The Privilege of Primacy
Experimental Data and Cognitive Explanations[1]

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Many things are arranged sequentially: the order in which children are born into a family; the order in which words occur in a sentence; and the order in which utterances occur in a discourse. Sequential order requires that some things come first. Items, events, or stimuli that occur in initial position often gain a unique psychological status. Indeed, some of the earliest experiments in contemporary American psychology document the psychological privilege of primacy.

For instance, the qualities of a person that we learn about first, figure most prominently in the impression we form of that person (Asch 1946). Consider the traits listed in (1) versus (2) below.

(1)   smart, artistic, sentimental, cool, awkward, faultfinding
(2)   faultfinding, awkward, cool, sentimental, artistic, and smart

If subjects are given a list of traits and are asked to imagine a person with such traits, they form a more favorable impression if they are given the traits arranged in order (1), and they form a less favorable impression if they are given the very same traits but arranged in order (2) (Anderson and Barrios 1961). The more favorable traits are primary in order (1); the less favorable traits are primary in order (2).

Consider the hand-written character in Figure 1. If that character is preceded by the letter **A**, subjects perceive it as the letter **B**. If the same character is preceded by the number **12**, subjects perceive it as the number **13** (Bruner and Minturn 1955). Perception depends on what character comes first.
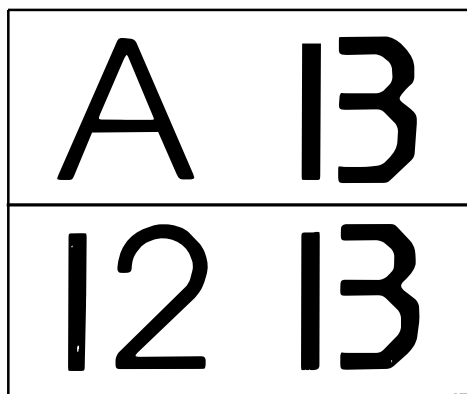
Figure 1

Forming impressions of people and recognizing hand-written characters demonstrate the privilege of primacy. Primacy effects also occur during language comprehension. In the next section, we review a large array of primacy effects that occur during sentence and discourse comprehension. These effects have been documented in a myriad of laboratories using a variety of experimental tasks. Consistently, a particular advantage is observed: The information that occurs first in a phrase, clause, sentence, or passage gains a privileged status in the comprehenders' minds.

Primacy effects in sentence and discourse comprehension

In some experiments, researchers measure how long it takes comprehenders to read each word of a sentence. In these experiments, subjects typically sit before a computer monitor; each word of a sentence appears in the center of the monitor. Subjects press a button to signal when they have finished reading each word. After each word disappears, another one appears. In this way, researchers can measure how long subjects need to read each word.

A consistent finding in these word-by-word reading time experiments is that the first word of a sentence takes longer to read than later-occurring words (Aaronson and Ferres 1983; Aaronson and Scarborough 1976;

Chang 1980). In fact, the same word is read more slowly when it occurs at the beginning of a sentence or phrase than when it occurs later. For example, the word *bears* occurs at the beginning of a clause in sentence (3) below.

(3)   *Even though Ron hasn't seen many, **bears** are apparently his favorite animal.*

But *bears* occurs at the end of a clause in sentence (4) below.

(4)   *Even though Ron hasn't seen many **bears**, they are apparently his favorite animal.*

Subjects read the word *bears* more slowly when it occurs at the beginning of a clause than when it occurs at the end (Aaronson and Scarborough 1976).

In some experiments, researchers measure how long it takes comprehenders to read each sentence of a passage. In these experiments, each sentence of the passage appears in the center of a computer monitor. Subjects press a button to signal when they have finished reading each sentence; the sentence then disappears, and another one appears. In this way, researchers can measure how long subjects need to read each sentence.

A consistent finding in these sentence-by-sentence reading time experiments is that initial sentences take longer to read than subsequent sentences (Cirilo 1981; Cirilo and Foss 1980; Glanzer, Fischer and Dorfman 1984; Graesser 1975; Haberlandt 1980, 1984; Haberlandt and Bingham 1978; Haberlandt and Graesser 1985; Olson, Duffy and Mack 1984).

In fact, initial sentences take longer to read than later-occurring sentences, even when the initial sentences are not the topic sentences of the paragraphs (Greeno and Noreen 1974; Kieras 1978, 1981). In addition, comprehenders take longer to read the beginning sentence of each episode within a story than other sentences in that episode (Haberlandt 1980, 1984; Haberlandt, Berian and Sandson 1980; Mandler and Goodman 1982). Similar phenomena occur when comprehenders encounter nonverbal materials, such as picture stories "told" without any text. For instance, researchers can set up a situation where subjects view each picture of a nonverbal picture story, one picture at a time. Although they can take as long as they want to view each picture, subjects spend more time viewing the beginning picture of each story and the beginning picture of each episode within a story than they spend viewing later-occurring pictures (Gernsbacher 1983).

To examine how comprehenders understand spoken language, some researchers play previously recorded sentences to subjects. The subjects'

major task is to comprehend the sentences as well as they can. But often they have the additional task of monitoring for a specific word or a specific phoneme. When they hear the target word or phoneme, they press a button, and their reaction times are recorded.

A consistent finding in these monitoring studies is that reaction times are longer when the target phonemes or target words occur at the beginning of the sentences or clauses than when they occur later (Cairns and Kamerman 1975; Cutler and Foss 1977; Foss 1969, 1982; Hakes 1971; Marslen-Wilson, Tyler and Seidenberg 1978; Shields, McHugh and Martin 1974).

For example, when listening for the word *bears* in sentences like (3) and (4) above, subjects identify it more slowly in sentence (3) than in sentence (4). This is because *bears* occurs at the beginning of its clause in sentence (3), but it occurs at the end of its clause in sentence (4). At the beginnings of clauses, comprehenders are laying foundations.

Another tool for studying comprehension involves measuring the brain's electrical activity (or brain waves). These event-related brain waves can be recorded from the subjects' scalps while they are listening to or reading sentences. A particular brain wave is elicited by the first content word of a sentence (as opposed to words that occur later in the sentence). First content words elicit larger than average N400 brain waves. N400 brain waves are the negative component of the event-related brain waves that occur about 400 milliseconds after the stimulus. N400 brain waves are associated with difficulty in processing; for instance, less familiar words and words that are unexpected (from the context) also elicit large N400s (Kutas, van Petten and Besson 1988).

So, the sentence-by-sentence reading time data, the word-by-word reading time data, the phoneme-monitoring data, the word-monitoring data, and the event-related brain wave data all display the same pattern: Comprehenders spend more cognitive capacity processing initial words and initial sentences than later-occurring words and sentences. The picture-by-picture viewing time data demonstrate the same pattern. That similarity suggests that the pattern is not specific to language comprehension, but is a general phenomenon that occurs during comprehension of both linguistic and nonlinguistic information. But rather importantly, this pattern does not occur when the stimuli are less comprehensible — for example, when the sentences, paragraphs, or picture stories are self-embedded or extensively right branching (Foss and Lynch 1969; Gernsbacher 1983; Greeno & Noreen 1974; Hakes and Foss 1970; Kieras 1978, 1981).

Memory phenomena also demonstrate the privilege of primacy. For instance, the first content words or pictures of those first content words provide the best recall cues for their sentences (Bock and Irwin 1980; Prentice 1967; Turner and Rommetveit 1968). Similarly, the beginnings of story episodes provide the best cues for recalling those story episodes (Mandler and Goodman 1982). Indeed, when asked to recall the main idea of a paragraph, comprehenders are most likely to select the initial sentence — even when the actual theme is a later-occurring sentence (Kieras 1980).

Why do these primacy effects occur in language comprehension? In our research, we take the view that language comprehension draws on general cognitive processes (as well as language-specific processes). The general cognitive processes underlie non-language tasks as well. This commonality might arise because, as Lieberman (1984) and others have suggested, language comprehension evolved from other nonlinguistic skills. Or the commonality might arise simply because the mind is best understood by reference to a common architecture.

The Structure Building Framework

In our effort to understand the general cognitive processes that underlie language comprehension, we have proposed a simple framework we call the Structure Building Framework (Gernsbacher 1990; Gernsbacher in press). According to the Structure Building Framework, comprehension involves building coherent, mental representations or **structures**. These structures represent phrases, clauses, sentences, passages, and so forth. Building mental structures involves several cognitive processes. The first cognitive process is laying a foundation for their mental structures. The next cognitive process is mapping: Incoming information that coheres or relates to previous information is mapped onto the developing structure. However, if the incoming information is less coherent or less related, a different cognitive process is engaged: Comprehenders automatically shift and a new substructure is developed. Therefore, most mental representations of discourse comprise several branching substructures.

It is the process of laying a foundation that we propose underlies the primacy effects we described earlier. Comprehenders take more time to read words when they occur at the beginnings of sentences, clauses, or phrases because during the beginnings of sentences, clauses, and phrases,

mental foundations are being laid. Similarly, comprehenders take more time to read sentences when those sentences occur at the beginnings of passages or episodes, because during the beginnings of passages or episodes, mental foundations are being laid. Similarly, comprehenders need more time to respond to target phonemes or words when those target phonemes or words occur during the the beginnings of sentences and phrases, because during the beginnings of sentences and phrases, mental foundations are being laid. Laying the foundation for a mental structure requires some mental effort; therefore, less mental effort is available to read words or sentences or to respond to target phonemes or target words.

Comprehenders recall sentences better when cued by initial words because the initial words form the foundations for the sentence-level mental structures. Similarly, comprehenders recall episodes better when cued by initial sentences because the initial sentences form the foundations for the episode-level mental structures. So, according to the Structure Building Framework, primacy effects occur in sentence and discourse comprehension because of the general cognitive process of laying a foundation.

The Advantage of First Mention in sentences

Another primacy effect that could result from the process of laying a foundation is what we refer to as the Advantage of First Mention. The advantage is this: After comprehending a sentence involving two participants, it is easier to remember the participant mentioned first in the sentence than the participant mentioned second. For example, after reading the sentence,

(5)   *Tina beat Lisa in the state tennis match.*

if subjects are asked whether the name *Tina* occurred in the sentence, they respond considerably faster if *Tina* was the first person mentioned in the sentence, as she was in sentence (5), than if *Tina* was the second person mentioned in the sentence, as she is in,

(6)   *Lisa beat Tina in the state tennis match.*

So the first-mentioned participant is more accessible from comprehenders' mental representations, which is what we mean by the Advantage of First Mention.

The Advantage of First Mention has been observed by several researchers (Chang 1980; Corbett and Chang 1983; Gernsbacher 1989; Stevenson

1986; von Eckardt and Potter 1985). One explanation draws on the Structure Building Framework's proposal that comprehension involves laying a foundation: First-mentioned participants are more accessible both because they form the foundations for their sentence-level structures, and because it is through this foundation that subsequent information is mapped onto the developing mental structure.

Because foundations can be based only on the information that comprehenders initially receive, first-mentioned participants must serve as the foundation for their sentence-level structures. Then, after a foundation is laid, subsequent information must be mapped onto that foundation; therefore, first-mentioned participants achieve even more accessibility because it is through them that subsequent information — including information about later-mentioned participants — is attached to the developing structure.

To summarize, we suggest that the Advantage of First Mention is a function of structure building: First-mentioned participants form the foundation of their sentence-level structures, and, therefore, the remainders of the sentences are represented *vis à vis* those initial participants.

Our proposal resembles the following idea advanced by MacWhinney (1977) in a paper aptly titled, "Starting Points":

> 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. (p. 152).

MacWhinney's notions of "using a starting point" and "attaching the body of the sentence to the starting point" are captured in the Structure Building Framework's processes of laying a foundation and mapping subsequent information onto that foundation.

However, there are other explanations of the Advantage of First Mention. For instance, first-mentioned participants might be more accessible because of the structure of English: In English declarative sentences, first-mentioned participants are typically the syntactic relation called "subject," and they typically fill the semantic role considered "agent."

In a series of experiments, we investigated whether the Advantage of First Mention was due to these other factors (Gernsbacher and Hargreaves 1988). These experiments used the following laboratory task: Subjects read sentences that were presented word-by-word in the center of a video

monitor. Each sentence was about two participants. After the last word of each sentence disappeared, a test name appeared. The subjects' task was to verify as rapidly and accurately as possible whether that test name had occurred in the sentence they just finished reading.

Is the Advantage of First Mention due to semantic agency?

In previous experiments, the first-mentioned participants were always semantic agents. Perhaps the Advantage of First Mention is actually an advantage of agency. Agents might gain a privileged place in comprehenders' mental representations for several linguistic and psycholinguistic reasons.

Semantic agents tend to be more animate (Clark 1965; Johnson 1967), more active (Osgood 1971), more positively evaluated (Johnson 1967), and more imageable (James 1972; James, Thompson and Baldwin 1973). Because of these characteristics, several theorists have suggested that agents are more likely to attract attention (Zubin 1979), stimulate empathy (Kuno and Kaburaki 1977), and match the speaker or listener's perspective (MacWhinney 1977). Semantic agents are also more likely to be their sentences' syntactic subjects (Greenberg 1963), topics (Givón 1983), and themes (Tomlin 1983). So, along many dimensions, semantic agents hold an advantage over semantic patients. Perhaps that is the basis of the Advantage of First Mention.

We empirically investigated this possibility in the following way: We constructed 32 sentence sets; an example appears in Table 1. Each sentence set comprised four versions of a prototype sentence. In two of the four ver-

Table 1

Agent

    Tina beat Lisa in the state tennis match.
    Lisa beat Tina in the state tennis match.

Patient

    Tina was beaten by Lisa in the state tennis match.
    Lisa was beaten by Tina in the state tennis match.

sions, the test names were the agents and either the first- or second-mentioned participants. In the other two versions, the test names were the patients and either the first- or second-mentioned participants.

In other words, we manipulated whether the test names were the first- versus second-mentioned participants, and whether the test names were the semantic agents versus patients. We also constructed 32 lure sentences whose test names had not occurred in their respective sentences (so the correct response to the test names following these sentences was "no"). The lure sentences resembled the experimental sentences in syntactic form: Half were in the active voice, and half were in the passive voice.[2]

We tested 96 subjects, whose average reaction times to the test names appear in Figure 2. As Figure 2 illustrates, we observed only an Advantage of First Mention. That is, first-mentioned participants were more accessible than second-mentioned participants, regardless of semantic agency. We replicated these results when we tested another 120 subjects using the same materials and procedures. We again observed only an Advantage of First Mention. So, comprehenders must represent sentences in such a way that first-mentioned participants are more accessible. But semantic role is not the factor underlying this greater accessibility.
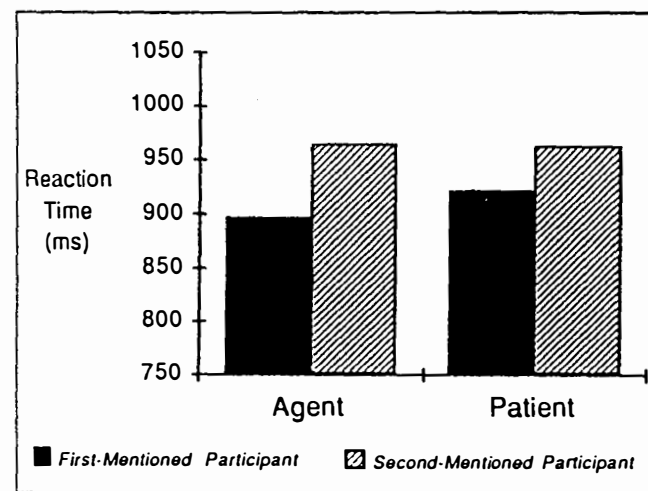

Figure 2. (*From Gernsbacher and Hargreaves 1988*)

Is the Advantage of First Mention due to syntactic subjecthood?

In previous experiments, the first-mentioned participants were always their sentences' syntactic subjects. However, in two other experiments we attempted to tease apart the Advantage of First Mention from an advantage for syntactic subject. We did this in one experiment by having both participants be subjects, as opposed to only the first-mentioned participants being subjects. Our sentences used joined-subject constructions, as in sentence (7), and single-subject constructions, as in sentence (8).

> (7)   *Tina and Lisa argued during the meeting.*
> (8)   *Tina argued with Lisa during the meeting.*

Our stimuli comprised three types of sentences. The first type was built around what we called lexical reciprocal verbs. These verbs described actions in which the two participants engaged in mutually complementary actions, and both participants were agents. For example, *argue*, *debate*, and *converse* are lexical reciprocal verbs. In the joined-subject condition, as in sentence (7) above, both participants were subjects. In the single-subject construction, as in (8) above, the first-mentioned participants were subjects, and the second-mentioned participants were objects of the preposition *with*.

The second type of sentences in our stimuli involved reciprocal anaphors. These sentences contained transitive verbs that could occur with reciprocal anaphoric expressions such as *each other* or *one another*. When used this way, both participants were subjects, as in

> (9)   *Tina and Lisa annoyed one another at the conference.*

However, when used without the reciprocal anaphoric expression, the first-mentioned participants were agents/subjects while the second-mentioned participants were patients/direct objects, as in

> (10)   *Tina annoyed Lisa at the conference.*

The third type of sentences in our stimuli were comitatives. These sentences contained simple intransitive verbs that did not involve reciprocal actions, for example,

> (11)   *Tina and Lisa hiked in the mountains.*

When used in a joined-subject construction, as in sentence (13), the verbs connoted that the two participants committed the act simultaneously, but not reciprocally.

For the lexical reciprocals and the reciprocal anaphors, we constructed 24 sentence sets by manipulating whether the test names were the first- versus second-mentioned participants, and whether the test names were joined versus single subjects. For the comitatives, we constructed 16 sentence sets by manipulating whether the test names were the first- versus second-mentioned participants. Table 2 shows examples.

We tested 120 subjects, whose average reaction times to respond to the test names appear in Figure 3. For all three types of sentences, we observed only an Advantage of First Mention: First-mentioned participants were considerably more accessible than second-mentioned participants. So, the Advantage of First Mention is not lost when both the first- and second-mentioned participants are syntactic subjects.

In another experiment, we separated the Advantage of First Mention from an advantage for syntactic subjects. We did this by taking one of the

Table 2

Lexical reciprocals
  Joined subjects
     Tina and Lisa argued during the meeting.
     Lisa and Tina argued during the meeting.

  Single subjects
     Tina argued with Lisa during the meeting.
     Lisa argued with Tina during the meeting.

Reciprocal anaphors
  Joined subjects
     Tina and Lisa annoyed one another at the conference.
     Lisa and Tina annoyed one another at the conference.

  Single subjects
     Tina annoyed Lisa at the conference.
     Lisa annoyed Tina at the conference.

Comitatives
  Joined subjects
     Tina and Lisa hiked in the mountains.
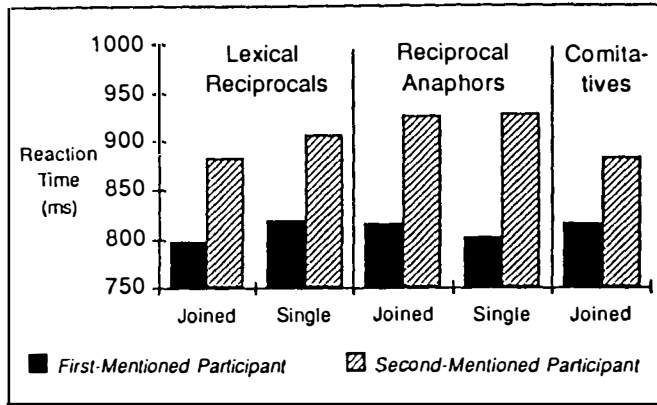   *Lisa and Tina hiked in the mountains.*

Figure 3. (*From Gernsbacher and Hargreaves 1988*)

participants out of its main clause and placing it in a complex prepositional phrase (Huddleston 1984). These prepositional phrases were either preposed, in which case the first-mentioned participants were not syntactic subjects, as in

(12) *Because of **Tina**, Lisa was evicted from the apartment.*

or the prepositional phrases were postposed, in which case the first-mentioned participants were syntactic subjects, as in

(13) ***Tina** was evicted from the apartment because of Lisa.*

In addition to manipulating the position of the prepositional phrases, we also manipulated whether the test names were the first- or second-mentioned participants.

We constructed 32 sentence sets. We used four different prepositional phrases: *because of, according to, compared with*, and *except for*. An example sentence set for each is shown in Table 3. We tested 80 subjects, whose reaction times to the test names appear in Figure 4. As Figure 4 illustrates, we observed an Advantage of First Mention: First-mentioned participants were considerably more accessible than second-mentioned participants. As Figure 4 also illustrates, the Advantage of First Mention was nearly doubled when the phrases were postposed. Perhaps the larger advantage in these postposed-sentences is due to the first-mentioned participants seeming to be the sole participants through the majority of their sentences.

Table 3

Preposed preposition

> *Because of **Tina**, Lisa was evicted from the apartment.*
> *Because of Lisa, **Tina** was evicted from the apartment.*
>
> *According to **Tina**, Lisa was an inspiring teacher.*
> *According to Lisa, **Tina** was an inspiring teacher.*
>
> *Except for **Tina**, Lisa was the oldest member of the club.*
> *Except for Lisa, **Tina** was the oldest member of the club.*
>
> *Compared with **Tina**, Lisa was a tidy housekeeper.*
> *Compared with Lisa, **Tina** was a tidy housekeeper.*

Postposed preposition

> ***Tina** was evicted from the apartment because of Lisa.*
> *Lisa was evicted from the apartment because of **Tina**.*
>
> ***Tina** was an inspiring teacher according to Lisa.*
> *Lisa was an inspiring teacher according to **Tina**.*
>
> ***Tina** was a tidy housekeeper compared with Lisa.*
> *Lisa was a tidy housekeeper compared with **Tina**.*
>
> ***Tina** was the oldest member of the club except for Lisa.*
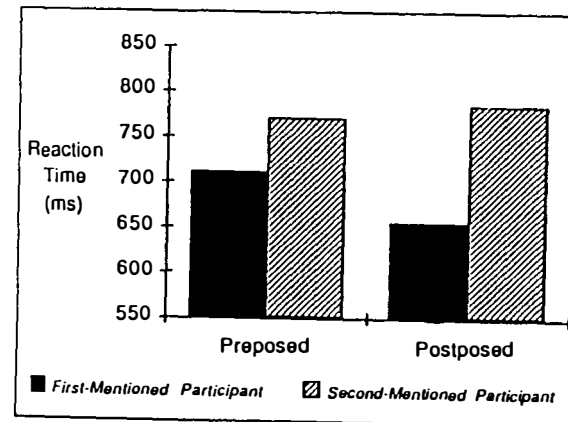> *Lisa was the oldest member of the club except for **Tina**.*

Figure 4. (*From Gernsbacher and Hargreaves 1988*)

From these experiments, we conclude that the Advantage of First Mention is not due to first-mentioned participants being semantic agents or syntactic subjects. Our Structure Building Framework explains the Advantage of First Mention by proposing that comprehension requires building a mental representation or structure. Building a mental structure requires both laying a foundation and mapping subsequent information onto that foundation. First-mentioned participants are more accessible because they form the foundation of their sentence-level representations, and because it is through them that subsequent information is mapped onto the developing representation.

The Advantage of First Mention versus the Advantage of Clause Recency

The Advantage of First Mention seems to contradict a second well-known advantage — what we call the Advantage of Clause Recency. The Advantage of Clause Recency is that immediately after comprehenders hear or read a two-clause sentence, words from the most recently heard or read clause are more accessible than words from an earlier clause (Bever and Townsend 1979; Caplan 1972; Chang 1980; Jarvella 1970, 1971, 1973, 1979; Jarvella and Herman 1972; Marslen-Wilson et al. 1978 ; von Eckardt and Potter 1985).

So, the Advantage of Clause Recency, like the Advantage of First Mention, is also caused by the order in which concepts are mentioned. But the Advantage of Clause Recency is an advantage for the most recent or second-mentioned concept.

How can this discrepancy be resolved? The Advantage of Clause Recency could also be due to structure building. According to the Structure Building Framework, language comprehension often requires shifting to initiate a new substructure. Comprehenders shift to initiate a new substructure when the incoming information is less related to the previous information, for instance, when the topic, point of view, or setting of a passage changes.

Indeed, words and sentences that change the ongoing topic, point of view, or setting take substantially longer to comprehend than words or sentences that continue the topic, point of view, or setting. We suggest that such words and sentences trigger comprehenders to shift and begin laying the foundation for a new substructure.

Comprehenders also have more difficulty retrieving information presented before a change in topic, point of view, or setting than they do retrieving information presented after such a change. According to the Structure Building Framework, information presented before the change is probably represented in one substructure, while information presented after the change is represented in another.

When building their representations of sentences, comprehenders might also shift and initiate a new substructure when speakers and writers signal the beginning of a new clause or phrase. In fact, one of Kimball's (Kimball 1973) seven parsing principles was that "the construction of a new node is signalled by the occurrence of a grammatical function word" (p. 29).

So, as Clark and Clark (1977) suggested, comprehenders might use signals such as determiners and quantifiers to initiate a substructure representing a new noun phrase. And they might use subordinating conjunctions (such as *because, although*) and coordinating conjunctions (*and, but*) as signals to initiate a substructure representing a new clause.

Thus, the Structure Building Framework can account for both of the seemingly contradictory phenomena: the Advantage of First Mention *and* the Advantage of Clause Recency. The Structure Building Framework accounts for these two phenomena by making the following assumptions: Comprehenders represent each clause of a multi-clause sentence in its own substructure. Comprehenders have the greatest access to the information that is represented in the substructure that they are currently developing, in other words, they have the greatest access to the most recent clause. However, at some point, the first clause becomes more accessible than other clauses because the substructure representing the first clause of a multi-clause sentence serves as a foundation for the whole sentence-level structure.

A series of experiments that we performed in collaboration with Mark Beeman tested these assumptions (Gernsbacher, Hargreaves and Beeman 1989). In each experiment, we measured the accessibility of sentence participants in two-clause sentences, for example,

(14)   *Tina gathered the kindling, and Lisa set up the tent.*

As in sentence (14), the first-mentioned participants (e.g. *Tina*) were the syntactic subjects of the first clauses, and the second-mentioned participants (e.g. *Lisa*) were the syntactic subjects of the second clauses. By measuring how rapidly subjects accessed these two sentence participants,

we investigated how comprehenders build their mental representations of sentence clauses.

Do comprehenders have greatest access to the substructure they are currently building?

In our first experiment we tested the Structure Building Framework's assumption that comprehenders have greatest access to information represented in the substructure that they are currently building. To test this assumption, we wanted to catch comprehenders when they were just finishing building substructures to represent the second clauses. If we could capture that point, we expected to find an Advantage of Clause Recency — in other words, we expected an advantage for the second-mentioned participant.

Because we wanted to present the test names right when our subjects were finishing comprehending the second clauses, we presented the test names coincident with the last words in the sentences. However, we presented the test names at a different location on the computer screen than where we presented the sentences. We supposed that by the time our subjects shifted their eyes and their attention (Posner 1980) from the sentences to the test names, our coincident presentation was comparable to an extremely short delay.

We constructed 48 sentence sets; an example appears in Table 4. Each sentence set resulted from manipulating whether the test name was the first- versus second-mentioned participant (in other words, whether the test name was the subject of the first clause or the subject of the second clause), and whether the test name was the subject of a main, a subordinate, or a coordinate clause.

Because each verb phrase had to serve in a main, subordinate, and coordinate clause, the two verb phrases in each sentence had to be relatively equivalent along several dimensions. For example, their action had to occur at about the same time, last about the same period, and be of equal importance, and neither action could be the impetus for the other.

To construct such sentences, we first selected pairs of verb phrases whose actions were relatively equivalent subcomponents of a larger activity, for example, *sang a song* and *played the guitar, dusted the shelves* and *swept the floor, did aerobics* and *lifted weights*. All verbs were transitive and took direct objects. To reduce temporal asymmetries, we assigned both verbs to the simple past tense (Haiman and Thompson 1984).

Table 4

Main clauses

> *Tina gathered the kindling as Lisa set up the tent.*
> *As Lisa set up the tent, Tina gathered the kindling.*

Subordinate clauses

> *As Tina gathered the kindling, Lisa set up the tent.*
> *Lisa set up the tent as Tina gathered the kindling.*

Coordinate clauses

> *Tina gathered the kindling, and Lisa set up the tent.*
> *Lisa set up the tent, and Tina gathered the kindling.*

When the sentences appeared in their subordinate clause condition, they appeared with one of the following four temporal subordinators: *as, when, before*, and *after*. Each subordinator was randomly assigned to twelve sentence sets. When the sentences appeared in their coordinate clause conditions, they were joined with *and*.

We tested 120 subjects, whose average reaction times to the test names are displayed in the two left-most bars of Figure 5. As Figure 5 illustrates, when the test names were presented coincident with the last words of their sentences, we observed an Advantage of Clause Recency: Second-mentioned participants were considerably more accessible than first-mentioned participants. This 60 millisecond difference is the same magnitude as the Advantage of Clause Recency observed by others (e.g. Caplan 1972).

So, immediately after a two-clause sentence is comprehended, the second clause — the more recent clause — is more accessible. This finding supports the Structure Building Framework's assumptions that comprehenders have greatest access to information represented in the substructure that they are currently developing.

Do comprehenders represent each clause in its own substructure?

According to the Structure Building Framework, after comprehenders represent the second clause of a two-clause sentence, they must map that sec-
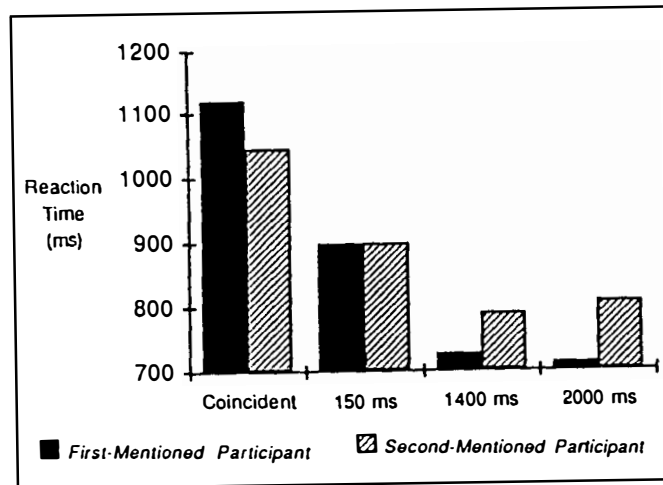
Figure 5. (*From Gernsbacher, Hargreaves and Beeman 1989*)

ond-clause representation onto their first-clause representation. In other words, to fully represent a two-clause sentence, comprehenders must incorporate the two substructures.

The goal in our next experiment was to catch comprehenders after they had built substructures to represent each clause, but before they had mapped the substructure representing the second clause onto the substructure representing the first clause. According to the Structure Building Framework, if we could capture that point, the two clauses should be equally accessible. To capture that point, we presented the test names 150 milliseconds after the offset of the final words of their sentences.

We tested 120 subjects, whose data appear in the third and fourth bars of Figure 5. As Figure 5 illustrates, when accessibility was measured 150 milliseconds after the sentences, the two clauses were equally accessible. That is, first-mentioned participants were just as accessible as second-mentioned participants. We observed the same results in a replication experiment. So, at some point during the comprehension of a two-clause sentence, the two clauses are equally accessible. This finding supports the Structure Building Framework's assumption that each clause is represented in its own substructure.

Do first clauses form the foundation for their sentence-level structures?

According to the Structure Building Framework, to fully represent a two-clause sentence, comprehenders must incorporate the two substructures. Therefore, in our experiments if we measured accessibility a little bit later — say, a little more than a second later — no longer should both clauses be equally accessible.

Instead, if comprehenders have successfully mapped the two clauses together, the first clause should be more accessible than the second clause. In other words, we should observe an Advantage of First Mention. This advantage would suggest that the substructure representing the first clause is serving as the foundation for the whole sentence-level representation.

We tested this prediction by measuring accessibility after we assumed that comprehenders had time to map the substructures representing the two clauses together. More specifically, we presented the test names 1400 milliseconds after the offset of the final words of their sentences.

We tested 96 subjects, whose data appear in the fifth and sixth bars of Figure 5. As Figure 5 illustrates, when accessibility was measured 1400 milliseconds after the end of each sentence we observed an Advantage of First Mention: First-mentioned participants were considerably more accessible than second-mentioned participants. This 60 millisecond Advantage of First Mention is the same magnitude as the advantage typically observed with simple sentences (e.g. those we described earlier in this chapter).

Let us review the three experiments we have just described: At our earliest test point, second-mentioned participants were more accessible; in other words, there was an Advantage of Clause Recency. According to the Structure Building Framework, comprehenders were still developing their substructures to represent the second clauses. When we measured accessibility 150 milliseconds later, the two sentence participants were equally accessible. According to the Structure Building Framework, comprehenders had built their substructures representing both clauses, but they had not begun mapping those substructures together. When we measured accessibility after 1400 milliseconds, we observed an Advantage of First Mention. According to the Structure Building Framework, comprehenders had finished mapping the two substructures together, and the first clause was more accessible because its substructure serves as the foundation for the whole sentence-level representation.

These results support the Structure Building Framework's assumptions about how comprehenders build mental structures to represent clauses: Comprehenders represent each clause of a two-clause sentence in its own substructure. Comprehenders have greatest access to information in the substructure that they are currently developing (i.e., the most recent clause). But at some point, the first clause becomes more accessible because the substructure representing the first clause of a two-clause sentence serves as a foundation for the whole sentence-level representation.

In another experiment, the test names appeared 2000 milliseconds after the offset of their sentences' final words. We tested 120 subjects, whose data appear in the two right-most bars of Figure 5. As Figure 5 illustrates, when accessibility was measured 2000 milliseconds after the end of each sentence, there was still an Advantage of First Mention. That is, first-mentioned participants were still considerably more accessible than second-mentioned participants.

So, two seconds after comprehenders finish reading a two-clause sentence, participants from the first clause are still more accessible than participants from the second clause. In fact, the Advantage of First Mention is even greater 2000 milliseconds after the sentences than it is 1400 milliseconds afterward. The Advantage of First Mention is a relatively long-lived characteristic of the representation of a sentence. In contrast, the Advantage of Clause Recency is relatively short-lived. It is observed only when we measure accessibility immediately after comprehenders finish reading the second clause.

Can the Advantage of First Mentioned and the Advantage of Clause Recency co-occur?

According to the Structure Building Framework, the Advantage of First Mention arises because first-mentioned participants form the foundations for their sentence-level structures, and through them subsequent information is mapped onto the developing structure. The Advantage of Clause Recency arises because comprehenders build a substructure to represent each clause of a two-clause sentence, and they have greatest access to information represented in the substructure that they are currently developing.

Thus, when comprehension is viewed as structure building, these two seemingly contradictory phenomena — the Advantage of First Mention and the Advantage of Clause Recency — are not mutually exclusive. In fact,

according to the Structure Building Framework, the two phenomena can occur simultaneously. We demonstrated this in a fifth experiment.

In this experiment, we measured the accessibility of each of four participants, for instance, *Tina, Lisa, Ann*, and *Pam* in

(15) *Tina and Lisa gathered the kindling, and Ann and Pam set up the tent.*

As in sentence (15), two participants were the joined subjects of the first clause (e.g. *Tina* and *Lisa*), and two participants were the joined subjects of the second clause (e.g. *Ann* and *Pam*). In other words, two participants were the first- and second-mentioned participants of the first clause, and two participants were the first- and second-mentioned participants of the second clause.

According to the Structure Building Framework, within both clauses we should observe an Advantage of First Mention: That is, the participants mentioned first in each clause should be more accessible than the participants mentioned second. This is because the participants mentioned first in each clause should form the foundation for their clause-level substructure.

In addition, according to the Structure Building Framework, if we catch comprehenders at the point where they are just finishing building their representations of the second clause, we should also observe an Advantage of Clause Recency: Both participants from the second clause should be more accessible than both participants from the first clause. This is because each clause of a two-clause sentence should be represented in its own substructure, and information should be most accessible from the substructure that comprehenders are currently developing.

To test these predictions, we constructed 32 sentence sets; an example appears in Table 5. Each sentence set resulted from manipulating (a) whether the test name was the clause's first- versus second-mentioned participant, and (b) whether the test name was from the first versus second clause.

The verb phrases for the sentence sets were drawn from the pool of verbs used in the previous four experiments. All verbs were in the simple past tense, and all sentences comprised two main clauses joined with *and*. We tested 80 subjects, whose average reaction times to the test names appear in Figure 6. As Figure 6 illustrates, we observed an Advantage of First Mention: For both clauses, the first-mentioned participants were considerably more accessible than the second-mentioned participants. As Fig-

Table 5

First clause

> *Tina and Lisa gathered the kindling, and Ann and Pam set up the tent.*
> *Lisa and Tina gathered the kindling, and Pam and Ann set up the tent.*

Second Clause

> *Ann and Pam set up the tent, and Tina and Lisa gathered the kindling.*
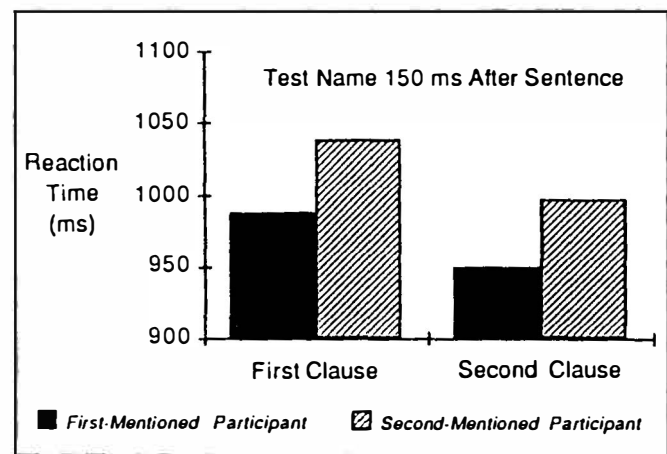> *Pam and Ann set up the tent, and Lisa and Tina gathered the kindling.*

Figure 6. (From Gernsbacher, Hargreaves and Beeman 1989)

ure 6 also illustrates, we observed an Advantage of Clause Recency: Partic-ipants from the second clause were more accessible than participants from the first clause. No other effects were reliable, including the interaction between the Advantage of First Mention and the Advantage of Clause Recency.

So, this experiment — like the first experiment of this series — demonstrated that immediately after a two-clause sentence, the most recently read clause is more accessible than an earlier clause. According to the Structure Building Framework, this is because each clause of a two-

clause sentence is represented in its own substructure, and comprehenders have greatest access to information represented in the substructure that they are currently developing.

This experiment also demonstrated that when two participants are mentioned in the same clause, the first-mentioned participant is more accessible. According to the Structure Building Framework, this is because the first participant in each clause forms the foundation for its clause-level substructure.

The Advantage of First Mention and the Advantage of Clause Recency can occur simultaneously. However, according to the Structure Building Framework, the Advantage of First Mention is a relatively long-lived characteristic of a sentence or clause, whereas the Advantage of Clause Recency is observed only when accessibility is measured immediately after comprehension of the most recent clause. Therefore, if we again presented two-clause sentences that mentioned two participants in each clause, but we measured accessibility a little later, we should no longer observe an Advantage of Clause Recency; instead, we should observe only an Advantage of First Mention. We tested this prediction in our sixth and final experiment.

This last experiment was identical to the experiment just described except that all test names appeared 2000 milliseconds after the offset of their sentences' final words. We tested 80 subjects, whose data appear in Figure 7. As Figure 7 illustrates, with two-clause sentences that mentioned
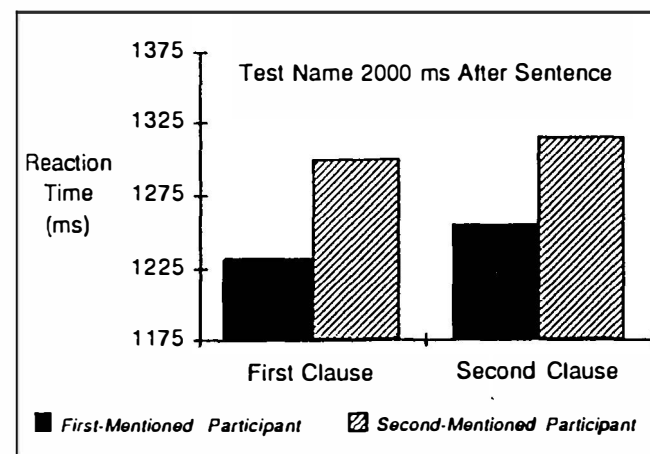

Figure 7. (From Gernsbacher, Hargreaves and Beeman 1989)

two participants in each clause, we again observed an Advantage of First Mention: For both clauses, first-mentioned participants were considerably more accessible than second-mentioned participants.

However, as Figure 7 also illustrates, when accessibility was measured 2000 milliseconds after the end of each sentence, as opposed to 150 milliseconds after, we no longer observed an Advantage of Clause Recency. In contrast to our fifth experiment in which the second-clause participants were considerably more accessible than the first-clause participants, in this last experiment the second-clause participants were slightly less accessible than the first-clause participants.

These experiments support the following assumptions made by the Structure Building Framework: Comprehenders represent each clause of a multi-clause sentence in its own substructure. Comprehenders have greatest access to information represented in the substructure that they are currently developing; that is, they have greatest access to the most recent clause. However, at some point the first clause becomes more accessible than later clauses because the substructure representing the first clause of a two-clause sentence serves as a foundation for the whole sentence-level representation.

Do comprehenders build hierarchical structures?

To observe the Advantage of First Mention simultaneously with the Advantage of Clause Recency, we capitalized on intra-clause versus inter-clause relations. We observed the Advantage of First Mention at one level — within a clause — and the Advantage of Clause Recency at another level — between two clauses.

Comprehenders' mental structures and substructures must capture these hierarchical relations. Clauses are represented in their own substructures, and sentences, comprising those clauses, are represented in larger substructures. Consider the four participants in sentence (17):

(17)   *Tina and Lisa gathered the kindling, and Ann and Pam set up the tent.*

Because *Tina* and *Lisa* are members of the first clause, they are represented in one substructure, while *Ann* and *Pam*, the members of the second clause, are represented in another substructure. If the four participants were remembered as only four names in an unstructured list, then Figure 6

should resemble a typical serial position curve. The first bar should be short (manifesting the primacy component of the curve); the second bar should be somewhat longer; the third bar might be equally long as the second or perhaps slightly longer, and the fourth bar should be short, perhaps even the shortest (manifesting the recency component).

But instead, the first bar is shorter than the second bar (manifesting the Advantage of First Mention in the first clause), and the third bar is shorter than the fourth bar (manifesting the Advantage of First Mention in the second clause). Furthermore, the third and fourth bars are shorter than the first and second bars (manifesting the Advantage of Clause Recency).

Comparing Figures 6 and 7, we see that the third and fourth bars change almost as a unit. Both bars become taller with the increased test delay; however, the relationship between the third and fourth bar is maintained. Again, this is not the pattern expected if the four participants are remembered only as four names in an unstructured list. If that were the case, Figure 7 should resemble a serial position curve with only the primacy component: The first bar should be the shortest, and the remaining bars but should be progressively longer. Instead, the third bar is shorter than the fourth bar, just as the first bar is shorter than the second bar. This pattern occurs because the first participant of each clause forms the foundation for its clause-level representation.

In what sense does the first-mentioned participant form a foundation? It is in the sense that a first-born child, a first trip to Europe, or a first romance earns a special status. All other children, trips to Europe, or romances are interpreted with reference to the initial one. So, by definition, later-occurring sentence participants must be understood with reference to the first-mentioned participant. *Lisa* accompanied *Tina* in gathering the kindling, and *Pam* accompanied *Ann* in setting up the tent. First-mentioned participants are not more important; they simply come first, and their precedence affects the subsequent representation.

The same privilege by precedence occurs with clauses — particularly clauses of equal status, like the ones we examined in our experiments. Knowledge that *Ann and Pam set up the tent* is added to the knowledge that *Tina and Lisa gathered the kindling*. Again, the first clauses are not more important; they simply come first, and their precedence affects the subsequent representation.

Primacy effects in sentence production

We have suggested that in language comprehension the privilege of primacy arises from general cognitive processes, those involved in structure building. Mental structures are built sequentially: First, foundations are laid. Because foundations can be based only on the information that comprehenders initially receive, initialized concepts must serve as the foundation for their sentence-level structures. Then, after a foundation is laid, subsequent information is mapped onto that foundation; therefore, first-mentioned concepts achieve even more accessibility because it is through them that subsequent information — including information about later-mentioned concepts — is attached to the developing structure.

Language production also involves sequencing. Speakers must confront what Levelt (1981) calls the *linearization problem*: They must decide "what to say first, what to say next, and so on" (p. 305). In other words, speakers face "the problem of mapping nonlinear meanings onto a highly constrained linear medium" (Bates and MacWhinney, 1989: 8). In this last section, we consider how speakers' placement of lexical items in initial position reflects their cognitive processes.

The demands of real time discourse constrain the ordering of elements in a message. For efficient, fluent production, those parts of the message that occur to the speaker first — for whatever reason — are most likely to be placed first in the sentence (Kempen and Hoenkamp 1987; Levelt 1989). However, the tendency to place more accessible items first is constrained by language-specific grammatical structures (Bates and Devescovi 1989; MacWhinney and Bates 1978). So, placement via accessibility competes with morphosyntactic constraints (Bates and MacWhinney 1989). In short, we would expect "free" word order languages to manifest placement via accessibility more transparently than other languages.

Several factors make lexical items more accessible. Experiments with English speakers demonstrate that perceptually salient, animate, and definite concepts are likely to be mentioned first (Clark and Chase 1974; Costerman and Hupet 1977; Grieve and Wales 1973; Harris 1978; Hupet and LeBoudec 1975; Johnson-Laird 1968a; Johnson-Laird 1968b; Turner and Rommetveit 1967); see reviews by Anisfeld and Klenbort (1973), Bock (1982) and MacWhinney (1977).

Experiments with English speakers also demonstrate that concepts that are explicitly cued or implicitly presupposed are also likely to be mentioned

first (Bock 1977; Bock and Irwin 1980; Carroll 1958; Englekamp and Zimmer 1982; Klenbort and Anisfeld 1974; MacWhinney and Bates 1978; Olson and Filby 1972; Prentice 1966; Prentice 1967; Singer 1976; Tannenbaum and Williams 1968; Turner and Rommetveit 1967; Turner and Rommetveit 1968); see reviews by Bates and MacWhinney (1982) and Bock (1982).

What about other languages? Unfortunately, cross-linguistic studies of sentence production are rare. One exception is Sridhar's (1988) study of ten diverse languages (Cantonese, American English, Finnish, Modern Israeli Hebrew, Hungarian, Slovenian, Mexican Spanish, Japanese, Turkish, and Kannada). Across these diverse languages, Sridhar observed reliable preferences for initialization.

When describing scenes, Sridhar's subjects commonly mentioned figures before grounds, and they mentioned near objects before far objects. When describing events, they mentioned sources before goals, and they preserved the chronological order of events. Other things being equal, speakers mentioned humans before animates and animates before inanimates.

Cross-linguistic text studies (as demonstrated by this volume) have analyzed a variety of "free" and "fixed" word orders. These studies demonstrate the discourse factors that favors first mention; that is, important, focused or newsworthy participants are mentioned first (Givón 1989; Mithun this volume). Important, focused or newsworthy items are likely to be more accessible in speakers' mental representations; therefore, they are likely to be mentioned first. Similarly, their discourse status is also likely to make them suitable foundations for comprehenders' mental representations. In the name of parsimony, we suggest that the privilege of primacy observed in language production, like the privilege of primacy observed in language comprehension, derives from general cognitive processes and the demands of sequential ordering.

What about pragmatic motivations?

We have suggested that general cognitive processes in both comprehension and production contribute to a privileged status for first-mentioned concepts. It is not surprsing then that cross-linguistic text studies demonstrate that speakers tend to initialize concepts that are important, focused or newsworthy. Nevertheless, we find it important to distinguish between the

general cognitive processes involved in production and comprehension and the pragmatic processes that are associated with word order.

Cooperative speakers presumably have a discourse model of what they think will be communicatively effective and contextually relevant for the listener (Clark and Wilkes-Gibbs 1986). This model could include the knowledge that initial position serves as the basis for comprehenders' mental structures. If speakers have this knowledge, they might intentionally exploit first mention to aid listeners in their structure building.

In addition, cooperative listeners presumably have a discourse model of what they think the speaker intends to communicate (Sperber and Wilson 1986). This model could include the knowledge that initial position reflects those items that are perceptually prominent or contextually salient to the speaker. If so, listeners might interpret initialization as an indicator of the speakers' viewpoint or intent.

Furthermore, in conversation, the role of the participants as speakers and listeners is negotiated via the turn-taking system (Sachs, Schegloff and Jefferson 1974). Thus, the turn-taking system might motivate speakers to initialize items in certain contexts (Duranti and Ochs 1979). Conversely, turn-taking allocation might constrain when and where items may be initialized (Ford 1988). In short, interactional features may also play a role in determining how speakers exploit first position in the clause.

The distinction we want to make is between an account of primacy effects in terms of general cognitive processes (like structure building) and an account of word order pragmatics in terms of discourse motivations and communicative goals. We are not in a position to describe how the complex inferential and intentional processes in discourse (what we would call pragmatics) interact with a general cognitive process like structure building. Indeed, the attribution and characterization of intentional processes is subject to intense debate in philosophy and cognitive science (Brand 1984; Dennett 1987; Fodor 1987; Stich 1983). However, we do suggest that when word order is exploited for communicative purposes, it is the general cognitive processes involved in production and comprehension that mediate the desired effects.

Notes

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2. To encourage our subjects to attend to all aspects of the sentences (not just the participants' names), we followed each experimental sentence with a two-alternative question. A third of the questions asked about the setting of the action, for example, *When did Tina beat Lisa?* or *When did Lisa beat Tina?* Another third asked about the action the participants engaged in, for example, *What did Tina do?* or *What did Lisa do?*. And the final third asked about the identity of the agents or patients, for example, *Who did Tina beat?* or *Who did Lisa beat?*

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