

Conceptual accessibility and syntactic structure in sentence formulation*

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Abstract

The grammatical relations of noun phrases in sentences are ordered in a hierarchy that is reflected in a wide array of linguistic phenomena. The hypothesis explored in this paper is that this hierarchy is related to the conceptual accessibility of the intended referents of noun phrases that commonly occur in particular relational roles, with relations higher in the hierarchy typically occupied by noun phrases representing more accessible concepts. An experiment on the formulation of sentences examined the relationship between conceptual accessibility and grammatical relations for three levels in the hierarchy, the subject, direct object, and indirect object. There was a strong and systematic influence of conceptual accessibility on the surface syntactic structure of sentences. The attribution of this effect to grammatical role assignments, rather than to serial ordering mechanisms, was supported by the absence of an effect of conceptual accessibility on the order of nouns in conjunctive noun phrases. This pattern of results can be explained within current theories of sentence production.

Converting thoughts into language requires that elements of the nonlinguistic conceptual system be mapped onto syntactic roles in sentences. In this paper we examine one aspect of this mapping process, arguing that an important factor in the assignment of conceptual elements to syntactic roles in the production of sentences is the ease of representing potential referents in thought, or their conceptual accessibility. An experiment provides evidence that conceptual accessibility is linked to a hierarchy of grammatical relations that influences sentence formulation.

The nature of the cognitive and communicative features encoded in the

*Portions of this paper are based on an undergraduate honors thesis submitted by the second author to the Department of Psychology at Michigan State University. We thank Frank C. Keil and Michael H. Kelly for comments on the manuscript. Requests for reprints should be sent to Kathryn Bock, Department of Psychology, Psychology Research Building, Michigan State University, East Lansing, Michigan 48824, U.S.A.

syntax of language has been a major concern in recent psycholinguistics. Several such features have been found to correlate with the structural characteristics of sentences. This is particularly true for the surface subject relation or, more broadly, what comes first in an utterance (MacWhinney, 1977). The referents of surface subjects tend to be more animate (H.H. Clark, 1965; Harris, 1978), more concrete (H.H. Clark & Begun, 1971), more imageable (James, Thompson, & Baldwin, 1973), more definite (Grieve & Wales, 1973), more salient (Osgood & Bock, 1977), given rather than new information (Carroll, 1958), the object of the speaker's interest (Tannenbaum & Williams, 1968), and the object of the speaker's empathy (Ertel, 1977; Kuno & Kaburaki, 1977).

Although the attention given to the subject relation can be justified by its centrality to the structure and content of sentences, any general theory must also account for such subsidiary roles as direct object, indirect object, oblique object, and object of comparison. The functional correlates of these grammatical relations and the differences among them have received less systematic investigation.

Views of the kinds of distinctions that might underlie different grammatical relations fall into two intersecting sets. The first includes approaches which emphasize differences among the conceptual roles or communicative functions served by different linguistic devices (MacWhinney, *in press*). An example from this perspective is that expressions are more likely to be direct objects when they represent the recipients of actions, and subjects when they represent agents. The second set of views tends to regard different relations as manifestations of variations along some conceptual continuum. An example in this vein is that an expression is more likely to be the subject when it receives a greater amount of the speaker's attention than another expression that serves as the direct object (MacWhinney, 1977). Another example is the Prague School's construct of communicative dynamism, which is defined, roughly, as a continuum of informational redundancy that influences sentence structure (Firbas, 1965, 1966). It is the validity of views of this second sort that will concern us.

The possible importance of a deep continuum related to the grammatical roles expressed in sentences is suggested by work in linguistics on grammatical relations (Cole & Sadock, 1977; Perlmutter, 1983). One of the most influential results of this work is reported by Keenan and Comrie (1977). They proposed a noun phrase hierarchy¹ or relational hierarchy that ranks the

¹Keenan and Comrie call this hierarchy the noun phrase accessibility hierarchy, where accessibility is related to the relativizability of a noun phrase in a particular grammatical role. We will use the term accessibility with the sense it generally carries in cognitive psychology (Tulving & Pearlstone, 1966), having to do with the ease of retrieving information from memory.

Table 1. *Examples of relative clauses formed on noun phrase constituents representing three levels of the relational hierarchy.*

Grammatical relation	Relative clause
SUBJECT: THE BOY gave the book to the girl	The boy who gave the book to the girl
DIRECT OBJECT: The boy gave THE BOOK to the girl	The book that the boy gave to the girl
INDIRECT OBJECT: The boy gave the book to THE GIRL	The girl to whom the boy gave the book

grammatical relations that noun phrases may assume. This hierarchy embodies the following claim: If a language permits a relative clause to be formed on a noun phrase representing a grammatical relation low in the hierarchy, it will permit relativization of noun phrases representing all grammatical relations above it. The top three relations in this hierarchy, the subject, direct object, and indirect object, are illustrated with examples from English in Table 1. Although English permits relativization of all of the grammatical relations in Table 1, as well as several lower-level relations not shown, many languages do not.

Most of the evidence for the relational hierarchy is cross-linguistic. However, Keenan and Comrie also suggest that there may be a within-language ordering of acceptability correlated with the noun phrase hierarchy, with relativization of higher-level relations being more acceptable than relativization of lower-level relations. They report that many English speakers find relativization of the low-level relation of object of a comparison to be marginally acceptable, as in *The man who Sandy is taller than*. The preferred way of expressing this idea involves relativization of a subject: *The man who is shorter than Sandy*. Subjects are of course higher in the hierarchy than objects of comparison.

A different type of evidence for the relational hierarchy can be found in word order universals. Pullum (1977) has claimed that the hierarchy is reflected in the dominant noun phrase constituent orders of the world's languages. In virtually all languages, the dominant order places the subject before the direct object, the direct object before the indirect object, and the indirect object before all lower-level relations. Only the placement of the verb varies.²

²Pullum proposes an auxiliary principle to account for the existence of subject-final languages, which are exceptionally rare.

Finally, constructions in which the underlying grammatical relations are changed in a sentence's surface structure appear to be sensitive to the relational hierarchy (Keenan & Comrie, 1977; Ransom, 1977). The passive is the prototypical example of such a construction: The underlying direct object is promoted or advanced to the subject role (Perlmutter & Postal, 1977). Another construction in English promotes indirect objects to the surface status of direct objects: In double-object datives, such as *The candidate told the audience a joke*, the underlying indirect object (*the audience*) is placed immediately after the verb in the sentence, in the position normally occupied by the direct object (e.g., *a joke* in *The candidate told a joke to the audience*). However, the dative rule is more restricted than passivization.³ This may follow from differences in the status of the constituents that are promoted: The dative rule promotes indirect objects, while passivization promotes direct objects. Since direct objects are higher in the relational hierarchy, this accords with the argument that higher-level grammatical relations are syntactically more active than those at lower levels (Keenan & Comrie, 1977).

Advancement operations such as passivization and dative movement suggest a way to approach the question of the functional correlates of different syntactic relations. If, as Keenan and Comrie argue, there is some uniform psychological basis to the relational hierarchy, the factors that support variations in the surface placement of constituents should be similar across constructions. That is, factors related to the appearance of direct objects in subject position might also be correlated with the appearance of indirect objects in direct object position.

The factor that we propose to be an important contributor to the relational hierarchy is conceptual accessibility. Conceptual accessibility is the ease with which the mental representation of some potential referent can be activated in or retrieved from memory. We assume that conceptual accessibility is closely tied to characteristics of perceptual and conceptual representation, with accessible concepts being those that are in some sense most "thinkable"—those whose mental representations are learned earliest and are most richly detailed in adult representations of knowledge. The suggestion is that a continuum of conceptual accessibility underlies the hierarchy of grammatical relations, with higher-level relations typically assumed by noun phrases representing more accessible concepts.

In language acquisition, several lines of research suggest a broad link be-

³All but a few transitive verbs may be passivized in English, but only a subset of dative verbs permit dative movement. Dative verbs of Germanic origin, such as *give* and *tell*, occur in both forms of the dative construction, but semantically similar Latinate verbs such as *donate* and *communicate* occur in the prepositional form alone.

tween the development of knowledge about entities and conceptual roles and the higher-level grammatical relations, particularly the subject. In general, this is manifested in attention to and early knowledge of the kinds of things that are prototypical sentence subjects, including actors and agents, or "movers" (E.V. Clark, 1979). With children whose spontaneous speech had not gone beyond two-word combinations, Robertson and Suci (1980) found that visual attention to a filmed event was centered on the actor, both during and after the performance of the action. Grace and Suci (1981) reported that this attentional priority facilitated children's learning of word-referent relationships for words denoting agents and actors. Since actors and agents are typically animate, young children's knowledge of animate entities would be expected to exceed their knowledge of inanimates, and the evidence on this point is overwhelming (e.g., Gelman & Spelke, 1981; Rescorla, 1981).

A more intricate connection between conceptual representation and the noun phrase hierarchy can be found in Keil's work on ontological knowledge (1979, 1981, 1983). Keil argues for a structural constraint on the development of ontological knowledge, represented in terms of hierarchical tree structures reflecting the natural language predicates that can be sensibly combined with terms denoting particular sorts of things. There is compelling evidence for a relationship between these hierarchical structures and the development of knowledge in children. Keil (1979) found that knowledge of the category of physical objects is developmentally prior to knowledge of the category of events, from which the category of abstract objects emerges. Certainly adult knowledge of things represented at lower levels of the hierarchy (concrete objects) is richer than that at higher levels (events and abstractions). Thus, the basic categories of human experience seem likely to differ in their conceptual accessibility.

To make the further claim that ontological knowledge structures are tied to the grammatical phenomena captured in the noun phrase hierarchy, it is necessary to establish the relationship between terms at different levels of the predicability tree and their appearance in particular syntactic roles. Ideally, concepts at lower levels of the ontological hierarchy should be those that are most commonly used in higher-level grammatical roles, and vice versa. This relationship clearly obtains for the subject role: In the predicability tree, the two lowest levels are occupied by people and animals, respectively, and H.H. Clark and Begun (1971) found that the most acceptable subjects of sentences were human nouns, with nouns denoting animals being the next most acceptable. Ascending the tree, we find common recipients or results of human action, including plants, artifacts, and natural inanimates, things likely to serve as direct objects. The concepts at the highest level are abstractions (fear, love) that, while by no means prohibited from appearing as the subjects

or direct objects of sentences, seem less natural in those roles than as oblique objects in prepositional phrases (*in love, out of fear, for pleasure*). In the Clark and Begun study, abstract mass nouns were in fact the least acceptable subjects.

Assuming this relationship, then, the connection between Keil's predicability tree and the noun phrase hierarchy of Keenan and Comrie is straightforward: A relative clause formed on a term from one level of the predicability tree may predicate of that term only properties from the same level or a higher level. It follows that there are more restrictions on the sensible predications that can be made of terms higher in the predicability tree than of lower-level terms,⁴ perhaps resulting in certain syntactically complex strategies for predication (e.g., relativization) being avoided in some languages, or being so rarely used as to be unacceptable. There is, then, reason to suspect at least a rough correspondence between the hierarchy of grammatical relations and the variations in conceptual accessibility represented in hierarchies of ontological knowledge.

Conceptual accessibility must be distinguished from lexical accessibility, which has also been argued to influence the structure of sentences (Bock, 1982). Lexical accessibility is the ease with which the representations of word forms can be recovered from memory. It may be closely related to conceptual accessibility, in that accessible concepts are likely to be represented by accessible words (e.g. because of the frequency with which they are used), but they are independent. To take one well-known example, an object that a word represents can be thought of even when the word itself cannot be recalled (Brown & McNeill, 1966).

The index of conceptual accessibility employed in the present experiment was imageability (Paivio, Yuille, & Madigan, 1968). Imageability was selected as the dimension of variation for several reasons. First, concrete concepts are clustered at lower levels of the predicability hierarchy (Keil, 1979) and are by many other criteria more accessible than abstract concepts, being more memorable (Dukes & Bastian, 1966), easier to talk about (Reynolds & Paivio, 1968; Taylor, 1969), and easier to think of associates for (Paivio, 1966). Second, there is evidence that differences in imageability influence the selection of the surface subject in simple declarative sentences. James et al (1973) investigated recall patterns for active and passive sentences

⁴Keil and Kelly (personal communication, October 1984) have found that when randomly selected predicates are assigned to their appropriate locations within the predicability tree, there is a striking preponderance of predicates applying to humans and other animals. Remarkably few apply uniquely to abstract objects and events. The distribution for terms denoting concrete objects, events, abstract objects, and so on is less skewed, suggesting that the limitation (at least as it is reflected in the English lexicon) is rooted in predication.

whose subject and objects varied in imageability. They found that sentences were more frequently recalled in a form that placed the more imageable constituent in surface subject position, rather than in object position. Finally, the existence of imageability norms makes it possible to vary imageability across different sentence types and grammatical relations with some precision.

To test the hypothesis that conceptual accessibility is related to the hierarchy of grammatical relations as it is reflected in the promotion of constituents to higher-level grammatical roles, we examined the recall of simple declarative, dative, and phrasal conjunct sentences. In sentences of each of these three types, the imageability of two noun phrase constituents differed. In simple declaratives, the underlying subject and direct object constituents differed in imageability, while in datives, the underlying direct and indirect objects differed. This made it possible to examine the effects of imageability on the placement of major constituents representing three levels of the relational hierarchy.

Phrasal conjuncts were used to control for the possibility that any effects observed might be attributable to a general tendency to place accessible elements earlier in sentences, rather than to assign them to higher-level grammatical roles. In sentences with phrasal conjuncts, simple leftward movement of a noun phrase is possible without any change in the surface grammatical structure. Thus, in a sentence such as *The lost hiker fought time and winter, time and winter* may exchange positions without influencing the syntactic structure. If variations in the syntactic structure of simple declaratives and datives result indirectly from cognitive pressure for early positioning, instead of from relationships between conceptual features and grammatical roles, phrasal conjuncts should show effects of conceptual accessibility that are comparable to those for simple declaratives and datives.

In order to relate the memory task employed in the experiment more closely to the processes of formulating and producing utterances, the analyses focused on an aspect of sentence recall that could not have resulted from rote memorization. This involved sentences that were recalled in syntactic forms different from those of the sentences that had been presented, but without distorting the sentences' meanings. Since these changes are most readily explained as the products of a sentence formulation process, their characteristics should reflect features of that process (Levelt & Kempen, 1975).

Method

Subjects

The participants were 64 Michigan State University undergraduates, all native English speakers. They served in return for extra credit toward introductory psychology course grades.

Materials

Sixteen pairs of sentences were constructed of each of three syntactic types. The three types were simple declaratives, datives, and phrasal conjuncts. The members of the declarative and dative pairs were alternative structural realizations for sentences of the type represented by the pair. These were active and passive declaratives, and prepositional and double-object datives. The members of the phrasal conjunct pairs differed only in the order of the nouns within the conjunct. Since one of these orders for each pair was intuitively more natural than the other, the members of these pairs were designated the natural-order and unnatural-order conjuncts. Both of the sentences in each pair had the same basic meaning and contained the same two target nouns. In the active and passive sentences making up the simple declarative pairs, the target nouns were the heads of the surface subject and object noun phrases. In prepositional and double-object datives, the targets were the heads of the direct and indirect object noun phrases. In phrasal conjuncts, the targets were the two nouns in a conjunctive noun phrase. Examples of pairs of each type are given in Table 2.

The 96 target nouns were selected from the Paivio et al (1968) imageability norms. Half of the targets were high in imageability, with a mean imageability rating of 6.58 and a range from 6.30 to 6.87, and half were low in imageability,

Table 2. *Examples of three types of sentence pairs*

Sentence type	Form	Example
Simple declarative	Active	The doctor administered the shock.
	Passive	The shock was administered by the doctor.
Dative	Prepositional	The old hermit left the property to the university.
	Double object	The old hermit left the university the property.
Phrasal conjunct	Natural order	The lost hiker fought time and winter.
	Unnatural order	The lost hiker fought winter and time.

with a mean rating of 3.84 and a range from 2.02 to 5.00. All had comparable Thorndike-Lorge frequencies (A or AA).

Every sentence contained one target noun from the high imageability set, and one from the low imageability set. For the sentences of each of the three types, the mean differences between the high- and low-imagery nouns were 2.80 for the simple declaratives, 2.59 for the datives, and 2.84 for the phrasal conjuncts. The range of the differences across individual sentences was 1.36 to 4.37.

The sentences were written with the aim of providing a sensible context for both target nouns. Ten of the target nouns were pluralized in order to increase the plausibility of the sentences in which they occurred. Half of the sentences in a given form of each sentence type (e.g., the active form of the simple declarative type) placed the high-imageability target before the low, while the other half used the opposite ordering. Because the alternative form of each sentence type (e.g., the passive form of the simple declarative) reversed the order of the target nouns, half of the sentences in the alternative structure also had the high-imageability target preceding the low.

All of the sentences were recorded on audio tape for presentation. Two intonational variants of each sentence were recorded. These differed in the locations of the sentence's primary stress. In one version, the primary stress occurred on the earlier of the two target nouns (the early stress condition), and in the other, the primary stress occurred on the later of the targets (the late stress condition).

Four lists of 48 sentences were recorded. Each list contained an equal number of sentences of each syntactic type, one from each pair, and within types, equal numbers of items in each of the cells formed by crossing the factors of target level (high imageability target in the higher or earlier versus lower or later grammatical constituent), stress (early versus late), and sentence form (active versus passive declarative, prepositional versus double-object dative, and natural-order versus unnatural-order conjunct).

Across the four lists, both of the sentences from every pair occurred once in each of the conditions formed by crossing the target level and stress factors. The same order of sentences was used in all lists, so that sentences from the same pairs appeared in the same list positions.

The lists were divided into four blocks of 12 sentences each. Order within blocks was random, with the restriction that sentences having the same syntactic form and stress pattern could not appear consecutively. The blocks contained at least 2 but no more than 5 sentences representing each sentence type. A pause roughly equal to the duration of the preceding sentence separated the recorded sentences in each block.

A prompt list containing the 48 main verbs from the paired sentences was

constructed for use with all four sentence lists. It was also divided into four blocks, but within blocks, the prompts occurred in an order different from that of the corresponding sentences in the sentence list. The only other restriction on this order was that no more than two sentences of the same syntactic type were prompted consecutively.

A list of eight practice sentences similar in construction to the experimental sentences was also recorded, and an appropriate prompt list was prepared. The same practice list preceded all four experimental lists.

Procedure

The taped sentences in a list were played to the subjects one block at the time. After each block, the experimenter administered a short digit-recall task in which the subjects were required to recall a set of eight digits in order. The experimenter then read the appropriate prompt list, allowing enough time between prompts for the subjects to write their responses. Subjects wrote the sentences on the blank pages of a booklet, one block per page. The four blocks were presented in different orders, with approximately equal numbers of subjects assigned to each order. The practice block was presented before the four experimental blocks using the same procedure and without informing subjects that it was practice.

Subjects were run in groups of three to eight. They were told that the experiment concerned memory for sentences, but the instructions emphasized remembering the ideas expressed by the sentences, rather than the exact wording.

After completing the recall task, the subjects were asked to listen to the taped sentences a second time. For each sentence, they marked on a list containing the two target nouns from each sentence the one that had received more stress. The purpose of this task was to validate the stress manipulation.

Design

Each sentence list was presented to 16 subjects. There were three within-subjects factors, with each subject receiving four sentences in each of the twelve cells of the design formed by crossing the target level factor, the stress factor (early versus late), and the sentence type factor (simple declarative, dative, phrasal conjunct).

In the design for items, there were 16 items at each level of the between-items factor of sentence type. There were two within-items factors, target level and stress. Each item was presented to 32 subjects in each of the four conditions formed by crossing these two factors. Each of the 48 sentence pairs constituted one item.

Scoring

Four categories were employed in scoring the recalled sentences, including *corrects*, *inversions*, *errors*, and *omissions*. To be considered *correct*, a recalled sentence had to preserve the basic syntax and word order of the presented sentence. Thus, the same or similar phrases had to appear as subjects, objects, and indirect objects, and in the same order, in the recalled sentence as in the original. Changes in tense, number, and definiteness were permitted, as well as synonym substitutions and minor deletions and additions (e.g., insertion or omission of adjectives or adverbs) that did not alter the major grammatical relations.

An *inversion* was scored when a recalled sentence met all of the criteria for a correct sentence except that its form was that of the alternative member of the sentence pair rather than that of the presented sentence. In phrasal conjuncts, only a change in the order of the targets was required to produce an inversion, but in datives and simple declaratives a syntactic change had to accompany the order change for an inversion to be scored.

All other responses were scored as *errors*. If nothing was recalled, an *omission* was scored.

Results

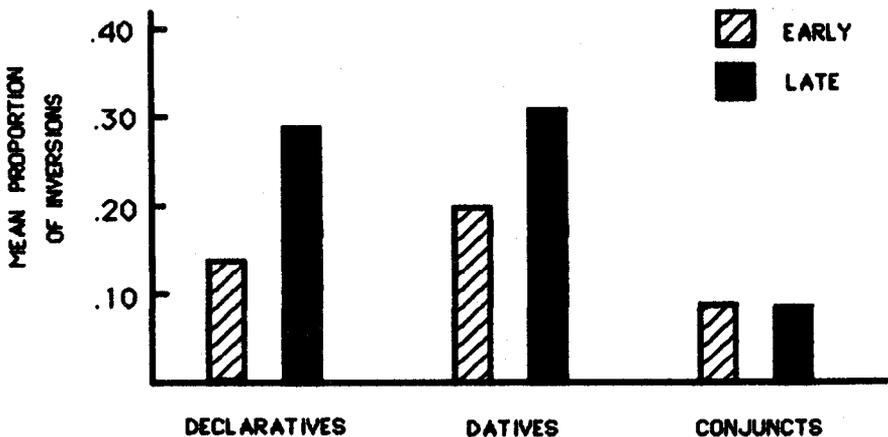
Preliminary analyses of variance performed on the mean percentages of corrects and inversions revealed no significant main effects of or interactions with stress location, so the data were collapsed over this factor in subsequent analyses. The major analyses were performed on proportions representing the number of inversions relative to the total number of corrects and inversions for each subjects and item in each condition. These proportions express the strength of the tendency to produce a sentence in a syntactic structure different from that which was actually presented, given that the basic idea underlying the sentence was remembered in one of the two target forms for that sentence type. This also neutralizes differences among the sentences in absolute level of recall across the various conditions of the experiment. Absolute recall level is only of interest with respect to the question of the memorability of the sentences, and not with respect to the question of the syntactic form in which a sentence is expressed, given that its content is remembered. These data were evaluated in analyses of variance that treated both subjects and items as random factors (H.H. Clark, 1973; Santa, Miller & Shaw, 1979). Effects were considered significant when their probabilities were less than or equal to .05, unless otherwise noted.

Overall, there were more inversions when the effect of the inversion was

to place the more imageable noun before the less imageable (.23) than when the effect was to place the less imageable noun earlier (.14), $F(1,63) = 10.06$ for subjects, $F(1,42) = 10.84$ for items, $\text{min } F'(1,102) = 5.22$. However, as Figure 1 reveals, this effect was confined to the simple declarative and dative sentences: In planned comparisons, the difference between the two target level conditions was significant for the declaratives and datives, but not for phrasal conjuncts, with confidence interval half-widths of .08 for subjects and .12 for items. The interaction between sentence type and target level was marginal for subjects, $F(2,126) = 2.44$, $p < .10$, although it did not reach significance in the items analysis.

To ensure that the imageability effects were not attributable to a small subset of the items, the results for the individual transitive and dative sentences were examined. Of the 32 sentence pairs, there were 3 for which no inversions occurred. Of the remaining 29, 19 ($p < .05$ by a sign test) or 66% yielded a greater number of inversions that placed the more imageable before the less imageable noun, rather than the reverse.

Figure 1. Mean inversion proportions (changes from a presented sentence form to an alternative form as a proportion of meaning-preserving recalls) for three sentence types. EARLY and LATE denote the locations in the presented sentences of the more imageable target noun. For declaratives, the early position was the subject, and the late position the direct object. For datives, the early position was the object immediately after the verb, and the late position was the second object. For conjuncts, the early position was the first noun in a conjunctive noun phrase, and the late position was the second noun in the same conjunctive noun phrase.



The inversion proportions for phrasal conjuncts were significantly lower than those for simple declaratives and datives, producing a main effect of sentence type ($F[2,126] = 10.86$ for subjects, $F[2,42] = 6.73$ for items, min $F'[2,98] = 4.16$). This raises the possibility of a floor effect. To investigate this problem, we carried out an analysis of the effect on phrasal conjunct inversions of the length in syllables of the conjoined nouns, a variable that is strongly related to conjunct order (Cooper & Ross, 1975; Pinker & Birdsong, 1979). In this analysis, each participant's mean inversion proportion for those presented sentences in which the shorter word occurred first in the conjunct was contrasted with that for the sentences in which the longer word occurred first. These proportions did not include the data from five sentence pairs in which the target words contained equal numbers of syllables. The mean inversion proportion when the shorter noun preceded the longer in the presented sentence was .05, a proportion that increased to .13 when the order was reversed ($p < .05$ by a sign test). Thus, the sentences tended to be produced with the shorter word first in the conjunct. This suggests that there was not a general floor effect.

Table 3 presents the mean percentages of errors and omissions in each condition. Analyses of variance performed on these categories revealed only two reliable effects, one for errors and one for omissions. Both were signifi-

Table 3. *Percentages of errors and omissions*

Sentence type		Imageability of first or higher-level target constituent		
		High	Low	
		Errors		
				\bar{X}
Simple declarative		24.8	19.0	21.9
Dative		22.1	21.6	21.9
Phrasal conjunct		25.6	23.4	24.6
	\bar{X}	24.2	21.4	
		Omissions		
				\bar{X}
Simple declarative		45.4	44.2	45.0
Dative		47.4	48.6	48.1
Phrasal conjunct		54.5	55.8	55.4
	\bar{X}	49.3	49.7	

cant for participants, but not for items. First, there were more errors when the high imageability target occurred earlier or in a higher-level grammatical relation (24%) than when it appeared later or in a lower-level relation (21%), $F(1,63) = 4.75$. This is similar to free-recall effects reported by James et al. (1973) and Perfetti and Goldman (1974, Experiment 1), and appears to be attributable to a greater willingness to attempt recall of a poorly-remembered sentence when the beginning of the sentence is accessible in memory. Second, phrasal conjuncts were omitted more often (55%) than either datives (48%) or simple declaratives (45%), resulting in a significant main effect of sentence type, $F(2,126) = 18.02$. It may have been harder to establish an integrated memory representation for the phrasal conjuncts than for the other two sentence types because of the generally greater difficulty of remembering *and* relations than causal relations (Mandler, 1983).

Although there were no effects of stress on sentence recall, the stress rating task indicated that subjects were able to perceive the intended stress assignment. Across all sentences and raters, the stressed noun was correctly indicated 94% of the time. Across the recorded sentences, the stressed noun phrase was correctly identified by more than two-thirds of the raters in 189 of the 192 sentences. The absence of a stress effect suggest that the variations in intonation did not influence the memory representations of the sentences or their later production.

Discussion

The results provide evidence that conceptual accessibility is closely related to the hierarchy of grammatical relations. Variations in conceptual accessibility, as reflected in ratings of the imageability of the heads of noun phrase constituents, produced a significant tendency for more accessible constituents to appear in grammatical relations higher than those assumed by their less accessible counterparts. This was true both for subject and direct object selection in simple declarative sentences and for direct and indirect object selection in dative sentences. Because the left-to-right order of constituents was related to conceptual accessibility only when variations in grammatical roles were involved, as in declaratives and datives, and not when serial order alone would be affected, as in phrasal conjuncts, it appears that conceptual accessibility is more closely tied to the process of grammatical role assignment than to the ordering of sentential constituents.

In models of sentence production, the assignment of conceptual elements to grammatical roles in sentences occurs at a different point than the determination of word order. In Garrett's theory (1975, 1980), these processes are

respectively attributed to the functional and positional levels. The functional level is responsible for the mapping from a conceptual representation to an abstract linguistic representation. This involves retrieving semantic representations of words from the lexicon and assigning those representations to particular relational roles. At the positional level, the functional representation is converted into a serially-ordered, phonologically-specified string. Among the positional level processes are those that insert representations of content words into a grammatical frame consisting of closed-class words and grammatical morphemes, and retrieve phonological representations from the lexicon.

In this framework, the functional level is the obvious locus of conceptual effects on syntax. The relationship between conceptual accessibility and grammatical role assignments can be explained if conceptual elements are assigned to roles in an order that is reflected in the relational hierarchy. Thus, other things being equal, the most accessible elements (those most adequately represented in and most easily retrieved from memory) are mapped onto the subject role, the next most accessible are mapped onto the direct object role, and so on.

The difference between phrasal conjuncts and the other sentence types suggest that word order is only indirectly affected by conceptual accessibility. If serial ordering takes place at the positional level, a level that is also responsible for phonological coding, phonological variables may be more likely to influence simple word order than conceptual factors. This argument is supported by the effect of differences in the number of syllables in words on the order in which the words were produced in conjuncts, a factor whose strength has been demonstrated previously by Cooper and Ross (1975) and Pinker and Birdsong (1979). Thus, although conceptual accessibility did not influence word order, differences in length did, providing further evidence that conceptual accessibility exerts its influence at a processing level different from that at which the order of constituents is determined.

There are a number of ways in which such a length effect might arise. One has to do with the retrieval of phonological form. If the syllables of a word are to some extent independent units, so that retrieval of the initial syllable does not automatically yield retrieval of subsequent syllables, the phonological forms of multisyllabic words may be more difficult to retrieve than the phonological forms of monosyllabic words. Brown and McNeill's (1966) observation that multisyllabic words were more likely to produce tip-of-the-tongue states than monosyllabic words is consistent with this hypothesis. The phonological forms of monosyllabic words could then be retrieved more reliably and more rapidly than the phonological forms of multisyllabic words, perhaps resulting in their earlier occurrence within a conjunct.

There are nonetheless many grounds for caution. The most obvious is that the differences attributable to length in this experiment, though significant, were small and based on a post hoc analysis. In addition, there is other empirical evidence that is not easily reconciled with these arguments. Levelt and Maassen (1981) found that the order of words in conjuncts was not at all sensitive to manipulations that, by other measures, clearly influenced the positional-level processing of sentences. Kempen and Huijbers (1983) suggest that such ordering differences arise only as a result of the retrieval of word meaning, and not the retrieval of phonological form. The many differences among these experiments, and the few certainties about the production processes involved, make it clear that further work will be required to resolve these conflicts.

The absence of an effect of imageability on the order of words within phrasal conjuncts should also be treated tentatively. Because the impact of conceptual variables may simply be weaker than that of phonological variables for sentences of this type, it remains possible that there is a conceptual or semantic influence on order within conjuncts. Cooper and Ross (1975) offer evidence from idiomatic or frozen conjuncts for such effects, and Kelly, Bock, and Keil (in press) have found that with frequency and number of syllables controlled, the ordering effect produced by variations in the prototypicality of words in sentences is stronger for conjuncts than for active and passive sentences. A second reason for caution is that the levels of the relational hierarchy are themselves correlated with serial order in the dominant word orders of the world's languages. Assuming that conceptual accessibility is linked to the relational hierarchy, this suggests that it influences, directly or indirectly, both grammatical role assignments and word order.

The key to this puzzle may lie in separating the effects of conceptual accessibility from those of lexical accessibility. These two types of effects are likely to arise at different levels of the production process. Thus, conceptual accessibility may operate primarily in the mapping from the conceptual representation of the content of an utterance onto a representation of its grammatical relations, while lexical accessibility may influence the coordination of lexical and syntactic forms that occurs at the level at which serial order is determined. Highly accessible concepts will become the subjects of sentences; if these conceptually accessible forms are also represented by highly accessible words, there may be a tendency for them to occur early in sentences. Because of our predisposition to talk more about familiar than about unfamiliar things, there is a probable correlation between conceptual and lexical accessibility, with words that commonly refer to accessible concepts themselves being more accessible. Grammatical subjects will therefore tend to occur earlier in sentences than direct objects, direct objects earlier than indirect objects, and so on.

When there is a conflict between conceptual and lexical accessibility, such that the lexical form for the concept assigned to the grammatical role of subject is less accessible than that assigned to the grammatical role of direct object, for example, an alternative sentence form may be selected. This selection may occur later in the production process than the assignment of grammatical roles. In the model proposed by Bock (1982), a conceptual representation activates a set of possible structural realizations, one of which may be more highly activated than its alternatives. It can be proposed in light of the current evidence that the most highly activated realization is the one that maps conceptual representations directly onto surface grammatical relations in terms of their accessibility. When a conflict between this assignment and lexical retrieval patterns occurs at the level that coordinates lexical forms and syntactic structures, an alternative structural realization may be generated from the activated set. A similar effect could be achieved in a different manner proposed by Levelt and Maassen (1981): Lexical-syntactic integration problems could cause a signal to be sent to the linguistic level that controls the development of the syntactic structure, prompting the preparation of another form.

The distinction between lexical and conceptual accessibility raises the issue of the status of imageability with respect to these two constructs. As it is commonly used in the memory literature, imagery may appear to be a lexical access variable rather than a conceptual variable. Bock (1982) also suggested that imageability may be connected to lexical accessibility. However, in Paivio's original formulation (1969), imageability was linked to the representation of possible referents, and not to the representation of words. In addition, recent evidence makes a strong case for regarding imageability as an index of the strength or richness of conceptual representations. Boles (1983) found that near-threshold word recognition was not influenced by imageability or concreteness; only familiarity affected performance, with more familiar words being correctly reported more often than less familiar words. Schwanenflugel and Shoben (1983) were able to eliminate differences in reading times for abstract and concrete sentences, and differences in lexical decision times for abstract and concrete words, by making appropriate contexts available during comprehension. Thus, easing the burden of developing a representation of a referent for an abstract word by providing a context in which that referent is predictable reduces differences between abstract and concrete words. Such results suggest that the usual effects of imageability on retrieval reflect the ease of developing a memory representation capable of supporting the recall of a word, perhaps a representation of a potential referent. If so, imageability will be more closely related to conceptual than to lexical accessibility.

Conceptual accessibility is similar to a number of other factors that have been hypothesized to influence sentence form. These include givenness (Halliday, 1970), perspective (MacWhinney, 1977), conceptual focus (Tannenbaum & Williams, 1968), empathy (Ertel, 1977; Kuno & Kaburaki, 1977), and salience (Osgood & Bock, 1977). Although discussion of the relationships among these notions is beyond the scope of this paper, it is important to indicate how the conceptual accessibility hypothesis differs. First, it emphasizes the role of retrieval processes in accessing the elements of knowledge in memory, providing a processing rationale for the effects. Second, although in principle applicable to the retrieval of any conceptual information from memory (e.g., information about the current topic of conversation, information about significant others, etc), it can be tied to an explicit theory of the structure of ontological knowledge (Keil, 1979), as elaborated in the introduction. This pairing of representation and process should permit a more systematic exploration of relationships between the structure of knowledge and the structure of language.

Although the present findings support the position that differences among the grammatical relations are related to a continuous dimension, the results do not contradict the view that different relations reflect different conceptual roles or communicative functions. Conceptual role differences may themselves be ordered in terms of accessibility, with roles such as that of the agent being more accessible than that of the patient. It is also possible that both accessibility and more content-centered features play important parts in the assignment of grammatical roles, with accessibility differences being sufficient but not necessary for creating differences in grammatical role assignments.

In conclusion, the present research has provided evidence that conceptual accessibility is related to a hierarchy of grammatical relations. This relationship may be created in part by the processes of sentence formulation that map conceptual representations onto grammatical roles in incipient utterances. Because the effects of the relational hierarchy pervade the linguistic system, as indicated by its involvement in such diverse phenomena as relative clause formation, causative formation, advancement rules, and the universal dominance of certain word orders (Keenan & Comrie, 1977; Pullum, 1977), exploration and identification of its cognitive underpinnings may provide valuable insights into the relationship between thought and language.

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Résumé

Les relations grammaticales des syntagmes nominaux sont ordonnées suivant une hiérarchie que l'on retrouve dans de nombreux phénomènes linguistiques. L'hypothèse développée dans cet article relie cette hiérarchie à l'accessibilité conceptuelle des référents intentionnels des syntagmes nominaux, qui apparaissent couramment dans des rôles relationnels particuliers, avec des relations plus élevées dans la hiérarchie pour les syntagmes nominaux représentant des concepts plus accessibles. Dans une expérience sur la formulation de phrases est examiné le rapport entre l'accessibilité conceptuelle et les relations grammaticales pour trois niveaux de la hiérarchie: le sujet, l'objet direct et l'objet indirect. Les résultats montrent une influence importante et systématique de l'accessibilité conceptuelle sur la structure syntaxique de surface des phrases. Il semble que cet effet soit dû à l'affectation des rôles grammaticaux, plutôt qu'à des mécanismes d'arrangement sériel, en raison de l'absence d'un effet de l'accessibilité conceptuelle sur l'ordre des noms dans les syntagmes nominaux conjonctifs. Ce type de résultats peut être expliqué dans le cadre des théories actuelles de production de phrases.