From Conceptual Roles to Structural Relations: Bridging the Syntactic Cleft

Kathryn Bock, Helga Loebell, and Randal Morey
Michigan State University

The distinction between underlying and superficial linguistic structure is a staple of modern cognitive psychology. Despite increasingly diverse conceptions of syntactic relations in linguistic theory, the received view in psycholinguistics has remained one in which the entities assigned to underlying relations may assume different surface relations. The present article examines this view in the context of language production and reviews evidence that the disposition to bind animate entities to the surface subject relation is a basic feature of language use, suggesting that mappings from conceptual categories to syntactic relations form a main support of the bridge from conception to language. Proceeding on this assumption, the article also evaluates competing accounts of the mapping process in production. The results argue against syntactic relation-changing operations, but favor a division between meaning- and form-related mechanisms.

One of the more remote components of language production involves the link between the elements of messages and the units and structures of language. A message, or a thought that is destined to be spoken, may be conceived without verbal content. An utterance, which is the encoding of a message in speech, contains words in linguistic structures. The business of language is to provide the means for turning messages into utterances in such a way that the latter convey the former. However, messages themselves seem to provide few clues as to how to proceed. The classic examples involve reference. English allows us to refer to the object itself. Even among Indo-European languages, the basic-level terms for what English speakers customarily call dogs differ substantially: The French is chien, Spanish perro, Dutch hond, and Russian sobaka.

In this article we are concerned with some of the workings of the thought-to-language mapping process in the domain of syntax. Here, too, we must draw a distinction between the elements and structures of messages and the elements and structures of utterances. We will mention two of the standard arguments for doing so. First, just as different languages have different lexicons, they have different structural resources and constraints: French (unlike English) places most adjectives after nouns, Spanish (unlike English) permits the omission of most pronominal subjects, Dutch (unlike English) places the verb at the end of subordinate clauses, and Russian (unlike English) marks syntactic functions with case morphology rather than word order. Yet the ideas and relations that speakers express appear to vary in relatively minor ways. Languages are satisfactorily if not perfectly intertranslatable, and the strongest claims about language-related differences in human conception, those embodied in the Whorf-Sapir hypothesis, seem to be much too strong (Brown, 1976; Carroll & Casagrande, 1958; Heider & Olivier, 1972). Second, it appears possible for thought to proceed in the absence of covert verbalization or, more controversially, images of any sort (Humphrey, 1963), which implies that the stuff of thinking and messages is not the stuff of language.

Despite its similarities to the meaning-to-form mapping problem for words, the meaning-to-form mapping problem for syntax is more vexed. Words, or the morphemes that compose them, can be memorized and linked to meanings in a relatively arbitrary fashion (although the phonological and semantic structures of words are themselves not arbitrary). Sentence-, clause-, and phrase-level structures are less facile objects of memorization, both because the number of different structures is unbounded and because their instantiated forms change: The words that appear in them may be drawn from any of the elements of the lexicon, subject to grammatical form–class restrictions (restrictions on whether a word must be a noun or verb, for example). So, to ensure that words are arranged in ways that convey speaker-intended meanings, there must be compositional principles that relate structures to meanings. John hit Mary and Mary hit John mean different things, as do John was hit by Mary and Mary was hit by John, manifestly not because of preexisting links between the words John or Mary and the action of hitting or between the sentence subject and the agent of hitting.

The connection to messages must therefore be carried in principles that constrain the organization of structures on the one hand and the composition of messages on the other. Be-
cause the establishment of such a mapping function in lan-
guage acquisition is more likely to be successful if there are
nonarbitrary links between structures and interpretations
(Pinker, 1979), a key problem is to identify those abstract struc-
tures and interpretations that may afford principled meaning-
to-form mappings. A related problem is to determine whether
the same principles operate within adult language perfor-
mance.

In various models of language production (Bock, 1982,
1987a; Dell, 1986; Garrett, 1975, 1988; Kempen & Hoek}

namp, 1987; Levet, 1989; MacKay, 1982) the first mapping from mes-
gages to linguistic relations involves some linking of nonlinguis-
tic cognitive categories to linguistic categories. However, the
categories themselves are variably specified, because there is
little consensus about what the appropriate ones might be. On
the side of nonlinguistic cognition, it has long seemed likely
that event roles (such as agent, theme, source, goal, etc.; see
Levet, 1989, chap. 3, for review) play some part in the mapping;

n the side of language, it has long seemed likely that syntactic
relations (such as subject, object, indirect object) are somehow
involved. But the status of event roles is a matter of considerable
debate (see, e.g., Ladusaw & Dowty, 1988), as is the status of
syntactic relations (contrast, e.g., Perlmutter, 1982, and Wil-
liams, 1984).

In this article we address these issues from the theoretical
and empirical perspectives of language performance. The piece
of the mapping puzzle on which we will focus concerns the
nature of the relationship between the conceptual features that
often characterize sentence subjects (notably animacy) and the
structural privileges of subjects (such as control of agreement).
The specific problem emerges from evidence that variations in
the conceptual features of subjects do not seem to be reflected
in variations in their structural privileges.

In our search for a solution, we first review evidence that
assignments to linguistic relations are heavily influenced by
such inherent features of role players as their animacy and
concreteness. We consider how this might come about within pro-
cessing models adapted from two alternative linguistic con-
struals of syntactic relations. In one, the interpretation of lin-
guistic relations is in terms of such categories as deep-structure
subjects and objects, according to which the underlying structural
roles played by Mary and John in the sentences Mary hit
John and John was hit by Mary are identical (Mary being the
deep subject and John the deep object in both cases). In the
other, syntactic functions are individuated with respect to verb
forms (Gazdar, Klein, Pullum, & Sag, 1985; Kaplan & Bresnan,
1982; Pollard & Sag, 1987). These frameworks allow a direct
mapping to surface syntactic relations, abjuring transforma-
tions of structure. The similarities between Mary hit John and
John was hit by Mary are captured in links among verb forms
rather than in movements or reassignments of sentence consti-

We then report an experiment designed to evaluate empiri-
cally the viability of these alternative views of the mapping
process in the context of normal language production. This
experiment yielded surprisingly consistent support for a con-
ception of basic syntactic relations that permits a direct map-
ing to surface positions. We then survey how this conception
fits with other evidence about conceptual and structural forces

in sentence formulation. We conclude with an endorsement of a
view of language production that incorporates a set of mapping
operations that are sensitive to animacy (along with other se-

mantic features) and a set of structural operations that are not.

As a terminological convention, we use the terms subject and
object to denote the traditional surface syntactic relations in
sentences and the terms subject argument and object argument
to indicate the noun phrases that take on those relations. Provi-
sionally, we also require the distinction between subject and
underlying subject (as well as the distinction between object and
underlying object). So, as depicted in the upper part of Figure 1,

n the sentence The university is run by the football coach,
the subject is the noun-phrase slot immediately dominated by
the sentence symbol, and the subject argument is the phrase “the
university.” The underlying subject of the same sentence, shown
in the lower part of Figure 1, is the noun-phrase slot immedi-
ately dominated by the sentence symbol in deep linguistic
structure, and the underlying subject argument is the phrase
“the football coach.”

Linguistic Categorization: Syntactic Relations

The role of syntactic relations in sentence processing has
been at issue since the earliest incursions of generative gram-
mar into psycholinguistic research, as represented in the deri-
vational theory of complexity (Miller, 1962). One assumption
of this view was that the surface relations in sentences are
obliquely related to the underlying relations, which must be
recovered in comprehension and transformed in production.
The structural transformations that linked the relevant repre-
sentations moved pieces of structure around, so that the argu-
ment of the surface subject relation was not the argument of the
underlying subject at another level of representation, as in Fig-
ure 1. This approach was abandoned in part because of the
implausibility of a transformational mechanism as a compo-
nent of the dynamic processes of language comprehension and
production (J. A. Fodor & Garrett, 1966), in part because of the
unevenness of its empirical support (J. A. Fodor, Bever, &
Garrett, 1974), and in part because of problems in isolating a
specific linguistic-structural (as opposed to a general concep-
tual) representation of underlying syntactic relations (Bran-
ford, Barclay, & Franks, 1972).

Although substantive movement operations play no role as
processing mechanisms in current psycholinguistic theories, a
conception of multilevel relational structures can be found in
some of the recent research on empty categories in sentence
comprehension (Bever & McElree, 1988; MacDonald, 1989;
McElree & Bever, 1989; see J. D. Fodor, 1989, for discussion).

Empty categories are phonologically null elements or gaps rep-
resenting tacit information that, like the antecedents of pro-

1 Because linguistic theories are generally not designed as process-
ing theories, the production hypotheses we derive are several steps
removed from the linguistic theories themselves. The hypotheses repre-
sent predictions from performance models that incorporate representa-
tional constructs which contrast along lines similar but not identical to
the points of contrast in linguistic theory. The processes that generate
or derive these representations are the province of the performance
theories alone.
nouns, must be recovered elsewhere. For example, to understand sentences like John promised Mary to go and John persuaded Mary to go, one must know who is going to go. A possible source of such information is an underlying representation in which a subject for go is indicated in some way. A similar conception of structural levels is called on to explain why sentence matching times are sensitive to some kinds of ungrammaticality but not others. Those ungrammaticalities that do not affect matching appear to represent configurations that are possible at more abstract structural levels, whereas those that slow matching times are impossible at all levels (Forster & Stevenson, 1987; Freedman & Forster, 1985; but see Crain & Fodor, 1987, for a different account).

Much of this work draws on a direct descendant of transformational grammar, government-binding theory (Chomsky, 1981; see Radford, 1988, for an introduction, and Sells, 1985, for a summary), in which structural relations are defined at two levels. At the deep-structure level, thematic roles such as agent, theme, and goal are assigned to the arguments of deep relations in accordance with constraints established primarily in the lexicon. For example, a verb such as put (... put the book on the shelf) assigns the theme role (a role designating the moved object in an event) to direct-object arguments (e.g., the book) and the goal role to oblique-object (roughly, prepositional-phrase) arguments (e.g., the shelf) in the deep representation. In this scheme, the deep-structure-object argument may become the surface-structure-object argument of a passive through a movement operation. Because empty categories are the surface-structure vestiges of moved-from deep-structure positions, this leaves a postverbal noun-phrase trace in the position from which the object was moved (The book was put on the shelf).

We use the term mediated mapping for this general conception of the relationship between structural relations and their arguments because arguments may be interpreted with respect to their underlying roles.

The alternative to mediated mapping is embraced in a variety of linguistic theories whose common bond is a rejection of movement operations of any sort. Surface structures are generated “directly,” without the mediation of deep structures, using a variety of nontransformational formal devices. One such device allows the subject and direct object and other syntactic relations to be stated with respect to different forms of verbs, generalizing the construct of lexical subcategorization to capture the fact that verb forms differ systematically in their placements of various arguments.

Consider the familiar distinction between the transitive and intransitive forms of verbs such as eat. Because John ate at noon and John ate a sandwich at noon are both possible English sentences (unlike, say, John slept at noon versus John slept a nap at noon), it is traditionally assumed that verbs say something about their syntactic privileges, roughly along the lines of

\[ \text{eat}_{\text{transitive}} \rightarrow \text{subject} \rightarrow \text{object} \]
\[ \text{eat}_{\text{intransitive}} \rightarrow \text{subject} \rightarrow \text{eat} \]

With this much in place, it is a short step to the proposal that other verb forms which also appear in different frames have those frames specified in their lexical representations, as for the verb give in John gave a book to Mary versus John gave a book to Mary. The structural privileges associated with these forms (which we will label the prepositional dative and the double-object dative, respectively) may be represented as

\[ \text{give}_{\text{prepositional dative}} \rightarrow \text{subject} \rightarrow \text{direct object} \rightarrow \text{oblique object} \]
\[ \text{give}_{\text{double-object dative}} \rightarrow \text{subject} \rightarrow \text{oblique object} \rightarrow \text{direct object} \]

Active (e.g., Ten men lifted the table) and passive (e.g., The table was lifted by ten men) forms may likewise be represented as

\[ \text{lift}_{\text{active}} \rightarrow \text{subject} \rightarrow \text{direct object} \]
\[ \text{lift}_{\text{passive}} \rightarrow \text{subject} \rightarrow \text{oblique object} \]

Subject and object positions are given directly in these representations, with subject slots preceding the verb and direct- and oblique-object slots following it. Elaborations of these representations designate the thematic features of the arguments that are permissible in different relations (e.g., the object of the active lift and the subject of the passive lift may be the theme of an event). As a result, different verb forms may be linked to systematically different meanings, permitting choices among them on the basis of message features (Lapointe, 1985; Lapointe & Dell, 1989).

Such an arrangement appears to undo a major advantage of transformational approaches, that of capturing the redundant-
cies among sentence forms. However, a different formal device, a lexical rule, performs some of this work. Lexical rules specify how the subcategorized relations of one verb form are rearranged for another verb form. So, the lexical rule would specify that, relative to an active verb, the passive form places the direct-object argument in the subject slot and the subject argument in a prepositional phrase after the verb. Lexical rules also do much of the work required to explain productivity, the fact that children (Gropen, Pinker, Hollander, Goldberg, & Wilson, 1989; Pinker, Lebeaux, & Frost, 1987) and adults need not have heard a particular verb in the passive, for example, in order to create acceptable passives using that verb. Once the lexical rule is learned, it may link a known active form to its never-heard passive counterpart. It is important, though, that such rearrangements need not be carried out every time the alternative form is used. After a lexical rule creates a new verb form, there is nothing to prohibit the storing of that form for future retrieval so that it may be accessed directly from the lexicon for use in production or comprehension processes, along with its subcategorization privileges.

In processing theories, too, enriched views about the lexical representations of verbs have superseded transformations in hypotheses about the relationship between surface sentences and their meanings (J. A. Fodor, Garrett, & Bever, 1968; Ford, 1982; Shapiro, Zurif, & Grimshaw, 1987). In such views, there are nontransformational (and perhaps nonstructural) routes from surface to conceptual relations (and vice versa) via the lexicon. Because the lexicon is almost by definition a repository of the unique phonological, syntactic, and semantic privileges of words, it may institutionalize as well as regulate communication among different sources of information. This in turn simplifies the operations of the syntax.

To illustrate how direct mapping might operate in production, we will adapt a scheme suggested in lexical-functional grammar (Bresnan & Kaplan, 1984; Kaplan & Bresnan, 1982). In this adaptation (shown in Figure 2), semantically distinct arguments (depicted as the patterned ellipses in the top panel) may be bound to syntactic functions (depicted as tags for the Subject, Object 1 [or direct object], and Object 2 [or oblique object]). These syntactic functions are not defined by deep-structure position but simply constitute a set of symbols to which various arguments may be temporarily linked (of more consequence is the idea that these symbols are drawn from a universal set whose members, at one level, perform similarly in all languages). In production, the processes involved in assigning these functions to arguments constitute what we will call functional integration (Bock, 1987a). The functions are associated with positions in constituent-structure configurations (e.g., the subject function is associated with the relation carried by the head of the preverbal noun phrase), so that arguments may be positioned in the sentence structure as one of the processes of constituent integration.

In contrast to mediated mapping, this style of mapping is said to be direct because whatever argument is assigned the subject function will also be the argument of the subject relation, assuming that there is a verb form that allows this argument to be placed in the constituent-structure position reserved for subjects. The argument that bears the subject function is thereby directly linked to a surface position. Note, however, that the subject function remains an underlying feature in two important senses: First, similar functional assignments may be associated with different constituent-structure configurations cross-linguistically, where the surface features of languages exhibit wide differences; and second, the serial order of functions is unspecified, in principle permitting arguments to be assigned to functions in any sequence. This unordered property helps to account for some of the features of speech errors (Garrett, 1975).

Conceptual Categorization: The Case for Animacy

The question that we examine in this section has to do with a conceptual distinction that seems to enter into the functional integration process in a way that favors a direct-mapping account of language use. We will analyze the evidence from psycholinguistic research, particularly from production research,
for a connection between subjecthood and animacy. This evidence has in the past fueled the argument for some sort of direct link between conceptual and linguistic categorization, because the regular appearance in the subject position of arguments with particular conceptual features has been regarded as a challenge to purely structural interpretations of the subject relation. The broad outlines of the connection have been sketched in many reviews (Bates & MacWhinney, 1982; Bock, 1982; Ertel, 1977; MacWhinney, 1977; Osgood & Bock, 1977). Here we draw on this evidence in a selective way, updating it where appropriate with more recent results. Our goal is to defend animacy as a conceptual feature that reliably characterizes subject arguments and, therefore, as a feature that may be used to trace the relations that such arguments assume during syntactic encoding. Although there are other candidate tracers, the range of evidence for animacy is much larger.

The statistical relationship between animacy and subject arguments is easily established. Animates make more natural subjects than inanimates: Corrigan (1986) collected "goodness" ratings for large numbers of sentences whose subject arguments varied in animacy, and found higher ratings for animates than for inanimates. Animates are more likely to be used as sentence subjects than inanimates, given equal opportunities. Thus, students who were instructed to compose a sentence for each word in a balanced set of animate and inanimate nouns used the animate subjects more often than the inanimates (Itagaki & Prideaux, 1985). Animacy continues to exert powerful control over the selection of the subject argument in the face of variations in the roles of event participants or variations in the sentence forms required to put a participant into the subject position. In our own work (Bock, 1986b; Bock & Loebell, 1990; and the experiment to be reported in the present article), we have seen this in an unusual bias toward passive sentences in describing pictured events with animate patients and inanimate agents. Across sets of pictures that elicited 4,845 transitive (active or by passive) event descriptions, passives constituted 74% of the responses. The passive allowed the animate patient to serve as the subject argument, and the desirability of this state of affairs apparently overrode the strictures against the use of the passive. The strength of these strictures is evident from the number of passives that occurred among 192 descriptions of events in which the agent was animate and the patient inanimate: There were none.

The interpretation of the statistical relationship between animacy and subject arguments depends in subtle and not-so-subtle ways on how animacy is construed. The category itself may seem to require no explication: Dictionaries define *animate* as alive or having life, distinguishing the life in question from plant life, and many components of the concept seem to be clear to very young children (Gelman & Spelke, 1982). However, speakers are less certain about the attribution of life to some concepts than to others. *Students* are typically animate, but *college class* leaves room for argument. *President* may denote a person (*I want to see the president*) or an office (*I want to be the president*), and offices, like college classes, are merely filled by animate entities. Similarly, there are variations in the confidence with which the characteristics of prototypical animate beings are attributed to less prototypical animate beings (Carey, 1978).

Though such gradations make it hard to predict for a given entity whether or to what degree it will be considered animate, similar gradations are found in the link to subjecthood, thereby helping to confirm the relationship. Sentences with human subject-arguments are judged more sensible than those with nonhuman animal subject-arguments, and those with animal subject-arguments are judged more sensible than those with nonanimate-count, concrete-mass, and abstract-mass nouns as subject-arguments (Clark & Begun, 1971; Itagaki & Prideaux, 1985). So, although animateness, in company with the features of other natural categories, is in some sense a matter of degree, those entities that are more likely to be accorded the attributes of animate beings also seem to be more likely to achieve subjecthood and are more natural in that role (Bates & MacWhinney, 1982).

Beyond the characterization of animacy itself, there are other complications in accounting for its link to subjecthood. We next consider two different ways of analyzing the connection. The first concerns the relationship between animacy and thematic roles, and the second involves an interpretation of animacy in terms of predicableability.

**Animacy and Thematic Roles**

The most familiar way to conceive of the relationship between animacy and subjecthood is in terms of the mediation of event or thematic roles. Some of these roles are more often linked to subjecthood than others (Fillmore, 1968; Jackendoff, 1972; Wilkins, 1988), and animacy is more often a feature of some roles than of others (Shafto, 1973), so the correlation between animacy and subjecthood may be a product of these associations.

To salvage a place for animacy independent of event roles, it is necessary to show first that the roles themselves are not defined with respect to animacy. In linguistic frameworks, the agent role is sometimes stipulated to involve animate entities (Jackendoff, 1972), but sometimes it is not (Chafer, 1970). Other roles tend not to be individuated with respect to animacy (with the exception of patient; see Levelt, 1989). The psycholinguistic evidence for speakers' conceptions about roles such as *actor* or *agent* suggests that they can be filled by inanimate entities. Working with 4- and 5-year-old children, Brainin and Wells (1978) found that animacy, although closely related to children's notions about what constituted the actor in an event (Corrigan, 1988), was not a requirement for attributing the actor role. As actors, vehicles were nearly although not quite as good as animate agents (also see Angiollillo & Goldin-Meadow, 1982; Byrne & Davidson, 1985), and even static inanimates could be reliably identified as actors.

It is also necessary to show that, regardless of its event role, an animate entity is likely to be linked to subjecthood. A key piece of evidence comes from Clark (1965). Its interpretation rests on the assumption that the event role typically encoded in the subjects of actives and the by-objects of passives is the same, as is the role typically encoded in the subjects of passives and the direct objects of actives. Clark had high-school students fill in active and passive sentence frames with nouns and verbs of their own choosing, and found that the subject arguments of the sentences so composed were more animate than would be ex-
pected on the basis of the animacy of the entities playing the same event roles but as by-objects or direct objects. Although this could be due to subtle role variations in the sentences composed by Clark's subjects, it also occurs when language producers are constrained with respect to the events they describe. So, when event types are held constant but producers are free to vary the assignments of event roles to syntactic relations, a given role is more likely to achieve subjecthood when it is filled by an animate entity (Dewart, 1979; Harris, 1978; Lempert, 1984, 1989). This suggests that animacy itself bears a relationship to subjecthood.

**Animacy and Predicability**

There are probably more verbs in all languages that permit or require animate subject-arguments than inanimate ones. This supposition emerges from consideration of a structural analysis of predicability relationships proposed by Sommers (1963) and elaborated by Keil (1979). The analysis is stated in terms of the tree structure illustrated in Figure 3, where predicates (which include any predicating expression, not only verbs) are in uppercase letters, and terms (the sorts of entities to which they may apply) are in lowercase letters. The rule is that each predicate spans all of those terms that every predicate below it spans, so, of everything of which it can be said that it is honest or sorry, it may also be said that it is asleep or hungry. In his application of this analysis to the development of ontological knowledge, Keil (1979) constructed and tested a hierarchy of predicates and terms in which, along the left branches, the predicates lowest in the tree apply to humans, next lowest to animals, next to living things, and so on up to physical objects, things with spatial location, and all things.

Because animates occupy the lowest branches of the tree, there are more predicates that apply to them than to other terms above them along the left branch. Though this does not mean that there are necessarily more predicates for animates than for inanimates (because the right-branching nodes represent predicates that do not apply to animates, and each node represents an indefinitely large class of terms or predicates), it is notable that there is considerably more depth along the left than along the right branches of the tree. This suggests that in formulating his analysis, Keil more readily generated predicates that are applicable to animates. If this is as true of verbs as it is of predicates in general (which may take any form ranging from is honest to leaks out of boxes to is thought about), we may be better able to express our thoughts about animates (Bock, 1982) as well as more likely to have highly elaborated knowledge about them in the first place. Though only the latter is implied in Keil's formulation, the former is a likely consequence of any reasonable relationship between thought and language. As a result, the predicability hierarchy suggests that subject arguments may tend to be animate simply because more things are known and can be said about animates than about inanimates.²

However, from this there also flows a trivial explanation for the animacy of sentence subjects. If it is easier to think about animate than inanimate categories, there may be more terms for those categories as well as more predicates, so more chance predicts that animates will be subject arguments more often than inanimates. Likewise, animates should be direct-object arguments more often than inanimates (as they might be), and so on. To establish that the link between animacy and subjecthood may be more principled, it is essential to show that animate subject-arguments occur more often than animate object-arguments for verbs that permit both animate and inanimate subject- and object-arguments.

The required evidence can be found in work reported by Jarvella and Sinnott (1972). They asked adults and children to fill in active and passive sentence frames that already contained verbs, and those verbs had different privileges with respect to the animacy of their underlying-subject and underlying-object arguments. For those verbs that allowed both animate and inanimate underlying-subject arguments, Jarvella and Sinnott found that the proportion of animates used when this argument

---

² The strictness of the predicability hierarchy is in some doubt because there are violations of the constraints that it predicts (Carey, 1983). Keil and Kelly (1986) argued that these violations may not be very common, which is all that is required for present purposes.
appeared as the subject was .75; when it appeared as the by-object, the proportion fell to .65. For those verbs that allowed both animate and inanimate underlying-object arguments, they found that the proportion of animates used when the underlying-object argument appeared as a subject was .59; when it appeared as a direct object, the proportion fell to .44. Negligible but consistent differences were found even for verbs that were classified as requiring animate underlying-subject arguments, animate underlying-object arguments, and inanimate underlying-object arguments, with all of them revealing preferences for animate subject-arguments. This general difference in animacy between subject and object arguments was reliable and replicates Clark's (1965) findings but with the verb forms controlled.

The implication is that something other than a chance connection between animacy and subject arguments is at work, and predictability suggests a more profound explanation. Predicates are, after all, about subjects in the logical sense. The abundance of predicates that can be applied to animate concepts argues that human cognition centers on animate beings, with the thoughts we have and the messages we compose reflecting this fact. The features of subject arguments follow from this very general feature of conception. The origin of those features is not in the linguistic system, then, but in the conceptual system, as many have argued (cf. Ertel, 1977; MacWhinney, 1977). The lexical system may reinforce the predisposition by offering more verbs and verb forms that permit animate than inanimate subject-arguments.

A Conceptual Analysis of Subjecdhood?

It is a short step from this analysis of subjecthood to the simple and appealing suggestion that the categories of language are closely linked to conceptual features. We call this the conceptual approach to syntactic functions, and we take the evidence we have just reviewed as strong support for it. The important and often neglected proviso is that it applies to the arguments of the subject relation, not to the relation itself. In the next section we survey whether and how such a conception of arguments can be reconciled with the structural features of the relations.

From Conceptual to Linguistic Categories: The Mapping Process

The conceptual approach to syntactic functions collides abruptly with the nature of the subject relation. Subjects—subjects as they are realized in the utterances speakers produce—have nearly (though not completely) invariant structural manifestations that seem to be impervious to gradations in animacy. Roughly and incompletely, the subject is the highest noun phrase that precedes the verb (intuitively, the noun phrase most likely to stand on its own in subjective groupings of clausal elements; though see Martin, 1970, for a caveat), the noun phrase with which the verb agrees, the noun phrase that takes the nominative case in pronouns, and so on. The conundrum is that speakers seem to prefer animate subject-arguments but at the same time seem to be relatively oblivious to animacy in matters of structural implementation (Bock & Miller, 1991).

An account of the production mapping process must reconcile these facts.

Different sorts of reconciliations are required for mediated and direct mapping because of their divergent views about how arguments become linked to syntactic relations. According to a mediated-mapping construal of the production process, there are two structural-syntactic levels over which formulation mechanisms are defined, as sketched in Panel a of Figure 4. Arguments are assigned not to the (surface) subject or object relations, but to underlying relations, on the basis of roles that are differentiated by various conceptual features (including features related to animacy). To account for the association between animacy and subject position, the mechanisms that relate underlying arguments to surface arguments must somehow be sensitized to their conceptual features (how this could occur is the topic of a slightly different debate that we will not pursue here; see Slobin, 1966, and Forster & Olbrei, 1973, for the opening arguments). However, once an argument is in place in a surface relation, the structural features of the relation may take over the implementation of the sentence without regard for the argument's conceptual features.

4a: Mediated mapping

Subject

V

Patient

4b: Direct mapping

Subject

V

Patient

Figure 4. Mediated (a) and direct (b) mapping of the syntactic relation of subject in a passive sentence. (According to the mediated-mapping account, the subject argument is originally the argument of the underlying object at a different level of structural-syntactic representation [following current linguistic theory, the underlying-subject slot is empty]. It originates as the patient in some representation of the to-be-communicated event. According to direct mapping, the subject function is assigned to an element [e.g., a lemma] that then becomes the argument of the surface subject.)
In contrast, direct mapping implies just one structural-syntactic level, fed by a process that assigns syntactic functions immediately to arguments, as in Panel b of Figure 4. The animacy bias in function assignment may arise because such features as animacy dominate a range of assignment options (see Bock & Warren, 1985, for a similar argument about concreteness). However, the same features may have little impact on the process that creates the structural-syntactic configuration. Figure 2 caricatures this state of affairs. As shown there, the features of the arguments are visible to the processes that assign function tags, but not to the processes that put those arguments in place in the constituent structure. The latter processes have access to distinctive information about the function tags only.

In the experiment to be reported here, our goal was to test the mapping hypotheses that we have just sketched, building on the presumption that animacy may be used to trace production mapping mechanisms. If animacy does affect mapping, we would expect to see variations in produced sentences that can be attributed to variations in the animacy of subject and object arguments. The likely patterns of change depend on where in the mapping process any effects of animacy arise, and this in turn depends on whether the mediated- or direct-mapping predictions are valid. The experiment permitted us to evaluate the merits of the two mapping proposals on the logic described in the next section.

**Priming the Mapping Mechanisms**

In the experiment we used the syntactic priming paradigm developed in previous work (Bock, 1986b, 1989; Bock & Loebell, 1990) and supplemented it with a manipulation of the animacy of the subjects and objects of the priming sentences. The working assumption behind the use of this paradigm is that the factors that are effective in eliciting syntactic priming or structural repetition may delineate features of basic sentence generation operations. Our work with the paradigm so far indicates that it is sensitive to the phrase-structure configurations of sentences (Bock, 1989; Bock & Loebell, 1990).

The procedure involved the production of a priming sentence followed by the description of an event, as shown in Figure 5. In other studies, we have found a tendency for the forms of priming sentences to be repeated in picture descriptions, so that active primes tend to be followed by active picture descriptions, passives by passives, prepositional datives by prepositional datives, and double-object datives by double-object datives (Bock, 1986b, 1989; Bock & Loebell, 1990; Loebell, 1989).

In the present experiment, half of the primes were actives such as Five people carried the boat and half were passives such as Five people were carried by the boat. We expected that the pictures following active primes would tend to be described with active sentences (such as "The alarm clock awakened the boy") and that those following passive primes would tend to be described with passive sentences (such as "The boy was awakened by the alarm clock"). We will refer to the active and passive picture descriptions as the target sentences. Because the repetition effects are reciprocal, such that the number of passive targets goes down when the number of active targets goes up and vice-versa, we will set out the predictions for active and passive primes with respect to the active target sentences only.

![Figure 5](image-url)  
**Figure 5.** A sample priming sequence within an experimental list.

We systematically varied the animacy of the subject and object arguments of the primes. Half had animate subject-arguments with inanimate object-arguments, as in the active and passive sentences in the previous paragraph, and half had animate subject-arguments and animate object-arguments, as in The boat carried five people and The boat was carried by five people. If the assignment of arguments to syntactic relations is sensitive to the animacy of the entities involved, and if the nature of the assignment exerts a priming effect (so that the type of assignment on one occasion predisposes or facilitates a similar assignment on a subsequent occasion), the animacy of the subject and object arguments in the primes should influence relation assignments in the target sentences. We controlled the animacy of the likely subject and object arguments in the target sentences by using pictures of events with animate agents and animate patients. As a result, the active targets had inanimate surface subjects.

If relational priming occurs, it should manifest itself as a tendency to assign arguments with similar features to similar syntactic relations or functions across successive sentences. So, if the prime contains an animate subject-argument, there should be a tendency to assign the animate entity in the event to the underlying relation or function most compatible with its realization as a subject in the target, as well. The two mapping hypotheses we set out earlier make different predictions about what these relations or functions are.

According to the mediated-mapping conception of such assignments, an argument that bears different surface relations in
active and passive sentences may have the same underlying relation in both. Specifically, the object of an active and the subject of a passive may both originate as the underlying object. If an animate (e.g., five people) is assigned to the underlying object relation in a priming sentence (as in The boat carried five people or Five people were carried by the boat), the assignment can be replicated in creating an active target sentence by assigning the animate ("boy" in the example in Figure 5) to the underlying object relation. Conversely, when the relation assignments in the priming sentences bind an inanimate (e.g., the boat) to the underlying object relation (as in Five people carried the boat and The boat was carried by five people), the assignments for the active target cannot replicate the features of the prime. The reason is that the inanimate participant in the event ("clock" in the example) must bear the underlying subject relation in the target.

The direct mapping predictions differ. According to this view, primes with inanimate subject-arguments (e.g., The boat carried five people; The boat was carried by five people), though they describe different events, share the property of binding inanimates to the subject function. They may therefore prime comparable bindings in the active target sentences (inanimate \( \rightarrow \) subject). But when the prime requires binding an animate to the subject function (as in Five people carried the boat and Five people were carried by the boat), the binding cannot be replicated in the active targets.

Generally, then, the mediated-mapping hypothesis predicts that active and passive primes with animate underlying-object arguments (the surface objects of the actives and the surface subjects of the passives) should elicit more active targets (all of which had animate objects and inanimate subjects) than active and passive primes with inanimate underlying-object arguments. Conversely, the direct-mapping hypothesis predicts that active and passive primes with animate object-arguments (the surface objects of both) should elicit more active targets than active and passive primes with inanimate object-arguments.

Coupling these hypotheses to the basic prediction for surface-form effects (that actives will follow other actives more often than passives), we get the projected results shown in the two panels of Figure 6. As a shorthand, the predictions are expressed only in terms of the animacy of the arguments of surface subject relations in the primes; expressed in terms of underlying relations, the predictions for the two views simply reverse. They are again given only for the active target sentences.

Table 1 renders these predictions as a simple checklist. It shows that mediated and direct mapping predict identical outcomes for both types of active primes (Five people carried the boat and The boat carried five people), because in this case the underlying and surface arguments are the same in the mediated scheme. For the passive primes, however, the predictions of the two views differ.

According to mediated mapping, passive primes share the features of the underlying arguments of the active targets in the cases when the subject argument of the passive prime is animate (Five people were carried by the boat) but not when it is inanimate (The boat was carried by five people). With the former, the similarity of the underlying arguments to those of the active target should increase the production of actives. However, their frequency should remain below that elicited by animate-subject-argument active primes, because the tendency for passive primes to elicit passive phrase-structure in the targets may neutralize the advantage of having the same arguments in the prime and target. With the inanimate-subject-argument passives, however, the primes and active targets share neither underlying-argument features nor surface phrase-structure configurations, yielding little to favor active-target production.

According to direct mapping, inanimate-subject-argument passive primes (The boat was carried by five people) share function-argument features with the active targets, and animate-subject-argument passive primes (Five people were carried by the boat) do not. Neither shares the phrase structure of the active target. Both should therefore be less likely than the corresponding active primes to elicit active targets, but the relative advantage of shared argument-features predicted for inanimate-subject-argument active primes (The boat carried five people) should be preserved with inanimate-subject-argument passive primes.

These predictions make no allowances for differences in event roles beyond the animacy features of the arguments. In
Table 1

Components of Prime-Target Relationships According to the Mediated-
and Direct-Mapping Hypotheses

<table>
<thead>
<tr>
<th>Prime form</th>
<th>Prime’s surface subject</th>
<th>Surface form</th>
<th>Animacy features of underlying arguments or function arguments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mediated mapping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>Inanimate</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Active</td>
<td>Animate</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Passive</td>
<td>Inanimate</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Passive</td>
<td>Animate</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Direct mapping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>Inanimate</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Active</td>
<td>Animate</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Passive</td>
<td>Inanimate</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Passive</td>
<td>Animate</td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

addition to the reasons offered earlier for suspecting that generalized event roles may not play an immediate part in the assignment of syntactic relations, there is a hint from the production priming task we will use that animacy has an effect that event roles do not. In two previous experiments (Bock, 1986b, Experiments 2 and 3), there were consistent but statistically unreliable tendencies for matches in animacy between the subjects of prime and target sentences to increase the magnitude of structural priming (also see deVilliers, 1980). In contrast, variations in event roles have yielded no variations whatsoever in this effect (Bock & Loebell, 1990). For this reason Bock and Loebell concluded that sentence structures are formed independently of event-role schemes.

It remains to be determined whether animacy has the same status with respect to the mapping processes. To the extent that there is any substance to the animacy patterns discernible in Bock’s (1986b) results, they could be attributed either to an effect on assignments to syntactic functions or to an effect on the formation of phrasal-syntactic structures. These possibilities could not be discriminated in the earlier work, in part because the animacy manipulation involved only one constituent of the priming sentences. The present experiment remedies that problem. If animacy proves to be as ineffective as event roles, we may assume either that we have so far failed to isolate any of the critical conceptual-to-syntactic mapping features or that our tasks are insensitive to those features.

To help to converge on the appropriate interpretation of the sources of the predicted effects, we accompanied the priming manipulations with instructions designed to emphasize either the meanings or the forms of the priming sentences. These instructions concerned the performance of a cover memory test, the purposes of which were to engage the interest of the speakers and to distract them from the features of their speech. The test required the participants to pick out any recurrences of pictures and sentences (the experimental lists included a large number of filler items, each of which was repeated sometime in the course of an experimental session). Half of the repeated sentences were identical to a previous sentence, and half were similar in meaning but not in form (e.g., The tomb took fifty years to build. It took fifty years to build the tomb). Half of the participants were told that when such differences in form occurred, they should indicate that the sentence had not appeared before. This constituted the form-focus instruction. The remaining participants were told that they should ignore such form differences in their responses, because the sentences meant the same thing, and should say that the sentence had occurred before. This constituted the meaning-focus instruction. Although the recognition response differences required by these instructions affected only the fillers, any processing consequences of the instructions should also influence the priming sentences, because the participants were uninformed about the priming manipulation and so were unaware of the distinction between priming and filler sentences.

If relation-assignment priming taps a component of the mapping from a meaning-based to a form-based representation, meaning-focus instructions should magnify the effects of animacy relative to those of form, though without changing the basic patterns of the predictions sketched in Figure 6. And if form priming affects the development of phrasal frames, form-focus instructions should magnify the effects of structural differences.

To check the effectiveness of these instructions and to assess how well the priming sentences were understood, we also administered a recognition memory test at the end of the experiment. The test items included all possible forms of each priming sentence, and the task was to select the sentences that had actually been presented during the experimental session.

Method

Participants

The participants were 192 Michigan State University undergraduates. Their service in the experiment earned them extra credits in introductory psychology courses.
Table 2
Sample Priming-Sentence Set

<table>
<thead>
<tr>
<th>Priming condition</th>
<th>Example sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active, animate subject</td>
<td>Five people carried the boat.</td>
</tr>
<tr>
<td>Active, inanimate subject</td>
<td>The boat carried five people.</td>
</tr>
<tr>
<td>Passive, animate subject</td>
<td>Five people were carried by the boat.</td>
</tr>
<tr>
<td>Passive, inanimate subject</td>
<td>The boat was carried by five people.</td>
</tr>
</tbody>
</table>

Materials

There were 16 sets of priming sentences like those shown in Table 2. Every set included four sentences, two actives and two passives. All of the sentences in each set contained the same two noun phrases, one animate and the other inanimate, and the same base verb. In one active sentence the animate and inanimate noun phrases served, respectively, as the subject and the direct object, and in the other as the direct object and the subject. The two passives were structural paraphrases of the actives. The Appendix lists all of the active animate subject-argument priming sentences.

The sentences from each set were paired with one of 16 target pictures, so that the same picture accompanied all of the sentences from the same set. The sentence-picture pairings were designed to minimize semantic or pragmatic relationships. One of the target pictures is illustrated in Figure 5, and descriptions of each pictured action are listed in the Appendix. Every pictured event included an inanimate agent and an animate patient, so a typical active-sentence description of the event had an inanimate subject-argument and an animate direct-object argument. The pictures were drawn in black ink on white paper and were photographed for presentation on slides.

In addition to these priming materials, there were 48 filler sentences and 48 filler pictures. The filler sentences represented an assemblage of constructions, including intransitives, datives, predicate adjectives, predicate locatives, clausal subject and object complements, reflexives, and simple actives. The filler pictures were similar in style and preparation to the experimental pictures but depicted actions that are commonly described with different sentence forms, including intransitives, datives, and reflexives.

The filler materials were used to create a single master list. The master list contained all 96 filler items, each repeated once. Half of the repeated filler sentences were repeated in exactly the same form, and half were repeated with a minor (non-meaning-changing) wording or stylistic change. The wording changes were created by substituting a synonym for one word in a sentence. The stylistic changes ranged over a variety of simple structural variants, such as 3-replacements (It took fifty years to build the tomb; The tomb took fifty years to build), equatives (Mike Ditka is the coach of the Chicago Bears; The coach of the Chicago Bears is Mike Ditka), and clefts and pseudoclefts (It was Oswald who shot Kennedy; The one who shot Kennedy was Oswald). The fillers were arranged so that no more than three pictures or three sentences appeared consecutively, and neighboring pictures and sentences were unrelated. Otherwise, the order of the fillers was random. Across successive quarters of the list, 9.4%, 31.2%, 25.0%, and 34.4% of the fillers were repeated.

The master list served as the template for eight experimental lists, and its features remained the same across these eight lists. Each of the experimental lists contained 208 items, including the fillers and the items for eight priming trials. Every priming trial was made up of a single priming sentence followed by its paired target picture. These trials were spaced evenly throughout each list so that 24 fillers preceded each one.

Every experimental list contained representatives of half of the priming sentence sets. Four of the lists (arbitrarily designated the A lists) contained representatives of 8 of the 16 sets, and the other four lists (the B lists) contained representatives of the other 8. The primes were divided between two lists because it was important to space the priming sequences far enough apart to eliminate persistence from one trial to the next (Bock, 1989; Bock & Kroch, 1989), but it was impossible to accommodate lists of the length required to do this within a 1-hr session. The assignments of sentence sets to the A and B lists were made randomly. Across the A lists, every sentence from each of the eight priming sets represented in those lists occurred just once, and similarly for the B lists.

In every list, each of the four types of primes (animate-subject active, animate-subject passive, inanimate-subject active, inanimate-subject passive) occurred twice. The primes from the same sets occurred in the same locations across the lists in which they appeared.

Two recognition tests were created, one for the A lists and the other for the B lists. There were eight items on each test, all typed on a single sheet of paper, one item for each of the eight priming sentences presented. The individual items included all four variants of each prime in a four-alternative forced-choice format. The order of the alternatives was the same in every item (the two actives and then the two passives, with the animate-subject form first for each). The same random order of items was used for both tests so that the relationship between test order and order of presentation in the two priming lists was the same.

Procedure

The syntactic priming manipulation was implemented in the context of a running recognition memory test. The participants were told that they would see a long list of pictures and sentences and that their task was to detect recurrences of the individual items. On the pretext of improving their memory performance, they were also asked to repeat each sentence after it was read by the experimenter and to describe what was happening in each picture after it was presented. Then, on each trial, they were to indicate whether the item had appeared previously in the list. They did this by saying "yes" or "no," and the experimenter provided feedback about the correctness of their judgment.

Specific instructions for describing the pictures were kept to a minimum. The participants were asked to describe what was happening in each picture in a single sentence without personal pronouns. Three practice trials were used to illustrate the procedure and to ensure that the participants understood the instructions. Two of these were picture trials, and one was a sentence trial.

The list items were presented on slides, with blank slides in the list positions where sentences occurred. At these points the experimenter read the sentences aloud. An interval of approximately 1 s separated the end of one trial from the beginning of the next. Figure 5 gives the order of events for every sentence and picture trial, in the context of a priming sequence. Because the filler items and the items constituting the priming sequences were treated in exactly the same fashion and with no discontinuities in their presentation, there were no differences between them from the perspective of the participants. The lists were divided into four blocks of 52 items each, with short breaks between each block for changing the slide carousels.
The participants were run in individual sessions. Each received one of the eight experimental lists along with one of two types of instructions, meaning focus or form focus. Both sets of instructions pointed out that there would be occurrences of sentences with meanings nearly identical to those of previous sentences but with slightly different wording. The form-focus instructions went on to say that because these sentences were not the same as their predecessors, the correct recognition response to them was "no," to indicate that they had not occurred before. The participants were warned "to pay close attention to how the sentences are worded" in order to perform well on the test. The meaning-focus instructions, conversely, went on to say that because these sentences meant the same thing as their predecessors, the correct recognition response to them was "yes," to indicate that they had occurred before. The participants who received these instructions were warned "to pay close attention to what the sentences mean." An example illustrating a wording change accompanied both sets of instructions. Every experimental list was accompanied equally often by meaning- and form-focus instructions.

The recognition test appropriate to the presented priming list was administered at the end of the session. The participants were instructed to indicate, for each test item, the sentence that exactly corresponded to the one presented during the session. They were informed that only one of the four sentences had actually occurred.

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

Scoring

The transcribed descriptions of the primed pictures were scored as actives or passives. To be scored as an active, a description had to contain the inanimate agent of the action as the subject and the animate patient as the direct object. To be scored as a passive, a description had to contain the animate patient as the subject and the inanimate agent as the by-object. To be scored in either category, a description had to have a grammatical alternative in the other category that changed the syntactic relations of the agent and the patient (to ensure that the message being conveyed could be realized in the alternative form). Application of these criteria to the descriptions yielded 813 target responses (53% of all responses), including 236 actives and 577 passives. Of the target responses, 23% occurred after active animate-subject-argument primes, 27% after active inanimates, 25% after passive animates, and 25% after passive inanimates.

Descriptions not meeting the scoring criteria for actives and passives were distributed about equally across the priming conditions and were excluded from the analyses. Such descriptions were relatively common because the forms of the speakers' utterances were not constrained and could not be constrained without creating a production task that radically distorted the normal demands of talking. For the most part, the excluded descriptions could not be brought to bear on the experimental hypotheses because they were in a different syntactic form or omitted mention of one of the event participants. The most problematic of the excluded cases are those involving so-called adjectival or stative passives like "The boy is wide-eyed at the noise." A major difficulty with such sentences is that, although they have the phrase structure of passives, there is reason to doubt that they stand in the same relationship to an active counterpart as the verbal, dynamic by-passive (to "The noise wide-eyed the boy") is very deviant; Wasow (1977). Among other things, the apparent event roles of the prepositional objects differ in adjectival and verbal passives (source vs. agent, respectively), and the form of the verb that follows the auxiliary or copula (be) in adjectival passives tends, eponymously, to have more adjectival than verbal properties, such as freer distribution in prenominal position. To the extent that they do not have active paraphrases, adjectival passives do not have the feature that permits the test of the mapping hypotheses and so were omitted.

Design and Data Analyses

Every participant received eight target pictures, two in each of the four priming conditions defined by the combinations of the form factor (active vs. passive) and the animacy factor (animate vs. inanimate subject). Half of the 192 subjects received these pictures with form-focus instructions, and half with meaning-focus instructions.

Each of the 16 target pictures was shown to 24 subjects in each of the eight conditions defined by the combinations of the form, animacy, and instruction factors.

The dependent variable was the number of active sentences produced as picture descriptions by each participant (or, for the item analyses, for each item) in each condition. Analyses of variance were performed on these data, with separate analyses treating participants and items as random effects. Differences were treated as significant when their associated probability was equal to or less than .05.

The results for passive sentences were complementary to those for actives. To show this, the data are graphed as proportions of the total numbers of active and passive sentences produced.

Results

Figure 7 shows the proportions of actives (all with inanimate subjects) among the active and passive picture descriptions in the animacy and form priming conditions. In parentheses are the numbers of active targets produced in each condition. The figure suggests that both the form of the prime and the animacy of its arguments affected the production of the sentences. More animate-subject actives were produced after primes with inanimate subject-arguments than after primes with animate subject-arguments and after active than after passive primes. The magnitude of the increase after active primes, relative to passives, was the same regardless of the animacy of the subject argument. Analyses of variance on the numbers of ac-

![Graph showing proportions of active sentences](image-url)
tive sentences confirmed these impressions: The effect of the form of the prime was significant, $F(1, 190) = 9.93$ for participants; $F(1, 15) = 8.47$ for items. Also significant was the effect of the animacy of the prime's arguments $F(1, 190) = 7.27$ for participants; $F(1, 15) = 6.71$ for items. No other main effects or interactions achieved reliability.

Figure 8 breaks these data down into the results for the separate form- and meaning-focus groups. Although the general configurations for both were similar, it is evident that the animacy effects were larger and the form effects smaller with meaning-focus than with form-focus instructions. Simple effects tests revealed a significant difference due to animacy with meaning-focus instructions: $F(1, 190) = 6.46$ for participants; $F(1, 15) = 6.43$ for items. There was no such difference with form-focus instructions: $F(1, 190) = 1.62$ for participants; $F(1, 15) = 3.65$ for items. Conversely, there was a significant difference due to form with form-focus instructions: $F(1, 190) = 7.92$ for participants; $F(1, 15) = 6.00$ for items. No such difference was apparent with meaning-focus instructions: $F(1, 190) = 2.70$ for participants; $F(1, 15) = 2.06$ for items.

On the postexperimental recognition test, the ability to correctly recognize the priming sentences did not differ between the meaning- and form-focus groups, who achieved 59.4% and 60.0% correct, respectively. More important than correct performance are the types of errors that were committed. The errors fall into three categories corresponding to selections of foils that, relative to the target, had (a) the same meaning but a different form, (b) the same form but a different meaning, or (c) both a different form and a different meaning. The distribution of the first two error types is shown in Table 3. Across both groups, meaning-same errors were overwhelmingly more likely than form-same errors, 25.1% to 6.6% for participants, $F(1, 190) = 189.6$, and for items, $F(1, 14) = 69.9$. As the table suggests, there were differences between the meaning- and form-focus groups in error performance, with the directions of those differences consistent with the nature of the instructions, but the interaction between instructions and error type was not significant: $F(1, 190) = 1.4$ for participants; $F(1, 14) = 1.6$ for items.

Discussion

The data show, first, that there was a propensity to bind semantically similar arguments to the same syntactic relations across successive, unrelated sentences. This appeared as a reliable tendency for primes with inanimate subject-arguments to elicit targets with inanimate subject-arguments more often than targets with animate subject-arguments. However, the magnitude of this tendency was unaffected by the structure of the priming sentences. The inanimate subject-arguments of passive primes were as likely as the inanimate subject-arguments of active primes to predispose inanimate subject-arguments in subsequent active targets.

Second, the results show that there was a propensity to build similar structural configurations across successive, unrelated sentences. This was manifested in a reliable tendency to repeat sentence forms: Active primes were more likely to be followed by other actives than by passives. This structural repetition effect was unaffected by the conceptual features of the subject arguments, because active primes with inanimate subject-arguments were as likely as active primes with animate subject-arguments to elicit active targets.

The outcome of the instructional manipulation reinforces the attribution of these effects to different sets of processes, one set related to the features of meaning and another set related to the features of structure. For speakers whose attention was directed to the meanings of the sentences, the impact of animacy differences was more prominent, whereas for those whose attention was directed to the forms of the sentences, the impact of structural differences was more prominent.

These results argue that the operations of the producer can be decomposed into at least two types of mechanisms relevant to the realization of syntactic form. We suggest that the mechanisms are, respectively, those involved in binding arguments to syntactic relations and those involved in building constituent structures. With respect to the former, the results point to a binding process more along the lines sketched in the direct-mapping hypothesis than in the mediated-mapping hypothesis. Similarities in the features of the so-called underlying arguments of active and passive sentences had no impact on the priming patterns, though similarities in the features of the sur-
face arguments did. Because a direct-mapping approach assumes that the arguments of syntactic functions are the same as the arguments of the corresponding surface relations, this is the predicted result.

Such a processing framework fits more comfortably with formal linguistic schemes in which syntactic-function assignments and constituent-structure building draw on different representational primitives, as in grammatical systems that countenance direct mapping (e.g., Bresnan, 1978, 1982; Gazdar et al., 1985; Pollard & Sag, 1987; Steedman, 1989). However, the implications of the results for processing models derived from linguistic theories may be questioned. J. D. Fodor (1989) has noted that the issue of multiple levels is less important to the evaluation of such theories than is the issue of the individuation of empty categories. The reason is that the various claims of the government-binding approach may be recast in terms of a single structural level in which different empty categories are generated in place. In such a reformulation, passives would not be derived but would be directly generated with a noun-phrase (NP) trace immediately following the verb, as in Five people were carried [NP trace] by the boat. The trace carries many of the features of the subject (obvious exceptions being the phonological features), because it is co-indexed (coreferential) with it. Looking at the present results from this perspective, one might ask whether the obtained priming pattern is more easily reconciled with such a single-level reformulation.

We do not think so. Assuming that the trace duplicates the semantic features of the subject, a mental representation of the priming sentence would include the features of animacy or animacy in the immediate postverbal (direct-object) position in passive sentences. This makes roughly the same prediction as the mediated-mapping hypothesis in that the priming patterns attributable to variations in the animacy of subjects and objects should be substantially different for passives than for actives (which have no traces). The absence of such differences is no more compatible with directly generated noun-phrase traces than with indirectly generated ones.

This should not be taken as evidence against traces of all kinds. Noun-phrase traces have a very different status than the traces that are postulated for questions and relative clauses, wh traces. The latter correspond to "gaps" where noun phrases would be required in canonical surface constituent-structures, as in What did the car hit [wh trace] ? and The man that the car hit [wh trace] was drunk. The pronoun that heads the question or clause is linked to this gap in most contemporary syntactic theories, but in direct-generation approaches the linkage is not transformational. The uncontroversial status of wh traces carries over to the processing domain, where there is a wide array of evidence for a strong and immediate bond between wh traces and their antecedents. The processing case for noun-phrase traces is weaker (again see J. D. Fodor, 1989, for review and discussion).

In theories of language performance, the notion of direct mapping between semantic and syntactic representations customarily implies a view of language processing in which the two types of information interact continuously and in a relatively unrestricted fashion (for recent statements of evidence for this position, see McClelland, 1987, and Taraban & McClelland, 1988). In such views, the semantic dimensions of sentences may immediately affect their structural analysis, so that parsing and understanding (and by extension, production and formulation) may be guided from beginning to end by the nature of the meaning that is conveyed. In their strongest forms, such views imply that semantic and syntactic processes are one and the same.

In contrast, our data point to a separation between production mechanisms that deal with meanings and production mechanisms that deal with forms, at least for function-argument assignments and constituent-structure building. To establish that this is not an isolated instance, in the next section we lay out a case for the generality of the separation between the semantic features of subject arguments and the structural features of the utterances in which they occur.

The Meanings and Structures of Subjects

If meanings and syntactic forms are the provinces of different mechanisms of language production, the conceptual features that afford access to the syntactic function of subject should not affect the structural relations into which subject arguments enter. Evaluating this requires an examination of the relationship between conceptual features and the various structural and morphological properties—the coding properties—of subjects (see Cole, Harbert, Hermon, & Sridhar, 1980, and Keenan, 1976, for a discussion of these properties). Few of the coding properties have been systematically examined from this perspective. However, at least one aspect of morphology, nominal case marking, is highly correlated with animacy, because it is all but categorically restricted to personal (animate) pronouns (e.g., I vs. me, she vs. her, he vs. him). It, this, that, those, and these do not inflect for case (although they may refer to either animate or inanimate entities and has an objective counterpart, them). To see whether animacy might also affect coding properties that are tied more directly to constituent

---

Table 3

Postexperimentation Recognition Test Performance (in Percentages)

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Fully correct</th>
<th>Same meaning, different form</th>
<th>Same form, different meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning focus</td>
<td>59.4</td>
<td>25.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Form focus</td>
<td>60.0</td>
<td>24.5</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Note. Percentages are based on a total of 768 responses in each instruction condition.
structures, we will consider the results of research on subject-verb agreement, preverbal positioning, and initialization.

**Animacy and subject-verb agreement.** The most extensive investigations of the contributions of animacy to language use have been carried out with respect to sentence interpretation rather than production (Bates, MacWhinney, Caselli, Devescovi, Natalie, & Venza, 1984; Bates, McNew, MacWhinney, Devescovi, & Smith, 1982; MacWhinney, Bates, & Kliegl, 1984; McDonald, 1986, 1987). This pathbreaking research is nearly alone in its effort to simultaneously assess semantic and syntactic components of processing across several languages. The studies generally used a paradigm in which participants were instructed to identify “the subject of the sentence, that is, the one who does the action” (MacWhinney et al., 1984, p. 140) in sequences such as *The eraser the pig chases. Licks the cow the goat, and The dog grabs the pencil.* The sequences manipulated word order, agreement, and animacy, as well as other factors that we will not consider here.

Granting the possibility that participants sometimes identified subject arguments and sometimes actors, and may have been more prone to do one or the other depending on the kinds of cues that were available, and also granting that what happens in interpretation may be fundamentally different from what happens in production, we can nonetheless ask about the nature of the interactions between agreement and animacy. The first impression that emerges from the study by MacWhinney et al. (1984), where agreement was included in the test situation, is that languages differ substantially in the degree to which their speakers rely on agreement and animacy cues in performing these tasks. A striking feature, though, is the relative absence of interactions between animacy and agreement cues. No reliable interactions were found in English or Dutch, and they appeared in Italian only when the morphological cues were ambiguous. The major exception occurred in German, where there was a reliable interaction between animacy and agreement (MacWhinney et al., 1984). However, the German speakers received materials without case-marking information, which is the syntactic cue that they use categorically to identify the subject. MacWhinney et al. reported that it was necessary to omit case-marking cues to achieve any variability in performance, indicating that German speakers would ignore animacy if unambiguous case marking were available. Apparently, across several languages, the tendency to use agreement in identifying the subject or agent was not enhanced by animacy.

A similar conclusion emerges from studies of production. Bock and Miller (1991) examined the effects of animacy on the occurrence of subject-verb agreement errors in constructions such as *The time for fun and games are over.* In these constructions, a singular head noun is separated from its verb by a postmodifier that terminates in a plural noun, and agreement errors occur at a comparatively high rate. This makes it possible to elicit agreement errors simply by asking speakers to finish preambles along the lines of *The bridge to the islands . . . with material that makes them into complete sentences. Using such an elicitation task, Bock and Miller examined whether the animacy of the head and postmodifier affected the error rate (Experiment 2). Speakers completed preambles in which the head and postmodifier varied in their animacy and in their number, as in the set below:

1. *The king of the islands . . .*
2. *The kings of the island . . .*
3. *The island of the kings . . .*
4. *The islands of the king . . .*

If animacy affects the agreement process, increasing its reliability with animate heads and decreasing it with inanimate heads, fewer errors should occur for (1) and (2) than for (3) and (4). However, no such effect occurred. Relative to control preambles (in which the number of the subject and the number of the postmodifier were the same), the incidence of error was equal after animates and inanimates.

**Animacy and preverbal position.** We know of no evidence to suggest that preverbal subjects are more likely to be animate than displaced subjects. In one relevant experiment, Lempert (1988) trained preschoolers to describe events with what was for most of the children a novel construction, a cleft object (e.g., *It's the tree the man is climbing*). In these constructions, with the relative pronoun absent, the verb in the lower clause is preceded by two noun phrases that, on the basis of their animacy, may be put into competition for the slot immediately preceding the verb.

After training, the children were asked to describe events that contained animate agents and either animate or inanimate patients. With animate-patient events, both the subject and the object of the produced sentence were animate (e.g., *It's the boy the girl is chasing*), whereas with inanimate-patient events, only the subject was animate (e.g., *It's the drum the boy is playing*). If animates compete for preverbal position in a way that an animate and an inanimate do not, it would be expected that more correct descriptions would be elicited for the inanimate-patient events than for the animate-patient events. However, Lempert (1988) reported that there were no reliable differences of this sort. Where there were differences was in the ability of the children to learn the construction to begin with: Here, patient animacy (*It's the drum the boy is playing*) had a substantial facilitatory effect, presumably because it allowed the children to differentiate objecthood and subjecthood and thereby to ascertain the structural correlates of the roles. For example, a child confronted for the first time with a sentence such as *It's the cat the dog bites* is likely to be confused about which entity is appropriately predicated by the verb bites. No such confusion occurs with *It's the apple the bird bites,* since bites may be readily predicated of birds but not of apples. Once the roles are differentiated, however, the suggestion from Lempert's data is that the assignments of the role-bearing elements to structural positions may be insensitive to animacy.

**Animacy and initialization.** Like preverbal positioning, initialization is at once highly correlated with the subject relation but neither necessary nor sufficient to identify it. Subjects may follow other, clause-initial constituents (*On the table John found three keys*); in questions, subjects follow verbal auxiliaries (*Will you see him now?*); in object relative clauses, subjects follow the object relative pronoun (*The man whom you admire*); in imperatives, subjects do not appear at all (*Go home*); and subjects may even follow the verb (*On the table were three keys*). But again, we know of no evidence that ties animacy more tightly to initial than to noninitial subject-arguments.

Even so, there is a connection between animacy and early positioning, which argues that there should be a tendency for
sentence-initial subject-arguments to be animate more often than noninitial subject-arguments. One illustration of the connection is found in a cross-linguistic study of language production reported by Sridhar (1989). Sridhar staged a set of similar events in which different objects that varied in perceptual salience performed the same event role. Although all of the participants were inanimate, Sridhar found that a “pseudoanimate” entity (a doll) was the most likely to be mentioned early in sentences. Other illustrations come from studies of phrasal conjunctions. Cooper and Ross (1975; also see Allan, 1987) suggested that animates tend to precede inanimates in such constructions, particularly in conjunctions whose form is relatively invariant (e.g., men and machines; animal, vegetable, or mineral). Although unique, “unfrozen” conjunctions from literary works have revealed very little in the way of an animacy bias (Kelly, 1986), the general tendency for animates to precede inanimates in phrasal conjunctions has been confirmed experimentally (McDonald, Bock, & Kelly, 1991).

Most persuasive are the findings of Byrne and Davidson (1985). In their experiments, children played with toy horses and carts that were each given a proper name. Thus, the horses might be named Kal and Wag, and the carts Tep and Zot. After a name-learning and play period, the children were presented with pairs of names representing paired horses and carts (e.g., Kal and Tep, or Zot and Wag). Half of the children were given the names in the horse–cart order, and half in the cart–horse order, and then they were asked to recall them in the presented order. The results showed that correct recall of the horse–cart order was more likely than correct recall of the cart–horse order. This was true not only for English-speaking children, whose language regularly places subjects first in sentences, but also for Fijian-speaking children, whose language regularly places subjects last. Thus, it is unlikely to be any linkage between animacy and subject status that produces the order preferences. Instead, it may be something about the memorability (Glanzer & Koppenaal, 1977; Rohrman, 1970) or salience (Luszcz & Bacharach, 1983) of animate entities (Bock, 1982).

There is support for this conjecture in Byrne and Davidson's (1985) work. Among their other results, they found that the horses were more likely to be recalled than the carts (Experiments 3 and 4). Thus, when children erred and recalled two like elements, rather than a horse–cart combination, they were much more likely to recall two horses than two carts.

Evidently, then, animates tend to toward initial position for reasons that can be divorced from actual subject-argument status. But across basic word orders in the world's languages, subjects do tend to precede objects: Estimates of the percentage of languages that do this are consistently above 95% (Tomlin, 1986). And as we have seen, subject arguments tend to be animate. The question is whether the associations between animacy and early positioning, between the subject relation and early positioning, and between subject arguments and animacy may have a unitary explanation (Hale, 1973; Pullum, 1977).

The answer, we believe, may hinge on the incrementality of the sentence formulation process (Kempen & Hoenkamp, 1987; Kempen & Vosse, 1989; Levelt, 1989). The links between syntactic functions and their arguments may normally be affected by the accessibility of argument information. So, concrete, animate, prototypical, frequent, repeated, and topical-ized concepts, among others, which are more readily activated in or retrieved from memory as indexed in list recall and other nonstructural tasks, may tend to occur as subjects more often than concepts that are less accessible, other things being equal (Bock, 1982, 1987a; Bock & Irwin, 1980; Bock & Warren, 1985; Kelly, Bock, & Keil, 1986). If more accessible entities are assigned to the subject function, this assignment may be completed faster than assignments involving less accessible entities, making the subject argument ready for positioning in the constituent structure sooner. As a result, elaboration of the piece of constituent structure that contains the subject argument may often begin before the pieces that contain other syntactic relations. There may therefore be a preponderance of structures with subjects placed early in sentences and a preponderance of languages that prefer this ordering.

In summary, the evidence we have reviewed suggests that with respect to most of their structural privileges and responsibilities, subjects with animate arguments do not differ in obvious ways from subjects with inanimate arguments, despite the affinity between animacy and the role of subject argument. As we noted at the beginning, this is not well-surveyed territory, so it remains possible that further study of the full range of subject coding properties will reveal that subjects with animate arguments are structurally as well as conceptually different from subjects with inanimate arguments. In the interim, however, we endorse an account of the mapping process that runs along the lines sketched in Figure 2. The major tenets of that account are, first, an equation between the argument that is assigned the subject function and the argument that becomes the subject of the produced utterance, and second, a differentiation between the types of processes that assign the function to an argument and those that create its constituent structure slot. The former seem to be sensitive to the conceptual features of the subject argument; the latter are not.

7 The chief exception to the divergence between conceptual and structural effects is the probable association between the animacy of subject arguments and the early positioning of sentence subjects in constituent structures, cross-linguistically. However, that association may have arisen not because structure-building processes are linked to animacy or to any other conceptual features, but because they are indirectly affected by the accessibility or availability of arguments for different syntactic functions.

Functional Integration: A Closer Look

The function-argument assignment process that is sketched in Figure 2 and evaluated in this article constitutes only one part of the production process that we have called functional integration. We conceive of functional integration as creating what Garrett (e.g., 1988) termed the functional representation, though we assume (with Garrett, 1982) that the elements of that representation need not be fully specified before a constituent representation begins to be formed. In Garrett's formulation, the functional representation captures the syntactic privileges of the lexical items (lemmas) for the utterance and the bindings between syntactic functions and lemmas. The operations are neutral with respect to word order in that the eventual sequence of lexical items need not be mirrored in the sequence of binding
operations (though our suggestion is that the latter may have an impact on the former). The questions we have addressed in the present article concern the nature of the semantic information that participates in the binding process and the nature of the syntactic functions to which they are bound. Our current answers to these questions can be incorporated into an account of functional integration in terms of two closely related operations that we will call argument binding and verb-form finding.

Argument binding. Together with the results of Bock and Loebell (1990), our data imply that the semantic information that participates in the binding or function-assignment process may be keyed to basic semantic features, singly or in combination, rather than to generalized event roles. Bock and Loebell found that variations between agent and location roles as represented in active and passive priming sentences had no impact beyond the basic structure-priming effect, whereas in the present experiment variations in the animacy of arguments mattered. On the assumption that those features which can be primed represent basic components of mapping and structure building, this counts as evidence against thematic roles as primitives of the mapping process.

As an alternative to treating thematic roles as primitives, Jackendoff's (1983, 1987) conception of them incorporates a vocabulary of primitive categories ("semantic parts of speech"; 1987, p. 375) that combine to create rough correspondences to thematic roles. One such category is actor, whose features include volitional and nonvolitional; another is affected object, whose features might include sentient and nonsentient; and so on. The concept of animacy may itself be a conflation of such features, rather than a primitive. Alternatively, notions of thematic roles may be epiphenomenal consequences of the semantics of verbs coupled with knowledge about the way the world works (Ladusaw & Dowty, 1988). Either way, it seems likely that current taxonomies of thematic relations are little more than crude sketches of the system in terms of which correspondences between semantics and syntax may ultimately be stated. In the meantime, we assume that syntactic functions are assigned to arguments on the basis of the arguments' semantic features and that the functions vary in their restrictions on the features they accept.

Verb-form finding. Arguments must also be linked to a verb form. The direct-mapping view assumes that different verb forms may be separately represented or individually accessible (Lapointe, 1985; Lapointe & Dell, 1989), so that functional integration should involve not just a verb with the right core meaning, but a verb form (active, passive, and so on) that allows arguments to serve the specific functions to which they are bound. Of course, there may be mismatches between argument bindings and verb forms that trigger searches for alternative verb forms, or realignments that change the sets of functions or arguments, or, occasionally, productions of erroneous sentences in which arguments are bound to the wrong functions (such as You're too good for that when That's too good for you was intended; Stemberger, 1985) or linked to the wrong verb forms.

The animacy-priming results suggest that the properties of a mapping that is successful for one utterance may influence the mapping for a subsequent utterance, implying that properties of recent mappings are preserved in the production system. Such short-term maintenance of mapping results—in particular, of the arguments that are bound to specific functions—is essential for syntactic processes that are key to those functions. To take a simple example, the choice of the correct pronoun in a reflexive or tag question depends on maintenance of the subject's features. These maintained properties may also be used in constructing subsequent mappings, whether in the normal preservation of discourse coherence, when it may be desirable to use the discourse topic as the subject of successive sentences, or in the somewhat abnormal situation of our production priming task.

Once subject-argument binding and verb-form finding are completed, assignments to positions in constituent structure may proceed. Because direct mapping makes it unnecessary to form a full functional representation before commencing that process, the transition to constituent integration may be incremental. Although there is little selective support for incrementality beyond that from intuition, there are results to be found in studies of sentence planning (Lindsay, 1975) and in experiments on lexically primed sentence production (Bock, 1986a, 1987b; Dell & O'Seaghdha, in press) which indicate that an utterance may be commenced before the object arguments are fully prepared.

Some Hesitations

There are several limitations to this work that deserve note. One concern (Bates & Devescovi, 1989) is that many of the utterances that are produced in the context of experiments like the present one are inapplicable to the experimental hypotheses (47%, in the present case), although fortunately—such utterances occur about equally often in all experimental conditions. Most of the available remedies for this situation are unacceptable because they require specifying utterance types to speakers, thereby bypassing the normal flow of sentence formulation. But because of this limitation and others, whenever we find that some factors are effective and others are not, the inferences that are invited must be heavily salted with qualifications.

One such qualification concerns the attribution of the animacy effects to the process of functional integration and, specifically, to the assignment of syntactic functions. In terms of an integrated account of the findings about production available in the current literature, this attribution is a compelling one. Both in observed error patterns (Garrett, 1975, 1980; Levelt, 1983) and in experimental manipulations of the production process (Bock, 1986a; Dell & O'Seaghdha, in press), meanings and syntactic functions go together in ways that meanings and serial positions do not. Likewise, the explanation makes sense in light of the disparate effects of animacy and form observed in the present work. The magnitude of the difference between animate and inanimate subject-argument primes was the same regardless of the surface forms of the primes. Because surface form and order are tightly interwoven, we think that if the serial order of the elements in the primes had been heavily involved in the effects, their animacy would have interacted with the forms of the primes.

However, if one ignores such considerations, the results may be explained solely in terms of a semantically conditioned positioning of phrases, such that the order of animate and inani-
mate elements in the prime is reproduced in the target. For English, it is very difficult to rule out this alternative in a convincing fashion. Its viability could be more readily assessed using free-word-order languages in which the positions of subject and object are independent of their syntactic functions.

One feature of the present data that favors the ordering account over the function-based account is that direct objects and by-objects were not associated with differences in animacy priming even though they represent different syntactic functions. It is relatively easy to rationalize this in terms of function assignments, because any arguments remaining after the subject is assigned may assume the residual syntactic functions required by the selected verb form. However, it may be straightforwardly explained if the animacy effects really reflect semantically sensitive linear ordering.

As a preliminary assessment of the ordering hypothesis, we examined the nontarget responses for sequencing variations that did not involve variations in syntactic functions. These included phrasal conjunctions like “There’s a boy and an alarm clock” and clausal conjunctions like “The boy wakes up as the alarm clock goes off.” In such cases the syntactic functions of the target elements were the same and could remain the same even if the order of the elements was reversed (cf. “There’s an alarm clock and a boy” and “As the alarm clock goes off the boy wakes up”). We found 14 responses like this, all of them with the critical arguments in the animate–inanimate order. Of these, 9 occurred after primes with animate subject-arguments. To increase the size of the sample, we also examined responses with conjunctions that included nontarget elements (i.e., entities that did not occur as subjects in any of the target sentences) that contrasted in animacy. There were 8 of these, all of them again in the animate–inanimate order, with 6 occurring after primes with animate subject-arguments. Taken together, the order of the elements in these responses matched the order of the elements in the primes 68% of the time ($p = .07$ by a sign test). This suggests that there is indeed a tendency in conjunctions to replicate the serial order of animate and inanimate elements from the prime.

Clearly, then, the ordering account must be regarded as a reasonable complement or competitor to the one we have offered. However, it is important to note that even if it should turn out to be correct, the evidence would still favor a direct-mapping interpretation of the production process. Because the mediated-mapping scheme has no straightforward way of explaining variations in the order of arguments that are attributable to the arguments’ semantic or pragmatic features (Bresnan & Kaplan, 1984), any consistent variations of this sort constitute a challenge, albeit a weaker one, to mediated mapping.

Related to this possibility is the objection that the procedure we used simply fails to tap the critical components of the mapping process. By this argument, though the priming method may be able to tap variations in sentence structures and meanings, it somehow simply misses essential variations in how they are linked. We cannot dismiss this argument, except to say that it is very difficult to prove that something does not exist. However, we can weaken one of the pillars on which this argument might stand. It might be maintained that our speakers could have formed the surface structures of the priming sentences and understood the meanings of the words that composed them, without forming links to the underlying propositions. If this were so, our postexperimental recognition test might have been expected to show relatively good retention of surface form, or retention of information about the order of the noun phrases, or an inability to discriminate among the tested forms. None of these things occurred: At 60%, performance was well above the chance level of 25%, and most of the errors consisted of selecting a sentence with the same propositional meaning in a different structural form, rather than a sentence with the same form but a different meaning. This suggests that the speakers understood the messages behind the priming sentences.

Summary and Conclusions

In this article we have argued for a lexicalist, or direct-mapping, view of the relationship between syntactic functions and surface syntactic relations and for a link between semantic features and the assignment of arguments to syntactic functions. The issues were formulated as problems of language production, and competing performance hypotheses were derived from the direct- and mediated-mapping accounts and tested in a production experiment.

The experiment was designed to explore how the tendency to repeat structure across successive sentences might be modified by semantic relationships between the elements of those sentences. As in earlier work, we found that speakers produced sentences in structural forms similar to those used in previously spoken, topically unrelated sentences. The critical issue was how this tendency interacted with the conceptual features of the sentences. Proceeding on the assumption that animacy is an important force in the assignment of arguments to syntactic relations, we examined the effects of animacy matches and mismatches between the surface subjects of active and passive priming sentences and active and passive target sentences.

The mediated-mapping view suggests that the occupants of surface relations in active and passive sentences are derived in different ways from underlying relations, with the surface relations in passives reflecting changes or movements of arguments from one relation to another. This implies that animacy matches between structurally different primes and targets should produce effects that are incommensurate with the effects of animacy matches between structurally similar primes and targets. In contrast, the direct-mapping view has no relation-changing mechanisms, so the underlying and surface arguments of syntactic relations are the same. In this view, then, the effects of animacy matches should be the same for both structurally similar and structurally dissimilar prime and target sentences.

The results favored direct mapping. Inanimate subject-arguments in priming sentences promoted the use of inanimate subject-arguments in target sentences regardless of the structural match between primes and targets. The magnitude of the effect of an animacy match was the same for active targets primed by actives as it was for active targets primed by passives. Furthermore, manipulations of the speakers’ attention to the meanings or to the forms of the priming sentences to which they were exposed yielded the same basic patterns, even as the relative magnitudes of the component effects changed: Atten-
tion to meaning enhanced the effect of animacy, whereas attention to form enhanced the effect of structure.

In terms of a theory of sentence production, these results argue for a distinction between processes concerned with the binding of arguments to syntactic functions and processes concerned with the construction of constituent phrases. The former appear to be keyed to the meanings of expressions that occupy basic syntactic relations, whereas the latter appear to be keyed to the syntactic privileges of those relations with little regard for the semantic features of the occupants. Along with analyses of errors in spontaneous speech and findings from other experiments, the results thus converge on a view of production that requires some segregation of processing operations, and add to that view a claim about the nature of the functions that link meanings to forms.

Going beyond the issues of language production, this claim is consistent with accounts of language competence and performance that accord a central role to the lexical or morphological differentiation of syntactic functions. As they have been formulated, such accounts require that specific verb forms be differentiated with respect to the syntactic functions they take, and that the means exist for language users to productively create verb forms and to convert and store variants of known verbs. This entails a more complex and dynamic morphology and lexicon than cognitive psychologists have traditionally envisioned. But the view of the syntax becomes correspondingly simpler. George Miller pointed out in 1978 that drawing a distinction between morphological and structural relations “makes the lexicon the repository of all those exceptions (partial relations) that are the despair of language learners, but it leaves the processes of sentence production and interpretation subject to rapid, automatic, and relatively exceptionless rules of syntax” (p. 118). Such a view may come closer to incorporating a set of principles and a sort of performance system capable of supporting our normally fluent implementation of language structure.

References


Bock, J. K. (1982). Toward a cognitive psychology of syntax: Informa-
tion processing contributions to sentence formulation. Psychological Review, 89, 1–47.


Clark, H. H. (1965). Some structural properties of simple active and


BRIDGING THE SYNTACTIC CLEFT

Appendix
Animate-Subject-Argument Active Priming Sentences and Pictured Events (in Parentheses)

1. The mountain climber held the rope. (fire hydrant sprays fireman)
2. Five people carried the boat. (runaway bicycle approaches pedestrian)
3. The builder cut the glass. (avalanche buries skiers)
4. The incoming pilot paged the control tower. (frayed wire shocks baby)
5. The baker burned the bread. (lightning strikes golfer)
6. The dog followed the car. (wave engulfs woman)
7. The child splattered the paint. (pitchfork skewers farmer)
8. The boy hit the tricycle. (tornado sweeps girl away)
9. The defendant exposed some new evidence. (tank runs down soldier)
10. The quarry worker crushed the huge stone. (jack-in-the-box startles young girl)
11. The truck driver forced the police car off the road. (tree branch knocks down horseback rider)
12. A robin held the small branch. (train about to run over woman)
13. The girl cut the rose bush. (alarm clock awakens sleeping boy)
14. The royal guard poisoned the dinner. (speeding ambulance strikes policeman)
15. The monkey held the net. (baseball hits boy)
16. The job applicant satisfied the requirements. (flyswatter crushes fly)

Received June 1, 1990
Revision received January 18, 1991
Accepted March 18, 1991

AMERICAN PSYCHOLOGICAL ASSOCIATION
SUBSCRIPTION CLAIMS INFORMATION

We provide this form to assist members, institutions, and nonmember individuals with any subscription problems. With the appropriate information we can begin a resolution. If you use the services of an agent, please do NOT duplicate claims through them and directly to us. PLEASE PRINT CLEARLY AND IN INK IF POSSIBLE.

PRINT FULL NAME OR KEY NAME OF INSTITUTION

MEMBER OR CUSTOMER NUMBER (MAY BE FOUND ON ANY PAST ISSUE LABEL)

ADDRESS

DATE YOUR ORDER WAS MAILED (OR PHONED):
P.O. NUMBER:

PREPAID CHECK CHARGE CHECK/CARD CLEARED DATE:

CITY STATE/COUNTRY ZIP

(If possible, send a copy, front and back, of your canceled check to help us in our research of your claim.)

ISSUES: MISSING DAMAGED

YOUR NAME AND PHONE NUMBER

TITLE

VOLUME OR YEAR NUMBER OR MONTH

Thank you. Once a claim is received and resolved, delivery of replacement issues routinely takes 4-6 weeks.

(TO BE FILLED OUT BY APA STAFF)

DATE RECEIVED:
ACTION TAKEN:
STAFF NAME:

DATE OF ACTION:
INV. NO. & DATE:
LABEL NO. & DATE:

SEND THIS FORM TO: APA Subscription Claims, 750 First Street, N.E., Washington, DC 20002

PLEASE DO NOT REMOVE. A PHOTOCOPY MAY BE USED.