between real world and narrative events may be driven by differences in how changes in these dimensions are experienced.

In autobiographical experiences, movement in time and space are experienced more contiguously. Furthermore, our presence in different locations is likely to be correlated with time of day. For example, we tend to be at a bar at night, but in a shopping mall during the day. As such, time of day may not provide sufficiently additional diagnostic information over and above location when trying to infer strangers' goals. In contrast, movement in time and space are not inextricably intertwined in narratives. Authors can maintain the narrative focus in a given location, but shift forwards and backwards in time. Conversely, they can create a sense of concurrency between narrative events that are occurring in different locations. As such, a shift in time is more predictive that there is a new story episode beginning than a shift in location (Magliano et al., 2001). A shift in region alone is not sufficient to create a sense that a situation had changed, but a shift in time was. The greatest sense that the situation had changed occurred when a change in location co-occurred with a shift in time.

Entities, properties, and structural relations. The data presented here suggest that people monitor entities and their properties when inferring strangers' goals. As with a virtual environment, we are active participants in autobiographical situations. As such, one may monitor and index characteristics of the self when constructing situation models for social experiences. However, the data from the stranger's goal study suggests that characteristics of the self are diagnostic of only some cases. Specifically, characteristics of the self were diagnostic of a stranger's goal when it involved establishing a social relationship. However, they were not for goals that involved recruitment or malice.

Not surprisingly, characteristics of the stranger were diagnostic of that stranger's goal. These characteristics involved gender, appearance, and objects in the stranger's

possession. However, as can be seen in patterns of judgments Table 2, people considered these characteristics only moderately diagnostics across the different goals.

Linking relations. The most direct evidence for the role of linking relations when inferring their goals involved cues associated with a stranger's actions. In narratives, authors can explicitly state the goals of a character. However, often our only insight into a stranger's goals is overt actions. As such, stranger's actions were highly diagnostic of his/her goals for all three categories. Furthermore, the average judgments for the high diagnostic cues ranged from 2.32 to 2.50, which were between highly likely and virtually certain. Given that actions are understood by inferring a causal linking between those actions and a goal (e.g., Suh & Trabasso, 1993, Trabasso et al., 1989), it is reasonable to assume that people were inferring causal relations between the stated action and the goal that they were considering.

In summary, the data from stranger's goal study suggest that, as with narrative texts (e.g., Zwaan & Radvansky, 1998), people use multiple situational components to infer the other's goals. Furthermore, goals can be distinguished from one another via the situational cues that co-occur with them (i.e. the location of a bar co-occurs with the goal of establishing a romance). The predictive value of a cue is based, in part, on its strength and uniqueness of association with a goal. Moreover, it has been found that some components carry more weight than others. This later point should be noted with caution. To accurately assess these differences, one would need to vary the number and categories of cues present, which was not done in the second study described above. We are currently working to achieve this end.

Summary

Although the majority of the research that has tested situation model theory has been in the context of narrative discourse, we believe that situation models are general mechanisms that are used to understand and remember many different types of events. Perhaps this claim is not surprising. As we have argued, it is reasonable to expect that a common set of cognitive mechanisms would operate in many different types of events that are experienced (e.g., texts, film, video games, and real life social interactions). However, this claim must be empirically addressed.

Furthermore, although similar mechanisms may operate to construct meaning across experiences, the nature of the situation models constructed may vary across different types of experiences. Such differences can only be revealed through research. In this chapter, we presented four different event domains where this theoretical approach has been successfully applied, although more research is needed. This research demonstrates that situation models for different types of experience are similar in some respects. For example, we expect elements of an event that provide a basis for linking parts of the events together in memory, such as causal reasoning, are critical regardless of experience. In particular, the research reported here suggests that causal relationships are important for understanding events across all modalities of experience.

However, the relative importance of static components of a situation may vary across experiences. For example, the extent that a person monitors location and time may

depend on the modality of experience. The data from the stranger's goal study suggest that monitoring where one is may provide more information than what time it is when understanding social events. Additionally, monitoring changes in location is very important for performing well in a virtual environment. This is in contrast to narrative understanding in which there is clear evidence that changes in time are monitored more closely than location changes (e.g., Magliano et al., 2001). Additionally, in many types of events, we are participants. In these experiences, characteristics of the self are important to defining the unfolding situation and may be incorporated into a situation model. Again, this is a departure from narrative experiences in which we are side participants.

It seems likely that there are other domains of cognition that are open to the theoretical insights and tools that have been successfully applied in the area of language comprehension. So much of cognition is based on the comprehension and memory of events. There are a myriad of ways that the humans can experience events, and it seems reasonable that a common mental apparatus underlies the comprehension all of them.

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Table 1.
Mean predictability judgments as a function of Goal Category, Diagnostic value, and Situation cue

		SITUATION CUE				
GOAL CATEGORY	DIAGNOSTIC VALUE	Self	Location	Time	Stranger	Actions
Social Relationship	High	1.10	1.43	0.86	1.13	2.53
	Low	0.79	0.90	1.05	0.56	0.74
Recruitment	High	0.68	1.29	0.81	1.79	2.32
	Low	0.73	0.84	0.51	0.59	0.76
Harm	High	0.84	1.31	1.00	1.47	2.40
	Low	0.72	0.79	0.72	0.57	0.74

TABLE NOTE: Predictability judgments were made on a four point scale: 0 = not likely, 1 = moderately likely, 2 = very likely, and 3 = virtually certain.

Table 2.
Diagnostic cues for the different goal categories.

	SITUATION CUE				
GOAL CATEGORY	Self	Location	Time	Stranger	Actions
Social Relationship	X	X		X	X
Recruitment		X		X	X
Harm		X	X	X	X

TABLE NOTE: X = that the mean for high diagnostic cues was different for low diagnostic cues in the Tukey analysis

Figure Captions

Figure 1. The estimated Euclidean distance between the stranger's goals.