§ 9. GENERATIVE CAPACITY AND ITS LINGUISTIC RELEVANCE

It may be useful to make one additional methodological observation in connection with the topics discussed in the last few sections. Given a descriptive theory of language structure,[34] we can distinguish its *weak generative capacity* from its *strong generative capacity* in the following way. Let us say that a grammar *weakly generates* a set of sentences and that it *strongly generates* a set of structural descriptions (recall that each structural description uniquely specifies a sentence, but not necessarily conversely), where both weak and strong generation are determined by the procedure f of (12iv) = (13iv) = (14iv). Suppose that the linguistic theory T provides the class of grammars $G_1, G_2, \cdots$, where G_i weakly generates the language L_i and strongly generates the system of structural descriptions Σ_i. Then the class $\{L_1, L_2, \cdots\}$ constitutes the *weak generative capacity* of T and the class $\{\Sigma_1, \Sigma_2, \cdots\}$ constitutes the *strong generative capacity* of T.[35]

The study of strong generative capacity is related to the study of descriptive adequacy, in the sense defined. A grammar is descriptively adequate if it strongly generates the correct set of structural descriptions. A theory is descriptively adequate if its strong generative capacity includes the system of structural descriptions for each natural language; otherwise, it is descriptively inadequate. Thus inadequacy of strong generative capacity, on empirical grounds, shows that a theory of language is seriously defective. As we have observed, however, a theory of language that appears to be empirically adequate in terms of strong generative capacity is not necessarily of any particular theoretical interest, since the crucial question of explanatory adequacy goes beyond any consideration of strong generative capacity.

The study of weak generative capacity is of rather marginal linguistic interest. It is important only in those cases where some proposed theory fails even in weak generative capacity — that is, where there is some natural language even the *sentences* of which cannot be enumerated by any grammar permitted by this theory. In fact, it has been shown that certain fairly elementary

theories (in particular, the theory of context-free phrase-structure grammar and the even weaker theory of finite-state grammar) do not have the weak generative capacity required for the description of natural language, and thus fail empirical tests of adequacy in a particularly surprising way.[36] From this observation we must conclude that as linguistic theory progresses to a more adequate conception of grammatical structure, it will have to permit devices with a weak generative capacity that differs, in certain respects, from that of these severely defective systems.

It is important to note, however, that the fundamental defect of these systems is not their limitation in weak generative capacity but rather their many inadequacies in strong generative capacity. Postal's demonstration that the theory of context-free grammar (simple phrase-structure grammar) fails in weak generative capacity was preceded by over a half-dozen years of discussion of the strong generative capacity of this theory, which showed conclusively that it cannot achieve descriptive adequacy. Furthermore, these limitations in strong generative capacity carry over to the theory of context-sensitive phrase-structure grammar, which probably does not fail in weak generative capacity. Presumably, discussion of weak generative capacity marks only a very early and primitive stage of the study of generative grammar. Questions of real linguistic interest arise only when strong generative capacity (descriptive adequacy) and, more important, explanatory adequacy become the focus of discussion.

As observed earlier, the critical factor in the development of a fully adequate theory is the limitation of the class of possible grammars. Clearly, this limitation must be such as to meet empirical conditions on strong (and, a fortiori, weak) generative capacity, and, furthermore, such as to permit the condition of explanatory adequacy to be met when an appropriate evaluation measure is developed. But beyond this, the problem is to impose sufficient structure on the schema that defines "generative grammar" so that relatively few hypotheses will have to be tested by the evaluation measure, given primary linguistic data. We want the hypotheses compatible with fixed data to be "scattered" in value, so that choice among them can be made relatively easily.

This requirement of "feasibility" is the major empirical constraint on a theory, once the conditions of descriptive and explanatory adequacy are met. It is important to keep the requirements of explanatory adequacy and feasibility in mind when weak and strong generative capacities of theories are studied as mathematical questions. Thus one can construct hierarchies of grammatical theories in terms of weak and strong generative capacity, but it is important to bear in mind that these hierarchies do *not* necessarily correspond to what is probably the empirically most significant dimension of increasing power of linguistic theory. This dimension is presumably to be defined in terms of the scattering in value of grammars compatible with fixed data. Along this empirically significant dimension, we should like to accept the least "powerful" theory that is empirically adequate. It might conceivably turn out that this theory is extremely powerful (perhaps even universal, that is, equivalent in generative capacity to the theory of Turing machines)[37] along the dimension of weak generative capacity, and even along the dimension of strong generative capacity. It will not necessarily follow that it is very powerful (and hence to be discounted) in the dimension which is ultimately of real empirical significance.

In brief, mathematical study of formal properties of grammars is, very likely, an area of linguistics of great potential. It has already provided some insight into questions of empirical interest and will perhaps some day provide much deeper insights. But it is important to realize that the questions presently being studied are primarily determined by feasibility of mathematical study, and it is important not to confuse this with the question of empirical significance.