CHAPTER NINE

Three models of discourse comprehension

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Over the last two decades, language processing researchers have proposed models to explain how it is that people come to understand connected text and spoken language, a medium known as discourse. Many questions arise, such as how do comprehenders build mental representations of discourse? How do comprehenders link the elements of discourse with information that they already know? How do comprehenders retrieve information from their representation of a discourse? In this chapter, we shall describe three models of discourse comprehension that have come to dominate the field of psycholinguistics: Kintsch and van Dijk's ever-evolving model of text comprehension (1978; van Dijk & Kintsch, 1983), presently under the name of the Construction–Integration Model (Kintsch, 1988; 1990); Sanford and Garrod's Memory-Focus Model (1981, 1994); and Gernsbacher's Structure Building Framework (1990; 1991; 1997). Because we are intimately familiar with the latter model, we shall spend more time reviewing it than the others.

KINTSCH AND VAN DIJK'S MODELS OF TEXT COMPREHENSION

One of the first attempts at developing a detailed model of discourse comprehension was made by Kintsch and van Dijk (1978). The Kintsch and van Dijk model combined Kintsch's earlier psychology-based work

on units of meaning, which were called *propositions* (Kintsch, 1974, 1977), with van Dijk's functional linguistics-based work on the rules of discourse, which were called *macro-operators*, for transforming propositions (van Dijk, 1972, 1977). The resulting model of text comprehension proposed three basic steps: First, the meaningful elements of the text (the propositions) must be organised into a locally coherent whole (*a text base*). Due to the constraints of working memory, this is a cyclical process, usually dealing with only one sentence or clause at a time. Second, processing operations called *macro-operators* transform the propositions of the text base into a set of overarching *macro-propositions* that retain the gist of the text. These operations include deleting irrelevant propositions from the macro-structure (though not necessarily from memory), generalising across redundancies, and constructing new propositions to fill in logical gaps in the text (i.e. making *bridging inferences* at a global level). *Schemas* (structured frameworks representing typical events) retrieved from memory control the application of these macro-operators by determining which propositions are relevant—in other words, by deciding which text elements fit the constraints imposed by a comprehender's expectations about how the discourse should proceed. Macro-operators are also applied in cycles, with the relevance criteria becoming more and more stringent with each cycle.

The third and last set of operations in Kintsch and van Dijk's (1978) original model comes into play only when the text needs to be recalled from memory. When the comprehender is asked to recall or summarise the text, a *new* text base is generated from the memorial consequences of the original comprehension process. Some of the operations used to produce this text base are reproductive, whereas others are constructive. Both types of operations result from the inverse application of the macro-operators. Kintsch and van Dijk (1978) demonstrated how these three sets of operations could be used to understand a paragraph from a psychological research report and went on to suggest methods for testing the model empirically.

Some early criticisms of the original Kintsch and van Dijk model (e.g. Sanford & Garrod, 1981) focused on its use of propositional notation to represent meaning and the ambiguity of exactly how much information can be held in a single proposition. If, as Kintsch and van Dijk (1978) suggest, the propositions that represent nuggets of meaning within the text can be something *beyond* Kintsch's (1974) word-based notation, it becomes difficult to make any claims about the model's processing capacity. Kintsch and van Dijk (1978) had asserted that processing must be done in cycles because the working memory buffer that transforms propositions into a coherent text base can handle only a few propositions at a time. But if propositions comprise knowledge structures other than

words (like event frames, for example), it is unclear what the capacity limits of the model really are. To illustrate, Sanford and Garrod (1981) questioned whether the concept of WOMAN-COOKING-CHIPS would be represented with one "pseudo-proposition" (as could be the case if propositions are event frames), or several formal propositions (as must be the case in Kintsch's (1974) propositional notation).

Kintsch and van Dijk's original model (1978) was also weakened by empirical results that suggested that a lot of discourse comprehension is done "on-line". A model that waits for an entire sentence or clause to be read into the working memory buffer before trying to figure out what that clause or sentence means was inconsistent with new data suggesting that attempts at local coherence are made *before* the ends of clauses are reached. In response to this shortcoming, van Dijk and Kintsch (1983) revised their model, making it more "strategic", dynamic, and on-line. In van Dijk and Kintsch's updated version (1983), the model attempts to establish local coherence as soon as possible instead of waiting for clause or sentence boundaries. This process was still conceived of as cyclical, but the length of the cycle had effectively shrunk from the size of a clause or sentence to that of a few words. Along the same lines, macro-operators were replaced by more flexible *macro-strategies*, which allow comprehenders to make inferences about the text and predictions about what will occur next before the entire text has been converted into a propositional text base.

Further modifications were soon to follow. After connectionist models became a popular way of explaining how memories might be stored and retrieved from the neural networks of the mind, Kintsch incorporated connectionist ideas into the model that he and van Dijk had developed. The result was Kintsch's (1988) Construction–Integration model of discourse comprehension, which was a hybrid between the symbolic systems used in the earlier Kintsch models and the connectionist systems used by computer modellers like Rumelhart and McClelland (1986).

Whereas the earlier Kintsch and van Dijk models (1978; van Dijk & Kintsch, 1983) suggested that discourse comprehension is driven by preformulated schemas in a top-down, expectation-based fashion, Kintsch's (1988) Construction–Integration model proposed that the initial processing is strictly data-driven and bottom-up. Such a change was needed to accommodate the late-1970s findings that the initial activation of meanings associated with a word occurs without regard to the context of that word (Swinney, 1979; Tanenhaus, Leiman, & Seidenberg, 1979). Priming experiments had shown that within the first several hundred milliseconds of presenting a word like *bat,* multiple meanings of that word become activated (both "a flying mammal" and "a club for hitting a ball"), even if only one of those meanings makes sense in the context of

the sentence in which the word occurs. It is only after about 400 ms that the contextually appropriate meaning of the word is selected and the contextually inappropriate meaning is suppressed.

Taking such findings into account, Kintsch (1988) proposed a two-step comprehension process of acontextual *construction* followed by context-guided *integration*. During the first step of construction, word meanings are activated and propositions are formed without regard to the discourse context. This activation process is sloppy and weakly constrained so as to be maximally flexible (i.e. weak production rules can operate in many different contexts because they do not have to yield precise outputs, whereas more strongly constrained production rules do not work at all in novel or atypical situations). These weaker production rules tend to produce multiple candidates for later selection, some of which are bound to be wrong: They are powerful enough so that the right element is likely to be among those produced, but weak enough that some of the elements generated will be irrelevant or entirely inappropriate. Hence, the output of this initial phase of construction is somewhat incoherent and inconsistent.

Following the lead of Rumelhart and McClelland (1986), Kintsch proposed that the output of the construction phase's bottom-up activation process is in the form of an unstable network of associations. This network, corresponding to a text base, is formed through the following steps: (1) concepts and propositions directly corresponding to the verbal input are formed; (2) the concepts are elaborated by activating a small number of the most closely associated neighbours in the general knowledge net (background knowledge stored in memory); (3) inferences necessary for local—but not global—coherence may be generated; and (4) connection strengths or *weights* are assigned to all pair-wise interconnections.

It is only during the second step of integration that discourse context comes into play, and the model chooses between those elements that are appropriate for the discourse context and those that are not. During the integration phase, the construction phase's incoherent and unstable net of associations is transformed into a coherent and stable text base through the wonders of spreading activation. Briefly, this is a process whereby an activation vector passes through the network, and the weights on the interconnections are updated so that positively interconnected items (those that are a "good fit" with the other items) are boosted in activation strength, while unrelated items lose activation and drop out of the network, and implausible or inconsistent items become inhibited. (A detailed description of connectionist models and the algebraic principles by which they operate is beyond the scope of this chapter, but a good introduction to these models can be found in McClelland and Rumelhart, 1985. For a more formal and fully instantiated connectionist model of discourse comprehension than that attempted by Kintsch, see the models developed by Sharkey, 1990, and Golden and Rumelhart, 1993.)

As in earlier models, Kintsch (1988) proposed that the two-step construction-integration process occurs in cycles corresponding to short sentences or phases. In each cycle, a new net of associations is constructed from whatever was held over in working memory from the previous cycle. Once this net of associations is constructed, the integration process steps in and activation vectors are passed through the system until the weights on the interconnections stop changing and the system stabilises. The highly activated nodes that remain are the discourse representation that is then held over in working memory to aid in the construction processes of the next cycle. To clarify that these processes are still occurring "on-line", Kintsch (1988, p. 168) noted that integration does not necessarily need to wait for a clause or sentence boundary: "It would be quite possible to apply the relaxation procedure outlined here repeatedly in each cycle, as propositions are being constructed. This would allow for the disambiguation of word senses before the end of a cycle."

The latest instantiation of Kintsch's Construction–Integration model (1990) is very similar to the 1988 version, except that it incorporates the ideas of Givón (1979, 1992) about the role of grammar in discourse processing. Givón (1992) illustrates how the grammar of referentiality (e.g. the use of definite versus indefinite modifiers, the use of more explicit anaphors like full noun phrases versus less explicit anaphors like pronouns) provides "processing instructions" that guide the comprehender in producing a referentially coherent representation of a text. As Kintsch (1990, p. 5) states in his summarisation of Givón's ideas: "Syntactic cues signal to the reader what is likely to be important for the construction of the situation model, and some rather general semantic rules allow the reader to put these elements together into a weak or sloppy situation model ... The grammar tells the reader precisely where to look for what in the text". By allowing that grammar and some "general semantic rules" may guide processing and text base construction right from the start, Kintsch's (1990) model differs from his assertion (1988, p. 163) that "initial processing is strictly bottom-up. Word meanings are activated, propositions are formed, and inferences and elaborations are produced without regard to discourse context". This assertion does not entirely hold if the grammar of the sentence and the referential structure of the text are considered as part of a word's context, and indeed, Kintsch (1990) seems to be suggesting that grammar is used to "contextualise" discourse elements in reference to one another.

SANFORD AND GARROD'S MEMORY FOCUS MODEL

A parallel model of discourse comprehension has been proposed by Sanford and Garrod (1981; Garrod & Sanford, 1994). Whereas Kintsch and van Dijk's original (1978) model developed out of work on propositional transformations and the representation of meaning, Sanford and Garrod's (1981) Memory Focus model developed out of an interest in referential coherence and anaphoric resolution (Garrod & Sanford, 1977). Hence, although the latest versions of these two models are not inconsistent, they focus on different portions of what are essentially the same underlying processes. Kintsch and van Dijk have focused on how information from the text (in the form of propositions) is connected to and completed by information from long-term memory (schemas, general knowledge, and so forth), whereas Sanford and Garrod have focused most of their attention on a particular instantiation of that process: anaphoric resolution, or how the various referents in a text become associated with their antecedents in the text. For Kintsch and van Dijk, the primary question of interest during processing is "How does this new element change the scenario I am constructing?" For Sanford and Garrod, the primary question of interest is "Does this new element refer to something mentioned previously in the text, and if so, what?"

Sanford and Garrod's (1981) Memory Focus model has not gone through as many versions as the text comprehension model of Kintsch and van Dijk (1978), but it has been elaborated and updated by their continuing work in the field of anaphoric resolution (e.g. Garrod, Freudenthal, & Boyle, 1994; Garrod & Sanford, 1983, 1990; Sanford, Moar, & Garrod, 1988). The basic goal of their model—and of any discourse comprehension model—is to come up with a coherent interpretation of all of the text encountered thus far, a process that hinges on first establishing who or what is being talked about in a given text fragment and whether or not that element has been discussed before. This resolution process is influenced by three factors: (1) the discourse focus, which is whatever elements are the most highly activated at any one time, and which is constrained to only a few elements due to the limits of memory and attention; (2) the linguistic properties of the anaphors (whether the word that may refer back to an antecedent is in the form of a pronoun, common noun, or repeated name); and (3) pragmatic inference constraints, which reflect the need for global coherence.

The main assumptions of the Memory Focus model are as follows: First, the discourse focus clearly differentiates between different levels of activation in the discourse model. Information that is central to the discourse focus is the "current topic" and is highly active, while information that is on the periphery of the discourse focus (either due to prior mention or through close association with a current topic) is somewhat less active, but still readily retrievable. To capture this distinction, Garrod and Sanford (1990) propose two partitions of memory: the *explicit focus*, which corresponds to the text elements, or *tokens*, currently under discussion; and the *implicit focus*, which contains the somewhat less-active background information about the text scenario as it relates to the tokens.

As with Kintsch's (1988) model, the Memory Focus model distinguishes between immediate primary processing and subsequent secondary processing. Final resolution of a sentence occurs at a later stage than initial activation (which will include some options that are later rejected and deselected). Activation is immediate and automatic, whereas resolution (the choice that must be made prior to integration), and integration (the act of joining an element to its referent), are not. When the new element is a pronoun, activation, resolution, and integration are all immediate. This is because pronouns tap their tokens (the current topic) directly, and the downflow of activation from the token to the elements in the implicit focus is fast and easy. Alternatively, fuller, more explicit elements (like common nouns) tap into elements in the implicit focus. The reasoning is straightforward and guided by functional linguistics: If the discourse were talking about the explicit focus's token, it would clearly signal that by using a pronoun. Using a fuller noun suggests that something other than the current topic is being discussed.

According to the Memory Focus model, the immediacy of sentence resolution depends in every instance upon the costs and benefits that are associated with making an early commitment. Pronouns have a low probability of *not* being in the focus, so resolving them quickly is likely to be of much benefit and little cost. More explicit nouns tend to initiate a search for a referent in the implicit focus. If a referent that attaches to the token in the explicit focus is found, it takes another step to attach that referent to its token. (The *up*flow of activation from an implicit role slot to the explicit token is not fast and immediate.) If no referent is found in the implicit focus, the discourse focus is disrupted and a move to establish a new token as the discourse focus is made. More explicit anaphors are processing instructions that suggest either an old topic that has fallen out of focus is being reactivated or that an entirely new topic is being introduced. Thus, local cohesion is immediate, but coherence evaluation (resolution) and integration (structure updating) is not.

Although Kintsch's models of discourse comprehension have evolved over the years with regard to whether processing is top-down or bottom-up (top-down, Kintsch & van Dijk, 1978; van Dijk & Kintsch, 1983; bottom-up, 1988; both, 1990), Sanford and Garrod (1994) propose that some of the selectivity in their model is of a top-down nature. They argue that pragmatic mapping can sometimes override syntax (global coherence

can sometimes predominate local coherence). Thus, the Memory Focus model aims for a satisfactorily high level of coherence, which in some cases can be obtained without detailed processing. When coherence is easily achieved due to the apparent fulfilment of expectations, sentences may be only shallowly analysed.

An example of a relatively shallow level of analysis is the Moses illusion: When subjects are asked, "How many animals of each sort did Moses put on the Ark?", they typically reply, "two", without commenting on the fact that it was Noah, and not Moses, who put animals on an ark. Sanford and Garrod (1994, p. 716) review numerous experimental data documenting their conclusion that "there is a considerable amount of evidence for partial or incomplete processing during the interpretation of sentences. In general, the effects appear to result from pragmatic aspects of interpretation dominating lower level semantic processing."

GERNSBACHER'S STRUCTURE BUILDING FRAMEWORK

Gernsbacher's (1990) Structure Building Framework is based on the assumption that language comprehension and language production draw on general, cognitive processes and mechanisms—processes and mechanisms that might underlie non-linguistic comprehension, as well. Therefore, the goal of her Structure Building Framework has been to identify these cognitive processes and mechanisms. She does so by observing discourse comprehension phenomena, such as those already discussed in the context of Kintsch and Garrod and Sanford's models, and then searching for common cognitive processes and mechanisms that enable those discourse comprehension phenomena.

Like each of Kintsch's models and Garrod and Sanford's (1990) Memory Focus model, the Structure Building Framework also proposes that the goal of comprehension is to build a coherent, mental representation or "structure" of the information being comprehended. According to the Structure Building Framework, building this mental structure involves several component processes. First, comprehenders lay foundations for their mental structures. Next, comprehenders develop their structures by mapping on information when that incoming information coheres or relates to previous information. But when the incoming information is less coherent or related, comprehenders employ a different process: They shift to initiate a new substructure. So, most representations comprise several branching substructures.

The building blocks of these mental structures are what Gernsbacher very loosely refers to as memory nodes. Memory nodes are activated by incoming stimuli. Initial activation forms the foundation of mental

structures. Once the foundation is laid, subsequent information is often mapped on to a developing structure because the more the incoming information coheres with the previous information, the more likely it is to activate the same or connected memory nodes. In contrast, the less coherent the incoming information is, the less likely it is to activate the same or connected memory nodes. In this case, the incoming information might activate a different set of nodes, and the activation of this other set of nodes might form the foundation for a new substructure.

According to the Structure Building Framework, once memory nodes are activated, they transmit processing signals. These processing signals either enhance (boost) or suppress (dampen) other nodes' activation and thereby control the structure building processes. Presumably memory nodes are enhanced because the information they represent is necessary for further structure building. They are suppressed when the information they represent is no longer as necessary.

Gernsbacher's empirical research has been aimed at investigating these three sub-processes involved in structure building, namely, laying a foundation, mapping relevant information onto that foundation, and shifting to initiate a new sub-structure. She proposes these processes account for many language comprehension phenomena. For example, Gernsbacher and Hargreaves (1988) suggested that the processes of laying a foundation and mapping information onto that foundation accounts for a phenomenon they dubbed, the Advantage of First Mention. The advantage is this: Participants mentioned first in a sentence are more memorable than participants mentioned later. Gernsbacher and Hargreaves (1988) demonstrated that the Advantage of First Mention is not due to first-mentioned participants' tendency to be semantic agents; neither is the advantage due to the first-mentioned participants being literally the first words of their stimulus sentences (and possibly artificially highlighted by the warning signal that preceded each experimental trial). The advantage maintains even when both the first- and second-mentioned participants are syntactic subjects, and even when the first-mentioned participants are not the syntactic subjects. Gernsbacher and Hargreaves (1988) suggest that the Advantage of First Mention arises because comprehension requires laying a foundation and mapping subsequent information onto that foundation. First-mentioned participants are more accessible because they form the foundations for their sentence-level representations and because it is through them that subsequent information is mapped onto the developing representations.

The Advantage of First Mention has since been replicated numerous times in spoken (MacDonald & MacWhinney, 1990; McDonald & MacWhinney, 1995) and written English (Garnham, Traxler, Oakhill, & Gernsbacher, 1996; Gernsbacher, 1989; Neath & Knoedler, 1994; Schaibe

& McDonald, 1993) as well as Spanish (Carreiras, Gernsbacher, & Villa, 1995), Korean (Lee, 1992), Chinese (Sun, 1997), and American Sign Language (Emmorey, 1997). Gernsbacher and Hargreaves (1992) reviewed numerous languages whose preferred word order is both more and less constrained than English word order. Despite the greater or lesser constraints on word order in these languages, first-mentioned participants play a specific functional role. That is, speakers and writers specifically choose among the grammatical structures provided by their language so that they can purposely mention certain participants first. Indeed, Carreiras et al. (1995) demonstrated that the Advantage of First Mention occurs in Spanish, even though native Spanish speakers rely considerably less on word order for sentence comprehension than do English speakers (presumably because word order is less constrained in Spanish than it is in English). Carreiras et al. (1995) also demonstrated that the Advantage of First Mention occurs with first-mentioned inanimates as well as animates, semantic patients as well as semantic agents, and syntactic objects as well as syntactic subjects.

Gernsbacher, Hargreaves, and Beeman (1989) demonstrated how the processes of laying a foundation and shifting can account for another phenomenon, the Advantage of Clause Recency, which had been observed by other researchers. The Advantage of Clause Recency means that information in the most recently mentioned clause is more memorable than information from an earlier clause. The Advantage of Clause Recency obviously conflicts with the Advantage of First Mention. In a series of experiments, Gernsbacher et al. (1989) resolved this conflict by suggesting that comprehenders represent each clause of a two-clause sentence in its own mental sub-structure; while comprehenders are building a clause-level sub-structure, they have greatest access to the information that is represented in that sub-structure. Thus, the Advantage of Clause Recency occurs when comprehenders are building a mental sub-structure to represent the most recently comprehended clause. However, after comprehenders finish building the sub-structure to represent the most recently comprehended clause, information from the first clause becomes more accessible because the sub-structure representing the first clause serves as a foundation for the whole sentence-level representation (hence, the Advantage of First Mention). In this series of experiments, Gernsbacher et al. (1989) also demonstrated that the Advantage of First Mention is a relatively long-lived characteristic of the mental representation of a sentence.

The process of mapping

Another facet of Gernsbacher's research on the Structure Building Framework has been to investigate the cues in discourse that encourage

comprehenders to employ the process of mapping (Gernsbacher, 1996). Gernsbacher and Robertson (in press) discovered that comprehenders use the definite article *the* as a cue for referential coherence; Deaton and Gernsbacher (in press) discovered that comprehenders use the conjunction *because* as a cue for causal coherence; Foertsch and Gernsbacher (1994) discovered that comprehenders use the explicitness of the referential device (from repeated noun phrases to definite noun phrases to pronouns) as a cue for referential coherence; Haenggi, Gernsbacher, and Bolliger (1993) discovered that comprehenders draw inferences about the implied location of protagonists in narratives, and comprehenders use those inferences as cues for mapping during discourse comprehension; and Gernsbacher, Goldsmith, and Robertson (1992; see also Gernsbacher & Robertson, 1992; Gernsbacher, Hallada, & Robertson, 1998) discovered that comprehenders draw inferences about the implied emotional states of protagonists in narratives, and comprehenders use those inferences as cues for mapping during discourse comprehension.

The process of shifting

Gernsbacher (1985) claimed that the process of shifting explained why comprehenders rapidly forget recently comprehended information (in particular, information that is typically considered "superficial" or "surface" information). These experiments demonstrated that comprehenders rapidly forget recently comprehended information when they are comprehending non-verbal picture stories; so, the phenomenon is not unique to language Furthermore, this rapid forgetting was most likely to occur when comprehenders encountered a structural boundary, for instance, when they encountered a new clause, a new sentence, or—as in Gernsbacher's (1985) picture story experiments—a new episode. Because the phenomenon occurs with non-verbal picture stories, it is probably not due to the traditional psycholinguistics explanation. Moreover, because the structure of the information, rather than the amount, affects comprehenders' memory, the phenomenon is probably not due to the limitations of a short-term memory. Gernsbacher (1985) empirically demonstrated that the phenomenon is not due to another popular explanation, namely, that comprehenders lose access to information—in particular verbatim information—because it is recoded into "gist". Instead, Gernsbacher (1995) empirically demonstrated that comprehenders rapidly forget information because comprehension involves the cognitive process of shifting. Once comprehenders have shifted to initiate a new sub-structure, information represented in a previous sub-structure is more difficult to access. Surface information is least likely to remain accessible because it is least likely to be represented in multiple substructures.

The mechanisms of suppression and enhancement

According to the Structure Building Framework, mental structures are built of memory nodes; once activated, two cognitive mechanisms control memory nodes' activation levels: suppression and enhancement. Gernsbacher and her students have also investigated these two mechanisms and identified many of the roles they play in comprehension. For example, Gernsbacher and Faust (1991b) demonstrated the role the mechanism of suppression plays in how comprehenders understand the meanings of words. As a test case, Gernsbacher and Faust (1991b) investigated how comprehenders understand the contextually appropriate meanings of words that have diverse meanings, namely, homographs. As described earlier, when comprehenders encounter homographs (such as *spade*), multiple meanings are often immediately activated, even though one meaning is clearly implied by the context (as in *He dug in the garden with the spade*). However, within a half second, only the contextually appropriate meaning (e.g. the garden tool meaning) remains activated. What happens to the contextually inappropriate meanings? Gernsbacher and Faust (1991b) discovered that the contextually inappropriate meanings do not become less activated through a mechanism they dubbed mutual inhibition (i.e. the contextually inappropriate meanings do not decrease in activation simply because the contextually appropriate meanings increase, as in a see-saw effect). They also discovered that the contextually inappropriate meanings do not become less activated simply because they decay. Rather, inappropriate meanings become less activated through an active dampening of activation; they are suppressed by signals transmitted by memory nodes representing the semantic, pragmatic, and syntactic context (see also Gernsbacher & St. John, in press).

Gernsbacher (1989) demonstrated the role that both the mechanisms of suppression and enhancement play in how comprehenders understand anaphoric devices. Through enhancement and suppression, the anaphor's antecedent becomes the most activated concept. Furthermore, the more explicit the anaphor is, the more likely it is to trigger the mechanisms of suppression and enhancement. Very explicit anaphors, such as repeated names, immediately enhance the activation of their antecedents and immediately suppress the activation of other concepts. Less explicit anaphors, such as pronouns, take longer to trigger suppression, and they trigger enhancement less powerfully.

Gernsbacher and Shroyer (1989) demonstrated that just as anaphoric devices mark concepts that have been mentioned before, cataphoric devices mark concepts that are likely to be mentioned again. For example, two cataphoric devices typically found in spoken English are spoken stress and the indefinite article *this* ("I know *this* guy who ...").

Gernsbacher and Jescheniak (1995) demonstrated how the mechanisms of suppression and enhancement make the concepts to which cataphoric devices refer more accessible: Concepts marked by cataphoric devices are enhanced; concepts marked by cataphoric devices are better at suppressing the activation of other concepts; and concepts marked by cataphoric devices better resist being suppressed by other concepts.

Individual differences in structure building

According to the Structure Building Framework, many of the cognitive processes and mechanisms underlying language comprehension are general cognitive processes and mechanisms; therefore, some of the bases of individual differences in comprehension skill might not be language specific. Gernsbacher and her colleagues have tested this prediction and found substantial support for it. For example, Gernsbacher, Varner, and Faust (1990) demonstrated that skill at comprehending linguistic media (written and auditory stories) is highly correlated with skill at comprehending non-linguistic media (picture stories). In a second experiment, they discovered that less-skilled comprehenders lose access to recently comprehended information more rapidly than more-skilled comprehenders do, and this difference occurs regardless of whether they are comprehending written, auditory, or picture stories. According to the Structure Building Framework, all comprehenders lose access to recently comprehended information when they shift from actively building one substructure and initiate another. So, less-skilled comprehenders might be worse at remembering recently comprehended information because they shift too often. In Gernsbacher et al.'s (1990) third experiment, they found evidence to support this hypothesis. In their last experiment they discovered why a greater tendency towards shifting might characterise less-skilled comprehenders: Less-skilled comprehenders are less able to suppress inappropriate information, such as the contextually inappropriate meanings of ambiguous words (e.g. the playing card meaning of *spade* in the sentence *He dug in the garden with the spade*). Because inappropriate information cannot be easily mapped onto an existing substructure, its activation could trigger the development of a new substructure, leading to an increased amount of shifting, and poorer access to previously comprehended information.

Gernsbacher and Faust (1991a; see also Gernsbacher, 1993; Gernsbacher & Faust, 1995) provided more evidence to support the hypothesis that less-skilled comprehenders have less-efficient suppression mechanisms. Gernsbacher and Faust (1991a) discovered that less-skilled comprehenders are also less able to suppress the incorrect forms of homophones (e.g. the word *rose* when they read *rows*); less-skilled comprehenders are less able

to suppress the typical-but-absent members of visual scenes (e.g. a picture of a *tractor* in a farm scene); and less-skilled comprehenders are less able to ignore words superimposed on pictures or pictures surrounding words. However, Gernsbacher and Faust (1991b) also discovered that less-skilled comprehenders are not less appreciative of context (see also Gernsbacher & Robertson, 1995); in fact, they often activate contextually appropriate information more strongly than more-skilled comprehenders do. Therefore, Gernsbacher and her colleagues have concluded that less-skilled comprehenders' suppression mechanisms, but not their enhancement mechanisms, are less efficient.

BRIEF COMPARISON AMONG MODELS

Clearly, these three models are alike. For instance, the general, cognitive process of laying a foundation proposed by Gernsbacher's Structure Building Framework is akin to the process by which tokens are used "an anchor for attaching information" in Garrod and Sanford's Memory Focus model. Similarly, the general, cognitive process of mapping proposed by Gernsbacher's Structure Building Framework resembles the following phenomenon in Garrod and Sanford's Memory Focus model: If a referent that attaches to the token in the explicit focus is found, it takes another step to attach (map) that referent. Furthermore, Garrod and Sanford's proposal that if no referent is found in the implicit focus, the discourse focus is disrupted and a move to establish a new token as the discourse focus is made sounds quite similar to Gernsbacher's general cognitive process of shifting.

The general cognitive mechanism of suppression found in Gernsbacher's Structure Building Framework resembles the process of integration found in Kintsch's (1988) Construction–Integration model. Recall that in Kintsch's (1988) model, two processes build mental representations during language comprehension: The process of *construction* builds a propositional network (a text base), and the process of *integration* edits that network. Like the Structure Building Framework's mechanism of enhancement, Kintsch's (1988) process of integration increases the activation of contextually relevant information. And, like the Structure Building Framework's mechanism of enhancement, Kintsch's process of integration operates after concepts have been initially activated.

We end this chapter by posing a challenge to those involved in researching discourse comprehension: Generate testable hypotheses from these models that make clearly *different* predictions about what will or will not occur, and then perform a critical experiment to see which of the models is correct. Those who take us up on the challenge may well find that the models do *not* make different predictions a vast majority of the time. If that is the case, and if the models merely describe the same basic processes using different terms, then we must do what our brains compel us to do: We must lump all the models together into one.

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