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## *Multidimensional Situation Models*

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### WHAT'S IN A SITUATION MODEL?

The research landscape examining situation models in discourse has been transformed considerably in the last 20 years. Van Dijk and Kintsch (1983) originally included the concept of a situation model to address issues that were problematic for earlier versions of their theory (Kintsch & van Dijk, 1978). Specifically, van Dijk and Kintsch (1983) argued that situation models were necessary to explain issues of reference, coreference, coherence, perspective taking, translation, individual differences, memory, reordering effects, problem solving, updating knowledge, and learning. One might first notice the comprehensive nature of such a list. It is not surprising, then, that there is general agreement regarding the theoretical importance of situation models. What is surprising, however, as originally pointed out by Glenberg, Meyer, and Lindem (1987), is the lack of agreement regarding what constitutes a situational model and the types of information it might contain.

For the purposes of this chapter, we use the term *situation model* to refer to a discourse representation that captures aspects of a micro-world created by the reader (Johnson-Laird, 1983; van Dijk & Kintsch, 1983). In this sense, a situation model can include propositional information, but also information beyond that given in the text proper. For example, situation models can contain information related to the gist of the text, a reader's potential background knowledge, and inferences not explicitly stated in the text (Zwaan & Radvansky, 1998).

One theory of situation-model construction (i.e., the event-indexing model) suggests that readers comprehend information in the story world at an *event* level (Zwaan, Langston, & Graesser, 1995). In this sense, events are

the building blocks of comprehension, capturing the nuances of situations described in narrative text. Readers are sensitive to specific dimensions when attending to these events: space, causality, intentionality, time, and protagonist/objects (Zwaan & Radvansky, 1998). The rationale for each of these dimensions is briefly reviewed below (we realize that there is a vast literature on situation model construction, but it is not our purpose to review that entire body here).

Managing our physical environment is critical to everyday functioning. It is not surprising, then, that readers might also form a spatial layout of a described text, referred to as the space dimension. Most of the early evidence documenting the existence of situation models is predicated on experiments showing that a reader's decisions about an object in a spatial layout is faster the closer that object is to a protagonist currently in focus within the text (Glenberg, Meyer, & Lindem, 1987; Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987; Rinck & Bower, 1995; Wilson, Rinck, McNamara, Bower, & Morrow, 1993). This suggests that readers are mentally keeping track of the protagonist's spatial movement in the story world. It is important to note, however, that in a typical experiment of this sort, subjects first memorize the layout of a building and then read a narrative, which is atypical of normal reading and of normal experience. There is evidence suggesting that readers, who do not have the benefit of a map, do not routinely represent complex spatial information (Hakala, 1999; Langston, Kramer, & Glenberg, 1998; Rinck, in press; Zwaan & Oostendorp, 1993).

Trabasso and Sperry (1985) and Trabasso and Suh (1993) argue that in order to understand text, readers must represent the causal relations between events, objects, and protagonists and that this is the backbone of the situation model. The causation dimension can be described as the representation of causal relations indicated in text by the connectives *because* or *therefore*. It has been demonstrated that using such connectives increases the coherence of a final representation of events described in a sentence (Millis, Golding, & Barker, 1995). It should be noted, however, that explicit connectives are typically not needed to build causal structures in narrative, unless the content is very unfamiliar or disconnected.

Readers also keep track of goals of the protagonist. This is referred to as the intentionality dimension. Goal monitoring has been well documented (Suh & Trabasso, 1993; Trabasso & Suh, 1993; Lutz & Radvansky, 1997). As an example, Lutz and Radvansky (1997) demonstrated that when readers are presented with a statement such as *David is attempting to submit his chapter in a timely manner*, they store David's goal to submit the chapter and maintain this goal in memory until David is removed from the focus of the text or until the goal has been accomplished. Moreover, recent evidence suggests that objects relevant to a protagonist's active goal remain highly accessible, that the accessibility of objects relevant to a completed goal decays over time, and that objects relevant to a postponed goal are inhibited almost immediately (Rinck & Bower, 2004).

Temporal information is pervasive in language. All sentences contain absolute or relative information about the time course of events described in those sentences (Ter Meulen, 1995; Zwaan & Radvansky, 1998). For example, in English there are 12 different categories in the tense-aspect system: past, present, and future tenses combined with the simple, perfect, progressive, and perfect-progressive aspectual forms (Celce-Murcia & Larsen-Freeman, 1999). The regularity of such temporal markers underscores the importance of time information in building coherent situation models (Magliano & Schleich, 2000; Radvansky, Zwaan, Federico, & Franklin, 1998; Rinck, Hähnel, & Becker, 2001; Zwaan, 1996).

Finally, in a review of situation model research, Zwaan and Radvansky (1998) highlight the importance of protagonist and objects during situation-model construction. There is some argument that they may be the core around which situation models are built. Research consistently demonstrates that readers monitor the identity and traits of a protagonist (Albrecht & O'Brien, 1993, 1995; Cook, Halleran, & O'Brien, 1998; O'Brien, Rizzella, Albrecht, & Halleran, 1998). For example, Albrecht and O'Brien (1993) found that readers slow down when reading a description of actions that are inconsistent with a protagonist's trait (e.g., a vegetarian orders a hamburger). This provides evidence that readers are sensitive to these inconsistencies and therefore must have stored the protagonist's traits in memory.

The selection of the critical dimensions in the event-indexing model appears apt, given their support in the literature. We would suggest, however, that a coherent situation model is more than an aggregation of dimensions. Traditional situation model research examines single dimensions; but it is also important to explore the relative contributions of the individual dimensions and their potential interactions. Consequently, the purpose of this chapter is to synthesize research exploring multidimensional situational models—more specifically, to explore the necessity and dominance of particular indices, interactions between dimensions, and appraise possible additions to the event-indexing model (i.e., emotions and/or reader perspective). The concluding remarks in this chapter will attempt to evaluate the status of the event-indexing model with respect to multidimensional situational models.

### STUDIES EXPLORING DIMENSIONAL DOMINANCE

Zwaan, Langston, and Graesser (1995) provided the first test of the event-indexing model using a verb clustering task. In their study, participants were presented with 10 unique verbs from narratives they had previously read. Participants were instructed to write down verbs that they thought belonged together, based on either their memory for the narrative or when the narrative was available for their inspection. In Experiment 1, participants read the narratives and completed the verb clustering task from memory and then

completed the verb clustering task a second time with the narratives present. In both conditions, beta weights from the multiple regression analyses indicated that all five situational dimensions predicted verb clustering scores. This was taken as evidence that readers simultaneously monitor all five dimensions specified in the model.

In Experiment 2, participants first completed the verb clustering task when the narratives were available for inspection and then completed the task a second time from memory. Experiment 2 mirrored many of the same results as Experiment 1 with two exceptions. Interestingly, the protagonist and time dimensions did not significantly predict verb clustering scores in Experiment 2. One possible explanation offered for this was that by providing the text first, participants focused more upon the surface structure at the expense of forming a more coherent situation model.

Zwaan, Langston, and Graesser (1995) did not report any colinearity issues between dimensions, suggesting that they were more or less orthogonal. However, there was a significant correlation of note. Causality was significantly correlated with time (.38,  $p < .001$ ). We interpret this correlation as reflective of the obvious temporal relationship between a cause and its effect (i.e., a cause must precede its effect), suggesting that the causal dimension can never truly be orthogonal to the superordinate time dimension.

Zwaan, Magliano, and Graesser (1995) explored how situational discontinuity (for natural literature) affected reading times on three of the event-indexing dimensions: time, space, or causality. Participants read two published short stories, and their time to read each sentence was recorded. Specific pieces of literature were selected in which temporality, spatiality, and causality approached orthogonal variation. That is, there were discrepancies between real world constraints and narrative structure. For example, in the narrative structures selected, an effect could be stated before its cause (causal discontinuity), events could be described as occurring at the same time in different locations (spatial discontinuity), and different events could be described as occurring in the same place at different times (temporal discontinuity).

Results from Zwaan, Magliano, and Graesser (1995) confirmed that readers slowed down considerably when encountering temporal and causal discontinuities. This was not the case for spatial discontinuities. Thus, these results provide some evidence that time and causality are more dominant than space. Interestingly, there were no significant correlations between the time, space, or causality dimensions. The authors suggest that this confirms the orthogonal nature of the dimensions in their particular materials.

Zwaan, Radvansky, Hilliard, and Curiel (1998) examined the extent to which readers monitor the five indices of the event-indexing model during narrative comprehension. The narratives used were coded for situational continuity, and participant reading times were recorded at the sentence and clause levels. Results indicated that reading times increased when temporal, causal, protagonist, and goal discontinuities were encountered. Spatial dis-

continuities did not elicit an increase in reading times. However, when participants were provided with a relevant map before they read the narratives, spatial discontinuities did increase reading times. This pattern of results was interpreted by Zwaan et al. (1998) as providing further evidence for the event-indexing model. Readers concurrently monitored all of the indices of the event-indexing model (with the exception of space).

Interestingly, the beta weights across three experiments (i.e., an indicator of how much reading time variance was accounted for by each dimensional variable) were greatest for time and causal dimensions. Discontinuities related to time and causation (overall) created the largest increases in reading times. Moreover, a significant correlation was obtained between time and causation across all experiments (Experiment 1:  $r = .36, p < .001$ ; Experiments 2 and 3:  $r = .55, p < .001$ ). We argue that this provides stronger evidence that causation is a subcomponent of the time dimension and highlights the importance of the time dimension (i.e., suggests the potential dominance of the time dimension over the other dimensions).

Magliano, Miller, and Zwaan (2001) investigated how various temporal and spatial shifts are understood in film. Participants identified the natural breakpoints of two segments of film by pushing a button. A priori, Magliano et al. identified three different types of film shifts: shifts in time, in movement, and in spatial region. Shifts in time and movement were sufficient to create a change in situation as decided upon by participants. However, shifts in region did not. Furthermore, there were differences in the monitoring levels of participants. Magliano et al. found that monitoring changes in time was more dominant in event understanding than monitoring changes in movement.

Rinck and Hähnel (2002) systematically compared the effects of spatial, intentional, causal, temporal, and emotional inconsistencies to each other. For each dimension, they created texts that contained critical information that was either consistent or inconsistent with information given earlier. Spatial information was related to the location of the protagonist, intentional information to his or her goals, causal information to causally related events in the narrative world, temporal information to the order of events, and emotional information to the feelings of the protagonist. Rinck and Hähnel (2002) found that for each dimension, inconsistent information yielded a reliable increase in reading times of the critical information. The size of this inconsistency effect, however, differed greatly: it was smallest for spatial information, intermediate for intentional and causal information, and largest for temporal and emotional information. However, this pattern has to be interpreted with caution because the different dimensions were assessed with the use of different texts.

Scott-Rich and Taylor (2000) explored the dominance of protagonist, time, and location shifts in narrative text at different levels of processing. They presented participants with narratives that included dimensional shifts (i.e., character, time, or location shifts) and asked readers to rate the cohesion (i.e., how well the sentence fits with the previous sentence), rate the coherence of

the sentence (i.e., how well integrated the narrative is overall), or simply read the sentences (i.e., a measure of on-line processing). Shifts in each dimension produced comprehension difficulties, providing further evidence for the event-indexing model. Protagonist shifts were the most disruptive to comprehension. Furthermore, evidence is presented that the protagonist and spatial indices were more dominant than time. Inspection of Scott-Rich and Taylor's materials provides some insight into the discrepancy between this study and the previously reviewed literature. All of the experimental sentences included shifts of two of the three dimensions being examined. Thus, in their design, it is not possible to isolate the effects of a single shift type. There was also little variability in the type of time statements used (e.g., a day later or a week later).

A stronger experimental test of the event-indexing model was reported by Rinck and Weber (2003). In two experiments, participants read narratives containing target sentences that involved situational shifts. Independently of each other, continuity versus shifting of the protagonist, time, and location dimension were varied. Thus, all possible combinations of the three dimensions were created, from completely continuous to completely discontinuous. Despite these variations, the target sentence was identical in all combinations. In both experiments, reading times of the target sentences increased for protagonist shifts and temporal shifts, whereas the effect of spatial shifts was weak. Moreover, an interaction of protagonist shifts and spatial shifts was found: a shift on one of these dimensions sufficed to yield an increase in reading time that was just as large as the increase for a shift on both dimensions. These results support the processing load predictions of the event-indexing model and extend previous correlational results by experimental evidence.

Therriault, Rinck, and Zwaan (submitted) directly tested the relative contributions of three situational dimensions when constructing situation models: space, time, and protagonist. In their study, participants were instructed to pay close attention to a single situational dimension (e.g., space) and then read a series of passages (always answering comprehension questions about the focus dimension). However, critical sentence-reading times were also analyzed for shifts in dimensions *not* focused on by the instructions (e.g., time shifts), providing information about the monitoring level of nonfocused dimensions. The study attempted to answer the question, when asked to pay attention to only one dimension, at which level do participants monitor the other dimensions? This inductive approach is conservative, in that the true contribution of nonhighlighted dimensions may be underestimated. Results from Therriault et al. (submitted) indicated that time and protagonist were more dominant indices than space, as evidenced by increased reading times for character and temporal shift sentences, even when the reader's attention was focused on another dimension. There was also a slight advantage for time over protagonist—overall, temporal shifts increased reading time more than character shifts.

In summary, the above literature provides converging evidence for the dominance of particular dimensions. Ostensibly, the protagonist and time dimensions are crucial, and this was evident across all experiments in which they were included as factors (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano, & Graesser, 1995; Zwaan et al., 1998; Magliano et al., 2001; Rinck & Hähnel, 2002, 2003; Scott-Rich & Taylor, 2000; Rinck & Weber, 2003; Therriault et al., submitted), with the exception of the work by Scott-Rich and Taylor (2000). Thus it can be argued that these two dimensions are the most dominant of the ones studied so far.

Discontinuities on the intentionality dimension (protagonists' goals) elicited reliable increases in reading times (Zwaan, Langston, & Graesser, 1995; Zwaan et al., 1998). However, both of these studies were correlational in nature. More work is necessary to determine the relative contribution of the intentionality dimension. It is also difficult to understand goals without relying on protagonist information. Thus we concur with Zwaan, Radvansky, and Whitten (2002) that intentionality is probably a second-order dimension. Even if the orthogonal nature of intentionality can be firmly established, there is little evidence that it is as dominant a dimension as time or protagonist.

Discontinuities on the causality dimension also elicited reliable increases in reading time (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano, & Graesser, 1995; Zwaan et al., 1998). The causality dimension has often been portrayed as orthogonal from the time dimension. This seems odd, considering that causality is essentially defined by using events in time. That is, an effect cannot precede its cause. One could argue, based upon the correlations data from the reviewed articles, that the causality dimension is also a second-order dimension, that is, a subset of the larger time dimension. Indeed, Rinck and Hähnel (2003) found that temporal inconsistencies yielded reading time increases even when they were not accompanied by causal inconsistencies. In two experiments, they employed an inconsistency paradigm. The inconsistencies were temporal, in that a sentence was either consistent or inconsistent with the order of two events mentioned earlier. In one condition, these two events were causally related: one was the cause of the other. In the alternative condition, the two events were causally unrelated. For causally related events, the inconsistency effect was significantly larger than for unrelated ones. However, even for the latter, the effect was large and highly significant. Thus, readers seem to monitor temporal relations because these are important in and of themselves. Causal relations, on the other hand, cannot exist independently of temporal ones.

There is further evidence that causality can be explained with the use of time. Thüring, Grobmann, and Wender (1985) conducted an experiment in which subjects were instructed to pay attention to the causal (i.e., causal connections between events) or temporal (i.e., the exact dates between events) relations in a series of experiments. Subjects then read sentences that contained explicit and implicit causal and temporal relations.

An example of Thüring et al.'s (1985) materials is provided here:

Example 1: Temporal, explicit passage

In 1553 Henry VIII married Anne Boleyn from England.

In 1554 she gave birth to a daughter, called Elizabeth I.

So just one year after marriage, there was a successor to the throne.

Example 2: Temporal, implicit passage

In 1553 Henry VIII married Anne Boleyn from England.

She gave birth to a daughter, called Elizabeth I.

So just one year after marriage, there was a successor to the throne.

Example 3: Causal, explicit passage

Near the coast of Scotland the Spanish fleet got into a storm.

Most of the ships sank.

Hence, the position of England as a leading naval power was assured in the period that followed.

Example 4: Causal, implicit passage

(1) Near the coast of Scotland the Spanish fleet got into a storm.

Hence, the position of England as a leading naval power was assured in the period that followed.

To the researchers' surprise, subjects that were instructed to make temporal inferences also made causal inferences when reading the causal texts, although they had not been asked to do so (as indicated by increased reading times on the third sentences). Furthermore, subjects actually did better on verification judgments of sentences that employed implicit causal relations when they received the temporal rather than causal instructions. These results suggest that causality is a subset of a larger understanding of the temporal relations in the text.

Finally, there is only minimal evidence that spatial information is routinely monitored by readers. In the original test of the event-indexing model, Zwaan, Langston, and Graesser (1995) found evidence that readers monitor spatial information in narratives (in a verb clustering task). Scott-Rich and Taylor (2000) also found some evidence that location shifts coupled with other dimensions (i.e., time and characters) increased reading times. However, the majority of the literature suggests that space is not a dominant index of the situation model. Further follow-ups exploring space suggest that readers do not form a spatial mental model when reading normal narratives un-



less explicitly asked to do so or when they are given a map before reading a narrative (Hakala, 1999; Langston et al., 1998; Zwaan & Oostendorp, 1993). We are forced to conclude that space is not a dominant index, but that there may be specific situations when it is conducive to monitor spatial shifts (see also Rinck, in press).

### STUDIES EXPLORING DIMENSION INTERACTIONS

In addition to comparing the relative dominance of situation model dimensions, several studies were designed to investigate possible interactions of dimensions. These experimental studies complement the correlational ones reported originally by Zwaan and his colleagues (1995). One set of experiments (Rinck & Bower, 2000, 2004) employed the map-plus-reading paradigm introduced by Morrow, Bower, and Rinck. Participants first studied the layout of a fictitious research center with rooms and objects located in them, then read narratives taking place within the building. At several points, reading was interrupted by yes-no test probes, which tested the current accessibility of previously learned objects. In Experiment 2 of Rinck and Bower (2000), effects of spatial distance were measured by testing of the accessibility of objects located at differing distances from the protagonist's current location (e.g., 0 or 1 room away). Before presentation of the test probe, however, an intervening episode was inserted in the narrative. Story time distance was manipulated by stating that the intervening episode lasted for either minutes or hours. Discourse time (that is, time spent reading the inserted episode) was manipulated by describing the intervening episode either briefly or at length. Clear effects of story time distance and spatial distance on accessibility were found: objects were more accessible if they were located in the same room as the protagonist, and if the intervening episode was described as short. In contrast, discourse time distance did not affect accessibility at all, demonstrating the negligible role of surface variables compared with situation model variables. These results show that readers use information about both temporal and spatial distance to focus attention on the more important parts of the situation model they create during narrative comprehension. Most importantly for our current question is the fact that the effects of spatial distance and story time distance were perfectly additive.

A similar conclusion was drawn by Rinck and Bower (2004) regarding the possible interaction of spatial distance and goal relevance. In two experiments that also employed the map-plus-reading paradigm, spatial proximity of objects to the current location of the protagonist as well as relevance of these objects to the protagonist's current goal increased the objects' accessibility in memory. These two factors had additive effects on accessibility, so that close, relevant objects were most accessible, and distant, irrelevant objects were least accessible.

The lack of interactions in the above experiments may be due to the fact that accessibility of situation model entities (i.e., objects) was the main dependent variable. This is quite different from other studies, which addressed situational shifts directly. In these studies, evidence for interactions was repeatedly found. First, Rinck and Weber (2003) observed an interaction of protagonist shifts and spatial shifts: a shift on one of these dimensions sufficed to yield an increase in reading time that was just as large as the increase for a shift on both dimensions. They explained this observation by pointing out that the different combinations are not equally plausible: Although a protagonist shift and a spatial shift together involve more situational updating than single shifts, this situation is highly plausible because it involves a second character in a second location. In contrast, the single shifts involve unexplained protagonist movements: There is either a sudden new protagonist in the known location (protagonist shift only), or the known protagonist is suddenly appearing in a new location (spatial shift only). These implicit changes require inferences that take additional time, just as the double shift takes time for updating (see Rinck & Weber, 2003). This result was replicated in Experiment 2 of Therriault et al. (submitted). Moreover, both studies also showed a three-way interaction of protagonist, time, and space shifts. This interaction was due to the fact that any single situational shift caused a large increase in reading time compared with the fully continuous baseline condition. A second or third additional shift caused only smaller increases. Moreover, the correlational study by Magliano et al. (2001) yielded evidence for interactions, too: some combinations of shifts were much more frequent in existing movies than other combinations. One has to keep in mind, however, that the assumption of independent dimensions inherent in the event-indexing model was made mainly for theoretical parsimony, because the early correlational studies had not yielded evidence for interactions. Now that this evidence is available, it should be accounted for. One way to do this would be to incorporate indices of frequency and/or plausibility for each combination of shifts, such that frequent and highly plausible combinations would yield smaller or even no increases in processing load.

### ARE ADDITIONAL DIMENSIONS NECESSARY?

The event-indexing model specifies a core set of dimensions that readers monitor. It is important to evaluate if the model has captured the fundamental set of necessary dimensions. Thus far, the review of dimensional dominance suggests that space is not fundamental, at least in normal, narrative reading (although there are specific situations where the monitoring of the spatial situation can be easily demonstrated). Another proposed vital dimension of the situation model is the causality dimension (Trabasso & Sperry, 1985). However, we have argued, based upon the correlations data from the reviewed ar-

ticles, that the causality dimension is a subset of the larger time dimension. If one is willing to entertain our arguments, the set of core dimensions in the event-indexing model has been reduced to protagonist, time, and possibly intentionality. However, it is important to consider whether there are other dimensions, previously unspecified, that warrant inclusion in the model.

Emotion is one potential candidate. The discourse literature provides ample evidence that readers can activate knowledge related to fictional characters' emotional states (de Vega, Diaz, & León, 1997; de Vega, León, & Diaz, 1996; Gernsbacher, Goldsmith, & Robertson, 1992; Gernsbacher & Robertson, 1992; Gernsbacher, Hallada, & Robertson, 1998; Gygas, Oakhill, & Garnham, 2003; Rapp, Gerrig, & Prentice, 2001). In a typical experiment of this sort, participants read emotion words that match or mismatch the context created by a narrative passage. Emotion words that do not match the context of the narrative consistently increase reading times. However, there is some debate about the specificity with which readers can predict particular emotions from context (see Gygas et al., 2003; Rapp et al., 2001).

It is interesting to note the different approaches researchers have taken in attempts to incorporate emotion into the event-indexing model. For example, Gernsbacher (1995) links readers' abilities to activate emotional information with the intentionality dimension of the event-indexing model. Consider the following passage taken from Gernsbacher et al. (1992):

Paul had always wanted his brother, Luke, to be good in baseball. So Paul had been coaching Luke after school for almost 2 years. In the beginning, Luke's skills were very rough. But after hours and hours of coaching, Paul could see great improvement. In fact, the improvement had been so great that at the end of the season, at the Little League Awards Banquet, Luke's name was called out to receive the Most Valuable Player Award.

Gernsbacher (1995) argues that readers would store the goal information that Paul wants Luke to excel at baseball. It is the achievement or failure of this goal that readers would then use to gauge emotionality. Positive outcomes should lead readers to attribute positive emotions to Paul's character, and inconsistent outcomes should lead readers to attribute negative emotions to Paul's character.

Another approach to explaining emotional traits has been offered by Rapp et al. (2001). They suggest that readers use specific information from the protagonist dimension (i.e., character dispositions and traits) to evaluate story outcomes and make inferences regarding the states of characters. Consider the following example taken from Rapp et al. (2001):

Peter was looking forward to the first day of the new semester. He was interested in seeing who his new professors would be. His first class was held in a lecture hall. He was well prepared for taking notes. Peter brought a new package of pens with him to class. A student sitting next to him asked to borrow a pen, and Peter said, "Take two."

Rapp et al. (2001) argue that the example paragraph would lead readers to infer that Peter is generous. Rapp et al. (2001) posit a link between such dispositional attributes (e.g., generosity) and the causal dimension of the event-indexing model. More specifically, they argue that readers focus upon dispositional, trait information (often emotional) and apply it to causal structures (i.e., whether Peter donates or not to a charity mentioned later in the passage).

An important theme in both Gernsbacher et al. (1998) and Rapp et al. (2001) is the second-order nature of the emotionality dimension. Ostensibly, emotions are tied to goals and protagonist traits. We would argue that emotional content derived from discourse is a by-product (an important one, to be sure) of interactions between dimensions. For example, Gernsbacher et al. (1998) argue that emotional states are discerned from the outcome of goals (intentionality), and Rapp et al. (2001) argue that emotional trait information is gleaned from the protagonist dimension and then applied (causally).

Another approach to studying emotion in discourse has been to view it as a type of mental perspective taking (de Vega et al., 1996, 1997). According to de Vega et al. (1997), literature often exploits the dissociation between protagonists' incorrect beliefs and the readers' privileged knowledge to create tension. Consider de Vega et al.'s (1997) example, Shakespeare's *Romeo and Juliet*, in which the patron knows that Juliet simulates her death but Romeo does not. In such a case, readers would need to keep two conflicting interpretations of the story world, namely their own and that of the protagonist, Romeo.

It will be challenging to find evidence for an independent emotional dimension given the research suggesting its reliance on more fundamental dimensions. Consequently, we would not promote including emotion as a new dimension. However, we are excited by the prospect of exploring emotion within the context of mental perspective taking. It follows, then, that another possible addition to the event-indexing model is perspective taking. We would posit that there are two main types: objective and mental. Objective perspective taking would entail the various *simulated* physical (perceptual) ways in which a reader could experience the described story world. For example, readers might be contemplating the process of scanning a horizon (Zwaan 1999a,b). In contrast, mental perspective taking would be the simulation of the more abstract beliefs, values, and emotions associated with described characters in the story world. Recently, perspective has been proposed as a fundamental tool for helping readers to organize information from a text (MacWhinney, in press; Zwaan, 2004).

It is beyond the scope of this chapter to review the extensive literature on objective perspective taking that exists in pragmatics and rhetoric (e.g., see Duchan, Bruder, & Hewitt, 1995). We would like to point out, however, that there is empirical evidence supporting objective perspective taking. For example, Spivey and Geng (2000) have demonstrated that when listening to stories, participants can adopt particular visual orientations/perspectives (i.e., participants will make eye movements that mimic directionality described in

the story world—looking up and down at absent objects). Furthermore, Zwaan and Stanfield (2001) and Zwaan, Stanfield, and Yaxley (2002) have shown that participants are sensitive to the verbally implied orientation and shape of objects.

Givón (1992) proposed that mental perspective taking is an integral part of communication. In mental perspective taking, the speaker must keep track of not only his own knowledge, but the listener's knowledge of the topic under discussion. A logical extension of this relates to discourse. One could argue that one prerequisite of comprehension is that readers keep track of their knowledge of the story world (privileged knowledge) coupled with various mental states of characters described in the story. More research is needed to explore this claim, but perspective appears to be a potential candidate for inclusion in the event-indexing model. One topic on the agenda of this research will be to determine whether objective perspective is a more fundamental situation model dimension than space. Obviously, objective perspective depends on spatial relations, and given the weak evidence for the importance of the spatial dimension, it will take extra effort to establish the role of perspective. Another topic will be to explore the relation of mental perspective and the protagonist dimension. Similar to the second-order nature of emotions, mental perspective may turn out to be dependent on the more fundamental protagonist dimension.

## CONCLUSIONS

Our review of the literature suggests that the event-indexing model has become a useful tool in the exploration of multidimensional situation models. Evidence strongly suggests that readers encapsulate event information during comprehension. There are differences, however, in the nature of the dominance of certain dimensions. Comparable results in correlational and experimental studies indicate that time and protagonist dimensions are always monitored. Readers are sensitive to time because this dimension provides critical duration, order, progression, and causal information about how events unfold. Readers are sensitive to protagonists because this dimension conveys information related to the objects and entities that make up events—including traits, emotions, and possibly goal and perspective information.

We also put forward the argument that intentionality (goals) and causality are second-order dimensions and as such should not be considered separate dimensions in the model. Goals cannot be defined without resorting to protagonist identity, trait, and disposition information. Similarly, causation cannot be understood without reference to time. The strength of causal relationships is often based on the amount of time between a cause and its potential effect. Moreover, temporal relations between events are monitored by readers even when there is no obvious causal relation between the events.

Several experimental studies provide evidence for dimensional interactions. For example, shifts in single dimensions caused the largest increases in reading time compared with fully continuous conditions. Increasing the number of dimensional shifts further caused only slightly smaller increases in reading times. More research will be necessary to explore the nature of these interactions, but one potential direction would be to document the plausibility for each shift combination and its frequency in natural text.

Two additions to the event-indexing model were considered. Evidence was presented suggesting that readers can monitor emotional and perspective information when constructing situation models. However, emotion can be classified as a second-order dimension (because emotions are a by-product of protagonist information). More work is necessary to gauge perspective, but it too may have its base in protagonist relations (i.e., mental perspective) and spatial relations (i.e., objective perspective).

In this chapter we attempted to identify how important the individual dimensions of multidimensional situation models are in general. It should be noted, however, that the importance may depend on a number of factors that modify dominance and interactions. For example, differences in individual abilities such as visuospatial working memory or imagery ability may turn out to be crucial. Individual differences might also explain why the evidence in favor of the spatial dimension is rather weak: if spatial dimensions are spontaneously monitored only by readers with high visuospatial abilities, mixed results are to be expected (see Dutke & Rinck, submitted). So far, research on the role of situation models in text comprehension has often ignored individual differences. Consequently, there is much work left for the future.

Finally, the scope of the event-indexing model (and others) is currently limited to the comprehension of narrative text. It will be an interesting challenge to develop and test comparable models of expository text comprehension. So far, research efforts on narrative comprehension versus expository text comprehension have not had much theoretical overlap (but see Otero, Leon, & Graesser, 2002). This is unfortunate because in both cases, deep comprehension involves the creation of multidimensional situation models (often called "mental models" in research on expository text). Thus, a truly general theory of text comprehension should address both types of text. If one wishes to extend the event-indexing model in this direction, at least two questions will have to be answered. First, what is the expository equivalent of a narrative event? Maybe this could be an idea or an argument. Second, which dimensions are critical to the comprehension of expository text? Naturally, protagonist information including emotions, goals, and intentions will not be relevant in this area. However, temporal and causal relations should be as important as they are for narrative comprehension, and spatial information may be important, depending on the particular contents of the text (e.g., assembly instructions, route directions). Answering these questions will be an interesting and fruitful task for researchers interested in general aspects of comprehension.

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