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THE STRUCTURE-BUILDING FRAMEWORK: WHAT IT IS, WHAT IT MIGHT ALSO BE, AND WHY[1]

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I have proposed previously that language comprehension can be described as structure building, and I have sketched a simple framework to use as a guide. I call this framework the Structure Building Framework. According to the Structure Building Framework, the goal of comprehension is to build cohesive mental representations, or structures. The first process involved in building a structure is laying a foundation. The next process involves developing the structure by mapping on incoming information when that information coheres with the previous information. However, if the incoming information is less coherent, comprehenders employ a different process: They shift to initiate a new substructure. Thus, most representations comprise several branching substructures.

The building blocks of mental structures are *memory nodes*. Memory nodes are activated by incoming stimuli. Their initial activation forms the foundation of mental structures. Incoming information often is mapped onto a developing structure because the more coherent the incoming information is with the previous information, the more likely it is to activate similar memory nodes. However, the less coherent the incoming information, the less likely it is to activate similar memory nodes. If the incoming information is less coherent, it activates different nodes, and the activation of these different nodes forms the foundation for a new substructure.

Once memory nodes are activated, they transmit processing signals. These processing signals either *enhance* (i.e., boost) or *suppress* (i.e., dampen) other nodes' activation. Memory nodes are enhanced if the information they represent is necessary for future structure building; they are suppressed if their information is no longer as necessary.

These three structure building processes (i.e., laying foundations for mental structures, mapping coherent information onto developing structures, and shifting to initiate new structures) and these two mechanisms (i.e., enhancement of some memory nodes but suppression of others) underlie numerous comprehension phenomena.

In Gernsbacher (1990), I described many of the phenomena that these general cognitive processes and mechanisms explain, including why adults differ in their comprehension skill. In the first section of this chapter, I briefly review these phenomena.

THE PROCESS OF LAYING A FOUNDATION

Because comprehenders first lay a foundation, they spend more time reading the first word of a clause or sentence (Aaronson & Ferres, 1983; Aaronson & Scarborough, 1976); they spend more time reading the first sentence of a paragraph or story episode (Haberlandt, 1984); they spend more time listening to the first word of a spoken clause or spoken sentence (Foss, 1969, 1982); and they spend more time viewing the first picture of a picture story or picture-story episode (Gernsbacher, 1983).

Comprehenders use these first segments (i.e., initial words, sentences, and pictures) to lay foundations for their mental representations of larger units, such as sentences, paragraphs, and story episodes. Because laying a foundation consumes cognitive effort, comprehenders slow down when comprehending initial segments. Indeed, none of these comprehension time effects emerges if the information does not lend itself to building cohesive mental representations, for example, if the sentences, paragraphs, or stories are self-embedded or scrambled (Foss & Lynch, 1969; Kieras, 1978, 1981).

The process of laying a foundation provides an explanation for why comprehenders are more likely to recall a sentence when cued by its first content word or a picture of that first content word (Bock & Irwin, 1980; Turner & Rommetveit, 1968); why comprehenders are more likely to recall a story episode when cued by its first sentence (Mandler & Goodman, 1982); and why comprehenders are more likely to consider the first sentence of a paragraph the main idea of that paragraph, even when the actual theme occurs later (Kieras, 1978, 1981). Initial words, sentences, and pictures are optimal cues because they form the foundations of their clause-level, sentence-level, and episode-level structures; only through initial words, sentences, and pictures can later words, sentences, and pictures be mapped onto the developing representation.

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The process of laying a foundation explains why comprehenders access the participant mentioned first in a clause faster than they access a participant mentioned later (Gernsbacher & Hargreaves, 1988, 1992). This *advantage of first mention* occurs regardless of the first-mentioned participant's syntactic position or semantic role (see also Carreiras, Gernsbacher, & Villa, in press). First-mentioned participants are more accessible because they form the foundation of their clause-level substructures.

The process of laying a foundation also explains why the first clause of a multiclause sentence is most accessible shortly after comprehenders hear or read that multiclause sentence (even though while they are hearing or reading the sentence, the most recent clause is most accessible). According to the Structure Building Framework, comprehenders represent each clause of a multiclause sentence in its own substructure. Although they have greatest access to the information that is represented in the substructure that they are currently developing, at some point, the first clause becomes most accessible because the substructure representing the first clause forms the foundation for the whole sentence-level structure (Gernsbacher, Hargreaves, & Beeman, 1989).

THE PROCESSES OF MAPPING AND SHIFTING

The process of mapping explains why sentences that refer to previously mentioned concepts (and are, therefore, referentially coherent) are read faster than less referentially coherent sentences (Haviland & Clark, 1974); why sentences that maintain a previously established time frame (and are, therefore, temporally coherent) are read faster than sentences that are less temporally coherent (Anderson, Garrod, & Sanford, 1983); why sentences that maintain a previously established location or point of view (and are, therefore, locationally coherent) are read faster than sentences that are less locationally coherent (Black, Turner, & Bower, 1979); and why sentences that are logical consequences of previously mentioned actions (and are, therefore, causally coherent) are read faster than sentences that are less causally coherent (Duffy, Shinjo, & Myers, 1990; Keenan, Baillet, & Brown, 1984; Myers, Shinjo, & Duffy, 1987).

The process of mapping also explains why sentences that contain the definite article *the* are read faster than sentences that contain indefinite articles (Gernsbacher & Robertson, 1994); why clauses that convey events that are at least moderately causally related are read faster if the clauses are conjoined by the causal conjunction *because* (Deaton & Gernsbacher, in press); and why sentences that match the conceptual or syntactic structure of previous sentences are read faster than sentences that are not matched in this way (Frazier, Taft, Roeper, Clifton, & Ehrlich, 1984; Gernsbacher & Robertson, 1994).

The process of shifting from actively building one substructure to initiating another explains why words and sentences that change the topic, point of view,

location, or temporal setting take substantially longer to comprehend than sentences that do not involve such changes (Anderson et al., 1983; Olson, Duffy, & Mack, 1984). The process of shifting also explains why information presented before a change in topic, point of view, location, or temporal setting is harder to retrieve than information presented afterward (Anderson et al., 1983; Clements, 1979). Such changes lead comprehenders to shift and initiate a new substructure; information presented before comprehenders shift is represented in a different substructure than information presented afterward.

The process of shifting also explains a well known language comprehension phenomenon: Comprehenders quickly forget the exact form of recently comprehended information. This phenomenon is not unique to language; it also occurs while comprehenders are viewing picture stories, and it also is exacerbated after comprehenders cross episode boundaries, even the episode boundaries of picture stories (Gernsbacher, 1985).

Finally, the process of shifting explains why comprehenders' memories for stories are organized by the episodes in which the stories were originally heard or read. Comprehenders shift in response to cues that signal a new episode; therefore, each episode is represented in a separate substructure (Beeman & Gernsbacher, 1994).

THE MECHANISMS OF SUPPRESSION AND ENHANCEMENT

The mechanism of suppression explains why only the contextually appropriate meaning of an ambiguous word, such as *bug*, is available to consciousness, even though multiple meanings, even contextually inappropriate ones, often are immediately activated (Swinney, 1979). The inappropriate meanings do not simply decay; neither do they decrease in activation because their activation is consumed by the appropriate meanings. Instead, the mechanism of suppression dampens the activation of inappropriate meanings. The mechanism of suppression also dampens the activation of less relevant associations of unambiguous words (Gernsbacher & Faust, 1991a).

The mechanisms of suppression and enhancement also explain how anaphoric devices (i.e., pronouns, repeated noun phrases, and so forth) improve the mental accessibility of their referents (i.e., the concepts to which they refer) (Gernsbacher, 1989). Anaphoric devices improve their referents' accessibility through the mechanism of enhancement: Referents are more highly activated after an anaphoric device is read or heard than they are before. Anaphoric devices also improve their referents' accessibility through the mechanism of suppression: Other concepts, which are not the referents, are activated less after an anaphoric device is read or heard than they are before. The net effect of the

mechanisms of suppression and enhancement is that after an anaphoric device is heard or read, the referents to which the anaphoric devices refer are more highly activated than other concepts. Therefore, they are more accessible to listeners and readers and play a more prominent role in the developing mental structure.

The mechanisms of suppression and enhancement are triggered by information that specifies the anaphor's identity. More explicit anaphoric devices (such as explicitly repeated proper names) trigger more suppression and enhancement than do less explicit anaphoric devices (such as pronouns or zero anaphora). Information from other sources (such as the semantic, syntactic, and pragmatic context) also triggers suppression, but it does so less quickly and less powerfully.

Therefore, the mechanisms of suppression and enhancement explain why speakers and writers use more explicit anaphoric devices at longer referential distances, at the beginnings of episodes, and for less topical concepts (Fletcher, 1984; Givon, 1983). The mechanisms of suppression and enhancement also explain why comprehenders have more difficulty accessing referents at longer referential distances, at the beginnings of episodes, and for less topical concepts (Clark & Sengul, 1979; Clifton & Ferreira, 1987).

The mechanisms of suppression and enhancement explain how concepts marked with cataphoric devices, such as spoken stress and the indefinite article *this*, gain a privileged status in comprehenders' mental representations (Gernsbacher & Shroyer, 1989). Cataphoric devices improve their concepts' representational status through the mechanism of enhancement: If concepts are marked with cataphoric devices, they are more activated than if they are not marked by cataphoric devices. Cataphoric devices also improve their concepts' representational status through the mechanism of suppression: Concepts marked with cataphoric devices are better at suppressing the activation of other concepts, and they are better at resisting being suppressed themselves (Gernsbacher & Jescheniak, in press).

Finally, the mechanisms of suppression and enhancement explain why comprehenders typically forget surface information faster than they forget thematic information (Sachs, 1967, 1974); why comprehenders forget more surface information after they hear or read thematically-organized passages than after they hear or read seemingly unrelated sentences (Anderson & Bower, 1973; Peterson & McIntyre, 1973); and why comprehenders better remember the surface forms of abstract sentences but the thematic content of concrete sentences (Begg & Paivio, 1969; Pezdek & Royer, 1974). Typically, thematic information is repeatedly introduced; therefore, it gets enhanced. Further, typically, surface information is constantly changing; therefore, it gets suppressed. However, if the surface information is more constant than the thematic information (as in the case of abstract sentences or unrelated sentences that share their syntactic structure), surface information changes less rapidly than thematic information; therefore, surface information gets enhanced and thematic information gets suppressed.

INDIVIDUAL DIFFERENCES
IN STRUCTURE BUILDING

The Structure Building Framework explains why skill at comprehending linguistic media (e.g., written and spoken stories) is highly related to skill at comprehending nonlinguistic media (e.g., picture stories). Comprehensible information, regardless of its media, is structured, and comprehenders differ in how skillfully they employ the cognitive processes and mechanisms that capture this structure (Gernsbacher, Varner, & Faust, 1990).

The process of shifting explains why less-skilled comprehenders have problems remembering recently comprehended information: They shift too often (Gernsbacher et al., 1990). The mechanism of suppression explains why, compared to highly skilled comprehenders, less-skilled comprehenders are less able to reject the contextually inappropriate meanings of ambiguous words (Gernsbacher et al., 1990); why they are less able to reject the incorrect forms of homophones (Gernsbacher & Faust, 1991b); why they are less able to reject typical-but-absent members of nonverbal scenes; why they are less able to ignore words written on pictures (Gernsbacher & Faust, 1991b); and why they are less able to ignore pictures surrounding words (Gernsbacher & Faust, 1991b). Less-skilled comprehenders have inefficient suppression mechanisms.

The distinction between the mechanism of suppression and the mechanism of enhancement explains why, compared to highly skilled comprehenders, less-skilled comprehenders are not less able to appreciate the contextually appropriate meanings of ambiguous words, and why they are not less able to appreciate typical members of nonverbal scenes (Gernsbacher & Faust, 1991b; Perfetti & Roth, 1981). It is less-skilled comprehenders' suppression mechanisms, not their enhancement mechanisms, that are faulty.

UNANSWERED QUESTIONS

Although the Structure Building Framework parsimoniously accounts for many comprehension phenomena, several questions remain unanswered. In this section, I briefly identify two of those questions.

Are These Cognitive Processes
and Mechanisms Automatic or Are They
Under Comprehenders' Conscious Control?

Some theories of cognition differentiate between automatic mental activity and mental activity that is more conscious, and, perhaps, controllable (Keele & Neill, 1978; Posner & Snyder 1975a 1975b) Do the three structure-building processes

(i.e., foundation laying, mapping, and shifting) occur automatically or are they under comprehenders' conscious control?

I have described these processes implying both positions. For instance, I have described the process of mapping as something that comprehenders do. I have suggested previously that comprehenders develop mental structures by mapping on incoming information. This description implies that mapping is something that comprehenders actively and strategically accomplish. However, I have also described the process of mapping as something that gets done. I have suggested that "incoming information is mapped onto a developing structure when it activates similar memory nodes. The more the incoming information overlaps with the previous information, the more likely it is to activate similar memory nodes" (Gernsbacher, 1990, p. 52). This description implies that mapping is something that is accomplished automatically, perhaps mediated by some objective similarity detector.

I have also been equivocal about the other two structure-building processes (i.e., foundation laying and shifting). Do they occur automatically, or are they under comprehenders' conscious control? What about the two structure building mechanisms, suppression and enhancement? Do they occur automatically, or are they under comprehenders' control? Perhaps the three structure-building processes (i.e., foundation laying, mapping, and shifting) are under comprehenders' control, but the mechanisms that enable these processes (i.e., suppression and enhancement) occur automatically.

It also is possible that none of the structure-building processes or mechanisms is purely automatic or purely under comprehenders' control. Perhaps each is a combination of the two. For example, the process of mapping often feels conscious; indeed, in some situations, it feels effortful. In other situations, however, the process of mapping must surely occur without conscious attention (e.g., when the comprehenders are very skilled, and the information is very comprehensible).

Whether these cognitive processes and mechanisms are automatic or under comprehenders' control is an empirical question, with a theoretically and practically important answer. If any of these structure building processes or mechanisms are under comprehenders' control, they are amenable to training. For example, if highly skilled comprehenders' greater skill at suppressing irrelevant information is under their control, then this skill might be taught to less-skilled comprehenders.

In What Medium Are Mental Structures
and Substructures Represented?

I also have been vague about the medium in which structures and substructures are mentally represented. Although I have empirically answered several questions about the representational *form* of mental structures and substructures

(e.g., What units are packaged into substructures? How are dependencies between substructures represented? Are substructures built hierarchically?), I have avoided asking about their representational *medium.*

Given the Structure Building Framework's amodal approach, the medium of mental structures must handle nonlinguistic as well as linguistic input. This requirement demands either a theory that proposes a variety of (compatible) representational media or a theory that proposes that input modality is irrelevant (because all information is represented in a common medium). Theories that propose a variety of representational media have recently become popular.

In 1983, three new theories each proposed a three-media representation scheme. According to Anderson (1983), information is represented as linear strings, propositions, or spatial images. Language can be represented as linear strings or propositions, but not as spatial images. According to Johnson-Laird (1983, p. 165), information is represented as propositions ("strings of symbols that correspond to natural language"), mental models ("structural analogs of the world" [p. 165]), or images ("the perceptual correlates of mental models from a particular point of view" [p. 165]). According to van Dijk and Kintsch (1983), information is represented as verbatim forms, propositions, or situational models.

Johnson-Laird's (1983) and van Dijk and Kintsch's (1983) theories exemplify another direction in which theorists are moving, particularly when describing how language is represented. Several theorists have suggested that comprehenders' mental representations capture the real world situations conveyed by language. For example, according to Johnson-Laird (1983), language is often represented by *mental models:* "A mental model goes beyond the literal meaning of the discourse because it embodies inferences, instantiations, and references" (p. 245). Similarly, according to van Dijk and Kintsch (1983), language is often represented by *situational models:* "A situational model is the cognitive representation of the events, actions, persons, and in general the situation that a text is about" (pp. 11–12).

The proposal that comprehenders mentally represent the physical situations expressed by language is supported by the following phenomena. Consider Example 1:

(1) Three turtles rested on a floating log and a fish swam beneath them.

A short time after reading the sentence in Example 1, many comprehenders incorrectly accept the following sentence as the sentence they read:

(2) Three turtles rested on a floating log and a fish swam beneath it.

Sentences 1 and 2 convey similar physical situations. In the situation conveyed by 1, the fish swam beneath the turtles; in the situation conveyed by 2, the fish swam beneath the log. However because the turtles were on the log, and the

log was floating on water, the situations are similar: Swimming beneath the turtles is similar to swimming beneath the log.

In contrast, if comprehenders first read sentence 3:

(3) Three turtles rested beside a floating log and a fish swam beneath them.

they are unlikely to accept the sentence in Example 4 as the sentence they read:

(4) Three turtles rested beside a floating log and a fish swam beneath it.

The sentences 3 and 4 convey different situations: When the turtles are beside the log, swimming beneath *them* is not the same as swimming beneath *it* (Bransford & Franks, 1972).

Consider another example. Comprehenders can easily remember whether they read that:

(5) The hostess received a telegram at the furrier's.

as opposed to:

(6) The hostess received a telegram from the furrier.

In contrast, comprehenders have difficulty remembering whether they read that:

(7) The hostess bought a mink coat at the furrier's.

as opposed to:

(8) The hostess bought a mink coat from the furrier.

(Garnham, 1981). Buying a mink coat *at* the furriers is similar to buying a mink coat *from* the furrier, but receiving a telegram *at* the furriers differs from receiving a telegram *from* the furrier.

Finally, consider a story about John, who went out for a jog. Consider what happens if one group of comprehenders read:

(9) After doing a few warm-up exercises, John put on his sweatshirt and
      began jogging.

whereas another group of comprehenders read:

(10) After doing a few warm-up exercises, John took off his sweatshirt and
       began jogging.

Now, both groups read:

(11) John jogged halfway around the lake without too much difficulty.

For one group of comprehenders, John is now halfway around the lake with his sweatshirt on; for the other group, John is also halfway around the lake, but his sweatshirt is back on the other side. If both groups of comprehenders are asked whether the word *sweatshirt* occurred in the story, both groups correctly say "yes." However, those who read that John took off his sweatshirt are slower to say "yes" than are those who read that John put on his sweatshirt (Glenberg, Meyer, & Lindem, 1987). For those who read that John took off his sweatshirt (and left it on the other side of the lake), John's sweatshirt is no longer part of the current situation.

These demonstrations suggest that comprehenders develop relatively iconic representations of the physical situations conveyed by the texts. Indeed, for some theorists, envisioning the situation is tantamount to successful comprehension. For instance, according to van Dijk and Kintsch (1983), "if comprehenders are unable to imagine a situation in which certain individuals have the properties or relations indicated by the text, [they] fail to understand the text itself" (p. 337). Further, according to Bower and Morrow (1990), constructing "mental models of the situation that a writer or speaker is describing . . . is the basis of language comprehension" (p. 44).

Are the mental structures and substructures proposed by the Structure Building Framework the same as the mental models or situational models proposed by Johnson-Laird (1983) and van Dijk and Kintsch (1983)? Although I cannot answer that question here, I do know that the cognitive processes and mechanisms involved in structure building also depend on comprehenders' ability to envision real world situations. For instance, suppose that I am describing my participation in a marathon. During my description, I might say the sentence in Example 12:

(12) Half an hour later, it began to rain.

Alternatively, I might say the following:

(13) Three days later, it began to rain.

Comprehenders would map sentence 12 onto their developing structures, but they would shift in response to sentence 13 because it changes the temporal setting of my story. To appreciate this change, comprehenders must envision the real world situation; thus, the processes of mapping and shifting must depend on comprehenders' ability to envision the real world situation.

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The mechanisms of suppression and enhancement must also depend on comprehenders' ability to envision real world situations. For instance, in Gernsbacher (1989), I found that after comprehenders read a pronoun, any person not referred to by that pronoun is suppressed. For instance, consider this pair of sentences:

(14) Bill lost the tennis match to John.

(15) Enjoying the victory, he walked slowly toward the showers.

After comprehenders read the pronoun *he* in sentence 15, *Bill* is suppressed. Now, consider the following sentences:

(16) Bill lost the tennis match to John.

(17) Accepting the defeat, he walked slowly toward the showers.

After comprehenders read the pronoun *he* in the sentence in Example 17, *John* is suppressed. Suppression of *Bill* following the sentence in 15 requires envisioning what happens when someone loses a tennis match; that is, who enjoys the victory? Similarly, suppressing *John* following the sentence in Example 17 requires envisioning what happens when someone loses a tennis match; who accepts the defeat?

These data suggest that comprehenders' success at building mental structures depends on their ability to envision real world situations. Whether these mental structures are represented by situation models, or whether mental structures are the same as situational models is unclear.

SIMILARITY TO OTHER APPROACHES

The processes and mechanisms identified by the Structure Building Framework are in some ways similar to processes and mechanisms proposed by other approaches. In this section of the chapter, I identify a few of the commonalities and differences between the Structure Building Framework and other models of cognitive processes and mechanisms in language comprehension.[2]

The Structure Building Framework's "process of laying a foundation" resembles MacWhinney's (1977) proposal that speakers and listeners use starting points. MacWhinney (1977) wrote:

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[2]In this section, I purposely quote extensively from the original sources. My motivation is not laziness, but the belief that paraphrase is best reserved for investigating subjects' memory in laboratory experiments.

The speaker uses the first element in the English sentence as a starting point for the organization of the sentence as a whole. Similarly, the listener uses the first element in a sentence as a starting point in comprehension. Both the speaker and the listener seem to use special techniques for attaching the body of the sentence to the starting point. Given the sentence *Mary ate the apple*, it seems that listeners take *Mary* as an initial node in processing, and then attach *ate the apple* to this node. Similarly, the speaker takes *Mary* as what he wants to talk about and then says something about *Mary*. (p. 152)

MacWhinney's starting points are like the Structure Building Framework's foundations. MacWhinney's process of "attaching the body of the sentence to the starting point" is like the structure building process of mapping information onto a foundation.

Would MacWhinney agree that starting points organize units larger than sentences, for instance, paragraphs in which the first sentence is the starting point for the other sentences? Would he agree that starting points are used outside the linguistic domain? Neither suggestion contradicts his proposal; his proposal is simply more constrained. In contrast, the Structure Building Framework explicitly proposes that the cognitive process of laying a foundation occurs whenever comprehenders are building mental structures, regardless of whether the units are clauses, sentences, story episodes, and regardless of modality.

The Structure Building Framework's *process of mapping* resembles a process that Hayes-Roth and Thorndyke (1979) call *integration*:

We assume that the basic units for representing facts in memory are lexical. The meanings of lexical units derive from their associative connections to other lexical units. Semantically related lexical units are presumably more closely associated than unrelated lexical units. These assumptions imply that memory representations of facts that include identical wordings can include identical subrepresentations. Memory representations of facts that include paraphrased wordings cannot contain identical subrepresentations but may contain associatively connected subrepresentations. Of course, memory representations of facts that express unrelated information will have neither identical subrepresentations nor close associative connections.

Memory representations can be "activated" in two ways. They can be activated directly, by apprehension of the information they represent in an external stimulus. They can also be activated associatively via excitation received from other activated memory representations. A memory representation can be activated more easily if (a) it has been activated recently; (b) it contains a subrepresentation of information in an external stimulus; or (c) it contains a subrepresentation that is identical to one in an activated memory representation. A memory representation is more difficult to activate if (a) it has not been activated recently; (b) it contains a subrepresentation of information that is synonymous with an external stimulus; or (c) it contains a subrepresentation that is associatively connected to one in an activated memory representation. Of course, a memory representation is least

likely to be activated if the information it represents is unrelated to any information in an external stimulus or an activated memory representation.

We assume that when two memory representations are simultaneously active and contain identical or associatively connected subrepresentations, the two representations are integrated into a single higher-order representation. In the case of identical subrepresentations, integration effectively "superimposes" the two representations upon one another so that they share a single subrepresentation. Thus, integration eliminates redundancy in memory for related facts. However, the integrated representation also preserves the identities of the original constituent representations. In the case of associatively connected subrepresentations, integration establishes a direct connection between the subrepresentations, reflecting the semantic relationship between them but preserving their individual identities. (pp. 92–93)

As in the Structure Building Framework's process of mapping, Hayes-Roth and Thorndyke's (1979) process of integration is affected by activation. Also, as is the case for Structure Building Framework's process of mapping, Hayes-Roth and Thorndyke's (1979) process of integration is affected by coherence.

In Hayes-Roth and Thorndyke's (1979) terminology, the greater the similarity between two representations (in terms of their content and their level of activation), the more likely they are to be integrated into a single, higher order representation. In the Structure Building Framework's terminology, the greater the similarity between incoming and previous information, the more likely they are to be mapped onto the same substructure.

The Structure Building Framework's process of mapping also resembles Hayes-Roth and Thorndyke's (1979) process of integration because in neither process is information recoded. Mapping (during structure building) simply connects information; it does not change it. Similarly, Hayes-Roth and Thorndyke's (1979) integration only "establishes a direct connection between the subrepresentation, reflecting [their] semantic relationship . . . but preserving their individual identities" (p. 93).

But Hayes-Roth and Thorndyke's (1979) process of integration differs from the Structure Building Framework's process of mapping in at least two ways. First, according to the Structure Building Framework, the building blocks of mental structures are memory nodes. Memory nodes can represent the meanings of words, the meanings of pictures, the "meanings" of tones, or any other meaningful unit. In contrast, the building blocks in Hayes-Roth and Thorndyke's model represent only the meanings of words.

The second way in which Hayes-Roth and Thorndyke's (1979) process of integration differs from the Structure Building Framework's process of mapping is that Hayes-Roth and Thorndyke's process of integration is driven primarily by lexical overlap and secondarily by semantic association. But coherence is not just a function of lexical overlap and semantic associations. Consider sentence pair 18 and 19:

(18) A waitress was counting her tips.

(19) A waitress was daydreaming about getting off early.

and the pair of sentences in 20 and 21:

(20) The waitress was counting her tips.

(21) The waitress was daydreaming about getting off early.

The sentences in 18 and 19 imply two waitresses, whereas the sentences in 20 and 21 imply only one. Thus, the sentences in Examples 20 and 21 are more referentially coherent than are the sentences in Examples 18 and 19. But the two sets of sentence pairs are equal in their lexical overlap and semantic association.[3]

The Structure Building Framework's *mechanism of suppression* resembles Neill and Westberry's (1987) conception of *selective inhibition*. They wrote:

> ... the activation of information in memory must be followed by a process of narrowing down the range of activations to those specifically appropriate to current task demands. It has been suggested that this focusing process is accomplished through the direct, selective inhibition of distracting information. (p. 331)

As does the Structure Building Framework's mechanism of suppression, Neill and Westberry's (1987) selective inhibition actively dampens previously activated information. This active characteristic is critical; it differentiates selective inhibition from other conceptions of inhibition. Neill and Westberry (1987) wrote:

> Selective inhibition differs operationally and theoretically from other forms of inhibition ... For example, Posner and Snyder (1975a, 1975b) refer to "inhibition" of processing unattended signals caused by the commitment of processing capacity to an attended signal (see also Neely, 1976, 1977). Inhibition here is *de facto* and nonselective, and it does not reflect an operation on specific unattended information (Posner, 1982). Other proposed forms of nonselective inhibition, such as attenuation of all unattended information (Treisman, 1964), or *dampening* of spreading activation (Anderson, 1976) also do not predict a specific bias against more recently activated information. Similarly, models based on an automatic *lateral inhibition* between cognitive or perceptual units (e.g., Brown, 1979; Estes, 1972; McClelland & Rumelhart, 1981; Walley & Weiden, 1973) do not make this prediction; because degree of inhibition would be directly determined by proximity (similarity) between activated units, more recently activated units should remain relatively more activated if such proximity is equated. (p. 327)

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[3]The inadequacy of a criterion for coherence based only on lexical overlap also is demonstrated in the sentences in Examples 12 and 13. Those two sentences are equivalent in how much they overlap with the prior context, but one sentence leads to mapping, whereas the other leads to shifting.

As does Neill and Westberry's (1987) selective inhibition, the Structure Building Framework's mechanism of suppression also differs from the automatic loss of activation caused by attention to other information, global attenuation of unattended information, or lateral inhibition. However, the Structure Building Framework's mechanism of suppression differs from Neill and Westberry's (1987) selective inhibition in at least two ways. First, Neill and Westberry (1987) proposed that selective inhibition is always under conscious control. The Structure Building Framework does not make that assumption. Second, Neill and Westberry (1987) proposed that "suppression of irrelevant information requires conscious awareness of what is relevant" (p. 332). In this way, Neill and Westberry's (1987) selective inhibition mechanism is similar to the inhibition mechanisms proposed by Marcel (1980, 1983) and Allport, Tipper, and Chmiel (1985).

Is the Structure Building Framework's mechanism of suppression triggered only by comprehenders' conscious awareness of what is relevant? It does not seem to be. For instance, as I described in Gernsbacher and Faust (1991a), one of the vital roles that the mechanism of suppression plays in comprehension is that it dampens the activation of the contextually inappropriate meanings of ambiguous words (e.g., the playing card meaning of *spade* in the context *He dug in the garden with a spade*). If the mechanism of suppression is triggered by a conscious awareness of what is relevant, comprehenders' awareness of the contextually relevant meanings of ambiguous words would predict their ability to suppress the contextually irrelevant meanings. But that is not the case.

As described in Gernsbacher and Faust (1991b), less-skilled comprehenders are just as able as more-skilled comprehenders to consciously select the appropriate meaning of an ambiguous word (e.g., they are just as able to accept the *garden tool* meaning of *spade* as appropriate in the context *He dug in the garden with a spade*). However, less-skilled comprehenders are considerably less able to suppress the inappropriate meanings of an ambiguous word (e.g., they are less able to reject the *playing card* meaning of *spade* as inappropriate in the context *He dug in the garden with a spade*). These data demonstrate that although less-skilled comprehenders are aware of what is relevant, they are less able to suppress what is irrelevant. Therefore, the mechanism of suppression must be independent of comprehenders' conscious awareness of what is relevant.

The Structure Building Framework's *mechanism of enhancement* resembles the process of integration in Kintsch's (1988) Construction-Integration Model. In Kintsch's (1988) model, two processes build mental representations during language comprehension: The process of *construction* builds a propositional network (a textbase), and the process of *integration* edits that network. Kintsch (1988) described these two processes in the following way:

> The steps in constructing a textbase according to the construction-integration model involve: (a) forming the concepts and propositions directly corresponding to the linguistic input; (b) elaborating each of these elements by selecting a small number of its most closely associated neighbors from the general knowledge net;

(c) inferring certain additional propositions; and (d) assigning connection strengths to all pairs of elements that have been created. (p. 166)

The result of the construction process is, therefore, a network expressible as a connectivity matrix, consisting of all the lexical nodes accessed, all the propositions that have been formed, plus all the inferences that were made at both the local and global level and their interconnections. (p. 168)

The network that has been constructed so far is not yet a suitable text representation. It was carelessly constructed and is therefore incoherent and inconsistent. At all levels of the representation, components associated with the text elements were included without regard to the discourse context, and many of them are inappropriate. An integration process in the connectionist manner can be used to exclude these unwanted elements from the text representation (e.g., see Rumelhart & McClelland, 1986, and Waltz & Pollack, 1985, for discourse).

Text comprehension is assumed to be organized in cycles, roughly corresponding to short sentences or phrases (for further detail, see Kintsch & van Dijk, 1978; Miller & Kintsch, 1980). In each cycle a new net is constructed, including whatever is carried over in the short-term buffer from the previous cycle. Once the net is constructed, the integration process takes over: Activation is spread around until the system stabilizes. More specific, an activation vector representing the initial activation values of all nodes in the net is postmultiplied repeatedly with the connectivity matrix. After each multiplication the activation values are normalized: Negative values are set to zero, and each of the positive activation values is divided by the sum of all activation values, so that the total activation on each cycle remains at a value of one (e.g., Rumelhart & McClelland, 1986). Usually, the system finds a stable state fairly rapidly; if the integration process fails, however, new constructions are added to the net, and integration is attempted again. Thus, there is a basic, automatic construction-plus-integration process that normally is sufficient for comprehension.

The result of the integration process is a new activation vector, indicating high activation values for some of the nodes in the net and low or zero values for many others. The highly activated nodes constitute the discourse representation formed on each processing cycle. In principle, it includes information at many levels: Lexical nodes, text propositions, knowledge-based elaborations (i.e., various types of inferences), as well as macropropositions. (p. 168)

As does the Structure Building Framework mechanism of enhancement, Kintsch's (1988) process of integration increases the activation of contextually relevant information. Moreover, the Structure Building Framework's mechanism of enhancement is similar to Kintsch's process of integration in that each operates after concepts have been initially activated.

In this way, both Kintsch's (1988) process of integration and the Structure Building Framework's mechanism of enhancement differ from "facilitation of activation" (Posner & Snyder, 1975b). Further, in this way, Kintsch's (1988) process of integration and the Structure Building Framework's mechanism of en-

hancement resemble the chemical transmission of neural information via neurotransmitters (which also occurs after initial activation) rather than the electrical transmission of neural information (which causes initial activation).

However, Kintsch's (1988) process of integration differs from the Structure Building Framework's mechanism of enhancement in at least two ways. First, Kintsch assumes that the process of integration is completed in cycles, but the Structure Building Framework does not assume that suppression signals are transmitted in cycles. Second, Kintsch's (1988) process of integration operates automatically, but (as mentioned previously) it is unclear whether the mechanism of enhancement operates automatically.

Finally, the Structure Building Framework's overall thesis that language depends on general cognitive processes and mechanisms resembles Bever's (1970) thesis. For instance, Bever began his classic (1970) paper, "The Cognitive Basis for Linguistic Structures" by writing:

This article explores the ways in which specific properties of language structure and speech behavior reflect certain general cognitive laws. [It] begins an exploration of an alternative approach to the study of language: as a conceptual and communicative system which recruits various kinds of human behavior, but which is not exhaustively manifested in any particular form of language behavior. (p. 279)

The Structure Building Framework differs in several ways from Bever's (1970) thesis; one primary difference being breadth. Bever's thesis argues only for commonality among language behaviors (production, acquisition, comprehension). The Structure Building Framework suggests that there exist commonalities among behaviors that are not bound by language.

WHY DESCRIBE LANGUAGE COMPREHENSION AT A GENERAL LEVEL?

According to the Structure Building Framework, language comprehension is not a specialized skill driven by language-specific processes and language-specific mechanisms. Rather, the Structure Building Framework describes language comprehension as driven by general cognitive processes and general cognitive mechanisms, processes and mechanisms that are involved in nonlinguistic tasks.

Is this level of description too general? As B. Repp (personal communication, March 12, 1990) asked:

Are the processes and mechanisms so general as to be applicable to any subject matter, be it cognition, social behavior, biological processes, evolution, or physics? A similar argument is often made in the area of speech perception research. By showing that certain general processes operate in speech perception, some believe they have shown that no speech-specific processes are required to explain speech

perception. This does not follow, of course. To show that no speech-specific processes exist, all processes involved must be shown to be general. Quite apart from the fact that we shall never know all the processes, there is soon a point where knowledge specific to the subject matter begins to play a role in perception or cognition. On the other hand, has anyone ever claimed that speech perception is accomplished only via specific processes, and that there are no general processes at all?

There are perhaps some exceptions, such as the "modular" systems for echolocation, stereopsis, and so forth. The division between modular and other systems may simply be that we are beginning to understand the neural architecture of the former, but not of the latter. Knowing the physiological mechanisms, we do not have to think about what those mechanisms might be. As soon as we psychologists need to engage our own cognitive faculties to make conjectures about processes, our limited inventory of general concepts (with a heavy dose of computer jargon) prescribes what those processes are going to be and insures their generality. We cannot think differently when we investigate language than when we investigate music or problem solving, and therefore the same general concepts will surface as hypothetical processes everywhere.

Why not focus on those aspects of language that distinguish it from everything else (B. Repp, personal communication, March 12, 1990)? By focusing on those aspects of comprehension that are specific to language, we might identify the limits of a general framework like structure building. In lieu of doing that, however, let me turn the tables and use the last section of this chapter to answer the question: What is gained by describing language comprehension at a general level?

Describing language comprehension at a general level saves me from committing five deadly sins, which according to Reber (1987, as cited in Gernsbacher, 1990) caused "the rapid rise and (surprisingly rapid) fall of psycholinguistics." In his essay bearing that title, Reber identifies these five transgressions:

1. *Believing in a Strong Version of Nativism*. Nativism is a position that is simply not conducive to the promotion of an empirical research program. Nativism, especially when blended with rationalism, looks for data in intuitions, introspections, and phenomenological experience; it does not encourage the kinds of research programs that experimental psychologists have typically felt comfortable with (p. 329). Moreover, nativism, almost by definition, down plays learning. In the Chomskyan form of psycholinguistics, ... all the interesting questions that psychologists asked about acquisition were recast into questions about the "growth of organs." This is not the kind of notion that sits comfortably with psychologist. ... And of course it becomes all the more difficult to accept when the psychologist is being told that the linguistic underpinning of psycholinguistics is actually a branch of cognitive psychology (p. 330).

2. *Isolating Psycholinguistics From Psychology*. The Chomsky-inspired psycholinguistics views language as the ultimate unique behavior for it is conceptualized as

doubly isolated from other psychological processes. Not only is language viewed as unique *to* man, but is also viewed as unique *within* man. The resulting psycholinguistic science becomes one in which it is presumed that nothing about language can be learned by the examination of any other cognitive or perceptual process— and vice versa. This is a very touchy point. Notice what it asks of a cognitive psychologist with an interest in language. It argues that linguistics and psycholinguistics, disciplines which have been put forward as properly within the umbrella of cognitive psychology, will, in the final analysis, only be admitted in a *sealed* box (p. 331).

3. *Preferring Theory Over Data*. The psychology of this century has been strongly in the data camp. Theory is not its long suit and whenever things start getting sticky psychologists will prefer empirical examination of phenomena to models of them (p. 332). [P]sycholinguistics was a good deal more linguistic than it was psychological and, given the tilt taken by the two contributing fields during the past two decades, it became a discipline whose prejudice was toward theory rather than data. [T]rying to fit such a field into the larger discipline of psychology—which not only did not share this prejudice but had a long history of battling against it—has not worked (p. 333).

4. *Relying on Linguistic Theories*. This problem was placed sharply in the attentional focus by the labored confusion in the study of sentence memory immediately following the publication of *Aspects of a Theory of Syntax* by Chomsky in 1965 (cited in Gernsbacher, 1990). In the preceding years, a number of studies had been published, primarily by George Miller and his co-workers, that seemed to show that people process sentential material in the fashion predicted by Chomsky's earlier model of language. Few of us around at the time can forget those marvelous graphs showing how the more transformations there were underlying a sentence the longer it took a subject to process it and the more errors the subject would typically make when trying to recall it.... *Aspects*, of course, pulled the rug out from under the new psycholinguists, as Miller was calling these frontier scientists. All of these transformations turned out not to be optional rules applied to terminal strings but parts of the deep structure tree. To this day many of us have wondered what to do with all that lovely data (pp. 333–334).

5. *Ignoring Functionalism*. Actually, within experimental psychology functionalism represents a loose confederation of attitudes more than anything else. It is not a theory of the organism nor is it a set of dictates or tenets. Rather, it is an approach to the examination of things psychological that is so much a part of the field that its existence is hardly noticed (p. 335). Adherence [to a functionalist perspective] simply means that one looks to the functional role that a given process or specific pattern of behavior has in the context within which it occurs (p. 336). The failure of [the Chomsky-inspired psycholinguistic] science to reckon with the deeply ingrained functionalist spirit is arguably the single most significant factor in its failure to establish itself as a robust science within psychology (p. 337).

What do I gain by describing language comprehension using the Structure Building Framework as a guide? I am not forced to accept nativism; isolate the

psychology of language from the remainder of psychology; honor theory over data; depend on linguistic theory; or ignore functionalism. Instead, by describing language comprehension as structure building, I hope to map the study of language comprehension onto the firm foundation of cognitive psychology.

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REFERENCES

Aaronson, D., & Ferres, S. (1983). Lexical categories and reading tasks. *Journal of Experimental Psychology: Human Perception and Performance, 9*, 675-699.

Aaronson, D., & Scarborough, H. S. (1976). Performance theories for sentence coding: Some quantitative evidence. *Journal of Experimental Psychology: Human Perception and Performance, 2*, 56-70.

Allport, D. A., Tipper, S. P., & Chmiel, N. R. J. (1985). Perceptual integration and postcategorical filtering. In M. I. Posner & O. S. M. Marin (Eds.), *Attention and performance XI* (pp. 107-132). Hillsdale, NJ: Lawrence Erlbaum Associates.

Anderson, A., Garrod, S. C., & Sanford, A. J. (1983). The accessibility of pronominal antecedents as a function of episode shifts in narrative text. *Quarterly Journal of Experimental Psychology, 35A*, 427-440.

Anderson, J. R. (1976). *Language, memory, and thought*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Anderson, J. R. (1983). *The architecture of cognition*. Cambridge, MA: Harvard University Press.

Anderson, J. R., & Bower, G. H. (1973). *Human associative memory*. Washington, DC: Winston.

Beeman, M., & Gernsbacher, M. A. (1994). *Structure building and coherence inferencing during comprehension*. Unpublished manuscript, University of Wisconsin.

Begg, I., & Paivio, A. (1969). Concreteness and imagery in sentence meaning. *Journal of Verbal Learning and Verbal Behavior, 8*, 821-827.

Bever, T. G. (1970). The cognitive basis for linguistic structures. In J. R. Hayes (Ed.), *Cognition and the development of language* (pp. 279-362). New York: Wiley.

Black, J. B., Turner, T. J., & Bower, G. H. (1979). Point of view in narrative comprehension, memory, and production. *Journal of Verbal Learning and Verbal Behavior, 18*, 187-198.

Bock, J. K., & Irwin, D. E. (1980). Syntactic effects of information availability in sentence production. *Journal of Verbal Learning and Verbal Behavior, 19*, 467-484.

Bower, G. H., & Morrow, D. G. (1990, January). Mental models in narrative comprehension. *Science*, 44-48.

Bransford, J. D., & Franks, J. J. (1972). The abstraction of linguistic ideas: A review. *Cognition, 1*, 211-249.

Brown, A. S. (1979). Priming effects in semantic memory retrieval processes. *Journal of Experimental Psychology: Human Learning and Memory, 5*, 65-77.

Gernsbacher, M. A. (Ed.) Hillsdale, NJ: Earlbaum.

Carreiras, M., Gernsbacher, M. A., & Villa, V. (in press). The advantage of first mention in Spanish. *Psychonomic Bulletin and Review*.

Clark, H. H., & Sengul, C. J. (1979). In search of referents for nouns and pronouns. *Memory & Cognition, 7*, 35-41.

Clements, P. (1979). The effects of staging on recall from prose. In R. O. Freedle (Ed.), *New directions in discourse processing* (pp. 287-330). Norwood, NJ: Ablex.

Clifton, C., Jr., & Ferreira, F. (1987). Discourse structure and anaphora: Some experimental results. In M. Coltheart (Ed.), *Attention and performance XII* (pp. 635-654). Hillsdale, NJ: Lawrence Erlbaum Associates.

Deaton, J. A., & Gernsbacher, M. A. (in press). Causal conjunctions and implicit causality cue mapping in sentence comprehension. *Journal of Memory and Language*.

Duffy, S. A., Shinjo, M., & Myers, J. L. (1990). The effects of encoding task on sentence pairs varying in causal relatedness. *Journal of Memory and Language, 29*, 27-42.

Estes, W. K. (1972). Interactions of signal and background variables in visual processing. *Perception and Psychophysics, 12*, 278-286.

Fletcher, C. R. (1984). Markedness and topic continuity in discourse processing. *Journal of Verbal Learning and Verbal Behavior, 23*, 487-493.

Foss, D. J. (1969). Decision processes during sentence comprehension: Effects of lexical item difficulty and position upon decision times. *Journal of Verbal Learning and Verbal Behavior, 8*, 457-462.

Foss, D. J. (1982). A discourse on semantic priming. *Cognitive Psychology, 14*, 590-607.

Foss, D. J., & Lynch, R. H., Jr. (1969). Decision processes during sentence comprehension: Effects of surface structure on decision times. *Perception & Psychophysics, 5*, 145-148.

Frazier, L., Taft, L., Roeper, T., Clifton, C., & Ehrlich, K. (1984). Parallel structure: A source of facilitation in sentence comprehension. *Memory & Cognition, 12*, 421-430.

Garnham, A. (1981). Mental models as representations of text. *Memory & Cognition, 9*, 560-565.

Gernsbacher, M. A. (1983). *Memory for the orientation of pictures in nonverbal stories: Parallels and insights into language processing*. Unpublished doctoral dissertation, University of Texas at Austin.

Gernsbacher, M. A. (1985). Surface information loss in comprehension. *Cognitive Psychology, 17*, 324-363.

Gernsbacher, M. A. (1989). Mechanisms that improve referential access. *Cognition, 32*. 99-156.

Gernsbacher, M. A. (1990). *Language comprehension as structure building*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Gernsbacher, M. A., & Faust, M. (1991a). The role of suppression in sentence comprehension. In G. B. Simpson (Ed.), *Comprehending word and sentence* (pp. 97-128). Amsterdam: North Holland.

Gernsbacher, M. A., & Faust, M. E. (1991b). The mechanism of suppression: A component of general comprehension skill. *Journal of Experimental Psychology: Learning, Memory and Cognition, 17*, 245-262.

Gernsbacher, M. A., & Hargreaves, D. (1988). Accessing sentence participants: The advantage of first mention. *Journal of Memory and Language, 27*, 699-717.

Gernsbacher, M. A., & Hargreaves, D. (1992). The privilege of primacy: Experimental data and cognitive explanations. In D. L. Payne (Ed.), *Pragmatics of word order flexibility* (pp. 83-116). Philadelphia: John Benjamins Publishing Company.

Gernsbacher, M. A., Hargreaves, D., & Beeman, M. (1989). Building and accessing clausal representations: The advantage of first mention versus the advantage of clause recency. *Journal of Memory and Language, 28*, 735-755.

Gernsbacher, M. A., & Jescheniak, J. D. (in press). Cataphoric devices in spoken discourse. *Cognitive Psychology*.

Gernsbacher, M. A., & Robertson, R. R. W. (1994). *The definite article "the" facilitates mapping in story comprehension.* Manuscript submitted for publication.

Gernsbacher, M. A., & Shroyer, S. (1989). The cataphoric use of the indefinite *this* in spoken narratives. *Memory & Cognition, 17,* 536–540.

Gernsbacher, M. A., Varner, K. R., & Faust, M. (1990). Investigating differences in general comprehension skill. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16,* 430–445.

Givón, T. (1983). *Topic continuity in discourse: A quantitative cross-language study.* Amsterdam: Benjamins.

Glenberg, A., Meyer, M., & Lindem, K. (1987). Mental models contribute to foregrounding during text comprehension. *Journal of Memory and Language, 26,* 69–83.

Haberlandt, K. (1984). Components of sentence and word reading times. In D. E. Kieras & M. A. Just (Eds.), *New methods in reading comprehension research* (pp. 219–252). Hillsdale, NJ: Lawrence Erlbaum Associates.

Haviland, S. E., & Clark, H. H. (1974). What's new? Acquiring new information as a process in comprehension. *Journal of Verbal Learning and Verbal Behavior, 13,* 512–521.

Hayes-Roth, B., & Thorndyke, P. W. (1979). Integration of knowledge from text. *Journal of Verbal Learning and Verbal Behavior, 18,* 91–108.

Johnson-Laird, P. N. (1983). *Mental models.* Cambridge, MA: Harvard University Press.

Keele, S. W., & Neill, W. T. (1978). Mechanisms of attention. In E. C. Carterette & M. P. Friedman (Eds.), *Handbook of perception* (pp. 3–47). New York: Academic Press.

Keenan, J. M., Baillet, S. D., & Brown, P. (1984). The effects of causal cohesion on comprehension and memory. *Journal of Verbal Learning and Verbal Behavior, 23,* 115–126.

Kieras, D. E. (1978). Good and bad structure in simple paragraphs: Effects on apparent theme, reading time, and recall. *Journal of Verbal Learning and Verbal Behavior, 17,* 13–28.

Kieras, D. E. (1981). Component processes in the comprehension of simple prose. *Journal of Verbal Learning and Verbal Behavior, 20,* 1–23.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review, 95,* 163–182.

Kintsch, W., & van Dijk, T. A. (1978). Toward a model of discourse comprehension and production. *Psychological Review, 85,* 363–394.

MacWhinney, B. (1977). Starting points. *Language, 53,* 152–168.

Mandler, J. M., & Goodman, M. S. (1982). On the psychological validity of story structure. *Journal of Verbal Learning and Verbal Behavior, 21,* 507–523.

Marcel, A. J. (1980). Conscious and preconscious recognition of polysemous words: Locating the selective effects of prior verbal context. In R. S. Nickerson (Ed.), *Attention and performance VIII* (pp. 435–457). Hillsdale, NJ: Lawrence Erlbaum Associates.

Marcel, A. J. (1983). Conscious and unconscious perception: Experiments on visual masking and word recognition. *Cognitive Psychology, 15,* 197–237.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review, 88,* 375–407.

Miller, J. R., & Kintsch, W. (1980). Readability and recall of short prose passages: A theoretical analysis. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 335–354.

Myers, J. L., Shinjo, M., & Duffy, S. (1987). Degree of causal relatedness and memory. *Journal of Memory and Language, 26,* 453–465.

Neely, J. H. (1976). Semantic priming and retrieval from lexical memory: Evidence for facilitatory and inhibitory processes. *Memory and Cognition, 4,* 648–654.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited capacity attention. *Journal of Experimental Psychology: General, 106,* 226–254.

Neill, W. T., & Westberry, R. L. (1987). Selective attention and the suppression of cognitive noise. *Journal of Experimental Psychology, Learning, Memory, and Cognition, 13,* 327–334.

Gernsbacher, M. A. (Ed.) Hillsdale, NJ: Earlbaum.

Olson, G. M., Duffy, S. A., & Mack, R. L. (1984). Thinking-out-loud as a method for studying real-time comprehension processes. In D. E. Kieras & M. A. Just (Eds.), *New methods in reading comprehension research* (pp. 253–286). Hillsdale, NJ: Lawrence Erlbaum Associates.

Perfetti, C. A., & Roth, S. (1981). Some of the interactive processes in reading and their role in reading skill. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 269–297). Hillsdale, NJ: Lawrence Erlbaum Associates.

Peterson, R. G., & McIntyre, C. W. (1973). The influence of semantic "relatedness" on linguistic information and retention. *American Journal of Psychology, 86,* 697–706.

Pezdek, K., & Royer, J. M. (1974). The role of comprehension in learning concrete and abstract sentences. *Journal of Verbal Learning and Verbal Behavior, 13,* 551–558.

Posner, M. I. (1982). Cumulative development of attention theory. *American Psychologist, 37,* 168–179.

Posner, M. I., & Snyder, C. R. R. (1975a). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola symposium* (pp. 55–85). Hillsdale, NJ: Lawrence Erlbaum Associates.

Posner, M. I., & Snyder, C. R. R. (1975b). Facilitation and inhibition in the processing of signals. In P. M. A. Rabbitt & S. Dornic (Eds.), *Attention and performance V* (pp. 669–682). New York: Academic Press.

Reber, A. S. (1987). The rise and (surprisingly rapid) fall of psycholinguistics. *Synthese, 72,* 325–339.

Rumelhart, D. E., & McClelland, J. L. (1986). *Parallel distributed processing. Explorations in the microstructure of cognition: Vol. 1. Foundations.* Cambridge, MA: MIT Press.

Sachs, J. S. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception & Psychophysics, 2,* 437–442.

Sachs, J. S. (1974). Memory in reading and listening to discourse. *Memory & Cognition, 2,* 95–100.

Swinney, D. A. (1979). Lexical access during sentence comprehension: (Re)consideration of context effects. *Journal of Verbal Learning and Verbal Behavior, 18,* 645–659.

Treisman, A. M. (1964). The effect of irrelevant material on the efficiency of selective listening. *American Journal of Psychology, 77,* 533–546.

Turner, E. A., & Rommetveit, R. (1968). Focus of attention in recall of active and passive sentences. *Journal of Verbal Learning and Verbal Behavior, 7,* 543–548.

van Dijk, T., & Kintsch, W. (1983). *Strategies of discourse comprehension.* New York: Academic Press.

Walley, R. E., & Weiden, T. D. (1973). Lateral inhibition and cognitive masking: A neuropsychological theory of attention. *Psychological Review, 80,* 284–302.

Waltz, D. L., & Pollack, J. B. (1985). Massively parallel parsing: A strongly interactive model of natural language interpretation. *Cognitive Science, 9,* 51–74.