Processing Interclausal Relationships

Studies in the Production and Comprehension of Text

Edited by
Jean Costermans
Michel Fayol

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Preface

Since the mid-1980s, more and more linguistic and psycholinguistic research has been devoted to the study of discourse and written texts. A number of these deal with the markers that underline the connections and the breaks between clauses and sentences and with the use of these markers in the production and comprehension of oral and written material, by adults and by children.

It seemed to us that sufficient data of an interesting nature has been gathered, on both sides of the Atlantic Ocean, to justify the idea of bringing together some of the major observations and the main theoretical views in the field. The idea was not to publish original data for the exclusive attention of specialists, but rather to present an overview of observations and perspectives to bring this research to the attention of a wide range of linguists, psychologists, and speech therapists.

In the production of text or discourse, whether it is of a narrative, descriptive, or argumentative nature, one has to cope with several universal constraints. On the one hand, when the author introduces pieces of information that are new or supposedly new to the addressee, he or she has to ensure the continuity of the stream of discourse, that is to say, bring together these new pieces of information with the ones already known or given. The connection between old and new information is achieved through the use of linguistic markers varying from one language to another, but also from one developmental level to another. These markers are concerned with referencing processes and with the linking of predicates. They either work within the clauses (like word order) or between clauses (e.g., indefinite vs. definite determinants, anaphora, imperfective vs. perfective forms of the verb).

On the other hand, the linearity that characterizes oral as well as written language forces us to juxtapose information that is not necessarily closely linked in the multidimensional representation of the situation of reference (i.e., the mental model). In oral speech, the variations in the strength of these links may be translated by some modulations in the duration of pauses between linguistic segments of varied span (e.g., words, sentences, episodes). They may also be shown by the use of connectives that indicate the strength of the links between states or events described in adjacent segments and provide some information about their nature. Similar variations are observed in written language by the use of connectives as well as by the use of a specific paradigm, namely, punctuation. Connectives and punctuation marks simultaneously signal the boundaries of information blocks and their integration into hierarchically organized structures. Again, the differences between languages and the specificities of the various developmental levels must be considered.

For realizing the referential and predicative continuity–discontinuity marking, as well as the segmentation–integration of the information flow, people need to make use of some system of markers that are more or less complex and, consequently, are more or less easy to acquire. They must perceive the corresponding notional distinctions, which are culturally bounded and may depend on specific areas of knowledge. They have to link the markers with what they are referring to in accordance with the specificity of each language, and take into account that these links may be dependent on the fields of knowledge and on the pragmatic conditions of the speech or text production.

After considering some aspects of the production processes, let us now devote some attention to comprehension. The comprehension of text or discourse may be viewed as the reconstruction of a mental model that wanders as little as possible from the one that the author had in mind. It bears on the addressee's previous conceptual and linguistic knowledge, on the procedures to which he or she resorts, and on the attentional resources at his or her disposal at the different processing stages. In this perspective, the markers of interclausal relations play a fundamental role. First, they demarcate linguistic segments of variable span, from clause to paragraph, at least. Second, they trigger some processes activating certain links with previous knowledge. Third, they induce a focalization of attention by inhibiting certain dimensions in favor of others (e.g., inhibiting some features of the surface form of an item in favor of its meaning). Finally, they contribute to the elaboration of a mental model by facilitating the conceptual setup between the states and events to which they refer.

The efficiency of the processing of the interclausal markers depends on their availability for the addressee, but also on the activation of the associated procedures and on the action of these procedures on the representations. The success of the comprehension process also requires the previous knowledge to be sufficient to allow the elaboration of the different representational levels and also demands relevant procedures to be activated. It finally assumes that attentional resources be sufficient so that the different treatments can go through without one of them being adversely affected.

In the chapters gathered in this book, these various facets are taken into account. The volume presents contributions from researchers mainly interested in adult language and others mainly concerned with developmental aspects. Some contributors deal mainly with production, and others deal with comprehension. Some work on oral discourse, and others are mainly concerned with written texts. To preserve overall coherence, however, the contributors were given four recommendations:

• The first recommendation concerned the level of linguistic analysis and asked the contributors to put the main emphasis on the clause level or, more in particular, on the relationships between clauses, even if this should not discard some interesting considerations about the way of linking sentences or even paragraphs.

• The second recommendation was to put special emphasis on the linguistic markers (such as connectives, markers of segmentation, and punctuation). The book should not primarily be devoted to discourse or text structure, but to how linguistic devices are used to process, signal, and detect that structure, as many authors do not seem to pay enough attention to the nature, function, and use of such devices.

• The third recommendation was to write the chapters so as to offer an overview of a given field of research. Although reporting current research is clearly desirable, much attention should be devoted to put this work in perspective, both with respect to the author's own research programs and with respect to the entire field.

• Finally, a fourth recommendation was especially addressed to contributors in the developmental field. They were asked to pay attention to the fact that an account of the acquisition of some language functions throughout childhood would be coherent with the present context only as far as it could be exploited to derive general principles of interclause relations that might be masked by the exclusive examination of adult evidence.

The 13 chapters gathered in this volume are divided into four parts. Part I presents two contributions very well suited to open the field by covering the use of a large range of linguistic markers that maintain discourse and text cohesion in adults and in children. Part II gathers five contributions on connectives, some of the main devices that secure the cohesion of discourse. Part III, in contrast, assembles three chapters devoted to some linguistic tools that allow for the expression of discontinuity, in particular, the punctuation marks and also some lexico–syntactic devices that hold similar functions in oral discourse. Finally, the three chapters of Part IV widen the subject beyond the cohesion–segmentation dichotomy and insert the problem into the broader field of text and discourse structuring.

No book, even dealing with as limited a field as the interclausal relations, could pretend to be exhaustive. It is obvious that the current volume does not escape form this rule. Two major themes remain unquestioned: the difficulties encountered during the production and the comprehension of cohesive devices, and the children's comprehension of such cohesive devices. Other aspects are barely mentioned; for example, the differential treatment of the diverse punctuation marks in comprehension, the individual variations in the implementation of different types of markers, or finally, and probably one of the most difficult questions to envisage, the problem of the relationships between the use of markers in production and their role in comprehension.

It goes without saying that these themes should be the concern of empirical and theoretical work in the coming years. The conceptions developed in the chapters of

this book, the methods used, and the results described aim to provide the re-searchers with material for reconsidering many questions and for elaborating new research programs. In that perspective, this work has to be conceived as a step toward the scientific study of the comprehension and the production of interclausal markers. Our wish is that it would lead other researchers to develop this field of investigation.

ACKNOWLEDGMENT

Part I

PROCESSING INTERCLAUSAL RELATIONSHIPS:
A MANY-SIDED TOPIC

Part I gathers two chapters, which, due to the complementarity of the topics encountered, give a general overview of the questions considered in this book and the way one can deal with them. Indeed, chapter 1 deals with comprehension by the adult and focuses on the linguistic cues and the previously acquired knowledge used by the subjects to elaborate a mental representation. In contrast, chapter 2 considers the children's oral production of narratives. Here, the authors evoke the relationships between the story plots and the cohesive devices, but also the constraints affecting the performance.

In chapter 1, Gernsbacher summarizes her model of the general processes implied in text comprehension: the Structure Building Framework. According to this model, comprehension aims at the elaboration of a coherent representation. This elaboration takes place by the setting up of foundations, followed by the development of the mental structures through mapping of the new information with the previous items. Depending on the coherence of the incoming information with the previously established items, either there is a follow up on the building of the ongoing structure or a new structure is initiated. The problem is to determine how the addressee knows whether a new piece of information can and must be put in relation with the one just processed. Two parameters determine the pairing: first, the previous knowledge of the world, which allows the interpretation of what remains implicit, and, second, some linguistic cues that operate as pairing instructions. A series of empirical data is reported illustrating how these two parameters intervene during the elaboration of different types of coherence: referential, temporal, situational, causal, and structural.

In chapter 2, Shapiro and Hudson develop a functional approach to the production of narratives by children. They wonder why canonical narratives are produced at a later stage of development. To account for the difficulties encountered, they consider that children are confronted with two tasks requir-

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ing simultaneous treatment: to elaborate a coherent frame and to set up markers ensuring cohesion (e.g., use of subordinate clauses, pronouns, and conjunctions). This hypothesis predicts that, when the task demands become too important to manage both tasks, performance degrades. It also predicts that an alleviation of one of the tasks would lead to an improvement in the text quality. This hypothesis is tested in two experiments during which help is provided: for example, pictures facilitate the production management. The data confirms that this help induces a complexification of the story plots as well as a diversification and an increase in the use of cohesive devices. The authors conclude that the use of interclausal devices vary with the complexity of the frames and with the task demands.

� Chapter 1

Coherence Cues Mapping During Comprehension

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Language can be viewed as a specialized skill involving language-specific processes and language-specific mechanisms. Another position views language as drawing on general, cognitive processes and mechanisms—processes and mechanisms that underlie nonlinguistic tasks as well. Such a commonality might arise because language comprehension evolved from nonlinguistic cognitive skills (Bates, 1979; Lieberman, 1984), or because the mind is based on a common architecture, such as a connectionist architecture (Rumelhart & McClelland, 1986).

In my research, I have adopted the view that many of the processes and mechanisms involved in language comprehension are general cognitive processes and mechanisms. I have proposed a simple framework, the Structure Building Framework, that identifies a few of those general cognitive processes and mechanisms (Gernsbacher, 1991a, 1996, in press). According to the Structure Building Framework, the goal of comprehension is to build coherent mental representations or *structures*. At least three component processes are involved. First, comprehenders lay foundations for their mental structures. Next, comprehenders develop mental structures by mapping on new information when that information coheres or relates to previous information. However, when the incoming information is less coherent or related, comprehenders employ a different process: They shift and build a new substructure. Thus, most representations comprise several branching substructures.

The building blocks of these mental structures are memory nodes. Memory nodes are activated by incoming stimuli. Initial activation forms the foundation of mental structures. Once memory nodes are activated, they transmit processing signals to enhance (increase) or suppress (decrease or dampen) other nodes' activation. Thus, once memory nodes are activated, two mechanisms control their level of activation: suppression and enhancement. Memory nodes are enhanced

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when the information they represent is necessary for further structure building; they are suppressed when the information they represent is no longer necessary.

Previously, I have empirically explored the three processes involved in structure building: (a) laying a foundation (Carreiras, Gernsbacher, & Villa, 1995; Gernsbacher & Hargreaves, 1988, 1992; Gernsbacher, Hargreaves, & Beeman, 1989); (b) mapping information onto a foundation (Carreiras & Gernsbacher, 1992; Deaton & Gernsbacher, in press; Gernsbacher, 1991b; Gernsbacher, Goldsmith, & Robertson, 1992; Gernsbacher & Robertson, 1992, 1996b; Haenggi, Gernsbacher, & Bolliger, 1993; Haenggi, Kintsch, & Gernsbacher, 1995; Oakhill, Garnham, Gernsbacher, & Cain, 1992); and (c) shifting to build new substructures (Foertsch & Gernsbacher, 1994; Gernsbacher, 1985; Gernsbacher, Varner, & Faust, 1990).

I have also explored the two mechanisms that control these structure-building processes: suppression and enhancement (Faust & Gernsbacher, 1996; Gernsbacher, 1989, 1993; Gernsbacher & Faust, 1991a, 1991b, 1994; Gernsbacher & Jescheniak, 1995; Gernsbacher & Robertson, 1995; Gernsbacher & Shroyer, 1989). I have found that these general cognitive processes and mechanisms underlie many comprehension phenomena. I have also found that differences in the efficiency of these processes and mechanisms underlie differences in adult comprehension skill (Gernsbacher, 1993; Gernsbacher & Faust, 1991a, 1994; Gernsbacher & Robertson, 1995; Gernsbacher, Varner, & Faust, 1990) and adult written composition skill (Traxler & Gernsbacher, 1992, 1993, 1995).

This chapter focuses on one of the central processes of structure building involved in text and discourse comprehension—the cognitive process of mapping. According to the Structure Building Framework, once comprehenders have laid a foundation for their mental structures, they develop those structures using the cognitive process of mapping. I envision the cognitive process of mapping as similar to creating an object out of papier-mâché. Each strip of papier-mâché is attached to the developing object, augmenting it. Appendages can be built, layer by layer. Comprehenders build mental structures in a similar way. Each piece of incoming information can be mapped onto a developing structure to augment it, and new substructures (like appendages) are built in the same way.

What guides this mapping process? In this chapter, I suggest that comprehenders interpret various cues that the incoming information coheres with the previously comprehended information. Comprehenders interpret these cues as signals or *instructions* to map the incoming information onto the structure or substructure that they are currently developing. Comprehenders learn the cues of coherence through their experience with the world and their experience with language (Gernsbacher & Givón, 1995).

Some coherence cues are explicitly provided in the text or discourse; for instance, anaphoric pronouns such as *she* and the definite article *the* are provided in the text or discourse. Yet, even for coherence cues that are explicitly provided in the text or discourse, comprehenders must acquire knowledge of these cues to interpret them as signals of coherence. Other coherence cues are more implicit; they are not explicitly provided by the text or discourse, but they arise through what some researchers call *inferential processing*. To interpret these cues, comprehenders also rely on previously acquired knowledge; however, this knowledge is knowledge of the events and relations in the world. Thus, coherence cues lie along a continuum, ranging from cues that are provided explicitly in the text or discourse to cues that are only implicitly suggested by the text or discourse.

Applicable to the entire continuum of coherence cues is the proposal that interpreting coherence cues is knowledge-based, be it the knowledge of the roles that different linguistic devices play (e.g., that the pronoun *she* refers to an animate female) or the knowledge that different descriptions of real-world situations imply. In contrast to other models of text and discourse comprehension, the Structure Building Framework does not distinguish between the type of knowledge that comprehenders have acquired about language nor the type of knowledge that comprehenders have acquired about the real world that language describes. Thus, according to the Structure Building Framework, comprehenders use their previously acquired knowledge to interpret cues of coherence, and they use these coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. In this way, coherence cues the process of mapping during comprehension.

But what is coherence? Dictionaries define coherence as consistency, continuity, or coordination. In text and discourse, I have identified five types of coherence: *referential coherence*, which is consistency in *who* or *what* is being discussed; *temporal coherence*, which is consistency in *when* the events that are being discussed occur; *locational coherence*, which is consistency in *where* these events occur; *causal coherence*, which is consistency in *why* these events occur; and *structural coherence*, which is consistency in the *form* in which events are described in the text or discourse. These five types are not independent; coherent information in text and discourse is typically characterized by all five—and sometimes more. According to the Structure Building Framework, each of these types of coherence should be cued by either implicit or explicit signals, and comprehenders' interpretation of the cues that signal each of these types of coherence should promote the cognitive process of mapping. The experiments I review in this chapter support these predictions. I begin by reviewing research that supports the prediction that comprehenders interpret cues that signal referential coherence as signals for mapping.

REFERENTIAL COHERENCE

Two utterances are considered referentially coherent if they refer to the same people, places, or things. So, one way to signal referential coherence is simply to repeat a word or phrase, for instance, the repeated word, *beer*, in the following two sentences: *We got some beer out of the trunk. The beer was warm.* These two sentences seem referentially coherent because they refer to the same concept: *the beer from the trunk, which was* (unfortunately) *warm.* However, simply repeating a word does not ensure referential coherence; the word must refer to the same concept. These two sentences both contain the word *beer, We got some beer out of the trunk. John was especially fond of beer*; yet, the beer referred to in the second sentence is not necessarily the same as the beer introduced in the first sentence.

According to the Structure Building Framework, comprehenders interpret coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. If comprehenders interpret repeated reference as a signal of referential coherence, then comprehenders should map sentences that contain repeated references onto their representation of sentences that contain previous references. And indeed, the sentence, *The beer was warm*, is read considerably faster when it follows the sentence, *We got some beer out of the trunk*, than when it follows the sentence, *We checked the picnic supplies* (Haviland & Clark, 1974), suggesting that comprehenders interpret repeated reference as a signal of referential coherence.

Referential coherence is also signaled in English by the definite article, *the*. Consider the following two sentences: *A psycholinguist was writing a chapter. The psycholinguist was trying to think of examples.* The use of the definite article, *the*, in the second sentence suggests that the psycholinguist who was writing a chapter was also the psycholinguist who was trying to think of examples. In contrast, consider the following two sentences: *A scholar was reading a chapter about coherence. A scholar could think only about how hungry he was.* In these two sentences, it is unclear whether the scholar who was reading a chapter was also the scholar who was getting hungry. However, if the definite article, *the*, replaces the indefinite article, *a*, in the second sentence, *A scholar was reading a chapter about coherence. The scholar could think only about how hungry he was*, this unfortunate situation is more apparent. Indeed, the definite article, *the*, can signal co-reference even when the noun it modifies is only a synonym of the previously mentioned noun, for instance, *A scholar was reading a chapter about coherence. The litterateur put down the book and went to the kitchen to fix dinner.* These examples illustrate how the English definite article, *the*, can signal co-reference.

According to the Structure Building Framework, comprehenders interpret coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. If comprehenders interpret the English definite article, *the*, as a signal of referential coherence, then comprehenders should map sentences that contain the definite article, *the*, onto their developing representations. A pioneering experiment by de Villiers (1974) suggested that comprehenders do interpret the definite article, *the*, as a cue for mapping. In de Villiers' experiments, two groups of subjects heard the same set of 17 sentences. For one group, all the sentences occurred with only indefinite articles; for example, *A store contained a row of cages. A man bought a dog. A child wanted an animal. A father drove to his house. A cottage stood near a park.* For the other group of subjects, the same sentences occurred, but in this condition the indefinite articles were replaced with definite articles; for example, *The man bought the dog. The child wanted the animal. The father drove to his house.* When the sentences were presented with indefinite articles, subjects were more likely to interpret them as independent sentences that referred to multiple people and unconnected events. In contrast, when the sentences were presented with definite articles, subjects were more likely to interpret them as forming a coherent narrative in which the same persons and events were referred to repeatedly. *The man bought a dog at the store. He drove home and gave the dog to his son, who was delighted.*

Recently, Robertson and I (Gernsbacher & Robertson, 1996)conducted two experiments to demonstrate that the phenomenon originally observed by de Villiers generalized to more than one set of experimental sentences. More importantly, the goal was also to demonstrate that comprehenders interpret the definite article, *the*, as a cue of referential coherence while they are building their mental structures. Ten different sets of sentences were constructed. Each set contained 14, 15, 16, or 17 sentences. These sentences were presented to two different subject groups. One group of subjects read all the sentences with indefinite articles, and the other group of subjects read the sentences with definite articles.

For example, one group of subjects read: *Some siblings were happy to be together. A road was icy and slick. A family stopped to rest. A cafe was almost deserted. A waitress took an order. A driver left to get gas. A man slipped and fell in a parking lot. A sister watched through a window. A gas station was nearby. An attendant rushed out of a building. A stranger helped a brother. A man walked slowly. A group stayed for a night. A trip was postponed.* The other group of subjects read: *The siblings were happy to be together. The road was icy and slick. The family stopped to rest. The cafe was almost deserted. The waitress took the order. The driver left to get gas. The man slipped and fell in the parking lot. The sister watched through the*

window. The gas station was nearby. The attendant rushed out of the building. The stranger helped the brother. The man walked slowly. The group stayed for the night. The trip was postponed.

The length of time subjects needed to read each sentence was measured. If the definite article, *the*, is interpreted as a cue for mapping, then subjects who read the sentences with the definite articles should have read those sentences more rapidly than subjects who read the sentences with indefinite articles, which is exactly what was observed (i.e., a 23% benefit in average sentence reading time). Furthermore, the subjects who read the sentences with the definite articles recalled those sentences in a more integrative way, often combining two or more sentences into one, and they were more likely to use pronouns. These results suggest that subjects who read the sentences with the definite articles were more likely to map the sentences of each set together. In our second experiment, we tested this hypothesis more directly.

We again presented 10 sets of sentences to two groups of subjects. We again manipulated whether the sentences were presented with definite versus indefinite articles, and we again measured subjects' reading times to the sentences. However, in lieu of asking subjects to recall what they remembered after reading each set of sentences, McKoon and Ratcliff's (1980) priming-in-item verification task was used: Each time subjects read two sets of sentences, they performed a timed recognition task. Thirty-two test sentences were presented; half were old and half were new. Unknown to the subjects, the test list was arranged in such a way that each "old" sentence was preceded in the test list by either an "old" sentence that was from the same set of sentences or an "old" sentence that was from a different set. For example, for half the subjects, the sentence *The sister watched through the window* was preceded in the test by the sentence *The man slipped and fell in the parking lot.* These two sentences are from the same original set. For the other half of the subjects, the same sentence was preceded in the test list by a sentence from a different set. We predicted that subjects who read the sentences with the definite articles would be more likely to map the sentences of each set together. If so, then they should recognize an "old" sentence more rapidly when it was preceded by a sentence from the same set of sentences than when it was preceded by a sentence from a different set of sentences. And indeed, that is what we found.

Another potential cue of referential coherence in English is pronominal anaphora. For example, in the sentence *The aunt ate the pie, and she was senile*, the pronoun *she* in the second clause indicates that the two clauses refer to the same person; the person who was senile was the same as the person who ate the pie. In contrast, the sentence *The aunt ate the pie, and Alice was senile* suggests two different referents; the person who was senile was probably not the same

as the person who ate the pie (unless the pie-eating, senile aunt is named Alice). Thus, when the second clause contains a pronoun, these two clauses are more referentially coherent.

According to the Structure Building Framework, comprehenders interpret coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. If comprehenders interpret pronominal anaphora as a cue for referential coherence, then comprehenders should map clauses containing pronouns onto their mental structures that represent the referents of those sentences. And, indeed, comprehenders remember more sentences in their entirety when the second clause contains a pronoun, as in *The aunt ate the pie, and she was senile*, than when the second clause introduces a new referent, as in *The aunt ate the pie, and Alice was senile*. Comprehenders also recall more words of the sentences when the second clause contains a pronoun (Foertsch & Gernsbacher, 1994; Lesgold, 1972). Both results suggest that comprehenders interpret pronominal anaphora as a signal for mapping.

Comprehenders' interpretation of anaphora as a cue for referential coherence and therefore as a signal for mapping is knowledge-driven. In Gernsbacher (1991b), I demonstrated that this knowledge extends beyond simply knowing that the pronoun *she* most likely refers to a singular female. I discovered that after subjects read the sentence *I need a plate*, they more rapidly read the sentence *Where do you keep them?* than the sentence *Where do you keep it?* In contrast, after subjects read the sentence *I need an iron*, they more rapidly read the sentence *Where do you keep it?* than the sentence *Where do you keep them?* Thus, comprehenders' knowledge that plates usually come in sets, whereas irons do not, and that if a person has a plate, he is likely to have at least a few, whereas if a person has an iron, he is likely to have only one, guides comprehenders' interpretation of pronouns. Note that in these instances the anaphor (e.g., *them*) can mismatch its literal antecedent in number (e.g., *a plate*); the crucial match is between the number of the conceptual referent (e.g., *plates in general*). These sentences illustrate a phenomenon I call *conceptual anaphora*.

In Gernsbacher (1991b), I identified three categories of conceptual referents (i.e., referents that might literally be singular but are more easily referred to with plural pronouns than singular pronouns). These conceptual referents included (a) frequently or multiply occurring items and events (e.g., *a plate, a birthday, an exam*) as opposed to infrequently or singularly occurring items and events (e.g., *an iron, a 40th birthday, a final exam*); (b) generic items (e.g., *a Sony walkman, a pet, a vacation*) as opposed to specific tokens (e.g., *my roommate's Sony walkman, my childhood pet, the vacation I took last winter*); and (c) collective sets (e.g., *the team, the phone company, the class*) as opposed to individual entities (e.g., *the players on the team, the people who work at the phone company, the students*

in the class). My European collaborators and I also demonstrated that conceptual anaphora are just as natural in British English and Spanish as they are in American English. Indeed, the phenomenon commutes to the verb in pro-drop languages, such as Spanish (Carreiras & Gernsbacher, 1992; Oakhill et al., 1992). Thus, interpreting anaphora as a cue for referential coherence is knowl-edge-based.

Referential coherence is crucial, but consistently referring to a previously mentioned concept does not guarantee that communication will be lucid. Consider the following passage, from Johnson-Laird (1983): *"My daughter works in a library in London. London is the home of a good museum of natural history. The museum is organized on the basis of cladistic theory. This theory concerns the classification of living things. Living things evolved from inanimate matter"* (p. 379). Each sentence in this passage consistently refers to a concept that was intro-duced in its preceding sentence. However, the passage seems disjointed. There must be other sources of coherence.

TEMPORAL COHERENCE

We communicate about actions, ideas, and events that occur, have occurred, or will occur during a certain time frame. Temporally coherent events occur during the *same* time frame. One simple cue of temporal coherence is consis-tency in the tense or aspect of the verbs within the sentences of a text or discourse. For example, these sentences share a common tense and aspect: *The siblings were happy to be together. The road was icy and slick. The family stopped to rest. The cafe was almost deserted. The waitress took the order. The driver left to get gas.* In contrast, these sentences differ in their tense and aspect: *The siblings are happy to be together. The road will be icy and slick. The family used to stop to rest. The cafe was almost deserted. The waitress had been taking the order. The driver will leave to get gas.* The first set of sentences seems more temporally coherent than does the second set.

Temporal coherence can also be cued by adverbial phrases. For example, if I were describing the events that occurred while I was running a marathon, I might say: *I arrived at the start line at 7:45 a.m. The marathon was scheduled to begin at 8:00. As I nervously awaited the start, I talked with the other runners. I also stretched a bit and tried very hard to relax. At 8 o'clock sharp the starter fired his pistol.* If I continued my narrative by saying *Half an hour later it began to rain*, the adverbial phrase, *half an hour later*, establishes the time that it began to rain at 8:30, a time during which I most likely was still running in the marathon. Thus, the sentence, *Half an hour later it began to rain*, coheres with the previous

sentences. In contrast, if I continued my narrative by saying *Three days later it began to rain*, the adverbial phrase, *three days later*, suggests that the event (the rain) occurred while I was not still running the marathon (as even I do not run that slowly). Rather the adverbial phrase, *three days later*, suggests that I am now describing an event (the rain) that occurred during a different time frame. Thus, the sentence, *Three days later it began to rain*, is less temporally coherent with the previous sentences.

According to the Structure Building Framework, comprehenders interpret coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. If comprehenders interpret adverbial phrases as cues for temporal coherence, then comprehenders should be more inclined to map sentences onto their developing mental structures when those sentences contain temporal adverbs that cohere with the previously suggested time frame than when those sentences contain temporal adverbs that do not cohere with the previously suggested time frame. Anderson, Garrod, and Sanford (1983) demonstrated that comprehenders do use their previously acquired knowledge of the typical duration of events to interpret cues of temporal coherence.

Anderson et al. (1983) collected subjects' estimates of the typical time frames for 20 common events. For example, the typical time frame for changing a baby is 30 seconds to 15 minutes, the typical time frame for eating a meal in a restaurant is 30 minutes to 3 hours, the typical time frame for attending a party is 1 hour to 5 hours, and the typical time frame for taking a vacation is 3 days to 4 weeks. After collecting these estimates of the typical time frames for common events, Anderson et al. (1983) presented narratives that were titled to indicate a particular event, for example, "Eating a Meal at a Restaurant." Following a sentence such as *John sat down at the restaurant table*, subjects read a sentence that began with an adverbial phrase that indicated a time period within the typical duration of the titled event, *Five minutes later, a waiter approached*, or subjects read a sentence that began with an adverbial phrase that indicated a time period that was beyond the typical duration of the titled event, *Five hours later, a waiter approached*. Anderson et al. (1983) observed that sentences were read considerably more rapidly when they began with adverbial phrases that indicated a time period within the typical time frame of the titled event (e.g., *five minutes later*, for the restaurant narrative) than sentences that began with adverbial phrases that indicated a time period outside the typical time frame of the titled event (e.g., *five hours later*). These data suggest that comprehenders use their previously acquired knowledge of the typical duration of events to interpret cues of temporal coherence, and that comprehenders use cues of temporal coherence, such as adverbial phrases, as signals to map the incoming information onto the structure or substructure that they are currently developing.

LOCATIONAL COHERENCE

Another type of coherence in text and discourse is locational coherence. The actions, ideas, and events about which we communicate typically occur, have occurred, or will occur at a certain location. Locationally coherent events occur at the *same* place. For example, if I were describing an impromptu meeting I had with a colleague, I might say: *Pat and I were standing in the hallway near my office. We were enthusiastically discussing a new set of data.* I might continue my description with a sentence such as, *In a nearby office, people had difficulty concentrating.* The adverbial phrase, *in a nearby office,* maintains the location established in the first two sentences. It signals that the sentence coheres with my two previous sentences. In contrast, if I would have said, *In a nearby town, people had difficulty concentrating,* the adverbial phrase, *in a nearby town,* changes the location of my narrative (and requires a new explanation as even I do not talk that loudly). Because the adverbial phrase, *in a nearby office,* maintains the previously established location, whereas the adverbial phrase, *in a nearby town,* changes the previously established location, the sentence containing the adverbial phrase, *in a nearby office,* is more locationally coherent.

A more subtle cue of locational coherence is consistency in narrative point of view. The narrative point of view is where the narrator would be located (if he or she were physically present) with relation to the other referents. For example, the verb, *came,* in the clause, *John came into the living room,* implies that the narrator is located inside the living room. In contrast, the verb, *went,* in the clause, *John went into the living room,* implies that the narrator is located outside the living room. According to the Structure Building Framework, comprehenders interpret coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. If comprehenders interpret narrative point of view as a cue for locational coherence, then comprehenders should be more likely to map sentences onto their mental structures when those sentences contain verbs that preserve a previously established narrative point of view than when those sentences contain verbs that alter a previously established narrative point of view.

Black, Turner, and Bower (1979) demonstrated that comprehenders do interpret narrative point of view as a cue for mapping. After reading the sentence, *Bill was sitting in the living room reading the evening paper,* which establishes the narrative point of view inside the living room, subjects read the sentence, *Before Bill had finished the paper, John came into the room,* more rapidly than they read the sentence, *Before Bill had finished the paper, John went into the room.*

Recently, Dieter Haenggi, Caroline Bolliger, and I (Haenggi et al., 1993) demonstrated comprehenders can infer the location of a protagonist in a narrative, and comprehenders use that inferred knowledge as a cue for mapping.

The subjects in our experiments read narratives that only implied a protagonist's location; the narratives never explicitly stated the protagonist's location. For example, the following narrative implied a jogger's location on a jogging course: *Carol enjoyed jogging to keep in shape, but lately she hadn't been able to jog very much because she'd been so busy. On Sunday, she decided to try to jog around a new 5-mile course. It was a loop course, meaning that it was one big circle. She hoped she'd be able to make it the whole 5 miles around the course. After she had jogged 1 mile, she still felt okay. But after she had jogged 2 miles, she wished she was in better shape. Still, she thought she could make it all the way around the 5-mile loop. After Carol finished the third mile, her legs really began to ache. And after she had jogged 4¾ miles she was truly exhausted.*

After reading each narrative, subjects read a sentence that was either congruent with the protagonist's implied location or a sentence that was incongruent with the protagonist's implied location. For example, this sentence is congruent with Carol, the jogger's, location: *Although she was so close to where she wanted to finish, she had to walk the rest of the way.* In contrast, this sentence is incongruent with Carol, the jogger's, location: *Although she was so far away from where she wanted to finish, she had to walk the rest of the way.*

These same two sentences were incongruent versus congruent for a different narrative, which was the following: *Julie loved to cycle and today she decided to bike along a nearby river. Along the river was a great 25-mile bike path. The entire 25-mile path was well-paved and conveniently marked off after every 5 miles. After Julie had ridden 5 miles, the path got steeper and she needed to pedal harder. After riding 10 miles, Julie felt the path flatten. She even passed a few other bikers. But after riding 15 miles, Julie heard the chain on her bike snap. She got off of her bike and inspected the chain.* Thus, for this narrative, the sentence, *Although she was so close to where she wanted to finish, she had to walk the rest of the way* is incongruent, whereas the sentence, *Although she was so far away from where she wanted to finish, she had to walk the rest of the way* is congruent. We found that sentences that were congruent with the implied location of the protagonist were read almost twice as fast as sentences that were incongruent with the implied location of the protagonist. These data suggest that comprehenders use their previously acquired knowledge of the spatial relations in the world to interpret cues of locational coherence, and comprehenders map locationally coherent information onto the structure or substructure that they are currently developing.

CAUSAL COHERENCE

I have suggested that coherent text and discourse is characterized by referential coherence (i.e., the same persons, places, or things are referred to), temporal

coherence (i.e., the time frame stays the same), and locational coherence (i.e., the location stays the same). But referential, temporal, and locational coherence are not the only types of coherence.

Consider the following set of sentences: *Brian punched George; George called the doctor; The doctor arrived.* Now, consider the following set of sentences: Brian punched George; George liked the doctor; The doctor arrived. The two sets of sentences are equal in their referential coherence as both sets repeat a reference to *George* and to *the doctor.* The two sets of sentences are equal in their temporal coherence. And the two sets are equal in their locational coherence. Nevertheless, the first set of sentences seems more coherent than the second. Because only the verbs in the middle sentences distinguish these two sets of sentences, it must be something about *George calling the doctor* versus *George liking the doctor* that makes the first set more coherent. *George calling the doctor* is a more likely cause for why *The doctor arrived* than is *George liking the doctor.* These sentences demonstrate the role of causal coherence—consistency in why events or actions occurred. The more causally coherent two sentences are, the more likely the action described by the first sentence caused the action described by the second sentence.

According to the Structure Building Framework, comprehenders interpret coherence cues as signals to map the incoming information onto the structure or substructure that they are currently developing. If comprehenders interpret causal consequences as a cue for coherence, then comprehenders should be more likely to map sentences onto their mental structures when those sentences describe a causally logical outcome than when those sentences do not describe a causally logical outcome. Haberlandt and Bihgman (1978) provided data that support this prediction. Subjects read sentences like *The doctor arrived* more rapidly when they followed sentences like *George called the doctor* than when they followed sentences like *George liked the doctor.*

Comprehenders interpret and use even finer gradations of causal coherence as a cue for mapping. Consider the following four context sentences: *(a) Joey went to a neighbor's house to play. (b) Joey's mother became furiously angry with him. (c) Racing down the hill, Joey fell off his bike. (d) Joey's big brother punched him again and again.* Now, consider the following consequence sentence: *The next day, Joey's body was covered in bruises.* The four context sentences vary in how likely they are to cause that consequence. The most likely cause is that *Joey's big brother punched him again and again,* and the least likely cause is *that Joey went to a neighbor's house to play.* Keenan, Baillet, and Brown (1984) observed that the more likely the context sentences was to cause the consequence, the faster the consequence sentences was read. The data, therefore, demonstrate that comprehenders interpret causal coherence as a cue for mapping.

Recently, Jennifer Deaton and I (Deaton & Gernsbacher, in press) demonstrated that comprehenders interpret the conjunction, *because*, as a cue for mapping. In three experiments, we demonstrated that two-clause sentences that described moderately causal events were read more rapidly when the two clauses were conjoined by *because* (*Susan called the doctor for help* because *the baby cried in his playpen*) than when they were conjoined by *and* (*Susan called the doctor for help* and *the baby cried in his playpen*), *then* (*Susan called the doctor for help* then *the baby cried in his playpen*), or *after* (*Susan called the doctor for help* after *the baby cried in his playpen*). In addition, when the clauses were conjoined by *because*, subjects recalled the second clauses more frequently when prompted with the first clauses. In two further experiments, we demonstrated that the facilitative effect of *because* depends on the clauses' causal relatedness. Unrelated clauses were read least rapidly and recalled least frequently, regardless of their conjunctions; as the clauses' causal relatedness increased, the second clauses of sentences conjoined by *because* were read more rapidly and recalled more frequently. We concluded that comprehenders use the conjunction, *because*, and their knowledge about causality as cues for mapping.

My colleagues and I have demonstrated that comprehenders use their knowledge about the emotional consequences of events as a cue for mapping. Subjects in our experiments read stories that explicitly stated only concrete actions but implied emotional consequences. For example, one narrative stated that the protagonist stole money from a store where his best friend worked and later learned that his friend had been fired. Following each narrative, subjects read a target sentence that contained an emotion word, which either matched the emotional state implied by the narrative (*guilt*) or mismatched that emotional state. In Gernsbacher, Goldsmith, and Robertson (1992), the nature of the mismatch was manipulated. Across three experiments, subjects read target sentences that contained matching emotion words at approximately the same rate; in contrast, and, as predicted, the more disparate the mismatching emotion words were to the implied emotional states, the more slowly subjects read the target sentences containing those mismatching emotion words. When the mismatching emotion words were the same affective valence as the implied emotions (*guilt* vs. *shyness*), subjects read the target sentences slowly; when the mismatching emotion words were the opposite affective valence of the implied emotions (*guilt* vs. *hope*), subjects read the target sentences even more slowly; and when the mismatching emotion words were the converses of the implied emotions (*guilt* vs. *pride*), subjects read the target sentences most slowly (40% more slowly than they read target sentences containing matching emotion words).

To demonstrate that the stories—without the target sentences—were indeed powerful sources of knowledge activation, subjects in Gernsbacher (1994)

simply pronounced the matching versus mismatching emotion words immedi-
ately after reading the stories (and did not read the target sentences). Mismatch-
ing emotion words were pronounced more slowly. In Gernsbacher and
Robertson (1992), we manipulated the number of emotional stories that our
subjects read. We predicted that subjects' knowledge of emotional states would
be more activated when they read more emotion stories, and, indeed, that is
what we observed. All these experiments demonstrated that comprehenders
activate knowledge about fictional characters' emotional states, and compre-
henders use that activated knowledge about emotional consequences as a cue
for mapping during comprehension.

STRUCTURAL COHERENCE

The final type of coherence that I shall discuss is structural coherence. Writing
specialists stress the importance of parallel structure. For instance, Strunk and
White (1972) urged writers to "express coordinate ideas in similar form.
Expressions [that are] similar in content and function [should] be outwardly
similar" (p. 20). Strunk and White further proposed that "likeness of form
enables the reader to recognize more readily the likeness of content and
function" (p. 20). Thus, comprehenders might interpret likeness of form, or
what I refer to here as *structural coherence*, as a cue for mapping.

Recently, Robertson and I demonstrated that comprehenders do indeed use
the syntactic and conceptual form of a preceding sentence as a cue for mapping
(Gernsbacher & Robertson, 1996b). Subjects read pairs of sentences. In our
first experiment, subjects made grammaticality judgments to both members of
each pair; in our second, third, and fourth experiments, subjects simply read
the first member of each pair and made a grammaticality judgment to only the
second member of the pair (our second experiment replicated our first experi-
ment with only this procedural change). Example experimental sentence pairs
are shown in Table 1.1.

As these examples in Table 1.1 illustrate, the first sentence in our experi-
mental sentence pairs contained either an unambiguous gerundive nominal
(*washing clothes*) or an unambiguous plural noun phrase (*whining students*). The
second sentence of our experimental sentence pairs contained a head noun
phrase that, in isolation, would be ambiguous (*visiting relatives*; Tyler & Marslen-
Wilson, 1977). In our first and second experiments, we found that subjects
decided 16% more rapidly and 19% more accurately that the second sentence
of each pair was grammatical when it matched the first sentence (as the first
two example sentence pairs do). In our third experiment, we replicated this

Table 1.1
Example Stimuli for Structural Coherence Experiment

Experiments 1 and 2	Experiment 3	Experiment 4
Washing dishes is a drag.	Washing dishes is often a drag.	Washing dishes can be a drag.
Visiting relatives is, too.	Visiting relatives is often a drag, too.	Visiting relatives is often a drag, too.
Whining students are a drag.	Whining students are often a drag.	Whining students can be a drag.
Visiting relatives are, too.	Visiting relatives are often a drag, too.	Visiting relatives are often a drag, too.
Washing dishes is a drag.	Washing dishes is often a drag.	Washing dishes can be a drag.
Visiting relatives are, too.	Visiting relatives are often a drag, too.	Visiting relatives are often a drag, too.
Whining students are a drag.	Whining students are often a drag.	Whining students can be a drag.
Visiting relatives is, too.	Visiting relatives is often a drag, too.	Visiting relatives is often a drag, too.

effect, despite the fact that the second sentence was less syntactically dependent on the first sentence (because the elliptical verb phrase was replaced by a full verb phrase). In our fourth experiment, we also replicated this benefit, despite the fact that the verb in the first sentence was a modal, not marked for number. This last experimental result suggests that the conceptual form of the first sentence, in addition to its syntactic form, facilitated subjects' ability to comprehend (and map) the second sentence.

CONCLUSIONS

From the experiments I have reviewed in this chapter, I draw the following conclusions. Referential coherence facilitates mapping. Sentences that refer to previously mentioned concepts are more likely to be mapped onto developing structures. Cues to referential coherence are repeated words, pronouns, and the definite article, *the*. Temporal coherence facilitates mapping. Sentences that maintain a previously established time frame are more likely to be mapped onto developing structures. Cues to temporal coherence are adverbial phrases such as *At 10:15* or *Five hours later* as well as the tense and aspect of verbs. Locational coherence facilitates mapping. Sentences that maintain a previously established location are more likely to be mapped onto developing structures. Causal coherence facilitates mapping. Sentences that are logical consequences of a previously mentioned action are more likely to be mapped onto developing structures. One powerful cue to causal coherence is the conjunction, *because*.

Structural coherence facilitates mapping. Sentences that maintain the syntactic or conceptual form of a previous sentence are more likely to be mapped onto developing structures.

The experiments that I have reviewed in this chapter support the Structure Building Framework's proposal that comprehenders develop mental structures by mapping. According to the Structure Building Framework, once comprehenders have laid a foundation for their mental structures, they develop those structures using the cognitive process of mapping. Incoming information that coheres with or relates to previously comprehended information is mapped onto the developing structure or substructure.

Comprehenders use various cues of coherence; these cues are learned through experience with the world and experience with language. For example, comprehenders familiar with English pronouns have learned that *she* (typically) refers to a female; comprehenders familiar with English articles have learned that *the* typically precedes a definite concept (a concept that has been mentioned before, is in the deictic environment (e.g., *Just put the papers on the desk*), is part of a shared culture (e.g., *the sun, the President*), or is a component of a previously mentioned entity (e.g., *I'm reading a chapter about mapping. The ideas are terrific*). Comprehenders familiar with the meanings of the terms *scientist*, *man*, and *woman* have learned that the two expressions, *the man* and *the woman*, probably do not refer to the same entity, whereas the two expressions, *the scientist* and *the man*, can refer to the same entity, as can, *the scientist* and *the woman* (although mapping the latter two expressions is a bit harder, an unfortunate circumstance that we have begun to investigate empirically). Comprehenders familiar with the event described by the clause, *Susan's baby was sick*, have learned that the event described by the clause, *Susan phoned the doctor*, is a likely consequence. Thus, comprehenders' knowledge gained through their experience with events, entities, and relations in the world, as well as their knowledge of the language used to communicate about those events, entities, and relations, enables comprehenders to interpret cues that signal coherence.

Interpreting coherence cues can feel relatively unconscious or relatively deliberate. The Structure Building Framework allows for activation that occurs relatively "passively" and activation that occurs relatively "strategically." The crucial issue is that information—knowledge of various sorts—is activated during comprehension; indeed comprehension *is* a quintessential act of using and acquiring knowledge.

According to the Structure Building Framework, the building blocks of mental structures are memory nodes. Memory nodes represent previously stored information in a distributed fashion, such that a pattern of memory node activation can represent the meaning of a word, the meaning of a phrase, the

meaning of a sentence, or the meaning of a passage (Hinton, McClelland, & Rumelhart, 1986). When memory nodes are activated, the information they represent becomes available for comprehension. This information might be knowledge that was acquired years earlier when the comprehender mastered the English pronoun system, knowledge that was acquired moments earlier when the comprehender read that a particular *cat is on a* (particular) *mat*, or knowledge that was acquired whenever that allows the comprehender to interpret the expression *the cat is on the mat* as a situation in which the cat is lying (as opposed to other positions) on a mat.

Although other models of language comprehension assume that previously acquired "real-world" knowledge is represented in a different "store" than is the knowledge used to comprehend language, the Structure Building Framework does not make this distinction. And although other models of language comprehension assume that the knowledge gained from reading or listening to a particular sentence, discourse, or text (what is sometimes referred to as a "text base") is represented separately from the knowledge used to comprehend that sentence, text, or discourse, the Structure Building Framework does not make that distinction (just as many models of memory find the distinction between episodic and semantic memory to be unnecessary, cf. Hintzman, 1984; McKoon, Ratcliff, & Dell, 1986). Thus, all aspects of comprehenders' interpretation of coherence are knowledge-based, and comprehenders' knowledge of coherence cues facilitates their cognitive process of mapping during comprehension.

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