Revue québécoise de linguistique

A Note on Phrase-Markers

James Higginbotham

Volume 13, numéro 1, 1983

Grammaire générative

URI : https://id.erudit.org/iderudit/602508ar
DOI : https://doi.org/10.7202/602508ar

Aller au sommaire du numéro

Éditeur(s)

Université du Québec à Montréal

ISSN

0710-0167 (imprimé)
1705-4591 (numérique)

Découvrir la revue

Citer cette note

Higginbotham, J. (1983). A Note on Phrase-Markers. *Revue québécoise de linguistique*, *13*(1), 147–166. https://doi.org/10.7202/602508ar

A NOTE ON PHRASE-MARKERS

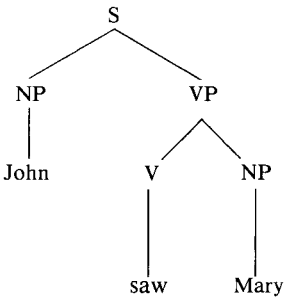
James Higginbotham

A proposition fundamental to linguistic theory is that expressions of natural languages belong to their various categories in virtue of how they may be construed as built up in progressive stages out of their parts. The building process, however, has two dimensions. The expressions of a language are sequences of its most primitive elements, or formatives, so that all are formed by concatenating subsequences of formatives: this is the *linear* dimension of linguistic structure. But also, expressions combine to form *constituents*, which may recombine to form yet other constituents, and so on up: this is a different, *hierarchical* dimension of structure. In the formalization of Chomsky (1955), the linear and hierarchical dimensions were brought into connection in the following way: the possible constituents of an expression E were restricted to the *gapless* subsequences of E. So, for instance,

in an expression abc, formed by concatenating the formatives a, b, and c in the manner shown, only the subsequences ab and bc (besides the sequence abc itself) were possible constituents; the subsequence ac was excluded by hypothesis, as containing a gap. However, a number of researchers over the years, for a variety of reasons, have explored or advocated modifications of Chomsky's conception that would admit so called *discontinuous* constituents, such as the sequence ac of our artificial example. It is my first purpose here to provide a formal background for the issues raised by these discussions. In addition I will discuss some recent proposals for understanding apparent "non-configurationality" in Japanese and Warlpiri, drawing on Hale (1983) and Zubizarretta and Vergnaud (1980), in the hope that preliminary sorting-out of some of the issues involved may aid future investigation.

Chomsky (1955) took the fundamental objects of grammatical theory to be P-*markers*, or equivalence-classes of derivations in a vocabulary that included *categorial* symbols, such as 'S' and 'NP', and *terminals* (formatives). In the usual case, P-markers so construed can be represented without loss in the linguist's *trees*, as in (1):

(1)



Trees of this sort encode linear order and hierarchical structure, as well as the categorial labelling of constituents. Formalizations such as Lasnik and Kupin (1977) do not depart from Chomsky's conception of P-markers in any respect essential to our discussion of the linear or hierarchical properties of linguistic structure; and of course trees are the common coin of a variety of syntactic theories. However, on any of these methods, discontinuous constituents are out of the question, and for this reason it seems appropriate to formulate matters so that hierarchy and linearity are radically divorced, such connections as there may be between them being expressible by general statements whose hypothetical character can be acknowledged. Modifying a construction due to McCawley (1968) and (1982), we give a framework for describing the fundamental objects such that questions of the interaction between linear order and the hierarchy of constituents are not foreclosed by the nature of the formalism itself.

A *phrase-marker* will consist of a finite set of (occurrences of) *linguistic elements*, among which are included the formatives and the categorial symbols, together with two binary relations: $\leq$, read "dominates," and λ read "precedes." The axioms governing $\leq$ are those shown in (2):

(2) i. $x \leq x$

ii. If $x \leq y \leq z$, then $x \leq z$

iii. If $x \leq y \leq x$, then $x = y$

iv. If $x \leq z$ and $y \leq z$, then $x \leq y$ or $y \leq x$

If Σ is a finite set of linguistic elements, then (i)-(iii) of (2) jointly state that $\leq$ partially orders Σ. If $\alpha \in \Sigma$, then (iv) additionally forces the class $C_\alpha = \{ x: x \leq \alpha \}$ to be fully ordered by $\leq$, in the sense that for any x and y in C_α, either x y, or y x, or x = y. The relation λ is:

(3) i. If $x \lambda y$, then not $(y \lambda x)$

ii. If $x \lambda y \lambda z$, then $x \lambda z$

The notion of precedence is to reflect the ordering of formatives in speech, and so, through their organization into constituents, the ordering of the constituents as well. The following statements in (4) hold therefore, with (4i) reflecting the fact that an element cannot be ordered by precedence with respect to another that is a part of it, or of which it is a part, and (4ii) reflecting the natural projection of the ordering upward from the *leaves* of a phrase-marker (that is,

elements that dominate only themselves) onto the whole of it:

(4) i. If $x \leq y$ or $y \leq x$, then not $(x \lambda y)$

ii. $x \lambda y$ iff for all leaves u and v

$x \leq u$ and $y \leq v$ jointly imply $u \lambda v$.

The principles governing λ stated in (3) and (4) do not force the leaves of a phrase-marker, the formatives, to be ordered with respect to one another. That they will be so ordered is a consequence of the application of the laws of nature to the human mouth: you can, in point of fact, just make one sound at a time. In a language spoken with two hands we might, pointing here with the left and there with the right, simultaneously produce two formatives (and mean, say, "Bring the package from here to there"). Similarly, graphic displays can make multiple uses of the same symbol, a thing impossible in speech. So, in addition to (3) and (4), for the case of phrase-markers reflecting the physics of speech we have (5):

(5) If x and y are leaves, then $x \lambda y$ or $y \lambda x$.

A phrase-marker is a structure as described, then, satisfying (1)-(5). A *root* of a phrase-marker is an element α such that if $x \leq \alpha$ then $x = \alpha$. Every phrase-marker has a root, since all are finite. The phrase-markers that display the categorial membership of a string of formatives, those that show that something is an S, an NP, etc., must have a

unique root; i.e., they must satisfy, in addition to (1)-(5), the statement (6):

(6) There is an element x such that for every y $x \leq y$.

A phrase-marker that satisfies (6) will be called *simple*.[1]

Suppose now that the structural description of a senten-

---

1. The above construction is to be compared especially with that of McCawley (1982). McCawley takes as primitive a relation ρ of *direct domination*, whose reflexive, transitive closure ρ^* corresponds to our $\leq$. The resulting axiomatization is not very natural from one point of view, since different underlying relations ρ may give rise to the same trees. Moreover, it seems to be unneccessarily restrictive, since unless it is assumed that there is a *unique* root, it will not follow even that ρ^* is a partial ordering (McCawley omits to mention this condition explicitly; but it is clearly necessary since otherwise, e.g., a two-element set $\{a, b\}$, with underlying ρ given by $a\rho b\rho a$, yields a relation ρ^* such that ρ and ρ^* together satisfy (3a)-(3c) of McCawley (1982), p. 93; whereas the resulting structure is not a tree, since we have $a\rho^*b\rho^*a$, but $a \neq b$). With the above provisos, the systems satisfying (2)-(6) are interchangeable with those satisfying (3a)-(3g) of McCawley (1982), to whose work I am indebted.

A word may be said about the role of *concatenation* in a system that assumes a precedence relation instead of that operation. A *string* $A_1 \ldots A_n$ answers to a structure $S = (\{A_1, \ldots, A_n\}, \lambda)$, with $A_1 \lambda A_2 \lambda \ldots \lambda A_n$ satisfying (3) above. A *substring* of a string S then becomes a substructure S' of S in which every element of S that lies between the extremes of S' is in S'. The other familiar notions concerning strings are definable as operations on structures. The theory of *transformations* formalized with respect to phrase-markers in the sense of this paper, can also be carried out in detail; we reserve this for another occasion, however.

ce includes a simple phrase-marker. The nodes of such a phrase-marker may be annotated in more or less complicated ways, in accordance with rules of feature-assignment. For instance, the feature *singular*, which might be attached in the first instance to a particular noun in S, may be allowed to "percolate" upward through heads eventually attaching itself to NP, triggering verb-agreement. Feature attachment, like categorial membership itself, is a way of representing *properties of strings of formatives*; as such, it articulates further the scheme of description of linguistic objects that a grammar provides, without extending linguistic structure in any fundamental way.

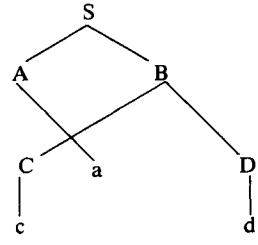
The direction of research over the past several years indicates that knowledge of language requires, besides a grasp of constituent structure, and the properties of formatives and strings of them, also an understanding of *linguistic relations* between points on a phrase-marker, among which the following are typical instances: x is *antecedent of* y, as in "*John* spoke about *himself*;" x is *predicated of* y, as *angry* is predicated of *Mary* in "Mary left the room angry;" x is *head of* y, as *man* is head of *old man*; x *assigns thematic role* A *to* y, as $[_{VP}$ *ran away*$]$ assigns the thematic role *agent* to *John* in "John ran away;" and so forth. In some cases, for instance in the case of the classical grammatical relations *subject*,

object, etc., it has generally been assumed that the notions expressed were to be captured through a theory of linguistic relations on points in phrase-markers (although opinion has sometimes divided on whether the relation was *primitive*; i.e., definable in terms of the fundamental relations $\leq$ and λ, for a particular language or within linguistic theory generally). Most of the interesting cases that research is concerned with, however, have only emerged in the light of theories such as EST, in which the role of transformations is restricted to the point where, for example, the illustrations given above are not interpreted through the transformational component of the grammar. A most interesting question, then, in all of these cases, is whether such linguistic relations are one and all to be defined, again either for particular languages or generally for the whole of linguistic theory, in terms of the fundamental relations and the properties of strings of formatives that are admitted in phrase-markers. I intend to take up this question in a sequel to the present note.*

Restricting ourselves in the present discussion to the linguistic relations of dominance and precedence, we return to the question of "discontinuous constituents" within the present framework of axioms. A *discontinuous constituent* x of a phrase-marker Σ is a node of Σ such that some leaf not dominated by x intrudes between two leaves dominated by x.

Thus, in the phrase-marker (7) the element B is a discontinuous constituent:

(7) $\Sigma = \{ S, A, B, C, D, a, c, d \}$;



In (7), we have $c\lambda a\lambda d$, so that a intrudes between the leaves c and d dominated by B. Another, and useful, way of looking at the situation in (7) is to observe that the elements A and B are unordered by the relation λ: $A\lambda B$ is false because we have $c\lambda a$, and $B\lambda A$ is false because we have $a\lambda d$. Indeed, it follows that a constituent is discontinuous if and only if there are elements that neither dominate nor are dominated by it that nevertheless stand in no order relation given by λ to it.

Do human languages have discontinuous constituents? This question is more theoretical than it might at first appear, because discontinuities in the sound-stream may not reflect discontinuities at other levels of structure. Let us

assume, following Chomsky (1981) that there is a level SS of *S-structure*, to which the level PF of *phonetic form* is related by some set of rules and principles. Then PF, which directly reflects the properties of sequences of sounds in speech, may alter an ordering at S-Structure, or impose an ordering where S-Structure left matters open. Various "scrambling" devices may then produce the appearance of discontinuity, an appearance dispelled at S-Structure. Thus, one point to be addressed in theory is the degree of matching between orderings at different linguistic levels. The theory of such matching, however, leaves open the question of discontinuities at the level SS itself.

In light of the above, we introduce the following notions. Let us say that a given PF X is a *rigid reflection* of an associated SS Y if the ordering of formatives in X is not disturbed in Y.[2] A language may be said to be *rigid* to the degree that its PF's are rigid reflections of its S-Structures. A second notion is that of *connexity*. A node x of a phrase-marker is said to be *connected* if for any y such that xyx, we have xλy or yλx. A phrase-marker is connected if every node in it is connected, otherwise *disconnected*.

---

2. More precisely, if for any occurrences of formatives common to X and Y, xλy in X if and only if xλy in Y: thus we allow, for instance, for deletions between SS and PF, as commonly assumed.

An observation of long standing is that languages that admit varieties of word-order nevertheless do not allow material to be interpolated from outside within a clause. Let us say that a phrase-marker is *X-connected* if any node x with label X is connected; and that a *language* is X-connected if all its phrase-markers are. Then, in this terminology, the observation is that all languages are S-connected, a non-trivial fact presumably reflecting properties of universal grammar. Connected languages are just those that are X-connected for every X, and the dimensions of connexity may therefore be a useful classificatory device.

A point to be emphasized is that rigidity and connexity are entirely independent concepts, belonging to different areas of investigation. Rigidity is concerned with the relations between SS and PF, independently of the degree of connectedness of SS itself. Thus English is connected; but it certainly is not rigid, if only because of stylistic devices, and possibly also because of certain movements such as Heavy-NP-shift. Chinese, however, may be both connected and rigid (Huang, 1982). A rigid language may nevertheless be disconnected: perhaps this is the case in Warlpiri, if the assumptions of Hale (1983) and earlier work that assumed relatively free ordering of constituents of S, and separations, e.g. of modifier from modified are correct. Finally, a language can be both non-rigid and disconnected.

Hale (1983) suggests that the characteristic features of Warlpiri, crucially including (a) relatively free word order, and the presence of discontinuous constituents, (b) the free use of "null anaphora," or the omission of arguments, (c) the absence of movement rules, and specifically of NP-movement, might all be derived by a *configurationality parameter* that is set so as to make, e.g., English configurational and Warlpiri non-configurational. This line of approach stands in contrast to a type of view that traces freedom of word-order to phrase-structure rules directly. The latter would fail to predict that (b) and (c) accompany (a), and so assuming that the features (a)-(c) do cluster together, the scheme of (1983) is to be preferred if the appropriate consequences can be made to follow.

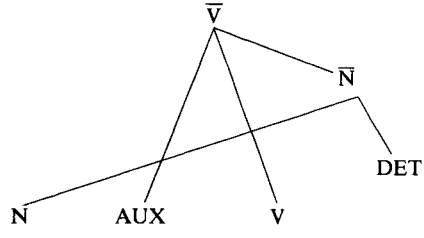
Hale (1983) suggests that S-Structure be *bifurcated* into two distinct representations: *Lexical Structure* (LS), and *Phrase Structure* (PS). The LS part of S-Structure is to satisfy the *projection principle* of Chomsky (1981); and it follows that the LS of a Warlpiri sentence will have constituents of all of the appropriate types demanded by $\bar{X}$-theory and the subcategorization features of heads. Hence, LS will contain Verb Phrases (although Verbs may appear with their arguments in such a way that VP is disconnected), and nominal structures with modifiers (where such constituents may appear dis-

connected as well). A simple example will illustrate the effects of the assumption:

(8) Wawirri kapi-rna panti-rni yalumpu
(kangaroo AUX spear-NONPAST that)
'I will spear that kangaroo'

(from Hale (1983, p. 6)). This sentence is interpreted so that *yalumpu* 'that' is in construction with the nominal *wawirri*. The organization of the verbal complex must then be as in (9), if the ordering is preserved:

(9)



so that $\bar{N}$ is not connected.

However, since Warlpiri is non-configurational, its PS need not satisfy the projection principle, so that various distortions of structure are in principle permitted. English is different: it is configurational, so that the projection principle holds of PS as well as LS. It follows that arguments cannot be omitted in English, unlike Warlpiri.

Hale's construction does not imply that what is *permitted* in a language that is non-configurational will actually

occur there. However, this does not blunt Hale's criticism of the attempt to account for free word-order by means of an autonomous level of rules of phrase-structure.

Let us extend Hale's construction in the following way, made possible by the view of phrase-markers advanced above. If we split S-Structure into LS and PS, we might suppose a) that languages agree on the hierarchic dimensions of LS, as part of universal grammar, and b) that they differ in how elements may be ordered. Now a phrase-marker on our construction is just a structure $S = (\Sigma, \leq, \lambda)$, so that the theory of the reductions $S_0 = (\Sigma, \leq)$ can be given independently of the theory of the relation of precedence λ. The theory of the S_0 being given, we might look upon full representations of LS as arising from a rule (10):

(10) Order S_0.

where (10) must satisfy the principles (3)-(5) above.

Linguistic differences then emerge depending upon the constraints to which (10) is subject. Those that are known to exist include (11) and (12):

(11) LS is connected (e.g., Chinese)

(12) Heads are final (e.g., Japanese)

and there are many others (see, among other sources, Stowell (1981) and Huang (1982) for some discussion of constraints on

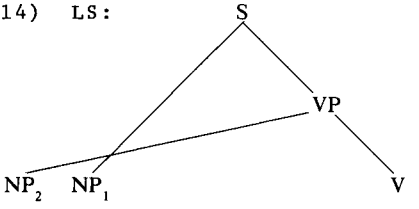
head-placement; our discussion is in fact directly indebted to Stowell).

The interaction of constraints on ordering will produce manifold consequences; for instance, a language satisfying both (11) and (12) will be rigidly SOV. Consider now Japanese, which as noted satisfies (12), but perhaps not (11), since the order OSV is permitted.[3] Let us suppose, returning to PS, that (13):

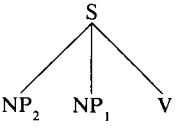
(13) PS is connected.

In that case, it is natural to assume that PS arises from LS by deletion of disconnected elements. The LS-PS pairs for a Japanese OSV sentence would then be as in (14):

(14) LS:



PS:



3. Saito (1982) suggests on the basis of crossover facts that Japanese has a category VP, the OSV orders being derived by movement.

We arrive by this means at a conception of Japanese S-Structure that accords with Hale (1983) (but see footnote 3 above).

In their (1982) Zubizarretta and Vergnaud introduce the interesting notion of a *virtual category*, or one which is, roughly speaking, unapparent at the level we have been calling PS, following Hale. The connection between that notion and the procedure suggested here for the case of Japanese (to which Zubizarretta and Vergnaud also advert) is formed as follows: the categories that are *virtual* are those that must be deleted if (13) is to be satisfied; thus the VP of (14). The child learning Japanese needs to learn (12), the principle that heads are final. The virtuality of the category VP follows from (13), a universal principle, given the appearance in speech of OSV sentences. The central notion of Zubizarretta and Vergnaud thus appears to be reconstructible in the present setting.

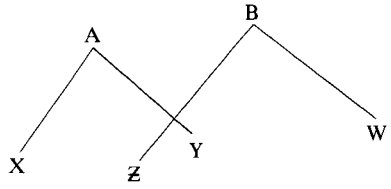
Returning to the main theme, it evidently follows that a language that has relatively few ordering constraints on the hierarchical structures S_0 is bound to violate the projection principle at PS; more precisely, to exempt representations at PS from the projection principle. The reason is that the disconnexity of LS, together with the requirement that PS be connected, will mandate the deletion of nodes: verbs will appear with no indication of their proper argu-

ments configurationally given, demonstratives will appear separated from their nouns as in (8) above, and so forth. The child, hearing the variety of word-orderings encountered in ordinary speech, will be able to infer that his or her language is non-configurational in Hale's sense. From this point of view, free word order and non-configurationality are associated *evidentially*, although the latter does not imply the former.*

The ordering restrictions in Navajo reported in Hale (1983, p. 41), fit into the above scheme in the following way. Navajo has verbal inflections *yi-* and *bi-* whose effect is to disambiguate the grammatical functions of nominal arguments. These must be taken as SO if *yi-* occurs, and as OS if *bi-* occurs. In our terms, the use of these inflections is as a constraint on the ordering of a structure S_0. But since the rule governing the inflections will disconnect the category VP, the latter will be a virtual category, and the language to that degree non-configurational.

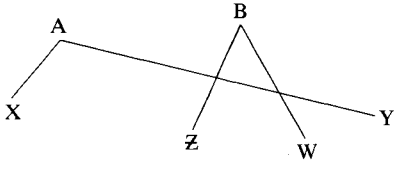
Languages with freedom of word order nevertheless do not allow any arbitrary LS to be associated with a given string. We may expect that there are quite delicate constraints in this regard, such as those reported in van Riemsdijk (1981) for the case of Warlpiri, which in certain cases rules out orderings as shown in (15):

(15)

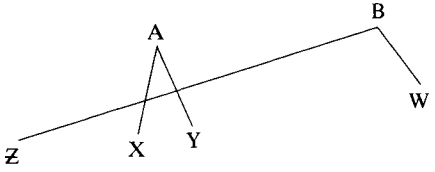


while permitting

(16)



(17)



Ordering conditions on LS that will have this effect can be stated straightforwardly.

To summarize: I have proposed that the theory of phrase-markers be cast in such a way that dominance and linear order are separated from one another, as first suggested in McCawley (1968). In the particular proposal given here, it is supposed the theory of S-Structure be decomposed as (i) the theory of *unordered* structures $S_0 = (\Sigma, \leq)$, subject not only to the axioms of the theory but also to the conditions on human languages, both particular and universal; (ii) the theory of

orderings of the S_0, giving rise to ordered *Lexical Structures*; and (iii) the theory of the *reduction* of Lexical Structures to *Phrase Structures*, assumed to be connected, resulting in the appearance of virtual categories in the sense of Zubizarretta and Vergnaud. The central ideas of Chomsky (1955), involving concatenation and transformations, are reconstructible within this framework. The theories of (i)-(iii), as well as the theory of transformations, would have to be developped in detail in order to judge of the merit of this proposal; nevertheless, I hope more clearly to have delineated points where the basic account of the fundamental objects of linguistic theory can be developed, in a way that separates the two dimensions of linguistic structure, and at the same time provides the means for investigating the connections between them that may or must obtain in human languages.

James Higginbotham
MIT

RÉFÉRENCES

CHOMSKY, N. (1955) *The Logical Structure of Linguistic Theory*, published with some emendations by Plenum Press, New York, 1975.

HALE, K. (1983) "Warlpiri and the Grammar of Non-Configurational Languages", *Natural Language and Linguistic Theory*, vol. 1, n° 1.

LASNIK, H. and J. KUPIN (1977) "A Restrictive Theory of Transformational Grammar", *Theoretical Linguistics 4*, 3.

McCAWLEY, J. (1968) "Concerning the Base Component of a Transformational Grammar", *Foundations of Language 4*.

McCAWLEY, J. (1982) "Parentheticals and Discontinuous Constituent Structure", *Linguistic Inquiry 13*, 1.

RIEMSDIJK, H. van (1981) "On Adjacency in Phonology and Syntax", in V. Burke and J. Pustejovsky, *Proceedings, NELS XI*.

SAITO, M. (1982) "Scrambling, Topicalization, and Strong Crossover", ms., MIT

ZUBIZARRETTA, M.-L. and J.-R. VERGNAUD (1982) "On Virtual Categories", *MIT Working Papers in Linguistics, 4*.

---

* The following revisions are to be added to the text:

p. 154: In general, the objects of grammar would be, on the conception sketched, *relational structures* of the form $(\Sigma, \leq, \lambda, R_1, \ldots, R_n)$, where the R_i represent the other primitive notions, besides dominance and precedence, that are involved in grammar. Other notions (for instance, that of c-command) would be defined in terms of these.

p. 163: If the above suggestion is on the right track, then we can close a possibility left open by Hale's construction, namely that there should be rigidly ordered but non-configurational languages. For we predict that, where free word order does not obtain, the child will project a configurational language, since no evidence to the contrary will be presented. In general, grammars may be *possible* from the point of view of general linguistic theory, in that no universal principle on the form of grammars rules them out, but *unprojectible* from linguistic data, in that principles of acquisition will always select other forms of grammar in preference to them. In the latter case also, such grammars are in a sense not possible, but the reasons are different from those operative in the former case. The distinction between the cases deserves further attention, I believe, even if the application suggested here proves to be mistaken.