

Framing sentences*

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Abstract

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The sentence frames formed during language production are commonly and rather uncontroversially represented as hierarchical constituent structures. There is less accord about whether the frames are pure structural configurations or limnings of meaning. We examined these alternatives with a sentence priming paradigm in which the primes and targets shared phrase structures and event structures, or only phrase structures. The results of the first and second experiments indicated that event-structure changes had no impact on a reliable tendency to replicate the phrase structures of the primes within sentence targets. The last experiment showed that this tendency could not be attributed to metrical or to closed-class lexical similarities. The implication is that sentence frames are not identifiable with metrical or conceptual information, but are comparatively independent syntactic representations.

Introduction

Like the exterior of a building, the exterior of a sentence is constructed around and upon a structural frame. The frame constitutes a skeleton that shapes the process and products of construction, as well as a support that anchors the superstructure to its foundation. These notions form the core of the framing assumption that is found in virtually all accounts of language production. Outside this core, there are divergent ideas about the composi-

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tion of sentence frames and how they are linked to the meanings that sentences convey. The purpose of this paper is to lay out two different conceptions of sentence frames and to report experimental evaluations of them. We begin by reviewing the mainstays of the framing assumption, and then take up a more embattled point.

Many of the characteristics of sentence frame are disclosed in speech errors. Three facets of errors that are particularly revealing are the form class law, syntactic accommodation, and the structural-distance constraint. The form class law is that the words involved in any individual error come from the same grammatical form class (nouns, verbs, adjectives, and so on). It is obeyed by virtually all whole-word errors. These include exchange errors ("speakers of the minds" when "minds of the speakers" was intended), substitution errors (including semantic substitutions such as "cauliflower" for "broccoli" as well as phonological substitutions such as "militates" for "mitigates"), and blends ("quandrum" when either "quandary" or "conundrum" was intended). A corollary of the law is that the words participating in such errors appear in the appropriate positions for their form class. Evidently, the processes that put words into place within utterances operate in terms of these grammatical categories, suggesting that both the words and the places carry form-class codes.

Syntactic accommodation indicates that whatever scheme anchors words to places observes not only form-class distinctions, but also syntactic function distinctions. Such functions include those of subject and direct object, among others. They are carried primarily through configurations in languages such as English, through a mix of configurations and inflections in languages such as Dutch and German, and primarily through inflections in languages such as Warlpiri. The phenomenon of syntactic accommodation in English is illustrated in two errors cited by Stemberger (1985): "Most cities are true of that" (when "That is true of most cities" was intended) and "You're too good for that" (when "That's too good for you" was intended). In both cases, number agreement on the verb conforms to the number of the noun occupying the position of subject, in spite of the fact that it is not the intended subject. Stemberger reported that this accommodation occurred in six of the seven errors in his corpus in which an agreement change was made necessary by another error.¹ Similarly, if an element that erroneously appears in subject

¹The generality of syntactic accommodation may be called into question by Berg's (1987) analysis of article agreement errors in German. Berg found that the gender and number of articles generally failed to accommodate to the gender and number of misplaced nouns following them. In the majority of these errors, the nouns represented erroneous anticipations of nouns intended for later placement in the utterances. These accommodation failures suggest that within-phrase syntactic constraints may be less rigidly observed than those that involve grammatical role assignments (e.g., subject/nominative, direct object/accusative) and require agreement across phrasal constituents.

position is one of the few in English that must be appropriately inflected in order to serve as a subject, the form may change. This is illustrated in an error cited by Garrett (1980): "He offends her sense of how the world should be", instead of "She offends his sense of how the world should be". Berg (1987) examined similar pronoun errors in German, and found that accommodation occurred in all 15 of the errors in his corpus that required it.

The structural-distance constraint was proposed by Garrett (1975) on the basis of differences between sound and word exchange errors in the distances they span. Garrett reported that in his corpus few of the sound exchanges were separated by two or more words, whereas half of the word exchanges were. Assuming that exchanges reflect the concurrent activity of the switched elements, this implies that the scope of advance planning for sounds is smaller than that for words. The nature of the representations that are planned may be reflected in the structural correlates of these distances. Overall, wide majorities of the sound and word exchanges occurred within clauses. They differed, though, in their predispositions to cross phrase boundaries. The rate of phrase-bounded sound exchanges was more than three times higher than that for word exchanges (71% versus 20%). Though hardly definitive, such patterns suggest that clause-sized units constitute the planning domain at levels where words matter most, with smaller units operating at levels where sounds matter most.

Taken together, these phenomena imply that the integration of words into a sentence is controlled by a scheme that represents form class and grammatical relation information within a clausal unit. To this we can add a variety of evidence which argues that, at least for English, the scheme is one in which words are grouped into a hierarchical phrase structure. The evidence comes from formal analysis, from pauses in speech, and from errors in sentence recall.

Formal linguistic analysis provides the traditional arguments for hierarchical structure. Without such a notion it is difficult to explain structural ambiguity (as found in the alternative readings of *The old [men and women] were left behind in the village* versus *The [old men] and [women] were left behind in the village*), or sentence segmentation (why a sentence such as *The girl that kissed the boy blushed* is not understood to assert that a boy blushed, despite the fact that it contains the sequence *the boy blushed*), or verb agreement (the fact that main verbs agree not with what immediately precedes them, in a positional sense, but with a particular constituent-structure category, roughly, the highest noun phrase in the same clause; cf. *The boys who watched the clowns was amused* versus *The boys who watched the clowns were amused*).

Data from language performance indicate that such structures characterize

the products of speech production processes. Pause patterns, in particular, have long been argued to reflect structures that are larger than individual words, but smaller than full clauses (Cooper, Paccia, & Lapointe, 1978; Ferreira, 1988; Grosjean, Grosjean, & Lane, 1979; Maclay & Osgood, 1959). Likewise, the products of sentence recall (which appear to reflect normal production processes) indicate that subjects tend to organize sentences at a level lower than that of the sentence itself but higher than that of individual words, specifically, a level of phrasal constituents (Johnson, 1965, 1966a, b).

Such things help to establish that speakers create utterances that have hierarchically organized phrase groupings, or frames. However, they say nothing about the processes that create the frames or the nature of the information that frames encode. It is here that questions about syntactic processes in language performance ignite into theoretical controversy. The parties to the debate divide over whether such structures grow immediately out of the ideas that sentences convey, or instead out of an intermediate linguistic categorization of the elements of those ideas. We will refer to these alternatives as the meaning-mapping and form-mapping approaches, respectively.

Precursors of the meaning-mapping view can be found among those classical associationists who demurred from the pure chaining view that came to characterize the stimulus-response view of speech production. In its place, they espoused connections between communicative intentions and whole-sentence forms of some kind:

When we seek to determine the conditions which lead to the formulation of the phrases and sentences or larger wholes of speech we find them to be in large part concealed. Ultimately the process resolves itself into a matter of association under the control of the general setting, the intentions and what not that are prominent at the moment. The first association is between the intention and the form of sentence that is to be used. Such a difference as that which gives rise to the ... interrogatory sentence, for example, must depend upon a connection between definite purpose and a definite arrangement of words. There is, of course, no explicit intention to use an interrogatory sentence, but the antecedents which make the speaker desire to obtain rather than to impart information lead to the appearance of the verb before the noun (Pillsbury, 1915, p. 124).

More recently, variants of the meaning-mapping position have been represented in the descriptions and accounts of production offered by Clark and Clark (1977), McNeill (1987), Osgood (1971, 1980; Osgood & Bock, 1977), and Schlesinger (1977) among others. These accounts stress the pragmatic, conceptual, and semantic correlates of structural distinctions. A standard element is the postulation of direct links between the components of ideas (e.g., intended referents and the relations among them) and locations within a constituent structure. What are deemed to control the locations are various

characteristics of the ideational components themselves (whether they are animate or inanimate, new to the discourse, objects of attention, and so forth), with prominent locations (typically beginnings, but sometimes ends) accorded to prominent conceptual elements. To take a representative example, subjecthood can be viewed as a structural reflection of prominence in thought (Bates & MacWhinney, 1982). A strong version of this position is that every utterance is sculpted out of a conceptual mass, with structure emerging as the product of a partially conventionalized parsing of thought (McNeill, 1987). Weaker versions impose a separation between content and sequence, but maintain linkages between them through one or another form of cross-classification: elements of content are syntactically categorized, and procedures for sequencing are conceptually categorized (MacKay, 1987).

The form-mapping view, conversely, maintains a separation between non-linguistic conception and syntactic construction. It was evoked by Karl Lashley in his argument that "syntax is not inherent in the words employed or in the idea to be expressed. It is a generalized pattern imposed upon the specific acts as they occur" (1951, p. 120). A contemporary version of the position can be seen in the account of production devised by Garrett (1975, 1988; see also Fromkin, 1971). Garrett's theory includes a level of grammatical categorization that projects linguistic relations onto abstract representations of the words to be used in a developing sentence. From the representation of these relations the constituent structures of utterances are generated. Only at this point are the precedence relations among words made explicit, by virtue of their locations in the structural representation.

It is hardly accidental that the proponents of form-mapping, from Lashley onward, have emphasized the constraints on errors that occur in speech, often isolated snatches of speech. Speech errors are as notable for their semantic anomaly as for their structural integrity: even prosaic ones verge on incomprehensibility, requiring painstaking reconstitution for the speaker's intention to emerge (consider *It'll get fast a lot hotter if you put the burner on* and *I can't believe you don't have a room in your phone*). If "right structure" were dependent upon "right thinking", it would be difficult to explain how intended messages can stray so far at the same time that target structures remain rigidly intact.

But conclusions based on speech errors are perilous in several ways. First, errors are rare events. Garnham, Shillcock, Brown, Mill, and Cutler (1982) tabulated the mistakes in a 170,000-word corpus of spontaneous conversations. They found only 86 word-level errors (including blends, substitutions, anticipations, and exchanges, among others), roughly one error in every two thousand words. Such infrequency raises the possibility that whatever is true of errant production may not be true of ordinary production. Second, the

collection of errors is a haphazard business fraught with the usual uncertainties of observational research. Suppose that errors that are anomalous but syntactically acceptable are easier to remember than those that are both syntactically and semantically unacceptable. Structurally well-formed errors might then be over-represented in error corpora simply because they are selectively recorded. Finally, even if errors do accurately reflect the processes of normal production, their structural integrity could be a byproduct of the integrity of a level of conceptual structure, not linguistic structure, that is abstract with respect to and separable from its components.

In the absence of more compelling evidence for the separation of form and meaning in language generation, the correlations between form and function that are manifest in the sentences that people produce have bolstered the meaning-mapping argument. There the focus shifts to the features of fully acceptable spoken utterances in natural discourse. The best-explored features are those that characterize the entities that serve as the subjects of sentences, including animacy, agency, concreteness, definiteness, locus of perspective, and discourse topicality. Since changes in sentence structure seem to be attendant upon changes in such characteristics (for reviews see Bates & MacWhinney, 1982; Bock, 1982), the correlations have sometimes been used to make the stronger argument that the features of sentence structure are immediately linked to and explainable in terms of the features of conceptual and discourse structures (Garcia, 1979; Givón, 1984).

Thus, a clear point of divergence between the meaning-mapping and form-mapping views concerns the dependence of changes in syntactic form on changes in nonlinguistic conception. Whereas the meaning-mapping hypothesis links syntactic variations directly to conceptual variations, the form-mapping view is open to the possibility that such variations may reflect changes in syntactic processes alone. That is the starting point for our studies. All of them employ an experimental procedure that makes it possible to induce a pattern of variation in sentence structure that need not be linked to variations in conceptual processing. To the extent that this can be done, it suggests that the dissociations of content and structure that are found in the production of speech errors can likewise be found in the production of error-free utterances, and that similar processing accounts may be appropriate. More tendentiously, such evidence would trace a potential boundary between syntactic mechanisms and nonlinguistic cognition. To the extent that this cannot be done, and variations in form are constrained by variations in conception, the results will bolster the interweaving of semantic and syntactic operations found in meaning-mapping approaches to production.

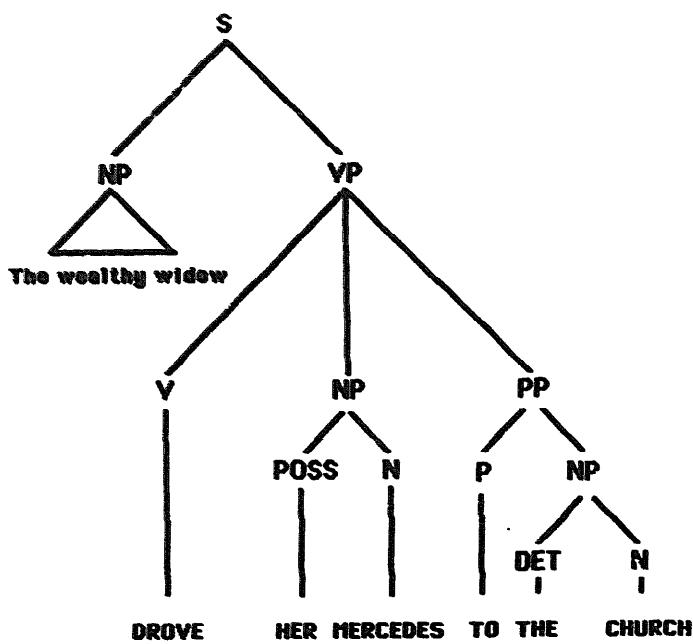
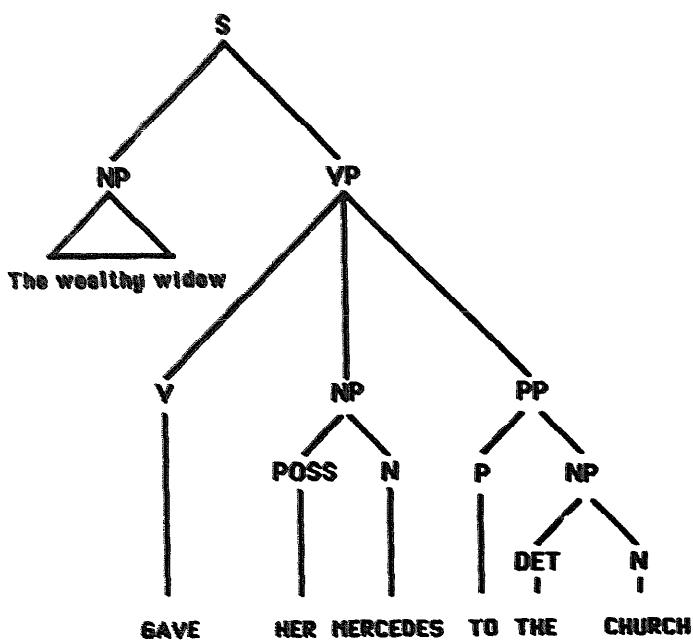
The method used in all of the experiments was primed sentence production (Bock, 1986, 1989). On each priming trial, the subjects heard and then said

a priming sentence (e.g., "The governor left a statue of himself to the university"). Next, they described a pictured event that was in all obvious respects dissimilar to the sentence (e.g., a picture of a man reading a story to a child). The conditions of presentation were devised to obscure the essential relationships between the priming sentences and the pictures, and to induce the subjects to attend to an ongoing memory test rather than to their speech. Under such conditions there is a reliable tendency for the syntactic structures of the priming sentences to emerge in the subsequent picture descriptions, cloaked in different words. Thus, the priming sentence "The governor left a statue of himself to the university" (a prepositional dative) would tend to be followed by the description "The man is reading a story to the child" (another prepositional dative), while the priming sentence "The governor left the university a statue of himself" (a double-object dative) would more often elicit "The man is reading the child a story" (also a double-object dative). There is little reason to regard this echoing of sentence patterns as forced or unnatural, since a similar tendency appears in spontaneous speech (Estival, 1985; Levelt & Kelter, 1982, Experiment 3; Tannen, 1987; Weiner & Labov, 1983).

Two accounts of such repetition can be contrasted. The first runs along form-mapping lines: if the procedures that build the constituent structures of sentences are sensitive primarily to relatively abstract syntactic categorizations of the material in the developing utterance, structural patterns should tend to repeat themselves whenever similar categorizations are made, regardless of whether the conceptual features of the categorized material are similar. For example, sentences such as *The wealthy widow gave her Mercedes to the church* and *The wealthy widow drove her Mercedes to the church* are commonly construed to have a subject, a direct object, and an oblique object in a prepositional phrase, in a structure like that shown in Figure 1 (Burt, 1971; Jackendoff, 1977; Larson, 1988). Consequently, both should tend to prime prepositional-phrase forms in descriptions of events such as a girl handing a paintbrush to a boy. Thus, relative to a control condition, both should tend to elicit descriptions along the lines of "The girl is handing a paintbrush to the boy" with greater frequency than "The girl is handing the boy a paintbrush".

The second account emphasizes the conceptual similarity of the events that occur when someone gives a Mercedes to a church or hands a paintbrush to a boy. Both events contain a human agent, a theme (the object that undergoes the action), and a beneficiary. Different sentence forms appear to emphasize different elements of such events, with the prepositional dative tending to be used when the beneficiary is focal or dominant or new information and the double-object dative tending to be used when the theme is focal or dominant

Figure 1. *Phrase structures of The wealthy widow gave her Mercedes to the church and The wealthy widow drove her Mercedes to the church.*



or new information (Bock, 1977; Creider, 1979; Erteschik-Shir, 1979). If the building of constituent structures is directly sensitive to such variations in focus, it would be expected that the configuration of elements in a priming sentence would influence the configuration of elements in a subsequent picture description. As a result, priming effects could be interpreted as a tendency to organize events in the same way across sentences, with the focus established in the prime maintained in the target. On this interpretation, *The wealthy widow gave her Mercedes to the church* should tend to prime *The girl is handing a paintbrush to the boy*. However, the priming sentence *The wealthy widow drove her Mercedes to the church* describes a different type of event, one which contains a locative goal rather than a beneficiary. Since the thematic components of this event differ from those in the pictured event (again, the girl handing the paintbrush to the boy), its organization should be less likely to induce a similar organization in the target. Thus, *The wealthy widow gave her Mercedes to the church* should be a better prime than *The wealthy widow drove her Mercedes to the church* for "The girl is handing a paintbrush to the boy".

Experiments 1 and 2 tested these predictions, comparing priming sentences that had the same syntactic frames but different thematic structures. Experiment 1 contrasted dative and locative primes like the examples above, and Experiment 2 contrasted passive and locative primes (e.g., *The 747 was alerted by the control tower* versus *The 747 was landing by the control tower*). If frame construction is immediately linked to message structure, more priming of the target structures should occur when the thematic components of the priming sentence are the same as those of the pictured event. Conversely, if frame construction proceeds on the basis of syntactic categorizations divorced from conceptual relations, sentences with similar frames should be equally effective primes, relative to controls.

The logic of these contrasts rests on the supposition that the priming procedure taps the organization of constituent structure, and not metrical structure or the identity and arrangement of closed-class words. The third experiment examined this directly, to establish that the structures that persist across utterances are plausibly the products of syntactic structure-building procedures.

Experiment 1

The first experiment examined whether structural similarities across successive sentences are driven by conceptual similarities, specifically, similarities defined over event roles: the paradigm employed in this and the two sub-

sequent experiments was based on the sentence priming technique sketched above. To review it briefly, on each priming trial a subject heard and immediately repeated a priming sentence in one or another of the manipulated syntactic forms. Then a picture was exposed and the subject described the depicted event. Our interest was in the syntactic form of these extemporaneous picture descriptions.

The priming trials were embedded in a long list of unrelated filler materials that included both sentences and pictures in an apparently haphazard arrangement. The subjects' task was to try to remember the sentences and pictures in order to be able to recognize them later, and most of the fillers were in fact repeated at some point in the list. To elicit speech, we told the subjects that it would aid their memory to repeat each sentence they heard and describe each picture they saw. The subjects were not apprised of the relationship between the priming sentences and pictures, nor were the items on the priming trials readily distinguishable from the fillers.

If the variations in sentence form created by this priming procedure are dependent upon variations in conceptual structures, the magnitude of the priming effect should change as a function of conceptual changes. Thus, prepositional datives should be reliably better primes for the production of prepositional datives than are prepositional locatives, relative to controls. On the other hand, if the variations in sentence form depend only upon the structures of the primes, and not the nature of the events they encode, prepositional datives and locatives should be equally reliable primes for prepositional datives.

Method

Subjects

The subjects were 96 undergraduates at Michigan State University. They received course credit in return for their participation in the experiment.

Materials

The experimental materials were composed of 30 sets of priming sentences paired with 30 pictures of dative events. The priming sentence sets consisted of triplets like those shown in Table 1. Each triplet included a prepositional dative, a prepositional locative, and a double-object dative. The prepositional datives contained dative verbs (verbs that take both a theme and a beneficiary as arguments; e.g., *sold*, *offered*, *promised*, *loaned*) with the theme as the direct object and the beneficiary as a prepositional object (the object of the preposition *to*). The prepositional locatives contained motion verbs (e.g., *walked*, *pulled*, *pushed*, *moved*) with the theme as the direct object and the

Table 1. Examples of priming sentence sets from Experiment 1

Prime type	Examples
Prepositional dative	<i>The wealthy widow gave an old Mercedes to the church.</i>
Prepositional locative	<i>The wealthy widow drove an old Mercedes to the church.</i>
Double-object control	<i>The wealthy widow sold the church an old Mercedes.</i>
Prepositional dative	<i>IBM promised a bigger computer to the Sears store.</i>
Prepositional locative	<i>IBM moved a bigger computer to the Sears store.</i>
Double-object control	<i>IBM offered the Sears store a bigger computer.</i>
Prepositional dative	<i>The hospital showed the bill to the patient by mistake.</i>
Prepositional locative	<i>The hospital returned the bill to the patient by mistake.</i>
Double-object control	<i>The hospital sent the patient the bill by mistake.</i>

locative goal as the prepositional object (again, the object of the preposition *to*). The direct objects and prepositional objects were the same in the prepositional datives and locatives in each triplet.

The double-object dative primes were included to provide a control for the production of prepositional datives, since previous work (Bock, 1986, 1989) has shown that such forms, used as primes, are less likely to elicit prepositional datives than are prepositional datives themselves. The double-object forms in each triplet contained the same noun phrase arguments as the prepositional forms, but in a different arrangement. The first object was the same as the prepositional object in the prepositional forms, and the second object was the same as the direct object in the prepositional forms. The syntactic subjects were also the same as the subjects of the prepositional forms, but the dative verb differed. Though it would have been feasible to use the same dative verbs in the double-object and prepositional datives, this would have created a similarity between these two forms that did not (and could not) exist between the double-object and locative forms, and thereby would have made the double-object priming condition a less appropriate benchmark.

Each of the 30 dative pictures depicted an action involving an agent, an object undergoing the action, and a human recipient of the action. Typical actions involved giving, showing, handing, and reading, performed in the context of events such as a boy giving an apple to a teacher, a woman showing a dress to a man, a man handing a pitcher to a woman, and a girl reading a book to a boy. The pictures were drawn in black ink on a white background and photographed for presentation on slides. Half had the beneficiary of the action on the right, and half on the left.

The sentences from the priming sets were paired with the dative pictures

to create the priming trials, with each of the sentences from a single set paired with the same picture. The pairings minimized the semantic and narrative connections between the sentences and pictures, so that they appeared to be unrelated.

An additional 150 items (75 sentences and 75 pictures) served as fillers in each presentation list. These provided the materials for the cover recognition memory test, added variety to the lists, and camouflaged the structural relationship between the sentences and the picture descriptions that arose on the priming trials. The fillers ranged widely in form and content.

Three 300-item presentation lists were formed from these materials. Each contained all 30 experimental pictures, with every picture preceded by one of the priming sentences from its paired set, to create 30 priming trials per list. Across the three lists, each experimental picture was preceded once by each of the three priming sentences from the paired set. On every list, one-third of the experimental pictures were preceded by prepositional datives, one-third by prepositional locatives, and one-third by double objects. Each experimental picture occupied the same position in all lists. The priming trials were evenly spaced within the lists, separated by eight fillers, but were in no obvious way different from the filler trials.

Every presentation list included 90 repeated fillers (45 pictures and 45 sentences, each of which occurred twice) and 60 unrepeated fillers (30 pictures and 30 sentences, each of which occurred only once). The filler trials were arranged so that no more than three pictures or sentences occurred consecutively and no clearly related items appeared together. For the repeated fillers, 10% of the repetitions occurred in the first quarter of the list, with 31%, 26%, and 33% in the three subsequent quarters, respectively.

Procedure

Subjects were run individually. The experiment was introduced to them in terms of the procedures for a running recognition memory test (Shepard & Teghtsoonian, 1961). They were told that they would receive a mixed list of pictures and sentences, and that they should indicate for each item whether it had occurred previously in the list. They did this by responding "yes" or "no". They were also asked to perform two secondary tasks, on the pretext of aiding memory performance. The first was to repeat each sentence aloud immediately after it was read by the experimenter. The second was to describe what was happening in each picture, in one sentence without pronouns. No other instructions about the form or content of the picture descriptions were given. Three practice items (one sentence and two pictures) were presented to ensure that the subjects understood the tasks.

The list items were presented on slides, with blank slides in those list

positions where sentences occurred. At these points the sentences were read aloud by the experimenter. The subjects performed the secondary task appropriate for each item in the list, then indicated whether the item had appeared previously, and then received feedback for the recognition decision. A one-second interval separated the end of one trial from the beginning of the next. The lists were presented in four blocks of 75 items each, with short breaks between each block for changing the slide carousels.

The sessions were recorded on audio tape. The tapes were transcribed to obtain a written record of the descriptions of the experimental pictures.

Scoring

The transcribed descriptions of the experimental pictures were scored as prepositional datives or as double-object datives.² To be scored as a prepositional dative, a description had to contain a dative verb followed first by the theme as the direct object and then by the beneficiary as the object of the preposition *to*. To be scored as a double-object dative, a description had to contain a dative verb followed by the beneficiary as the first direct object and by the theme as the second direct object. To be scored in either category, a description had to have a grammatical alternative in the other category that reversed the positions of the theme and the beneficiary (this was done to ensure that each prepositional description allowed a control form, and vice versa). Descriptions not meeting these criteria were excluded from the analyses.

Application of these criteria yielded a total of 1915 scorable responses among the 2880 picture descriptions (66%). Of the 1915, 33.0% occurred in the dative priming condition, 33.4% in the locative priming condition, and 33.6% in the double-object priming condition.

Design and data analyses

Every subject received 30 experimental pictures, 10 in each of the three priming conditions (prepositional dative, prepositional locative, and double-object control). Every experimental picture was presented to 96 subjects, 32 in each of the same three conditions.

²Double-object and prepositional datives seem to constitute a natural class, in that they express comparable meanings with comparable predicates and sets of nominal arguments. Among other things, they tend to trade off against one another in experiments like the present ones (cf. Bock, 1986, 1989), suggesting that they represent different realizations of the same communicative intention. We therefore treat them as representing similar interpretations of the pictured events, and the only sorts of interpretations about whose realizations in speech we can justifiably generalize on the basis of these experiments. Though we think that the conceptual representations of these sentences may be very similar, we do not hold the view that they originate in the same abstract syntactic representation.

The two dependent variables were the numbers of prepositional and double-object descriptions produced by each subject in each cell of the design. Single-factor analyses of variance were performed on the data, with separate analyses treating subjects and items as random effects. Specific predictions were evaluated with planned comparisons, using the mean square error from the overall analyses to construct confidence intervals for pairwise contrasts (Winer, 1971, p. 196). Differences were treated as significant when they exceeded the 95% confidence intervals. Because the production of double-object descriptions complemented that of the prepositional descriptions, the results are summarized in column graphs that show the proportions of the prepositional dative descriptions relative to the total number of prepositional and double-object descriptions in each condition.

Results

The overall proportions of prepositional datives produced in the three priming conditions are presented in Figure 2. Both the dative and the locative priming conditions showed increased use of the prepositional dative form when compared to the double-object control, but little difference when compared to one another. Planned comparisons of the numbers of prepositional datives in each condition (shown in Table 2) revealed that the dative and the locative conditions were each reliably different from the double object control

Figure 2. *Overall proportions of prepositional datives produced in the three syntactic priming conditions of Experiment 1.*

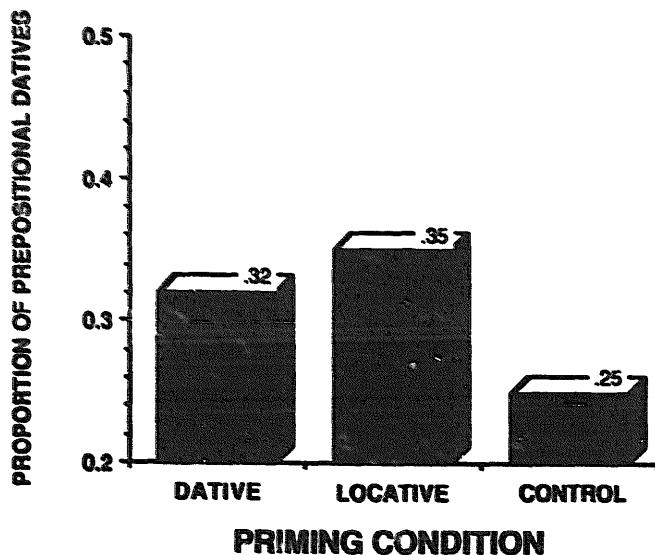


Table 2. *Number of prepositional and double-object utterances produced in the three syntactic priming conditions of Experiment 1*

Priming condition	Utterance form	
	Prepositional	Double-object
Prepositional dative	202	429
Prepositional locative	223	417
Double-object control	159	486

(yielding 43 and 64 more prepositional datives, respectively), but the dative and locative conditions did not differ significantly (with 21 more prepositional datives in the locative than in the dative condition). This was true of the comparisons for subjects (where the confidence interval was 25.0) as well as those for items (where it was 38.1).

Table 2 also gives the number of double-object forms produced in each condition. The priming effects are obviously complementary, with increased numbers of prepositional forms and decreased numbers of double-object forms after prepositional primes, and the opposite pattern after double-object primes. Statistical analyses of the double-object forms yielded the same configuration of significant and nonsignificant effects as the analyses of the prepositional forms, with confidence intervals of 32.7 for subjects and 45.3 for items.

To begin to explore the influence of the priming manipulation on ongoing production processes, we examined the dysfluencies that occurred in the subjects' prepositional and double-object descriptions. The dysfluencies were coded during transcription. They included delays in the initiation of utterances (marked by pause fillers such as umm and ahh, repetition and prolongation of sentence-initial articles, and unusually long delays before speaking), false starts (when utterances were initiated, stopped, and reinitiated), and utterance-internal pauses, repetitions, prolongations of words, and errors. Although the criteria for delays, pauses, and prolongations were subjective, research on hesitations and other paralinguistic features of speech suggests that such criteria yield results very similar to those of more objective measurements (e.g., Deese, 1980).

Table 3 shows the number of dysfluencies per utterance for the prepositional and double-object forms in each priming condition. There was a general tendency across all conditions for prepositional utterances to be produced less fluently than double-object utterances.

Any statistical evaluation of this result is suspect because of the number

Table 3. *Number of dysfluencies per utterance in Experiment 1*

Priming condition	Utterance form	
	Prepositional	Double-object
Prepositional dative	0.99(0)	0.80(1)
Prepositional locative	1.11(0)	0.87(0)
Double-object control	0.96(1)	0.95(0)

Note. The numbers in parentheses represent the number of items for which data were missing in the dysfluency analysis.

of cells in which individual subjects failed to produce a relevant form, resulting in missing data for the purposes of a dysfluency analysis. However, to garner some index of the reliability of the effects, an analysis was done across items, replacing all missing cells with the means of the remaining cells in the condition. Table 3 gives the number of cells (out of 30 possible in each case) that were estimated in this way. The analysis confirmed that the prepositional forms were less fluent than the double-object forms, $F(1,29) = 4.94$. The interaction between priming form and utterance form was not significant, $F(2,58) = 1.17$. Though there is an apparent decrease in fluency for prepositional datives that were not primed by other prepositional datives, Newman-Keuls pairwise comparisons revealed no significant differences.

Discussion

Conceptual similarity was no more likely than conceptual dissimilarity to lead to structural repetition. Though the structural repetition effect was itself reliable, it was roughly equivalent for events with comparable and incomparable roles. What difference there was actually favored increased use of a primed form when the prime and picture involved contrasting event types, with a location in the prime and a beneficiary in the picture. However, this difference was not significant.

Implicit in the claim that the prepositional datives and locatives behaved equivalently as primes is the assumption that both caused changes in the production of prepositional datives. An alternative is that the double-object form simply served to decrease the production of prepositional datives, and that the prepositional forms had no effects of any kind. One argument against this interpretation of the data comes from the first experiment reported by Bock (1986). That study included an intransitive priming condition along with the prepositional and double-object dative priming conditions. The pro-

duction of prepositional datives in the intransitive condition fell midway between the prepositional and double-object conditions, suggesting that the prepositional primes tended to increase the production of prepositional forms relative to a more neutral form, while the double-object primes tended to decrease it.

Experiment 2

The first experiment found no effect of conceptual differences on structural repetition. However, the event roles that were contrasted in that experiment—beneficiaries and locations—are sufficiently similar to be treated as identical by some linguists (e.g., Jackendoff, 1983). In these treatments, beneficiaries and moved-to locations are both classified as the goal arguments of different verbs. Accordingly, it may be that they had similar structural effects because they have similar conceptual features. Experiment 2 addressed this concern by comparing sentences such as the passive *The 747 was alerted by the control tower* and the locative *The 747 was landing by the control tower*. The event roles of the noun-phrase objects of the prepositions in these kinds of sentences are quite different, with those in the passives being agents, and those in the locatives being locations. Once again, though, their constituent structures were the same.

The first experiment also yielded a nonsignificant trend toward increased production of prepositional datives after the locative primes. Although this raises the suspicion that structure-building may have been sensitive to the conceptual differences between the priming sentences, there is a mundane methodological explanation. The distance between priming trials appears to influence the variability of priming, with shorter distances permitting contamination of the responses on one trial by the events of earlier trials (Bock, 1989). Since it happened that locative trials were more likely to be preceded in the lists by prepositional dative trials than vice versa, the structural priming effect for the locatives could have been adventitiously boosted. The likelihood of this contamination was reduced in the present experiment by increasing the intertrial interval, from 8 items to 12.

Method

Subjects

The subjects were 96 members of the Michigan State campus community, recruited via a newspaper advertisement. Each received \$4 for participating in the experiment.

Materials

Each of the 18 triplets of priming sentences contained a full passive (a *by* passive), a prepositional locative (with a *by* phrase), and an active that served as the control form. Four examples are shown in Table 4. The passives contained passive verbs (including the auxiliary *was* or *were*, and the past participle of the verb) with a patient as subject and an agent as the object of the preposition *by*. The locatives contained the same subject and prepositional object, though the event roles conveyed by the constituents in these grammatical roles differed: the subject was an agent and the prepositional object was a location. To force the locative reading, the verbs were progressive, preceded by the same auxiliary as in the passives. The active member of each triplet had the same subject as the other forms, a direct object that was the same as the prepositional object in the other forms, and an active verb in the simple past tense. The main verbs in all three sentence forms differed.

The 18 transitive-event pictures that were paired with the priming sentences depicted events involving a nonhuman (usually inanimate) agent and a human patient. Some examples of the events include a baseball hitting a boy, a bee stinging a man, an alarm clock awakening a sleeper, and lightning striking a golfer. Half had the agent on the left, and half on the right. The pictures were unrelated to the sentences with which they were paired.

An additional 126 items (63 sentences and 63 pictures) served as fillers in each presentation list. The fillers were similar to those used in Experiment 1.

Table 4. *Examples of priming sentence sets from Experiment 2: passives, locatives, and actives*

Prime type	Examples
Passive	<i>The construction worker was hit by the bulldozer.</i>
Locative	<i>The construction worker was digging by the bulldozer.</i>
Active	<i>The construction worker drove the bulldozer.</i>
Passive	<i>The minister was cut by the broken stained glass window.</i>
Locative	<i>The minister was praying by the broken stained glass window.</i>
Active	<i>The minister fixed the broken stained glass window.</i>
Passive	<i>The foreigner was confused by the blinking traffic light.</i>
Locative	<i>The foreigner was loitering by the blinking traffic light.</i>
Active	<i>The foreigner misunderstood the blinking traffic light.</i>
Passive	<i>The 747 was alerted by the airport's control tower.</i>
Locative	<i>The 747 was landing by the airport's control tower.</i>
Active	<i>The 747 radioed the airport's control tower.</i>

These materials were used to create three 252-item lists. Every list contained all 18 transitive pictures, in the same locations in each list. A third of these were preceded by passive primes, another third by locatives, and the remaining third by actives. Each priming set was represented by one sentence on each list; across lists, all of the sentences from each set occurred just once. Of the fillers, 90 (45 pictures and 45 sentences) occurred twice, and the remaining 36 occurred only once (these 36 items constituted the priming trials for Experiment 3, and are described below). Twelve fillers preceded every priming trial, including the first. Otherwise, their arrangement duplicated that for the first experiment. The lists were presented in four blocks of 63 items each.

Procedure

See the description for Experiment 1.

Scoring

The transcribed descriptions of the experimental pictures were scored as passives or actives. To be scored as a passive, a description had to contain the patient of the pictured event as the subject of the sentence, a verb in the passive voice, a *by* phrase following the verb, and the agent of the action as the object of *by*. Descriptions scored as actives contained the agent as subject, a verb in the active voice, and the patient as direct object. To be scored in either category, a description had to have a grammatical alternative in the other category that reversed the positions of the agent and patient. Descriptions not meeting these criteria were excluded from the analyses. The excluded descriptions included truncated passives (passives in which the agent was not mentioned), so-called lexical or adjectival passives (passives in which an argument that has not been interpreted as an agent is marked by a preposition other than *by*), and actives in which the patient served as the subject and the agent as the direct object.

Application of these criteria yielded 1051 scorable responses (61% of all the descriptions). Of the scorable responses, 34.2% occurred in the passive priming condition, 33.4% in the locative priming condition, and 32.4% in the active control condition.

Design and data analyses

Every subject received 18 experimental pictures, 6 in each of the three priming conditions (passive, locative, and active control). Every experimental picture was presented to 96 subjects, 32 in each of the same three conditions.

The analyses were analogous to those of the previous experiment.

Results

The overall proportions of passives produced in the three priming conditions are presented in Figure 3. The proportions of passives produced in the passive and locative conditions were similar, with a smaller proportion in the active control condition. Table 5 gives the numbers of passives and actives on which these proportions are based.

With number of passives as the dependent variable, the 95% confidence intervals were 27.7 for subjects and 24.8 for items. The differences between the passive and active priming conditions (33) and between the locative and active priming conditions (29) were therefore significant, but the passive and locative conditions did not differ significantly from each other.

The results for active descriptions followed the usual complementary pat-

Figure 3. Overall proportions of passives produced in the three syntactic priming conditions of Experiment 2.

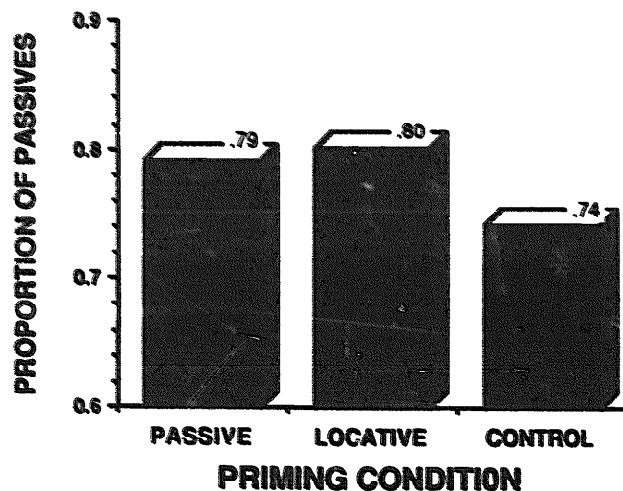


Table 5. Number of passive and active utterances produced in the three syntactic priming conditions of Experiment 2

Priming condition	Utterance form	
	Passive	Active
Passive	285	75
Locative	281	70
Active control	252	88

tern. However, the differences were small (13 and 18 for the passive and locative primes, respectively, relative to the active prime controls) and failed to achieve significance in the subjects analysis, where the 95% confidence interval was 23.9. The difference of 18 between the active and locative priming conditions was significant for items, where the confidence interval was 14.8, and the difference of 5 between the passive and locative conditions was not. The difference of 13 between the active and passive conditions was marginally significant, exceeding the 90% confidence interval of 12.9.

Table 6 shows the number of dysfluencies per utterance for the active and passive forms in each priming condition. The active forms were produced less fluently than the passives, overall, but neither this nor any other effect achieved significance in an analysis of variance.

Discussion

As in the first experiment, differences in the conceptual features of the primes had no impact on the forms of the sentences produced, in contrast to the impact of differences in their structural features. The structural difference again yielded a reliable effect, with both the passive and the locative primes tending to elicit passives more often than did the active control. Since the structures of the passive and the locative were the same, and thus differed in the same way from the active, it is reasonable to conclude that their structural features were largely responsible for the observed priming patterns.

The results of Experiment 2 replicated those of Experiment 1 with a pair of event roles that are more divergent than beneficiaries and locations. The roles contrasted in the primes of the present experiment were those of agency and location, with the object of the preposition representing the agent in one priming condition and the location in the other. Clearly, agents are unlike locations. One manifestation of their uniqueness is their status in hierarchies

Table 6. Number of dysfluencies per utterance in Experiment 2

Priming condition	Utterance form	
	Passive	Active
Passive	0.52 (0)	0.53 (1)
Locative	0.49 (0)	0.57 (3)
Active control	0.56 (0)	0.62 (2)

Note. The numbers in parentheses represent the number of items for which data were missing in the dysfluency analysis.

of thematic roles designed to account for links between conceptual and syntactic relations: agency occupies the topmost position, and location the lowest (cf. Fillmore, 1968; Jackendoff, 1972; Quirk, Greenbaum, Leech, & Svartvik, 1972). So, while an argument might be made for the essential similarity of the roles in the first experiment, it would be much less compelling here. Yet the findings are similar. In neither experiment were the event roles found to affect the repetition of structure.

Similarities in the behavior of passives and locatives are startling from the perspective of early transformational theories in linguistics and psycholinguistics, since different transformations (such as the passive) defined different sentence constructions. However, more recent developments in linguistics, particularly in government-binding theory, have blurred or completely done away with the transformational definition of constructions by reducing all transformational operations to a single movement rule (Chomsky, 1981). As a result, in such theories there is no longer any clear sense in which the passive is a natural syntactic kind, distinct from other so-called sentence types.

In another respect, though, the present results are hard to reconcile with the structures proposed for passives in government-binding theory. The passive is assumed to have a trace after the verb (representing the direct object from the active counterpart), but there is certainly no postverbal trace in a locative with a progressive verb. In studies of sentence comprehension, the psycholinguistic evidence for traces in passives is mixed (compare Bever & McElree, 1988, with Caplan & Hildebrandt, 1988). The priming patterns found in the current experiment are clearly more compatible with a traceless structure. One way to reconcile the results is to assume a purely lexical source for all passives (Bresnan, 1978), and to attribute the processing evidence for traces to the inferential activities required to recover information necessary for language understanding. Such inferences are unlikely to be drawn by producers (who presumably understand what they are saying), and may be a chancier component of comprehension among aphasics, as in Caplan and Hildebrandt's work.

Experiment 3

The first two experiments suggested that the constituent structures of sentences may be created without direct access to the conceptual structures that underlie them. This conclusion rests on the assumption that it is the constituent structures that are primed, and not more superficial sentence features like the rhythms of the sentences or the phonological forms of the closed class

words that demarcate phrases. Experiment 3 was designed to help rule out the latter interpretations.

Sentences such as (a) *Susan brought a book to Stella* and (b) *Susan brought a book to study* are comparable in their subject noun phrases, verbs, and direct object noun phrases, in their metrical structure (number of syllables and lexical stress patterns), and in the phonological identity and positioning of the closed-class words they contain. However, as Figure 4 shows, they differ in their constituent structures. Whereas (a) contains two postverbal constituents at the same level in the hierarchy, (b) has only one.³ If sentence priming engages processes related to constituent-structure building, only (a) should effectively prime the production of target structures such as *The girl is handing a paintbrush to the boy*, since it has the same constituent structure. However, if repetition is the product of more superficial relationships between primes and possible targets, both (a) and (b) should be effective, relative to a control.

These hypotheses were tested in the present experiment. It was run concurrently with Experiment 2, so the subjects and lists were identical.

Method

Subjects

The subjects were those in Experiment 2.

Materials

Eighteen triplets of priming sentences were constructed, with each containing a prepositional dative, an infinitive, and a double-object control. Four examples are shown in Table 7. The prepositional dative and infinitive forms were identical up to and including the word *to*, where they diverged. The datives were completed with a noun phrase and the infinitives with a verb that was generally followed by a noun phrase or other verb phrase complement. The numbers of syllables and the stress patterns of the dative and infinitive completions were equated.

The double-object control forms had the same sentential subjects as the prepositional datives and infinitives, and their second objects were the same as the direct objects of the prepositional datives and infinitives. The first objects were phrases that were matched in numbers of syllables and stress

³There is a different analysis of *Susan brought a book to study* in which *to study* serves as a sentence adjunct rather than an adjunct of the noun phrase. However, this analysis also yields a structure quite different from that of *Susan brought a book to Stella*.

Figure 4. Approximate phrase structures of Susan brought a book to Stella and Susan brought a book to study.

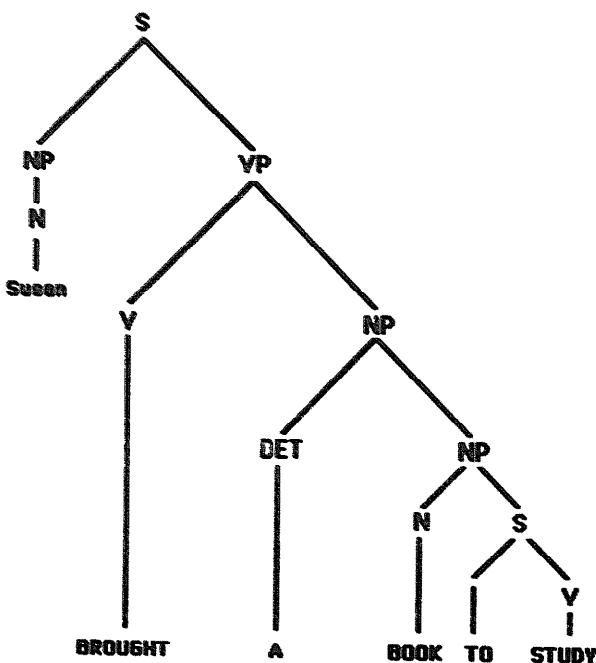
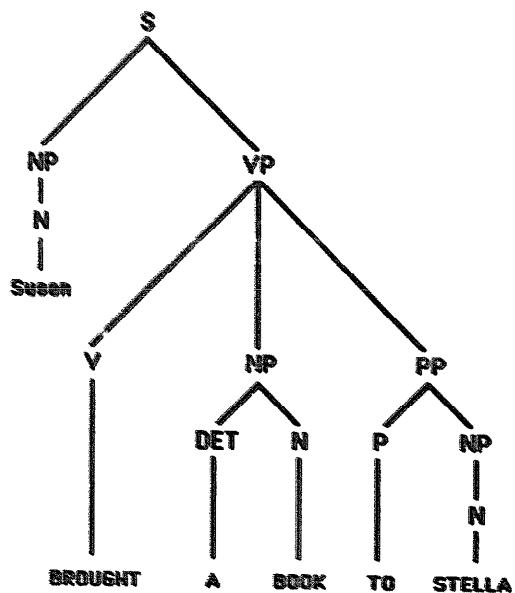


Table 7. Examples of priming sentence sets from Experiment 3

Prime type	Examples
Prepositional dative	<i>Susan brought a book to Stella.</i>
Infinitive	<i>Susan brought a book to study.</i>
Double-object	<i>Susan brought the student a book.</i>
Prepositional dative	<i>The candidate wrote a letter to the state delegation.</i>
Infinitive	<i>The candidate wrote a letter to explain his position.</i>
Double-object	<i>The candidate wrote the Republican mayor a letter.</i>
Prepositional dative	<i>The defendant told a lie to the crowded courtroom.</i>
Infinitive	<i>The defendant told a lie to protect his daughter.</i>
Double-object	<i>The defendant told the suspicious lawyer a lie.</i>
Prepositional dative	<i>The housewife mailed a check to Michigan's Wildlife Fund.</i>
Infinitive	<i>The housewife mailed a check to pay the electric bill.</i>
Double-object	<i>The housewife mailed the minister's bankrupt church a check.</i>

patterns to the *to*-phrases in the dative and infinitive forms, so the lengths of all the sentences within each triplet were equated.

The sentences from the priming sets were paired with dative pictures to create the priming trials, as in previous experiments. Half of the 18 pictures had the recipient of the action on the right, and half on the left.

The lists were as described for Experiment 2, with the priming trials for this experiment constituting nonrepeated fillers with respect to that experiment, and vice versa. The priming trials were also arranged in the same way within and across lists as in Experiment 2, except that five fillers preceded the first trial and seven followed the last.

Procedure

The procedure followed that of the previous experiments.

Scoring

The scoring criteria were the ones described for the first experiment. Application of these criteria yielded 953 scorable responses (55% of all the descriptions). Of the scorable responses, 31.6% occurred in the prepositional dative priming condition, 33.1% in the infinitive priming condition, and 35.4% in the double-object control condition.

Design and data analyses

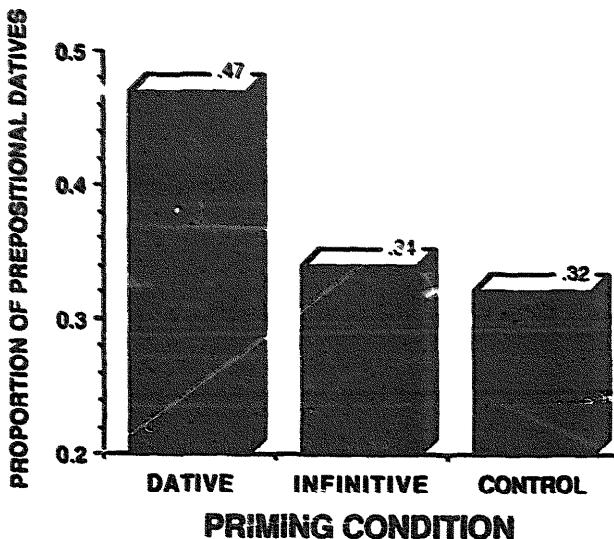
Every subject received 18 experimental pictures, six in each of the three priming conditions (prepositional dative, infinitive, and double-object control). Every experimental picture was presented to 96 subjects, 32 in each of the same three conditions. The types of analyses duplicated those of the preceding experiments.

Results

The overall proportions of prepositional datives produced in the three priming conditions are presented in Figure 5. The graph shows that only in the prepositional dative priming condition was there an appreciable elevation in the proportion of prepositional datives produced, with the infinitive and double-object conditions being roughly equal.

The total numbers of prepositional and double object forms produced in each condition are given in Table 8. For the prepositional dative utterances, planned comparisons showed that the prepositional dative primes and the other prime types differed significantly for both subjects and items (with 95% confidence intervals of 22.2 and 30.2, respectively). For the double-object utterances, there was significantly increased use in the double-object priming condition relative to the prepositional dative priming condition (the 95% confidence intervals for these comparisons were 24.9 and 29.3 for subjects and items). Although there were also more double-object forms after double-

Figure 5. *Overall proportions of prepositional datives produced in the three syntactic priming conditions of Experiment 3.*



object primes than after infinitive primes, the difference of 21 did not achieve either conventional or marginal significance (the 90% confidence intervals were 21.8 and 25.4 for subjects and items).

Table 9 shows the number of dysfluencies per utterance for the prepositional and double-object forms in each priming condition. There was a general tendency for prepositional forms to be produced less fluently than double-object forms, along with a trend toward more fluent production of primed forms (prepositional datives after prepositional dative primes and double-object datives after double-object dative primes). An analysis of variance with items random yielded a main effect of utterance form, $F(1,17) = 5.22$, but no significant interaction between prime type and form type, $F < 1$. The increased fluency of utterances that matched the priming forms did not achieve reliability in Newman-Keuls pairwise comparisons.

Discussion

The results suggest that neither the metrical structure nor the arrangement of closed-class words in the primes had appreciable effects on the structural

Table 8. *Number of prepositional and double-object utterances produced in the three syntactic priming conditions of Experiment 3*

Priming condition	Utterance form	
	Prepositional	Double-object
Prepositional dative	140	161
Infinitive	108	207
Double-object control	109	228

Table 9. *Number of dysfluencies per utterance in Experiment 3*

Priming condition	Utterance form	
	Prepositional	Double-object
Prepositional dative	0.75 (1)	0.72 (0)
Infinitive	0.88 (1)	0.72 (0)
Double-object control	0.83 (2)	0.71 (0)

Note. The numbers in parentheses represent the number of items for which data were missing in the dysfluency analysis.

forms of the picture descriptions. What influenced them instead were the primes' constituent structures.

These findings dovetail with others. The negligible contribution of closed class elements to structural priming has been reported previously: varying the preposition in a priming sentence seems to have no impact at all on the target form (Bock, 1986, 1989). The separate contributions of metrical and syntactic structure to production are indicated in the work of Ferreira (1988). In studies of pause patterns, Ferreira found that some of the effects that are often ascribed to syntactic factors (e.g., vowel lengthening in phrase-final words) instead reflect features of the timing structure. When the features that affect timing structures were controlled, the syntactic complexity of subject and predicate phrases produced systematic and separable changes in sentence initiation times and pre-verb pause times. Ferreira argued that there is a separate syntactic representation that must be converted into a timing structure, which in turn controls utterance execution. This is consistent with the present data, which suggest that syntactic structures can be distinguished from metrical patterns in their consequences for production.

The only feature of the results that departs in any way from this claim involves the production of double-object utterances. Because their structure also differs from that of the infinitives, they should have been produced more often after double-object primes than after infinitival primes. In fact they were, but not significantly so. The double-object form may be more similar to the structure of the infinitive form than to that of the prepositional dative, but there is currently too much divergence in the linguistic analyses of double objects and infinitives to allow this conjecture to be evaluated with any confidence.

Although the metrical similarities of the primes did not neutralize their syntactic differences, we have reason to believe that stronger metrical effects would emerge under other conditions. Some of our pilot subjects were uniquely and unaccountably inept at producing the priming sentences, and tended to attempt them at least twice, sometimes more often, before getting them correct. For these subjects, the prepositional dative and infinitive priming forms yielded similar patterns, different from the controls. It is tempting, albeit speculative, to regard this as the result of turning the primes into little more than rhythmic sequences of syllables in immediate memory.

The results of Experiment 3 were obtained in conjunction with those of the second experiment. There are two points to be made about that. The first has to do with the spacing of the priming trials, as discussed in the introduction to Experiment 2. Because the trials were farther apart in this experiment than in the first experiment, there was less likelihood of spillover from one priming trial to the next. This should have increased the clarity of the priming

effect, and a comparison of the dative conditions with the control conditions in Figures 1 and 3 reveals that it did. The second point concerns the possibility of insensitivity among the subjects to the kinds of contrasts that were tested in these experiments. On the measures used, the same subjects who responded similarly to *The 747 was alerted by the control tower* and *The 747 was landing by the control tower* responded differently to *Susan brought a book to Stella* and *Susan brought a book to study*. This pattern of results can be interpreted more parsimoniously in terms of the characteristics of the sentences' constituent structures than in terms of changes in subjects' sensitivities or strategies.

General discussion

Together, these studies suggest that some of the procedures that create sentences are, or at least can be, relatively indifferent to certain features of the ideas being expressed. Variations in the event roles encoded in utterances, as in a change from a beneficiary or an agent to a location, had no readily detectable impact on the tendency to generate a target sentence form. At the same time, superficially minor variations in wording, as in a change from a *to + NOUN* phrase to a *to + VERB* phrase, had a regular effect on the tendency to produce the same target form. Our explanation turns on the fact that the event-role change had no consequences for the hierarchical constituent pattern, whereas the wording change did. Whatever the operations that create sentence frames, they are prone to repeat themselves, and this predisposition is not much affected by changes in basic conceptual roles.

Though others have observed that people tend to say the same thing on successive occasions, it is rarely obvious what constitutes "the same thing". Even when what is said is nominally identical to something that has gone before, the level at which the repetition is implemented may be more abstract, with the concrete details following upon a higher-level perseveration. In the case of sentence-form priming, it appears that constituent-structure similarity may play a more substantial part than closed-class word frames or metrical structure, which might provide a phonological basis for the phenomenon, or the organization of the components of events, which might provide a conceptual basis for the phenomenon. Instead, much of what drives this sort of repetition appears to be due to the hierarchical configurations of sentences.

These results supplement earlier ones (Bock, 1986, Experiments 2 and 3) which showed that structural priming occurred despite variations in the animacy of the arguments in the priming sentences. We now have further evi-

dence that structural priming occurs independently of the effects of animacy (Bock, Loebell, & Morey, 1989). Findings like these fit comfortably with Garrett's (1988) theory of the production process. In his theory, a constituent structure is formed after the assignment of syntactic functions to the arguments of sentences, and without access to the features of messages. Sentence priming provides additional support for this sort of segregation of language structure and conceptual structure.

The complex problem of characterizing the mechanisms that are at work can be divided into three more and less tractable sets of issues. The first is comprised of questions about the operations that create constituent structures. The second concerns the priming mechanism itself. The third consists of questions about the information from which such structures are generated, information whose nature remains a matter of tenuous inference more than direct evidence. We will address these three sets of issues in turn.

Forming constituent representations

Although there is virtually no disagreement that speakers do form structures that can be characterized in terms of hierarchical constituent representations, little is known about how the structures are created. Beginning at least with Yngve (1960), relatively explicit models of processes that might be involved have been developed by computer scientists (see Kempen & Hoekamp, 1987, for a good example), along with less specific contributions by linguists and psycholinguists. However, beyond some early attempts to evaluate the psychological adequacy of Yngve's ideas and the notions inspired by transformational grammar, the problem has received scant attention in psycholinguistics. The barriers are by and large the same ones that confounded earlier tests. The integrity of constituent representations relative to other sorts of structures is controversial, the choice of a complexity metric is vexed, and the assessment of endogenously controlled behaviors that are extended in time is hard. The present experiments will perhaps go a small way toward breaking down the first of these barriers, showing that constituent structures are processing entities in their own right, divorceable from operations associated with conceptual information or phonological and metrical information. If the picture is accurate, the implication is that the structures are very shallowly rooted, drawing on information that bears not on the nature of constituents but on their number and configuration.

The shallow integrity of constituent representations

In part, the shallowness of surface constituent representations may have caused the foundering of early quests for syntactic processing operations.

Some of these studies were devoted to testing the implications of what Fodor, Bever, and Garrett (1974) called the derivational theory of complexity (Miller, 1962, 1965). One prediction of the theory was that the operations that form surface structures in production could be equated with syntactic transformations (Miller & McKean, 1964). Transformations were conceived as operations over phrase markers that yielded other phrase markers, with the initial phrase markers being representations of basic grammatical relations – deep structures. The power of transformations was such that the same deep structures could yield different surface structures, and different deep structures could yield the same surface structures. The form of the surface structure was therefore unrevealing of what were regarded to be the basic processing representations and mechanisms.

To tap these deeper features, investigators examined some of the consequences (often for recall) of equating surface form while varying deep structure complexity (Blumenthal, 1967; Blumenthal & Boakes, 1967; Rohrman, 1968). The results of these tests were soon challenged by findings which were interpreted as showing that apparent complexity effects were not due to deep syntactic structure, but to lexical and propositional structure (Polzella & Rohrman, 1970; Rohrman, 1970; Wanner, 1974). From there it was a short step to the contention that meaning-based representations directly drive surface structure formation. That step was taken by most psycholinguists (Garnham, 1985).

We would suggest that this research overshot the mark. If there is a separable domain of syntactic operations in language production, it may not extend very far below the surface. This is not to say that it is simple and transparent. However, with the rejection of transformations first as processing operations (Fodor & Garrett, 1966) and rather later as substantive grammatical formalisms (Bresnan, 1978, 1982; Chomsky, 1982; Gazdar, Klein, Pullum, & Sag, 1985), it now seems more plausible to argue that when similar surface trees are built, similar mechanisms build them.

Constituent structure and rhythmic structure

Another shadow on the integrity of syntactic structure has been cast from a different direction, from the perspective of intonational and rhythmic factors. Its source is the identification of syntax with the rhythms of speech, codified in some way, perhaps, but still a derivative of rhythm: "The rhythm of speech ... is very nearly the structure itself, corresponding intimately to the listener's internal representation" (Neisser, 1967, p. 262).

Evidence linking rhythmic factors to language processes has undermined the credibility of various demonstrations of the role of constituent structure in language processing. Of particular note is the fate of an experiment by Mehler and Carey (1967; see also Carey, Mehler, & Bever, 1970; Mehler &

Carey, 1968). Mehler and Carey used a sentence-perception-in-noise task in which a test sentence was preceded by a group of other sentences that were similar to or different from it in surface structure. Thus, *They are conflicting desires* might have been preceded by sentences such as *They are recurring mistakes* (same structure) or *They are forecasting cyclones* (different structure). Mehler and Carey found that structural similarity between the prime and test sentences was strongly correlated with correct sentence reports.

Subsequently, however, Dooling (1974) showed that part of this effect might have been the result of rhythmic patterns. Changing the rhythms of syntactically matched prime and test sentences significantly reduced performance in the sentence perception task, and keeping the syntax of the target the same as that of a different-rhythm prime did not significantly improve performance relative to a control condition. The appearance is that syntax did not matter, but it may be only an appearance: the effect of syntactic matching was substantial, even if it was not reliable. Moreover, the experiment did not include a complementary condition in which the rhythm stayed the same and the syntax changed. As Dooling recognized, the results left a creditable niche for operations linked to syntactic constituency.

The need to assume separate syntactic and rhythmic components of sentence generation is becoming evident. Experiment 3 makes a case for a syntactic contribution, showing that sentences with different syntactic structures have different consequences for production even when they have similar rhythmic patterns – the same number of syllables and the same sequence of strong and weak stresses. Though syntax and rhythm may be tightly interfaced, with the former serving as the input to the latter (Ferreira, 1988), neither can be eliminated.

The mechanism of priming

Taking the locus of the priming effect to be the sentence frame, the mechanism of priming seems likely to be found in the retrieval and assembly of the frame's component structures. Accordingly, the repetition of sentence structure may involve the tendency to retrieve similar fragments of phrase structure from a fragment store (cf. Lapointe, 1985) and to assemble them in similar ways.

There is an alternative to this procedural account of sentential priming which says that an episodic trace of the frame that was first built for the priming sentence may be recycled for use in the picture description, perhaps just stripped of its terminal string and fitted out with a new one. Though appealing in its simplicity, this story is hard to reconcile with some of the features of structural repetition. First, an episodic trace should be easier to

reinstantiate if it shares appropriate terminal elements with a to-be-produced sentence. To date, no tendency of this sort has been found. The magnitude of structural priming is identical when the prime and target share prepositions and when they do not (Bock, *in press*, Experiment 2). Second, it is rarely the case that the frame from a prime can be reused in its entirety, since the picture descriptions add or subtract adjectives, auxiliaries, adverbs, determiners, and so on. This means that the episodic trace would have to be adjusted in ways whose appropriateness could only be determined by referencing mechanisms that subserve syntactic acceptability. Thus, the mechanisms of adjustment would either be the same mechanisms that are involved in generating sentences from scratch, or have access to the same knowledge that such mechanisms call on. The former claim reduces to the procedural priming account, and the latter requires postulating a duplicate set of sentence production mechanisms that work on episodic traces only.

This leaves many questions open. It is unclear at what level of the phrase-structure configuration the priming effects emerge. Though we have focused on sentential configurations, we doubt that priming is restricted in this way. It should arise at all levels. It is also unknown whether priming is possible from comprehension to production, or vice versa. Assuming that production mechanisms are distinct from parsing mechanisms, a strict procedural view would predict no intermodality priming. However, if the assumption is wrong, even a procedural account would predict intermodal effects.

There are other questions that arise with respect to the links among priming, form repetition, and fluency. Although our fluency analyses were an obviously crude foray into the assessment of ongoing syntactic formulation, they disclosed one consistent pattern: the structural forms that were produced more frequently tended to be produced more fluently. This was most striking in the dysfluency results of Experiment 2, where there was a nonsignificant but nonetheless startling trend toward more fluency in passives than in actives. This departure from the usual superiority of actives on virtually all measures of language performance can be traced to the frequency of passive use in Experiment 2: because the pictured events involved nonhuman agents, the passive was used more often than the active. Similarly, in Experiments 1 and 3 the more frequent form was the double object, and in both experiments double objects were produced significantly more fluently than prepositional datives.

The increased fluency of the more frequently produced forms cannot be readily explained in terms of their overall frequency in the language, particularly in light of the fluency of the passives (Svartvik, 1966, reported that actives were more than 15 times more frequent than passives in narrative texts, and the disparity in spoken language is probably even greater). It

seems more likely that fluency arose from the repetition of those sentence forms that the subjects generated themselves. Since the priming sentences had little impact on the fluency but a reliable impact on the form of the sentences that followed them, it is obvious that the repetition of a form is not enough by itself to cause more fluent production. Instead, increased fluency of speech may reflect increased fluency within other processes correlated with the use of particular forms, such as the mapping from conceptual roles to syntactic functions, or the mapping from syntactic structures to timing structures.

The input to structure formation

Although there is a certain consensus about the nature of the representations that constitute the output of the structure-building mechanisms of speech, there is none at all about the nature of the input. With the demise of the derivational theory of complexity and the deep structure hypothesis, the idea that there is a real but more abstract syntactic representation underlying either production or comprehension was scuttled (though see Garrett, 1988). It was supplanted by various proposals that emphasize the semantic or conceptual correlates of putatively syntactic categories. A similar move has taken place in linguistics.

One focus of this convergence is the idea that thematic relations (agent, theme, goal, etc.) are an important component of language knowledge, use, and acquisition. Generally speaking, such relations are viewed from one of two different perspectives. From the first, they are seen as a finite, small set of primitive elements in the linguistic system, specifically within the lexicon (see Sells, 1985, for a brief exposition). There they serve to represent the nature of the arguments required by words (chiefly verbs, but others as well). In practice, the set is left unenumerated, and intuition arbitrates their identification and individuation. This opens the way to the usual criticism of the approach, the absence of either an agreed-upon set of relations or an agreed-upon set of criteria for membership.

The second view of thematic relations emphasizes their nonlinguistic conceptual foundations, and is skeptical about the existence of a discrete set of roles with consistent features. Ladusaw and Dowty (1988) argue that particular thematic relations are simply labels for various clusters of verb entailments and presuppositions interacting with knowledge of human action. Jackendoff (1983, 1987) has worked out a detailed account along related lines. In Jackendoff's scheme, thematic roles are structural relations within configurations of primitive conceptual elements such as Thing, Event, and Place. Changes in these configurations can create novel relations or subtle modifications of

previous ones, making the difficulty of individuating the relations a principled one. The appearance of certain common roles, over and over again, is attributable to the re-creation of the same configurations.

However they are construed, thematic relations figure prominently in current linguistics. Williams (1984) made a persuasive argument that a system grounded in thematic relations renders redundant such grammatical relations as subject and direct object. This argument has impelled a move toward the treatment of grammatical relations as derived categories in government-binding theory, though they have retained the status of primitives within other approaches, most influentially, in relational and lexical-functional grammar (see Aissen, 1987, for the former and Kaplan & Bresnan, 1982 for the latter).

Given their *prima facie* compatibility with the categories of cognition, thematic relations have also seemed to offer a way to forge the link between form and meaning in language use and acquisition without invoking extremely abstract syntactic categorizations. Encouragingly, they appear to be implicated in language acquisition (Braine & Hardy, 1982), in language understanding (Carlson & Tanenhaus, 1988), and in the dissolution of language in certain aphasics (Schwartz, Linebarger, Saffran, & Pate, 1987).

Despite the burgeoning enthusiasm for thematic-relation-based accounts of linguistic categorization, recent work in linguistics should prompt hesitation in doing away with syntactic roles. Levin and Rappaport (1986) show that certain syntactic patterns that have been argued to require analysis in terms of thematic roles in fact cannot be explained in these terms. What explains them instead are features of predicate-argument structure: how many arguments a verb takes and which of those arguments the verb can directly control. Predicate-argument structures contain only a representation of roles corresponding roughly (though not perfectly) to subjects, direct objects, and so on, and are devoid of thematic content. The proposal is not to eliminate thematic relations from the lexicon, but to supplement the thematic representation with a representation that is specifically relevant to syntactic processes.

Similar caution in abandoning syntactic categories may be appropriate for accounts of language use. The results of the present experiments suggest that, if thematic relations do operate in production, their workings are insulated from the elaboration of constituents. This by no means shows that thematic relations (or the sets of features they roughly label) are irrelevant to language performance, only that they may play their part before constituent representations are formed. In further investigations employing the syntactic priming paradigm (Bock, Loebell, & Morey, 1989), we have obtained evidence that semantically differentiated elements are selectively linked to syntactic roles like subject and object, but in an operation that is distinguishable from the

from the elaboration of constituent structure. The implication of such evidence is that the ongoing use of language involves abstract syntactic categorizations. The products of these categorizations are the obvious candidates for the input to structure formation.

Conclusion

We have offered evidence for a syntactic construction process that is separable from certain meanings that sentences convey. The first two experiments revealed a predisposition toward structural similarity across consecutive sentences that was unperturbed by changes in the meanings that were expressed. The third experiment showed that this predisposition could not be attributed to function-word or metrical similarity. The meanings at issue were linked to the roles of things in events, meanings that differentiate case or thematic relations and are deeply implicated in both language and thought. The structures at issue were prepositional phrases within verb phrases, encoding oblique objects. It may well be that different sorts of meaning have a more direct impact on structure, and that different sorts of structures are more directly sensitive to meaning. Within the limited domain we have explored, however, the structures and meanings appear to be disparate.

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