TRANSFORMATIONAL ANALYSIS

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Preface

This study had its origin in certain problems that arose in attempting to extend linguistic techniques to the analysis of discourse. This extension naturally presupposed standard linguistic analysis, but in the attempt to develop effective techniques of discourse analysis it was found necessary to assume certain knowledge about linguistic structure which was not in fact provided by existing methods, though it seemed within the range of distributional study. In particular, these methods failed to account for such obvious relations between sentences as the active-passive relation. Systematic investigation of this problem exposed other gaps in syntactic theory, and led finally to this attempt to construct a higher level of transformational analysis.

This is basically a study of the arrangement of words and morphemes in sentences, hence a study of linguistic form. Thus it is syntactic study in both the narrow sense (as opposed to phonology) and in the broader sense (as opposed to semantics). No reliance is placed on the meaning of linguistic expressions in this study, in part, because it is felt that the theory of meaning fails to meet certain minimum requirements of objectivity and operational verifiability, but more importantly, because semantic notions, if taken seriously, appear to be quite irrelevant to the problems being investigated here.

This study was carried out in close collaboration with Zellig Harris, to whom I am indebted for many of the fundamental underlying ideas . I have also received suggestions and criticism from Morris Halle. I would like to express my gratitude to the Society of Fellows of Harvard University for their support of the program of research of which this study constitutes a part.

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1. This study of transformational analysis is part of a more general attempt[1] to construct an abstract theory of linguistic structure which can be applied in the construction of grammars of actual languages. The general theory of linguistic structure aims to provide a procedure for (i) delimiting the class of grammatical utterances, and (ii) evaluating any proposed grammatical description, in the case of any given language. Thus given a general theory, and given a corpus of linguistic material in some language, it should be possible to compare various grammars proposed for the language in question, and to select the best of them. Problems (i) and (ii) are related, and transformational analysis has bearing on both of them. See [Logical], chapters I, IV, for a detailed discussion of (i).

To give significance to this program for the development of linguistic theory, it is necessary to develop a formal system for grammatical description in a fixed and precise manner. It is then necessary to build into linguistic theory every consideration that is relevant to the choice among grammars. Since one of the major factors involved in this choice is the consideration of relative complexity, it is

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[1] This general theory will appear under the title "The Logical Structure of Linguistic Theory" in the Indiana University Publications on Anthropology and Linguistics. In the following pages, it will be referred to as [Logical]. This can be taken as a general reference for the notions and terminology used below.

necessary furthermore to develop a formal notion of simplicity of grammar as a part of linguistic theory. These matters are taken up in detail in [Logical], chapters III, VI.

In attempting to develop such an abstract theory of linguistic structure, we are led to construct a set of systems of representation which we call "linguistic levels." Each linguistic level has the basic form of a concatenation algebra,[2] and it may have further algebraic structure. We assume that each level contains set theory, so that among the objects constructible in any given level we may have strings, sequences and classes of strings, etc. On each level $\underline{\underline{L}}$ we construct a set of $\underline{\underline{L}}$-markers. These are objects of some sort, each of which is associated with a single grammatical utterance. The $\underline{\underline{L}}$-marker of an utterance must contain within it all information relevant to describing the structure of this utterance on the level $\underline{\underline{L}}$. In linguistic theory we must provide the means for reconstructing from the grammar the $\underline{\underline{L}}$-markers of each utterance, for each level $\underline{\underline{L}}$. That is, given the grammar, we

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[2]The general notion of linguistic level is discussed in chapter II, [Logical], in a form which was heavily influenced by an unpublished paper by Henry Hiż, entitled "Positional Algebras and Structural Linguistics". Cf. Quine, Mathematical Logic, Cambridge, 1940, chapter VII, and Rosenbloom, Elements of Mathematical Logic, New York, 1950, Appendix 2, p. 189, for approaches to concatenation theory which also influenced the form of the construction of the abstract notion of level in chapter II.

must be able to reconstruct the set of underlying algebras that give the structure of the language. Each of these algebras underlying a given language must be an interpretation of one of the abstract levels constructed in linguistic theory. The set of markers on the level $\underline{\underline{L}}$ we denote "μ^{L}".

The conditions of compatibility among levels can be stated as mappings of one level into another. In particular, each level $\underline{\underline{L}}$ is provided with a mapping Φ^{L} which carries $\underline{\underline{L}}$-markers into grammatical utterances. Suppose that Φ^{L} maps an element of $\underline{\underline{L}}$ into the identity element (denoted "$\underline{U}$", on each level). Then the mapped element is called a "zero element" and is denoted "$\underline{\emptyset}$". Suppose that Φ^{L} maps two markers into the same utterance. Then we have a case of constructional homonymity; the image utterance is structurally ambiguous on the level $\underline{\underline{L}}$. Each linguistic level provides a certain point of view from which we can investigate and describe the structure of the set of grammatical utterances. Each grammar is based on a set of compatible levels, which can be reconstructed from the grammar. We determine the proper interpretation of linguistic theory for a given language as the set of levels reconstructed from the simplest grammar of the language (in a sense of "simplicity" which it is one of the tasks of linguistic theory to define).

In chapters I-V, [Logical], these notions are applied to the lower levels of phonemics, morphology, and analysis into words and syntactic categories. We now assume that on

the basis of this application, we can construct a first approximation (denoted "Gr(W)") to the set of grammatical strings of words. This first approximation is extended and refined by utilizing the descriptive potential of the level $\underline{\underline{P}}$ of phrase structure. In chapter VI, [Logical], the level of phrase structure (i.e., the set of techniques of constituent analysis) is developed in detail, and in chapter VII, this abstract theory is applied to the description of English syntax.

The major conclusion reached in this application of the abstract theory of phrase structure to English syntax is that up to a point, the level $\underline{\underline{P}}$ provides an adequate theoretical basis for syntactic analysis, but that this theory breaks down if we attempt to provide a direct description of phrase structure for all grammatical sentences. Such an attempt not only leads to extreme systematic complexity in the formulation of the grammar, but also to many counter-intuitive analyses. Thus the level of phrase structure (or constituent analysis) is an adequate underlying algebra for syntactic description only if the set of sentences to be described is artificially and arbitrarily limited. The procedures of transformational analysis which we will discuss below are designed to remedy the inadequacies which appear in a rigorous application of the familiar levels of linguistic analysis to actual linguistic material.

Briefly, then, the problem of syntactic analysis is to determine and describe the membership of the class μ^W of grammatical strings of words (where $\underline{\underline{W}}$ is the level of words), given the class Gr(W) which is provided by lower levels as a first approximation to this set. And the goal of a grammar is to generate exactly this set in a mechanical way. Given μ^W, there are trivial ways to meet this requirement. For instance, the set of sentences of books in the New York Public Library (with obvious qualifications) is probably a fairly good approximation to the set μ^W. But the purpose of a linguistic grammar is to rebuild the vast complexity of the language more elegantly and systematically by extracting the contribution to this complexity of the various linguistic levels. And in linguistic theory, we face the problem of constructing each level in an abstract manner, so that we can systematically develop a characterization of μ^W for any given language by interpreting the abstract formalism of linguistic theory for the corpus of observed sentences of this language. The system of levels of linguistic theory not only provides the means for giving a simplified description for this enormously complex set of grammatical sentences, but also for determining the bounds of this set in the first place. Thus the New York Public Library contains an approximation not to μ^W itself, but only to that part of it that the linguist might ever come in contact with. But a linguistic grammar must answer further questions which cannot be dealt with by this trivial 'grammar',

e.g., how can a speaker generate new sentences? (Cf. §24.2, [Logical]).

Clear examples of this systematic and piecemeal reconstruction of the complexity of language appear in chapter VI, [Logical]. A straightforward characterization of μ^W could be achieved if the level $\underline{\underline{P}}$ of phrase structure were taken as simply $\underline{\underline{W}}$, with the element Sentence adjoined, and if a derivation were defined as a sequence (Sentence, X), where X is a member of μ^W. The set of such derivations would provide a complete grammar. But it is clear that an enormous simplification in the characterization of μ^W is achieved when we develop a notion of derivation in terms of which μ^W can be developed stepwise, with the higher level similarities between members of μ^W marked in terms of phrase structure. Similarly, we can develop a more systematic and workable notion of constituent by requiring non-overlap of constituents (relative to a given interpretation of a sentence); and we can recover the original complexity by assigning alternative $\underline{\underline{P}}$-markers ('interpretations') to certain strings, where special and statable circumstances dictate this multiple assignment. In chapter VII, [Logical], it is shown that when we interpret the abstract levels in the prescribed manner so as to lead to the simplest grammar, there are, in specific instances, correspondences with strong intuition about language structure. This result may be interpreted as giving an explanation, in terms of a theory of linguistic structure, for these intuitions of the native speaker.

In other words, suppose that we had constructed only one syntactic level, namely W. We would then be able to represent utterances only as strings of phonemes, morphemes, and words. The result of attempting to construct a grammar in accordance with this limited theory of linguistic structure would have been an enormously complex grammar of completely unmanageable proportions. Furthermore, we would have found that many strong intuitions of the native speaker would be quite unaccounted for. These considerations would have led us to construct a new and higher level P, as a part of linguistic theory.

Having constructed P, we must investigate the extent of its success in resolving these two difficulties. That there is a considerable degree of success is evident from the results in chapter VII, [Logical]. But it appears, in the course of working out the interpretation of P for English, that both types of inadequacy remain. All but the simplest sentences must be excluded if we wish to achieve anything near an 'optimal' grammar in which each rule applies when just the relevant specification of strings has been given and in which what is essentially a single rule of selection need not be repeated in several different forms for the various cases. In chapter VII, [Logical], it is shown that any attempt to introduce more complex sentences not only leads to overwhelming complexities (which, incidentally, threaten to distort seriously the simple

and adequate picture of the simple sentences) in the formulation of the grammar, but also appears to favor analyses that are in sharp contradiction to strong intuition.

We might, then, seek to amend P, perhaps along the lines suggested in §66.2 and §69.2, [Logical]. Alternatively, for exactly the reasons that led to the establishment of P in the first place, we might attempt to construct a new level of linguistic structure in terms of which utterances can be described. An investigation of the specific shortcomings of familiar syntactic theory will, I think, favor the latter course. We will now proceed to survey some of the problems that this theory leaves unresolved.

2.1 There are cases where similar strings have intuitively quite different interpretations, but where we can discover no grounds, on any of our present levels, for assigning different markers to them. For instance,

(1) This picture was painted by a real artist

(2) This picture was painted by a new technique

are quite different sorts of sentences. (3) lends itself to either interpretation.

(3) John was frightened by the new methods.

This can mean, roughly, "John is a conservative -- new methods frighten him." Or it can have the sense of "new methods of

frightening people were used to frighten John" (an interpretation which would be the normal one in the case of ("John was being frightened by the new methods"). Introspecting, the two interpretations seem to involve a difference of construction. In the first case, "methods" is the 'subject' (as is "artist" in (1)); in the second, it seems to be the noun of a prepositional phrase expressing means (as in "technique" in (2)).

(4) differs intuitively from (5) in the same way that (1) differs from (2).

(4) The escaped prisoner was caught by the police.

(5)(a) The escaped prisoner was caught by the railroad tracks.
(b) The escaped prisoner was caught by ten o'clock.

(6), much like (3), is ambiguous, being subject to the interpretations of either (4) or (5a).

(6) The man was killed by the car.

In the intuitive conception, then, (1) and (4) are classed together as opposed to (2) and (5), the distinction being some feature of construction. (A subsidiary three-way distinction within the group (2), (5a), (5b) apparently has to do with the meaning of "by", and need not concern us in our investigation of the adequacy of a grammatical theory.) (3) and (6) seem intuitively to be cases of constructional homonymity, cases of overlap of opposed structural patterns.

Yet (1)-(6) are all instances of the pattern NP - was - A - PP (cf. §62.2-3 and statements 3, 5, 17, and 18, §67.2 [Logical]). A theory of selectional relations might be of some help here. A detailed account of statement 18, §67.2 [Logical], would reveal that the PP in (2) and (5) is of a type that need not be stated as a conditioning context in statement 18,[3] whereas the PP of (1) and (4) must be stated there. But even if this distinction can be developed in some systematic way, it will apparently class (3) and (6) along with (2) and (5), rather than as ambiguous sentences. Furthermore there are many potential trouble spots in this approach (cf. §66.2, [Logical]). Finally, such an approach will provide no explanation for the 'verbal force' of "paint", "frighten", "catch", "kill" in (1)-(6), or of "tire" in

(7) John was tired by the unusually hard work.

as compared with the non-verbal character of "tire" in (8) or of "bore" in (9)

(8) John was tired by evening.

(9) John was bored by that time.

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[3]Further investigation of grammaticalness might wipe out even this distinction if, e.g., such sentences as "the factory was owned by a new technique", "the factory was owned by the railroad tracks", are excluded as not fully grammatical.

Note further that such sentences as (10) are intuitively cases of constructional homonymity, in a different way than are (3) and (6).

(10) $\left\{\begin{matrix}a\\b\\c\end{matrix}\right\}$ John was $\left\{\begin{matrix}\text{frightened}\\\text{surprised}\\\text{bored}\end{matrix}\right.$

E.g., in (10a), "frightened" can be 'verbal' as in either interpretation of (3) or in "he was once frightened by a mad dog," or it can be 'adjectival' as in the interpretation of "John was obviously very frightened." But in all of these cases, we are compelled simply to classify these V^en forms in a single way, as a certain subclass of adjectives.

There is thus a complex of intuitively quite different structural patterns, overlapping in cases of constructional homonymity, but with no counterpart in the rigorous application of our present theory.

There are other instances of intuitively felt difference in structure that are not properly accounted for in the application of the theory of syntactic structure as so far developed. Consider the difference in our feeling for the structure of (11) and (12)

(11) The growling of lions ...

(12) The reading of good literature ...