

## Syntactic Persistence in Language Production

J. KATHRYN BOCK

*Michigan State University*

Activation processes appear to have an important impact on the mechanisms of language use, including those responsible for syntactic structure in speech. Some implications of this claim for theories of language performance were examined with a syntactic priming procedure. On each priming trial, subjects produced a priming sentence in one of several syntactic forms. They then viewed an unrelated event in a picture and described it in one sentence. The probability of a particular syntactic form being used in the description increased when that form had occurred in the prime, under presentation conditions that minimized subjects' attention to their speech, to the syntactic features of the priming sentences, and to connections between the priming sentences and the subsequent pictures. This syntactic repetition effect suggests that sentence formulation processes are somewhat inertial and subject to such probabilistic factors as the frequency or recency of use of particular structural forms. Two further experiments showed that this effect was not appreciably modified by variations in certain conceptual characteristics of sentences, and all three experiments found evidence that the effects of priming were specific to features of sentence form, independent of sentence content. The empirical isolability of structural features from conceptual characteristics of successive utterances is consistent with the assumption that some syntactic processes are organized into a functionally independent subsystem. © 1986 Academic Press, Inc.

The fundamental feature of the native speaker's knowledge of language is productivity. This implies a capacity, under ideal circumstances, to generate and understand an unlimited number of different grammatical sentences in one's language. The primary constraints on this capacity have been ascribed to a set of performance factors that customarily includes memory limitations, a tendency to make mistakes, and distractibility.

Experiment 1 was supported by a grant from the Alfred P. Sloan Foundation to the University of Pennsylvania, and Experiment 2 by a faculty research grant from the Department of Psychology at Cornell University. Many people have contributed to this work, and I thank them all. Barbara Finlay, Jennifer Freyd, David Irwin, Frank Keil, Anthony Kroch, Joseph Stemberger, and Rose Zacks commented on earlier versions of the manuscript. Dorrit Billman, Anthony Kroch, John McKinney, Ruth Ostrin, and Eleanor Saffran offered valuable suggestions and materials for the research. Gina Cherry, Douglas Files, Paul Petersen, James Yeomans, and, singularly, Constance Stillinger assisted in carrying out the experiments. Finally, W. J. M. Levelt and two anonymous reviewers helped to clarify the issues addressed in the paper. Please send correspondence, including requests for reprints, to Kathryn Bock, Department of Psychology, Psychology Research Building, Michigan State University, East Lansing, MI 48824.

lity (Chomsky, 1965). This paper investigates a performance constraint of a type not directly implicated in this traditional list. The constraint is manifested in a tendency to repeatedly employ the same syntactic form across successive utterances, suggesting the existence of additional processes that are antagonistic to the productivity of syntax in actual language use.

The processes in question are central to a number of current discussions of sentence production mechanisms (Bates & MacWhinney, 1982; Bock, 1982; Dell, 1985, in press; Harley, 1984; MacKay, 1982; Motley, Baars, & Camden, 1983; Stemberger, 1985). The common feature of these accounts is their incorporation of activation or strength constructs. In essence, the activation or strengthening of information implies a quasi-neurological energizing, excitation, or threshold reduction that persists over time, increasing the probability that the activated or strengthened information will influence subsequent cognitive processes (Anderson, 1983; Posner, 1978).

The intuitive evidence for activation processes in language production is most striking in everyday speech errors, which provide much of the data for current models of speech formulation. Consider mistakes such as "Get out of the clark" (where "car" was intended, said while glancing at a store front with the name "Clark's" printed on it; Harley, 1984), "I am a sheep in lamb's clothing" (where "wolf's clothing" was intended; Norman, 1981), and "If he says, 'here's looking at you, babe,' take your foot out of the stirrups and wallop him in the chollops" (where "chops" was intended, Garrett, 1980). These errors suggest, respectively, the activation by environmental events of information which then intruded into the utterance, the activation by one word in an utterance of a related word that displaced an intended item, and the persistence of activation of a phonological pattern from one word into a subsequent word.

Although effects of activation processes in language production are most clearly documented in cases involving sounds and words, there are also subtle indications of their role in determining the syntactic features of utterances. Some of the arguments again come from speech errors. For example, mistakes such as "Do I have to put on my seatbelt on?" and "This is getting very difficult to cut this" have been interpreted as a reflection of the simultaneous activation of two different syntactic structures capable of expressing the same semantic intention (Stemberger, 1982, in press).

Possible influences of activation processes on syntax are also suggested by a pattern that has been observed in normal language use. This involves the repetition of syntactic forms across successive utterances. There have been several discussions of this and related phenomena

(Kempen, 1977; Lashley, 1951; Selz, 1922, cited by Levelt & Kelter, 1982; Schenkein, 1980), but two recent studies will serve to illustrate it. Weiner and Labov (1983) have shown that in sociolinguistic interviews, one of the factors that is significantly associated with the occurrence of a passive utterance is the presence of another passive somewhere in the previous five sentences. Levelt and Kelter (1982) also found repetition across speakers in question-answer sequences. For example, they called several hundred merchants in the Netherlands and asked them the Dutch equivalents of the questions (a) *At what time does your shop close?* or (b) *What time does your shop close?*. The responses to these questions varied in a very regular way: When the question contained a prepositional phrase, as in (a), the answer tended to be in the form of prepositional phrase, such as *At five o'clock*; when the question contained a simple noun phrase, as in (b), simple noun phrase responses such as *Five o'clock* increased in frequency.<sup>1</sup>

Observations such as these, which involve the structural features of utterances, raise a critical issue about the nature of the activated information. In the case of lexical and phonological intrusions, exchanges, anticipations, and related errors, it seems natural to ascribe them to the activation of mental representations of the intruding elements. Indeed, they can be elegantly explained and their relative incidence predicted by speech production models that include such activation and representational assumptions (Dell, 1985, in press; Stemberger, 1985). In the case of syntactic intrusions or perseverations, however, it is not clear that the effects can be accounted for in a comparable way.

The major problems center on differences between words and sentences that are related to the abstractness and discreteness of their representations. In the case of lexical knowledge, it is customary to assume that the mental representations encode such features of words as the sounds that comprise them and the order in which the sounds occur. In addition, because lexical and phonological knowledge can be represented as relatively discrete inventories of items that repeatedly enter into behavior in much the same form, it is possible to link their mental representations within networks that define similarity relationships among elements in terms of shared features. Activation can then be viewed as spreading from the representation of one element in the network to the representation of another element, causing it to influence subsequent behavior.

<sup>1</sup> Levelt and Kelter interpreted the repetition effect they observed in terms of a tendency to reuse particular words, which in their studies were always prepositions. However, structural repetition is also involved in the effect, since the repetition of the preposition required the repetition of prepositional phrase structure.

Neither of these assumptions holds in any clear way for the representations of sentences. First, the type-to-token relationships are more complex than for sounds and words. In particular, it makes little sense to assume that there are permanently stored representations of sentence types that directly encode such information as the order of their component words, whether in terms of the words themselves or their form-class categories (e.g., an encoding such as "definite article, adjective, noun, past tense singular auxiliary, progressive verb, preposition, noun, adverb" to represent the category of sentences that includes "The little girl was walking to school slowly"). Second, because the grammatical sentences tacitly known by an individual do not constitute a discrete set, it appears even less likely that sentence codes (at the level of sequences of grammatical categories, for example) might be linked to one another to represent shared syntactic properties. It is therefore difficult to assume that syntactic perseverations or syntactic blends result from anything along the lines of the activation of elements of knowledge similar in character to those that represent words, or to the spread of activation from the representation of one sentence to the representation of a related sentence that is about to be produced.

A different notion is that an episodic (i.e., token based) representation of a previously heard or spoken sentence directly influences the formation of subsequent utterances. This hypothesis received careful scrutiny in several experiments reported by Levelt and Kelter (1982). They examined a number of ways in which the maintenance of a prior sentence in memory might create persistence of the sort they observed in the telephone question-answer sequences. Their findings suggested that the repetition effect could not be fully explained by the maintenance of the question in working memory, or by its persistence in an articulatory buffer, or by long term storage of the surface structure of the question. Each of these sources (with the possible exception of the articulatory buffer) seemed to contribute to the effect, but no single one fully accounted for it.

An alternative hypothesis is that it is not type- or token-based sentence representations that are responsible for the repetition effect, but the syntactic processes responsible for their generation or interpretation. This hypothesis assumes that grammatical patterning in speech results from the application of cognitive realizations of syntactic rules or structural heuristics, perhaps via procedural representations of grammatical structures (e.g., condition-action pairings; Anderson, 1983; Bock, 1982). One likely result of this application would be an increase in the activation level or strength of the procedures, raising the probability of their subsequent use. The repetition of syntactic structure is a possible consequence.

Such an account is consistent with a number of current views of syn-

tactic formulation mechanisms (Bock, 1982; Dell, in press; MacKay, 1982; Stemberger, 1985). However, it is not completely clear that it is necessary. There have been too few systematic observations of syntactic persistence to make identification of its causes possible, and most of those that appear in the literature can perhaps be explained without appealing to the activation or strengthening of syntactic procedures. For example, some may be attributable to lexical repetition, as Levelt and Kelter (1982) assume, or to a socially motivated matching of the form of one's utterances to the form of an interlocuter's utterances (Giles & Powesland, 1975; Putnam & Street, 1974), or to the persistence of communicative intentions or discourse strategies that trigger the same syntactic forms, or to communicative tactics that predispose the repetition of structure, such as maintaining a question in active memory while formulating an answer (Malt, 1985). None of these explanations requires a change in the state of syntactic mechanisms, per se, but only the maintenance or reinstatement of information that is correlated with their use.

The advantage of the syntactic activation hypothesis is that it provides a unitary explanation for phenomena that otherwise seem quite disparate. For example, on occasions when communicative intentions were likely to have been very similar, as in the merchants' responses to the telephone inquiries in Levelt and Kelter's (1982) experiment, the syntactic forms that were used nonetheless varied. In the case of Weiner and Labov's (1983) sociolinguistic interviews, despite the likelihood of changes in speakers' communicative intentions, the syntactic forms that were used showed some persistence. What both cases have in common is simply the repetition of a preceding syntactic form.

The studies that follow were designed to explore the syntactic activation or strengthening hypothesis under conditions less susceptible to these alternative accounts. All of the experiments employed a syntactic priming paradigm that created a controlled analog of the situations that have revealed syntactic repetition in natural speech. On each priming trial, the subjects first heard and then repeated a priming sentence in a particular syntactic form. For example, a subject might hear and repeat the sentence *The corrupt inspector offered a deal to the bar owner*. Then a line drawing unrelated to the priming sentence was presented, such as a picture of a boy handing a valentine to a girl, and the subject described the depicted event. What was of interest was the syntactic form of the description the subject produced: The picture might be described either as *The boy is handing a valentine to a girl* or *The boy is handing the girl a valentine*. The first of these descriptions has the same syntactic form as the priming sentence, while the second is different. Other subjects received an alternative form of the priming sentence, *The corrupt inspector offered the bar owner a deal*, followed by exactly the same target picture.

The priming trials were embedded in a recognition memory test that

made speaking appear incidental to the purpose of the experiment, in order to minimize subjects' attention to their speech and its structural

sponding to the target picture. The alternative descriptions of the target pictures that were examined differed substantially in the order and grammatical roles of their primary constituents, so that structural as well as lexical variations were required if the form of a picture description was to correspond to the form of the priming sentence. Under these conditions, the occurrence of syntactic repetition (manifested as an increased probability of producing a sentence in a given syntactic form after producing another sentence in the same form) would provide support for the hypothesis that the procedures responsible for the creation of a sentence's structure can be activated or strengthened by use.

The first experiment explored this hypothesis for cases in which there was no regular relationship between the messages or likely communicative intentions expressed in consecutive sentences. The second and third experiments examined the persistence of abstract structural features in the face of variations in meaning that are commonly associated with changes in syntactic form.

## EXPERIMENT 1

### *Method*

*Subjects.* The subjects were 48 members of the University of Pennsylvania campus community, predominantly students. They were paid \$4 for their participation in the 1-h experiment.

*Materials.* The primary materials for the experiment consisted of two types of priming sentences and target pictures, transitives and datives. There were 24 transitive target pictures, each paired with one of 24 sets of transitive sentences, and 12 dative target pictures, each paired with one of 12 sets of dative sentences. Figure 1 gives an example of a sentence set and target picture of each type. Appendix A contains a complete list of the priming sentences.

The 24 transitive target pictures depicted events that could be described with either an active or a full passive sentence. Every event involved an agent, an action, and a patient, with half of the events having human agents, and half nonhuman agents. Each set of transitive priming sentences included two different forms, an active sentence (e.g., *A gang of teenagers mugged the building manager*) and a corresponding full passive (e.g., *The building manager was mugged by a gang of teenagers*).

Each of the 12 dative target pictures depicted events that could be described with either a prepositional or a double-object dative sentence (see Fig. 1). All of the events involved an agent, an action, a patient, and a beneficiary of the action. The 12 sets of dative priming sentences included a prepositional dative (e.g., *The governess made a pot of tea for the princess*) and a corresponding double-object dative (e.g., *The governess made the princess a pot of tea*). Eight of the sets had prepositional forms in which the prepositional phrase began with the preposition *to*, and four had prepositional forms in which the prepositional

## TRANSITIVE

## DATIVE

## PRIMING SENTENCES

## ACTIVE:

ONE OF THE FANS  
PUNCHED THE  
REFEREE.

## PREPOSITIONAL:

A ROCK STAR SOLD  
SOME COCAINE TO AN  
UNDERCOVER AGENT.

## PASSIVE:

THE REFEREE WAS  
PUNCHED BY ONE  
OF THE FANS.

## DOUBLE OBJECT:

A ROCK STAR SOLD  
AN UNDERCOVER AGENT  
SOME COCAINE.

## TARGET PICTURES



FIG. 1. Examples of transitive and dative priming sentences and target pictures used in Experiment 1. Only one of the two alternative priming sentence forms was presented on each priming trial, followed by a target picture. Note that the target pictures can be described with either of the two primed syntactic forms, as in *Lightning is striking the church* or *The church is being struck by lightning* for the transitive picture, and *The man is reading a story to the boy* or *The man is reading the boy a story* for the dative picture.

phrase began with the preposition *for*. Each set also contained an intransitive sentence (e.g., *The rhododendrons are blooming*) in order to assess preferences for the two alternative dative forms after a minimally related sentence type.

In addition to the transitives and datives, six target pictures and six sets of priming sentences of another syntactic type were incorporated into the list. Each of the transitive sentence sets also contained an agentless passive and an unrelated lexical passive. These materials were included for purposes that go beyond the scope of the present work, and are not considered further.

There were 42 filler pictures and 42 filler sentences in addition to the priming sentences and target pictures. Most of the filler pictures depicted intransitive actions (e.g., a woman running, a boy sleeping). The filler sentences represented a wide assortment of constructions, including reflexives, locatives, existentials, clefts, pseudoclefts, predicate adjectives, and complement constructions.

The target and filler pictures were sketched in black ink on white paper, or photocopied

from line drawings created for an adolescent personality test (McKinney, 1978) and the testing of speech production in aphasics (Ostrin, 1982; Saffran, Schwartz, & Marin, 1980). They were then reproduced on 15 × 22.5-cm index cards. To lend face validity to the cover recognition task, several sets of pictures were included that differed in relatively subtle ways; for example, in the age or sex of the agent, or in the roles of the participants in an event.

The priming sentences, target pictures, filler sentences, and filler pictures were assigned to twelve 168-item test lists. The 12 versions of the list varied only in the specific priming sentences that they contained. They were in all other respects identical, having the same

priming sentences immediately preceded a target picture of the same type. In all lists, the two transitive priming conditions (active versus full passive) were each represented by six sentences, and the three dative priming conditions (prepositional, double-object, intransitive) were each represented by four sentences. No priming sentence occurred more than once in any given list. Across lists, all of the transitive priming sentences occurred exactly three times, and all of the dative priming sentences occurred exactly four times.

Any given target picture was always primed with sentences from the same priming set. Care was taken in the pairing of priming sentences and target pictures to ensure that there was little possibility of inferring co-reference between expressions in the priming sentences and elements of the target pictures, little likelihood of similar rhythms or intonation contours in the priming sentences and elicited picture descriptions, and, for transitive pairings, no regular relationship between the priming sentence and the pictured event in the distributions of animacy across the agent and patient roles.

The following constraints on test list order were observed: (a) No consecutive priming trials involved sentence-picture pairs of the same type (transitive or dative); (b) no more than two filler pictures, or two filler sentences, or two priming trials occurred consecutively; and (c) no more than three "yes" or "no" trials occurred in sequence (in the cover

sentences and the target pictures. (The target pictures were presented in the study list to familiarize subjects with the depicted events, in an effort to facilitate the verbal description of the pictures that was required during the subsequent presentation of the test list.) The arrangement of items in the study list was random, with the constraints that no more than two pictures or two sentences occurred consecutively, and that items in the same neighborhood within the list were thematically unrelated to one another.

The pictures in the study and test lists were presented in booklets constructed from acetate-bound photograph album pages. There was one picture per page, with the page facing each picture always empty. The booklets contained blank pages at those positions in the list where sentences would be presented.

*Procedure.* The experimental sessions were recorded on audio tape using a cassette tape recorder equipped with a lapel microphone. Subjects were run individually, and leafed through the study and test booklets at their own pace. When they reached a blank page, the experimenter read the sentence that occurred in that list position aloud. The sentences were read at a moderate rate with normal intonation.

The experiment was divided into two phases in order to establish the recognition memory format. The study list was presented during the first phase, when subjects were told only



that they should carefully examine the pictures and listen to the sentences in order to be able to recognize them later. They did not describe the pictures or repeat the sentences in the study phase, nor did they know they would be asked to do so later.

After completing the study phase, the subjects were given instructions for the test list (reproduced in full in Appendix B). They were asked to identify the pictures and sentences they had encountered in the study list by saying "yes" or "no." In addition, they were instructed to perform two secondary tasks that instituted the priming procedure, sentence repetition and picture description. The sentence repetition task required the subjects to repeat the sentences out loud immediately after the experimenter read each one. The picture description task involved a brief description of what was happening in the pictures, in one sentence without pronouns. Four practice pictures were presented for subjects to describe before testing began. None of the subjects had any difficulty following the instructions.

The subjects repeated every sentence and described every picture in the test list. The sequence of events on the pairs of items that constituted the priming trials was as follows: The experimenter read the priming sentence aloud, and the subject repeated it. (Repetition errors were rare; when they occurred, the experimenter repeated the entire sentence and asked the subject to repeat it again.) The yes-no recognition decision followed, and the experimenter provided feedback about its accuracy (the correct decision for all priming sentences was *no*). The subject immediately turned the page for the next item (the target picture), described what was happening in the picture, and made another yes-no decision for which the experimenter again provided feedback (the correct decision for all target pictures was *yes*).

After completing the recognition test, subjects were questioned about their awareness of relationships between the pictures and the sentences, effects that the sentences they repeated might have had on their descriptions of the pictures, special characteristics of the sentences that they repeated, and deviations in their picture descriptions from their normal speech patterns.

*Design.* Every subject described six transitive pictures in each of the two cells representing the two levels of the transitive priming factor (active versus full passive), and four dative pictures in each of the three cells representing the three levels of the dative priming factor (prepositional, double-object, and intransitive), so the design was completely within subjects. Each of the 24 transitive pictures was viewed by 12 subjects in both cells of the

were scored as *active*, *full passive* or *other*, and descriptions of the dative pictures were scored as *prepositional*, *double object*, or *other*. All utterances not scored as *other* had to contain a description of the event in a complete clause without pronouns, except for omissions of articles or auxiliary forms of *be*. When a subject produced two different descriptions of an event in immediate succession, only the first was scored.

To be scored as an *active*, a description had to include a transitive verb with the agent of the depicted action in subject position and the patient in direct object position. To be scored as a *passive*, the patient had to appear in subject position, with the main verb preceded by one form of *be* or *get* and followed by the agent of the action within a *by* phrase. *With* or instrumental passives, e.g., *The boy's being hit with a ball*, were scored as *other*, as were sentences with intransitive or middle verbs accompanied by prepositions (e.g., *crash into*, *collide with*). Any active descriptions that could not have occurred in the passive, and any passive descriptions that could not have occurred in the active were also excluded.

*Prepositional* datives required a dative verb followed by the direct object and a prepositional phrase incorporating the indirect object; *double-object* datives required the verb to be followed by the indirect and direct object noun phrases, in that order. Prepositional datives without corresponding double-object forms (e.g., *The girl is presenting flowers to her teacher*) were scored as *other*.

### Results

The priming patterns were clear and unusually orderly (see Table 1). For datives, prepositional primes increased the incidence of prepositional utterances by 23% relative to their frequency following double-object primes, and double-object primes increased the incidence of double-object utterances by 22% relative to their frequency following prepositional primes. Active and passive utterances each increased in frequency by 8% following corresponding primes. Confidence intervals (shown in Table 1) for the differences between the means were constructed using the appropriate values of the *t* statistic. All of these differences were significant for both subjects and items ( $p < .05$ ).

The total percentages of descriptions produced in the alternative utterance forms are relevant to an interpretation of the locus of the priming effects. Within each sentence type, these totals were essentially identical: for the two transitive priming conditions, the totals were exactly the same, 85% in both cases, and for the datives, the total was 79% in the prepositional priming condition and 78% in the double object priming

TABLE 1  
Effect of Syntactic Priming on Form of Sentences: Percentages of Utterances in Four Syntactic Forms following Priming Sentences in the Same or an Alternative Form

Priming condition	Utterance form		Total
	Prepositional dative	Double-object dative	
Prepositional dative	48	31	79
Double-object dative	25	53	78
Difference	23 $\pm$ (8), (10)	22 $\pm$ (7), (13)	
	Active transitive	Passive transitive	
Active transitive	73	12	85
Passive transitive	65	20	85
Difference	8 $\pm$ (6), (7)	8 $\pm$ (7), (6)	

*Note.* The percentages for datives are based on a possible 192 responses in each priming condition and those for transitives on a possible 288 responses in each priming condition. The 95% confidence interval half-widths for each condition difference are given parenthetically for subjects and items (S), (I).

condition. This suggests that the priming sentences did not influence the perception or conceptual interpretation of the pictured events.

In order to examine the role that specific words might play with respect to syntactic persistence, the repetition effects for the two different kinds of prepositional dative priming sentences were contrasted. These consisted of *to*-datives and *for*-datives. Since all of the prepositional dative picture descriptions employed *to* in the prepositional phrase, disparities in the effects for the two different types of primes would suggest that closed-class word frames play an important role. Table 2 gives the mean percentages of descriptions of each type (prepositional versus double object) produced after the two kinds of prepositional primes and their corresponding double-object primes. Two features of the data are worth noting. First, all of the comparisons revealed the repetition effect found in the overall analysis: There was a consistent tendency for the primed form to be used more frequently than the unprimed form. This was true for the prepositional primes, both for the *to* primes (with seven of the eight items showing the predicted effect) and for the *for* primes (with three of the four items showing the predicted effect). Second, the effect appeared to be somewhat stronger in the case of *to* primes than in the case of *for* primes (although the small numbers of items involved in this partitioning of the data make statistical comparisons uninformative). However, this occurred not only for the prepositional primes, but also for the double-object primes, where there were no differences between the *to*- and *for*-datives in their closed-class frames. This suggests that the specific pictures paired with the *to*-dative versus the *for*-dative primes may have been partly responsible for the minor differences between them in the strength of the repetition effects.

Following the intransitive primes for the dative pictures the preposi-

TABLE 2  
Effect of Closed-Class Word Frames on Priming: Percentages of Utterances in Two Dative Forms following *to*-Dative versus *for*-Dative Priming Sentences

Priming form	Utterance form	
	Prepositional dative	Double-object dative
Prepositional <i>to</i> -dative	49	29
Double-object <i>to</i> -dative	22	56
Prepositional <i>for</i> -dative	44	34
Double-object <i>for</i> -dative	31	47

*Note.* All of the prepositional dative utterances were *to*-datives.

tional form was used 41% of the time and the double-object form 37% of the time. This difference was not significant, indicating that there were no strong preferences for the prepositional or the double-object form in the absence of a dative prime.

Although the overall priming patterns for the transitive utterances were regularly related to the syntactic forms of the priming sentences, inspection of the descriptions of pictures with human versus nonhuman agents showed that the use of passive sentences was highly correlated with nonhuman agency. Half of the events depicted by the transitive pictures had human agents, and descriptions of these showed no priming effect (see Table 3).

Subjects' responses to the postexperimental questions indicated that the recognition cover task was very effective. The subjects did not think that the sentences were in any way related to the pictures; they did not think their speech was influenced by the characteristics of the sentences they repeated; and they were fully convinced that the experiment concerned recognition memory for pictures and sentences.

### *Discussion*

for two different types of sentences, with use of the alternative forms of each type (active versus passive transitives, and prepositional versus double-object datives) varying as a function of the form of a previous sentence. These variations occurred under conditions in which there was little or no impetus for the active maintenance of the priming sentences in memory, or for the use of syntactic devices to create discourse coherence. In addition, the subjects' lack of awareness of the similarities between the forms of the priming sentences and picture descriptions suggests that the matching was not performed consciously or strategically.

TABLE 3  
Percentages of Active and Passive Utterances Used to Describe Pictures of Events with Human versus Nonhuman Agents as a Function of Active versus Passive Primes: Experiment 1

Priming condition	Nonhuman agent		Human agent	
	Active utterances	Passive utterances	Active utterances	Passive utterances
Active transitive	51	24	93	1
Passive transitive	36	39	94	1

in the use of closed-class or function words, particularly prepositions. This involved *by* for passives, and *to* for prepositional datives. However, lexical repetition does not seem to be a necessary component of the priming effect. First, it was observed for active and double-object structures in which there were no distinctive closed-class structural markers. Second, there were no striking disparities in the prepositional dative priming effects when both the priming sentence and the picture description employed the preposition *to*, compared to when the priming sentence contained *for* and the description *to*.

Another hypothesis about the source of the repetition effect concerns the influence of the priming sentence on the processes involved in interpreting the picture. For example, it might be argued that passive priming sentences caused subsequent pictures to be viewed in such a way that recipients of the action assumed greater prominence in the events, thereby biasing the production of passive descriptions. The total number of transitive descriptions produced in each priming condition can be used to evaluate this and other "input bias" hypotheses. Since there are natural event-viewing preferences (for example, a tendency to focus on the agent that is found even in young children; Robertson & Suci, 1980), any disruption of such preferences by the priming sentences should lower the number of transitive descriptions produced (for example, by increasing the number of agentless passives). This did not occur. Comparisons between the two transitive priming conditions, and between the two dative priming conditions, revealed virtually identical numbers of descriptions produced.

Thus, the only obvious correlate of the variations in the syntactic form of the picture descriptions was the syntactic form of the priming sentence. A parsimonious explanation of these results, and those of previous investigations (Levelt & Kelter, 1982; Weiner & Labov, 1983), is that the production of sentences results in the activation or strengthening of the syntactic rules or procedures involved in their creation. Subsequently, if the conditions for the application of the procedures are met, they will be more likely to be used than alternatives that are less activated. This view of linguistic rules as graded rather than fully determinate is comparable to that incorporated into the competition model of Bates and MacWhinney (1982; MacWhinney, Bates, & Kliegl, 1984).

The picture is potentially complicated by the results for descriptions of

of messages, with the occurrence of passives strongly associated with

inanimate or nonhuman agents (Clark, 1965; Clark & Begun, 1971; Dewart, 1979; Harris, 1978). Such a pattern suggests that the priming manipulation may be ineffective when activated syntactic procedures are blocked from application by the conceptual features of a message. This raises a controversial issue about the nature of syntactic processing in sentence production that is explored in the next two experiments.

## EXPERIMENT 2

It is clear that conceptual representations are the input to syntactic processes in the creation of speech. What is less clear is the depth of the penetration of conceptual features into syntactic mechanisms. Garrett, for instance, argues that "we should take seriously the view that most significant aspects of syntactic processing for sentences are done independently of their ultimate semantic consequence . . . both for sentence production and sentence comprehension" (1976, p. 232). Such a view suggests that the influence of conceptual factors should be confined to an initial mapping from the message to an abstract syntactic representation, after which syntactic processing proceeds without further intervention from message characteristics (Garrett, 1975, 1980, 1982). The conceptual features required in this framework might be only those that are needed to distinguish grammatical from ungrammatical sentences.

This approach contrasts with the view that language structures are relatively direct reflections of semantic notions or communicative strategies that are generally important in human thought and social interaction (Bates & MacWhinney, 1982). Applying this view to comprehension, MacWhinney et al. (1984) hypothesize that semantic and syntactic cues have equal and direct access to parsing procedures, allowing the structure of a to-be-comprehended sentence to be inferred from structural and semantic information working in concert. Analogizing to production, it might be supposed that the grammatical structures provided by a language interact with the features of the message to determine the surface syntactic form of the utterance. There need be no intermediate level of linguistic structure beyond which processing is wholly syntactic. Any conceptual feature that is regularly associated with a particular form or structure might therefore come to influence its use.

The absence of priming effects for human agent events in the previous experiment is consistent with this latter view, since it suggests that an important condition on the use of a particular constituent structure is a conceptual feature of the message that is not strictly associated with grammaticality: There are no absolute prohibitions on the English passive that can be traced to the humanness of agents. Instead, the grammaticality of the passive is regulated by the argument structure of English verbs, with almost all transitive verbs being grammatical in either the active or the passive form.

If direct message-to-form mappings are a critical part of the use of particular syntactic devices, the prior use of a particular form to express a message with a feature that is central to the mapping process should bias the subsequent expression of similar messages to a greater degree than the expression of dissimilar messages. Experiment 2 was designed to test this hypothesis by comparing, for passive picture descriptions of non-human agent events, the effect of passive priming sentences with human agents and passive priming sentences with nonhuman agents. If features of messages such as human agency play a critical role in determining the use of a particular linguistic form, there should be a stronger tendency to employ a passive in describing a nonhuman agent event after using another nonhuman agent passive, since the same linking, matching, or condition-testing procedures apply.

The alternative hypothesis is that human and nonhuman agent passives should be equally effective as primes for passive descriptions of non-human agent events. If the structure of a sentence is determined in part by message-neutral processes that apply to abstract syntactic representations, those processes may be activated roughly equally by the prior use of human- and nonhuman-agent passives (since any differences in their abstract syntactic representations would be relatively minor). There should therefore be a general syntactic priming effect, with passives increasing in frequency after passive relative to active primes, but without a difference between the two types of passive primes.

Analogous predictions apply to passive descriptions of human agent events (although the rarity of passive descriptions of such events make them vulnerable to floor effects) and to active descriptions of human and nonhuman agent events.

### *Method*

*Subjects.* The subjects were 48 Cornell University students recruited by sign-up sheets in a campus building and paid \$3 for participating.

*Materials.* There were 24 sets of transitive priming sentences and 24 transitive target pictures. The sets of priming sentences consisted of an active sentence and its corresponding passive. Most of the transitive priming sentences from the first experiment were used, but with some of the human agent sentences replaced by nonhuman agent sentences so that the agent of the action was human in half of the sets and nonhuman in the other half. Examples of both types of sets are shown in Table 4. Within each of these types, half of the sets had human patients, and half had nonhuman patients.

The 24 events in the transitive target pictures included 12 in which the agent was human and 12 in which the agent was nonhuman. All of the human agent pictures had human patients; 8 of the nonhuman agent pictures had nonhuman patients and 4 had human patients. The drawings were similar to those used in the first experiment, but with seven replacements designed to increase the diversity of the human agents and patients (for example, several events involving a young boy and girl were replaced with events involving a boxer, a referee, a fireman, a nun, and so on).

The 40 filler pictures and 40 filler sentences were essentially the same as those employed

TABLE 4  
Example of a Priming Sentence Set for Experiment 2: Actives and Passives with Human  
versus Nonhuman Agents

Condition	Sentence
Active, human agent	<i>A janitor cleans the floors daily.</i>
Passive, human agent	<i>The floors are cleaned by a janitor daily.</i>
Active, nonhuman agent	<i>A blizzard ruined spring vacation.</i>
Passive, nonhuman agent	<i>Spring vacation was ruined by a blizzard.</i>

in the first experiment. There were also 16 dative target pictures and 16 pairs of dative priming sentences. These were comparable to the dative materials in Experiment 1, but modified to explore an issue that is unrelated to the role of message factors in syntactic repetition. They are not considered in detail in this paper.

Every list contained 40 priming sentences, one from each of the 40 sets, preceding a target picture of the appropriate type. In every list, each of the four transitive priming conditions (human agent active versus passive; nonhuman agent active versus passive) was represented by 6 sentences. No priming sentence occurred more than one in any given list. Across lists, all of the transitive priming sentences occurred exactly twice, so that every target picture was primed with both the active and the passive sentences from two different priming sets, one human agent set and one nonhuman agent set. Otherwise, the restrictions on pairs of priming sentences and target pictures were the same as those in Experiment 1. The same constraints on test list order were also observed.

An 80-item study list was assembled from the 40 filler sentences and 40 target pictures. No more than 2 pictures or 2 sentences were permitted to occur consecutively, and thematic relationships among items close together in the list were prohibited. Otherwise, the study list order was random.

All of the filler and target pictures were presented on slides. The filler and priming sentences from the study and test lists were recorded on cassette tape by a female speaker.

**Procedure.** The procedure was in most respects identical to that of Experiment 1, except for the modifications required to present the pictures on slides and the sentences on tape. Subjects controlled the presentation of the slides with the remote advance of the slide projector, advancing the carousel after each trial. Blank slides appeared in those list positions where sentences were to be presented, at which point the experimenter played the next item from the prerecorded tape.

Instructions to subjects for the study and test lists were in most respects the same as those in Experiment 1. Three practice pictures preceded the presentation of the test list. If a subject repeated a sentence from the test list incorrectly, the experimenter read the entire sentence again from a prepared script and asked the subject to repeat it once more. These mistakes were rare. The same postexperimental questions were asked as in Experiment 1.

**Design.** Every subject described 6 transitive pictures in each of the four cells of the design formed by crossing the syntactic form factor (active versus passive) and the agency factor (human versus nonhuman agent). Each of the 24 transitive pictures was viewed by 12 subjects in each of the four cells of the same design.

**Scoring and data analyses.** The scoring procedure described for the transitive utterances in Experiment 1 was adopted in the current experiment. Separate analyses of variance were



performed for active and passive utterances, using the mean percentages for each subject or item in each cell of the design. In both sets of analyses, one analysis was performed with subjects as the random factor, and a second with items as the random factor. Effects were considered significant when their probability was less than or equal to .05.

### Results

Table 5 shows the effects of human- versus nonhuman-agent primes on the production of passive descriptions. Focusing on the results for descriptions of events with nonhuman agents in the upper panel, it can be seen that there was again a syntactic priming effect: Passive utterances occurred significantly more often after passive primes than after active primes, 31.9% to 25.0%, with 95% confidence intervals of 5.2% for subjects and 6.6% for items.

The magnitude of the syntactic effect was not significantly changed by the variation in human agency in the priming sentences. None of the interactions involving the prime agency factor were significant, with all  $F$ s  $< 1$  in analyses of variance treating subjects as random effects, and all  $F$ s  $< 1.07$  in analyses of variance treating items as random effects. There was an apparent trend toward a higher percentage of passives when both the prime and the picture had nonhuman agents. However, the confi-

able following both active and passive primes (3.1% versus 2.1%). This resulted in a significant interaction between the syntax of the priming sentence and the picture agent factor ( $F[1,47] = 4.47$  for subjects; the same interaction for items was marginal,  $F[1,22] = 3.30$ ,  $p < .09$ ). The continued low level of passive descriptions of these pictures indicates once more that there is a strong bias against passives in describing human agent events.

TABLE 5  
Percentages of Passive Utterances Used after Active and Passive Primes with Human versus Nonhuman Agents: Experiment 2

Priming sentence form	Type of agent in priming sentence		Mean
	Nonhuman agent prime	Human agent prime	
Descriptions of nonhuman agent events			
Active	23.6	26.4	25.0
Passive	32.6	31.2	31.9
Descriptions of human agent events			
Active	4.2	2.1	3.1
Passive	2.1	2.1	2.1

The results for actives are given in Table 6. There were trends toward more active sentences after active primes in all but one of the four cells, and these trends appear to have been magnified when the humanness of the agent in the priming sentence matched that of the agent of the action in the picture. However, none of these effects were significant. In particular, the interaction between the syntax of the priming sentence, the humanness of the agent in the priming sentence, and the humanness of the agent in the picture was not significant in analyses of variance with either subjects ( $F[1,47] = 1.14$ ,  $p < .30$ ) or items ( $F[1,22] = 1.49$ ,  $p < .25$ ) treated as random effects.

The effect of human agency in the picture was reliable for both passive and active descriptions. Human agency increased the number of active sentences, from 54.9% for descriptions of nonhuman agent pictures to 89.6% for descriptions of human agent pictures ( $F[1,47] = 110.43$  for subjects, and  $F[1,22] = 27.35$  for items). Conversely, it decreased the number of passives, from 28.5% passives for descriptions of nonhuman agent pictures to 2.6% for descriptions of human agent pictures ( $F[1,47] = 73.32$  for subjects, and  $F[1,47] = 28.39$  for items).

The percentages of simple transitives (i.e., the combined percentages of active and passive utterances) did not differ as a function of the syntactic form of the priming sentences. After active primes 87% of the utterances were simple transitives, and after passive primes 88% of the utterances were simple transitives.

As in the first experiment, postexperimental questions showed that subjects noticed no systematic relationships between the sentences and pictures, did not believe that the sentences had influenced their descriptions of the events in any regular way, and were very confident that the purpose of the experiment was to test memory.

TABLE 6  
Percentages of Active Utterances Used after Active and Passive Primes with Human versus Nonhuman Agents: Experiment 2

	Descriptions of nonhuman agent events		
	Active	Passive	Total
Active	57.6	54.2	55.9
Passive	52.1	55.6	53.8
	Descriptions of human agent events		
	Active	Passive	Total
Active	89.6	91.7	90.6
Passive	88.9	88.2	88.5

*Discussion*

The most important finding of the second experiment was that the repetition effect for passives persisted across variations in the messages conveyed by the priming sentences. This provides further support for the view that the development of a sentence's surface form is controlled in part by strength-based conflict resolution principles that give priority to the most highly activated syntactic procedures, and suggests that this resolution occurs somewhat independently of relationships between messages and structural features. The syntactic features of sentences may therefore be determined by processes that are at least in part dissociable from conceptual features. Two possible accounts of this dissociability are considered in the General Discussion.

The absence of an agency effect creates the usual indeterminacy associated with null results, leaving open the possibility that message factors may have had a less consistent impact than syntactic factors because the agency manipulation was weak. There are three counters to such an argument. First, human agency is one of the most powerful factors known to influence sentence form: A wide range of experiments and observations, including the present ones, have confirmed its effects on the use of active versus passive sentences (Clark, 1965; Clark & Begun, 1971; Dewart, 1979; Harris, 1978; Ransom, 1977). Second, if sentence structure were crucially dependent on characteristics of this type, it should be impossible to manipulate the syntax without a corresponding difference in the underlying thought. Yet the structure of subjects' utterances varied more consistently in response to changes in the syntax of the priming

messages have even shown to influence reading times for the second clause (Frazier, Taft, Roeper, Clifton, & Ehrlich, 1984), suggesting that the influence of features of the agent on sentence processing persists.

The priming patterns for active utterances were similar to those for passives, although the differences were nonsignificant. A possible explanation for the reduction in the magnitude of the effect for these forms is considered in the discussion following Experiment 3.

As in the first experiment, descriptions of human agent events were essentially immune to the priming manipulations. This may be dictated by their nature in a way that remains to be delineated, but a more immediate possibility is a floor effect. If the number of passive descriptions were to increase, repetition effects should emerge unless there is some qualitative difference in the use of the passive to describe human versus nonhuman agent events. Inspection of the set of human agent events revealed one factor that might have disproportionately reduced the number

of passives: Eight of the 12 human agent pictures depicted the agent on the left, compared to 6 of the 12 nonhuman agent events. The bias toward left-to-right description of pictures (Flores d'Arcais, 1975) would thus favor the production of active descriptions of human agent events. This was remedied in the third experiment.

### EXPERIMENT 3

Although the results of Experiment 2 were consistent with the hypothesis that certain syntactic processes in production can be isolated from conceptual processes, several concerns remain. First, although the effects of agency variations on syntactic form were not significant, they were in a direction that suggests some conceptual influence. Second, the lack of impact of the priming manipulation on descriptions of human agent events remains a problem. The third experiment was designed to address these issues by replicating Experiment 2 with a stronger priming manipulation and with pictures controlled for left-to-right orientation of agents and patients.

The priming manipulation was strengthened by encouraging fuller processing of the priming sentences. In the second experiment, subjects had only to process the primes deeply enough to repeat them and recognize that they had not heard them before (in order to make a correct memory judgment). This raises the possibility that the sentences were understood in such a shallow fashion that the agency variation had no effect on their interpretation or the representation of the message they conveyed. One way to encourage deeper analysis is to make every priming sentence one on which subjects might later be tested. To do this, the study-test format was replaced with a running recognition task in which old, previously presented items were interspersed with new items in a continuous list (Shepard & Teghtsoonian, 1961). Since any of the new items might subsequently be tested, the subjects had to attend carefully to the priming sentences.

#### *Method*

*Subjects.* The subjects were 48 members of the Michigan State University campus community, recruited through an advertisement in the student newspaper and paid \$3 for their participation in the 45-min sessions.

*Materials.* The picture materials were identical to those employed in Experiment 2, with one change. The left-to-right relationship between the agent and patient was balanced, so that half of the agents of the human agent events appeared on the left, and half on the right, and similarly for the nonhuman agent events. This was accomplished by reversing four of the slides. The 24 transitive target pictures were otherwise identical to those used in the second experiment. The priming sentences and filler pictures were also the same except for minor modifications in content required by differences in the subject population.

Four 240-item test lists were created for use in the running recognition task. There were 40 priming sentence/target picture pairs in each list, 24 of them transitives, with each

priming sentence and target picture occurring only once per list. The 40 filler sentences and 40 filler pictures each occurred twice per list. The constraints on the pairings of priming sentences and target pictures, and the counterbalancing of items within and across lists, were the same as in the second experiment.

The orders of items across the four lists were identical. Eight filler trials preceded the first transitive priming trial, and eight fillers separated all subsequent priming trials. No more than four pictures or four sentences occurred consecutively, and no more than three repetitions of previous items occurred consecutively. In every list, 33, 78, 85, and 100% of all previous filler items were tested by the end of each of the four respective quarters of the list. Otherwise, the constraints on list construction were the same as in previous experiments.

*Procedure.* At the beginning of each session subjects were given instructions appropriate for the running recognition task coupled with the two secondary tasks, sentence repetition and picture description. The instructions for the secondary tasks were the same as in previous experiments. On the recognition task, subjects were instructed to respond "yes" or "no" to every item in the list, including the first, in order to indicate whether they had seen that item previously. All other aspects of the procedure were the same as Experiment 2.

*Scoring and data analyses.* The utterances were scored using the previously described procedures for transitives. Analyses of variance were performed as in Experiment 2.

## Results

The results were similar to those obtained in the second experiment, with one exception. As Table 7 shows, the increase in the percentage of passive utterances after passive primes occurred not only for nonhuman agent events, but also for human agent events. Overall, 21% of the passives occurred after passive primes, compared to 17% after active primes ( $F[1,47] = 4.11$  in the subjects analysis; the effect in the items analysis was marginal,  $F[1,22] = 3.62$ ,  $p = .07$ ). There was again a substantial main effect of human agency in the picture, with 34% of the passives occurring as descriptions of nonhuman agent events versus 3% as descriptions of human agent events ( $F[1,47] = 136.76$  for subjects and  $F[1,22] = 26.80$  for items). The interaction with the syntactic form of the

TABLE 7  
Percentages of Passive Utterances Used after Active and Passive Primes with Human versus Nonhuman Agents: Experiment 3

Priming sentence form	Type of agent in priming sentence		Mean
	Nonhuman agent prime	Human agent prime	
Descriptions of nonhuman agent events			
Active	30.6	31.2	30.9
Passive	38.9	35.4	37.2
Descriptions of human agent events			
Active	3.5	1.4	2.4
Passive	3.5	4.7	4.2

priming sentence was not significant ( $F[1,47] = 1.94$  for subjects, and  $F[1,22] = 1.16$  for items).

None of the interactions involving agency in the priming sentence were significant, with all  $F$ s  $< 1$ . As in Experiment 2, the data suggested a possible magnification of the priming effect when the agent in the picture matched the agent in the priming sentence, but this was not significant: The overall priming effect (the increase in passives after passive as compared to active primes) was 5.9% when the agents matched, versus 2.1% when they mismatched (the 95% confidence interval for this difference was 8.4%).

The results for active utterances are given in Table 8. There was again a trend favoring an increased number of actives following active primes (66.7%, compared to 63.2% following passives), but this did not achieve significance ( $F[1,47] = 1.69$ ,  $p < .20$  for subjects and  $F[1,22] = 1.83$ ,  $p < .20$  for items). More actives were used to describe human than nonhuman agent pictures, 84.2% versus 45.7% ( $F[1,47] = 156.05$  for subjects and  $F[1,22] = 22.23$  for items). No other effects approached significance, with all  $F$ s  $< 1$ .

The syntactic forms of the priming sentences again did not influence the number of simple transitive sentences produced. The combined percentages of simple transitives (actives plus passives) after active versus passive primes were 83 and 84%, respectively.

as they normally would, often claiming that in their normal speech they would have used pronouns (9 of 48 subjects mentioned this difference). However, none were aware of any regular syntactic deviations from their usual speech patterns, or factors other than pronoun avoidance likely to be correlated with syntactic differences.

TABLE 8  
Percentages of Active Utterances Used after Active and Passive Primes with Human versus Nonhuman Agents: Experiment 3

Priming sentence form	Type of agent in priming sentence		Mean
	Nonhuman agent prime	Human agent prime	
Descriptions of nonhuman agent events			
Active	47.9	47.9	47.9
Passive	42.4	44.4	43.4
Descriptions of human agent events			
Active	85.4	85.4	85.4
Passive	81.2	84.7	83.0

*Discussion*

This experiment again revealed a syntactic repetition effect that occurred in the face of conceptual changes in the priming sentences. The results thus replicated those of Experiment 2, but with a different cover task that encouraged fuller processing of the primes.

Experiment 3 was the first in this series of studies to find a repetition effect for events with human agents. The most interesting point about this result is that it appeared to emerge as extraneous factors that simplified the description of human agent events were eliminated. Thus, including pictures of events with more varied participants in Experiment 2 appeared to slightly increase the number of passive sentences employed relative to Experiment 1, and disrupting the left-to-right description strategy for half of the human agent pictures in Experiment 3 further increased the number of passives. At this point, then, it appears that the failure to find priming effects for descriptions of human agent events in the first two experiments can be traced to the low rates of producing passives, rather than categorical differences between the two types of events in their susceptibility to syntactic repetition.

Again in Experiment 3 there was no reliable influence of the primes on the production of actives, although the general pattern mirrored that found for passive utterances. It is not clear why the effects of the primes on active production were smaller in the last two experiments than in the first. However, the reduction was not specific to active forms, since the passive priming effects were also considerably weaker in Experiments 2 and 3 than in Experiment 1: The overall difference in Experiment 1 was 8%, compared to 3% and 4% in the last two studies. One possible explanation is related to changes in the interstimulus intervals. In the first experiment, subjects leafed through a booklet, and in the last two they advanced slides in a projector. A rough estimate of average page-turning time after hearing and repeating the priming sentence is 1500 ms, compared to 600 ms for a slide advance. If activation patterns change over time, the magnitude of the priming effect may vary as a function of differences in this interval.

Despite the apparent weakness of their influence on syntactic form, there remained interesting trends suggesting that the variations in the priming sentences' agents played some role: There was once more the suggestion of an increased number of nonhuman agent passives after nonhuman agent passive primes. Two final efforts were therefore made to evaluate this effect. First, the data from Experiments 2 and 3 were analyzed together. This provides a rough check on the reliability of the interaction between syntactic form and human agency with a sample of 96 subjects. None of the interactions involving prime agency were significant, or even approached significance.

The second effort produced a more ambiguous pattern. Experiments 2 and 3 were primarily concerned with the effects of the agent in the primes and target pictures. However, the patient may also contribute. Perhaps the selection of the subject and the object for a picture description is guided by the conceptual characteristics of the subject and the object in the priming sentence, independently of the syntactic form of the sentence. This prediction can be examined for four of the pictures in Experiments 2 and 3. These pictures all had nonhuman agents with human patients, and all were primed equally often with human agent/nonhuman patient and nonhuman agent/human patient sentences, which were equally often active or passive. It is therefore possible to examine whether there was a greater likelihood of a match between the syntactic forms of the primes (active versus passive) and the syntactic forms of the utterances, or between the conceptual characteristics of the primes (human subject and nonhuman object, independent of syntactic form) and the conceptual characteristics of the utterances. These effects were in fact nearly identical in magnitude when summed over the two experiments: For syntactic forms, 47% of the utterances matched the primes and 39% mismatched, irrespective of the conceptual characteristics of the primes, while for conceptual characteristics, 48% matched and 39% mismatched, irrespective of the syntactic forms of the primes. Although neither of these differences was significant ( $\chi^2[1] = 1.95, p > .10$ ), their similarity suggests that both the syntax of a priming sentence and its conceptual features may influence a sentence's form. In one case, the determination of the syntactic form fixes what must be the subject and object, while in the other case the determination of subject and object may fix the syntactic form. Such a symmetrical pattern fits nicely with the framework of the competition model (Bates & MacWhinney, 1982; MacWhinney et al., 1984) and production models that assume parallel processing of lexical and syntactic information (Bock, 1982; Stemberger, *in press*). But because the differences were unreliable and based on a very

## GENERAL DISCUSSION

Speakers tend to repeat the syntactic forms of sentences in subsequent utterances that are minimally related in lexical, conceptual, or discourse content. This repetition was manifested in alterations between active and passive sentences and between prepositional and double-object dative sentences, with the alternations occurring as a function of comparable changes in the structure of preceding priming sentences. These alternations involved variations in word order and grammatical relations, and in the last two experiments, a change in the animacy of the agent. The phe-



nomenon thus does not seem to depend on superficial relationships between successive sentences, but on more abstract structural similarities.

The abstractness of the relationships between the sentences makes it unlikely that the locus of the repetition effect was the overlap in the active memory representations of the elements of the successive sentences, or priming of their conceptual or lexical components. Instead, the cognitive procedures responsible for the realization of syntactic structure may mediate the effect. If such procedures increase in strength or are activated by use, the probability of their subsequent application in the formulation of a sentence should increase. This assumes that competitions among the procedures controlling different syntactic forms are resolved

Mackay, 1982; Stemberger, 1985). The priming effects are readily interpreted in terms of such activation-based systems: An utterance takes the grammatical form that it does because the procedures controlling its syntax are more activated than the procedures responsible for an alternative form, with the higher level of activation being an automatic consequence of the prior production of the same form.

Because they appear to involve abstract procedures or operations over representations rather than connections between them, the interpretation of the priming patterns observed in the present experiments is somewhat different from that of other effects commonly found in the cognitive literature. Most of these involve relationships among words, interpreted as associative connections among elements in a network (Anderson, 1983, ch. 3; Collins & Loftus, 1975). The nearest analog to the priming of abstract operations may be set effects in problem solving (e.g., Luchins, 1942), but with the important difference that set effects imply heuristic operations strategically assembled for a limited purpose. Since there was no indication that subjects were controlling or attending to their speech to an unusual degree, or were even aware of the relationship between the priming sentences and the picture descriptions, it is unlikely that they deliberately copied the syntax of their descriptions from the syntax of the primes. The repetition seems to have been relatively automatic, in the sense that it occurred without conscious intention.

Processes such as these may limit the flexibility of syntax in the spontaneous, real-time use of language, perhaps contributing to differences in syntactic diversity between planned and extemporaneous speech (Goldman-Eisler & Cohen, 1970). However, they may also have an adaptive function. Selecting among the wide array of syntactic options available for the expression of a message in unplanned speech can create problems that lead to hesitations, errors, and other disruptions (Deese, 1980). Using procedures that are already activated may ease the demands

of message formulation and actually contribute to fluency (see Levelt & Kelter, 1982, for a similar argument with respect to the repetition of words in speech).

Two basic implications of the persistence of structural features across successive utterances concern the role in a theory of sentence production of factors such as the frequency or recency of use of particular syntactic forms, and the functional independence of syntactic processes. The next two sections examine these issues in turn.

### *Frequency and Syntax in Sentence Production*

Accounting for syntax in speech requires an explanation of dynamic features of the language production system that change with use. The priming phenomenon suggests that some of these features reflect the recency of use of the structure-building mechanisms that participate in the mapping between meaning and form.

Studies of sentence comprehension and grammaticality judgments provide additional support for this view. In comprehension, Frazier et al. (1984) have shown that repetition of structural features across two successive clauses reduces reading times for the second clause, relative to matched controls. A related effect has been reported with young children: Whitehurst, Ironsmith, and Goldfein (1974) found that a group of 4- and 5-year-olds who heard adults describe pictures using passive sentences were less likely to make mistakes in comprehending passives (and more likely to produce them<sup>2</sup>) than another group that did not receive this exposure. In judgments of grammaticality, Matthews (1979) claimed that sentences such as (a) *The canoe floated down the river sank* change in classification (as grammatical or ungrammatical) as a function of their position in a list with respect to sentences such as (b) *The man that was*

There is an intimate connection between recency and frequency. If the recent perception or production of a particular form increases the probability of using the same form, it should increase in frequency relative to alternative structures. This connection may help to explain certain patterns of language change. Kroch (1982) has argued that an appeal to the frequency of use of grammatical forms is required for a complete account of the development of periphrastic *do* in

<sup>2</sup> Whitehurst et al. (1974) regarded this finding not as evidence for the increased probability of using an already acquired form, but for the introduction of a new form into the

lack of pretesting for passive use makes this conclusion somewhat speculative.

English (the *do* that supports tense in questions and negative sentences; e.g., *Did you go?*, *They do not want to*). Several lines of evidence suggest that periphrastic *do* developed between the 13th and early 18th centuries in part to facilitate the identification of direct objects. However, it also appeared in environments where it did *not* perform an important parsing role, and its frequency of use rose at the same rate in these environments. To explain this, Kroch proposed that the speech community possessed a norm for the overall rate of use of periphrastic *do*. A mathematical model including this frequency assumption provided a much better fit for data charting the increased use of *do* across the several environments in which it appeared than a model that assumed only the effect of parsing facilita-

operating characteristics of the cognitive procedures that generate it (Hasher & Zacks, 1984).

Such findings stand in an uncomfortable relationship to a strong pre-supposition in psycholinguistics about the role of frequency in performance theories of syntax. In general, the argument that the frequency of particular sequences of words is largely irrelevant to explanations of our knowledge of language—which follows from the fact that the actual frequency of most of the possible English sentences is zero—tends to obscure the possibility that factors related to frequency (such as activation, strength, or persistence phenomena) may play an important role in explanations of language performance when calculated over more abstract rules or procedural representations. An earlier controversy, of course, centered on the need for psycholinguistic theories to incorporate just such abstract representations of language forms and structures (e.g., Bever, Fodor, & Weksel, 1965). But having assumed them, it may be necessary to consider how activation affects their use.

### *The Isolability of Syntax*

The three experiments reported above are consistent with the hypothesis that syntactic processing is isolable, in the minimal sense that it can be manipulated independently of higher level conceptual processes (Posner, 1978). Two types of evidence for such isolability were found, although both must be regarded as tentative. The first was that changes in critical conceptual relationships between the priming sentences and the sentences used to describe the pictures neither eliminated nor significantly modified the syntactic repetition effect. This argues that syntactic processes to some degree follow their own lead.

The second type of evidence concerns the invariance of the total percentages of simple transitive descriptions following active and passive primes. The datives in Experiment 1 behaved similarly. One explanation

for this stability is that the picture descriptions produced in the two different priming conditions were represented in the same way at some level of processing, perhaps a level related either to interpretations of or abstract linguistic codes for the pictured events. If so, the syntactic differences between the priming sentences affected only the syntactic realizations of messages or underlying linguistic structures that were themselves invariant.

There are two broad implications of such evidence for isolability, one methodological and the other theoretical. Methodologically, these experiments address a classic problem in the study of syntax in language production. That problem is the need for experimental paradigms in which structural variables can be manipulated independently of content variables (cf. Fodor, Bever, & Garrett, 1974, chap. 7). A major difficulty has been that of eliciting designated syntactic forms without inducing ad hoc strategies. Because the priming technique introduced in these experiments allowed some control over the forms of utterances that were used, but in a relatively natural speech situation, it provides a way to explore many unanswered questions about syntactic processes in sentence production.

The theoretical implications of isolability derive from the relevance of such findings to the claim that the structural features of sentences are determined somewhat independently of message-level processes (Garrett, 1976). In terms of a related formulation, certain syntactic processes might be viewed as informationally encapsulated, in that they do not have access to all of the information available to message formulation processes (Fodor, 1983).<sup>3</sup> Garrett's model of sentence production (1975, 1980, 1982) assumes such encapsulation, postulating a specifically linguistic representation created during the formulation of an utterance that is neutral with respect to certain message features. This provides a natural explanation for the occurrence of syntactic repetition effects despite changes in conceptual relationships. At the level of processing that controls surface syntax, such relationships may be irrelevant.

This pattern of priming effects is inconsistent with a model in which disjoint sets of message features constitute necessary conditions for the use of particular syntactic structures. However, a weaker type of direct generation view is potentially compatible with the results. Such a system would be one in which partial matches between messages and syntactic

<sup>3</sup> Fodor's discussion centers on parsing rather than production. He specifically exempts speech production from candidacy for modularity (1983, p. 102) on the argument that the mechanisms of production must have access to all of our knowledge of the world, however represented or acquired. Since the processes therefore cannot be domain specific (one of his criteria for modularity), they cannot be modular. In this respect his view differs from Garrett's.

features are sufficient but not necessary to drive syntactic elaboration. For example, the optimal conditions for the use of the passive might include the presence of a theme, a nonhuman agent, or a special discourse focus in the message. However, in the absence of such features, the passive might still be used if the procedures responsible for its creation were strongly activated by other, nonmessage sources. In such a model, levels of activation might reflect both the relationship between the form and the communicative intention to be realized, and the history of the use of the form somewhat independently of these intentions.

### *Conclusion*

The experiments reported in this paper suggest that activation processes play an important role in controlling the syntax of speech. The results were consistent with the hypothesis that the activated information corresponds to procedures that create grammatical structures in sentences, and that these procedures are at least minimally isolable from the conceptual features that serve as the input to syntactic processes in language production. In addition, the priming paradigm developed in the context of this research offers a new method for the investigation of production processes, providing an unintrusive way to explore the generation of the structural features of utterances in relatively natural speech.

## APPENDIX A: PRIMING SENTENCES FOR EXPERIMENT 1

### *Transitives (Active/Passive)*

1. The chairman is suggesting a compromise./A compromise is being suggested by the chairman.
2. One of the fans punched the referee./The referee was punched by one of the fans.
3. The premier embraced each of the returning cosmonauts./Each of the returning cos-
5. The drunk is jostling a passerby./A passerby is being jostled by the drunk.
6. The chain didn't trip the jogger./The jogger wasn't tripped by the chain.
7. A brick struck the car's windshield./The car's windshield was struck by a brick.
8. The government isn't evacuating the embassy staff./The embassy staff isn't being evacuated by the government.
9. The candidate kissed the wailing baby at the rally./The wailing baby was kissed by the candidate at the rally.
10. A reporter observed the mayor leaving the mobster's home./The mayor was observed by a reporter leaving the mobster's home.
11. A union leader is assisting the players in organizing the strike./The players are being assisted by a union leader in organizing the strike.
12. The president thanked one of the campaign workers for his help./One of the campaign workers was thanked by the president for his help.
13. A clerk dropped the file into the wastebasket./The file was dropped by a clerk into the wastebasket.

14. Some hunters found a corpse behind the ice-cream plant./A corpse was found by some hunters behind the ice-cream plant.
15. The headmistress killed the diet doctor several years ago./The diet doctor was killed by the headmistress several years ago.
16. A janitor cleans the floors daily./The floors are cleaned by a janitor daily.
17. A crew from the Department of Transportation is repairing the potholes./The potholes are being repaired by a crew from the Department of Transportation.
18. An avalanche buried the mountain climbers under tons of snow./The mountain climbers were buried by an avalanche under tons of snow.
19. A tank ran over the fallen soldier./The fallen soldier was run over by a tank.
20. The Sixers beat the Lakers in four games./The Lakers were beaten by the Sixers in four games.
21. A gunshot shattered the forest's stillness./The forest's stillness was shattered by a gunshot.
22. The computer outsmarted the chess master./The chess master was outsmarted by the computer.
23. The museum misplaced a medieval manuscript after the exhibit./A medieval manuscript was misplaced by the museum after the exhibit.
24. The fire destroyed millions of acres of forest in less than a week./Millions of acres of forest were destroyed by the fire in less than a week.

### *Datives (Prepositional/Double object)*

1. The corrupt inspector offered a deal to the bar owner./The corrupt inspector offered the bar owner a deal.
2. The secretary is baking a cake for her boss./The secretary is baking her boss a cake.
3. The lifeguard tossed a rope to the struggling child./The lifeguard tossed the struggling child a rope.
4. The governess made a pot of tea for the princess./The governess made the princess a pot of tea.
5. The foundation is giving several million dollars to the university./The foundation is giving the university several million dollars.
6. A rock star sold some cocaine to an undercover agent./A rock star sold an undercover agent some cocaine.
7. The legislature is sending a bill legalizing capital punishment to the governor./The legislature is sending the governor a bill legalizing capital punishment.
8. The management company is renting three suites of offices to the CIA./The management company is renting the CIA three suites of offices.
9. The Secretary of Agriculture told an ethnic joke to the columnist./The Secretary of Agriculture told the columnist an ethnic joke.
10. The cheerleader saved a seat for her boyfriend./The cheerleader saved her boyfriend a seat.
11. The oil sheikh bought a Rolls Royce for his son./The oil sheikh bought his son a Rolls Royce.
12. The waitress took a tray of appetizers to the customers./The waitress took the customers a tray of appetizers.

## APPENDIX B: TEST LIST INSTRUCTIONS FOR EXPERIMENT 1

Now I'm going to give you another set of pictures and sentences. This set includes some of the pictures and sentences you just studied, plus some new ones. For each picture and sentence, I'd like you to indicate whether it occurred in the first set. Just say "yes" if it was in the first set, and "no" if it wasn't.

There are two other things I'd like you to do. Whenever I read a sentence to you, please repeat that sentence out loud before you say "yes" or "no." And when you see a picture, please describe what's happening in the picture before you say "yes" or "no." This is to make sure that you've understood the sentences and pictures.

You don't have to give elaborate descriptions of the pictures. Just describe what's happening in them briefly, in one complete sentence without any pronouns. Let me show you a few sample pictures to make sure all of this is clear. How would you describe this one? [Present picture of man watching television.] Have you seen it before? And these? [Present pictures of a girl crying, a woman ironing, a woman soaking her foot.]

Do you have any questions before we begin?

## REFERENCES

- Anderson, J. R. (1983). *The architecture of cognition*. Cambridge, MA: Harvard Univ. Press.
- Bates, E., & MacWhinney, B. (1982). Functionalist approaches to grammar. In E. Wanner & L. R. Gleitman (Eds.), *Language acquisition: The state of the art* (pp. 173-218). Cambridge: Cambridge Univ. Press.
- Bever, T. G., Fodor, J. A., & Weksel, W. (1965). Is linguistics empirical? *Psychological Review* 72, 493-500.
- Bock, J. K. (1982). Toward a cognitive psychology of syntax: Information processing contributions to sentence formulation. *Psychological Review*, 89, 1-47.
- Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, MA: MIT Press.
- Clark, H. H. (1965). Some structural properties of simple active and passive sentences. *Journal of Verbal Learning and Verbal Behavior*, 4, 365-370.
- Clark, H. H., & Begun, J. S. (1971). The semantics of sentence subjects. *Language and Speech*, 14, 34-46.
- Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, 82, 407-428.
- Deese, J. (1980). Pauses, prosody, and the demands of production in language. In H. W. Dechert & M. Raupach (Eds.), *Temporal variables in speech: Studies in honour of Frieda Goldman-Eisler* (pp. 69-84). The Hague: Mouton.
- Dell, G. S. (1985). Positive feedback in hierarchical connectionist models: Applications to
- Dewart, M. H. (1979). Role of animate and inanimate nouns in determining sentence voice. *British Journal of Psychology*, 70, 135-141.
- Flores d'Arcais, G. B. (1975). Some perceptual determinants of sentence construction. In G. B. Flores d'Arcais (Ed.), *Studies in perception: Festschrift for Fabio Metelli* (pp. 344-373). Milan, Italy: Martello-Giunti.
- Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT Press.
- Frazier, L., Taft, L., Roeper, T., Clifton, C., & Ehrlich, K. (1984). Parallel structure: A source of facilitation in sentence comprehension. *Memory & Cognition*, 12, 421-430.
- Fodor, J. A., Bever, T. G., & Garrett, M. F. (1974). *The psychology of language*. New York: McGraw-Hill.
- Garrett, M. F. (1975). The analysis of sentence production. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 9, pp. 133-177). New York: Academic Press.
- Garrett, M. F. (1976). Syntactic processes in sentence production. In R. J. Wales & E. C. T. Walker (Eds.), *New approaches to language mechanisms* (pp. 231-256). Amsterdam: North-Holland.

- Garrett, M. F. (1980). Levels of processing in sentence production. In B. Butterworth (Ed.), *Language production* (Vol. 1., pp. 177-220). Orlando/London: Academic Press.
- Garrett, M. F. (1982). Production of speech: Observations from normal and pathological language use. In A. Ellis (Ed.), *Normality and pathology in cognitive functions* (pp. 19-76). Orlando/London: Academic Press.
- Giles, H., & Powesland, P. F. (1975). *Speech style and social evaluation*. Orlando/London: Academic Press.
- Goldman-Eisler, F., & Cohen, M. (1970). Is N, P, and PN difficulty a valid criterion of transformational operations? *Journal of Verbal Learning and Verbal Behavior*, 9, 161-166.
- Harley, T. A. (1984). A critique of top-down independent levels models of speech production: Evidence from non-plan-internal speech errors. *Cognitive Science*, 8, 191-219.
- Harris, M. (1978). Noun animacy and the passive voice: A developmental approach. *Quarterly Journal of Experimental Psychology*, 30, 495-501.
- Hasher, L., & Zacks, R. T. (1984). Automatic processing of fundamental information: The case of frequency of occurrence. *American Psychologist*, 39, 1372-1388.
- Kempen, G. (1977). Conceptualizing and formulating in sentence production. In S. Rosenberg (Ed.), *Sentence production: Developments in research and theory* (pp. 259-274). Hillsdale, NJ: Erlbaum.
- Kroch, A. S. (1982, October). *Function and grammar in the history of English periphrastic do*. Paper presented at the 11th Annual Colloquium on New Ways of Analyzing Variation in English, Georgetown University, Washington, DC.
- Lashley, K. S. (1951). The problem of serial order in behavior. In L. A. Jeffress (Ed.), *Cerebral mechanisms in behavior* (pp. 112-136). New York: Wiley.
- Levelt, W. J. M., & Kelter, S. (1982). Surface form and memory in question answering. *Cognitive Psychology*, 14, 78-106.
- Luchins, A. S. (1942). Mechanization in problem solving: The effect of *Einstellung*. *Psychological Monographs*, 54(6, Whole No. 248).
- MacKay, D. G. (1982). The problems of flexibility, fluency, and speed-accuracy trade-off in skilled behavior. *Psychological Review*, 89, 483-506.
- MacWhinney, B., Bates, E., & Kliegl, R. (1984). Cue validity and sentence interpretation in English, German, and Italian. *Journal of Verbal Learning and Verbal Behavior*, 23, 127-150.
- Malt, B. C. (1985). The role of discourse structure in understanding anaphora. *Journal of Memory and Language*, 24, 271-289.
- Matthews, R. J. (1979). Are the grammatical sentences of a language a recursive set? *Synthese*, 40, 209-224.
- McKinney, J. P. (1978). *Test of engagement style: A measure of agency-patience*. Unpublished manuscript, Department of Psychology, Michigan State University, East Lansing.
- Motley, M. T., Baars, B. J., & Camden, C. T. (1983). Experimental verbal slip studies: A review and an editing model of language encoding. *Communication Monographs*, 50, 79-101.
- Norman, D. A. (1981). Categorization of action slips. *Psychological Review*, 88, 1-15.
- Ostrin, R. (1982). *Framing the production problem in agrammatism*. Unpublished manuscript, Department of Psychology, University of Pennsylvania, Philadelphia.
- Posner, M. I. (1978). *Chronometric explorations of mind*. Hillsdale, NJ: Erlbaum.
- Putnam, W. B., & Street, R. L., Jr. (1984). The conception and perception of noncontent speech performance: Implications for speech-accommodation theory. *International Journal of the Sociology of Language*, 46, 97-114.



- Ransom, E. N. (1977). Definiteness, animacy, and NP ordering. In K. Whistler, R. D. van Valin, Jr., C. Chiarello, J. J. Jaeger, M. Petruck, H. Thompson, R. Javkin, & A. Woodbury (Eds.), *Proceedings of the 3rd annual meeting of the Berkeley Linguistics Society* (pp. 418-429). Berkeley, CA: Berkeley Linguistics Society.
- Robertson, S. S., & Suci, G. J. (1980). Event perception by children in the early stages of language production. *Child Development*, 51, 89-96.
- Saffran, E. M., Schwartz, M. F., & Marin, O. S. M. (1980). The word order problem in agrammatism, II. Production. *Brain and Language*, 10, 263-280.
- Schenkein, J. (1980). A taxonomy of repeating action sequences in natural conversation. In B. Butterworth (Ed.), *Language production: Vol. 1. Speech and talk* (pp. 21-47). Orlando/London: Academic Press.
- Selz, O. (1922). *Über die Gesetze des geordneten Denkverlaufs* (Vol. 2). Bonn: Cohen.
- Shepard, R. N., & Teghtsoonian, M. (1961). Retention of information under conditions approaching a steady state. *Journal of Experimental Psychology*, 62, 302-309.
- Stemberger, J. P. (1982). Syntactic errors in speech. *Journal of Psycholinguistic Research*, 11, 313-345.
- Stemberger, J. P. (1985). An interactive activation model of language production. In A. Ellis (Ed.), *Progress in the psychology of language* (Vol. 1, pp. 143-186). London: Erlbaum.
- Weiner, E. J., & Labov, W. (1983). Constraints on the agentless passive. *Journal of Linguistics*, 19, 29-58.
- Whitehurst, G. J., Ironsmith, M., & Goldfein, M. (1974). Selective imitation of the passive construction through modeling. *Journal of Experimental Child Psychology*, 17, 288-302.
- (Accepted January 16, 1986)