Building and Accessing Clausal Representations: The Advantage of First Mention versus the Advantage of Clause Recency

MORTON ANN GERNSBACHER, DAVID J. HARGREAVES, AND MARK BEEMAN

University of Oregon

We investigated two seemingly contradictory phenomena: the Advantage of the First-Mentioned Participant (participants mentioned first in a sentence are more accessible than participants mentioned second) and the Advantage of the Most Recent Clause (concepts mentioned in the most recent clause are more accessible than concepts mentioned in an earlier clause). We resolved this contradiction by measuring how quickly comprehenders accessed participants mentioned in the first versus second clauses of two-clause sentences. Our data supported the following hypotheses: Comprehenders represent each clause of a two-clause sentence in its own mental substructure. Comprehenders have greatest access to information 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 because the substructure representing the first clause of a two-clause sentence serves as a foundation for the whole sentence-level representation. © 1989 Academic Press, Inc.

What cognitive processes are involved in language comprehension? And what are the mental representations like that comprehenders create during comprehension? As an initial step in understanding these processes and representations, we envision language comprehension as structure building, and we suggest that some of the cognitive processes involved in comprehension can be described by a very simple framework that we call the *structure building framework* (Gernsbacher, 1985; in press

(a), (b); Gernsbacher & Hargreaves, 1988, in press).

According to the structure building framework, the goal of comprehension is to build a coherent, mental representation or "structure" of the information being comprehended. To build these structures, several component processes are involved. First, comprehenders must lay a foundation for their mental structures. Next, comprehenders must develop their mental structures by mapping on information when that incoming information coheres with the previous information. However, if the incoming information is less continuous, comprehenders employ a different process: They shift and initiate a new substructure. For this reason, most representations comprise several branching substructures.

In this paper, we suggest how the structure building framework can resolve two seemingly contradictory phenomena. Both phenomena provide insights to the processes involved in language comprehension and the structure of comprehenders' mental representations.

The first phenomenon is what we call the *advantage of the first-mentioned participant*. The advantage is this: After compre-

hending a sentence involving two participants, the participant mentioned first in the sentence is considerably easier to access than the participant mentioned second. For instance, after hearing or reading the sentence.

(1) Tina beat Lisa in the state tennis match.

comprehenders verify that *Tina* was in the sentence considerably faster than they do after hearing or reading

(2) Lisa beat Tina in the state tennis match.

So, the first-mentioned participant (*Tina*) is more easily accessed from comprehenders' mental representations, and that is what we mean by the advantage of the first-mentioned participant.

The advantage of the first-mentioned participant has been observed numerous times by different researchers (Chang, 1980; Corbett & Chang, 1983; Gernsbacher, in press (a); Gernsbacher & Hargreaves, 1988; Stevenson, 1986; Von Eckardt & Potter, 1985). The advantage does not depend on some strategy that subjects might employ when they think that they only have to remember the names of sentence participants as the advantage occurs even when filler trials test subjects' memory for words that are not participants' names.

One explanation of the advantage of the first-mentioned participant arises from the structure building framework: Perhaps first-mentioned participants are more accessible both because they form the foundations for their sentence-level structures, and because it is through them that subsequent information is mapped onto the developing structure.

Other comprehension phenomena support this assumption. For instance, a large body of converging data suggests that comprehension slows down when comprehenders are presumably laying their mental foundations for mental structures. More specifically, the initial word of a sentence

takes longer to read than other words in that sentence except the final word (Aaronson & Ferres, 1983; Aaronson & Scarborough, 1976; Chang, 1980).[1] In fact, the same word is read more slowly when it occurs at the beginning of its sentence or phrase than when it occurs later (Aaronson & Scarborough, 1976).

During spoken language comprehension, phonemes and words are identified more slowly when they occur at the beginning of their sentences or phrases than when they occur later (Cairns & Kamerman, 1975; Cutler & Foss, 1977; Foss, 1969; 1982; Hakes, 1971; Marslen-Wilson, Tyler, & Seidenberg, 1978; Shields, McHugh, & Martin, 1974).

The first open class word of a sentence elicits a larger N400 than later occurring words (Kutas, Van Petten, & Besson, 1988).[2] The N400 is the negative component of the event-related brain wave that occurs about 400 ms after the stimulus. The N400 is associated with difficulty in processing; for instance, low frequency words and words with a low cloze probability also elicit large N400s.

So the reading-time data, the event-related brain wave data, and the phoneme- or word-monitoring data display the pattern expected if comprehenders use initial words to lay a foundation for their mental structures representing larger units, such as phrases, clauses, and sentences. But— importantly—this pattern is not displayed

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[1] Initial words are not always read most slowly when subjects are required to recall (as opposed to freely read) the stimulus sentences. Neither are they read most slowly when subjects must perform a second task immediately after they finish reading each sentence (e.g., answer a question or press a key to signal congruence or anomaly). In preparation of this second task, subjects often delay reading the last words of the sentences causing those last words to manifest extremely long reading times. Furthermore, initial words are more likely to be content words than function words.

[2] Open class words are nouns, verbs, most adjectives, and *ly* adverbs.

in any of these data when the stimuli do not lend themselves to coherent mental structures—for example, when the sentences are scrambled, self-embedded, or extensively right branching (Foss & Lynch, 1969; Hakes & Foss, 1970; Van Petten & Kutas, 1988).

Furthermore, the first word of a sentence, or a picture of the first word, provides a better cue for recalling the entire sentence than do later occurring words (Bock & Irwin, 1980; Prentice, 1967; Turner & Rommetveit, 1968). This finding suggests that the initial words of a sentence serve as a foundation onto which subsequent information is added.

So, the advantage of the first-mentioned participant might arise because first-mentioned participants form the foundations for their sentence-level representations, and because it is through them that subsequent information is mapped onto the developing representation. However, other explanations of the advantage of the first-mentioned participant draw on the linguistic structure of English. For example, first-mentioned participants might be more accessible because in English declarative sentences they are virtually always the syntactic relation known as "subjects," and they typically also fill the semantic role known as "agents."

In Gernsbacher and Hargreaves (1988), we tried to untangle these linguistic factors from a factor we called simply "order of mention." In these experiments, subjects read sentences such as

(3) Tina beat Lisa in the state tennis match.

Each sentence appeared word by word in the center of a computer screen. After the last word of each sentence disappeared, a test name appeared, and the subjects verified whether that name had occurred in the sentence they just finished reading.

Our first experiment and its replication demonstrated that the advantage of the first-mentioned participant does not depend

on semantic agency. That is, the participant *Tina* is just as accessible when she is the semantic agent, as in sentence (3) above, as when she is the semantic patient, as in

(4) Tina was beaten by Lisa in the state tennis match.

The crucial issue is whether *Tina* is mentioned first, as she is in sentences (3) and (4), or whether *Tina* is mentioned second, as she is in

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

(6) Lisa was beaten by Tina in the state tennis match.

Our third experiment and its replication investigated whether the advantage of the first-mentioned participant depends on the first-mentioned participants being literally the initial words of their stimulus sentences. If so, our laboratory task might be somewhat to blame as the first word of each sentence is typically preceded by an attention-getting warning signal, which is itself preceded by a brief blank period.

To investigate this, we manipulated whether an adverbial phrase like *two weeks ago* was preposed at the beginning of the sentence, as in

(7) Two weeks ago Tina mailed Lisa a box full of clothes.

Or it was postposed at the end of the sentence, as in

(8) Tina mailed Lisa a box full of clothes two weeks ago.

Or it did not occur at all, as in

(9) Tina mailed Lisa a box full of clothes.

The advantage of the first-mentioned participant maintains regardless of whether the first-mentioned participants are literally the initial words of their stimulus sentences. So, the advantage must depend on each participant's position relative to the other participants.

Our fifth, sixth, and seventh experiments

investigated whether the advantage of the first-mentioned participant is due to syntactic subjecthood. Of course, the typical sequence of events in a subject–verb–object language like English is that the first-mentioned participant is the syntactic subject. However, in our fifth experiment, the advantage of the first-mentioned participant was not attenuated even when the two participants shared subjecthood, as, for example, when both Tina and Lisa were the syntactic subjects, as in

(10) Tina and Lisa argued during the meeting.

as opposed to Tina being the sole subject, as in

(11) Tina argued with Lisa during the meeting.

In fact, in our sixth and seventh experiments, the advantage of the first-mentioned participant was not attenuated even when the first-mentioned participants were no longer their sentences' syntactic subjects, as in

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

We concluded that the advantage of the first-mentioned participant does not arise from any of the linguistic factors that we investigated. Instead we suggested that the advantage results from general cognitive processes that occur naturally during comprehension. These processes involve laying a foundation and mapping subsequent information onto that foundation.

However, the advantage of the first-mentioned participant seems to contradict a second well-known advantage—what we call the advantage of the most recent clause. The advantage is this: Immediately after subjects 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 & Townsend, 1978; Caplan, 1972; Chang, 1980; Flores d'Arcais, 1978; Jarvella, 1970, 1971, 1973, 1979; Jarvella & Herman, 1972;

Marslen-Wilson et al., 1978; von Eckardt & Potter, 1985).

For example, the word *oil* is more accessible immediately after the sentence,

(13) Now that artists are working fewer hours, oil prints are rare.

than it is immediately after the sentence,

(14) Now that artists are working in oil, prints are rare

(Caplan, 1972). Presumably this advantage arises because the word *oil* was in the most recent clause in sentence (13). So the advantage of the most recent clause is also caused by the order in which concepts are mentioned, but it is an advantage for the most recently or second-mentioned concept.

How can this discrepancy be resolved? Perhaps this second phenomenon is also attributable to structure building. According to the structure building framework, language comprehension often requires shifting to initiate a new substructure. Presumably 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 those that continue it. This finding suggests that such words and sentences trigger comprehenders to shift and begin laying the foundation for a new substructure (Anderson, Garrod, & Sanford, 1983; Black, Turner, & Bower, 1979; Daneman & Carpenter, 1983; Dee-Lucas, Just, Carpenter, & Daneman, 1982; Haberlandt, Berian, & Sandson, 1980; Lesgold, Roth, & Curtis, 1979; Lorch, Lorch, & Mitchell, 1985; Mandler & Goodman, 1982; Olson, Duffy, & Mack, 1980).

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. This finding

suggests that information presented before the change is represented in one substructure, while information presented after the change is represented in another (Anderson et al., 1983; Clements, 1979; Mandler & Goodman, 1982).

When building their representations of sentences, comprehenders presumably 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 (1973) seven parsing principles was that "the construction of a new node is signalled by the occurrence of a grammatical function word." So comprehenders might—as Clark and Clark (1977) suggested—use signals such as determiners and quantifiers to initiate a substructure representing a new noun phrase. And they might use subordinating and coordinating conjunctions as signals to initiate a substructure representing a new clause.

Thus, the structure building framework can account for two seemingly contradictory phenomena—the advantage of the first-mentioned participant and the advantage of the most recent clause. The framework accounts for these two phenomena by making the following assumptions: Comprehenders represent each clause of a multiclause sentence in its own substructure. Comprehenders have greatest access to the information that is represented in the substructure that they are currently developing, in other words, 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 multiclause sentence serves as a foundation for the whole sentence-level representation.

The experiments reported here tested these assumptions. In each experiment, we measured the accessibility of sentence participants in two-clause sentences, for example,

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

As in sentence (15), 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.

EXPERIMENT 1

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 their representations of the second clause. If we could capture that point, we expected to find an advantage of the most recent clause—in other words, an advantage for the second-mentioned participant. To capture that point, we presented the test names coincident with the last words in the sentences but at a different location on the computer screen. We supposed that by the time our subjects shifted their eyes and their attention (Posner, 1980) to the test names, our coincident presentation was comparable to an extremely short delay.

Method

Materials and design. We constructed 48 sentence sets. An example sentence set appears in Table 1. Each sentence set comprised six versions of a prototype sentence. The six versions resulted from factorially manipulating two variables: (1) whether the test name was the first- versus second-

TABLE 1
EXAMPLE SENTENCE SET FOR EXPERIMENTS 1 AND 2

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

mentioned participant (in other words, whether the test name was the subject of the first clause or the subject of the second clause) and (2) whether the test name was the subject of a main, a subordinate, or a coordinate clause.

Because each clause had to serve as a main, subordinate, and coordinate clause, the two clauses in our stimulus sentence sets had to be relatively equivalent along several dimensions. For example, the action in each clause 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 a list of verb phrase pairs whose actions were relatively equivalent subcomponents of a larger activity. Some examples are *sang a song* and *played the guitar*, *dusted the shelves* and *swept the floor*, and *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 & Thompson, 1984).

We verified our impressions that the members of each verb phrase pair were roughly equal in importance and were likely to occur simultaneously by asking a group of subjects (who did not participate in the actual experiment) to make two judgments: They judged which of the two verb phrases would occur first and which was more important. Only verb pairs that showed approximate symmetry along these two criteria—that is, only pairs for which no member was clearly judged as being more important or occurring first—were used in the experimental sentences.

Two common American first names, matched for gender, perceived familiarity, and relative length (in number of characters and syllables), were randomly assigned to each sentence set. Across all the experimental sentences, half the names were stereotypically female, and half were stereotypically male. But within each sentence, the two names were stereotypic of the same

gender. One name of each pair was randomly selected as the test name.

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 conjoined with *and.*

We constructed 48 lure sentences for "catch trials." The test names presented for these lure sentences had not occurred in their respective sentences, so the correct answer was "no." The lure sentences resembled the experimental sentences in syntactic structure: All comprised two clauses; 16 had initial subordinate clauses; 16 had final subordinate clauses; and in 16 the two clauses were conjoined with *and.* We also constructed 32 filler sentences whose test names were tested at random points throughout the sentence. Half of the filler test names had occurred in their sentences, and half had not.

To encourage comprehension and attention to all aspects of the sentences (not just the participants' names), each experimental sentence was followed by a two-alternative WH-question. Half the questions asked about one of the participants' action, for example, "What did Lisa do?" or "What did Tina do?" The other half asked about one of the participants' identity, for example, "Who gathered the kindling?" or "Who set up the tent?"

Six material sets were formed by randomly assigning one of the six versions of an experimental sentence set to each material set so that each material set contained eight experimental sentences in each experimental condition. The 48 experimental sentences were randomly intermixed with the 48 lure sentences and the 32 filler sentences. All 128 sentences appeared in the same order across the six material sets. Twenty subjects were randomly assigned to each material set so that each subject was

exposed to only one version of a sentence set.

Procedure. A trial began with a warning signal, which was a plus sign that appeared for 750 ms in the center of the screen. After that, each word of the sentence appeared in the center of the screen for 300 ms plus 16.667 ms per character. The interval between words in the sentence was 150 ms.[3]

All stimuli appeared as white letters on a green phosphor screen. The words of the sentences appeared in upper and lower case. A typical lower case letter extended approximately .5 cm and .5 to 1° of visual angle. A typical five-letter word extended approximately 3 cm and 3 to 6° of visual angle (the subjects were not constrained in their seats, so distance to the screen and visual angle varied). The test names appeared in all uppercase letters at the top of the screen, approximately 15 to 20° of visual angle away from where the words of the sentences appeared. The test names remained on the screen until the subjects pressed a key labelled either "yes" or "no," or until 3 s elapsed.

After each experimental sentence, the words *Test Question* appeared near the bottom of the screen for 750 ms. After that, a comprehension question appeared, and below it, two answer choices. One answer choice was positioned on the left side of the screen, and the other was positioned on the right. Subjects pressed the left response key to select the answer choice on the left side of the screen, or they pressed the right response key to select the answer choice on the right side of the screen. The correct answer choice appeared equally often on each side. The questions and answer choices remained on the screen until either the subjects responded or 10 s elapsed. After each question, the subjects were given accuracy feedback.

Subjects were told that their primary task was to read each sentence and answer its

comprehension question. They were also told that at some point during each sentence a name would appear in capital letters at the top of the screen and their task was to verify whether that name had occurred in the sentence they were currently reading. They were told to respond as quickly as they could without making many errors. Subjects practiced on 10 sentences before they began the experiment.

Subjects. One-hundred twenty undergraduates at the University of Oregon participated as one means of fulfilling a course requirement. As in all the experiments reported here, all subjects were native English speakers, and no subject participated in more than one experiment. Eight additional subjects were replaced because they failed to meet the following criteria: 90% accuracy at responding to "yes" test names, 90% accuracy at responding to "no" test names, and 75% accuracy at answering the two-choice comprehension questions. The 120 subjects whose data were analyzed answered, on the average, 85% of the comprehension questions correctly, and discriminated "yes" from "no" test names with an average d' of 3.47.

Results

The results are displayed in the two leftmost bars of Fig. 1. As shown in Fig. 1, when the test names were presented coincident with the last words of their sentences, the most recently read clause was most accessible. In other words, we observed an advantage of the most recent clause: Second-mentioned participants (M = 1118 ms, SE = 20 ms, 96% accuracy) were considerably more accessible than first-mentioned participants (M = 1065 ms, SE = 19 ms, 93% accuracy), $minF'(1,108)$ = 12.98, $p < .0005$.[4] This 60 ms difference

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[3] This presentation rate leads to reading times slower than typical for this subject population.

[4] We report subjects' average accuracy at responding "yes" to the experimental test names; however, because we screened subjects by this criterion, and therefore artificially truncated these data, we did not statistically analyze them.
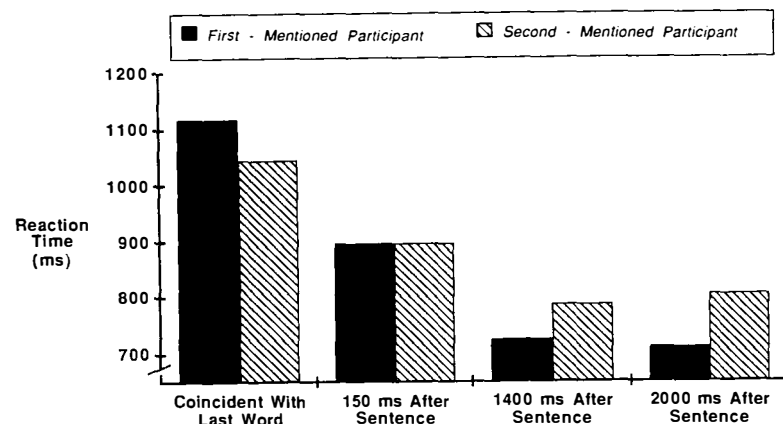
FIG. 1. Subjects' mean correct response times in Experiments 1, 2, 3, and 4.

is similar in magnitude to the advantage of the most recent clause observed by others (e.g., Caplan, 1972). No other main effects or interactions were reliable (all $minF$'s < 1).

EXPERIMENT 2

Our first experiment demonstrated that 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 each clause is represented in its own substructure, and comprehenders have greatest access to information represented in the substructure that they are currently developing.

But according to the structure building framework, after comprehenders represent the second clause of a two-clause sentence, they must map that second-clause representation onto their first-clause representation. In other words, to fully represent a two-clause sentence, one must incorporate the two substructures.

The goal in our second 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 in Experiment 2, we presented the test names 150 ms after the offset of the final words of their sentences.

Method

Experiment 2 was identical to Experiment 1 except that all test names appeared 150 ms after the offset of their sentences' final words, and there were no filler sentences. Data from 120 subjects were analyzed. Six additional subjects were replaced for failing to meet the criteria described in Experiment 1. The 120 subjects whose data were analyzed answered, on the average, 86% of the comprehension questions correctly, and discriminated "yes" from "no" test names with an average d' of 3.54.

Results

The results are displayed in the third and fourth bars of Fig. 1. As illustrated in Fig. 1, when accessibility was measured 150 ms after the sentences, the two clauses were equally accessible. That is, first-mentioned participants ($M = 897$, $SE = 16$, 94%) were

just as accessible as second-mentioned participants ($M = 897$, $SE = 16$, 94%), both Fs = 0.0.[5] No other effects were reliable (all ps > .05).

EXPERIMENT 3

Our second experiment demonstrated that at some point during the comprehension of a two-clause sentence, the two clauses are equally accessible. This finding further supports the structure building framework's assumption that each clause is represented in its own substructure. But according to the structure building framework, to fully represent a two-clause sentence, one must incorporate the two substructures. So if we measured accessibility a little bit later—say, a little more than a second later—no longer should both substructures 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 the first-mentioned participant. 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 assumption in our third experiment by measuring accessibility after we assumed that comprehenders had time to map the substructures representing the two clauses together.

Methods

Materials. We constructed 64 sentence sets. Each sentence set comprised eight versions of a prototype sentence. The eight versions resulted from factorially manipulating three factors: (1) whether the test name was the first- or second-mentioned participant (in other words, whether the test name was the subject of the first or second clause), (2) whether the test name

was the subject of a main or subordinate clause, and (3) whether the verbs in the two clauses shared their tense or differed in tense. An example sentence set appears in Table 2.

When the verbs shared their tense, they were both in the simple past tense, as in Experiments 1 and 2. When the verbs differed in tense, one verb remained in the past tense while the other was changed to either the past perfect (for sentences assigned the subordinators *after* and *before*) or the past progressive (for sentences assigned the subordinators *while* and *as*).

We constructed 64 lure sentences for "catch trials." The test names presented for these lure sentences had not occurred in their respective sentences; so the correct answer was "no." The lure sentences resembled the experimental sentences in syntactic form. An equal number resembled each of the eight experimental combinations. Each experimental sentence was followed by a two-alternative WH-question.

Eight material sets were formed by randomly assigning one of the eight versions of each sentence set to each material set, such that each material set contained eight sentences of each condition. The 64 experimental sentences were randomly intermixed with the 64 lure sentences (there were no filler sentences). All 128 sentences appeared in the same order across the eight material sets. Sixteen subjects were randomly assigned to each material set so that each subject read only one version of a sentence set.

Procedure. The procedure was identical to the procedure followed in Experiment 2 except that 250 ms after the offset of the last word in each sentence, the words *Test Name* appeared. This warning signal remained on the screen for 750 ms. Then, 400 ms after it disappeared, the test name appeared. So, in Experiment 3, each test name appeared 1400 ms after the offset of the last word of its sentence.

Subjects. Ninety-six undergraduates at the University of Oregon participated as

[5] Before prematurely accepting the null hypothesis we conducted a replication experiment ($N = 128$). We observed the same results.

TABLE 2
EXAMPLE SENTENCE SETS FOR EXPERIMENT 3

Shared tense
John sang a song as Dave played the guitar.
As Dave played the guitar, John sang a song.
As John sang a song, Dave played the guitar.
Dave played the guitar as John sang a song.

Different Tense
John sang a song as Dave was playing the guitar.
As Dave was playing the guitar, John sang a song.
As John was singing a song, Dave played the guitar.
Dave played the guitar as John was singing a song.

Shared tense
Rob sorted the change while Ted counted the bills.
While Ted counted the bills, Rob sorted the change.
While Rob sorted the change, Ted counted the bills.
Ted counted the bills while Rob sorted the change.

Different tense
Rob sorted the change while Ted was counting the bills.
While Ted was counting the bills, Rob sorted the change.
While Rob was sorting the change, Ted counted the bills.
Ted counted the bills while Rob was sorting the change.

Shared tense
Joan selected the wine after Kate ordered the food.
After Kate ordered the food, Joan selected the wine.
After Joan selected the wine, Kate ordered the food.
Kate ordered the food after Joan selected the wine.

Different tense
Joan selected the wine after Kate had ordered the food.
After Kate had ordered the food, Joan selected the wine.
After Joan had selected the wine, Kate ordered the food.
Kate ordered the food after Joan had selected the wine.

Shared tense
Ann took a shower before Pam fixed breakfast.
Before Pam fixed breakfast, Ann took a shower.
Before Ann took a shower, Pam fixed breakfast.
Pam fixed breakfast before Ann took a shower.

Different tense
Ann had already taken a shower before Pam fixed breakfast.
Before Pam fixed breakfast, Ann had already taken a shower.

TABLE 2—*Continued*

Different tense
Before Ann took a shower, Pam had already fixed breakfast.
Pam had already fixed breakfast before Ann took a shower.

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one means of fulfilling a course requirement. Six additional subjects were replaced for failing to meet the criteria described in Experiment 1. The 96 subjects whose data were analyzed answered, on the average, 89% of the comprehension questions correctly, and discriminated "yes" from "no" test names with an average d' of 3.9.

Results

The results are displayed in the fifth and sixth bars of Fig. 1. As illustrated in Fig. 1, when accessibility was measured 1400 ms after the end of each sentence, the first clause was more accessible. That is, we observed an advantage of the first-mentioned participant: First-mentioned participants ($M = 726$, $SE = 17$, 96%) were significantly more accessible than second-mentioned participants ($M = 788$, $SE = 18$, 94%), $minF'(1,153) = 17.52$, $p < .0001$. This 60 ms advantage of the first-mentioned participant is similar in magnitude to the advantage typically observed with simple sentences (e.g., Gemsbacher & Hargreaves, 1988). No other effects were reliable (all other $minF$'s < 1).

EXPERIMENT 4

To review our first three experiments: At our earliest test point (in Experiment 1), second-mentioned participants were more accessible; in other words, there was an advantage of the most recent clause. We suggest that at that point, comprehenders were still developing their substructures to represent the second clauses. When we measured accessibility 150 ms later (in Experiment 2), the two sentence participants were equally accessible. We suggest that at that point, comprehenders had built their sub-

structures representing both clauses, but they had not begun mapping those substructures together. When we measured accessibility after 1400 ms (in Experiment 3), we observed an advantage of the first-mentioned participant. We suggest that at that point, 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 representations of clauses. In particular, these results suggest that 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.

However, an alternative explanation of these first three experiments is that we observed changes in accessibility over time simply because we caught subjects at different stages in their cycles of rehearsing the two participants' names (e.g., "Tina . . . Lisa . . . Tina . . . Lisa"). To rule out this explanation, we conducted a fourth experiment in which we delayed the test point even longer for a total of 2000 ms.

Methods

Experiment 4 was identical to Experiment 2 except that all test names appeared 2000 ms after the offset of their sentences' final words. More specifically, 250 ms after the offset of the last word in each sentence, the words *Test Name* appeared for 1250 ms. Then, 500 ms later, the test name appeared. One-hundred twenty subjects participated. Seven additional subjects were replaced for failing to meet the criteria

described in Experiment 1. The 120 subjects whose data were analyzed answered, on the average, 86% of the comprehension questions correctly, and discriminated "yes" from "no" test names with an average d' of 3.9.

Results

The results are displayed in the two leftmost bars of Fig. 1. As shown in Fig. 1, when accessibility was measured 2000 ms after the end of each sentence, there was still an advantage of the first-mentioned participant. That is, first-mentioned participants ($M = 712$, $SE = 14$, 96%) were still significantly more accessible than second-mentioned participants ($M = 806$, $SE = 15$, 93%), $minF'(1,155) = 65.98$, $p < .00001$. No other effects were reliable (all other $minF$s < 1).[6]

EXPERIMENT 5

Our fourth experiment demonstrated that 2 s 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 the first-mentioned participant is even greater 2000 ms after the sentences than it is 1400 ms afterward. Thus, the advantage of the first-mentioned participant must be a relatively long-lived

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[6] As illustrated in Fig. 1, subjects responded progressively faster as we delayed the test point. Most likely this reflects how much processing comprehenders had to conclude before they could respond to the test name. Recall that with the coincident presentation, the test word appeared coincident with the last word of the sentence. Therefore, subjects had to first finish reading the last word of the sentence before they could respond to the test name. Because reaction times were measured from the *onset* of the last word in the sentence (which was also the onset of the test name), we assume that reaction times include the time required to finish reading the sentence. In contrast, when the test names were presented 1400 or 2000 ms after the *offset* of the last word of the sentence (and reaction times were measured from that point), we assume that subjects had ample time to finish reading the sentence; therefore, reaction times were faster.

characteristic of the representation of a sentence. According to the structure building framework, the advantage of the first-mentioned participant arises because first-mentioned participants form the foundations for their sentence-level structures, and through them subsequent information is mapped onto the developing structure.

In contrast, the advantage of the most recent clause appears to be relatively short-lived. It is observed only when we measure accessibility immediately after comprehenders finish reading the second clause. According to the structure building framework, the advantage of the most recent clause 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.

So, when comprehension is viewed as structure building, these two seemingly contradictory phenomena—the advantage of the first-mentioned participant and the advantage of the most recent clause—are not mutually exclusive. In fact, according to the structure building framework, it should be possible to observe both phenomena simultaneously. That was the goal in our fifth experiment.

In this fifth experiment, we measured the accessibility of each of four participants, for instance, *Dave, Rick, John,* and *Bill* in

(16) Dave and Rick gathered the kindling, and John and Bill set up the tent.

As in sentence (16), two participants were the conjoined subjects of the first clause (e.g., *Dave* and *Rick*), and two participants were the conjoined subjects of the second clause (e.g., *John* and *Bill*). 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 the first-mentioned participant: That is, within each clause, the first-mentioned participants should be more accessible than the second-mentioned participants. This is because the first of the two participants mentioned 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 the most recent clause: That is, 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.

Methods

Materials. We constructed 32 sentence sets. Each sentence set comprised four versions of a prototype sentence. The four versions resulted from factorially manipulating two factors: (1) whether the test name was the clause's first- versus second-mentioned participant, and (2) whether the test name was from the first versus second clause. An example sentence set appears in Table 3.

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 conjoined with *and*.

We constructed 32 lure sentences for "catch trials." The test names presented for these lure sentences had not occurred in their respective sentences, so the correct answer was "no." The lure sentences resembled the experimental sentences in syntactic structure. Each experimental sentence was followed by a two-alternative WH-question. Half asked about the action performed by the two sentence participants in one clause (e.g., "What did Dave and Rick do?" or "What did John and Bill do?"), and half asked about the identity of two of the participants (e.g., "Who gathered the kindling?" or "Who set up the tent?").

Four material sets were formed by randomly assigning one of the four versions of each sentence set to a material set. This way, each prototype sentence occurred in all of its four versions across material sets, but it occurred in only one version within each material set. The 32 experimental sentences were randomly intermixed with the 32 lure sentences. All 64 sentences appeared in the same order across the four material sets. Twenty subjects were randomly assigned to each material set so that each subject read only one version of a sentence set.

Procedure. The procedure was identical to the procedure followed in Experiment 2 except that in order to present the more complex sentences of Experiment 5 at a slower rate, each word was presented for 400 ms (instead of 300 ms) plus 16.667 per character. Other than that change, all other timing was identical to Experiment 2, including the fact that all test names appeared 150 ms after the offset of the final word in each sentence.

Subjects. Eighty undergraduates at the University of Oregon participated as one means of fulfilling a course requirement. Because the sentences in Experiment 5 were more complex than those of Experiments 1 through 4, we lowered one crite-

rion for replacing subjects from 90% accuracy at responding to experimental ("yes") and lure ("no") test names to 85% accuracy. Subjects still had to achieve 75% accuracy at answering the two-choice comprehension questions. Six subjects were replaced. The 80 subjects whose data were analyzed answered, on the average, 85% of the comprehension questions correctly and discriminated "yes" versus "no" test names with an average d' of 2.8.

Results

The results are displayed in Fig. 2. As illustrated in Fig. 2, we observed an advantage of the first-mentioned participant: For both clauses, the first-mentioned participants ($M = 968$, $SE = 18$, 93%) were significantly more accessible than the second-mentioned participants ($M = 1018$, $SE = 17$, 90%), $minF'(1,89) = 13.49$, $p < .0005$. As also illustrated in Fig. 2, we observed an advantage of the most recent clause: Participants from the second clause ($M = 972$, $SE = 17$, 93%) were significantly more accessible than participants from the first clause ($M = 1012$, $SE = 18$, 91%), $minF'(1,78) = 5.94$, $p < .02$. No other effects were reliable, including the interaction between the advantage of the first-mentioned participant and the advantage of the most recent clause (all other F's < 1).

EXPERIMENT 6

Our fifth experiment, like our first experiment, demonstrated that immediately after a two-clause sentence, the most recently read clause is more accessible than an earlier clause. This finding again supports the structure building framework's assumptions that 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.

Our fifth experiment also demonstrated that when two participants are mentioned in the same clause, the first-mentioned par-

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TABLE 3
EXAMPLE SENTENCE SET FOR EXPERIMENT 5

Dave and Rick gathered the kindling, and John and Bill set up the tent.
Rick and Dave gathered the kindling, and Bill and John set up the tent.
John and Bill set up the tent, and Dave and Rick gathered the kindling.
Bill and John set up the tent, and Rick and Dave gathered the kindling.
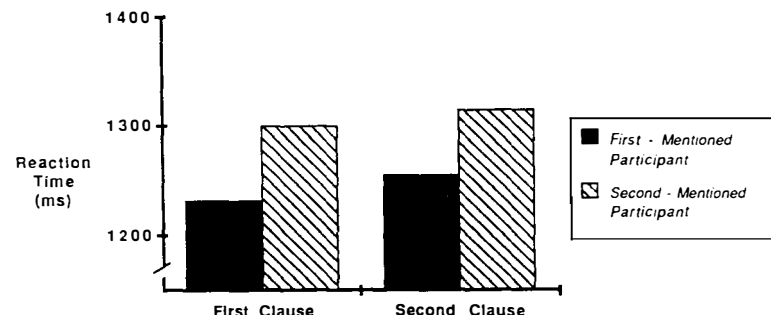
Test Name 150 ms After Sentence
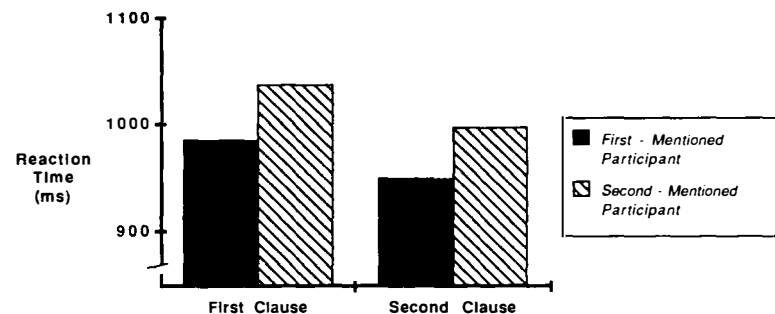
FIG. 2. Subjects' mean correct response times in Experiment 5.

ticipant 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.

So, the advantage of the first-mentioned participant and the advantage of the most recent clause can occur simultaneously. However, according to the structure building framework, the advantage of the first-mentioned participant is a relatively long-lived characteristic of a sentence or clause, whereas the advantage of the most recent clause is observed only when accessibility is measured immediately after comprehension of the most recent clause. Therefore, if we again presented two-clause sentences that mention two participants in each clause, but if we measured accessibility a little later than we did in the fifth experiment, we should no longer observe an advantage of the most recent clause; instead, we should observe only an advantage of the first-mentioned participant. We tested this prediction in our sixth and final experiment.

Methods

Experiment 6 was identical to Experiment 5 except that all test names appeared 2000 ms after the offset of their sentences' final words. More specifically, 250 ms after

the offset of the last word in each sentence the words, *Test Name*, appeared for 1250 ms. Then, 500 ms later, the test name appeared. Eighty subjects participated. Seven additional subjects were replaced for failing to meet the criteria described in Experiment 5. The 80 subjects whose data were analyzed answered, on the average, 83% of the comprehension questions accurately, and discriminated "yes" from "no" test names with an average d' of 2.98.

Results

The results are displayed in Fig. 3. As illustrated in Fig. 3, with two-clause sentences that mentioned two participants in each clause, we again observed an advantage of the first-mentioned participant: For both clauses, first-mentioned participants ($M = 1245$, $SE = 21$, 93%) were significantly more accessible than second-mentioned participants ($M = 1307$, $SE = 22$, 91%), $minF'(1,86) = 17.78$, $p < .0005$. However, as also illustrated in Fig. 3, when accessibility was measured 2000 ms after the end of each sentence, as opposed to 150 ms later, we no longer observed an advantage of the most recent clause. In contrast to Experiment 5 in which the second-clause participants were considerably more accessible than the first-clause participants, in Experiment 6 the second-clause partici-

Test Name 2000 ms After Sentence

FIG. 3. Subjects' mean correct response times in Experiment 6.

pants were slightly less accessible ($M = 1285$, $SE = 22$, 91%) than the first-clause participants ($M = 1268$, $SE = 22$, 92%), although this difference was not statistically reliable, $F_1(1,79) = 2.52$; $F_2(1,31) = 1.44$. Indeed, an analysis combining Experiments 5 and 6 revealed a significant effect of "experiment" (latencies were faster in Experiment 5 than 6), a significant advantage of the first-mentioned participant, and a significant interaction between "experiment" and the advantage of the most recent clause, $minF'(1,149) = 5.65$, $p < .05$. At the point when we measured accessibility in Experiment 5, the advantage of the most recent clause was reliable; at the point when we measured accessibility in in Experiment 6, the advantage of the most recent clause had disappeared.

DISCUSSION

These experiments support the following assumptions made by the structure building framework: Comprehenders represent each clause of a two-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 the 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.

Representing Clausal Dependencies

By saying that comprehenders represent each clause in its own substructure we are not suggesting that all substructures are equally independent. Rather, we envision that comprehenders build rich mental representations in which some substructures are more closely connected than others. In particular, we suggest that more dependent clauses are represented in more connected substructures.

We tried to examine this proposal in the experiments reported here. We tried to induce clause dependency by affixing subordinating conjunctions and by varying the two clauses' tense. Yet despite our manipulations, all our clauses were semantically very independent: The two clauses in each sentence conveyed actions that occurred at about the same time, lasted about the same period, and were of equal importance. Thus, semantically, the two clauses in each sentence were relatively independent.

Moreover, our clauses were functionally very independent. Indeed, they belong to the top tier of Tanenhaus and Carroll's (1975) four-tier hierarchy of clause indepen-

dence. Tanenhaus and Carroll's top tier comprises independent main clauses and complete clauses with initial and medial subordinators. These were the type of clauses we explored in our experiments. Lower on Tanenhaus and Carroll's hierarchy are more dependent clauses. For instance, their next tier comprises embedded clauses, such as relative clauses. Their third tier comprises nominalizations, and their bottom tier comprises noun phrases.

Experiments with clauses that are more dependent than the ones we examined here—that is, experiments with clauses lower on Tanenhaus and Carroll's hierarchy—do support our assumption that comprehenders capture clausal dependencies by building more closely connected substructures.

For example, the more one clause depends on another, the better that clause cues the recall of the other. So, after hearing

(17) Howard who revised the game rules/aggravated the old pros.

if comprehenders are given the cue, *game rules,* and their task is to say the word that came next, they say *aggravated* more rapidly if the first clause is a somewhat dependent, sentential subject, as in (18) below

(18) That Howard revised the game rules/aggravated the old pros.

than if the first clause is a relative clause, as in (17) above. In other words, the more the first clause depends on the second, the better the cue. Responses are faster still when the first clause is even more dependent, for instance, when the first clause is a nominalization, as in

(19) Howard's revision of the game rules/aggravated the old pros

(Carroll, Tanenhaus, & Bever, 1978). Thus, the more dependent the previous clause— the lower it is on Tanenhaus and Carroll's hierarchy—the better the last word of that clause primes the first word of the next

clause. We suggest this is because the more one clause depends on another, the more closely comprehenders connect the two clausal substructures.

Our proposal that comprehenders represent more dependent clauses in more closely connected substructures is also supported by experiments that have explored the advantage of the most recent clause, but have explored the advantage with more dependent clauses than those we used here. For instance, the advantage of the most recent clause predicts that immediately after comprehenders hear either sentence (20) or (21), the third clause will be most accessible.

(20) [John prepared a cup of coffee]$_M$ [[because Mary was so tired]$_{S_1}$ [that she fell asleep]]$_{S_2}$.

(21) [[Because Mary was so tired]$_{S_1}$ [that she fell asleep]]$_{S_2}$ [John prepared a cup of coffee]$_M$

And, indeed, immediately after comprehenders hear sentence (20) or (21), the third (and most recent) clause is more accessible. But in addition, the more the most recent clause depends on its previous clause, the more the advantage of the most recent clause extends to that previous clause.

For instance, the third clause of sentence (20) depends more on its second clause than does the third clause of sentence (21). The third clause of sentence (20) is a relatively dependent *that* clause from Tanenhaus and Carroll's second tier. In contrast, the third clause of sentence (21) is relatively independent main clause from Tanenhaus and Carroll's highest tier. Immediately after comprehenders hear sentence (20), the advantage of the most recent clause extends to the second clause (that is, the second clause is momentarily more accessible than an earlier clause, Flores d'Arcais, 1978). We suggest this is because the more one clause depends on another, the more closely comprehenders connect the two clausal substructures.

Clauses are also more dependent when

they contain forward-referring pronouns, such as *he* in the first clause of (22).

(22) Even though *he* hasn't seen many bears, they are apparently Ron's favorite animal.

When clauses contain forward-referring pronouns, comprehenders no longer demonstrate typical end-of-clause behavior. Typically comprehenders identify a pre-specified target word, like *bears,* faster when it occurs at the end of a clause, as in (23), than when it occurs at the beginning of a clause, as in (24).

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

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

Presumably this difference occurs because at the end of a clause comprehenders are completing a substructure, whereas at the beginning of a clause they are initiating one (and initiating a new substructure involves the time-consuming process of laying a foundation). However, this difference is attenuated when clauses contain forward-referring pronouns, such as the first clause in (22). In these situations, comprehenders identify a target word just as slowly at the end of a clause as at the beginning of a clause (Marslen-Wilson et al., 1978). Presumably, this is because when comprehenders reach the end of more dependent clauses, they are not completing their substructures; rather they are preparing to connect that substructure to the next substructure.

To summarize, experiments with clauses that are more dependent than those we manipulated here support our proposal that comprehenders build rich mental representations in which some substructures are more closely connected than others.

Building Hierarchical Structures

To observe the advantage of the first-mentioned participant simultaneously with

the advantage of the most recent clause, we capitalized on intra-clause versus inter-clause relations. We observed the advantage of the first-mentioned participant at one level—within a clause—and the advantage of the most recent clause at another level—between two clauses.

We suggest that comprehenders' mental structures and substructures capture these hierarchical relations. Clauses are represented in their own substructures, and the sentences comprising those clauses are represented in larger substructures. If comprehenders did not build hierarchical structures and substructures, then the data from Experiment 5 would have looked different. Consider the four participants in the sentence

(25) Dave and Rick gathered the kindling, and John and Bill set up the tent.

Because *Dave* and *Rick* are members of the first clause, we suggest that they are represented in one substructure, while *John* and *Bill,* the members of the second clause, are represented in another substructure. If the four participants were remembered only as four names in an unstructured list, then we would expect Fig. 2 to 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 we see that the first bar is shorter than the second bar (manifesting the advantage of the first-mentioned participant in the first clause), and the third bar is shorter than the fourth bar (manifesting the advantage of the first-mentioned participant in the second clause). Furthermore, we see that the third and fourth bars are shorter than the first and second bars (manifesting the advantage of the most recent clause).

When we compare Fig. 2 with Fig. 3 we

see that the third and fourth bars change almost like 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, we might expect Fig. 3 to resemble a serial position curve with only the primacy component: The first bar should be the shortest, and the remaining bars but should be either equally long or perhaps progressively longer. Instead the third bar is shorter than the fourth bar, just as the first bar is shorter than the second bar. We suggest that 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? Perhaps 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. *Rick* accompanied *Dave* in gathering the kindling, and *Bill* accompanied *John* in setting up the tent. We are not suggesting that the first-mentioned participant is more important, simply that it came first and its precedence affects the subsequent representation.

The same privilege by precedence occurs with clauses—particularly clauses of equal status such as the ones we examined here. Knowledge that *John and Bill set up the tent* is added to the knowledge that *Dave and Rick gathered the kindling*. Again, we are not suggesting that the first clause is more important, simply that it comes first and its precedence affects the subsequent representation.

Accessing Semantic Information

What type of information is represented in comprehenders' mental structures and substructures? In other words, what type of information becomes more or less accessible as comprehenders build clausal representations? Traditionally, a trade-off between superficial (verbatim) information and more meaningful (semantic) information was assumed. Verbatim information was assumed to be more accessible while comprehenders heard or read a clause but less accessible a short while later. In contrast, semantic information was assumed to be less accessible while comprehenders heard or read a clause but more accessible a short while later. In fact, some theories assumed that semantic information was unavailable until after comprehenders completely finished hearing or reading a clause.

However, semantic, lexical, and verbatim information all become more accessible at the same time, and they all become less accessible at the same time. In other words, there is no trade-off.

Indeed, the advantage of the most recent clause occurs at the same time for all three types of information. That is, all three types of information are more accessible while comprehenders are building their mental representations of one clause, and all three types of information become less accessible when comprehenders begin building their representations of another clause.

For instance, the word *hammer* is more accessible immediately after comprehenders hear

(26) We found the carton of nails and bolts, but the hammer and wrench were gone.

than it is immediately after comprehenders hear

(27) The hammer and wrench were gone, but we found the carton of nails and bolts.

This is the advantage of the most recent clause. The advantage occurs when the sentence and test word match in superficial form, for instance, when both the sentence

and test word are written (as in our experiments and Chang, 1980), or when both the sentence and test word are spoken (Caplan, 1972; von Eckardt & Potter, 1985). Moreover, the advantage is equally strong when the sentence and test word match in lexical form but not superficial form, for instance, when the sentence is spoken and the test word is written (Caplan, 1972; von Eckardt & Potter, 1985). In fact, the advantage is equally strong when the sentence and test word match only in semantic form, for instance, when the sentence is spoken and the test "word" is a picture of a hammer (Von Eckardt & Potter, 1985; see also Marslen-Wilson et al., 1978).

So, comprehenders do not have to complete building their clausal substructures before they can access semantic information. Indeed, some semantic information is available only while comprehenders are building their clausal substructures. For instance, a word like *queen* is read more rapidly when it is preceded by a semantically related word like *king*. But, this facilitation occurs only if the two words are in the same clause, as in

(28) The guard saluted the king and the queen in the carriage, but they didn't notice.

No facilitation occurs when the semantically related word is in a different clause, as in

(29) The guard saluted the king, and the queen in the carriage looked annoyed (Carroll & Slowiaczek, 1986).

Furthermore, semantic information enjoys the advantage of first mention just as much as lexical or verbatim information. For instance, after hearing or reading

(30) The hammer and wrench were gone, but we found the carton of nails and bolts.

comprehenders verify that the concept *hammer* occurred more rapidly than they verify that the concept *wrench* occurred.

This advantage of first mention maintains regardless of whether the concepts are tested with written words, spoken words, or pictures (von Eckardt & Potter, 1985).

Conclusion

The structure building framework can account for two seemingly contradictory sentence comprehension phenomena: the advantage of the first-mentioned participant and the advantage of the most recent clause. We suggest that the advantage of the first-mentioned participant arises because first-mentioned participants form the foundations for their sentence or clause-level substructures; through them subsequent information is mapped onto the developing substructure. The advantage of the most recent clause 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 viewed from the perspective of the structure building framework, these two seemingly contradictory phenomena are not mutually exclusive. Indeed, they inform us about the processes involved in comprehension and the nature of the representations that comprehenders build.

However, it is important to note that the structure building framework accounts for these two phenomena by drawing on general cognitive processes. Neither the process we refer to as "laying a foundation" (and that we suggest accounts for the advantage of the first-mentioned participant) nor the process that we refer to as shifting to initiate a new substructure (and that we suggest accounts for the advantage of the most recent clause) is specific to language comprehension; both processes are involved in comprehension in general. So, phenomena analogous to the advantage of the first-mentioned participant and the advantage of clause recency should be observed during the comprehension of nonlin-

guistic media. The crucial commonality is that the goal of comprehension is building a coherent, mental representation. To build this representation, comprehenders use initial information to lay a foundation. Furthermore, they often shift to initiate a new substructure. What is specific to sentences is that nouns (or participants) are important bases for representing sentences and can therefore serve as foundations, while clauses provide good units for substructures.

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