

Deictic Centers and the Cognitive Structure of Narrative Comprehension

William J. Rapaport,
Erwin M. Segal, Stuart C. Shapiro,
David A. Zubin, Gail A. Bruder, Judith Felson Duchan,
Michael J. Almeida, Joyce H. Daniels, Mary Galbraith,
Janyce M. Wiebe, & Albert Hanyong Yuhan

Center for Cognitive Science
State University of New York at Buffalo, Buffalo, NY 14260

Email for contact: rapaport@cse.buffalo.edu
<http://wings.buffalo.edu/cogsci/>

26 May 1994

Abstract

This paper discusses the theoretical background and some of the results of an interdisciplinary, cognitive-science research project on the comprehension of narrative text. The unifying theme of our work has been the notion of a deictic center: a mental model of spatial, temporal, and character information contributed by the reader of the narrative and used by the reader in understanding the narrative. We examine the deictic center in the light of our investigations from the viewpoints of linguistics, cognitive psychology, individual differences (language pathology), literary theory of narrative, and artificial intelligence.

This document is a very slightly updated version of *Technical Report 89-01* (SUNY Buffalo Department of Computer Science).

1 Narrative and the Problem of Comprehension

Narrative . . . is a "primary and irreducible form of human comprehension."
(Landau 1984: 262, citing Mink 1978: 132.)

The study of the mechanisms, structures, and processes involved in the comprehension of text has involved the talents of philosophers, linguists, computer scientists, psychologists, neuroscientists, literary theorists, and researchers in language pathology to a greater and greater degree over the last quarter-century (e.g.: Quine 1960; Chomsky 1965; Lenneberg 1967; Minsky 1968; Bobrow & Collins 1975; Gunderson 1975; Iser 1978; Halle, Bresnan, & Miller 1978; Joshi, Webber, & Sag 1981; Norman 1981; Maida & Shapiro 1982; Opler & Menn 1982; Barwise & Perry 1983; Johnson-Laird 1983; Greenspan & Segal 1984). An important distinction that has emerged among researchers is whether or not text comprehension is considered to involve *constructive* processes over and above the interpretation of the expressed text (Bransford, Barclay, & Franks 1972). One reason that comprehension is such an interesting problem is that what a cognitive agent understands often includes much that is not expressed. This is particularly obvious in narrative text. The comprehender (reader or listener) infers from the text many unexpressed properties and relations of events, people, and objects. What are the characteristics of a text that support the inference of these relationships? What are the mechanisms of the comprehender that perform the task? And what does the comprehender have to know in order to make the appropriate inferences?

This paper discusses some of the theoretical background and some of the results of an interdisciplinary, cognitive-science research project on the comprehension of narrative text. The unifying theme of our joint work

has been the notion of a deictic center—roughly, a mental model of spatial, temporal, and character information contributed by the comprehender of the narrative and used by the comprehender in understanding the narrative. We shall first present the theoretical background of this theory; in subsequent sections, we examine the deictic center in the light of our investigations from the viewpoints of linguistics, cognitive psychology, the study of individual differences, literary theory of narrative, and artificial intelligence. (A more complete survey of our work is in Duchan, Bruder, & Hewitt 1995.)

Let us begin with an example from a narrative, John Steinbeck's novel *The Pearl*:

The dawn came quickly now, a wash, a glow, a lightness, and then an explosion of fire as the sun arose out of the Gulf. Kino looked down to cover his eyes from the glare. He could hear the pat of the corncakes in the house and the rich smell of them on the cooking plate. The ants were busy on the ground, big black ones with shiny bodies, and little dusty quick ants. Kino watched with the detachment of God while a dusty ant frantically tried to escape the sand trap an ant lion had dug for him. A thin, timid dog came close and, at a soft word from Kino, curled up, arranged its tail neatly over its feet, and laid its chin delicately on the pile. (Steinbeck 1945: 3–4.)

The paragraph is easy to understand; one can paraphrase it without difficulty. But it is not clear why we understand it so easily. Why did the dawn “come”? To where did it come? To where did the dog come? How do you know? Why use the deictic term ‘come’ at all? Where are the ants? Did Kino have to look at them in order for the reader to know where they are? These questions can be answered by assuming that, as a reader reads a narrative, she assumes a particular perspective in the world of the story told by the narrative.

2 The Deictic Center

The term ‘deixis’ (which comes from a Greek word meaning “pointing” or “indicating”) is now used in linguistics to refer to the function of personal and demonstrative pronouns, of tense and of a variety of other grammatical and lexical features which relate utterances to the spatio-temporal co-ordinates of the act of utterance. (Lyons 1977: 636.)

Then he went *there*. (O'Connor 1949: 82.)

Deictic terms include ‘come’ and ‘go’, ‘now’ and ‘then’, and ‘I’ and ‘you’. When these words are used in face-to-face dialogues, their meanings depend, as Lyons says, on “the spatio-temporal co-ordinates of the act of utterance.” These co-ordinates originate at a point we call the *deictic center* (DC), consisting of the “origin” of place (‘come’ and ‘go’), time (‘now’ and ‘then’), and person (‘I’ and ‘you’) (cf. Bühler 1934, Fillmore 1975, Traugott 1978). We call the “origin” of place the *WHERE*, the “origin” of time the *WHEN*, and the “origin” of person the *WHO*.

Interestingly, deictic terms occur in third-person narratives, even though, strictly speaking, there is no relevant “act of utterance”. They are not understood in terms of a speaker and an addressee. The “here” and “now” of the story do not derive from the spatio-temporal co-ordinates of the author at the time of writing, nor of the reader at the time of reading (cf. Hamburger 1973, Banfield 1982). Instead, there is a *narrative DC* consisting of a narrative *WHO*, a narrative *WHEN*, and a narrative *WHERE*, which the reader must keep track of, if deictic terms are to be understood properly.

The reader's construction and modification of the DC is important for understanding a narrative. The DC is in the reader's mind; it is the reader's contribution to understanding the narrative. The events that carry the temporal and spatial core of the narrative are linguistically and conceptually constrained according to certain principles that can be relatively well defined. A narrative obviously unfolds linguistically one word, or one sentence, at a time. We suggest that cognitively a narrative usually unfolds one place and time at a time. That region functions as the moving DC of the narrative. It becomes the “here” and “now” of the reader's “mind's eye” in the world of the story. It moves temporally and spatially as the center of activity advances and shifts. The DC also includes the perspective from which the events are described—the “I” changes as the perspective shifts from character to character.

We see the DC as the locus in conceptual space-time of the objects and events depicted or described by the sentences currently being perceived. At any point in the narrative, the reader's attention is focused on particular characters (and other objects) standing in particular spatial and temporal relations to each other. Moreover, the reader “looks” at the narrative from the perspective of a particular character, temporal location, or spatial location—the *WHO*, *WHEN*, and *WHERE*. The DC is an appropriate and useful data structure for representing and integrating the information in narrative and is thus a useful construct for studying how local sentence interpretation is integrated into more global comprehension of narrative text. Because the events that take place within the DC occur in the “presence”

of the reader, they are generally focused or foregrounded. Our handling of the foreground-background distinction is a cognitive-pragmatic one rather than a strictly syntactic or semantic one (Hopper 1979). Our theory predicts that (1) the objects and events in the DC are relatively active cognitively (they can be referred to much more easily pronominally than can objects outside of it), (2) certain aspects of the DC may be implied by the text and therefore eliminable from it (as in ellipsis), and (3) the interpretation of terms and phrases will be constrained by the DC (such local constraints on the selection of terms and on their interpretation have been explored in discourse by Grosz (1981)).

2.1 The WHERE

The place in the world of the story from which the reader “perceives” the objects and events described in the narrative serves as “here” to the reader for the purpose of comprehending deictic references. The narrative “here” functions in roughly the same way that the “here” of the real world does when a person engages in everyday conversation. For this reason, in the passage quoted in §1, Steinbeck could use the term ‘come’ without specifying to where the dawn and the dog came. In this case, the narrative “here” is identified as the location of Kino, the major character. This location contains one person, one dog, two species of ants, and a single house nearby. A reader who did not have this limited perspective would not be able to comprehend the ellipses and definite determiners that pervade the passage.

As a narrative progresses, the story may move from one location to another: the WHERE may shift. One linguistic device that identifies the WHERE and contributes to its movement is the use of the term ‘come’. In most cases, if ‘come’ is followed by a locative prepositional phrase, the object of the preposition identifies the new WHERE. A shift in the WHERE results in changes in the area to which entities come, the use of definite determiners, and the referents of pronouns. All are redefined to fit the new reference space. The WHERE serves the important function of constraining the domain of reference of the sentences to a particular locale in the world of the narrative. (For details, see §4.3, below, and Yuhan 1991, Yuhan & Shapiro 1995.)

2.2 The WHEN

In addition to the WHERE, there is also a WHEN, identifying the narrative “now”. The concept of a narrative “now” has been around for relatively longer than the narrative “here”. Writers have for some time spoken of reader’s time, narrator’s time, and story time, the latter often being identified as a narrative “now”. According to some literary theory, within the narrative “now” one can establish the moment within which a particular event occurs (cf. Chatman 1978). The WHEN constrains the relative time of the events referred to by the sentences.

Most narrative texts are written primarily in the past tense. The same tense is used from the beginning of the narrative to the end. In spite of this, time advances throughout the narrative. There is a general principle of dynamic inertia (see §5.1.3, below): Events that are described later in the text occur after those that are described earlier, unless some linguistic device informs us otherwise. The tense of the narrative is independent of whether the narrative purports to be fact or fiction, and is also independent of the narrative’s reference time: it might refer to prehistoric times or to an imagined distant future. Past tense in a narrative is not necessarily a signal of a past event.

Except where temporal relations among events are explicitly expressed, by the use of such terms as ‘before’ and ‘after’ or verb tenses such as past perfect or future perfect, the temporal relations among the events in a narrative are not coded semantically or morphologically. Since temporal relations between events are not always expressed, the reader needs a mechanism for deriving them. She takes the perspective of the point in time in the narrative that corresponds to the time of the events currently being read about: “Everything which comes before the now-point is in the past (in the world of the story) and everything that comes after the now-point is in the future from the perspective of that moment of the story” (Almeida & Shapiro 1983). (For further details, see §4.2, below, and Almeida 1987, 1995.)

2.3 The WHO

What are the psychological entities in a narrative? How are human or personified entities represented, and how does their representation affect narrative comprehension? We suggest that readers recognize four types of psychological entities in a narrative—the focal WHO, non-focal characters, the focalizing WHO, and the narrating WHO—which differ according to the way the DC is constructed and manipulated, and whether or not it provides a subjective perspective through which the reader understands the narrative.

2.3.1 The Focal WHO

The *focal WHO* is a psychological entity who “captures” the DC, as indicated by the way the subsequent context tracks the spatial, temporal, and psychological coordinates of that character. The reader may or may not be given information about the character’s internal states such as feelings, thoughts, and judgments. George is the focal WHO in the following example:

- (1) George watched an old woman crossing the street. Then he watched some birds landing on the roof of the bank.

2.3.2 Non-Focal Characters

A *non-focal character* is a psychological entity who is mentioned, but to whom the DC is not shifted. In narrative passage (1), above, the mention of the psychological entity “old woman” does not shift the focal WHO. The reader is not given access to the subjective world of non-focal characters.

2.3.3 The Focalizing WHO

The *focalizing WHO* is a subjective epistemological perspective expressed in terms of a character’s own “living” of events. This “living” may be perceptual, cognitive, or kinesthetic: the text may represent thoughts, feelings, sounds, sights, or unconscious desires as lived by the focalizing WHO.

Whereas the focal WHO is the psychological entity who is topicalized by the text, the focalizing WHO is a psychological entity whose experiential process topicalizes other entities and events in the story world. When a character reflects on his or her own experience as s/he is living it, the focal WHO and the focalizing WHO are co-referential.

Not all narrative texts contain a focalizing WHO. There is a focalizing WHO only when events in the narrative are being presented as mediated by a character’s experience. In this case, the reader must construct and maintain a mediating subjective perspective (the focalizing WHO) until signs of objective narration signal that the mediating perspective is no longer operative. In the following narrative passage,

- (2) George watched an old woman crossing the street. Why was she striding so purposefully, looking neither to left or right?

George is the focal WHO of the first sentence and the focalizing WHO of the second. The old woman is the focal WHO of the second sentence, embedded within the focalizing WHO of George.

The focalizing WHO is to be distinguished from objective narration, in which the reader need not construct any mediating subjective perspective. In objective narration, the story world is presented declaratively—things and events exist by virtue of having been declared to exist.

2.3.4 The Narrating WHO

The focalizing WHO must also be distinguished from the *narrating WHO*. Whereas the focalizing WHO is a character, not a teller of the story—an experiencing self rather than a reporting self—the narrating WHO is a psychological entity who tells a story from a different epistemological level than that of the story itself. This different level may be constituted by time (retrospective narration) or ontology (the narrator’s existence is not in the same realm as the story). Like focalizing WHOs, narrating WHOs require the reader to construct a mediating perspective, though we believe that the structure of this kind of mediation is different from that of the focalizing WHO. Not all narratives have a narrating WHO.

A narrating WHO’s actions are restricted to the actions of narrating or writing. A narrator may have the same identity as a character in the story, but, linguistically, the narrator has different characteristics from the character. For example, in “I remember when I was a child, I liked to roller-skate”, the “I” who remembers is logically the same “I” as the child who likes to roller-skate, but epistemologically they are not the same. The present tense “belongs” to the narrator, the past to the child.

With regard to focal and focalizing WHO and non-focal characters, we have generated some rules of evidence and some description of the relations between the WHO, WHEN, and WHERE (see §5, below). With regard to the focalizing WHO, we have studied markers that signal a switch from objective narration to focalizing WHO and from focalizing WHO to objective narration (Wiebe & Rapaport 1988; Wiebe 1990, 1991, 1994). (For further discussion of

the notions of “point of view”, “focalization”, “subjectivity in narrative”, “narrative style”, and “narrative logic”, cf. Benveniste 1970, Hamburger 1973, Kuroda 1973, Uspensky 1973, Fowler 1977, Chatman 1978, Cohn 1978, Genette 1980, Bakhtin 1981, Banfield 1982, Bal 1985, Li & Zubin 1995.)

3 Narrative Comprehension and the Deictic Center

In this paper, we specify in detail some DC devices that provide contextual cues allowing the comprehender to relate the information given in each successive sentence to the narrative as a whole. This is one task of the DC. That is, information conveyed by sentences is related to the overall gist of the narrative by construction and dynamic modification of successive DCs that identify and locate characters in narrative time and space. Other tasks of the DC include foregrounding, referencing, building narrative structure, inferring temporal relations, inferring spatial relations, and determining lexical usage. In order to describe the role of the DC in narrative comprehension, it is important to consider what knowledge is mentally represented by the reader as she reads a story, and how that knowledge is extracted from the sentences.

Let us begin by elaborating upon two aspects of the mental representation of narrative (or of any other complex configuration of information that is comprehended and remembered). One such aspect is the structure of the mental representation of information, that is, the nature and interrelationships of the units of information in the reader’s mind. The other is the processes used by the reader during comprehension to understand the narrative and form the memorial representation.

3.1 The Structure of the Mental Representation of Narrative

The mental model developed in our research should be understood as the reader’s construction of the story from the narrative text, based, among other things, on the information in the DC. *It is, thus, the reader’s theory of the story that is being told through the narrative text.* This memorial construction, or mental model, or theory, is very much like Kamp’s (1984) discourse representation structures (DRS) or Webber’s (1987) event/situation structure (ESS). (We discuss it at greater length in §4, below; cf. Rapaport 1988, 1991; Nakhimovsky & Rapaport 1988; Shapiro & Rapaport 1995, Rapaport & Shapiro 1995 for further discussion.)

3.2 Narrative Comprehension: Interaction of Process and Structure

A number of researchers have described cycles of processing in which propositions in a buffer (e.g., a DRS) are related to propositions in incoming sentences (Kintsch & Van Dijk 1978; Shapiro 1982; Kamp 1984; Wiebe & Rapaport 1986; Rapaport 1988, 1991; Shapiro & Rapaport 1995; Rapaport & Shapiro 1995). The conceptualization of a cycle of processing—processes operating on sentences and building representations of the information, which are then used for further processing—is a useful approach. We conceive of such a cycle as primarily using currently active components of the representations and integrating them with incoming information to build a new representation. One type of cycle applies to the interpretation of incoming sentences; the result of each such cycle is a representation of events depicted in the sentences. Another type of cycle with different types of processes would be involved in building and modifying the representation of the unfolding episode. A less frequently occurring, but additional, cycle would add to or change the overall story representation.

Kintsch and Van Dijk used propositions as their basic unit of information. We suggest some further categorization of types of information in the representation of simple events. These representations should include information about the temporal and spatial location of events and the cognitive agents involved in the events. But this information is not continuously repeated with each sentence. Indeed, narratives can go on for paragraphs without direct mention of the spatial or temporal location of events, or of which characters are aware of the events. How, then, is that information accessible for integration with the event information obtained from local, on-line processing of sentences?

Various global structures have been proposed to account for this, such as frames (Minsky 1975), scripts and MOPs (Schank & Abelson 1977, Schank 1982), and story grammars (Rumelhart 1975, Mandler & Johnson 1977). But none of these have dealt in detail with the dynamic interplay of contextual and sentential cues as a comprehender progresses through the narrative. How does a comprehender determine from the text which events end with an episode, which characters are involved or evoked in an episode, and where the characters are located in relation to one another?

Researchers have begun to take a dynamic approach in studying how context-related constructive processes work. For instance, the work of Polanyi and Scha (1984) is concerned with the overall structure of discourse and narrative—the cues that signal shifts in topic or episode—as is the work of Grosz (1981) and Reichman (1985).

The DC is a dynamic data structure that mediates between global contextual information and local sentential information. It is an active and, thus, accessible part of the reader’s mental representation of the narrative that facilitates ongoing integration and incorporation of local information into the global model of the narrative. Thus, the DC provides a means for constant updating and revision of the global structure in light of local information and constraints. It is the missing link between the bottom-up approaches of local *cohesion* theories (e.g., Halliday & Hasan 1976) and the top-down approaches of global *coherence* theories.

3.3 Some Specific Uses of the Deictic Center

The DC is used by the reader to make inferences from ellipses, about references of anaphora, about temporal sequencing, and about reference frames for events. The DC is constructed or modified by the reader using information from current sentences. The DC is maintained unless there is specific information that it should be modified, and it is modified when specific linguistic devices or other information signal the reader to do so.

An additional role of the DC is its use by the reader to establish the scope of knowledge about ongoing events. It provides the reader with information about which characters within the story share event information with the reader and with each other. This is done both directly and through inference.

By “direct”, we mean that the reader knows that a character knows something because that knowledge is explicitly mentioned to the reader in the text. If the text states that character *C* figures out that event *E* occurred, we take that to mean that the reader has direct knowledge that *C* knows that *E* occurred. Obviously, if *C* is the agent or object (patient, experiencer) of an action, the reader attributes knowledge of the event to the character.

But the DC plays its most interesting role when the reader must *infer* that *C* knows that *E* occurred. If the character is the focalizing WHO, from whose perspective the events are described, the reader infers that the character knows that the event occurred. Therefore, even when the character is not mentioned in the sentences describing the event (neither by name, description, nor pronominal reference), the reader may infer that the character has knowledge of the event (Wiebe & Rapaport 1988; Wiebe 1990, 1991, 1994).

Even if a character is not the focalizing WHO, the DC may still provide the reader with a basis for inferring that the character has knowledge of an event. If characters are in the same spatio-temporal location as the event, the reader may infer that they have knowledge of the event. The current DC provides information about the spatial and temporal location of a current event when this information is not explicitly mentioned in text. And prior DCs provide information about the spatial and temporal locations of characters in previous events. Therefore, mental representations of episodes include the spatial and temporal locations of characters during events and can be used to make inferences about the scope of current event knowledge.

But what does it mean for a character to be in the DC or to share some aspects of the DC in which the event is occurring? The DC can be viewed as a constituent of the conceptual representation of the story the reader has constructed so far. Perhaps we can describe the DC as a spotlight on certain aspects of that representation; the breadth and shape of the beam of light defines the DC. The DC is an intermediary data structure: it is more global than individual bits of information about WHO, WHEN, and WHERE, but more local than a full description of the story world.

4 Computational Models of the Deictic Center

We now turn to a description of the separate components of our project, beginning with a discussion of the computational implementation that uses the SNePS semantic-network processing system: an intensional, propositional system for knowledge representation and reasoning (Shapiro 1979; Shapiro & Rapaport 1987, 1991, 1992, 1995).

In earlier work, we have used SNePS as a belief-representation system (Maida & Shapiro 1982; Rapaport & Shapiro 1984; Rapaport 1984, 1986). When used in this way, the system models the mind of a cognitive agent—“Cassie” (Cognitive Agent of the SNePS System, an *Intelligent Entity*)—who has beliefs about various objects (cf. Rapaport 1988). We are extending Cassie to model the comprehender of a narrative text. Cassie needs to be able to represent and reason about such things as spatial and temporal relations among objects and events, identification of

the WHO, and the relations between characters' beliefs and the story world. The SNePS/Cassie system operates as follows:

1. Initially, Cassie is provided with beliefs about the representation and functioning of spatial and temporal information (together with whatever background “world knowledge” is needed for the specific text being read).
2. Cassie reads and interprets the first sentence of the narrative. The sentence is parsed by a generalized ATN parsing and generating grammar that builds a SNePS semantic-network representation (Shapiro 1982). This representation is determined by the sentence along with Cassie's initial knowledge. The representation includes a DC data structure containing the current WHO, WHEN, and WHERE (with default values if necessary). It is this representation that corresponds to Kamp's DRS or Webber's ESS.
3. Cassie continues to read and interpret the succeeding sentences of the narrative. Each succeeding sentence's representation is determined by:
 - (a) the current sentence
 - (b) Cassie's current state of mind, including:
 - (i) her initial knowledge
 - (ii) the representations built as a result of processing the previous sentences
 - (iii) the current DC

As a result, Cassie's state of mind will change; in particular, the DC may be updated. Independent DCs will be created if the narrative does not proceed linearly. For instance, two DCs might be needed if the narrative switches back and forth between two scenes.

Some general principles about the behavior of the DC inform our research:

- Typically, Cassie will update the DC on the basis of linguistic or other cues indicating that it should be changed or maintained.
- The DC can be thought of as a “window” on a currently active fragment of Cassie's memory. This window is “moved along” by changes in the WHO, WHEN, or WHERE. Thus, we have a notion of *activation*: Parts of Cassie's memory outside the scope of the active window should be less accessible, but can be activated if needed for interpretation.
- The WHEN and WHERE can often be identified in terms of the WHO. On the other hand, Cassie may often determine the WHO by consulting the other DC components. For instance, if the focal WHO moves to a new location (but is maintained), the WHEN and the WHERE will also shift. Conversely, if the WHEN and WHERE shift, the focal WHO is assumed to have moved along with them, unless there are explicit cues to the contrary. (This is discussed in more detail in §5, below.)

4.1 Belief Representation and the WHO

Cassie's knowledge base—her “mind”—contains information about the real world, the text, and the story world, including such cognitive agents as the narrator (if any) and the characters.

In particular, it contains information about the narrator's and characters' beliefs, and Cassie is able to reason about them. Although our research has been primarily concerned with written or oral narrative, an example from cinema may be apt: in the film *Desperately Seeking Susan*, two characters talk about Susan; unknown to them, but known to the audience, each is talking about a different person (only one of whom is really Susan), yet each believes that they are talking about the same person. In order for Cassie to understand such a situation, she must be able to represent who Susan “really” is (i.e., the person whom the audience believes to be the real Susan) as well as the beliefs of these two characters about the identity of Susan. Such a knowledge base constitutes *Cassie's beliefs* about these characters and about their beliefs. Moreover, each character in a narrative is also a cognitive agent, and may have beliefs about the beliefs of (some of) the others. Cassie is able to represent (i.e., have beliefs about) such *nested beliefs* and to reason about them (cf. Chalupsky 1993).

Cassie is also sensitive to the *intensionality of belief*, which puts constraints on SNePS/Cassie's inference mechanism. For instance, given Cassie's beliefs that a character *C* believes some proposition *p* and that *p* is logically

equivalent to another proposition q , Cassie should not automatically infer that C believes q , in the absence of further information. On the other hand, in ordinary circumstances, people often do draw such inferences. Insofar as Cassie is to be a model of a (human) cognitive agent, she would also need to be able to draw such inferences, yet be able to *correct* or *revise* her beliefs in the light of further information.

Cognitive agents can have inconsistent beliefs. To use the classic example, Cassie (or a character in a narrative) might believe both that the Evening Star is a planet and that the Morning Star is not a planet, even though the Morning Star *is* the Evening Star. This can happen as long as Cassie (or the character) does not believe that the Morning Star is the Evening Star. In this case, Cassie's (or the character's) knowledge base contains *two* items, one for the Morning Star, one for the Evening Star (i.e., her "mind" contains two intentional entities). Such items are *intensional objects*, and SNePS/Cassie is able to deal with them (cf. Rapaport 1986, Shapiro & Rapaport 1991).

Of special relevance to the concept of a DC, Cassie is sensitive to the *indexicality* of certain beliefs, in particular, to the phenomenon of *quasi-indexicality* (Castañeda 1966, 1967). This feature is at the core of *self-referential* beliefs—i.e., beliefs about oneself—and their expression by others. Thus, the belief that some character C would express by "I am rich" must be reported by someone else thus: " C believes that he^* is rich"; it clearly should not be reported as " C believes that I am rich". The starred occurrence of 'he' is called a "quasi-indicator".

Quasi-indexicality is a feature that pervades all deictic phenomena; this makes it a crucial aspect of the language of narrative (cf. Brecht 1974, Banfield 1982). Suppose that Cassie believes that character C performs action A at the DC's WHEN and WHERE. Cassie's representations of these are *not* "full" demonstratives representing Cassie's actual "here" and "now". Rather, they are *quasi-indexicals* used by Cassie to depict the *narrative's* "here" and "now". Our belief-representation system was developed precisely in order to be able to handle quasi-indexical self-reference. The techniques used for this can be generalized to handle these other cases of quasi-indexical (or "shifted") reference.

Cassie is able to distinguish between *de dicto* and *de re* belief reports. The former express or communicate the actual propositional content of the agent's belief (cf. Castañeda 1970: 167ff); the latter report the belief in terms known to the speaker/listener/reader, but not necessarily to the believer. The representation of this distinction involves the construction of separate "belief spaces" for each agent (e.g., each character) whose beliefs are under consideration. An agent's belief space in the context of a reporter of the agent's beliefs (in this case, Cassie) is the set of propositions believed by the agent, together with the set of items about which the agent has beliefs, as represented by the reporter (cf. Rapaport 1984, 1986; Wiebe & Rapaport 1986, 1988).

Finally, Cassie must be able to change her beliefs. If Cassie is to be considered as a cognitive agent, and especially if the SNePS/Cassie system is to be used as a tool in understanding *human* belief-representation mechanisms, it ought to interpret ordinary statements about belief, expressed in (grammatical) natural language, the way humans do. Thus, Cassie must make reasonable or plausible interpretations of sentences in the narrative—based on such things as subject matter and prior beliefs—and to modify its initial representation, i.e., to revise its beliefs, as additional narrative is processed.

4.2 Temporal Deixis and the WHEN

The temporal deixis part of our research is an investigation into the many factors that operate together within a narrative to indicate the temporal relations holding between the events and situations mentioned in the text. Among these factors are tense, the progressive/non-progressive distinction, time adverbials, world knowledge, and aspectual class. All of these factors interact with the WHO to determine the temporal structure of the narrative.

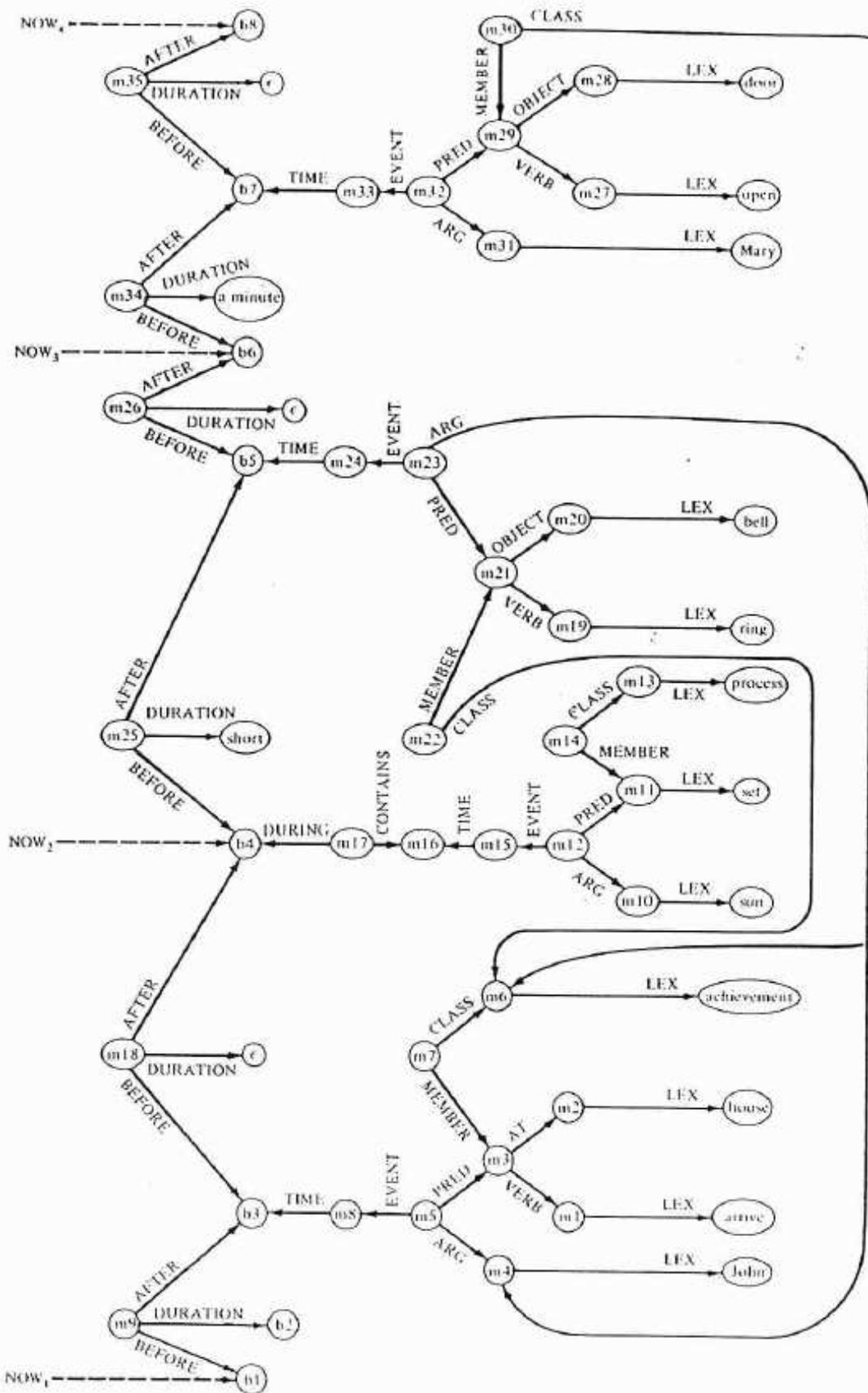
In this part of the project, we use an event-based, rather than a proposition-based, approach. That is, intervals and points of time are associated with events (represented as objects in the network) rather than with the propositions that describe them. The temporal model itself consists of these intervals and points of time related to one another by such relations as BEFORE/AFTER, DURING/CONTAINS, etc.

For example, the representation of the following narrative passage is shown in Figure 1:

John arrived at the house. The sun was setting. He rang the bell; a minute later, Mary opened the door.

The ARG-PRED-EVENT case frame asserts that the proposition consisting of the argument pointed to by the ARG-arc and the predicate pointed to by the PRED-arc describes the event pointed to by the EVENT-arc. Notice that the predicates are classified into various types; this information plays an important role in the temporal analysis of a text.

The "now"-point is a reference point that indicates the present moment of the narrative; it is updated as the story progresses through time (Almeida & Shapiro 1983). The "now"-point, our current implementation of the WHEN,



659

Figure 1. SNePS network showing Cassie's understanding of the temporal structure of the narrative in Sect. 4.2.

is implemented as a variable whose current value is indicated in Figure 1 by a dotted arrow. Subscripts are used in the figure to show the successive values of “now”.

The BEFORE-AFTER-DURATION case frame is used to indicate that the period of time pointed to by the BEFORE-arc temporally precedes the period of time pointed to by the AFTER-arc by the length of time pointed to by the DURATION-arc. These durations are usually not known precisely. The value ϵ stands for a very short interval; whenever an event occurs in the narrative line, it has the effect of moving “now” an interval of ϵ beyond it.

The DURING-CONTAINS case frame is used to indicate that the period of time pointed to by the DURING-arc is during (or contained in) the period of time pointed to by the CONTAINS-arc. Notice that the progressive sentence, “The sun was setting”, created an event that contains the then-current “now”. If Cassie knows about such things as sunsets, then she should infer that the event of the sun’s setting also contains John’s arrival, his ringing of the bell, and probably also Mary’s opening of the door. (For a more complete description of this aspect of the project, cf. Almeida 1987, 1995.)

4.3 Spatial Deixis and the WHERE

Tracking the WHERE in a narrative is considerably more complicated than tracking the WHEN, because space has more dimensions than time. By this, we are not just referring to the common notion that space is three-dimensional, while time is one-dimensional. For one thing, we are convinced that space is treated linguistically as two independent domains—a one-dimensional vertical domain (‘high’, ‘low’, ‘deep’, ‘shallow’, ‘tall’, ‘short’, ‘above’, ‘below’, etc.) and a two-dimensional horizontal domain (‘in front of’, ‘behind’, ‘to the left of’, & ‘to the right of’, ‘north’, ‘south’, ‘east’, ‘west’, etc.)—that never combine into a “diagonally vertical” direction (Zubin & Choi 1984). For example, one goes *up* a hill no matter how steep or shallow the grade. Besides these directional terms, there are neutral extent or distance terms, such as ‘close’, ‘near’, and ‘far’, that already have context-dependent scales (Mark, Svorou, & Zubin 1987; Nakhimovsky & Rapaport 1988).

Even these considerations do not exhaust the complexities of space over time. Time is treated as an objective dimension, independent of any observer or of any observed object, event, or action. Spatial directions, however, are relative both to the observer and to observed objects. For example, ‘in front of the bush’ means between the bush and the observer, while ‘in front of the chair’ means next to the chair at the side where people sit, and is independent of the observer. Some directions are fixed by the observed object regardless of its position in space. If you have a freckle three inches above your knee, it remains three inches *above* your knee, even when you are lying down. At other times, however, directions are changed by the background object or space in which the observed object is located. If Mary is seated in a theater and John is sitting in a row closer to where the performance occurs, then John is sitting *in front of* Mary, even if she is turned around talking to someone *behind* her.

The problem of deciding how to orient the spatial axes around an object so that spatial directions are defined has been called the “reference-frame problem” (Clark 1973; Sondheimer & Perry 1975; Talmy 1975, 1978, 1983; Sondheimer 1976, 1978ab; Lyons 1977; McDermott 1980; Pinxton et al. 1983; Zubin & Choi 1984). In order to keep track of the movement of the WHERE in narratives, we must have a representation that relates various places (where the WHERE can be) by possible spatial directions, so that when a particular reference frame is imposed on these directions, the linguistic spatial-direction terms have meaning. It may be that a full understanding of spatial deixis requires the comprehender to build a “mental map” similar to the mental representation of a place actually visited. (Kuipers’s model of human spatial knowledge acquisition provides a useful basis for this work; cf. Kuipers 1978, 1983ab.)

In natural languages, interpretation of a spatial directional description of an object (Figure) expressed relative to a background (Ground) presupposes an orientational system established around the Ground. For instance, in the expression ‘the rock in front of the tree’, the real spatial relationship of the rock to the tree hinges on the front/back reference frame set around the tree. In natural languages, directional references are usually made without explicitly indicating how the reference frame is to be established, and the burden of its determination is left to the listener/reader’s inferences.

We recognize three kinds of reference-frame resolutions—intrinsic, inherited, and perspective—distinguished by the source of the directionality that anchors the reference frame. We have provided a set of heuristic rules for reference-frame resolution, derived from a few widely accepted principles of discourse processing (such as the clause-boundary principle and the discourse-coherence principle). As shown in Figure 2, using the heuristic rules, Cassie can successfully resolve the reference-frame problems encountered in understanding the rich spatial information expressed

by short narrative texts such as the following (for further details, see Yuhan, forthcoming):

Mary, Tom, and Bob went to a theater together in order to see Bob's uncle's show. They walked to the front of the hall. Bob sat two rows in front of Mary, and Tom sat just behind her. They had a few minutes before the show would start. Mary was turned around in her seat talking with Tom. Then she saw a person who looked like Bob walking down the aisle toward her with a tall girl on his left. Recognizing Mary, he stopped in front of her to say hello. Mary glanced back and saw that Bob was still there in his seat. The person standing in front of Mary was Jim, who was Bob's twin brother. She had met him once before. Jim and the tall girl found seats a little distance away to Mary's left. Then the lights in the hall dimmed. They saw Bob's uncle standing behind a lectern to the left of a microphone.

5 Deictic Devices in Natural Text

Grammatical devices that contribute to the stability and movement of the DC have been studied under various rubrics, such as topicalization, focus, extraposition, foregrounding and backgrounding, presentatives, anaphora, tense, aspect, and spatial deixis. The study of each of these phenomena has dealt with specific, isolated aspects of the structuring of narrative discourse. But there has not been a unified account of how cohesive devices are used to introduce, maintain, shift, and void the WHO, WHEN, and WHERE of the DC. Significant steps have been taken in this direction by text linguists such as Grimes (1975) and Longacre (1983), but these proposals lack the hypothesis-generating precision of our DC model.

We are studying textual cohesive devices, hereafter called *DC-devices*, as they are used to signal both stability and change in the DC of narrative texts. A DC-device is thus a morphemic or syntactic structure of the text that affects the listener's construction of the DC by setting up candidate actors, places, and times for the DC, by signaling stability or shift in the DC, or by temporarily voiding some component of the DC. In this section, we discuss the general operation of the DC in the comprehension process.

5.1 Deictic-Center Principles

5.1.1 Principles of Deictic Operations

Deictic operations are mental operations that the comprehender performs on the DC during the process of constructing an interpretation for a stretch of narrative text. Much of the coherence of narrative text arises from the performance of these operations. In §§5.3-5.5, we shall give examples of each operation applied to the WHO, WHEN, and WHERE. The deictic operations are:

- (a) *Introducing* actors, places, or time intervals into the narrative as potential or actual WHOs, WHENs, or WHEREs of the DC.
- (b) *Maintaining* stability in the DC: Components remain stable either (i) when the listener expects this (cf. the Principles of Inertia, §5.1.3, below) or (ii) when the listener might expect a shift, except for the presence of an anti-shifting device (cf. the Principles of Scope, §5.1.5, below).
- (c) *Shifting* the WHO, WHEN, or WHERE of the DC from one character, place, or time to another: A new WHO is usually introduced before the DC shifts to it.
 - (c1) A special instance of shifting is *initializing* the DC, i.e., specifying the initial WHO, WHEN, and WHERE at the beginning of a narrative. Introducing and shifting may be accomplished as a single operation.
 - (c2) Another special case of shifting is *voiding*: One or more DC components may become indeterminate if the presence and identity of a WHO, WHEN, or WHERE is not relevant at that point in the narrative; for example, the WHO and WHEN of the DC may temporarily shift to null during a scene description. The voiding operation may thus be regarded as shifting to a null component.

```

: They saw <Bob's uncle standing behind a lectern
  to the left of a microphone>.
SNePS Structures after the Initial Interpretation
=====
t12283
#> I understand that
  a group of individuals
    namely, Bob , Tom and Mary
  saw
    a standing act of an uncle of Bob .
Going into the Extended Interpretation
=====
#> Particularly, I note that,
  due to m465 the <standing> act of an uncle of Bob ,
  the Figure Object, individual b7
    where
      b7 is an uncle of Bob , as I remember
  was BE-LOCated
  at a place b124
    where
      b124 has a Spatial Relation of "left-away"
        to the Ground Object, individual b125
          where
            b125 is a member of class microphone
            with the intrinsically resolved reference frame of SR
            anchored to the canonical left/right directionality
            of the Ground Object itself
          and
            b124 has a Spatial Relation of "behind"
              to the Ground Object, individual b123
                where
                  b123 is a member of class lectern
                  with the intrinsically resolved reference frame of SR
                  anchored to the canonical front/back directionality
                  of the Ground Object itself .
Deictic-NOW is maintained as b122
Deictic-HERE is maintained as b10
Deictic-WHO is maintained as m16

```

Figure 2. Output of SNePS/Cassie after processing the last sentence in the spatial-deixis narrative of §4.3. The 2 lines following the :-prompt are the input (what Cassie “reads”); the remaining lines are the system’s output, expressing Cassie’s understanding of the narrative at this point. (Labels such as ‘t12283’, ‘m465’, ‘b7’, etc., are system-generated labels of SNePS nodes.) The last three lines express part of the DC at this point in the narrative.

5.1.2 Principles of Textual Economy

The listener/reader constructs the DC in the process of comprehension, based not only on DC-devices in the text itself, but also on shared knowledge (Smith 1982) and on what Clark and Clark (1977: 72–73) have called the reality and cooperative principles. In consequence of this construction process, much of what happens in the DC can be anticipated by the comprehender and need not be overtly encoded in a DC-device. Put briefly, the text “evokes” ideas for the comprehender and may remain silent when the comprehender can anticipate them (Slobin 1979), resulting in considerable economy in the text. Specific aspects of this economy include ellipsis and *in media res* devices.

5.1.3 Principles of Inertia

The DC remains stable unless a change is explicitly signaled. The WHO and WHEN stay the same unless they are signaled to change. In contrast, since time is sequential, the WHEN has dynamic inertia; i.e., a “stable” WHEN moves forward with each successive event in the narrative, unless a jump or stop is signaled. Events are inferred to occur in the sequence in which they are mentioned unless signaled to be out of sequence (Clark & Clark 1977).

5.1.4 Principle of Deictic Synchronism

A norm of narrative discourse seems to be that the WHO, WHEN, and WHERE of the DC are maintained and shifted together. A complementary norm seems to be that this synchronism is periodically broken, either by voiding a component of the DC or by shifting them apart. In a text segment of character description, the WHEN and WHERE of the DC are voided while the WHO is maintained throughout; in scene descriptions, the WHERE is maintained, voiding the WHO and WHEN.

The Principle of Deictic Synchronism leads to specific implicational relationships among DC components. These relationships can be used by the comprehender as inferences in constructing the DC; that is, they are functionally equivalent to DC-devices:

- (a) Time sequencing entails a WHO and a WHERE; that is, progression in time may be stopped by voiding either the WHO or the WHERE.
- (b) A shift in the WHERE entails a shift in the WHO or in the WHEN (both can occur); that is, if the WHERE shifts to a new place, time is updated or the WHO shifts to another character.

5.1.5 Principles of Scope

Scoping principles are closely related to the Principle of Deictic Synchronism:

- (a) Individual DC-devices have a specific scope or “mental space” (Fauconnier 1985), corresponding to a chunk of text, within which the parameters they set are valid. Some scopes, such as the scope of initial adverbials, are broad, that is, valid until they are cancelled by another DC-device signaling a shift. Other scopes, e.g., the scope of anti-shifting devices, are narrow, that is, limited to one clause or phrase.
- (b) When scopes conflict, narrow scope supersedes broad scope. In the following example,

Kino stood perfectly still. He could hear Juana whispering the old magic again, and he could hear the evil music of the enemy. (Steinbeck 1945: 7.)

the definite subject NP ‘Juana’ should shift the DC, but there is no shift, since this device occurs within the narrow scope of a complement clause (an anti-shifting device).

5.1.6 Principles of Extraposition

- (a) DC-devices will be located at the beginning or end of clause or sentence units to the extent that these dislocations are permitted by the grammar of the particular language.
- (b) Initial DC-devices will establish the DC for the next sentences; final DC-devices will signal a pending shift in the DC (e.g., relative clauses).

5.1.7 Principles of Cumulative Cohesion

Cohesive devices in text tend to be redundant (Halliday & Hasan 1976; Zubin 1977, 1980; de Beaugrande & Dressler 1981). In a narrative, there will be intervals of certainty about the DC, as well as intervals of uncertainty during which it is unclear whether the WHO, WHEN, or WHERE have shifted. Agreement of several DC-devices will clearly shift or maintain the DC. Absence of DC-devices or conflict among them will correspond to intervals of uncertainty in the text.

5.2 Morphological, Lexical, and Syntactic DC-Devices

In this section and §§5.3–5.5, below, we summarize some ways in which individual cohesive devices introduce, maintain, and shift the WHO, WHEN, and WHERE of the DC, providing illustrative examples from Steinbeck's *The Pearl*.

Hopper & Thompson (1980) describe a number of morphological and syntactic features that affect what they call the “transitivity” of the clause, and show how these features affect the discourse foregrounding and backgrounding of the information conveyed by the clause. Many of the following devices, individually and conjointly, serve either to maintain or to void the DC:

Devices in English that contribute to:	
High Transitivity	Low Transitivity
main clause	dependent clause
definite, anaphoric object	indefinite object
simple past tense	progressive or perfect tense
direct object	no direct object
affirmative	negative
telic predicate	atelic predicate

Conjoined clauses signal that the DC remains stable within the conjunction (Fillmore 1975). This reflects the frequent observation that the members of a conjunction are somehow conceptually bound closely together. Clause conjoining is often combined with other maintenance devices such as zero-anaphora.

Complement and relative clauses are anti-shifting devices. They permit reference to another character, time, or place within their scope, while preventing the DC from shifting there. At the end of the clause, the scope of the device is cancelled, and the narrative automatically continues at the unshifted DC. Complement-taking predicates that seem to fulfill this function include perception predicates (‘see’, ‘hear’, ‘feel’, etc.), cognition predicates (‘know’, ‘understand’, ‘think’, etc.), speech predicates (‘say’, ‘mean’, etc.), and causatives (‘make’, ‘let’, ‘have’, etc.).

Initial adverbial clauses shift the WHEN and WHERE. Brown and Yule (1983) suggest that initial adverbials may in general be a marker of “topic shift”. In Fauconnier’s (1985) terms, initial adverbials would mark a shift to a new “mental space” that the listener is constructing in the comprehension process, an idea implicit in Geis’s (1985) study of initial and non-initial spatial and temporal adverbials. Geis found that initial placement of a spatial adverbial sets up a spatial frame within which the event occurs, whereas non-initial placement does not. For example, (3a), below, places John in Chicago in the narrative context, while (3b) does not:

(3a) In Chicago, John knew about some good Chinese restaurants.

(3b) John knew about some good Chinese restaurants in Chicago.

The DC is a type of mental space in Fauconnier’s sense, which is crucial to the construction of narrative discourse. Specifically, we claim that initial spatial and temporal adverbials will shift these aspects of the DC.

5.3 Devices that Affect a Specific Component of the WHO

5.3.1 Introducing

There are several devices that introduce a new actor as a potential WHO: (1) *Presentative structure* might consist of (a) a preposed adverbial phrase/clause + subject NP (usually indefinite):

Down the rope that hung the baby’s box from the roof support a scorpion moved slowly. His stinging tail was straight out behind him, but he could whip it up in a flash of time. (Steinbeck 1945: 6; italics added.)

Or (b) it could be a ‘there’/‘it’ + ‘be’ + NP construction:

His eyes flicked to a rustle beside him. *It was Juana* arising, almost soundlessly. On her hard bare feet she went to the hanging box where Coyotito slept (Steinbeck 1945: 3–4; italics added.)

Other introducing devices are (2) *noun phrases with extended attributes or relative clauses*:

And the newcomers, *particularly the beggars from the front of the church who were great experts in financial analysis*, looked quickly at Juana’s old blue skirt (Steinbeck 1945: 11; italics added.)

and (3) *definite NPs in direct/indirect-object position*:

And last he turned his head *to Juana*, his wife, who lay beside him on the mat (Steinbeck 1945: 1; italics added.)

5.3.2 Maintaining

Among the devices that maintain a character as the WHO are *simple maintenance* and *anti-shifting devices*: (1) There are three forms of simple maintenance, in which the reader expects maintenance:

(a) Coordinate-clause conjoining:

And as always when he came near to one of this race, Kino felt weak and afraid and angry at the same time. . . . He could kill the doctor more easily than *he* could talk to him (Steinbeck 1945: 12; italics added.)

Note that the italicized subject pronoun refers to Kino, the WHO of the DC, even though the doctor is most recently mentioned.

(b) Subject chaining, including pronominalization and zero-anaphora: successive mention of a character as the subject of adjacent clauses (cf. Zubin 1979):

Kino’s eyes opened, and *he* looked first at the lightening square which was the door and then *he* looked at the hanging box where Coyotito slept. At last *he* turned his head to Juana (Steinbeck 1945: 1; italics added.)

(c) Overall frequency of mention: Kino and Juana are the most frequently mentioned characters in the story. The DC shifts to them with fewer supporting features than an infrequently mentioned character, such as the beggars. For example, after an extensive passage of scene description in which the WHO and WHEN are voided, a simple subject NP shifts the WHO from null to Kino, and thereby sets the dynamic WHEN back in motion:

But the pearls were accidents, and the finding of one was luck, a little pat on the back by God or the gods or both.

Kino had two ropes, one tied to a heavy stone and one to a basket. He stripped off his shirt and trousers and laid his hat in the bottom of the canoe. (Steinbeck 1945: 22; italics added.)

(2) Anti-shifting devices block a shift to a new WHO. These take four forms:

(a) Relative clauses:

And every year Kino refinished his canoe with the hard shell-like plaster by the secret method *that had also come to him from his father*. (Steinbeck 1945: 19; italics added.)

Here, the WHO does not shift to Kino’s father, since ‘his father’ occurs in a relative clause.

(b) Indefinite subjects:

. . . he [Kino] squatted down and gathered the blanket ends about his knees. He saw the specks of Gulf clouds *flame* high in the air. And *a goat* came near and sniffed at him and stared with its cold yellow eyes. Behind him Juana’s fire leaped into *flame* *A late moth* blustered in to find the fire. . . .

The dawn came quickly now Kino looked down to cover his eyes from the glare. (Steinbeck 1945: 3; italics added.)

(c) Complementation:

Kino stood perfectly still. He could hear Juana whispering the old magic again, and he could hear the evil music of the enemy. (Steinbeck 1945: 7.)

In this example, the definite subject NP ‘Juana’ is introduced as a potential WHO (cf. example 5.3.3 (2), below), but the clause is a complement to the verb ‘hear’, so the DC does not shift.

- (d) Switch-reference markers in other languages often have an anti-shifting function in narrative (Haiman & Munro 1983).

5.3.3 Shifting

There are three devices that shift to another actor as the WHO. (1) There are *perception and mental predicates*: In the next example, the verb ‘feel’ shifts the DC briefly to the scorpion, as shown by the deictic verb ‘come’ in its scope:

He [Kino] could not move until the scorpion moved, and it felt for the source of the death that was coming to it. Kino’s hand went forward very slowly, very smoothly. (Steinbeck 1945: 7.)

- (2) There are *definite noun phrases (including names) in subject position*:

He [Kino] brought out a paper folded many times. Crease by crease he unfolded it, until at last there came to view eight small misshapen seed pearls, as ugly and gray as little ulcers, flattened and almost valueless. The servant took the paper and closed the gate again, but this time he was not gone long. He opened the gate just wide enough to pass the paper back. (Steinbeck 1945: 15.)

- (3) There is a *shift in the WHERE*:

The gate closed a little, and the servant refused to speak in the old language. “A little moment,” he said. “I go to inform myself,” and he closed the gate and slid the bolt home. The glaring sun threw the bunched shadows of the people blackly on the white wall.

In his chamber the doctor sat up in his high bed. He had on his dressing gown of red watered silk that had come from Paris, a little tight over the chest now if it was buttoned. (Steinbeck 1945: 13; italics added.)

- (4) Finally, a device that temporarily *voids* the WHO (i.e., shifts it to null) is *chained indefinite reference*:

[a] The beach was yellow sand, but at the water’s edge a rubble of shell and algae took its place. Fiddler crabs bubbled and sputtered in their holes in the sand, and in the shallows little lobsters popped in and out of their tiny homes in the rubble and sand. (Steinbeck 1945: 17–18.)

[b] A town is a thing like a colonial animal. A town has a nervous system and a head and shoulders and feet. A town is a thing separate from all other towns, so that there are no two towns alike. And a town has a whole emotion. How news travels through a town is a mystery not easily to be solved. (Steinbeck 1945: 27.)

5.4 Devices that Affect a Specific Component of the WHERE

5.4.1 Introducing

Two devices introduce a location as a potential WHERE. These are:

1. ‘go’/‘take’ + non-initial goal adverbial:

And rage surged in Kino. He rolled up to his feet and followed her as silently as she had gone, and he could hear her quick footsteps going toward the shore. (Steinbeck 1945: 75–76.)

and

2. preposed adverbials, which simultaneously introduce and shift:

Thus, in La Paz, it was known in the early morning through the whole town that Kino was going to sell his pearl that day. (Steinbeck 1945: 53–54.)

5.4.2 Maintaining

The devices that maintain a location as the WHERE again consist of simple maintenance and anti-shifting devices.

(1) Simple maintenance can take at least three forms:

(a) Clause conjoining (as in example 5.3.2 (1a), above).

(b) Spatial deictic adverbs ‘here’ and ‘there’:

And in the pearl he saw Juana with her beaten face crawling home through the night. “Our son must learn to read,” he said frantically. And there in the pearl Coyotito’s face, thick and feverish from the medicine. (Steinbeck 1945: 93–94.)

(c) Deictic verbs ‘come’, ‘go’, ‘bring’, ‘take’: In this example, maintenance of the WHERE is signaled by ‘come’:

Kino squatted by the fire pit and rolled a hot corncake and dipped it in sauce and ate it. ... When Kino had finished, Juana came back to the fire and ate her breakfast. (Steinbeck 1945: 5.)

Often, the goal of ‘come’ and ‘bring’ is left unspecified, since these convey movement toward the DC, which is already known to the comprehender:

... Juana brought a little piece of consecrated candle and lighted it at the flame and set it upright on a fireplace stone. (Steinbeck 1945: 49.)

(2) The anti-shifting devices are complement clauses (cf. example 5.3.2 (2c), above), relative clauses, and perception verbs.

5.4.3 Shifting

There are four devices that shift to another location as the WHERE:

1. The first are the spatial deictic adverbs ‘here’ and ‘there’ (note that these are also maintenance devices if they agree with a previous DC-device):

Even in the distance he could see the two on foot moving slowly along, bent low to the ground. Here, one would pause and look at the earth, while the other joined him. They were the trackers, they could follow the trail of a bighorn sheep in the stone mountains. They were as sensitive as hounds. Here, he and Juana might have stepped out of the wheel rut, and ... these hunters, could follow, could read a broken straw or a little tumbled pile of dust. (Steinbeck 1945: 95–96.)

2. Next are preposed locative adverbials:

He [Kino] slipped his feet into his sandals and went outside to watch the dawn.
Outside the door he squatted down and gathered the blanket ends about his knees. He saw the specks of Gulf clouds flame high in the air. (Steinbeck 1945: 3.)

3. Third, verbs with directional valence (‘come’, ‘go’, ‘enter’, ‘leave’, ‘bring’, and ‘take’): In this example, ‘come’ successively shifts the narrative not only to a new WHERE but to a new WHO:

The news came to the doctor where he sat with a woman whose illness was age ... the doctor grew stern and judicious at the same time ...
The news came early to the beggars in front of the church, and it made them giggle a little with pleasure ... (Steinbeck 1945: 28–29.)

In the following example, ‘go’ and ‘come’ in combination signal a shift in the WHERE, which begins outside the hut:

The world was awake now, and Kino arose and went into his brush house.
As he came through the door Juana stood up from the glowing fire pit. (Steinbeck 1945: 5.)

4. Finally, a shift in the WHO can shift the WHERE. In the example below, the place where Juana is becomes the WHERE:

The scorpion moved delicately down the rope toward the box. Under her breath Juana repeated an ancient magic to guard against such evil, and on top of that she muttered a Hail Mary between clenched teeth. (Steinbeck 1945: 6.)

5.5 Devices that Affect a Specific Component of the WHEN

5.5.1 Introducing

An initial adverbial is a device that introduces a time interval as a potential WHEN and *shifts* to it:

In the afternoon, when the sun had gone over the mountains of the Peninsula to sink in the outward sea, Kino squatted in his house with Juana beside him. (Steinbeck 1945: 30.)

5.5.2 Maintaining

The two classes of devices that maintain the WHEN actually maintain its dynamic inertia (i.e., they keep updating the WHEN). (1) *Simple maintenance* can take three forms:

(a) Tense chaining (simple past, simple present, preterite followed by infinitives in Latin):

And the newcomers, particularly the beggars from the front of the church who were great experts in financial analysis, looked . . . , saw the tears in her shawl, appraised the green ribbon . . . , read the age of Kino's blanket . . . , and set them down as poverty people . . . (Steinbeck 1945: 11.)

(b) Accomplishment and achievement predicates (Vendler 1957):

Then from his bag he took a little bottle of white powder and a capsule of gelatine. He filled the capsule with the powder and closed it, and then around the first capsule he fitted a second capsule and closed it. (Steinbeck 1945: 40–41.)

and

(c) Clause conjoining (again, see example 5.3.2 (1a), above).

(2) *Anti-shifting devices* signal that an event is out of sequence, but that otherwise events are still sequential; i.e., beyond the scope of the anti-shifting device, sequencing returns to normal. There are two such devices:

(a) Conjunction adverbs: 'while', 'after', 'before', 'when', etc.

And as always when he came near to one of this race, Kino felt weak . . . (Steinbeck 1945: 12.)

and

(b) Past perfect, 'would' + infinitive, conditional in conjoined sentences:

In the pearl he saw Coyotito sitting at a little desk in a school, just as Kino had once seen it through an open door. (Steinbeck 1945: 33.)

5.5.3 Shifting

(1) Preposed temporal adverbials are devices that can shift the WHEN:

And then, *in the first light*, he heard the creak of a wagon, and he crouched beside the road and watched a heavy two-wheeled cart go by, drawn by slouching oxen. (Steinbeck 1945: 92; italics added.)

(2) Four devices that can *void* the time sequence of the WHEN (i.e., shift it to null) are:

(a) Stative and activity verbs (Vendler 1957):

She, who was obedient and respectful and cheerful and patient, she could arch her back in child pain with hardly a cry. She could stand fatigue and hunger almost better than Kino himself. In the canoe she was like a strong man. (Steinbeck 1945: 9.)

(b) Habitual and iterative adverbs:

For centuries men had dived down and torn the oysters from the beds and ripped them open, looking for the coated grains of sand. (Steinbeck 1945: 21.)

(c) Imperfective aspect (Reid 1977, Hopper 1982):

Kino was not breathing, but his back arched a little and the muscles of his arms and legs stood out with tension and a line of sweat formed on his upper lip. (Steinbeck 1945: 97.)

and

(d) Absence of a WHO: In the example in 5.3.3 (4a), above, the chained indefinite subjects are not embedded within a focalizing WHO, so they void the WHO, which, in this case, voids the WHEN.

5.6 The Effect of Agreement and Conflict among DC-Devices

When devices agree with each other, the certainty of a maintenance or shift in the DC is increased. When devices of like scope disagree, the certainty of a maintenance or shift is decreased; that is, the comprehender will be in momentary uncertainty about the WHO, WHEN, or WHERE of the DC. Note that this is distinct from a voided DC, in which case the comprehender is certain that there is temporarily no WHO, WHEN, and/or WHERE.

5.6.1 Agreement

Certainty about the identity of the WHO, WHEN, or WHERE of the DC during an interval in the narrative is proportional to the number of DC-devices that agree about the identity of this component of the DC. The following passage illustrates the strong and certain DC resulting from multiple devices that maintain it:

She [Juana] uncovered an ember from the ashes and shredded little pieces of cornhusk over it and blew a little flame into the cornhusks And then . . . Juana brought a little piece of consecrated candle and lighted it at the flame and set it upright on a fireplace stone. (Steinbeck 1945: 49.)

The following passage illustrates how anti-shifting devices cooperate to prevent a DC shift:

The four beggars in front of the church knew everything in the town. They₁ were students of the expressions of young women as they₂ went in to confession, and they₃ saw them₄ as they₅ came out and \emptyset ₆ read the nature of the sin. They₇ knew every little scandal and some very big crimes. They₈ slept at their₉ posts in the shadow of the church (Steinbeck 1945: 11; subscripts added).

In this example, the WHO = the beggars, and the WHERE = in front of the church. Four anti-shifting devices cooperate to prevent shift of the WHO to the women and of the WHERE to the inside of the church: The obviating preposition 'of', the indefinite NP 'young women', the subordinating conjunction 'as', and the perception verb 'see' with the beggars as subject. This maintenance of the WHO is supported by the deictic verbs 'go' (signaling movement away from the WHERE) and 'come' (signaling return).

Note that the concerted maintenance of the beggars as the WHO throughout the passage allows the anaphoric pronoun 'they' and zero-anaphora (marked with subscripts in the passage) to switch back and forth in reference between the beggars and the women. Occurrences 2 and 5 referring to the women are in the scope of the anti-shifting devices and 'of' (cf. the Principles of Scope, above). Occurrences 1, 3, 6, 7, and 8 referring to the beggars are not in the scope of such devices. (Occurrence 4 is assigned to the women by a co-reference principle.) Thus, because of the stable DC, the reader is able to keep track of switching reference, despite the use of potentially ambiguous pronouns and zero-anaphora.

5.6.2 Conflict

Uncertainty about the identity of the WHO, WHEN, or WHERE of the DC during an interval in the narrative is proportional to the number of DC-devices of like scope that conflict concerning the identity of this component of the DC:

. . . he crept into the cover of a thorny tree
. . . and peeked out from under a fallen branch. . . . Even *in the distance* he could see the two on foot moving slowly along, bent low to the ground. Here, one would pause and look at the earth, while the other joined him. (Steinbeck 1945: 95–96; italics added.)

In this example, the WHO and WHERE start off together in the first sentence. In the second sentence, the initial adverbial signals a shift in the WHERE, but the anaphoric subject pronoun ‘he’ signals maintenance of the WHO. This conflict leads to uncertainty about whether the WHERE has really shifted, or whether the WHO is going to shift. This uncertainty is resolved in the last sentence by the initial ‘here’ and the change in subject pronoun: the WHO and WHERE have shifted to the location of “the two on foot”.

The following passage reveals a similar conflict, resulting in momentary uncertainty about the DC:

Juana went to the fire pit and uncovered a coal and fanned it alive

Now Kino got up and wrapped his blanket about his head and nose and shoulders. He slipped his feet into his sandals and went outside to watch the dawn. (Steinbeck 1945: 2–3.)

At this point, the WHERE is inside the hut and Kino is the WHO. But since the WHO is leaving the WHERE, it is highly probable that one will shift, and we are left in uncertainty; i.e., we don’t know if we, the reader, are staying inside with Juana (shift of the WHO) or going outside with Kino (shift of the WHERE). This is resolved by the next sentence:

Outside the door he squatted down and gathered the blanket ends about his knees. (Steinbeck 1945: 3.)

The anaphoric pronoun ‘he’ referring to Kino signals maintenance of the WHO, while the initial spatial adverbial ‘Outside the door’ signals a shift of the WHERE; that is, the reader is now certain that the WHO is maintained while the WHERE has shifted.

5.6.3 Stable Dissynchronism of the DC

We have identified one nexus of DC-devices resulting in a separation of the WHO and WHERE that is stable, i.e., that does not show the evidence of conflict of the examples above. This nexus seems to evoke a “Journey” schema (Lakoff & Johnson 1980) in the comprehender’s mental model of the narrative. The WHO is composed of the individual or group making the journey, and the WHERE is their final goal as well as places they pass along the way. What creates the dynamic quality of the journey in the narrative is the fact that the WHERE keeps shifting out “ahead” of the WHO.

The following passage illustrates this effect. Kino and Juana are going to the town doctor with their baby, accompanied by their neighbors and others in the town:

- (a) The people in the door pushed against those behind to let her [Juana] through.
- (b) Kino *followed* her. They *went* out of the gate to the rutted path and the
- (c) neighbors *followed* them.
 . . . They *came* to the place where the brush houses
- (d) stopped and the city of stone and plaster began The procession *crossed*
- (e) the blinding plaza and *passed* in front of the church.
 . . . the beggars from
- (f) the front of the church . . . *went* along to see what kind of drama might
- (g) develop. . . they *followed* the procession, these endless searchers after
- (h) perfect knowledge of their fellow men, to see what the fat lazy doctor
- (i) would do about an indigent baby with a scorpion bite.
 The scurrying
- (j) procession *came* at last to the big gate in the wall of the doctor’s house.
(Steinbeck 1945: 10–12; italics added; indented lines indicate paragraph breaks.)

One of the many devices of the text that set up the movement of the procession are the motion verbs ‘follow’, ‘pass’, and ‘cross’ on lines (b), (c), (d), (e), and (g) of the text passage. The verbs ‘come’ (c, j) and ‘go’ (b, f), in addition to expressing motion, express movement toward and away from the DC, respectively. If the WHO (the procession) and the WHERE are synchronized, then ‘come’ and ‘go’ should express movement toward and away from the procession, respectively. But the opposite is the case. To show this, we define a *locus* as a location that is non-coterminous with the WHO and with respect to which the WHO is moving. Both instances of ‘come’ in the passage express movement toward a locus, not toward the WHO. The word ‘went’ in line (b) expresses movement away from a locus and, in (f), away from a locus and toward the WHO. In other words, the deictic verbs in this passage orient toward loci away from the WHO, as if these were the WHERE of the DC. Thus, either our claim about ‘come’ and ‘go’ is wrong, or the WHO and WHERE are indeed dissynchronous in this passage. We believe that such dissynchronism of DC-devices maintaining the WHO and WHERE will be systematically exploited in narrative to evoke a “Journey” schema.

6 Psychological Validity of Some DC-Devices

6.1 Studies of the WHERE

In order for narrative comprehension to proceed smoothly, the reader must construct and modify successive DCs by making a number of critical inferences about the identity and position of characters and events in narrative time and space. We claim that, during comprehension, the reader makes these critical inferences on the basis of a variety of linguistic cues in the text. These cues include grammatical information (e.g., verb tense and aspectual class), lexical information (e.g., the use of special deictic words), and syntactic information (such as the positioning of adverbial phrases within sentences). In the following sections, we report on experiments that tested the influence of the deictic words ‘come’ and ‘go’ and locative adverbial phrases on the establishment, maintenance, and shifting of the WHERE of the DC.

The words ‘come’ and ‘go’ are considered deictic in narrative text because they are understood only by reference to the objects and events currently unfolding in the constantly changing narrative world. For example, the motion verb ‘come’ only makes sense by reference to the location of those characters and events currently in the reader’s focus of attention; characters ‘come’ into the currently activated DC. Conversely, when the motion verb ‘go’ is used, it usually signals movement away from the DC. Consider the following example from *The Pearl*:

As he *came* through the door Juana stood up from the glowing fire pit. She put Coyotito back in his hanging box
(Steinbeck 1945: 5; italics added.)

Here, the use of the verb ‘come’ in this excerpt informs the reader where the DC is: Regardless of where the previous DC was, the current DC must be where Juana is, since Kino “comes” into the place where she is. Furthermore, since it helps to establish the fact that Juana is already in the DC (whereas Kino is only now coming into it), the use of the verb ‘come’ in connection with Kino encourages the reader to view the action from Juana’s perspective. If the verb ‘went’ were used instead of ‘came’ in the above example, the reader’s inferences about the DC would be very different. The use of ‘go’ would encourage the reader to view the scene from outside the hut: the reader would (mentally) go through the door with Kino from outside to inside, rather than watch him come in from inside.

The verb ‘come’ can also be used more subtly to show the ideological center from which the interpretation of narrative circumstances is made. Consider the following:

- (3) The doctor never *came* to the cluster of brush houses. Why should he, when he had more than he could do to take care of the rich people who lived in the stone and plaster houses of the town. (Steinbeck 1945: 9; italics added.)

The second sentence expresses an opinion seemingly from the doctor’s point of view, but the verb ‘came’ in the first sentence signals that the current WHERE is the brush houses. The use of ‘came’ helps the reader to interpret that the second sentence is an imputation against the doctor by the poor people of the brush houses, or by someone sympathetic to them and thus “with” them.

Another linguistic device that cues the reader to make certain DC inferences is the positioning of adverbial phrases within sentences. In particular, preposed spatial adverbials signal the reader to move the WHERE from its previous location to the new location specified by the adverb:

The glaring sun threw the bunched shadows of the people blackly on the white wall.
In his chamber the doctor sat up in his high bed. He had on his dressing gown of red watered silk
At the gate the servant opened the door a trifle and looked out at the waiting people. (Steinbeck 1945: 13, 15; italics added.)

Here, the preposed adverbial ‘In his chamber’ shifts the WHERE to the chamber, where it stays until the preposed adverbial ‘At the gate’ moves the WHERE to the gate. If ‘at the gate’ were placed elsewhere in the sentence, it might not move the WHERE.

The use of the deictic verbs ‘come’ and ‘go’ and the sentential positioning of spatial adverbials have distinct effects on the establishment, maintenance, and shifting of the WHERE. In the following sections, we report on three experiments that attempt to establish the psychological reality of these effects.

6.2 Experiment 1

In this experiment (first reported in Segal, Bruder, & Daniels 1984), we presented subjects with true-false statements about a narrative that they were in the process of reading. This was done by presenting the text a few sentences at a time and then presenting the true-false statements after each set of sentences. Three versions of the text were constructed in order to compare the movement of the DCs of the text, as evident in answers to where- and when-questions, as a function of the linguistic devices used in the different versions.

6.2.1 Method

Three versions of the first chapter of *The Pearl* were composed. Twenty-five sentences differed across the versions in one of two ways:

1. When a movement of characters in the story from one location to another was described by Steinbeck using the verbs ‘came’ or ‘went’, we substituted ‘came’ for ‘went’ and ‘went’ for ‘came’ in half of the instances selected. The changes were distributed equally over the three versions.
2. When, in the original text, the location of an entity or an event was either deictically identified, identified by the use of a preposed adverbial, or identified by the use of an adverbial elsewhere in the sentence, we sometimes inserted, moved, or deleted adverbials. Each instance selected occurred without an adverbial or with the adverbial in initial or non-initial position. These three possibilities occurred in the three different versions of the text.

In addition to these modifications, several sentences designed to simulate background description were added to the text. These sentences introduced animals to the narrative, with no explicit locatives, in order to see whether the DC devices under investigation would be used by readers to inferentially determine the animals’ locations.

The chapter was broken into 30 units of from 2 to 17 sentences each. There was no attempt to control sentence length or unit length. Subjects were asked to read a unit and then respond to 2 to 6 true-false statements about it. For each version, there were a total of 115 statements. Each statement was to be responded to with a number from 1 (= definitely false) to 6 (= definitely true). Subjects were presented a booklet, each page of which contained one unit of the narrative and the statements associated with that unit. After responding to the statements following one unit, they were asked to turn the page and do the same thing with the next unit. At no time were they to read ahead or to re-read a unit on a previous page.

The subjects were 60 paid volunteers, not including one who was replaced for not following directions. Subjects were randomly assigned to the three versions. Instructions were presented on the covers of the booklets. The task was self-paced, with subjects working without direct supervision.

6.2.2 Results and Discussion

One subject found the task difficult because of tense differences between the narrative text and the true-false statements: 82 of the statements were in a present tense, whereas the narrative was predominantly in the past tense. This tense shift was deliberate, to test whether the subjects responded to what was occurring “now”, that is, at the conceptual time of the text being perused. This was very successful: 59 of 60 subjects had no expressed difficulty in performing the task. Subjects tended to use the complete range of truth values: the mean score ranged from 1.2 to 5.7—from most subjects agreeing that a statement was certainly false to most of them agreeing that a statement was certainly true.

Our view of the WHEN was that temporal relations would be rather tightly controlled: if one event logically must end when another begins, then, if the second has begun, the first should have ended. That result was not universally supported in this experiment. Consider the following sentences:

It was Juana arising On her hard bare feet she went to the hanging box where Coyotito slept, and she leaned over and said a little reassuring word. Coyotito looked up for a moment and closed his eyes and slept again. (Steinbeck 1945: 2.)

Following these sentences, subjects were asked to evaluate the following two sentences among others:

Juana is walking across the room.
Juana is looking into Coyotito’s box.

Both of these sentences were simultaneously evaluated to be definitely true by a large minority of the subjects (mean scores 5.1 and 5.5, respectively), and almost all of the others evaluated both of them to be at least probably true. Since they cannot both literally be true at the same time, subjects must consider “now” to encompass a broader period of time than an instant. Perhaps they consider those actions to be occurring in a single conceptual time unit.

There were 16 of the true-false statements for which the variations in the presented narrative were predicted to bias responses in one way or the other. The results of 15 of the statements were in the predicted direction. However, the effects of text variations only reached statistical significance in two instances.

In the first instance, the presence of a preposed adverbial was varied:

Kino awakened in the near dark. The stars still shone and the day had drawn only a pale wash of light Outside the brush house in the tuna clump, a covey of little birds chattered and flurried

Kino heard the little splash of morning waves on the beach. (Steinbeck 1945: 1–2.)

The prepositional phrase in a preposed position—‘Outside the brush house’—implies that the text that preceded it was *inside* the brush house by contrast. The true-false statement was:

Kino is on the beach.

The group receiving the preposed-adverbial version rejected this statement (mean = 2.0), whereas the other groups were neutral (means = 3.2 and 3.5). The overall analysis of variance yielded $F(2,57) = 4.33$, $p < 0.02$. The comparison of the preposed-adverbial version with the other groups yielded $F(1,57) = 8.24$, $p < 0.01$.

In the second significant instance, the text read either:

They came out of the gate to the rutted path as the neighbors watched them.

or:

They went out of the gate to the rutted path as the neighbors watched them.

(In both cases, ‘they’ refers to Juana and Kino.) The true-false statement was:

The neighbors see the backs of Kino and Juana’s heads going through the gate.

Subjects who saw ‘came’ tended to be neutral to this statement (mean = 3.6), whereas those who saw ‘went’ tended to accept it (mean = 4.8). This difference was significant: $F(1,57) = 10.68$, $p < 0.005$.

Although the comparison was not statistically significant, it is worth noting the one instance in which the results were not in the predicted direction, namely, passage (3), cited above (§6.1). That case used ‘came’ not as a spatial deictic location, but as a more abstract attitudinal one. In some texts, ‘went’ was substituted for ‘came’. The true-false statement was:

The doctor likes to help the poor people but he doesn’t have time.

The means were 2.7 for ‘came’ and 2.5 for ‘went’. We expected sympathy for the poor to be strengthened by localizing the DC among the brush houses. An ad-hoc explanation for this directional deviancy is that the sympathy obviously lay with the poor, so ‘went’ functioned ironically and, if anything, strengthened it.

In the running text, almost all the events that occurred were quite redundantly reported. Any particular effect of these linguistic devices could be countermanded by expectancies set up by the other sentences in the text and certain narrative conventions that lie outside the scope of this study.

6.3 Experiment 2

The DC does not necessarily shift at each mention of a new character, place, or time. Introduction of such new terms in a sentence may signal the “potential” for a shift, which may or may not occur, depending on subsequent sentences. One linguistic device that may signal such a shift in space or location is the use of locative adverbials in an initial or preposed position. The purpose of this experiment (preliminary data were reported in Bruder, Engl, & Schultz 1985), was to investigate the hypothesis that preposed locative adverbials in a narrative indicate that the story line at that point involves a significant shift in location, a shift that the author “intends” the reader to follow. In a sense, the story line has moved on to a new location, and subsequent sentences should refer to events in that location. If updating the

DC depends in part on specific linguistic devices, such as preposed adverbials, then removal of those devices should interfere with comprehension.

We predicted that comprehension would be more difficult, as indicated by slower reading times, when the explicit signal of deictic shift (a preposed locative adverbial) was removed or moved from the initial position in the sentence. The difficulties imposed by failing to mark a deictic shift might not show up until the WHERE in the reader's DC failed to match the location of the events of the narrative described in subsequent sentences. Therefore, the effect on reading times of manipulating the adverbials should be greater for sentences immediately following the sentence with the adverbial manipulation. We expected deletion of adverbials to be more detrimental to understanding subsequent sentences than shifting adverbials within sentences, since in the latter case the information about the new location was still available.

6.3.1 Method

Design. The study used a $2 \times 2 \times 3$ within-subject design. Since a natural text was used, there were two types of "target" sentences; those that had preposed locative adverbials in the original version and those that did not. Reading times for two types of sentences were evaluated, the target sentence and the sentence that immediately followed the target sentence. There were three versions of the text. In one version, the target sentence was presented with a preposed locative adverbial; in the second, the target was presented with the locative adverbial in a non-initial position; and, in the third, the target had no adverbial.

Subjects. Subjects were 50 paid volunteers including high-school, undergraduate, and graduate students.

Materials and Task. The narratives to be read were variants of the first part of *The Pearl*, which is rich in adverbials and does not contain much dialogue. Eight target sentences that had preposed locative adverbials in the original text and eight that had none were selected. Three versions of the narrative were prepared, so that each target sentence appeared in a different form in each of the versions. Each subject read only one version of the narrative but received all 6 conditions (three types of target sentences in place of each of the two types of sentences in the original version).

The task was a self-paced, sentence-by-sentence reading task. Subjects viewed one sentence at a time on a computer monitor and signaled for the next sentence by pressing the space bar. Sentence reading times were measured by the time between space-bar presses. Subjects received a short practice passage from a mystery novel in order to get used to the task.

Subjects were periodically asked questions about the story in order to maintain an adequate level of attention and comprehension throughout the task. After each 30 or 40 sentences, subjects were stopped and asked to evaluate a set of 5 sentences about the most recently read section of the story. Subjects used a 6-point rating scale from certainly true to certainly false to indicate the degree to which they believed that the sentence was true or false of the narrative. There were 2 sets of test sentences in the practice passage and 7 sets in the test narrative.

6.3.2 Results

Because of the extreme variations in sentence length caused by using natural text, correlations between sentence length (number of words) and reading time were calculated for each subject, using only non-target sentences. These correlations were high, most in the 0.70s, 0.80s, and 0.90s, with a mean of 0.82. (One subject whose correlation was below 0.30 was replaced.)

A $2 \times 2 \times 3$ analysis of variance was performed on the reading times for the target and subsequent sentences after adjusting for sentence length. Difference scores were obtained by subtracting scores predicted on the basis of sentence length from the actual reading times. Thus, the reading score indicated whether reading time was faster than predicted by sentence length.

We assumed that an original sentence with a preposed adverbial signaled a shift in the WHERE of the DC. Overall, target and subsequent sentences were read more slowly if the original sentences had preposed adverbials: $F(1, 47) = 65.76$, $p = 0.0001$. The most interesting results, however, involve the significant three-way interaction of type of original sentence (preposed or not) by type of target sentence (preposed, non-initial, or no adverbial) by type of test sentence (target or subsequent): $F(2, 94) = 4.78$, $p = 0.0106$. This interaction reflects the fact that the importance of an adverbial and its position depends on whether a deictic shift occurs and whether the target sentence or subsequent

sentence is being read. When the target sentence is being read, an adverbial in a non-initial position slows reading time only when a shift occurs. Although preposing was still advantageous in the subsequent sentences, this was true whether or not a deictic shift occurred. The comparison of adverbial position as a function of both presence of a shift and the sentence being tested was significant: $F(1, 47) = 6.99, p = 0.0111$.

The effect of having no adverbial in the test sentence also depended on whether a shift occurred and which sentence was being tested. Lack of an adverbial did not influence reading time for target sentences regardless of whether or not a shift occurred. But a missing adverbial did slow reading time for subsequent sentences when a shift was signaled by the original version. This comparison of no adverbial with the average of both types of adverbials approached significance: $F(1, 47) = 3.26, p = 0.0773$.

6.3.3 Discussion

The results provide support for three conclusions. First, as predicted, after a deictic shift occurs (i.e., where the original text used a preposed adverbial), subsequent sentences are read more slowly if this shift was not signaled in the previous (target) sentence by an adverbial, particularly a preposed adverbial.

Second, our prediction about the effect of adverbial position as the signal of deictic shift received support. When a shift occurs, initial position seems to facilitate reading target sentences. Initial position may also have a slight advantage over non-initial position on subsequent sentences. When there is no deictic shift, none of the adverbial conditions have an effect on reading times for target sentences. This is consistent with our hypothesis about the importance of initial position in signaling a deictic shift in location.

We did not expect any effects of adverbials on reading times for subsequent sentences when no shift occurred. We assumed that restatement of the WHERE when no shift in location of narrative events has occurred would not be necessary or helpful. The reading time with initial-position adverbials was slightly faster than with no adverbials, but both led to faster reading times compared with non-initial-position adverbials.

There may be some basis for predicting slower reading of subsequent sentences when adverbials appear in the last position of the sentence. Adverbials in the final clause indicate a potential shift in the DC. Whether the shift occurs depends on the information in the subsequent sentences. An examination of reading times for certain subsequent sentences compared those following targets with adverbials in the middle of the sentence to those following targets with the adverbials in the final position. Reading times appear to be slower after final-position adverbials, but this comparison involved different sentences, and no statistics were applied. Further research on the role of adverbial position is clearly called for.

Third, there was a general tendency for both target and subsequent sentences around the location of a shift in the DC to be read more slowly than those where no such shift occurred. Further research is needed to determine whether this reflects the computation time needed to update the DC or whether it reflects some other factor, for example, the introduction of new terms.

6.4 Experiment 3

In this experiment (first reported in Daniels 1986), the stimuli were artificially constructed and reflected situations in the real world, acknowledging that general information has an influence on responses. General information should be used in construction of the mental model by the reader, not in construction of the response.

This experiment also examined the effect of the deictic verbs 'come' and 'go' and of preposed adverbials on conceptual movement of the DC in narrative text. It was assumed that the verb 'come' would maintain the WHERE of the DC and that 'go' would shift it to a new WHERE if the WHO were maintained. A reader should take longer to respond to a statement about an event that occurred in a WHERE that she has moved away from, since she must leave where she currently is in memory (the current DC) and go back to a previous DC to respond. We assume that a preposed adverbial in the text will shift the reader to a new DC, causing the reader to take longer to respond to a question about a past event than if the adverbial were absent. This would be due to the reader's returning mentally to a previous DC in order to find the relevant information to answer the question. However, the absence of a preposed adverbial may cause confusion if the reader cannot determine where she is in the mental model, because an important cue is missing. This will leave the reader in the previous DC, trying to incorporate current linguistic input into an incomplete model.

John and Mary were eating dinner when there was a knock at the door.
John got up and went to answer the door.
John looked up to see his partner come in.
Kevin greeted John with a bottle of champagne and a big hug.
They had just won a large advertising account.

Mary is in the dining room.

Figure 3. Sample Experimental Set for Experiment 3.

6.4.1 Method

Subjects. Subjects were 48 SUNY Buffalo undergraduate students, who participated to fulfill a requirement for their introductory psychology course.

Materials. Each subject was presented with 50 narratives of 4 sentences each (cf. Fig. 3). Ten narratives were designed to investigate the role of preposed adverbials: 5 compared a sentence with ‘come’ vs. ‘go’, and 5 compared a sentence with ‘go’ vs. a non-movement marker such as ‘remain’, ‘stay’, or ‘be’.

In each case, two versions of each narrative were used; only one sentence differed between versions. For example, in the narrative of Figure 3, the starred sentences were the only differences in the presentation set; each set had only one of the starred sentences. The target (the statement requiring a true-false response) was the same in all versions; it always referred back to the original DC.

Subjects also saw 28 fillers, also composed of 4 sentences each. Fillers generally described a situation or scene without any movement, and fillers were the same for all versions.

The narrative presentation order was randomized. After the first 4 sentences had been presented, the subject saw a row of asterisks flash on the screen to signal that he or she should respond ‘true’ or ‘false’ to the statement that would immediately follow, based on the information provided in the preceding sentences.

Procedure. Narratives were presented on an Apple IIe computer with a Thunder Clock Card controlling the timing to the nearest millisecond. Subjects were given printed instructions to read. They were then given oral directions, with general printed directions repeated again on the computer screen. This was followed by 10 practice narratives. After the practice session, general directions were again displayed. Subjects pressed the space bar to have the present sentence disappear and the next sentence or row of asterisks appear. The true-false test statement was presented automatically after the row of asterisks disappeared. Subjects pressed the space bar if the statement was true, and any other key if it was false.

6.4.2 Results

The results (see Figure 4) were significant for both the ‘come’/‘go’ and the preposition/no-preposition distinctions using the paired sample *t*-test. The ‘come’/‘go’ distinction showed significance: $t(8) = 4.74, p < 0.01$. The preposition/no-preposition distinction showed significance: $t(11) = 3.11, p < 0.05$. There was also a main effect of movement vs. non-movement: $t(19) = 4.07, p < 0.01$. (Two narrative sets examining the ‘come’/‘go’ distinction were deleted from analysis due to excessive errors in subject responses to the final statement. Item-by-item examination determined that these sets should be eliminated, since the overall error rate excluding these two sets was less than 1%.)

	Movement		Non-Movement
'go'	3.17 sec.	'come'	2.64 sec.
Preposition	2.77 sec.	No Preposition	2.49 sec.

Figure 4. Mean reading/reaction times to the same final statement presented in compared test sets.

6.4.3 Discussion

Movement through narrative in terms of space and time is dependent not only upon general world knowledge about how events and space are laid out in the real world and on specific types of linguistic markers, but also on the previous DC. The WHO, WHEN, and WHERE that are involved at any place in a narrative text are all currently activated in a focusing mechanism, the DC. When the DC shifts to a new WHO, WHEN, or WHERE, we, as comprehenders, update our current knowledge accordingly. The psychological validity of the DC is evident from the results investigating the movement of the WHERE in this experiment. If a reader remains in a DC and new information does not update this DC to a new DC, then, when asked about the first DC, the reader is “there” at the first DC in his or her mental model, and can respond quickly. If the DC has shifted and the reader is asked about the first DC, then s/he takes longer to respond, because s/he must leave the current center—the second DC—and interrogate information about the first DC, which is now at a mental distance.

7 Deixis and Individual Differences

Although the research described thus far deals with third-person, fictional texts, we are also investigating the production and comprehension of spontaneous oral narratives, including first-person, non-fictional accounts of events. Individuals understand narrative by regarding the events described in a heard or read text from the vantage point of the DC. Distinct individual comprehenders may understand deictic specifications in narrative differently from one another, since they construct their understandings from a unique knowledge base. That knowledge base is built from many sources. One important variable is the comprehender’s real-world deictic position in relation to the speaker’s act of utterance. Another is the world knowledge a comprehender draws upon to make sense of a particular text.

As an example of differing relations to the act of utterance, compare the situation in which an intended audience faces a narrator as she speaks with the situation of reading a transcript of the same narrative without access to the narrator’s paralinguistic cues. In the text below, a 5-year-old is addressing her comments to comprehenders who are sitting around in a “sharing time” situation in a kindergarten:

And I got *this* for my birthday.
 My mother bought *it* for me.
 And I had two dollars for my birthday.
 And I put it in *here*.

Non-present comprehenders reading this must infer the objects of the italicized referring expressions, since they are not specified in the text, whereas comprehenders who are present and to whom the text is addressed are able to see the objects of the referring expressions and are spared the task of supplying plausible objects.

While physical situational differences obviously affect the task of comprehension, differences in contextual knowledge influence comprehenders in more subtle and idiosyncratic ways. For example, a comprehender who is familiar with a particular family’s tradition of having birthday parties at a park would easily infer that the birthday gift described by the child in the following narrative passage was given to her in the park:

I went . . . to the park and I got this for my birthday.

Comprehenders who do not have the background knowledge about this child’s family traditions might be able to infer from narrative conventions that the birthday gift was given in the park, but they would take more time to make the inference and might regard the narrative as confusing or difficult.

An oral narrative such as that spoken by the above 5-year-old to her familiar peers is intended for a particular comprehender—the *intended* comprehender. If such a narrative is presented to an *unintended* comprehender, it will usually take longer to understand, as well as increase the comprehender’s judgment of text difficulty.

As part of our investigation of the DC and its effects on the comprehension of narrative texts, we have made selections from narrative transcripts that present particular difficulty for readers who are unintended comprehenders. Our selections involve passages that require missing spatial deictic information for their comprehension. Since unintended comprehenders lack such knowledge, they will experience what we call *spatial gaps*. These are informational gaps in spatial knowledge that create potential for idiosyncratic interpretations. The spatial gaps have to do with lack of knowledge needed to establish a DC, indicate deictic shift, determine relevance of provided content, and resolve apparent contradictory deictic information.

7.1 Establishing Deictic Centers

In order to understand some texts, the reader uses a mental model of where the characters are located. The model is created from what is provided in the text as well as what is known about the world. Consider the following text, a transcript of an oral narrative produced by 5-year-old Wally:

Once there was a little boy who lived in the forest with his mother and father and his pet water beetle.
* He waited in the rain for his water beetle to come inside.
He said, “Come inside, water beetle!”
“No, I’m supposed to like the rain.
That’s why they call me the water beetle.”
(Paley 1981.)

Unintended comprehenders reading this text have no background information about the location of the boy and the water beetle. The opening sentence might lead unintended comprehenders to place the characters in a house in the forest, since that is where they live. The beginning of the starred sentence then contradicts this assumption, since the boy is waiting for his water beetle in the rain, implying that the boy is outside rather than in the house. But the end of the starred sentence, ‘to come inside,’ once again cues the comprehender that the boy is inside, since the verb ‘come’ indicates that the WHERE is inside, and the boy as focal WHO occupies the WHERE.

Presented with these apparent contradictions, a comprehender may try to “save” the text by constructing a scenario that makes sense of the text as it is. For example, one might picture the boy as on the porch of the house, so that he might be in the rain but also close enough to inside to say ‘come inside’, as people returning home say to friends who accompany them to their doorstep. Alternatively, a comprehender may decide that the narrative is anomalous. The various strategies that individual comprehenders use to resolve the apparent contradictions in the deictic cues of the text will produce different resulting interpretations of the story.

7.2 Indicating Deictic Shifts

In the passage that follows, a 4-year-old (J) is describing an event to her questioner (E) involving a visit to her grandmother. The questioner is unfamiliar with E’s family history and knows nothing about the circumstances surrounding the told event:

E: Have you ever been on a trip?
J: Uh-huh. Yeah.
E: You have?
J: Yeah, to my grandma’s.
E: You went to your grandma’s? What happened?
J: I just said “Hiii,”
and then and then they, Mom said, said, “Say, say something.”
And I said, “Noo, I wanta go home.”
“Not till you say, say, say hello.”
“I said hello, Ma.”
* And then she, and then my Mom goed back to my grandma’s
and then she said, “Oh, she’s just a bad girl,”
Like that.

The event depicted by J revolves around a dispute held between her and her mother. Unintended comprehenders as well as E, the intended comprehender, are likely to interpret the description as being about a dispute that took place in the presence of the child's grandmother at her grandmother's house. This creates a problem for both intended and unintended comprehenders when interpreting the starred sentence, which requires that the mother be away from the grandmother's, since she is described here as returning. In order to understand the narrative, comprehenders must resolve the problem. One possible resolution is to presume that the mother at some point left the scene and then went back. A second is to presume that the child and mother are at one place at the grandmother's house talking behind the grandmother's back, and that the mother then goes back to the vicinity of where the grandmother is (cf. "My mom goed back to my grandma's"). The second interpretation presumes that the possessive 's' in 'grandma's' was not said or intended by the child.

This example indicates how a spatial gap can be created when characters move from one place to another and the origin or destination is not explicitly specified or easily inferrable. In this case, intended as well as unintended comprehenders need to fill in the spatial gap in order to construct a coherent sense from the various circumstances being described.

7.3 Determining Relevance of Provided Content

Comprehenders, whether intended or unintended audiences of the speaker, presume that the deictic information that is provided is consistent and can be integrated with other information known about the text content (cf. Grice's (1975) Principle of Relevance). Consider the following passage told by a 5-year-old (M) to a relative stranger (E):

E: Did your dog ever run away?

M: Noo. 'Cept when we moved over to the old house, 'cause he missed it.

E: When you were over to the old house? 'Cause you moved and he ran away?

M: Yeah, but we didn't move that day.

We're at, we lived at our own, our new house.

E: Oh, I see.

M: Then when we went to our old house, Fritz ran away.

* We have a cousin by the old house.

E: Oh you do?

M: Yep.

Unintended comprehenders, such as those who read this passage for the first time, might not know why the narrator has mentioned that she has "a cousin by the old house". By inference, an unintended comprehender might presume that the family had moved, that they had gone back to an old neighborhood to visit a cousin, and that the dog ran away from the cousin's house. The confusion is exacerbated by information provided in the child's first sentence about moving over to the old house. One possible resolution for an unintended comprehender is to assume that 'over to the old house' was an adverbial phrase modifying the verb phrase 'ran away' rather than 'moved'. A second would be to assume that the speaker made a mistake, not saying what she meant. For example, she may have intended to mean:

'Cept when we moved over to the new house, 'cause he missed the old house.

In this example, the source of the deictic gap is the connection between the starred sentence and the rest of the text. The high degree of inference which an unintended comprehender needs in order to be able to resolve the coherence problem in this passage is evidence that unintended comprehenders sometimes need to do considerable work to make texts cohere deictically.

7.4 Resolving Contradictory Deictic Information

Texts may include not only non-integrated information, but also information that, when integration is attempted, is contradictory. For example, in the following text, a 5-year-old (B) first reports that her friend Barbara went to the party and then that she didn't go. Similarly, she depicts herself in the beginning as going, but later in the discussion says that she didn't go:

B: So we had a witch game at Renee's party.

E: You had a witch game?

B: We had a party, and we had some gum and chips.
 E: You had some chips?
 B: Yeah. And gum, and pretzels.
 and all the people comed.
 * And so me and Renee and Beth Ann and Barbara come.
 * Barbara didn't come to the party cause she didn't want to.
 So, so we had, we have a fun party.
 And Beth Ann and Barbara comed over Renee's and she blew out the can.
 And now go to the party.
 E: She blew out all the candles?
 B: Yeah. And she, and, and they cut up the cake
 And I didn't get any cake.
 E: You didn't get any cake?
 B: * But I was home, at my, my Mom didn't want me go.
 E: You were home and your Mommy didn't want you to go?
 B: She didn't want me go Renee's house.
 E: Oh.
 B: She didn't want me to go to Renee's house.

A comprehender would need to resolve the deictic inconsistencies by hypothesizing that one version of the story is a fantasy version or that the child is talking about two different parties. An unintended comprehender who tracks deictic information will become confused under these contradictory textual conditions and must construct a hypothesis for accounting for the two versions. Different listeners are likely to supply coherence in very different ways in this passage, resulting in different mental models of what the child is intending.

8 Conclusion

In this paper, we have described an interdisciplinary, cognitive-science research program in which we propose that the comprehender of a narrative contributes to his or her understanding of the narrative by actively constructing and updating a data structure—the deictic center—containing information about “WHERE” and “WHEN” events occur in the world of the story told by the narrative and “WHO” participates in these events. We have presented some of our initial findings from linguistics and literary narrative theory (on specific textual cues for constructing and updating the DC), from cognitive psychology and the study of individual differences (on the results of experiments with adult readers to test some of these cues and on the differences between children's and adults' narratives), and from artificial intelligence (on the computational model of our theory). We are continuing to explore the varieties of spatial, temporal, and personal deixis in narrative and to interrelate our findings.

Acknowledgments

This paper discusses an interdisciplinary research project supported principally by National Science Foundation Grant No. IRI-8610517. Bruder was Project Director; Bruder, Duchan, Rapaport, Segal, Shapiro, and Zubin were Co-Principal Investigators; Almeida, Daniels, Galbraith, and Yuhan were Research Assistants. Parts of the research have also been supported by National Science Foundation Grant No. IST-8504713 (Rapaport). An earlier version of this paper appeared as Bruder, Duchan, et al. 1986. We also wish to thank Daniel Devitt, Lorraine Engl, Lynne Hewitt, David Mark, Carol Siegel, and Noriko Watanabe for their contributions to the project and for their comments on earlier versions of this paper. Current addresses of the authors are:

Michael J. Almeida, Department of Mathematics and Computer Science, University of Maryland Eastern Shore,
 Princess Anne, MD 21853;
 Gail A. Bruder, c/o Department of Psychology, SUNY Buffalo, Buffalo, NY 14260;
 Judith Felson Duchan, c/o Department of Communicative Disorders and Sciences, SUNY Buffalo, Buffalo, NY
 14214;
 Mary Galbraith, 4502 Mont Henry Ave., San Diego, CA 92117;
 Erwin M. Segal, Department of Psychology, SUNY Buffalo, Buffalo, NY 14260;
 Stuart C. Shapiro, Department of Computer Science and Engineering, SUNY Buffalo, Buffalo, NY 14260;

William J. Rapaport, Department of Computer Science and Engineering, SUNY Buffalo, Buffalo, NY 14260;
Janyce M. Wiebe, Department of Computer Science, University of Pittsburgh, Pittsburgh, PA 15260;
Albert Hanyong Yuhan, 6 Haytown Road, Lebanon, NJ 08833-4004;
David A. Zubin, Department of Linguistics, SUNY Buffalo, Buffalo, NY 14260.

Correspondence and requests for reprints should be addressed to Rapaport (rapaport@cse.buffalo.edu).

References

- Almeida, Michael J. (1987), "Reasoning about the Temporal Structure of Narratives," *Technical Report 87-10* (Buffalo: SUNY Buffalo Department of Computer Science).
- Almeida, Michael J. (1995), "Time in Narratives," in Duchan, Judith F.; Bruder, Gail A.; & Hewitt, Lynne (eds.), *Deixis in Narrative: A Cognitive Science Perspective* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Almeida, Michael J., & Shapiro, Stuart C. (1983), "Reasoning about the Temporal Structure of Narrative Texts," *Proceedings of the 5th Annual Conference of the Cognitive Science Society (University of Rochester)* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Bakhtin, Mikhail (1981), *The Dialectical Imagination*, M. Holquist (ed.), C. Emerson & M. Holquist (trans.) (Austin: University of Texas Press).
- Bal, Mieke (1985), *Narratology*, C. van Boheemen (trans.) (Toronto: University of Toronto Press).
- Banfield, Ann (1982), *Unspeakable Sentences: Narration and Representation in the Language of Fiction* (Boston: Routledge & Kegan Paul).
- Barwise, Jon, & Perry, John (1983), *Situations and Attitudes* (Cambridge, MA: MIT Press).
- Benveniste, Emile (1970), *Problems in General Linguistics*, M. E. Meek (trans.) (Coral Gables, FL: University of Miami Press).
- Bobrow, D. G., & Collins, A. (eds.) (1975), *Representation and Understanding: Studies in Cognitive Science* (New York: Academic Press).
- Brachman, Ronald J., & Levesque, Hector J. (eds.) (1985), *Readings in Knowledge Representation* (Los Altos, CA: Morgan Kaufmann).
- Bransford, John D.; Barclay, J. Richard; & Franks, Jeffery J. (1972), "Sentence Memory: A Constructive Versus Interpretive Approach," *Cognitive Psychology* 3: 193–209.
- Brecht, Richard D. (1974), "Deixis in Embedded Structures," *Foundations of Language* 11: 489–518.
- Brown, G., & Yule, G. (1983), *Discourse Analysis* (Cambridge, Eng.: Cambridge University Press).
- Bruder, Gail; Engl, Lorraine; & Schultz, J. (1985), "Proposed Adverbials Signal Change in the Narrative Deictic Center," paper presented at the Psychonomic Society, Boston.
- Bruder, Gail A.; Duchan, Judith F.; Rapaport, William J.; Segal, Erwin M.; Shapiro, Stuart C.; & Zubin, David A. (1986), "Deictic Centers in Narrative: An Interdisciplinary Cognitive–Science Project," *Technical Report No. 86-20* (Buffalo: SUNY Buffalo Department of Computer Science).
- Bühler, Karl (1934), "The Deictic Field of Language and Deictic Words," in R. J. Jarvella & W. Klein (trans. and eds.), *Speech, Place and Action: Studies in Deixis and Related Topics* (Chichester, Eng.: John Wiley & Sons): 9–30. .EQ delim off .EN
- Castañeda, Hector-Neri (1966), "'He': A Study in the Logic of Self-Consciousness," *Ratio* 8: 130–157.
- Castañeda, Hector-Neri (1967), "Indicators and Quasi-Indicators," *American Philosophical Quarterly* 4: 85–100.
- Castañeda, Hector-Neri (1970), "On the Philosophical Foundations of the Theory of Communication: Reference," *Midwest Studies in Philosophy* 2 (1977) 165–186.
- Chalupsky, Hans (1993), "Using Hypothetical Reasoning as a Method for Belief Ascription," *Journal of Experimental and Theoretical Artificial Intelligence* 5: 119–133.
- Chatman, Seymour (1978), *Story and Discourse* (Ithaca, NY: Cornell University Press).
- Chomsky, Noam (1965), *Aspects of the Theory of Syntax* (Cambridge, MA: MIT Press).
- Clark, Herbert H. (1973), "Space, Time, Semantics, and the Child," in T. E. Moore (ed.), *Cognitive Development and the Acquisition of Language* (New York: Academic Press): 27–63.
- Clark, Herbert H., & Clark, Eve V. (1977), *Psychology and Language: An Introduction to Psycholinguistics* (New York: Harcourt Brace Jovanovich).
- Cohn, Dorrit (1978), *Transparent Minds: Narrative Modes for Presenting Consciousness in Fiction* (Princeton: Princeton University Press).
- Daniels, Joyce H. (1986), "A Psychological Investigation into the Deictic Center," *Proceedings of the 8th Annual Conference of the Cognitive Science Society (University of Massachusetts at Amherst)* (Hillsdale, NJ: Lawrence Erlbaum Associates): 621–626.
- de Beaugrande, R., & Dressler, W. (1981), *Introduction to Text Linguistics* (London: Longman).
- Duchan, Judith F.; Bruder, Gail A.; & Hewitt, Lynne (eds.) (1995), *Deixis in Narrative: A Cognitive Science Perspective* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Fauconnier, Gilles (1985), *Mental Spaces: Aspects of Meaning Construction in Natural Language* (Cambridge, MA: MIT Press).

- Fillmore, Charles (1975), *Santa Cruz Lectures on Deixis* (Bloomington: Indiana University Linguistics Club).
- Fowler, Roger (1977), *Linguistics and the Novel* (London: Methuen).
- Geis, M. (1985), "On the Superiority of Monostratal to Multistratal Accounts of Adverb Preposing," *Proceedings of ESCOL 1985*.
- Genette, Gerard (1980), *Narrative Discourse: An Essay in Method*, J. E. Lewin (trans.) (Ithaca: Cornell University Press).
- Givon, Talmy (ed.) (1979), *Syntax and Semantics 12: Discourse and Syntax* (New York: Academic Press).
- Greenspan, S. L., & Segal, E. M. (1984), "Reference and Comprehension: A Topic-Comment Analysis of Sentence-Picture Verification," *Cognitive Psychology* 16: 556–606.
- Grice, H. Paul (1975), "Logic and Conversation," in P. Cole & J. Morgan (eds.), *Syntax and Semantics 3* (New York: Academic Press): 41–58.
- Grimes, J. (ed.) (1975), *The Thread of Discourse* (The Hague: Mouton).
- Grosz, Barbara J. (1981), "Focusing and Description in Natural Language Dialogues," in Joshi, Webber, & Sag 1981: 84–105.
- Gunderson, Keith (ed.) (1975), *Language, Mind, and Knowledge* (Minneapolis: University of Minnesota Press).
- Haiman, J., & Munro, P. (eds.) (1983), *Switch Reference and Universal Grammar* (Amsterdam: J. Benjamins).
- Halle, Morris; Bresnan, Joan; & Miller, George A. (eds.) (1978), *Linguistic Theory and Psychological Reality* (Cambridge, MA: MIT Press).
- Halliday, M. A. K., & Hasan, R. (1976), *Cohesion in English* (London: Longman).
- Hamburger, Kate (1973), *The Logic of Literature*, M.J. Rose (trans.) (Bloomington: Indiana University Press).
- Hopper, Paul (1979), "Aspect and Foregrounding in Discourse," in Givon 1979: 213–241.
- Hopper, Paul (ed.) (1982), *Tense-Aspect: Between Semantics and Pragmatics* (Amsterdam: J. Benjamins).
- Hopper, P., & Thompson, S. A. (1980), "Transitivity in Grammar and Discourse," *Language* 56: 251–299.
- Iser, Wolfgang (1978), *The Act of Reading* (Baltimore: John Hopkins University Press).
- Johnson-Laird, Philip N. (1983), *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness* (Cambridge, MA: Harvard University Press).
- Joshi, Aravind K.; Webber, Bonnie L.; & Sag, Ivan A. (eds.) (1981), *Elements of Discourse Understanding* (Cambridge, Eng.: Cambridge University Press).
- Kamp, Hans (1984), "A Theory of Truth and Semantic Representation," in J. Groenendijk, T. M. V. Janssen, & M. Stokhof (eds.), *Truth, Interpretation and Information* (Dordrecht: Foris): 1–41.
- Kintsch, W., & Van Dijk, T. A. (1978), "Toward a Model of Text Comprehension and Production," *Psychological Review* 85: 363–394.
- Kuipers, Benjamin (1978), "Modeling Spatial Knowledge," *Cognitive Science* 2: 129–153.
- Kuipers, Benjamin (1983a), "The Cognitive Map: Could It Have Been Any Other Way?," in Pick & Acredolo 1983: 345–359.
- Kuipers, Benjamin (1983b), "Modeling Human Knowledge of Routes: Partial Knowledge and Individual Variation," *Proceedings of the National Conference on Artificial Intelligence (AAAI-83, Washington, DC)* (Los Altos, CA: Morgan Kaufmann): 216–219.
- Kuroda, S.-Y. (1973), "Where Epistemology, Style, and Grammar Meet: A Case Study from the Japanese," in P. Kiparsky & S. Andersen (eds.), *A Festschrift for Morris Halle* (New York: Holt, Rinehart and Winston): 377–391.
- Lakoff, George, & Johnson, Mark (1980), *Metaphors We Live By* (Chicago: University of Chicago Press).
- Landau, Misia (1984), "Human Evolution in Narrative," *American Scientist* 72: 262–268.
- Lenneberg, Eric H. (1967), *Biological Foundations of Language* (New York: Wiley).
- Li, Naicong, & Zubin, David A. (1995), "Perspective Taking in Mandarin Discourse," in Duchan, Judith F.; Bruder, Gail A.; & Hewitt, Lynne (eds.), *Deixis in Narrative: A Cognitive Science Perspective* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Longacre, Robert F. (1983), *The Grammar of Discourse* (New York: Plenum Press).
- Lyons, John (1977), *Semantics*, Volume 2 (London: Cambridge University Press).
- Maida, Anthony S., & Shapiro, Stuart C. (1982), "Intensional Concepts in Propositional Semantic Networks," *Cognitive Science* 6: 291–330; reprinted in Brachman & Levesque 1985: 169–189.
- Mandler, J. M., & Johnson, N. S. (1977), "Remembrance of Things Parsed: Story Structure and Recall," *Cognitive Psychology* 9: 111–151.
- Mark, David; Svorou, Soteria; & Zubin, David A. (1987), "Spatial Terms and Spatial Concepts: Geographic, Cognitive, and Linguistic Perspectives," *Proceedings of the International Symposium on Geographic Information Systems: The Research Agenda* (Crystal City, VA).
- McDermott, Drew (1980), "A Theory of Metric Spatial Inference," *Proceedings of the First Annual National Conference on Artificial Intelligence (AAAI-80, Stanford University)* (Los Altos, CA: Morgan Kaufmann): 246–248.
- Mink, L. O. (1978), "Narrative Form as a Cognitive Instrument," in R. H. Canary & H. Korzicki (eds.), *The Writing of History* (Madison: University of Wisconsin Press): 129–149.
- Minsky, Marvin (ed.) (1968), *Semantic Information Processing* (Cambridge, MA: MIT Press).
- Minsky, Marvin (1975), "A Framework for Representing Knowledge," in P. H. Winston (ed.), *The Psychology of Computer Vision* (New York: McGraw-Hill); reprinted in J. Haugeland (ed.) *Mind Design* (Cambridge, MA: MIT Press, 1981): 95–128; reprinted in Brachman & Levesque 1985: 245–262.
- Nakhimovsky, Alexander, & Rapaport, William J. (1988), "Discontinuities in Narratives" *Proceedings of the 12th International*

- Conference on Computational Linguistics (COLING-88, Budapest).*
- Norman, Donald A. (ed.) (1981), *Perspectives on Cognitive Science* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Oblor, L.K., & Menn, L. (eds.) (1982), *Exceptional Language and Linguistics* (New York: Academic Press).
- O'Connor, Flannery (1949), *Wise Blood* (New York: Farrar, Strauss and Giroux).
- Paley, V. (1981), *Wally's Stories* (Cambridge, MA: Harvard University Press).
- Pick, Herbert L., Jr.; & Acredolo, Linda P. (eds.) (1983), *Spatial Orientation: Theory, Research, and Application* (New York: Plenum Press).
- Pinxton, R.; van Dooren, I.; & Harvey, F. (1983), *Anthropology of Space: Explorations into the Natural Philosophy and Semantics of Navajo* (Philadelphia: University of Pennsylvania Press).
- Polanyi, Livia, & Scha, Remko (1984) "A Syntactic Approach to Discourse Semantics," *Proceedings of the 10th International Conference on Computational Linguistics (COLING-84, Stanford University)* (Morristown, NJ: Association for Computational Linguistics): 413–419.
- Quine, Willard Van Orman (1960), *Word and Object* (Cambridge, MA: MIT Press).
- Rapaport, William J. (1984), "Belief Representation and Quasi-Indicators," *Technical Report No. 215* (Buffalo: SUNY Buffalo Department of Computer Science).
- Rapaport, William J. (1986), "Logical Foundations for Belief Representation," *Cognitive Science* 10: 371–422.
- Rapaport, William J. (1988), "Syntactic Semantics: Foundations of Computational Natural-Language Understanding," in J.H. Fetzer (ed.) *Aspects of Artificial Intelligence* (Dordrecht, Holland: Kluwer Academic Publishers): 81–131; preprinted as *Technical Report 86-24* (Buffalo: SUNY Buffalo Department of Computer Science, 1986).
- Rapaport, William J. (1991), "Predication, Fiction, and Artificial Intelligence," *Topoi* 10: 79–111.
- Rapaport, William J., & Shapiro, Stuart C. (1984), "Quasi-Indexical Reference in Propositional Semantic Networks," *Proceedings of the 10th International Conference on Computational Linguistics (COLING-84, Stanford University)* (Morristown, NJ: Association for Computational Linguistics): 65–70.
- Rapaport, William J., & Shapiro, Stuart C. (1995), "Cognition and Fiction," in Duchan, Judith F.; Bruder, Gail A.; & Hewitt, Lynne (eds.), *Deixis in Narrative: A Cognitive Science Perspective* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Reichman, Rachel (1985), *Getting Computers to Talk Like You and Me: Discourse Context, Focus, and Semantics (An ATN Model)* (Cambridge, MA: MIT Press).
- Reid, W. (1977), "The Quantitative Validation of a Grammatical Hypothesis: The Passé Simple and the Imparfait," *NELS* 7: 315–333.
- Rumelhart, Donald E. (1975), "Notes on a Schema for Stories," in Bobrow & Collins 1975: 211–236.
- Schank, Roger C. (1982), *Dynamic Memory: A Theory of Reminding and Learning in Computers and People* (Cambridge, Eng.: Cambridge University Press).
- Schank, R.C., & Abelson, R.P. (1977), *Scripts, Plans, Goals and Understanding* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Segal, Erwin; Bruder, Gail; & Daniels, Joyce (1984), "Deictic Centers in Narrative Comprehension," paper presented at Psychonomic Society, San Antonio.
- Shapiro, Stuart C. (1979), "The SNePS Semantic Network Processing System," in N.V. Findler (ed.), *Associative Networks* (New York: Academic Press): 179–203.
- Shapiro, Stuart C. (1982), "Generalized Augmented Transition Network Grammars for Generation from Semantic Networks," *American Journal of Computational Linguistics* 8: 12–25.
- Shapiro, Stuart C., & Rapaport, William J. (1987), "SNePS Considered as a Fully Intensional Propositional Semantic Network," in N. Cercone & G. McCalla (eds.), *The Knowledge Frontier: Essays in the Representation of Knowledge* (New York: Springer-Verlag): 262–315; earlier version preprinted as *Technical Report No. 85-15* (Buffalo: SUNY Buffalo Department of Computer Science, 1985); shorter version appeared in *Proceedings of the Fifth National Conference on Artificial Intelligence (AAAI-86, Philadelphia)* (Los Altos, CA: Morgan Kaufmann): 278–283.
- Shapiro, Stuart C., & Rapaport, William J. (1991), "Models and Minds: Knowledge Representation for Natural-Language Competence," in R. Cummins & J. Pollock (eds.), *Philosophy and AI: Essays at the Interface* (Cambridge, MA: MIT Press): 215–259.
- Shapiro, Stuart C., & Rapaport, William J. (1992), "The SNePS Family," *Computers and Mathematics with Applications* 23: 243–275.
- Shapiro, Stuart C., & Rapaport, William J. (1995), "An Introduction to a Computational Reader of Narrative," in Duchan, Judith F.; Bruder, Gail A.; & Hewitt, Lynne (eds.), *Deixis in Narrative: A Cognitive Science Perspective* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Slobin, D. I. (1979), *Psycholinguistics* (Glenview, IL: Scott, Foresman).
- Smith, N.V. (1982), *Mutual Knowledge* (London: Academic Press).
- Sondheimer, Norman (1976), "Spatial Inference and Natural-Language Machine Control," *International Journal of Man-Machine Studies* 8: 329–336.
- Sondheimer, Norman (1978a), "Semantic Analysis of Reference to Spatial Properties," *Linguistics and Philosophy* 2: 235–280.
- Sondheimer, Norman (1978b), "Spatial Reference and Semantic Nets," *American Journal of Computational Linguistics*, microfiche

- Sondheimer, Norman, & Perry, D. (1975), "SPS: A Formalism for Semantic Interpretation and Its Use in Processing Prepositions that Reference Space," *American Journal of Computational Linguistics*, Microfiche 34.
- Steinbeck, John (1945), *The Pearl* (New York: Bantam Books).
- Talmy, Leonard (1975), "Semantics and Syntax of Motion," in J.P. Kimball (ed.), *Syntax and Semantics 4* (New York: Academic Press): 181–238.
- Talmy, Leonard (1978), "Figure and Ground in Complex Sentences," in J. Greenberg, C. Ferguson, & E. Moravcsik (eds.), *Universals of Human Language* (Stanford, CA: Stanford University Press): 625–649.
- Talmy, Leonard (1983), "How Language Structures Space," in Pick & Acredolo 1983: 225–282.
- Traugott, Elizabeth C. (1978), "Spatio-Temporal Relations," in J. Greenberg, C. Ferguson, & E. Moravcsik (eds.), *Universals of Human Language*, Vol. 3 (Stanford, CA: Stanford University Press).
- Uspensky, Boris (1973), *A Poetics of Composition*, V. Zavarin & S. Wittig (trans.) (Berkeley: University of California Press).
- Vendler, Zeno (1957), "Verbs and Times," *Philosophical Review* 66: 143–160.
- Webber, Bonnie Lynn (1987), "The Interpretation of Tense in Discourse," *Proceedings of the 25th Annual Meeting of the Association for Computational Linguistics (Stanford University)* (Morristown, NJ: Association for Computational Linguistics): 147–154.
- Wiebe, Janyce M. (1990), "Recognizing Subjective Sentences: A Computational Investigation of Narrative Text," *Technical Report 90-03* (Buffalo: SUNY Buffalo Department of Computer Science).
- Wiebe, Janyce M. (1991), "References in Narrative Text", *Noûs*, Special Issue on Cognitive Science and Artificial Intelligence, Vol. 25: 457–486.
- Wiebe, Janyce M. (1994), "Tracking Point of View in Narrative", *Computational Linguistics* 20.
- Wiebe, Janyce M., & Rapaport, William J. (1986), "Representing *De Re* and *De Dicto* Belief Reports in Discourse and Narrative," *Proceedings of the IEEE* 74: 1405–1413.
- Wiebe, Janyce M., & Rapaport, William J. (1988), "A Computational Theory of Perspective and Reference in Narrative" *Proceedings of the 26th Annual Meeting of the Association for Computational Linguistics (SUNY Buffalo)* (Morristown, NJ: Association for Computational Linguistics): 131–138.
- Yuhan, Albert Hanyong (1991), "Dynamic Computation of Spatial Reference Frames in Narrative Understanding," *Technical Report No. 91-03* (Buffalo: SUNY Buffalo Department of Computer Science).
- Yuhan, Albert Hanyong, & Shapiro, Stuart C. (1995), "Computational Representation of Space," in Duchan, Judith F.; Bruder, Gail A.; & Hewitt, Lynne (eds.), *Deixis in Narrative: A Cognitive Science Perspective* (Hillsdale, NJ: Lawrence Erlbaum Associates).
- Zubin, David A. (1975), "On the Distributional Properties of Surface Morphology and Their Consequences for Semantic Analysis," in W. Diver (ed.), *Columbia University Working Papers in Linguistics* 2: 189–218.
- Zubin, David A. (1977), "The Semantic Basis of Case Alteration in German," in R. Fasold & R. Shuy (eds.), *Studies in Language Variation* (Washington, DC: Georgetown University Press).
- Zubin, David A. (1979), "Discourse Function of Morphology: The Focus System in German," in Givon 1979: 469–504.
- Zubin, David A. (1980), "Meaning Versus Government," in W. Diver (ed.), *Columbia University Working Papers in Linguistics* 5: 20–33.
- Zubin, David A., & Choi, S. (1984), "Orientation and Gestalt: Conceptual Organizing Principles in the Lexicalization of Space," in Testen, Mishra, & Drogo (eds.), *Papers from the Parasession on Lexical Semantics, Chicago Linguistics Society* 20: 333–345.