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Constructing Inferences During Narrative Text Comprehension

Arthur C. Graesser, Murray Singer, and Tom Trabasso

The authors describe a constructionist theory that accounts for the knowledge-based inferences that are constructed when readers comprehend narrative text. Readers potentially generate a rich variety of inferences when they construct a referential situation model of what the text is about. The proposed constructionist theory specifies that some, but not all, of this information is constructed under most conditions of comprehension. The distinctive assumptions of the constructionist theory embrace a principle of *search (or effort) after meaning*. According to this principle, readers attempt to construct a meaning representation that addresses the reader's goals, that is coherent at both local and global levels, and that explains why actions, events, and states are mentioned in the text. This study reviews empirical evidence that addresses this theory and contrasts it with alternative theoretical frameworks.

An adequate psychological theory of text comprehension should be able to account for the generation of inferences when readers construct a *situation model* of what a text is about. A situation model is a mental representation of the people, setting, actions, and events that are mentioned in explicit clauses or that are filled in inferentially by world knowledge (Bower, 1989; Garnham & Oakhill, in press; Glenberg, Meyer, & Lindem, 1987; Johnson-Laird, 1983; Kintsch, 1988; Morrow, Greenspan, & Bower, 1987; Singer, 1990; van Dijk & Kintsch, 1983). For example, suppose that an adult reads a novel. Several classes of knowledge-based inferences are potentially constructed during comprehension: The goals and plans that motivate characters' actions, characters' knowledge and beliefs, traits, emotions, the causes of events, properties of objects, spatial relationships among entities, expectations about future episodes in the plot, referents of nouns and pronouns, attitudes of the writer, emotional reactions of the reader, and so on. Some of these inferences are normally generated "on-line" (i.e., during the course of comprehension), whereas others are normally "off-line" (i.e., generated during a later retrieval task but not during comprehension). Researchers in cognitive psychology and discourse processing have attempted to identify and explain which classes of inferences are normally generated on-line (Balota, Flores d'Arcais, & Rayner, 1990; Graesser & Bower, 1990; Graesser & Kreuz, 1993; Kintsch, 1993; Magliano & Graesser, 1991; McKoon & Ratcliff, 1992; Singer, 1988, in press; Whitney, 1987).

In this article, we present a constructionist theory that makes decisive predictions about the classes of inferences that are constructed on-line during the comprehension of narrative text. One of the shortcomings of early constructionist theories (Anderson & Ortony, 1975; Bartlett, 1932; Bransford, Barclay, & Franks, 1972; Schmidt, 1982; Weimer & Palermo, 1974) is that they failed to make specific predictions about the inferences and meaning representations that are constructed during encoding. Because of this shortcoming, some researchers (e.g., McKoon & Ratcliff, 1992) have concluded that constructionist theories assume that a complete, lifelike cognitive representation is constructed and that virtually all classes of inferences are generated on-line. During the past decade, however, the research conducted by constructionist theorists has revealed that only a subset of inferences are on-line. The constructionist theory presented in the present article accommodates these empirical findings and thereby positions constructionism on more solid footing.

The proposed constructionist theory embraces a principle that has a long history in experimental psychology and that distinguishes it from other contemporary psychological theories in discourse processing: *Search (or effort) after meaning* (Bartlett, 1932; Berlyne, 1949, 1960; Spiro, 1980; Stein & Trabasso, 1985). A more precise specification of this search-after-meaning principle has three critical assumptions:

1. *The reader goal assumption.* The reader constructs a meaning representation that addresses the reader's goals. These goals and meaning representations are normally pitched at deep levels of processing (e.g., semantics and the referential situation model) rather than at shallow levels (e.g., wording and syntax).

2. *The coherence assumption.* The reader attempts to construct a meaning representation that is coherent at both local and global levels. Local coherence refers to structures and processes that organize elements, constituents, and referents of adjacent clauses or short sequences of clauses. Global coherence is established when local chunks of information are organized and interrelated into higher order chunks.

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3. *The explanation assumption.* The reader attempts to explain why actions, events, and states are mentioned in the text. These explanations involve naive theories of psychological and physical causality in an effort to achieve coherence in understanding.

Thus, readers attempt to construct a meaningful referential situation model that addresses the readers' goals, that is coherent, and that explains why actions, events, and states are mentioned in the text.

Previous constructionist theories have either explicitly or implicitly adopted one or more of these assumptions. The proposed constructionist theory is distinctive because it explicitly adopts all three assumptions and it directly focuses on the problem of inference generation. Previous constructionist theories have been vague or indecisive in delimiting the classes of inferences that are generated on-line. This was not a salient objective for these theories in the past because there was very little research on inference generation two decades ago. Now that inference generation has received more attention in the fields of experimental psychology, cognitive science, and discourse processing, it is time to sort out what a constructionist theory would provide. The three assumptions of the search-after-meaning principle empower a constructionist framework to make decisive predictions about inference generation.

A constructionist theory that embraces the search-after-meaning principle offers predictions that are not uniquely shared by alternative theoretical frameworks in the discourse-processing literature. By way of illustration, the proposed constructionist theory predicts that the following three classes of inferences are generated on-line under most processing conditions:

1. *Superordinate goals* of characters that motivate explicit actions in the text. For example, the superordinate goal of "getting revenge" motivates the action of a victim killing a villain; getting revenge explains why the victim kills the villain.
2. *Causal antecedents* that explain why an action, event, or state is explicitly mentioned in the text. For example, the event of a character becoming ill is explained by the causal antecedent "the character went bankrupt."
3. *Global thematic inferences* that integrate major chunks of the text or that convey the point of a message. For example, a story might be an instantiation of the virtue "practice what you preach."

In contrast, the theory predicts that readers do not normally construct inferences that forecast future episodes in the plot and inferences that track the spatial locations of objects within a spatial region.

According to the proposed constructionist theory, those inferences that are predicted to be generated on-line are not generated under all conditions of reading. Readers abandon such attempts at search-after-meaning under one or more of the following conditions: (a) if the reader is convinced that the text is "inconsiderate" (i.e., lacks global coherence and a message), (b) if the reader lacks the background knowledge that permits the establishment of explanations and global coherence, or (c) if the reader has goals that do not require the construction of a meaningful situation model (e.g., proofreading the text for spelling errors).

Our primary focus is on narrative text rather than on other discourse genres (such as expository, persuasive, and descriptive texts). This emphasis is nonarbitrary. Narrative text has a close correspondence to everyday experiences in contextually specific situations (Britton & Pelligrini, 1990; Bruner, 1986; Kintsch, 1980; Nelson, 1986; Schank, 1986). Both narrative texts and everyday experiences involve people performing actions in pursuit of goals, the occurrence of obstacles to goals, and emotional reactions to events. Knowledge about these actions, goals, events, and emotions are deeply embedded in our perceptual and social experience because it is adaptive to understand the actions and events in our social and physical environment. The inferencing mechanisms and world knowledge structures that are tapped during the comprehension of everyday experiences are also likely to be tapped during the comprehension of narratives; there is no justifiable reason to believe that readers would turn off these pervasive interpretive mechanisms during reading. Of course, this claim does not imply that there is a perfect overlap between the inferences generated during everyday experiences and the inferences generated during narrative comprehension. In particular, global thematic inferences may not be generated when we comprehend activities in the world because people coordinate multiple agendas in a complex, dynamic world.

In contrast to narrative text, expository text is decontextualized and is normally written to inform the reader about new concepts, generic truths, and technical material (Brewer, 1980; Bruner, 1986; Nystrand, 1986). The typical reader does not have extensive background knowledge about the topics in expository texts, so readers generate fewer inferences than they generate during the comprehension of narrative text (Britton & Gülgöz, 1991; Graesser, 1981). Narrative text is an important genre to study, given that we are interested in inference generation and the construction of referential situation models.

One major goal of this article is to present a constructionist theory that makes decisive predictions about the knowledge-based inferences that are generated on-line during narrative comprehension. These knowledge-based inferences are critical building blocks in the referential situation model that readers construct. It is beyond the scope of this article to dissect the vast number of shallow-level inferences that are needed to "flesh out" linguistic code and explicit propositional code. It is widely acknowledged that most of these shallow-level inferences are reliably generated on-line (Frazier & Flores d'Arcais, 1989; Perfetti, 1993; Swinney & Osterhout, 1990), perhaps automatically (McKoon & Ratcliff, 1992). Most of the uncertainty and controversy addresses the status of deeper knowledge-based inferences that presumably are generated during the construction of situation models. It is also beyond the scope of this article to discriminate between those inferences that are automatically versus strategically generated on-line. The distinction between automatic and strategic inferences was central to McKoon and Ratcliff's (1992) *minimalist hypothesis*, but it is not central to the proposed constructionist theory. Instead, the relevant contrast is between on-line and off-line inferences while readers *comprehend* text.

A greater appreciation of the constructionist theory is achieved when it is contrasted with alternative hypotheses, models, and theories. Therefore, in this article, we compare the predictions of the constructionist theory with the predictions of alternative theoretical frameworks: an explicit textbase position, a minimalist hypothesis, a current-state selection (CSS) strategy, a prediction–substantiation model, and a promiscuous inference generation position. The fact that these frameworks furnish different predictions about the on-line status of inferences supports the claim that the constructionist theory offers nontrivial predictions.

A second major goal of this article is to review the empirical evidence that tests the proposed constructionist theory and alternative theoretical frameworks. As it turns out, the fact that we are investigating knowledge-based inferences has some critical methodological consequences. In particular, a satisfactory empirical test of these models must ensure that the readers have adequate world knowledge to generate the inferences. We therefore advocate a *three-pronged method* (Magliano & Graesser, 1991; Suh & Trabasso, 1993; Trabasso & Suh, 1993) that coordinates (a) the collection of verbal protocols that expose candidate inferences, (b) the articulation of alternative theoretical frameworks concerning inference generation, and (c) the collection of time-based behavioral measures that test which inferences in (a) are actually generated on-line. The verbal protocols involve a think-aloud task or a question-answering task, while a normative group of subjects reads text, sentence by sentence. If an inference is exposed by these verbal protocols, then there is some assurance that the readers have adequate background knowledge to make the inference.

In this article, we do not articulate the constructionist theory to the point of covering all levels of language processing and of furnishing a detailed processing trace of the construction of inferences. In principle, the constructionist theory could be integrated with more comprehensive psychological models of text processing, such as Kintsch's construction–integration model (Kintsch, 1988), Just and Carpenter's READER model (1992), or Gernsbacher's structure-building framework (Gernsbacher, 1990). In principle, we also could present a detailed processing model that traces the construction of particular inferences on the basis of the text, relevant world knowledge structures, and the reader's goals (see Graesser & Clark, 1985, for one attempt). Although it is beyond the scope of this article to furnish this level of detail, the key components of a processing mechanism are described in sufficient detail to show how it narrows down the set of potential knowledge-based inferences.

Comprehension and Knowledge-Based Inferences

It is important to clarify what we mean by "comprehension" and "knowledge-based inferences" because they are central ideas in the constructionist theory. As mentioned earlier, the constructionist theory is applicable only in cases when the reader attempts to comprehend the meaning of a text. All bets are off when, for example, the reader is merely proofreading the text for spelling errors or the reader is scanning the text for a particular word. As mentioned earlier, the constructionist theory makes predictions about those knowledge-based inferences that participate in the construction of a situation model. The distinctive properties of the theory are not pitched at the shallow-level inferences that are needed to construct syntactic code, propositional code, and the explicit textbase.

What Does It Mean to Comprehend?

Comprehension has traditionally been one of the elusive, controversial constructs in cognitive science (Kintsch, 1980; Schank, 1986; Weizenbaum, 1976; Winograd & Flores, 1986). It is perhaps impossible to propose a definition that is complete and that would be accepted by all researchers in all disciplines. Everyone agrees that comprehension consists of the construction of multi-level representations of texts. Everyone agrees that comprehension improves when the reader has adequate background knowledge to assimilate the text, but what else exists or occurs when comprehension succeeds? How does a researcher determine whether a computer really understands a text or whether one person really understands another person?

Comprehension improves to the extent that the reader constructs more levels of representation and more inferences at each level. To illustrate some multiple levels of representation, consider the following short text.

> The truck driver saw the policeman hold up his hand. The truck driver's vehicle stopped, but a car rear-ended the truck driver.

The *textbase* level of representation would include a propositional description of the explicit text (Kintsch, 1992; Kintsch & van Dijk, 1978). For example, the first sentence would have the following propositional representation:

PROPOSITION 1: saw (truck driver, PROPOSITION 2)

PROPOSITION 2: hold-up (policeman, hand)

Each proposition has a predicate (i.e., verb, adjective, or connective) and one or more arguments (i.e., noun or embedded proposition). The textbase level would also connect the explicit sentences by argument overlap. The first sentence would be connected to the second sentence by the overlapping argument "truck driver."

The textbase provides a shallow representation of the explicit text but does not go the distance in capturing the deeper meaning of the text. Deeper meaning is achieved by computing a *referential* specification for each noun. For example, the car would rear-end the vehicle of the truck driver rather than the body of the truck driver. Deeper comprehension is achieved when the reader constructs *causes and motives* that explain why events and actions occurred. Readers would infer that an abrupt stop of the truck caused the car to rear-end the truck, even though the text never states that there was an abrupt stop. The reader would infer that the truck driver had the goal of stopping the truck and performed some intentional action to stop it, even though this was never explicitly stated. Deeper comprehension is achieved when the reader infers the *global message*, or *point*, of the text, such as "accidents occur even when people follow society's rules." However, this level of representation may be difficult to construct without the pragmatic context of the text, such as who wrote the text, why it was written, who read the text, and why it was read. Nevertheless, according to our definition of comprehension, readers attempt to construct representations at all of these levels.

A definition of comprehension is incomplete without a principled way of determining what content to elaborate at the various levels. The proposed constructionist theory was indeed developed to provide a more discriminating specification of content elaboration. Most readers would not normally construct a detailed description of the subplan that the truck driver executed to stop the truck (e.g., he moved his foot to the brake pedal, he pumped the brake, he calculated the distance between the truck and the policeman). These details would normally be omitted from the constructed representation. Yet it might be important to construct these details when the reader is an insurance agent trying to settle an insurance claim for the accident. Thus, the goals of the reader and the pragmatic context of the message must also be considered. It is widely acknowledged that it is not sufficient to build a theory of comprehension on the basis of the text alone.

Some researchers have enriched the definition of comprehension by adopting a "systemic" perspective that appeals to the notion of *harmony* (i.e., congruity, compatibility, and synchrony). One sense of harmony addresses the global coherence of the text; comprehension succeeds when there is harmony among explicit ideas within the text (Britton & Eisenhart, 1993). A second sense of harmony addresses the compatibility among the three major components of a communication system: the author, the text, and the reader (Britton & Gülgöz, 1991; Rosenblatt, 1978; Tierney & Shanahan, 1991). That is, comprehension succeeds to the extent that there is harmony among three representations: (a) the author's intended meaning of the text, (b) the explicit text, and (c) the reader's constructed meaning of the text. Writers compose the content and wording of text in service of their communication goals, whereas readers attempt to recover the writers' goals during comprehension. Comprehension breaks down to the extent that there is discord among the author's intended meaning, the explicit text, and the reader's constructed meaning. Inconsiderate text is incoherent and underspecified, so it fails to deliver a successful transmission of information from author to reader.

There are several important benefits when comprehension succeeds. The reader draws inferences that are relevant and correct. The reader asks good questions that tap potential knowledge gaps, anomalies, and contradictions. The reader's answers to questions are relevant, correct, and informative. The reader can paraphrase the message and generate good summaries. In fact, inference generation, question asking, question answering, paraphrasing, and summary generation have traditionally been the litmus tests of whether computers can understand text in the field of artificial intelligence (Kass, 1992; Lehnert, Dyer, Johnson, Young, & Harley, 1983; Schank & Abelson, 1977). When comprehension succeeds, the reader is able to detect whether an incoming statement in the text involves a contradiction, anomaly, or irrelevancy with respect to the earlier information (Glenberg, Wilkinson, & Epstein, 1982; Graesser & McMahen, 1993; Markman, 1979; Otero & Kintsch, 1992). However, sometimes comprehension does not succeed and the reader settles for a simplistic, shallow representation of the text. A reader may have the illusion of successful comprehension even though the reader's simplistic representation fails to capture all of the explicit text and the depth of the material (Glenberg & Epstein, 1987; Weaver, 1990).

What Is a Knowledge-Based Inference?

The purpose of this section is to delimit the classes of inferences that our constructionist theory addresses rather than to offer a complete and perfectly accurate taxonomy of inferences. Researchers in psycholinguistics and discourse processing have proposed several taxonomies of inferences (Clark, 1977; Graesser & Kreuz, 1993; Harris & Monaco, 1978; Kintsch, 1993; Magliano & Graesser, 1991; Nicholas & Trabasso, 1981; Reiger, 1975; Singer, 1988), but a consensus has hardly emerged.

Knowledge-based inferences are constructed when background knowledge structures in long-term memory (LTM) are activated, and a subset of this information is encoded in the meaning representation of the text. The meaning representation includes both the textbase and the referential situation model (Kintsch, 1988, 1992, 1993; Kintsch, Welsch, Schmalhofer, & Zimny, 1990; Schmalhofer & Glavanov, 1986; van Dijk & Kintsch, 1983). The background knowledge consists of specific and generic knowledge structures that are relevant to the text. The specific knowledge structures include memory representations of particular experiences, of other texts, and of previous excerpts within the same text. The generic knowledge structures include schemata (J. M. Mandler, 1984; Rumelhart & Ortony, 1977), scripts (Bower, Black, & Turner, 1979; Schank & Abelson, 1977), frames (Minsky, 1975), stereotypes (Wyer & Gordon, 1984), and other structured packets of generic knowledge. Most background knowledge structures are meaningful and contextually rich. That is, they are grounded in experience, with content organized by meaningful relations, for example, a script of eating at a restaurant. These rich structures furnish much of the content needed to interpret, explain, predict, and understand narrative events. However, other background knowledge structures are abstract and decontextualized, such as the schema for the rhetorical format of a fairy tale (J. M. Mandler, 1984; Stein & Glenn, 1979). Background knowledge structures (either specific or generic) are activated through pattern recognition processes by explicit content words, combinations of content words, and interpreted text constituents. When a background knowledge structure is very familiar and therefore overlearned, much of its content is automatically activated in working memory (WM) at very little cost to the processing resources in WM (Graesser & Clark, 1985; Kintsch, 1988, 1993).

When a knowledge-based inference is directly inherited or copied from a background knowledge structure, the process of incorporating it into the meaning representation of the text imposes small or intermediate costs to WM. However, sometimes a novel knowledge-based inference is constructed. A novel inference is a product of several incremental, cognitive cycles of searching memory and accumulating information from multiple information sources (Just & Carpenter, 1992). The precise mechanisms of constructing these novel knowledge-based inferences are not well understood, although several researchers have offered speculations (Graesser & Clark, 1985; Graesser & Zwaan, in press; Johnson-Laird, 1983; Schank & Abelson, 1977; Wilensky, 1983). These novel knowledge-based inferences are believed to place more burdens on WM. A potential inference has a lower likelihood of being generated on-line to the extent that its generation imposes greater demands on WM.

Examples of knowledge-based inferences are presented in the context of the following parable by Ambrose Bierce, entitled "How Leisure Came."

A Man to Whom Time was Money, and who was bolting his breakfast in order to catch a train, had leaned his newspaper against the sugar bowl and was reading as he ate. In his haste and abstraction he stuck a pickle-fork into his right eye, and on removing the fork the eye came with it. In buying spectacles the needless outlay for the right lens soon reduced him to poverty, and the Man to Whom Time was Money had to sustain life by fishing from the end of the wharf.

Table 1 presents 13 classes of inferences and examples of these inferences in the context of this passage. These 13 classes are defined according to the content of the inference and its relation to the explicit text. These classes do not exhaust all of the potential inferences during comprehension, but they do provide an initial foundation for discussing the constructionist theory.

The order in which the inference classes are listed in Table 1 is not altogether arbitrary. Inference classes 1, 2, and 3 are needed to establish local coherence, whereas inference classes 3 and 4 are critical for establishing explanations. Classes 4, 5, and

Table 1
Inferences Relevant to "How Leisure Came"

Type of inference	Brief description	Text that elicits inference	Inferences
Class 1: Referential	A word or phrase is referentially tied to a previous element or constituent in the text (explicit or inferred).	". . .on removing the *fork* the eye came with *it*"	Fork is the referent for it.
Class 2: Case structure role assignment	An explicit noun phrase is assigned to a particular case structure role, e.g., agent, recipient, object, location, time.	"the man leaned his newspaper against the sugarbowl"	Against the sugarbowl is assigned to a location role.
Class 3: Causal antecedent	The inference is on a causal chain (bridge) between the current explicit action, event, or state and the previous passage context.	"In his haste and abstraction he stuck a pickle fork into his right eye. . ."	The man was careless and mis-aimed his fork.
Class 4: Superordinate goal	The inference is a goal that motivates an agent's intentional action.	"A Man to Whom Time was Money, and who was bolting his breakfast in order to catch a train. . ."	The man wanted to get to work and earn money.
Class 5: Thematic	This is a main point or moral of the text.	The entire passage	Haste makes waste.
Class 6: Character emotional reaction	The inference is an emotion experienced by a character, caused by or in response to an event or action.	". . .the needless outlay reduced him to poverty"	The man became sad.
Class 7: Causal consequence	The inference is on a forecasted causal chain, including physical events and new plans of agents. These inferences do not include the character emotions in class 6.	". . .on removing the fork the eye came with it"	The man became blind in his right eye.
Class 8: Instantiation of noun category	The inference is a subcategory or a particular exemplar that instantiates an explicit noun or an implicit case role that is required by the verb.	". . .breakfast. . ."	Bacon and eggs.
Class 9: Instrument	The inference is an object, part of the body, or resource used when an agent executes an intentional action.	". . .the Man to Whom Time was Money had to sustain life by fishing from the end of a wharf"	The man used a rod and reel (to fish).
Class 10: Subordinate goal–action	The inference is a goal, plan, or action that specifies how an agent's action is achieved.	". . .who was bolting his breakfast"	The man grasped his fork and moved it toward his mouth.
Class 11: State	The inference is an ongoing state, from the time frame of the text, that is not causally related to the story plot. The states include an agent's traits, knowledge, and beliefs; the properties of objects and concepts; and the spatial location of entities.	". . .the Man to Whom Time was Money had to sustain life by fishing from the end of a wharf"	Fishermen are poor; the city has a wharf.
Class 12: Emotion of reader	The inference is the emotion that the reader experiences when reading a text.	". . .on removing the fork the eye came with it"	The reader is disgusted.
Class 13: Author's intent	The inference is the author's attitude or motive in writing.	The entire passage	Bierce wants to lambaste workaholics.

6 are important for establishing global coherence. Classes 7 through 11 are elaborative inferences that are not needed for establishing coherent explanatory meaning representations. Classes 12 and 13 address the pragmatic communicative exchange between reader and author. The order of listing the inference classes is weakly correlated with the amount of attention that the inference classes have received in the psychological literature. Referential inferences (class 1) have received the most attention, whereas inferences about author intent and attitude (class 13) have received the least attention. The local inferences that are elicited by one or two sentences have received more attention than the global inferences. Inferences that are elicited from rich textual cues have received more attention than inferences that are remotely derived from the text by virtue of background knowledge structures.

The researchers' preferences in the selection of inferences to investigate can be attributed both to methodology and to theory. The most familiar and defensible research methods in experimental psychology carefully manipulate stimulus texts, so there is a preference for investigating local text-bound inferences. Early theories in psycholinguistics, text linguistics, and reading focused on inferences that were derived symbolically from explicit linguistic elements (Brady & Berwick, 1983; Brown & Yule, 1983; Katz & Fodor, 1963; Kempson, 1977). These inferences were derived by rules, meaning postulates, and compositional analyses that stripped away most of world knowledge. It is very tedious and difficult to specify the numerous knowledge structures associated with text, so theorists and empirical researchers have normally avoided a systematic analysis of world knowledge. Nevertheless, a mature theory of inference generation would need to analyze world knowledge in detail. Consequently, some researchers have pursued rather ambitious projects that map out the world knowledge structures that participate in text comprehension (Alterman, 1985; Dahlgren, 1988; Graesser & Clark, 1985; Mannes & Kintsch, 1991; Schank & Abelson, 1977). Clearly, it is important not to confuse the likelihood that a class of inferences is generated on-line and the amount of attention that the class of inferences has received in the scientific literature.

There is an important distinction between *text-connecting* inferences and *extratextual* inferences (Graesser & Bower, 1990; Singer & Ferreira, 1983; Trabasso & Suh, 1993). In the case of a text-connecting inference, the current clause being comprehended is related to a previous explicit statement in the text; the previous statement is reinstated (i.e., activated or reactivated) and is inferentially linked to the current clause. The referential inferences (class 1 in Table 1) are always text-connecting inferences. In the case of extratextual inferences, the inference is copied or derived from generic and specific knowledge structures that are relevant to the explicit text.

The taxonomy in Table 1 does not include some classes of inferences that normally are difficult to generate and are therefore off-line. First, there are logic-based inferences, which are derived from systems of domain-independent formal reasoning, such as propositional calculus, predicate calculus, and theorem proving (Newell & Simon, 1972; Rips, 1990). Second, there are quantitative inferences and statistical inferences that are products of complex formulae and mathematical procedures (Kahneman, Slovic, & Tversky, 1982). These inferences are usually a struggle to generate (Bruner, 1986; Graesser & Clark, 1985; Kintsch, 1993; Schank, 1986), as everyone who has attempted to solve analytical brain teasers and algebra word problems knows. Of course, this does not mean that these inferences are never generated during the comprehension of narrative text (Lea, O'Brien, Fisch, Noveck, & Braine, 1990).

For the convenience of communication, we consider whether each class of inferences is in one of two discrete states: on-line versus off-line. However, there undoubtedly is a probabilistic continuum between on-line and off-line. The continuum can be attributed to fluctuations in reader abilities, reader goals, text materials, samples of inferences, experimental tasks, and so on. The continuum can also be explained by the theoretical possibility that inferences are encoded to some degree rather than all-or-none (Gernsbacher, 1990; Kintsch, 1988; McKoon & Ratcliff, 1992; Sharkey & Sharkey, 1992). The degree to which an inference is encoded might be strengthened or attenuated as more information is received. Technically speaking, when we claim that a class of inferences is generated on-line, our intention is to convey that it has a substantially higher strength of encoding or higher likelihood of being generated than the contrast classes of inferences that are off-line. A full-blown theory would account for likelihood of generation, the strength of encoding, the time-course of generation, and the exact locus of generation (within the text) for each class of inference.

A Constructionist Theory of Inference Generation

As discussed earlier, the proposed constructionist theory emphasizes Bartlett's (1932) principle of search (or effort) after meaning. This principle embraces the reader goal assumption, the coherence assumption, and the explanation assumption. We elaborate on these distinctive characteristics of the constructionist theory in this section. In addition to these distinctive characteristics, the theory adopts some components, assumptions, and predictions that are widely accepted by psychological researchers in discourse processing (Gernsbacher, 1990; Just & Carpenter, 1992; Kintsch, 1988; Sanford & Garrod, 1981; Singer, 1990; van Dijk & Kintsch, 1983). These uncontroversial assumptions are succinctly enumerated in this section before turning to the theory's distinctive characteristics.

Uncontroversial Components and Assumptions

1. Information sources. The three main information sources include the *text* (i.e., graphemes, phonemes, syntax, lexical items, propositions, and clauses), the relevant *background knowledge structures* (both specific and generic), and the *pragmatic context* of the message (i.e., the author, reader, setting, and purpose of the exchange).

2. Levels of cognitive representation. Following Kintsch and his colleagues (Kintsch, 1988, 1992; van Dijk & Kintsch, 1983), three levels of code are constructed as a result of comprehension: the *surface code* (i.e., the exact wording and syntax), the *textbase* (explicit text propositions plus inferences needed for text cohesion), and the *situation model.*

3. Memory stores. There are three memory stores: *short-term memory* (STM; which holds the most recent clause), *working memory* (WM; which holds approximately the last two sentences, plus information that is actively recycled in WM), and *long-term memory* (LTM). It should be noted that some models do not distinguish between STM and WM.

4. Discourse focus. Attention may be focused on any of the three levels of cognitive representation (see assumption 2). From the standpoint of the situation model, the discourse focus is analogous to a mental camera that scans across the scenario and zooms in on particular characters, actions, events, spatial regions, and hot spots (Bower, 1989).

5. Convergence and constraint satisfaction. Both the explicit information and inferences receive more strength of encoding to the extent that they are activated by several information sources (i.e., there is convergence), and they satisfy the conceptual constraints imposed by the various information sources (Golden & Rumelhart, 1991; Graesser & Clark, 1985; Kintsch, 1988; Mannes & Kintsch, 1991; Sharkey & Sharkey, 1992; St. John, 1991).

6. Repetition and automaticity. Repetition increases the speed of accessing knowledge structures and the elements within a knowledge structure. In the case of an automatized package of knowledge (e.g., a familiar generic knowledge structure), the content is wholistically accessed and activated at little cost to the processing resources in WM.

Distinctive Components and Assumptions of the Theory

The proposed constructionist theory embraces the search-after-meaning principle (Bartlett, 1932; Berlyne, 1949; Spiro, 1980; Stein & Trabasso, 1985). At a general level, this search-after-meaning principle asserts that comprehenders attempt to construct meaning out of text, social interactions, and perceptual input. The principle has three assumptions that empower the constructionist theory with distinctive predictions: (7) satisfaction of reader goals, (8) achievement of both local and global coherence, and (9) explanation of explicit information.

It is important to emphasize that the search-after-meaning principle is an effort, not necessarily an achievement. In most reading contexts, the fruits of these efforts are realized because writers–authors construct messages to be understood. However, there are conditions that prevent the reader from constructing a meaning representation that provides coherence, that explains the explicit text, and that satisfies the reader's goals. If the reader fails to devote any effort, then these inferences are not drawn. The inferences are not generated if the reader is given insufficient time for comprehension. A globally coherent message is not constructed if the text is choppy, incoherent, and pointless. An explanation may not be generated when there is a random sequence of events or a puzzling sequence of propositions that satisfy a researcher's counterbalancing constraints. Inferences are not constructed without the prerequisite background knowledge structures.

7. Satisfaction of reader goals. When readers comprehend a text, they are motivated by one or more goals. In some contexts, the goals are ill defined and general. This is the case when an adult reads the morning newspaper to become informed about current events and when a person reads a novel to be entertained. The reader must understand the meaning of the text under these conditions. In other contexts, the reader's goals are specific. This is the case when a reader tries to determine whether it is a good time to invest some money in the stock market (while reading a newspaper) and when a reader tries to form a mental picture of what a character looks like (while reading a novel). According to the reader goal assumption, readers are persistent in their attempts to satisfy their goals and therefore will construct inferences that address these goals.

We distinguish among three levels of goal specificity: default, genre-based, and idiosyncratic. At the first, most undifferentiated, level, the reader's goal is to construct a meaningful situation model that is compatible with the text. This level is the least constrained and is regarded as the default level.

At the next level, there are goals associated with the genre of the text. Readers of fictive narrative have the goal of being entertained in some fashion (e.g., excited, enthralled, amused, or frightened), whereas readers of expository text have the goal of being informed about events and facts in the real world (Brewer, 1980; Kintsch, 1980; Pearson & Fielding, 1991; Zwaan, 1993). Brewer (1980) has contrasted four "discourse forms" that reflect different goals of reading text: to entertain, to persuade, to inform, and to have an aesthetic–literary impact. Zwaan's (1993) experiments on reading and memory have demonstrated that substantially different information is extracted from a text when it is called a newspaper article versus a literary story.

The final level of goal specificity involves idiosyncratic reader goals. These goals may lead the reader to construct virtually any type of code (i.e., surface or textbase vs. situation model) and virtually any dimension of the situation model (e.g., spatiality, causality, plans, or traits of characters). An adequate account of idiosyncratic goals would need to incorporate a general theory of human motivation, which is quite outside the boundaries of our constructionist theory. The constructionist theory offers a priori predictions about inference generation in the context of default goals and genre-specific goals, whereas its predictions are ad hoc in the context of idiosyncratic goals. The ad hoc prediction is that inferences are generated if they are directly relevant to the idiosyncratic goals.

Reader goals must be carefully analyzed in the experiments conducted by researchers in discourse processing. The task demands constrain the goals that readers adopt and therefore the inferences that they construct. Readers may not generate deep inferences, for example, if the tests, materials, and tasks only require shallow processing. Unfortunately, this has been the case in a significant proportion of experiments on inference processing (see Magliano & Graesser, 1991). For example, suppose that an experiment is conducted in which the reader's task is to recognize whether character A or B is activated by a pronoun *she*. Suppose further that the words are presented very quickly (250 ms per word), and the reader is asked to recognize which of two words had been presented, as quickly as possible (namely, character A vs. B after presenting *she*). Shallow processing is sufficient to complete this task because (a) the task merely involves the recognition of explicit text, (b) the material is quickly presented, (c) shallow processing is satisfactory for performance, and (d) the recognition test requires the discrimination of only two characters. The reader might adopt an artificial reading strategy that is similar to monitoring a list of unrelated items. The reader might be frustrated from having the normal comprehension goal of constructing a meaningful situation model. In contrast, a meaningful situation model would be constructed in a task that allows readers to read at their normal pace and that tests them on deep inferences relevant to the situation model.

8. Local and global coherence. The comprehender attempts to build a meaning representation that establishes local and global coherence among the events, actions, and states in the text. Once again, this does not mean that a coherent representation is necessarily achieved at all levels, however. If the reader believes that the text is not considerate and lacks global coherence, then the comprehender settles for local coherence. If the reader believes that the text lacks local coherence, then the reader regards the text as incoherent. Stated differently, the reader attempts to construct the most global meaning representation that can be managed on the basis of the text and the reader's background knowledge structures. A globally coherent cognitive representation is successfully achieved when the following conditions are met: (a) the textual features support global coherence, (b) the reader has the prerequisite background knowledge, and (c) the reader does not have a specific goal that prevents understanding of the material. When there is a breakdown in one or more of these conditions, the reader settles for local coherence or gives up trying to achieve any coherence at all.

Coherence is achieved to the extent that elements and constituents in a text are conceptually connected by virtue of background knowledge structures, the constructed situation model, linguistic features of the text, or all three. There is an imprecise but important distinction between local and global coherence. Local coherence is achieved when conceptual connections relate the content of adjacent text constituents (i.e., a phrase, proposition, or clause) or short sequences of constituents. For example, in the story "How Leisure Came," there is a causal connection between the "man's haste and abstraction" and the event "he stuck a pickle fork into his right eye." Global coherence is achieved to the extent that most or all of the constituents can be linked together by one or more overarching themes. For example, the theme "haste makes waste" ties together most of the content of "How Leisure Came."

Features of the explicit text have a prominent role in the construction of local coherence (de Beaugrande, 1980; Halliday & Hasan, 1976; Kintsch & van Dijk, 1978; Mann & Thompson, 1986). In fact, the term *cohesion* is sometimes reserved for local connections that are based entirely or primarily on linguistic and textual features, as opposed to the situation model and background knowledge. Referential cohesion is established, for example, when an explicit noun in a sentence is connected referentially to a previous noun phrase or proposition in the text. Another example of cohesion is when a connective (e.g., *because, so, and, therefore*) explicitly links adjacent clauses with a particular type of conceptual relation.

Nevertheless, features of language and the explicit text do not go the distance in establishing local coherence. Sometimes readers need to infer the relations between constituents. The classes of inferences that are important for establishing local coherence are referential inferences (class 1 in Table 1), case structure role assignments (class 2), and those causal antecedent inferences (class 3) that connect adjacent constituents. There is substantial evidence that the process of inferring these relations increases comprehension time (Bloom, Fletcher, van den Broek, Reitz, & Shapiro, 1990; Haberlandt & Bingham, 1978; Keenan, Baillet, & Brown, 1984; Myers, 1990; Myers, Shinjo, & Duffy, 1987; Singer, 1990).

The establishment of global coherence involves the organization of local chunks of information into higher order chunks. For example, a moral, main point, or theme of a text (class 5 in Table 1) organizes many of the events and episodes in narrative. A higher order chunk has its tentacles attached to constituents that span large stretches of text. As a consequence, readers sometimes need to link an incoming constituent to an excerpt much earlier in the text; the earlier excerpt is in LTM but no longer in WM. In these situations, reinstatement searches are executed to fetch the earlier text and to place it in WM. These reinstatement searches take additional processing time (Bloom et al., 1990; Dopkins, Klin, & Myers, 1993; Fletcher & Bloom, 1988; Kintsch & van Dijk, 1978; Singer, 1990, 1993; Suh & Trabasso, 1993; van den Broek & Lorch, 1993).

Detailed analyses of global coherence are available in several fields: text linguistics (Grimes, 1975; Halliday & Hasan, 1976), artificial intelligence (Dyer, 1983; Hobbs, 1979; Lehnert, 1981), education (Meyer, 1985), and cognitive psychology (J. M. Mandler, 1984; van Dijk & Kintsch, 1983). Some global structures are contextually specific and detailed, such as a script for eating at a restaurant (Schank & Abelson, 1977). Others are abstract frames. In one type of REVENGE structure, for example, characters A and B have a positive bond, character C harms B for unjustifiable reasons, and subsequently character A harms character C. Readers infer these global structures and thereby construct thematic inferences (class 5 in Table 1). Unfortunately, there have been very few empirical tests of whether these inferences are generated on-line (Seifert, McKoon, Abelson, & Ratcliff, 1986).

Although it is beyond the scope of this article to provide a detailed account of the representation and processing assumptions of the constructionist theory, it is worthwhile to point out briefly how coherence could be achieved computationally. Coherent representations have traditionally been expressed in a symbolic form and have been constructed by procedures that manipulate symbols (Dyer, 1983; Fletcher, 1986; Golden & Rumelhart, 1991; Graesser & Clark, 1985; Kintsch & van Dijk, 1978; Lehnert, 1981; Trabasso, van den Broek, & Suh, 1989; van Dijk & Kintsch, 1983). That is, the textbase, situation model, and background knowledge structures have consisted of structured packages of nodes (i.e., nouns, states, events, or goals) that are connected by relational arcs of different categories. The global structures have either been tree hierarchies or nonhierarchical networks. The process of constructing the coherent representations during comprehension has normally consisted of recursive transition networks or production systems (Allen, 1987; Anderson, 1983; Just & Carpenter, 1992).

More recently, researchers have adopted connectionist architectures for computing coherence (Britton & Eisenhart, 1993; Holyoak & Thagard, 1989; Kintsch, 1988; Read & Marcus-Newhall, 1993; Rumelhart & McClelland, 1986). In Kintsch's (1988) construction–integration model, for example, all N nodes in the total node space (involving the textbase, situation model, and background knowledge) are connected with one another in an $N \times N$ connectivity matrix. Each connection between two nodes is assigned a positive excitatory weight, a negative inhibitory weight, or a zero weight. As each constituent in the text is interpreted, the activation values of the nodes in the node space are modified by a spreading activation process through the node space, as stipulated by the connectivity matrix; a parallel constraint satisfaction process settles on activation values for the nodes by converging on the best compromise of the constraints imposed by positive, negative, and zero-weight connections. After the last clause in the text is comprehended, each of the N nodes has a final activation value. Those nodes that meet some criterion of activation are included in the final coherent meaning representation, whereas the other nodes are not included.

According to the constructionist theory, a computational model would need to be designed in a manner that ensures that readers make every effort to establish both local and global coherence. In Kintsch's construction–integration model, for example, there would need to be a special set of nodes in the node space and connections in the connectivity matrix that explicitly capture the coherence assumption. Similarly, the model would need to be augmented with a special set of nodes and connections that incorporate the reader goal assumption and the explanation assumption. In other words, the three distinctive assumptions of the constructionist theory do not naturally emerge from the version of the construction–integration model reported in Kintsch (1988).

9. Explanation. Comprehenders attempt to explain *why* episodes in the text occur and *why* the author explicitly mentions particular information in the message. Thus, comprehension is typically guided by why-questions rather than other types of questions (e.g., what-happens-next, how, where, or when). There is extensive evidence that causal explanations of actions, events, and states play a central role in our understanding of narrative (Black & Bower, 1980; Bloom et al., 1990; Bower et al., 1979; Fletcher, 1986; Graesser, 1981; Rumelhart, 1975; Schank, 1986; Singer, 1990; Trabasso & Sperry, 1985; Trabasso et al., 1989; van den Broek, 1990). The importance of causal explanations is also bolstered by theories outside of the discourse-processing arena. For example, it is compatible with theories of causal attribution in social psychology (Hastie, 1983; Hilton, 1990; McLaughlin, 1990; Pennington & Hastie, 1986; Read, 1987; Read & Marcus-Newhall, 1993) and with theories of planning and mundane reasoning in artificial intelligence (Kuipers, 1985; Mooney, 1990; Schank, 1986).

Researchers have analyzed the information that is accessed when individuals answer why-questions (Graesser, 1981; Graesser & Clark, 1985; Graesser & Franklin, 1990; Graesser & Hemphill, 1991; Graesser, Lang, & Roberts, 1991; Graesser, Robertson, & Anderson, 1981; Lehnert, 1978; Schank & Abelson, 1977). Explanations of why involuntary events occur include their causal antecedents and enabling states (class 3 in Table 1). The reasons why characters perform intentional actions include their superordinate goals (class 4) and the causal antecedents that trigger these goals (class 3). Regarding goals, superordinate goals are appropriate answers to why-questions but not subordinate goals and subplans. For example, consider the following question in the context of the "How Leisure Came" story: "Why did the man buy spectacles?" Appropriate answers to this why-question would include the superordinate goal "in order to improve his eyesight" but not the subordinate goal "in order to pay the doctor." Regarding causal chains, causal antecedents are appropriate answers to why-questions but not causal consequences. An appropriate answer to the example question would be the causal antecedent "because his right eye was damaged" but not the causal consequence "because he was reduced to poverty." Therefore, the claim that comprehension is guided by why-questions rather than other types of questions substantially narrows down the set of inferences that readers normally construct.

Comprehenders are particularly sensitive to actions and events in the world, rather than to constancies and ongoing states. This is because changes frequently convey new and interesting information: discrepancies from normal states in the world, violations of normative standards, danger, obstacles to an agent's goals, goal conflicts between agents, methods of repairing planning failures, emotions that are triggered by goal failures, and abnormal occurrences that have adaptive significance to the organism. The comprehender's attention is captured and explanations are sought when there is an abnormal deviation from the homeostatic balance in a physical, social, or psychological system (Berlyne, 1960; Cheng & Holyoak, 1985; Hart & Honore, 1985; Hilton, 1990; Lazarus, 1991; Mackie, 1980; G. Mandler, 1976). States become important only to the extent that they enable actions and events that dynamically unfold. It should be noted that the state inferences in Table 1 (class 11) do not include those states that enable actions and events.

Explicit actions and events are easy to explain when they are motivated or caused by a previous event, action, or state mentioned in the text. Explicit events and states are also easy to explain when they are very typical of the activated scripts and other background knowledge structures. For example, drinking a glass of wine is a very typical action in a BAR script. Such an action is stored in the generic script for BARS and in thousands of specific experiences involving bars. In contrast, the same voluntary action of drinking wine would be more difficult to explain if it could not be causally linked to the previous text and if it was not typical knowledge in the background knowledge structures (such as a person drinking wine in the context of a classroom). There is a coherence break when an incoming clause cannot be readily explained by prior text or by background knowledge structures. When these coherence breaks occur, the comprehender attempts to piece together an explanation from fragments of information in the activated information sources. It takes more time to explain these atypical actions and events (Bower et al., 1979; Hastie, 1983), but this atypical information is more distinctive and discriminable in memory than is the typical information (Bower et al., 1979; Graesser, Gordon, & Sawyer, 1979; Hastie, 1983). If the reader's attempt to explain an incoming clause fails, the reader may wait for the subsequent text to explain it (Stein & Trabasso, 1985).

A pragmatic level of explanation must also be considered when readers comprehend explicit actions, events, and states in the text. The reader considers why the author would bother mentioning the information conveyed in each explicit clause. Readers normally follow the Gricean postulate that whatever the author expresses is relevant and important (Grice, 1975; Roberts & Kreuz, 1993; Sperber & Wilson, 1986). When static information is presented at the beginning of the novel (e.g., a description of the protagonist's house), the author is presumably supplying a rich setting to anchor the story world. An explicit state might also be intended as a clue that ends up solving a mystery (e.g., there was a red stain on the shirt of a character).

A Processing Model for the Constructionist Theory

We present a processing model at this point to clarify what cognitive mechanisms would be involved in the production of inferences. The processing model would apply to situations where readers are attempting to comprehend considerate narrative text, without any idiosyncratic comprehension goals. We do not present a complete processing model. Instead, we briefly sketch a simple model that captures those inferences that are products of the explanation assumption and global coherence. These inferences are the most distinctive in the sense that they are not predicted to be generated by a number of alternative models of inference generation. Our processing model could be expanded to accommodate idiosyncratic reader goals and the establishment of local coherence; however, the resulting inferences would be generated by most theoretical frameworks and therefore are not particularly controversial.

Our processing model is built on the computational platform of Just and Carpenter's READER model (1992). There is a set of production rules that scan and operate on the contents of WM at each comprehension cycle, as text is comprehended online. The grain size of the comprehension cycle is defined as an explicit action, event, goal, or state in the discourse focus. A production rule has an "IF(condition, cognitive processes)" composition. If the specified conditions are met, then the cognitive processes are executed; if the conditions are not met, then the processes are not executed. All of the production rules are evaluated and executed in parallel, as is assumed in the READER model. The production rules are "soft" rules rather than "hard," brittle rules. That is, a condition is satisfied when there is a configuration of WM content that meets or exceeds some activation threshold; when cognitive processes are executed, the activation values of WM content are modified.

The READER model assumes that there is a limited supply of processing resources in WM. For the present purposes, it is not necessary to declare the precise upper bound in the capacity limitations. However, a few points need to be made about the amount of resources that are consumed by particular cognitive processes. According to the model, the process of accessing and utilizing generic information sources places very little demand on WM because this information is overlearned and automatized (see assumption 6). Access to generic information in LTM is very quick and executed in a parallel, rather than a serial, fashion. Access to specific information sources in LTM is accomplished more slowly (in parallel); the utilization of content within a specific information source is comparatively time consuming, at times in a serial fashion, and places more demands on WM. Therefore, it takes a noticeable amount of time to reinstate information that appeared much earlier in the text being read, after the information exits WM. Comprehension processes, including inference generation, slow down to the extent that the demands on WM approach the upper bound of capacity limitations. When the demands on WM exceed the upper bound, there is a catastrophic deterioration of comprehension, and few inferences are constructed. It should be noted, once again, that these assumptions are compatible with the basic processing mechanism of Just and Carpenter's (1992) READER model.

In Table 2, we present six production rules that implement the explanation assumption and the global coherence assumption. For each rule, there is a specification of the condition element, a succinct description of the cognitive processes, and an elaborated description of these processes. The condition element for rules A, B, C, and D declares the type of statement in the discourse focus (i.e., action, goal or state vs. event) that "fires" the production rule. For rules E and F, the rule is fired when particular content in WM has an activation level that reaches some threshold. When a production rule is fired, various cognitive processes are executed: (a) searching for information sources in LTM and WM, (b) searching for information within information sources, (c) increasing the activation value of content in WM, and (d) verifying whether potential inferences are compatible with constraints of the WM content that is highly active. All six production rules are evaluated and possibly fired at each comprehension cycle, as text is comprehended on-line, statement by statement.

Production rules A, B, C, and F handle the explanation-based inferences. These inferences are needed to explain *why* characters perform actions, *why* events occur, and *why* information is explicitly stated in the text. Production rule A generates superordinate goals (i.e., motives) of character actions and goals. Production rule B generates causal antecedents of actions, goals, and events. Production rule C generates inferences that explain why statements are explicitly mentioned in the text. According to production rule F, these inferences are encoded in the situation model if their activation values meet some threshold.

All six production rules are needed to establish global coherence. According to production rule E, global plot structures are activated when WM contains a particular configuration of actions, goals, events, states, and emotions. Some of this WM content was established by explicit text and some by inferences: goal inferences through rule A, action/event/state inferences through rule B, and emotional reactions of characters through rule D. A global structure is constructed in the situation model if its activation value meets some threshold. Production rule C generates genre schemata, such as a schema for a mystery story, or a schema for a joke. Once again, a genre schema ends up being encoded if its activation value in WM manages to meet some threshold.

The six production rules implement the reader's active comprehension strategies when reading narrative text. As we discuss later, other models of inference generation do not postulate this ensemble of production rules. For example, McKoon and Ratcliff's (1992) minimalist hypothesis does not highlight these classes of inferences as being important for text comprehension. Except for the causal antecedent inferences, all elaborative inferences have an equivalent status in the minimalist hypothesis, namely that they are not consistently made during comprehension. If we were to implement the minimalist hypothesis in the form of a production system model, then the only production rules would be B and F. However, even rule B would need to be modified because the minimalist hypothesis states that causal antecedent inferences are made only under two conditions: (a) when the inference establishes local text coherence or (b) when

Table 2
Production Rules of the Constructionist Theory That Model the Process of Explanation and Establishing Global Coherence

Production rule	Condition	Succinct description of cognitive processes	Elaborated description of cognitive processes
A	Explicit statement in the discourse focus is an intentional action (A) or goal (G) of a character.	Explain why the character performed action A or has goal G.	1. Search information sources in WM and LTM for plausible superordinate goals of A or G. 2. Increase the activation of superordinate goals in WM to the extent that (a) they are in multiple information sources and (b) they are compatible with the constraints of WM content that meet some threshold of activation.
B	Explicit statement in the discourse focus is an intentional action (A), a goal (G), or an event (E).	Explain why the character performed action A, why the character has goal G, or why event E occurred.	1. Search information sources in WM and LTM for plausible causal antecedents of A, G, or E. 2. Increase the activation of the causal antecedents in WM to the extent that (a) they are in multiple information sources and (b) they are compatible with the constraints of WM content that meet some threshold of activation.
C	Any explicit statement (S) in the discourse focus.	Explain why the writer mentions S.	1. Search text genre schemas in LTM that would accommodate S. 2. Increase the activation of the genre schema to the extent that it is compatible with the constraints of S and with WM content that meets some threshold of activation.
D	Explicit statement in the discourse focus is an intentional action (A) or an event (E).	Track the emotional reactions of characters.	1. Search information sources in WM and LTM for salient emotional reactions of characters to A or E. 2. Increase the activation of the emotional reactions in WM to the extent that (a) they are in multiple information sources and (b) they are compatible with the constraints of WM content that meet some threshold of activation.
E	WM contains a particular configuration (C) of goals, actions, events, emotions, and/or states that meet some threshold of activation.	Create global structures.	1. Search for information sources in LTM that match configuration C. 2. Increase the activation of the information source in WM to the extent that it is compatible with the constraints of WM content that meet some activation threshold.
F	An implicit statement or structure in WM meets some activation threshold.	Construct inferences that receive high activation in WM.	The implicit statement or structure is constructed as an inference in the situation model.

Note. WM = working memory; LTM = long-term memory.

there is a break in local text coherence that prompts a strategic search for causal antecedents (in the prior text or other information sources). The condition element of the production rules would need to be tuned to these discriminations. Unlike the minimalist hypothesis, the constructionist model always searches generic and specific information sources for causal antecedents of explicit events, actions, and goals; the search occurs regardless of whether or not there is a break in local text coherence. In summary, alternative models of inference generation would not have exactly the same set of production rules and the condition elements would not be tuned in exactly the same way. In a subsequent section, we examine assumptions and predictions of some alternative models.

Predictions of the Constructionist Theory

The constructionist theory makes distinctive predictions about which classes of inferences are likely to be generated on-line during the comprehension of narrative text. As discussed earlier, there undoubtedly is a continuum between on-line and off-line, but we assume a discrete demarcation for ease of communication.

In many contexts, readers have a general goal of reading a coherent text for understanding or for entertainment (rather than an idiosyncratic goal). The default or genre-based level of goal specificity would apply, as discussed earlier, and the predictions of the constructionist theory are clear-cut. The theory predicts that the following classes of inferences are generated on-line: referential (class 1), case structure role assignment (class 2), causal antecedent (class 3), superordinate goal (class 4), thematic (class 5), and character's emotion reaction (class 6). The referential, case structure, and causal antecedent inferences (classes 1, 2, and 3) are needed to establish local coherence in the text. The inferences that assign case structure roles to explicit noun phrases and prepositional phrases establish local coherence within a clause. The referential inferences and causal antecedent inferences are prevalent when establishing local coherence between clauses. The causal antecedent and superordinate goal inferences (classes 3 and 4, respectively) are needed to explain why involuntary events occur and why characters perform intentional actions. Thematic inferences (class 5) are generated during the establishment of global coherence. The emotional reactions of characters (class 6) and the superordinate goals (class 4) also play a prominent role in global plot configurations of stories (Dyer, 1983; Lehnert, 1981; Stein & Levine, 1991) and are therefore needed for the establishment of global coherence. Interesting story plots involve goal conflicts and salient emotional reactions of characters to episodes in the story world.

The constructionist theory predicts that several classes of "elaborative" inferences in Table 1 are not normally generated on-line: causal consequences (class 7), instantiations of noun categories (class 8), instruments (class 9), subordinate goals/actions (class 10), and states (class 11). These inferences are not needed to construct a coherent explanation of the explicit content in the narrative so they have a lower likelihood of being generated on-line.

An elaborative inference in one of the above five classes might be constructed on-line by virtue of convergence and constraint satisfaction (see assumption 5). This occurs when an inference receives a high strength of activation from multiple information sources, and it satisfies the constraints from multiple information sources. It is important to point out that there are theoretical and empirical criteria for identifying these elaborative inferences that are products of convergence and constraint satisfaction (Graesser & Clark, 1985; Kintsch, 1988; Mannes & Kintsch, 1991). Therefore, the predictions of the constructionist theory remain tractable.

As a case in point, causal consequence inferences are normally not constructed on-line according to the constructionist theory. That is, readers do not forecast a hypothetical plot that involves new plans of agents and long event chains into the future. According to the constructionist theory, the only causal consequences that are generated on-line are (a) superordinate goals of existing plans that may end up being achieved in the future plot (class 4 inferences), (b) emotional reactions of characters to events and actions (class 6 inferences), and (c) causal consequences that have a high strength of encoding by virtue of assumption 5. Researchers have frequently proposed that causal consequences are not made on-line because there are too many alternative hypothetical plots that could potentially be forecasted, because most of these alternatives would end up being erroneous when the full story is known or because it takes a large amount of cognitive resources to forecast a single hypothetical plot (Graesser & Clark, 1985; Johnson-Laird, 1983; Kintsch, 1988; Potts, Keenan, & Golding, 1988; Reiger, 1975). However, a causal consequence inference is likely to be generated on-line if it is highly constrained by context and there are few if any alternative consequences that would be likely to occur (Keefe & McDaniel, 1993; McKoon & Ratcliff, 1986; Murray, Klin, & Myers, 1991; van den Broek, 1990).

In some contexts, readers are motivated by idiosyncratic goals. They are predicted to generate those classes of inferences that are directly relevant to the idiosyncratic goals. For example, if their goal is to gain a vivid mental picture of the spatial setting and to track the location of objects, then spatial state inferences (class 11 in Table 1) would be constructed on-line even though it is time consuming to generate such inferences (Morrow et al., 1987; Morrow, Bower, & Greenspan, 1989; Perrig & Kintsch, 1985). However, spatial inferences are not normally generated on-line when readers read naturalistic stories for understanding and entertainment (Zwaan & Van Oostendorp, 1993). In some contexts, the reader's idiosyncratic goals are pitched at a shallow level of comprehension, such as proofreading a manuscript for spelling errors or performing in an experimental task that involves word recognition. In such cases, the reader would not construct a meaningful situation model, and virtually none of the inferences in Table 1 would be generated on-line. Therefore, there is not an invariant set of on-line inferences when considering all of the reader goals that potentially motivate reading. However, there are clear-cut predictions when the reader goals are pitched at a default level or a genre-based level of goal specificity.

The status of author intent or attitude (class 13) is uncharted at this point of inference research. There has been very little theoretical discussion of the psychological impact of author intent and attitude (Hunt & Vipond, 1986; Rosenblatt, 1978) and no empirical research investigating on-line processing. From one perspective, the reader is expected to generate inferences about author intent and attitude because it explains why the author expresses particular clauses in the text and why the author wrote the text. From another perspective, however, there are several reasons for being pessimistic about the likelihood of generating these inferences on-line. There rarely is a rich pragmatic context that anchors communication between the author and reader of a story, so there is very little information to support such inferences. In fact, the author of a text is normally invisible to the reader. There are cases in which there is a rich pragmatic context, for example, a letter to a friend or a politician writing a story to be read by a constituency; in these cases, readers are predicted to generate inferences and explanations about author intent and attitude on-line. A second reason to be pessimistic is that the reader may fail to achieve a globally coherent interpretation of the text per se; establishing a globally coherent message is presumably a prerequisite or corequisite of computing author intent and attitude. There is a yet a third reason to be pessimistic. People do not normally construct author intent and attitude when they observe events and actions in the everyday world, so this cognitive skill is not overlearned through everyday experience.

The status of reader emotions (class 12) is also uncharted. In one sense, reader emotions are reactions of the reader to the text rather than inferences per se. The reader experiences suspense, surprise, fear, curiosity, amusement, and other emotions while reading episodes in the narrative (Brewer & Ohtsuka, 1988; Graesser, Long, & Mio, 1990; Jose & Brewer, 1984). The reader may identify with a character and empathetically experience some semblance of the character's emotions. These reader reactions do not refer directly to the situation model depicted in the story plot so they are not really knowledge-based inferences. In another sense, however, they are inferences that refer to the pragmatic context of the author–message–reader system. Authors write texts to elicit particular reader emotions, readers have these emotions, and readers cognitively acknowledge (consciously or unconsciously) that they are experiencing these manipulated emotions. Readers may experience the appropriate emotion during an episode, with elevated physiological arousal, in a manner carefully crafted by the author (Beach & Brown, 1987). Alternatively, readers may cognitively infer that they should be having a particular emotion during a particular episode, even though they are not physiologically aroused or in the mind set of experiencing the appropriate emotion. When a reader reads a story for a second or third time, the reader may cognitively infer that an episode is surprising or suspenseful even though the entire story is known and there is no uncertainty about the plot (Gerrig, 1989). Clearly, the phenomenon of reader emotion is complex. For this reason, the constructionist theory does not offer a decisive prediction about its processing status (i.e., on-line vs. off-line).

In summary, the constructionist theory predicts that six classes of inferences are normally generated on-line (1, 2, 3, 4, 5, and 6) and five classes are off-line (7, 8, 9, 10, and 11). These predictions prevail when reading narrative under the default and genre-based reading goals. All things being equal, there should be a higher strength of encoding for the first six classes than for the second five classes. A decisive prediction is not offered for inferences referring to reader emotion (class 12) and to author intent and attitude (class 13).

The significance of these predictions can be appreciated once we consider the predictions of other theories of narrative comprehension. We cover alternative theoretical positions in the next section.

Other Theories of Inference Generation During Narrative Comprehension

In this section, we discuss other theoretical positions that offer predictions about inference generation during narrative text comprehension. It is beyond the scope of this section to present all of the components and assumptions of each theoretical position. Instead, we directly focus on the salient features of each theoretical position and then declare the resulting predictions. In Table 3, we summarize the inference classes that are predicted to be drawn on-line by each theoretical position.

Explicit Textbase

This is a straw-man theoretical position that asserts that no knowledge-based inferences are constructed during comprehension. None of the production rules in Table 2 would exist according to this position. Early psychological theories of discourse processing indirectly endorsed this position to the extent that they focused exclusively on explicit text in the construction of meaning representations. This position is not a serious contender among contemporary discourse-processing theories, but it is an interesting extreme position to consider conceptually.

Minimalist Hypothesis

McKoon and Ratcliff (1989, 1992) recently proposed this hypothesis to account for those inferences that are automatically (vs. strategically) encoded during comprehension. According to the minimalist hypothesis, the only inferences that are encoded automatically during reading are those that are based on easily available information (either from explicit statements in the text or from background world knowledge) and those that are necessary for establishing local coherence. The inferences needed to establish local text coherence are classes 1, 2, and 3 (referential, case structure role assignment, and causal antecedent). Therefore, inferences in classes 1, 2, and 3 are the only inferences that are automatically encoded. McKoon and Ratcliff (1992) did not offer predictions about which inferences are strategically generated on-line. However, they did specify that strategic inferences (a) are more time consuming to construct (greater than 500 ms), (b) are constructed when local coherence cannot be established during the interpretation of a clause, and (c) are not as consistently encoded during comprehension (i.e., there are fluctuations among readers, reader goals, and tasks). These claims permit us to extrapolate some predictions about what inferences are most likely to be constructed on-line after readers have more time to process a given clause. Given that strategic inferences are only probabilistically generated on-line, whereas automatic inferences are consistently generated, then inference classes 1, 2, and 3 should have a higher likelihood of being generated on-line than the other classes of inferences in Table 1. The minimalist position would assume the existence of production rules B and F in Table 2 but not production rules A, C, D, and E. As discussed earlier, it would be essential to tune production rule B more precisely to capture the exact conditions under which causal antecedents are generated according to the minimalist hypothesis.

Current-State Selection Strategy

This is a model of narrative comprehension that specifies various rules for making causal connections between explicit events, actions, and states in STM (Bloom et al., 1990; Fletcher, 1986; Fletcher & Bloom, 1988). The CSS strategy of Fletcher and Bloom (1988) merged a causal network model of narrative representation (Trabasso & van den Broek, 1985) with the STM assumptions of earlier models by Kintsch and his colleagues (Kintsch & van Dijk, 1978; Miller & Kintsch, 1980). This hybrid model was compared with the earlier, proposition-based, "leading edge" rule of Kintsch and van Dijk (1978). The leading edge rule relies heavily on argument repetition as the main basis for linking propositions. The CSS strategy would assume the existence of production rules A, B, and F in Table 2 but not production rules C, D, and E. Moreover, production rules A and B would be tuned somewhat differently than that of the constructionist theory.

The CSS strategy specifies that causal connections are made between the current clause and a causal antecedent (i.e., an antecedent event, an antecedent state, or a superordinate goal) if the causal antecedent resides in STM. A causal antecedent remains in STM as long as it has no causal consequent. When a connection is made, the causal antecedent is transferred out of STM to LTM. If no causal antecedent can be found for an incoming clause, a local causal coherence break occurs, and a search for a cause is made in LTM.

The CSS strategy constructs a representation that is based on local coherence, similar to that of the minimalist hypothesis

Table 3
Predictions of On-line Inference Processing, Derived From Six Theoretical Positions

Type of inference	Explicit text-base	Minimalist hypothesis	Current-state selection strategy	Constructionist theory	Prediction–substantiation model	Promiscuous inference generation
Class 1: Referential		X	X	X	X	X
Class 2: Case structure role assignment		X	X	X	X	X
Class 3: Causal antecedent		X	X	X	X	X
Class 4: Superordinate goal			X	X	X	X
Class 5: Thematic				X	X	X
Class 6: Character emotional reaction				X	X	X
Class 7: Causal consequence					X	X
Class 8: Instantiation of noun category						X
Class 9: Instrument						X
Class 10: Subordinate goal–action						X
Class 11: State						X
Class 12: Reader emotion						X
Class 13: Author intent						X

Note. X = on-line prediction.

(McKoon & Ratcliff, 1992). In both systems, a strategic search for causal coherence occurs at local coherence breaks. However, the kinds of coherence assumed by the two positions are different. For example, referential coherence and argument repetition are critical in the minimalist hypothesis, whereas causal coherence is critical in the CSS strategy. Another difference addresses the generation of superordinate goal inferences. According to the CSS strategy, there must be a failure in establishing a local causal antecedent for global coherence to be achieved through the retrieval of a goal mentioned much earlier in the text. In contrast to the minimalist position, the CSS allows a goal to reside in STM for more than one clause as long as it does not find a consequent. Once the goal is connected, however, it is removed from STM and is retrieved as a cause only when there is a subsequent break in local causal coherence. Breaks in other kinds of local coherence are not relevant to the CSS assumptions.

The CSS strategy predicts that four classes of inferences are generated on-line: referential inferences (class 1), case structure role assignments (class 2), causal antecedents (class 3), and superordinate goals (class 4). Technically speaking, the superordinate goals are generated under limited conditions in the CSS strategy described above. However, Fletcher and Bloom (1988) did have a version of their model that predicted that the superordinate goal inferences are made whenever possible (i.e., the "CSS + Goal" strategy). The original CSS strategy is similar to the minimalist hypothesis in that it emphasizes the achievement of local coherence; it differs from the minimalist hypothesis in that the kind of coherence is causal rather than referential (i.e., argument repetition). The CSS + Goal strategy is similar to the constructionist theory in its emphasis on the formation of causal explanations and its predictions that causal antecedents and goals are constructed on-line. However, the constructionist theory predicts that two additional classes of inferences are constructed on-line to achieve global coherence: thematic inferences (class 5) and the emotional reactions of characters (class 6).

Prediction–Substantiation Model

This model asserts that reading is expectation-driven in addition to explanation-driven. That is, readers generate expectations about future occurrences in the plot, and these expectations guide the interpretation of clauses in a top-down fashion (Bower et al., 1979; DeJong, 1979; Dyer, 1983; Schank & Abelson, 1977). Expectations are formulated whenever higher order knowledge structures are activated, such as a script or a theme. For example, if a story activates a RESTAURANT script and the text mentions that two characters entered a restaurant together, then the reader would form expectations that the characters will eat, talk, and be served food. If a story activates a REVENGE theme and the text specifies that character A hurts character B, then the reader would form the expectation that character B will hurt character A. Expectations are normally formulated at a superordinate abstract level rather than being fleshed out in fine detail. For example, a comprehender might expect that character B will hurt character A but will not generate a fine-tuned expectation of exactly how the hurt will be realized (e.g., verbal abuse, physical harm, or the use of a gun).

The prediction–substantiation model predicts that seven classes of inferences are generated on-line: referential (class 1), case structure role assignment (class 2), causal antecedent (class 3), superordinate goal (class 4), thematic (class 5), character emotional reaction (class 6), and causal consequence (class 7). Inferences in classes 1, 2, and 3 establish local coherence. Those in classes 3 and 4 explain why actions and events occur. Those in classes 4, 5, and 6 are critical for constructing higher order knowledge structures and establishing global coherence. The inferences in class 7 are expectations about forecasted plots. There is only one discrepancy between the theoretical predictions of the constructionist theory and that of the prediction–substantiation model, namely that of the causal consequence inferences. The prediction–substantiation model would incorporate all of the production rules in Table 2 (A through F) and would add an additional production rule to account for causal consequence inferences.

Promiscuous Inference Generation

This extreme straw-man position predicts that all classes of inferences are generated on-line. Thus, all of the production rules in Table 2 would be adopted, plus many others. It is assumed that the reader builds a complete, lifelike situation model by fleshing out all of the details about the characters, props, spatial layout, setting, actions, events, and so on. The meaning representation would be a high-resolution mental videotape of the narrative, along with exhaustive information about the mental states of the characters and about the pragmatic exchange between the author and reader. No researchers have directly proposed this promiscuous inference generation position. We should point out, nevertheless, that McKoon and Ratcliff (1992) have claimed that a constructionist theory would embrace such a position.

As discussed earlier, each of the classes of inferences in Table 1 could potentially be generated on-line if the experimenter tuned the instructions, task, and materials properly. For example, if the experimenter encouraged the reader to have the goal of constructing the spatial layout of the narrative, then the reader would construct spatial inferences on-line. Of course, it might take a long time to construct these inferences and some readers might give up trying. The critical tests of the constructionist theory and the alternative theoretical positions described in this section perhaps consist of experimental conditions in which the reader is not tuned to the class of inferences under scrutiny. For example, would the reader construct spatial inferences when reading the narrative for understanding, for entertainment, or for the specific goal tracking of the traits of a character? If spatial inferences are constructed when readers have these latter goals, then that would be compelling evidence that spatial inferences are generated on-line; if not, then these spatial inferences are not generated on-line.

More generally, several conditions must be met before there is a fair test of whether an inference class is normally generated on-line versus off-line: (a) the reader must be motivated to understand the text, (b) the reader must have prerequisite background knowledge, (c) the text must be considerate, (d) there must be sufficient time for the reader to construct the inferences, and (e) the instructions and tasks must not be specially tuned to the inference class under investigation.

Empirical Evidence for the Constructionist Theory

There have been some lively debates over the proper measures and experimental designs that test whether or not a class of inferences is generated on-line (Graesser & Bower, 1990; Keenan, Golding, Potts, Jennings, & Aman, 1990; Magliano & Graesser, 1991; McKoon & Ratcliff, 1989, 1990; Potts et al., 1988; Singer, 1988). However, in this article, we do not dissect the methodological problems with each of the existing measures and tasks. There does not appear to be a perfect measure and task; there are merely trade-offs, with each enjoying some benefits and some shortcomings. The evidence presented in this section is based on empirical studies that have minimal methodological problems. An ideal dependent measure would tap processes that occur during the course of comprehension rather than reconstructive processes well after comprehension is completed; this eliminates recall and summarization tasks in which data are collected after a reader finishes comprehending a text. An ideal dependent measure would track the time-course of various cognitive processes by charting response times. Such measures include self-paced reading times for text segments (e.g., words, clauses, and sentences), gaze durations on words in eye-tracking studies, lexical-decision latencies on test words (i.e., whether a test string is a word or a nonword), naming latencies on test words, latencies to verify whether a test statement is true or false, latencies to decide whether a test segment had been presented earlier (i.e., recognition memory), or speeded recognition judgments under a deadline procedure. Moreover, an ideal experimental design would eliminate or control extraneous variables.

To test whether knowledge-based inferences are generated on-line, it is critical to demonstrate that subjects have a sufficient knowledge base and sufficient information sources to produce the inferences. It would be pointless to test whether readers generate an inference if they do not have the prerequisite world knowledge or if an inference test item (i.e., a word or statement) fails to match any cognitive representation that a reader could manage to construct. There is one, very critical, methodological implication of this note of caution: Experimenters should not generate their own inference test items and assume that the subjects are actually making these inferences, particularly if the experimenter ends up concluding that the inference class is not generated on-line. The experimenter must validate that the inferences could be generated by the designated reader population if the readers had sufficient time to do so.

In light of the above cautionary note, researchers have sometimes collected verbal protocols from readers during comprehension to validate that the readers could potentially generate the inferences under investigation. These verbal protocols are collected while the reader comprehends the text sentence by sentence or clause by clause. In think-aloud tasks, the readers express whatever comes to mind as each explicit clause is comprehended (Beach & Brown, 1987; Daly, Weber, Vangelisti, Maxwell, & Neel, 1989; Ericsson, 1988; Ericsson & Simon, 1980; Fletcher, 1986; Olson, Duffy, & Mack, 1984; Suh & Trabasso, 1993; Trabasso & Suh, 1993). In question-answering tasks, the readers answer particular questions about each clause, such as why, how, and what-happens-next (Graesser, 1981; Graesser & Clark, 1985). In question-asking tasks, the reader asks questions that come to mind about each sentence (Collins, Brown, & Larkin, 1980; Olson, Duffy, & Mack, 1985). These verbal protocols expose potential knowledge-based inferences. The researcher has some assurance that the inference could be made, that the reader population has the prerequisite world knowledge, and that the inference is expressible in language. The researcher can measure the proportion of subjects who produce the inference at particular points in the text that elicit the inference.

Of course, the fact that an inference is expressed in verbal protocols does not imply that the inferences are normally generated on-line. It is possible that readers adopt unnatural reading strategies when producing the verbal protocols (Nisbett & Wilson, 1977). Therefore, it is necessary to test the on-line status of candidate inferences by collecting appropriate measures from a separate group of readers who do not supply verbal protocols. Such measures include sentence reading times, gaze durations on words, lexical-decision latencies or naming latencies on test items in a secondary task, latencies in making recognition memory judgments on words or sentences, and so on. Researchers have satisfactorily demonstrated that particular classes of inferences exposed by verbal protocols do in fact predict these on-line temporal measures collected from a different group of readers (Graesser, Haberlandt, & Koizumi, 1987; Long, Golding, & Graesser, 1992; Long & Golding, 1993; Magliano, Baggett, Johnson, & Graesser, 1993; Millis, Morgan, & Graesser, 1990; Olson et al., 1984; Sharkey & Sharkey, 1992; Suh & Trabasso, 1993). These studies have shown that some, but not all, classes of inferences from the verbal protocols are generated on-line. Therefore, theories of inference generation can be tested by coordinating verbal protocol analyses and on-line temporal measures, as we illustrate later. Magliano and Graesser (1991) have advocated the implementation of a three-pronged method that coordinates (a) the collection of verbal protocols to expose potential inferences, (b) theories of discourse processing that make distinctive predictions about which classes of inferences are generated on-line, and (c) the collection of on-line temporal measures to assess whether a class of inferences is actually made on-line.

At this stage of development, most investigations of inference generation have not used the three-pronged method. It takes considerable effort to collect and analyze the verbal protocols, so most researchers have resisted the temptation to pursue the methodology. However, we believe that the most compelling evidence involves the collection of these protocols to ensure that readers have sufficient knowledge to make these inferences. Once we are satisfied that the readers can make these inferences under unlimited time constraints, we can then collect time-based behavioral measures to investigate the time-course of generating these inferences.

This section has three parts. In the first subsection, we review empirical tests of inference processing in studies that used time-based behavioral measures to tap on-line processing but did not adopt the three-pronged method. The focus is on inference classes 1 through 4 and 6 through 11 because there are essentially no adequate empirical tests of classes 5, 12, and 13. In the second subsection, we report a study that adopted the three-pronged method to investigate text-connecting inferences during narrative comprehension. As mentioned earlier, these inferences specify how explicit clauses in the text are connected conceptually. In the third subsection, we report studies that used the three-pronged method to investigate extratextual inferences during narrative comprehension. As reported below, the available evidence supports the constructionist theory to a greater extent than the alternative theoretical positions presented in the previous section.

Evidence From Studies That Do not Use the Three-Pronged Method

As summarized in Table 3, the constructionist theory predicts that the following five inference classes are generated online (under normal comprehension conditions in which the reader is not tuned to generate a particular class of inferences): referential inferences, case structure role assignments, causal antecedents, characters' emotional reactions, and superordinate goals. In fact, there is empirical support for these predictions in studies that have used the time-based behavioral measures described above. Support has accrued in the case of referential inferences (Bever & McElree, 1988; Dell, McKoon, & Ratcliff, 1983; Duffy & Rayner, 1990; Gernsbacher, 1990; McKoon & Ratcliff, 1992; O'Brien, Duffy, & Myers, 1986; Sanford & Garrod, 1981), case role assignments (Frazier & Flores d'Arcais, 1989; Just & Carpenter, 1980; Swinney & Osterhout, 1990), causal antecedents (Bloom et al., 1990; Fletcher & Bloom, 1988; McKoon & Ratcliff, 1986, 1989; Myers et al., 1987; Potts et al., 1988; Singer, Halldorson, Lear, & Andrusiak, 1992; van den Broek & Lorch, 1993), superordinate goals (Dopkins et al., 1993), and characters' emotional reactions (Gernsbacher, Goldsmith, & Robertson, 1992).

In contrast, the constructionist theory predicts that several classes of "elaborative" inferences in Table 3 are not generated on-line (unless the reader has a specific goal to generate these inferences or the inferences are highly predictable through constraints of multiple information sources): instantiations of a noun category, instruments, causal consequences, subordinate goals/actions, and states. These inferences are not needed to construct a coherent explanation of the explicit actions and events in the narrative, so they have a lower likelihood of being generated on-line. Once again, available empirical studies support the prediction that these classes of elaborative inferences are not constructed on-line. The prediction is supported in the case of instantiations of noun categories (Whitney, 1986), instruments (Corbett & Dosher, 1978; McKoon & Ratcliff, 1981; Singer, 1979, 1980), causal consequences (Bloom et al., 1990; McKoon & Ratcliff, 1986, 1989; Potts et al., 1988; Singer & Ferreira, 1983), and states (Seifert, 1990; Seifert, Robertson, & Black, 1985).

The central argument, therefore, is that the constructionist theory predicts the exact subset of inferences that are generated on-line and the conditions under which they are generated. In contrast, accurate predictions are not delivered by the alternative theoretical positions: the explicit textbase position, the minimalist hypothesis, the CSS strategy, the prediction–substantiation model, and the promiscuous inference generation position.

There is considerable variability in the amount of empirical evidence available for each class of inference. Therefore, at this point, we identify some of the most solid empirical findings and trace the theoretical implications.

Most of the theoretical positions predict that causal antecedent bridging inferences are generated during comprehension. Indeed, there is substantial support for the prediction (see above citations). For example, in studies by Singer (Singer et al., 1992; Singer, Revlin, & Halldorson, 1990), subjects read sentence pairs such as 1a and 1b below.

1a. Dorothy poured the bucket of water on the bonfire.

1b. The fire went out.

An understanding of this sentence pair requires the recognition that the first event caused the second event. The reader must also know something that, when coupled with the fact that water was poured on the fire, accounts for the fire going out; specifically, the reader fills in a causal antecedent enabling event *water extinguishes fire*. According to Singer's model, the reader initially constructs a mental syllogism with a missing premise (called an *enthymeme*) and then solves the syllogism with the inferred enabling causal antecedent (i.e., the inference). In this case, 1a and the inference are two premises that imply conclusion 1b in the solved constructed syllogism. In a contrast condition, subjects read the sentence pair 2a and 2b.

2a. Dorothy placed the bucket of water by the fire.

2b. The fire went out.

In this case, the inference *water extinguishes fire* is not generated in the explanation. The sentence pairs are causally related in the 1a–1b sequence (the causal condition) but only temporally contiguous in the 2a–2b sequence (the temporal condition).

After subjects read one of the sentence pairs, they were asked to verify the inference by answering the question, "Does water extinguish fire?" They pushed either a "yes" or "no" button as quickly as possible. Of course, the answer to this generic fact should be yes in both conditions. The latencies to answer this question were in the expected direction. Answer time for the test question was faster in the causal condition than in the temporal condition. This result has consistently occurred in a number of studies that Singer and his colleagues have conducted (Singer et al., 1990, 1992). The effect occurs when the sequences are isolated sentence pairs and when the sentence pairs are embedded in text. The effect even occurs when the order of presenting 1a and 1b is reversed. Moreover, the effect cannot be explained by extra priming of the question by the words in 1a of the causal condition because the effect disappears when the second sentence (1b or 2b) is deleted (Singer et al., 1992).

The consistent finding that causal antecedent inferences are generated on-line is sufficient to eliminate the explicit textbase position but not the alternative theoretical positions. The causal consequence inferences provide a more discriminating test among the theoretical positions. Potts et al. (1988) investigated whether causal antecedent inferences and causal consequence inferences are generated while comprehending short two-sentence excerpts. They collected naming latencies on test words shortly after subjects read the sentences. For example, consider the test word *broke* in the context of the following three texts:

Causal antecedent condition. No longer able to control his anger, the husband threw the delicate porcelain vase against the wall. It cost him well over one hundred dollars to replace the vase.
Causal consequence condition. No longer able to control his anger, the husband threw the delicate porcelain vase against the wall. He had been feeling angry for weeks, but had refused to seek help.
Control condition. In one final attempt to win the delicate porcelain vase, the angry husband threw the ball at the bowling pins that stood against the wall. He had never won anything and was determined not to miss this time.

The inference *the vase broke* is a causal antecedent bridging inference while comprehending the second sentence in the causal antecedent condition; therefore, this inference should be generated on-line. The same inference is a causal consequence of the first sentence of the causal consequence condition; in this case, the status of this inference varies among the theoretical positions. The inference would not be generated in the control condition. The naming latencies in the Potts et al. (1988) study were consistent with the proposal that causal antecedent inferences are generated on-line but not causal consequence inferences. The naming latencies showed the following pattern: causal antecedent < causal consequence = control.

The finding that causal consequence inferences were not generated on-line in this study and several other studies (see earlier citations) eliminates additional theoretical positions. Specifically, the data are not compatible with the predictions of the prediction–substantiation model and the promiscuous inference generation position. We are therefore left with three viable theoretical positions: the constructionist theory, the minimalist hypothesis, and the CSS strategy.

Characters' emotional reactions are generated on-line according to the constructionist theory but not according to the minimalist hypothesis and the CSS strategy (see Table 3). Gernsbacher et al. (1992) investigated these inferences by collecting sentence reading time measures and naming latency measures. Subjects read stories that had explicit concrete actions and events and that triggered emotional inferences. An example story involved a main character stealing money from a store where his best friend worked and later learning that his best friend had been fired. In such a story, the emotion of *guilt* is predicted to be generated on-line according to the constructionist theory. Test words were presented during the reading of stories, and subjects provided naming latencies. The test words were either an appropriate emotion (e.g., *guilt*) or an inappropriate emotion (e.g., *pride*). Gernsbacher et al. (1992) reported that naming latencies were shorter for the appropriate emotions than for the inappropriate emotions. This outcome supports the constructionist theory rather than the minimalist hypothesis and the CSS strategy.

Another test that discriminates the above three theoretical positions involves global inferences that link an incoming explicit statement with information several episodes earlier in the story (i.e., information that is outside of WM). According to the minimalist hypothesis and the CSS strategy, these global inferences are made only when there is a failure in establishing local coherence or causal coherence. However, according to the constructionist theory, these global inferences are generated even when local coherence is intact. The evidence favors the constructionist theory (Dopkins et al., 1993; O'Brien & Albrecht, 1992; Singer, 1993; Suh & Trabasso, 1993; van den Broek & Lorch, 1993). The materials in the study by Singer (1993), for example, are illustrated below.

3a. Valerie left early for the birthday party. (global inference condition)

3a′. Valerie left the birthday party early. (control condition)

3b. She checked the contents of her purse.

3c. She backed out of the driveway.

3d. She headed north on the freeway.

3e. She exited at Antelope Drive.

3f. She spent an hour shopping at the mall.

TEST: Do birthday parties involve presents?

Sentences 3b, 3c, 3d, and 3e intervened between the motivating statement (3a), or the control statement (3a′), and the attempt to prepare for the party by shopping (3f). Statements 3a and 3a′ should be deleted from WM by the time 3f is comprehended. It should be noted that both versions were referentially and causally coherent. According to the minimalist hypothesis, 3a should not be inferentially bridged to 3f because they are several sentences apart and local coherence is established; the constructionist theory predicted the two sentences should be inferentially bridged to establish global coherence. The time to subsequently answer the test question supported the constructionist position: The latencies were shorter in the global inference condition than in the control condition. Further support for the constructionist theory was provided by an explicit control condition, in which sentence 3f explicitly referred to the inference (i.e., She spent an hour shopping for a present at the mall). Answer latencies to the test question were similar in the explicit control condition and the global inference condition, indicating that the global inference has a status in the text representation similar to an explicitly stated idea. Once again, readers attempted to achieve global coherence even when mechanisms of local coherence are intact.

A Study of Text-Connecting Inferences Using the Three-Pronged Approach

Suh and Trabasso (1993) have used the three-pronged method to investigate text-connecting inferences during the comprehension of more lengthy narrative texts. A discourse model predicted the points in the text where particular text-connecting inferences would be constructed on-line. Specifically, they were interested in the process of reinstating superordinate goals that were explicitly mentioned earlier in the text. Think-aloud protocols were collected from a group of subjects while they comprehended the stories, sentence by sentence. The content extracted from these verbal protocols confirmed the predicted text-connecting inferences of the discourse model; that is, superordinate goals were reinstated by explicit clauses at predictable text locations. A separate group of readers provided recognition test decisions and latencies for test statements at different points in the text (instead of providing verbal protocols). The patterns of recognition decisions and latencies confirmed the model's predictions regarding the locations in the text where the superordinate goals are reinstated.

In Table 4, we present two versions of an example story that was investigated by these researchers (Suh & Trabasso, 1993; Trabasso & Suh, 1993). In the hierarchical version, Jimmy has a main (superordinate) goal of wanting to buy a bike. Jimmy tries to get his mother to buy the bike, but this strategy fails because she refuses. Later on in the story, after the main goal is presumably no longer in WM, Jimmy tries a second approach to getting the bike by asking for a job, earning money, and purchasing the bike by himself. Many of the actions in the second half of the hierarchical story should reinstate Jimmy's goal of buying a bike (G11; see Table 4). In contrast, this goal should not be reinstated by these actions in the second half of the sequential story version. Jimmy's goal of buying the bike is satisfied early in the sequential version of the story because Jimmy's mother agrees to get the bike for Jimmy.

Both the constructionist theory and the discourse model of Suh and Trabasso (1993) predict that the superordinate goal will be reinstated by particular story actions in the hierarchical version. Reinstatement of this goal supports global coherence. It should be noted that the superordinate goal should be reinstated even though there is no break in local coherence. All of the sentences in both stories are locally coherent by virtue of argument repetition (Halliday & Hasan, 1976; Kintsch & van Dijk, 1978): The subject of each sentence after sentence 1 is Jimmy. According to the minimalist hypothesis and the CSS strategy, the global goal inference should not be reinstated because there is no break in local coherence or causal coherence.

One prong of the three-pronged method addresses theory. The theoretical predictions of Suh and Trabasso (1993) were based on a discourse theory that specifies in detail how the content of the stories are organized into causal network structures and how the structures are constructed during comprehension (Trabasso & Suh, 1993; Trabasso & van den Broek, 1985; Trabasso et al., 1989). Each sentence is classified by its

Table 4
Hierarchical and Sequential Versions of the Jimmy Story (Suh & Trabasso, 1993)

Category	Sentence
	Hierarchical version
S11	Once there was a boy named Jimmy.
E11	One day, Jimmy saw his friend Tom riding a new bike.
G11	Jimmy wanted to buy a bike.
A11	Jimmy spoke to his mother.
O11	Jimmy's mother refused to get a bike for him.
R11	Jimmy was very sad.
E21	The next day, Jimmy's mother told him that he should have his own savings.
G21	Jimmy wanted to earn some money.
A21	Jimmy asked for a job at a nearby grocery store.
A22	Jimmy made deliveries for the grocery store.
O21	Jimmy earned a lot of money.
A31	Jimmy went to the department store.
A32	Jimmy walked to the second floor.
O31	Jimmy bought a new bike.
	Sequential version
S11	Once there was a boy named Jimmy.
E11	One day, Jimmy saw his friend Tom riding a new bike.
G11	Jimmy wanted to buy a bike.
A11	Jimmy spoke to his mother.
O11	Jimmy's mother got a bike for him.
R11	Jimmy was very happy.
E21	The next day, Jimmy's mother told him that he should have his own savings.
G21	Jimmy wanted to earn some money.
A21	Jimmy asked for a job at a nearby grocery store.
A22	Jimmy made deliveries for the grocery store.
O21	Jimmy earned a lot of money.
A31	Jimmy went to the department store.
A32	Jimmy walked to the second floor.
O31	Jimmy bought a new basketball.

Note. S = setting; E = event; G = goal; A = attempt; O = outcome; R = reaction. The first number after the letter indicates the episode to which the statement belongs. The second number indicates the cumulative number of times that the statement's category has occurred in that episode. For example, A32 refers to the second attempt in the third episode.

role in an episodic structure. That is, it is assigned to one of six main categories: settings (S), events (E), goals (G), attempts (A), outcomes (O), and reactions (R). Settings introduce characters and indicate the spatial-temporal context of the story. Events have an impact on characters and influence goals. Goals are desired and valued states, activities, objects, and resources. Attempts are actions carried out to achieve goals. Outcomes index the success or failure of a goal being achieved. Reactions are emotions and cognitions that evaluate events and outcomes. The numbers in the lettered subscripts in Table 4 refer to the episode in which the sentence occurs (the first digit) and the ordinal number of a particular category within an episode (the second digit). For example, G21 is the second episode's first goal statement and A32 is the third episode's second attempt statement. Trabasso's discourse theory specifies how the sentences are connected with different categories of causal arcs and how these connections are built on-line during comprehension. The discourse theory predicts that G11 should be causally linked (on-line) to sentences A11, G21, A31, and A32 in the hierarchical version but only to sentence A11 in the sequential version.

Another prong of the three-pronged method states that verbal protocols should be collected to confirm that the theoretically predicted inferences are generated on-line. Suh and Trabasso (1993) collected think-aloud protocols as subjects read the stories sentence by sentence. After a subject read each sentence, the subject told the experimenter what his or her understanding of the story was in the context of the story, no matter how obvious it was to the subject. The protocols were tape recorded and analyzed. The theoretical prediction is that the superordinate goal (G11, Jimmy wanting to buy a bike) should frequently be mentioned when A11, G21, A31, and A32 are comprehended in the hierarchical version and when A11 is comprehended in the sequential version. This prediction was confirmed. The likelihoods of mentioning G11 were 1.00, .92, .58, and .92 for the respective actions in the hierarchical version, and .92, .29, .04, and .17 in the sequential version. The verbal protocols clearly confirmed the predictions of the discourse theory.

The other prong of the three-pronged method states that time-based behavioral measures should be collected to more rigorously assess whether an inference is actually made on-line. Suh and Trabasso (1993) collected recognition decisions and latencies for test items that were interspersed with the sentences during comprehension. Test statements were presented after story sentences, and subjects decided as quickly as possible whether the test statement was presented earlier in the text (by pressing a "yes" or a "no" key). A critical test item was the G11 goal sentence. The recognition latency was expected to be shorter if the reader had reinstated G11 during the comprehension of a story sentence. The results confirmed the predictions of the discourse model. Recognition latencies (in milliseconds) were 973, 986, and 1,084 for the critical test item after A11, G21, and A32, respectively, in the hierarchical version; the corresponding latencies were 980, 1,123, and 1,209 in the sequential version. Once again, the significant differences between the hierarchical and sequential versions at positions G21 and A32 would not be predicted by the minimalist hypothesis.

The results of Suh and Trabasso's (1993) application of the three-pronged method are compatible with the constructionist theory. The theory predicts that readers generate superordinate goals during the comprehension of narrative to explain why goals, actions, and events are explicitly mentioned. These inferences may either be text-connecting inferences or extratextual inferences. Superordinate goals are generated even when local coherence is intact and when the incoming sentence needs to be linked to a superordinate goal that was mentioned much earlier in the text.

Studies of Extratextual Inferences Using the Three-Pronged Method

Graesser and his colleagues have used the three-pronged method to investigate extratextual inferences during the comprehension of short narrative texts (Graesser et al., 1987; Long & Golding, 1993; Long et al., 1992; Long, Golding, Graesser, & Clark, 1990; Magliano et al., 1993) and short expository texts (Millis, 1989; Millis et al., 1990). They focused on five classes of inferences because the status of these classes discriminated among alternative theoretical positions: superordinate goals (class 4), subordinate goals (class 10), causal antecedents (class 3), causal consequences (class 7), and states (class 11). Below, we present an example story and an example inference in each of these five classes:

> The Czar and His Daughter
>
> Once there was a Czar who had three lovely daughters. One day the three daughters went walking in the woods. They were enjoying themselves so much that they forgot the time and stayed too long. A dragon kidnapped the three daughters. As they were being dragged off they cried for help. Three heroes heard their cries and set off to rescue the daughters. The heroes came and fought the dragon and rescued the maidens. Then the heroes returned the daughters to their palace. When the Czar heard of the rescue, he rewarded the heroes.
>
> Inferences when comprehending "The dragon kidnapped the daughter":
>
> 1. Superordinate goal: The dragon wanted to eat the daughters.
> 2. Subordinate goal: The dragon grabbed the daughters.
> 3. Causal antecedent: The dragon saw the daughters.
> 4. Causal consequence: Someone rescued the daughters.
> 5. State: The dragon has scales.

The first prong of the method addresses theory. The theoretical predictions are summarized in Table 3 and were discussed earlier in this article.

The second prong of the three-pronged method involved the collection of question-answering protocols while readers comprehended the stories clause by clause. After reading each clause (that referred to an action, event, or state), the subjects answered questions about the clause. One group answered a why-question, a second group answered a how-question, and a third group answered a what-happened-next question. The question categories were selected to extract particular types of extratextual inferences. As discussed earlier, research on human question answering has strongly established that why, how, and what-happened-next questions are selective in extracting particular inferences (Graesser & Franklin, 1990; Graesser et al., 1981, 1991; Graesser & Murachver, 1985). Why-questions expose superordinate goals and causal antecedents; how-questions expose subordinate goals/actions and causal antecedent events;

what-happened-next questions expose causal consequences. States are exposed by more than one of these question categories and can be distinguished by content.

A *constructive history chart* was prepared for each of the inferences that was elicited by the question-answering protocols. The chart identified which explicit clauses in the text elicited a particular inference, the type of question that elicited it, and the proportion of subjects who articulated the inference in the question-answering protocols. The point in the story where an inference first emerged was particularly informative. In fact, all experiments that collected time-based measures tested an inference when it first emerged in the situation model, as manifested in the question-answering protocols.

Whenever Graesser and his colleagues evaluated the on-line status of classes of inferences, they always equilibrated the classes of inference test items on the proportion of subjects who produced the item in the question-answering task (Graesser & Franklin, 1990; Graesser et al., 1981, 1991; Graesser & Murachver, 1985). Inference test items were also equilibrated on a number of extraneous measures, such as word length, word frequency, and word class (i.e., nouns, verbs vs. adjectives).

The third prong of the three-pronged method involved the collection of lexical-decision latencies or naming latencies for test words during the comprehension of the stories. Long et al. (1992) reported a study that adopted the three-pronged methodology to test whether superordinate goal inferences and subordinate action inferences are generated on-line when stories are comprehended. According to the constructionist theory, superordinate goals should be generated on-line because they explain why characters perform intentional actions. In contrast, subordinate actions should not be generated because they do not explain why actions occur; subordinate actions merely elaborate the details about how actions are executed. Long et al. used question-answering protocols to extract a sample of superordinate goals and subordinate actions associated with explicit actions in the text. Why-questions uncovered the superordinate goals, whereas how-questions uncovered the subordinate actions. The two samples of inferences were equilibrated on a number of extraneous variables, such as production likelihood in the question-answering protocols, word frequency, word length, and word class.

Long et al. (1992) collected word-naming latencies to test whether inference words are generated on-line during comprehension. A test word was presented 500 ms after each sentence in a story was read. The subjects were instructed to say the test word aloud as quickly as possible. The test word was sometimes a word that came from a superordinate goal and sometimes a word from a subordinate goal/action. These items were new inferences constructed for the first time in the story by explicit target actions. There also was a control condition in which the superordinate and subordinate inferences were named in an unrelated passage context. Therefore, an *inference activation score* could be computed for each test word by subtracting the naming latency of the word in the inference context from the naming latency of the word in an unrelated context. This computation of inference activation scores has been used by other researchers who have collected lexical-decision latencies to study inference processing (Kintsch, 1988; Sharkey & Sharkey, 1992; Till, Mross, & Kintsch, 1988). Long et al. (1992) reported significantly higher inference activation scores for superordinate goal words than for subordinate goal/action words (which in turn were essentially zero). Using the same design, Long et al. reported a similar pattern of data when lexical decisions were collected instead of naming latencies. The activation scores showed the following pattern: superordinate goal > subordinate goal/action > 0.

In another study, Long and Golding (1993) reported that superordinate goals are constructed very quickly (within 750 ms) in the case of fast readers with good comprehension. In contrast, inference activation scores were essentially zero in the case of subordinate goal/actions for all readers and in the case of superordinate goals for readers who are not fast, good comprehenders. Precise control over reading time was accomplished by implementing a rapid serial visual presentation (RSVP) rate of 250 ms per word. There was precise control over the time-course of inference activation by imposing a short 200-ms stimulus onset asynchrony (SOA) between the final word of the sentence and the test word. The results of these investigations of superordinate and subordinate goals are compatible with the constructionist theory and incompatible with most of the alternative theoretical positions (i.e., explicit textbase position, minimalist hypothesis, and promiscuous inference generation position).

Magliano et al. (1993) tested whether causal antecedent and causal consequence inferences are generated on-line and also determined the time-course of their activation. They manipulated inference category (causal antecedent vs. causal consequence), RSVP rate (250 vs. 400 ms), and SOA interval (250, 400, 600, and 1,200 ms). Lexical-decision latencies were collected on test items after each sentence, following the same procedure as the studies presented above. The results indicated that there was a threshold of 400 ms after stimulus presentation (either RSVP or SOA) before causal antecedents were generated, whereas causal consequence inferences were never generated on-line.

Studies using the three-pronged method have revealed that state inferences are not generated on-line. Long et al. (1990) compared causal antecedent event inferences with state inferences in a study that collected lexical-decision latencies. Latencies were shorter for test words that referred to causal antecedent event inferences than for those referring to state inferences. Graesser et al. (1987) collected word reading times using a moving window method and focused on times for end-of-clause words. It was assumed that inferences are generated primarily at end-of-clause words, following the results of previous research (Haberlandt & Graesser, 1985; Just & Carpenter, 1980; Kintsch & Van Dijk, 1978). Graesser et al. (1987) found that end-of-clause reading times were predicted by the number of new goal inferences and causal antecedent event inferences that were constructed during the comprehension of the clause but not by the number of state inferences.

In summary, Graesser's research on extratextual inferences using the three-pronged method was compatible with the predictions of the constructionist theory and one version of the CSS strategy (i.e., the CSS + Goal strategy). Superordinate goals and causal antecedents are generated on-line, whereas subordinate goals/actions, causal consequences, and states do not tend to be generated on-line. Stated differently, the first two inference classes have substantially higher encoding strengths than do the latter three classes. These results are not consistent with the predictions of the explicit textbase position, the minimalist hypothesis, the original version of the CSS strategy, the prediction–substantiation model, and the promiscuous inference generation position. In addition, the collection of verbal protocols was effectively coordinated with theory and the collection of on-line behavioral measures.

Summary of Empirical Findings

This section has presented evidence for the constructionist theory of inference generation and against the alternative theoretical positions. Although most of the available research has been on short texts that do not use the three-pronged method, a few studies have adopted the methodology that coordinates theory, the collection of verbal protocols, and the collection of time-based behavioral measures.

When considering all of the evidence, the constructionist theory is supported by the finding that inference classes 1, 2, 3, 4, and 6 (see Tables 1 and 3) are normally generated on-line, whereas inference classes 7, 8, 9, 10, and 11 do not tend to be on-line. These predictions are not made by the explicit textbase position, the minimalist hypothesis, the CSS strategy, the prediction–substantiation model, and the promiscuous inference generation model. The constructionist theory predicts that the latter five classes (7 through 11) are generated on-line only under two conditions: (a) when the reader has a specific goal to generate these inferences, (b) the inferences are highly predictable by virtue of the constraints imposed by multiple information sources (as specified by assumption 5), or both. Unfortunately, there is no solid evidence one way or another about the status of inference classes 5, 12, and 13. One direction for further research is to examine these inferences in more detail. The constructionist theory also correctly predicts that global inferences are generated on-line even under conditions in which local coherence is intact. In contrast, the minimalist hypothesis and the CSS strategy predict that these inferences are made only when there is a breakdown in local coherence or causal coherence.

In closing, it would appear that the proposed constructionist theory provides the best foundation for predicting and explaining inference generation during the comprehension of narrative text. Readers construct rather rich situation models during the comprehension of narrative. However, it is not the case that the reader constructs a complete lifelike rendition of the story, as if a camera captured all pictorial details in fine detail and a narrator tracked the minds of all of the characters. Instead, a predictable subset of the situation is preserved and another subset never makes it into the meaning representation. The search-after-meaning principle goes a long way in distinguishing what knowledge is in the representation versus what is out.

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