ASPECTS OF THE THEORY OF SYNTAX

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Preface

The idea that a language is based on a system of rules determining the interpretation of its infinitely many sentences is by no means novel. Well over a century ago, it was expressed with reasonable clarity by Wilhelm von Humboldt in his famous but rarely studied introduction to general linguistics (Humboldt, 1836). His view that a language "makes infinite use of finite means" and that its grammar must describe the processes that make this possible is, furthermore, an outgrowth of a persistent concern, within rationalistic philosophy of language and mind, with this "creative" aspect of language use (for discussion, see Chomsky, 1964, forthcoming). What is more, it seems that even Panini's grammar can be interpreted as a fragment of such a "generative grammar," in essentially the contemporary sense of this term.

Nevertheless, within modern linguistics, it is chiefly within the last few years that fairly substantial attempts have been made to construct explicit generative grammars for particular languages and to explore their consequences. No great surprise should be occasioned by the extensive discussion and debate concerning the proper formulation of the theory of generative grammar and the correct description of the languages that have been most intensively studied. The tentative character of any conclusions that can now be advanced concerning linguistic theory, or, for that matter, English grammar, should certainly be obvious to anyone working in this area. (It is sufficient to

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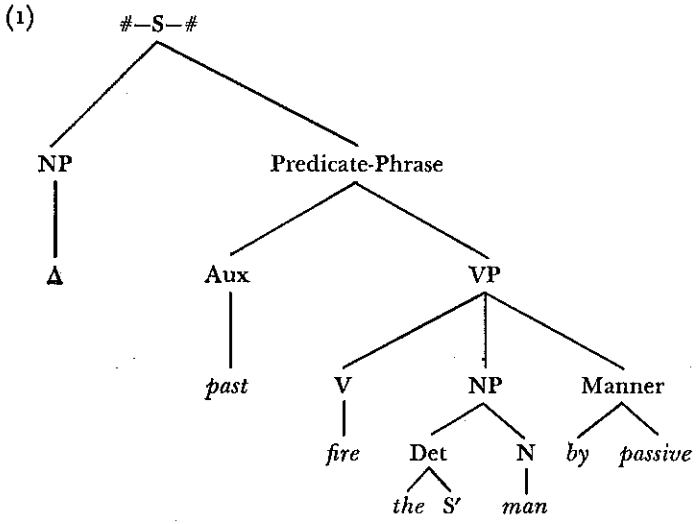
Deep Structures and Grammatical Transformations

LET us adopt, tentatively, the theory of the base component sketched in § 4.3 of Chapter 2, and continue to use the fragment of § 3, Chapter 2, appropriately modified to exclude subcategorization rules from the categorial component of the base, as an illustrative example of a grammar.

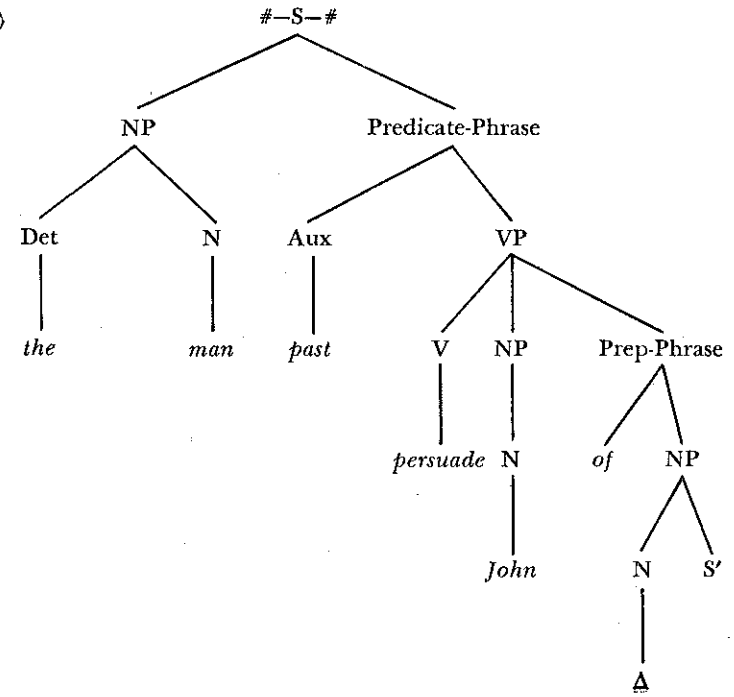
The base will now generate base Phrase-markers. In § 1, Chapter 1, we defined the basis of a sentence as the sequence of base Phrase-markers that underlies it. The basis of a sentence is mapped into the sentence by the transformational rules, which, furthermore, automatically assign to the sentence a derived Phrase-marker (ultimately, a surface structure) in the process.

For concreteness, consider a base component which generates the Phrase-markers (1)–(3).[1] The base Phrase-marker (3), with a different choice of Auxiliary, would be the basis for the sentence "John was examined by a specialist." The Phrase-marker (1) would be the basis for the sentence "the man was fired," were we to modify it by deleting S′ from the Determiner associated with *man*. (In this case, the passive transformation is followed by the deletion of unspecified agent.) As it stands, however, to form the basis for some sentence, the base Phrase-marker (1) must be supplemented by another Phrase-marker, a transform of which will fill the position of S′ in (1) and thus serve as a relative clause qualifying *man*. Similarly, (2) alone cannot serve as a basis for a sentence because the S′ appearing in the Verbal Complement

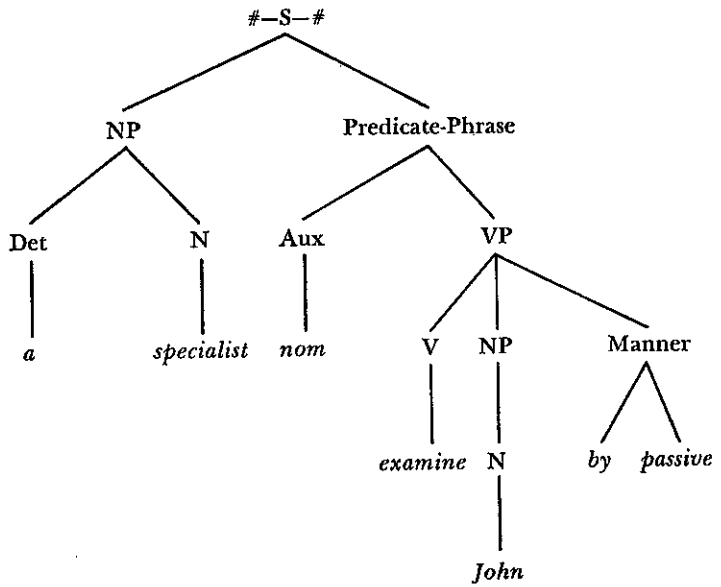
(1)



(2)



(3)

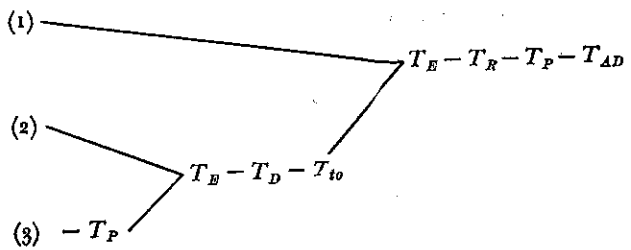


must be replaced by the transform of some other Phrase-marker. In fact, however, the sequence of base Phrase-markers (1), (2), (3) is the basis for the well-formed sentence

(4) the man who persuaded John to be examined by a specialist was fired

The "transformational history" of (4) by which it is derived from its basis might be represented, informally, by the diagram (5).

(5)



We interpret this as follows: First, apply the Passive transformation T_P to the base Phrase-marker (3); embed the result in the base Phrase-marker (2), in place of S', by a generalized (double-base) substitution transformation T_E, giving a Phrase-marker for "the man persuaded John of Δ John *nom* be examined by a specialist"; to this apply first T_D, which deletes the repeated NP "John," and then T_{to}, which replaces "of Δ *nom*" by "to," giving a Phrase-marker for "the man persuaded John to be examined by a specialist"; next embed this in the position of S' in (1), by T_E; to this apply the relative transformation T_R, which permutes the embedded sentence with the following N and replaces the repeated phrase "the man" by "who," giving a Phrase-marker for "Δ fired the man who persuaded John to be examined by a specialist by *passive*"; to this Phrase-marker apply the passive transformation and agent deletion (T_{AD}), giving (4).

I have left out of this description quite a few transformations that are necessary to give the correct form of (4), as well as other details, but these are, by and large, well known, and introduction of them changes nothing relevant to this discussion.

The diagram (5) is an informal representation of what we may call a *Transformation-marker*. It represents the transformational structure of the utterance (5) very much in the way a Phrase-marker represents the phrase structure of a terminal string. In fact, a Transformation-marker may be formally represented as a set of strings in an alphabet consisting of base Phrase-markers and transformations as its elements, just as a Phrase-marker may be formally represented as a set of strings in an alphabet consisting of terminal symbols, category symbols, and with the developments of the preceding sections, specified features.[2]

The deep structure of an utterance is given completely by its Transformation-marker, which contains its basis. The surface structure of the sentence is the derived Phrase-marker given as the output of the operations represented in the Transformation-marker. The basis of the sentence is the sequence of base Phrase-markers that constitute the terminal points of the tree-diagram (the left-hand nodes, in (5)). When Transformation-markers are

represented as in (5), the branching points correspond to generalized transformations that embed a constituent sentence (the lower branch) in a designated position in a matrix sentence (the upper branch).

A theoretical apparatus of this sort, in its essentials, is what underlies the work in transformational generative grammar that has appeared in the last ten years. However, in the course of this work, several important points have gradually emerged which suggest that a somewhat more restricted and conceptually simpler theory of transformations may be adequate.

First, it has been shown that many of the optional singulary transformations of Chomsky (1955, 1957, 1962) must be reformulated as obligatory transformations, whose applicability to a string is determined by presence or absence of a certain marker in the string. This was pointed out by Lees (1960*a*) for the negation transformation, and by Klima (personal communication) for the question transformation, at about the same time. In fact, it is also true for the passive transformation, as noted in § 2.3.4 of Chapter 2. Katz and Postal (1964) have extended these observations and formulated them in terms of a general principle, namely that *the only contribution of transformations to semantic interpretation is that they interrelate Phrase-markers* (i.e., combine semantic interpretations of already interpreted Phrase-markers in a fixed way).[3] It follows, then, that transformations cannot introduce meaning-bearing elements (nor can they delete lexical items unrecoverably, by the condition mentioned in note 1). Generalizing these remarks to embedding transformations, they conclude also that a sentence transform embedded in a matrix sentence Σ must replace a dummy symbol of Σ. (In the foregoing discussion, adopting this suggestion, we have used S′ as the dummy symbol — this assumption is also implicit in Fillmore, 1963.)

Katz and Postal point out that the principle just stated greatly simplifies the theory of the semantic component, since semantic interpretation will now be independent of all aspects of the Transformation-marker except insofar as this indicates how base structures are interrelated. They have also succeeded in

showing that in a large variety of cases, where this general principle has not been met in syntactic description, the description was in fact incorrect on internal syntactic grounds. The principle, then, seems very plausible.

Second, notice that the theory of Transformation-markers permits a great deal of latitude so far as ordering of transformations is concerned. Thus the grammar, in this view, must contain rules generating the possible Transformation-markers by stating conditions that these objects must meet for well-formedness (what Lees, 1960*a*, calls "traffic rules").[4] These rules may state the ordering of transformations relative to one another, and may designate certain transformations as obligatory, or obligatory relative to certain contexts, by requiring that they appear in specified positions in Transformation-markers. However, only some of the possibilities permitted by this general theory have been realized convincingly with actual linguistic material. In particular, there are no known cases of ordering among generalized embedding transformations although such ordering is permitted by the theory of Transformation-markers. Furthermore, there are no really convincing cases of singulary transformations that must apply to a matrix sentence before a sentence transform is embedded in it, though this too is a possibility, according to the theory.[5] On the other hand, there are many examples of ordering of singulary transformations, and many examples of singulary transformations that must apply to a constituent sentence before it is embedded or that must apply to a matrix sentence after embedding of a constituent structure in it. Thus the diagram (5) is typical of the kind of structure that has actually been discovered in Transformation-markers.

In brief, presently available descriptive studies suggest the following restrictions on ordering of transformations. The singulary transformations are linearly ordered (perhaps only partially ordered). They may apply to a constituent structure before it is embedded, or to a matrix structure, and the constituent structure embedded in it, after this constituent structure is embedded. There is no reason for imposing an extrinsic order on the generalized transformations.[6]

These observations suggest a possible simplification of the theory of transformational grammar. Suppose that we eliminate the notions "generalized transformation" and "Transformation-marker" altogether.[7] In the rewriting rules of the base (in fact, in its categorial component) the string #S# is introduced in the positions where in the illustrative example we introduced the symbol S'. That is, wherever a base Phrase-marker contains a position in which a sentence transform is to be introduced, we fill this position with the string #S#, which initiates derivations. We now allow the rules of the base to apply cyclically, preserving their linear order. Thus, for example, after having generated (1), with #S# in place of S', they reapply to the new occurrence of #S# in the terminal line of the derivation represented by (1). From this occurrence of #S# the rules of the base can generate the derivation represented by (2), with #S# in place of the occurrence of S' in (2). From the latter occurrence of #S#, the same base rules can reapply to form the derivation represented by (3). In this way, the base rules will generate the *generalized Phrase-marker* formed from (1), (2), (3) by replacing S' in (1) by (2) and replacing S' in (2) by (3).

We have thus revised the theory of the base by allowing #S# to appear on the right in certain branching rules, where previously the dummy symbol S' had appeared, and by allowing the rules to reapply (preserving their order) to these newly introduced occurrences of #S#. A generalized Phrase-marker formed in this way contains all of the base Phrase-markers that constitute the basis of a sentence, but it contains more information than a basis in the old sense since it also indicates explicitly how these base Phrase-markers are embedded in one another. That is, the generalized Phrase-marker contains all of the information contained in the basis, as well as the information provided by the generalized embedding transformations.[8]

In addition to the rules of the base, so modified, the grammar contains a linear sequence of singulary transformations. These apply to generalized Phrase-markers cyclically, in the following manner. First, the sequence of transformational rules applies to the most deeply embedded base Phrase-marker. (For example, it applies to (3), in the generalized Phrase-marker formed by embedding (3) in (2) and the result in (1), as described earlier.) Having applied to all such base Phrase-markers, the sequence of rules reapplies to a configuration dominated by S in which these base Phrase-markers are embedded (to (2), in the same example), and so on, until finally the sequence of rules applies to the configuration dominated by the initial symbol S of the entire generalized Phrase-marker (to (1), in our example). Notice that in the case of (1)–(3), the effect of this convention is precisely what is described in the Transformation-marker (5). That is, singulary transformations are applied to constituent sentences before they are embedded, and to matrix sentences after embedding has taken place. The embedding itself is now provided by the branching rules of the base rather than by generalized transformations. We have, in effect, converted the specific properties of the Transformation-marker (5) into general properties of any possible transformational derivation.

The grammar now consists of a base and a linear sequence of singulary transformations. These apply in the manner just described. The ordering possibilities that are permitted by the theory of Transformation-markers but apparently never put to use are now excluded in principle. The notion of Transformation-marker disappears, as does the notion of generalized transformation. The base rules form generalized Phrase-markers that contain just the information contained in the basis and the generalized transformations of the earlier version. But observe that in accordance with the Katz-Postal principle discussed earlier (p. 132), it is precisely this information that should be relevant to semantic interpretation. Consequently, we may take a generalized Phrase-marker, in the sense just defined, to be the deep structure generated by the syntactic component.

Thus the syntactic component consists of a base that generates deep structures and a transformational part that maps them into surface structures. The deep structure of a sentence is submitted to the semantic component for semantic interpretation, and its surface structure enters the phonological component and undergoes phonetic interpretation. The final effect of a grammar, then,

is to relate a semantic interpretation to a phonetic representation — that is, to state how a sentence is interpreted. This relation is mediated by the syntactic component of the grammar, which constitutes its sole "creative" part.

The branching rules of the base (that is, its categorial component) define grammatical functions and grammatical relations and determine an abstract underlying order (cf. § 4.4, Chapter 2); the lexicon characterizes the individual properties of particular lexical items that are inserted in specified positions in base Phrase-markers. Thus when we define "deep structures" as "structures generated by the base component," we are, in effect, assuming that the semantic interpretation of a sentence depends only on its lexical items and the grammatical functions and relations represented in the underlying structures in which they appear.[9] This is the basic idea that has motivated the theory of transformational grammar since its inception (cf. note 33, Chapter 2). Its first relatively clear formulation is in Katz and Fodor (1963), and an improved version is given in Katz and Postal (1964), in terms of the modification of syntactic theory proposed there and briefly discussed earlier. The formulation just suggested sharpens this idea still further. In fact, it permits a further simplification of the theory of semantic interpretation presented in Katz and Postal (1964), since Transformation-markers and generalized transformations, as well as "projection rules" to deal with them, need no longer be considered at all. This formulation seems to be a natural extension and summary of the developments of the past few years that have just been summarized.

Notice that in this view one major function of the transformational rules is to convert an abstract deep structure that expresses the content of a sentence into a fairly concrete surface structure that indicates its form.[10] Some possible reasons for such an organization of grammar, in terms of perceptual mechanisms, are suggested in Miller and Chomsky (1963, § 2.2). It is interesting to note, in this connection, that the grammars of the "artificial languages" of logic or theory of programming are, apparently without exception, simple phrase structure grammars in most significant respects.

Looking more closely at the recursive property of the grammar, we have now suggested the following modification of transformational theory. In the earlier version of the theory, the recursive property was assigned to the transformational component, in particular, to the generalized transformations and the rules for forming Transformation-markers. Now the recursive property is a feature of the base component, in particular, of the rules that introduce the initial symbol S in designated positions in strings of category symbols. There are, apparently, no other recursive rules in the base.[11] The transformational component is solely interpretive.

It is worth mentioning that with this formulation of the theory of transformational grammar, we have returned to a conception of linguistic structure that marked the origins of modern syntactic theory, namely that presented in the *Grammaire générale et raisonnée*.[12]

One additional point must be emphasized in connection with the notion "deep structure." When the base rules generate a Phrase-marker from an occurrence of S that is embedded in an already generated Phrase-marker, they cannot take account of the context in which this occurrence of S appears. For example, instead of the generalized Phrase-marker M consisting of (1)–(3) (with (3) embedded in (2) and the result embedded in (1)), we might just as well have constructed the generalized Phrase-marker M' formed from (1), K, and (3), where K is a Phrase-marker differing from (2) only in that *man* in (2) is replaced by *boy* in K. But now, at the stage of derivation at which the relative clause transformation (T_R of (5)) is applied to K with (3) embedded within it, we shall have not the string (6) but rather (7):

(6) Δ fired the man (# the man persuaded John to be examined by a specialist #) by *passive*

(7) Δ fired the man (# the boy persuaded John to be examined by a specialist #) by *passive*

The string (6) (with its Phrase-marker) is of the form that permits the relative clause transformation to apply, replacing "the man" by "who," since the condition of identity of the two Nouns

is met and we thus have a recoverable deletion (cf. note 1). But in the case of (7), the transformation will block. Thus the phrase "the boy" cannot be deleted from (7) because of the general condition that only recoverable deletions are permitted — that is, the identity condition of the transformation is not satisfied.[18] This is precisely what we want, for obviously the generalized Phrase-marker formed from (1), *K*, (3) does not provide the semantic interpretation of (4), as it would if application of the relative clause transformation were permitted in this case. In fact, the generalized Phrase-marker formed from (1), *K*, and (3), although generated by the base rules, is not the deep structure underlying any surface structure.

We can make this observation precise, in this case, by defining the relative clause transformation in such a way that it deletes the boundary symbol # when it applies. Thus if its application is blocked, this symbol will remain in the string. We can then establish the convention that a well-formed surface structure cannot contain internal occurrences of #. Such occurrences will indicate that certain transformations that should have applied were blocked. The same (or similar) formal devices can be used in a variety of other cases.

Putting aside questions of formalization, we can see that not all generalized Phrase-markers generated by the base will underlie actual sentences and thus qualify as deep structures. What, then, is the test that determines whether a generalized Phrase-marker is the deep structure of some sentence? The answer is very simple. The transformational rules provide exactly such a test, and there is, in general, no simpler test. A generalized Phrase-marker M_D is the deep structure underlying the sentence S, with the surface structure M_S, just in case the transformational rules generate M_S from M_D. The surface structure M_S of S is well formed just in case S contains no symbols indicating the blocking of obligatory transformations. A deep structure is a generalized Phrase-marker underlying some well-formed surface structure. Thus the basic notion defined by a transformational grammar is: *deep structure M_D underlies well-formed surface structure M_S*. The notion "deep structure" itself is derivative from this. The

transformational rules act as a "filter" that permits only certain generalized Phrase-markers to qualify as deep structures.

Notice that this filtering function of the transformational component is not an entirely new feature specific to the version of transformational grammar that we are developing now. In fact, it was also true of the earlier version, though this fact was never discussed in exposition. Thus a sequence of base Phrase-markers might have been selected that could not serve as the basis of any sentence; furthermore, any system of rules for generating Transformation-markers would certainly permit certain structures that do not qualify as Transformation-markers because of inconsistencies and blocks arising in the course of carrying out the instructions that they represent. In the present version this filtering function is simply brought out more clearly.

In § 4.3 of Chapter 2 we suggested: (*a*) that the distributional restrictions of lexical items be determined by contextual features listed in lexical entries, and (*b*) that these contextual features be regarded as defining certain substitution transformations. Thus strict subcategorial and selectional restrictions of lexical items are defined by transformational rules associated with these items. We have now observed that the transformational rules must also carry the burden of determining the distributional restrictions on base Phrase-markers. Thus the categorial rules that generate the infinite set of generalized Phrase-markers can apparently be context-free, with all distributional restrictions, whether of base Phrase-markers or lexical entries, being determined by the (singulary) transformations.

Such a description of the form of the syntactic component may seem strange if one considers the generative rules as a model for the actual construction of a sentence by a speaker. Thus it seems absurd to suppose that the speaker first forms a generalized Phrase-marker by base rules and then tests it for well-formedness by applying transformational rules to see if it gives, finally, a well-formed sentence. But this absurdity is simply a corollary to the deeper absurdity of regarding the system of generative rules as a point-by-point model for the actual construction of a sentence by a speaker. Consider the simpler case of a phrase

structure grammar with no transformations (for example, the grammar of a programming language, or elementary arithmetic, or some small part of English that might be described in these terms). It would clearly be absurd to suppose that the "speaker" of such a language, in formulating an "utterance," first selects the major categories, then the categories into which these are analyzed, and so forth, finally, at the end of the process, selecting the words or symbols that he is going to use (deciding what he is going to talk about). To think of a generative grammar in these terms is to take it to be a model of performance rather than a model of competence, thus totally misconceiving its nature. One can study models of performance that incorporate generative grammars, and some results have been achieved in such studies.[14] But a generative grammar as it stands is no more a model of the speaker than it is a model of the hearer. Rather, as has been repeatedly emphasized, it can be regarded only as a characterization of the intrinsic tacit knowledge or competence that underlies actual performance.

The base rules and the transformational rules set certain conditions that must be met for a structure to qualify as the deep structure expressing the semantic content of some well-formed sentence. Given a grammar containing a base component and a transformational component, one can develop innumerable procedures for actually constructing deep structures. These will vary in exhaustiveness and efficiency, and in the extent to which they can be adapted to the problems of producing or understanding speech. One such constructive procedure is to run through the base rules (observing order) so as to form a generalized Phrase-marker M, and then through the transformational rules (observing order) so as to form a surface structure M' from M. If M' is well formed, then M was a deep structure; otherwise, it was not. All deep structures can be enumerated in this way, just as they can all be enumerated in many other ways, given the grammar. As noted earlier, the grammar defines the relation "the deep structure M underlies the well-formed surface structure M' of the sentence S" and, derivatively, it defines the notions "M is a deep structure," "M' is a well-formed surface structure," "S is a well-formed sentence," and many others (such as "S is structurally ambiguous," "S and S' are paraphrases," "S is a deviant sentence formed by violating rule R or condition C"). The grammar does not, in itself, provide any sensible procedure for finding the deep structure of a given sentence, or for producing a given sentence, just as it provides no sensible procedure for finding a paraphrase to a given sentence. It merely defines these tasks in a precise way. A performance model must certainly incorporate a grammar; it is not to be confused with a grammar. Once this point is clear, the fact that transformations act as a kind of filter will occasion no surprise or uneasiness.

To summarize, we have now suggested that the form of grammar may be as follows. A grammar contains a syntactic component, a semantic component, and a phonological component. The latter two are purely interpretive; they play no part in the recursive generation of sentence structures. The syntactic component consists of a base and a transformational component. The base, in turn, consists of a categorial subcomponent and a lexicon. The base generates deep structures. A deep structure enters the semantic component and receives a semantic interpretation; it is mapped by the transformational rules into a surface structure, which is then given a phonetic interpretation by the rules of the phonological component. Thus the grammar assigns semantic interpretations to signals, this association being mediated by the recursive rules of the syntactic component.

The categorial subcomponent of the base consists of a sequence of context-free rewriting rules. The function of these rules is, in essence, to define a certain system of grammatical relations that determine semantic interpretation, and to specify an abstract underlying order of elements that makes possible the functioning of the transformational rules. To a large extent, the rules of the base may be universal, and thus not, strictly speaking, part of particular grammars; or it may be that, although free in part, the choice of base rules is constrained by a universal condition on the grammatical functions that are defined. Similarly, the category symbols appearing in base rules are selected from a

fixed universal alphabet; in fact, the choice of symbol may be largely or perhaps completely determined by the formal role the symbol plays in the system of base rules. The infinite generative capacity of the grammar arises from a particular formal property of these categorial rules, namely that they may introduce the initial symbol S into a line of a derivation. In this way, the rewriting rules can, in effect, insert base Phrase-markers into other base Phrase-markers, this process being iterable without limit.

The lexicon consists of an unordered set of lexical entries and certain redundancy rules. Each lexical entry is a set of features (but see note 15 of Chapter 2). Some of these are phonological features, drawn from a particular universal set of phonological features (the distinctive-feature system). The set of phonological features in a lexical entry can be extracted and represented as a phonological matrix that bears the relation "is a" to each of the specified syntactic features belonging to the lexical entry. Some of the features are semantic features. These, too, are presumably drawn from a universal "alphabet," but little is known about this today, and nothing has been said about it here. We call a feature "semantic" if it is not mentioned in any syntactic rule, thus begging the question of whether semantics is involved in syntax.[15] The redundancy rules of the lexicon add and specify features wherever this can be predicted by general rule. Thus the lexical entries constitute the full set of irregularities of the language.

We may construct a derivation of a generalized Phrase-marker by applying the categorial rules in the specified order, beginning with S, reapplying them to each new occurrence of S introduced in the course of the derivation. In this way, we derive a preterminal string, which becomes a generalized Phrase-marker when lexical entries are inserted in accordance with the transformational rules specified by the contextual features that belong to these lexical entries. The base of the syntactic component thus generates an infinite set of generalized Phrase-markers.

The transformational subcomponent consists of a sequence of singulary transformations. Each transformation is fully defined

by a structure index, which is a Boolean condition on Analyzability, and a sequence of elementary transformations. The notion "Analyzable" is determined in terms of the "is a" relation, which, in turn, is defined by the rewriting rules of the base and by the lexicon. Thus transformations may refer to specified syntactic features as if they were categories. In fact, transformations must also be designed so that they can specify and add syntactic features, but we shall not go into this modification of the theory of transformational grammar here (see Chapter 4, § 2). Given a generalized Phrase-marker, we construct a transformational derivation by applying the sequence of transformational rules sequentially, "from the bottom up" — that is, applying the sequence of rules to a given configuration only if we have already applied it to all base Phrase-markers embedded in this configuration. If none of the transformations blocks, we derive in this way a well-formed surface structure. In this and only this case, the generalized Phrase-marker to which the transformations were originally applied constitutes a deep structure, namely the deep structure of the sentence S, which is the terminal string of the derived surface structure. This deep structure expresses the semantic content of S, whereas the surface structure of S determines its phonetic form.

The interpretive components of a grammar have not been our concern here. Insofar as details of their structure have been worked out, they seem to function in parallel ways. The phonological component consists of a sequence of rules that apply to a surface structure "from the bottom up" in the tree-diagram representing it. That is, these rules apply in a cycle, first to the minimal elements (formatives), then to the constituents of which they are parts (a constituent of a Phrase-marker being a substring of its terminal string dominated by a single category symbol), then to the constituents of which these are parts, and so on, until the maximal domain of phonological processes is reached. (See Chomsky, Halle, and Lukoff, 1956; Halle and Chomsky, 1960, forthcoming; Chomsky, 1962*b*; Chomsky and Miller, 1963.) In this way a phonetic representation of the entire sentence is formed on the basis of the intrinsic abstract phono-

logical properties of its formatives and the categories represented in the surface structure.

In a somewhat similar way, the projection rules of the semantic component operate on the deep structure generated by the base, assigning a semantic interpretation (a "reading") to each constituent, on the basis of the readings assigned to its parts (ultimately, the intrinsic semantic properties of the formatives) and the categories and grammatical relations represented in the deep structure. (See Katz and Fodor, 1963; Katz and Postal, 1964; and other papers by Katz listed in the bibliography.) To the extent that grammatical categories and relations can be described in language-independent terms, one may hope to find universal projection rules, which need not, therefore, be stated as part of a specific grammar.

Throughout this discussion, we have simply been presupposing the theory of grammatical transformations as presented in the references cited, but it is perhaps worth mentioning that this theory, too, can apparently be simplified in various ways. First, it appears that permutations can be eliminated from the set of elementary transformations in favor of substitutions, deletions, and adjunctions. That is, the derived Phrase-markers that would be provided by permutations may not be necessary in addition to those provided by the other elementary transformations. Elimination of permutations from the base set would greatly simplify the theory of derived constituent structure.[16] Second, it seems that the structural analyses that determine the domain of transformations can be limited to Boolean conditions on Analyzability. That is, quantifiers can be eliminated from the formulation of transformations in favor of a general convention on deletion, as mentioned in note 13. If so, this places a severe additional restriction on the theory of transformations.

The latter point deserves some further clarification. We shall discuss it briefly here and then return to the question in Chapter 4, § 2.2. We are proposing the following convention to guarantee recoverability of deletion: a deletion operation can eliminate only a dummy element, or a formative explicitly mentioned in the structure index (for example, *you* in imperatives), or the

designated representative of a category (for example, the *wh*-question transformations that delete Noun Phrases are in fact limited to indefinite Pronouns — cf. Chomsky, 1964, § 2.2), or an element that is otherwise represented in the sentence in a fixed position. To clarify the latter point further, let us define an *erasure transformation* as one that substitutes a term X of its proper analysis for a term Y of its proper analysis (leaving X intact), and then deletes this new occurrence of X which replaced Y. In the example of relativization discussed earlier (pp. 128 f.), if we have the string

(8) $\overbrace{\text{the man}}^{1} - \overbrace{[\#wh\text{-}}^{2} - \overbrace{\text{the man}}^{3} - \overbrace{\text{had been fired}\#]}^{4}$ returned to work

the relative transformation can be formulated as an erasure operation that substitutes the first term X of the proper analysis for the third term Y, erasing the latter[17] in the process. Avoiding details of formalization, which are straightforward within the general theory of transformations, we may say briefly that the erasure operation *uses the term X to delete Y* in such a case. We say, then, that an erasure operation can use the term X to delete Y just in case X and Y are identical. We shall investigate the exact nature of the required relation between X and Y somewhat more fully in Chapter 4, pp. 177f.

As an additional illustration, consider the reflexivization operation (see Lees and Klima, 1963, for a detailed discussion). It has frequently been observed that in a sentence such as "John hurt John" or "the boy hurt the boy," the two phonetically identical Noun Phrases are necessarily interpreted as differing in reference; sameness of reference requires reflexivization of the second Noun Phrase (this is also true of pronominalization). Various attempts have been made to build an account of this into the syntactic component, but none has been very convincing. The availability of lexical features suggests a new approach that might be explored. Suppose that certain lexical items are designated as "referential" and that by a general convention, each occurrence of a referential item is assigned a marker, say, an integer, as a feature.[18] The reflexivization rule can be formulated

as an erasure operation that uses one Noun Phrase to delete another. As in the case of relativization (cf. note 17), the erasure leaves a residue, in particular, the feature [±Human], and it introduces the new phonetic element *self*. Thus when applied to "I hurt I," the first Noun Phrase is used to delete the second, finally giving, "I hurt myself." But by the recoverability condition on deletion, the reflexivization rule (similarly, the pronominalization rule) will apply only when the integers assigned to the two items are the same. The semantic component will then interpret two referential items as having the same reference just in case they are strictly identical — in particular, in case they have been assigned the same integer in the deep structure. This gives the right answer in many cases, but there are interesting problems that arise when the referential items are plural, and of course there are problems in specifying the notion "referential" properly.

Notice, incidentally, that the reflexivization rule does not always apply (though pronominalization does) even when the two Nouns are strictly identical and hence coreferential. Thus we have "I kept it near me" alongside of "I aimed it at myself," and so on. The difference is that in the first, but not the second, the repeated Noun is in a Sentence-Complement to the Verb. Thus "I kept it near me" has a deep structure of the form "I — kept — it — # S #," where S dominates "it is near me." But "I aimed it at myself" has a deep structure of the form "I — aimed — it — at me" (there is no underlying sentence "it is at me"). The reflexivization rule does not apply to a repeated N dominated by an occurrence of S that does not dominate the "antecedent" occurrence of N. This particular remark about English is, apparently, a consequence of a more general condition on transformations, namely that no morphological material (in this case, *self*) can be introduced into a configuration dominated by S once the cycle of transformational rules has already completed its application to this configuration (though items can still be extracted from this constituent of a larger "matrix structure," in the next cycle of transformational rules). There are a few examples that seem to conflict with this analysis (such as "I

pushed it away from me," "I drew it toward me"), for reasons that I do not understand, but it covers a large number of convincing cases, and, in the distinction it makes between superficially analogous cases that differ only in that one but not the other is based on an independently existing embedded sentence, it provides an interesting confirmation of the theory of transformational grammar.

Returning to the main theme, we can apparently define a grammatical transformation in terms of a "structure index" that is a Boolean condition on Analyzability and a sequence of elementary transformations drawn from a base set including substitutions, deletions, and adjunctions. It seems also that these form larger repeated units (for example, substitution-deletions, erasures) and that the limitations on their application can be given by general conventions of the sort just mentioned. If this is correct, then the formal properties of the theory of transformations become fairly clear and reasonably simple, and it may be possible to undertake abstract study of them of a sort that has not been feasible in the past.

ture, although the surface structures given by stylistic inversions do not affect Case. Even in English, poor as it is in inflection, this can be observed. For example, the Pronoun in the sentences "he was struck by a bullet," "he is easy to please," "he frightens easily" is, in each case, the "logical Object," that is, the Direct-Object of Verbs *strike, please, frighten,* respectively, in the underlying deep structures. Nevertheless, the form is *he* rather than *him.* But stylistic inversion of the type we have just been discussing gives such forms as "him I really like," "him I would definitely try not to antagonize." Where inflections are richer, this phenomenon, which illustrates the peripheral character of these processes of inversion, is much more apparent.

The relation between inflection, ambiguity, and word order was discussed at some length in traditional linguistic theory. See Chomsky, forthcoming, for some references.

NOTES TO CHAPTER 3

1. Some details irrelevant to the problem under discussion are omitted in these examples. We here regard each lexical item as standing for a complex of features, namely those that constitute its lexical entry in addition to those entered by redundancy rules. The use of the dummy symbol Δ has been extended here to the case of various unspecified elements that will be deleted by obligatory transformations. There is, in fact, good reason to require that only "recoverable deletions" be permitted in the grammar. For discussion of this very important question, see Chomsky, 1964, § 2.2. We shall return to it at the end of this chapter and in Chapter 4, § 2.2.

   The formative *nom* in (3) is one of several that might be assigned to the Tense⌢Modal position of the Auxiliary, and that determine the form of the Nominalization (*for-to, possessive-ing,* etc.).

2. The details of this, both for Transformation-markers and Phrase-markers, are worked out in Chomsky (1955), within the following general framework. Linguistic theory provides a (universal) system of *levels of representation.* Each level L is a system based on a set of primes (minimal elements — i.e., an alphabet); the operation of concatenation, which forms strings of primes of arbitrary finite length (the terms and notions all being borrowed from the theory of concatenation algebras — cf. e.g., Rosenbloom, 1950); various relations; a designated class of strings (or sets of strings) of primes called L-markers; a mapping of L-markers onto L'-markers, where L' is the next "lower" level (thus levels are arranged in a hierarchy). In particular, on the level P of phrase structure and the level T of transformations we have P-markers and T-markers in the sense just described informally. A hierarchy of linguistic levels (phonetic, phonological, word, morphological, phrase structure, transformational structure) can be developed within a uniform framework in this way. For details, see Chomsky (1955). For a discussion of T-markers, see Katz and Postal (1964).

3. For discussion of negation, see Klima (1964), Katz (1964*b*). The formation of questions and imperatives and the semantic interpretation of the question and imperative markers are discussed in Katz and Postal (1964). In Hockett (1961) the proposal is made that the passive transformation be conditional on a marker in the underlying form, but no supporting argument is given for what, in the context of that paper, is no more than a notational innovation.

   Notice that the reformulation of the passive transformation as obligatory, relative to choice of an optional marker in the underlying string, is independent of the principle that we have just cited, since the passive marker, as distinct from the question, negation, and imperative markers, has no independent semantic interpretation. Furthermore, we have noted in § 4.4 of Chapter 2 that there are good reasons to distinguish such transformations as passive from purely stylistic inversion operations. These observations suggest that we attempt to formulate a more general condition of which the principle just cited is itself a consequence, namely that "nonstylistic transformations" are all signaled by optional markers drawn from a fixed, universal, language-independent set. This attempt presupposes a deeper analysis of the notion "nonstylistic transformation" than we have been able to provide here, however.

4. For illuminating discussion of this question, and several others that we are considering here, see Fillmore (1963) and Fraser (1963).
5. Both of these observations are due to Fillmore (1963).
6. In connection with ordering of rules, it is necessary to distinguish *extrinsic order,* imposed by the explicit ordering of rules, from *intrinsic order,* which is simply a consequence of how rules are formulated. Thus if the rule R_1 introduces the symbol A and R_2 analyzes A, there is an intrinsic order relating R_1 and R_2, but not necessarily any extrinsic order. Similarly, if a certain transformation T_1 applies to a certain structure that is formed only by application of T_2, there is an intrinsic order T_1, T_2. Taxonomic linguistics disallows extrinsic ordering, but has not been clear about the status of intrinsic ordering. Generative grammars have ordinarily required both. For some discussion of this matter, see Chomsky (1964).

7. We are discussing only embedding transformations here, but should extend the discussion to various generalized transformations that form coordinate constructions (e.g., conjunction). There are certain problems concerning these, but I believe that they can be incorporated quite readily in the present scheme by permitting rule schemata (in the sense of Chomsky and Miller, 1963, p. 298; Chomsky and Schützenberger, 1963, p. 133) introducing coordinated elements that are then modified, rearranged, and appropriately interrelated by singulary transformations. If the suggestion of note 9, Chapter 2, is workable, then such rule schemata need not be stated in the grammar at all. Rather, by a general convention we can associate such a schema with each major category. This approach to coordination relies heavily on the filtering effect of transformations, discussed later. Thus wherever we have coordination, some category is coordinated n times in the matrix sentence, and n occurrences of matched sentences are independently generated by the base rules.

8. Notice, incidentally, that we can now eliminate *Complement* from the set of category symbols. We could go on, at this point, to define "Complement" as a functional notion (to be more precise, as a cover term for several functional notions), in the manner of pp. 70–71.

9. As it stands, this claim seems to me somewhat too strong, though it is true in one important sense of semantic interpretation. For example, it seems clear that the order of "quantifiers" in surface structures sometimes plays a role in semantic interpretation. Thus for many speakers — in particular, for me — the sentences "everyone in the room knows at least two languages" and "at least two languages are known by everyone in the room" are not synonymous. Still, we might maintain that in such examples both interpretations are latent (as would be indicated by the identity of the deep structures of the two sentences in all respects relevant to semantic interpretation), and that the reason for the opposing interpretations is an extraneous factor — an overriding consideration involving order of quantifiers in surface structures — that filters out certain latent interpretations provided by the deep structures. In support of this view, it may be pointed out that other sentences that derive from these (e.g., "there are two languages that everyone in the room knows") may switch interpretations, indicating that these interpretations must have been latent all along. There are other examples that suggest something similar. For example, Grice has suggested that the temporal order implied in conjunction may be regarded as a feature of discourse rather than as part of the meaning of "and," and Jakobson has also discussed "iconic" features of discourse involving relations between temporal order in surface structure and order of importance, etc. Also relevant in this connection is the notion of Topic-Comment mentioned in note 32, Chapter 2. For some references to remarks in the Port-Royal Logic on the effect of grammatical transformations on meaning, see Chomsky (forthcoming).

10. The other function of the transformational component is to express restrictions on distribution for lexical items and for sentence structures.

11. Formally speaking, what we are suggesting is this. Suppose that the symbol A immediately dominates XBY (where B is a symbol) in the Phrase-marker K; that is, $A \rightarrow XBY$ was one of the categorial rules used in generating this Phrase-marker. Then (A,B) constitutes a branch of K. Furthermore, if this occurrence of B immediately dominates ZCW (where C is a symbol), so that (B,C) is a branch, then (A,B,C) is a branch, etc. Suppose now that $(A_1, \cdots, A_n)$ is a branch of the generalized Phrase-marker K formed by base rules, and that $A_1 = A_n$. Then it must be that for some i, $1 \leqslant i \leqslant n$, $A_i = \mathrm{S}$. In other words, the only way to form new deep structures is to insert elementary "propositions" — technically, base Phrase-markers — in other Phrase-markers. This is by no means a logically necessary feature of phrase structure grammars.

    Notice that the schemata that underlie coordination (cf. note 7) also provide infinite generative capacity, but here too the true recursive property can apparently be limited to the schema $\mathrm{S} \rightarrow \mathrm{S\#S\#} \cdots \mathrm{\#S}$, hence to rules introducing "propositions."

    This formulation leaves unexplained some rather marginal phenomena (e.g., the source of such expressions as "very, very, . . . , very Adjective" and some more significant ones (e.g., the possibility of iterating Adverbials and various kinds of parenthetic elements, the status of which in general is unclear). For some discussion of Adverbial sequences, see Matthews (1961).

12. Cf. pp. 117–118. For some discussion, see Chomsky (1964, § 1.0, and forthcoming).

13. Notice, incidentally, that this identity condition need never be stated in the grammar, since it is a general condition on the functioning of grammars. This is important, since (as was pointed out by Lees, 1960*a*), the condition is not really identity of strings but rather total identity of structures, in all cases in which identity conditions appear in transformations. But to define identity of structures in terms of Analyzability it is necessary to use quantifiers; in fact, this may be the only case in which quantifiers must

appear in the structural analyses that define transformations. Extracting the identity condition from grammars, we are therefore able to formulate the structural analyses that define transformations strictly as Boolean conditions on Analyzability, thus greatly restricting the power of the theory of transformational grammar.

14. For discussion see Miller and Chomsky (1963); Schlesinger (1964); Miller and Isard (1964); and the résumé in Chapter 1, § 2.

15. See § 2.3.1 of Chapter 2, and § 1 of Chapter 4. A serious discussion of this question, as well as the question of dependency of syntax on semantics, awaits a development of the theory of universal semantics, that is, an account of the nature of semantic representation. Although various positions about these questions have been stated with great confidence and authority, the only serious work that I know of on the relation of these domains is that of Katz, Fodor, and Postal (see bibliography; for discussion of other claims that have been made, see Chomsky, 1957, and many other publications). For the moment, I see no reason to modify the view, expressed in Chomsky (1957) and elsewhere, that although, obviously, semantic considerations are relevant to the construction of general linguistic theory (that is, obviously the theory of syntax should be designed so that the syntactic structures exhibited for particular languages will support semantic interpretation), there is, at present, no way to show that semantic considerations play a role in the choice of the syntactic or phonological component of a grammar or that semantic features (in any significant sense of this term) play a role in the functioning of the syntactic or phonological rules. Thus no serious proposal has been advanced to show how semantic considerations can contribute to an evaluation procedure for such systems or provide some of the primary linguistic data on the basis of which they are selected. See Chapter 1, § 6, and Chapter 4, § 1, for some additional related discussion.

16. Some of the details of this modification are worked out in Fraser (forthcoming). The extent to which the complexity of the theory of derived constituent structure depends on the presence of permutations is quite clear, for example, from the analysis of these notions in Chomsky (1955, Chapter 8).

17. Notice that in this case the third term of the proper analysis is not strictly deleted. Rather, this term is deleted except for the feature [± Human], which then assumes its phonological shape (giving *who, which,* or *that*) by later rules. This is often true of what we are here calling erasure operations.

18. A natural notational decision would be to restrict the integers one and two to first and second person, respectively.

NOTES TO CHAPTER 4

1. Whether the rule is a rewriting rule or a substitution transformation — cf. Chapter 2, § 4.3 — does not concern us here; for convenience of exposition, we shall assume the latter.

2. To avoid what has been a persistent misunderstanding, it must be emphasized again that "grammaticalness" is being used here as a technical term, with no implication that deviant sentences are being "legislated against" as "without a function" or "illegitimate." Quite the contrary is true, as has repeatedly been stressed and illustrated, in discussions of generative grammar. For discussion, see Chomsky (1961) and many other references. The question as to whether the grammar should generate deviant sentences is purely terminological, having to do with nothing more than the technical sense of "generate." A descriptively adequate grammar must assign to each string a structural description that indicates the manner of its deviation from strict well-formedness (if any). A natural terminological decision would be to say that the grammar *directly generates the language* consisting of just the sentences that do not deviate at all (such as (3)), with their structural descriptions. The grammar *derivatively generates* all other strings (such as (1) and (2)), with their structural descriptions. These structural descriptions will indicate the manner and degree of deviance of the derivatively generated sentences. The principles that determine how interpretations can be imposed on deviant sentences may be universal (as suggested in Chomsky, 1955, 1961; Miller and Chomsky, 1963; and again here) or specific to a given language (as suggested in Katz, 1964*a*). This is a substantive issue, but many of the other questions that have been debated concerning these notions seem to me quite empty, having to do only with terminological decisions.

3. Recall that selectional rules, as illustrated earlier, are rules that insert Verbs and Adjectives into generalized Phrase-markers on the basis of the intrinsic syntactic features of the Nouns that appear in various positions. But not all of the rules referring to intrinsic syntactic features of Nouns are selectional rules; in particular, the rules violated in the formation of (4) involve such features but are not selectional rules.

4. Many of the Verbs of the category [+[+ Abstract] · · · — · · · [+ Animate]] do not have Adjectival forms with *ing*, but these seem invariably to have other affixes as variants of *ing* (*bothersome* for *bothering, scary* for *scaring, impressive* for *impressing,* etc.).

5. These examples do not begin to exhaust the range of possibilities that must be considered in a full study of interpretation of deviant sentences. For one thing, they do not illustrate the use of order-