CHAPTER 2

Three Sorts of Generative Devices

To describe a language as a linguist, then, is to specify the software of a device that will generate the strings of terminal symbols (words) that are the sentences of the language and, at the same time, to provide a structural description of these sentences. Doing this is part of specifying competence in a particular language; it is not specifying the complicated mixture of linguistic and nonlinguistic talents that people call upon in actual conversation nor is it indicating the actual character of the hardware employed. Recalling the Scrabble® Sentence Cube Game, our problem is to specify a device that will generate all and only the moves that might be made, given the (terminal) vocabulary of English, plus the nonterminal vocabulary of syntactical categories (VP, NP, N, Adj., and so on), and a set of rules. Whatever our linguistic hardware is it cannot be simpler, or less powerful, than that of the simplest device that can generate (and thus structurally describe) these sentences. The investigation will not tell us what human linguistic hardware actually is; but it will tell us, in a general sort of way, what the mind must be powerful enough to do—just as any computing machine that can add numbers must be capable of certain extremely simple operations, however complex its actual hardware may be.

I Finite-State Grammars

In the last chapter I briefly described finite-state devices as those that had only a terminal vocabulary and had only a finite number of internal states. At “start” the device is in one of its finite states, then it switches to its next state by following an arrow to a box from which it randomly selects a (terminal) vocabulary item, the beginning of its output. So it proceeds, following the arrows and switching from state to state by printing out items in a string, until it reaches “stop.”

There are two sorts of finite-state devices: those without “loops” that allow the device to return to a previous state, and those that have such loops. If a device lacks loops, it will soon run through all of the boxes that the arrows allow it to travel through. Hence it can generate only strings that are no longer than the number of boxes (at best). With loops, indefinitely longer sentences may be generated, but the device is still a finite-state device. Why? Because the device proceeds in exactly the same way whichever state it is in (whichever box it is approaching), no matter what its previous states have been—it is not part of its state to know what its previous states have been. It does not “remember,” for example, how many times it has been back to a previous state by looping. If it did “remember,” then it would have as many states as the number of times it could loop back (which has no definite limit and hence one would no longer have a finite-state device).

In Syntactic Structures Chomsky considered a finite-state device without loops that could generate two strings—the man comes, and the men come. He changed it to a finite-state device with loops by adding a loop, which provided the vocabulary item old, at the node after the, thus recursively generating the old man comes, the old old man comes, the old old old man comes, and so on. Another example is shown in Figure 6 (p. 74). Whether or not we ignore the loops, the device of Figure 6 has as many states (twenty-three) as boxes. If we treat it as a loopless device, the longest sentence it could generate would be eight words long: for example, the old man has seen the old men, the old God has loved the visible worlds, these colorless men have seen my old father. With loops, longer sentences are possible. And, of course, we can have sentences that are shorter: the invisible God created the visible world, my father loves that colorless idea, this man created furiously. It will also generate queer sentences which seem meaningless but which none the less are grammatical, at least by comparison with clearly ungrammatical strings. For example, the sentence colorless green ideas sleep furiously—which the finite-state device shown in Figure 6 generates exactly as it does the sentences colorless old
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men love furiously or the old man created furiously—does not seem to have a meaning; but it does seem to preserve grammatical structure in a way that is not done by sentences like furiously sleep ideas green colorless or colorless green idea sleep furiously (neither of which can be generated by the finite-state device of Figure 6).

There are two crucial questions one wants to ask about finite-state grammatical devices: (1) Why might someone consider human languages to be finite state languages? That is, if English were, for example, a finite-state language, what (if anything) might this fact imply about the mental processes of people who are linguistically competent users of English? (2) What proof—in a reasonably strict sense of proof—has Chomsky provided that English and other human languages cannot be finite-state languages? But before considering these major issues there are two preliminary points that I want to make.

The first point is that we could construct a finite-state diagram—a version of the one diagrammed in Figure 6—that would provide a more restricted simulation of grammaticality. One might call Figure 6 a “liberal” grammar in that it does generate semigrammatical sentences, or what I called “queer” sentences in the second to the last paragraph. The question is, in various ways, a matter of degree. The strings furious sleep ideas green colorless or green sleeps father old my are obviously ungrammatical. And strings such as the men come and the man comes are obviously grammatical. Most of us would feel, however, some uncertainty if asked whether colorless green ideas sleep furiously is a full-fledged grammatical English sentence. In Syntactic Structures (1957) Chomsky operated under “liberal” assumptions. He was interested in devices that would generate such more-or-less grammatical, though meaningless, sentences as colorless green ideas sleep furiously: sentences which might be called poetic, or metaphorical, or syntactically well-formed but senseless. In Aspects of the Theory of Syntax (1965) Chomsky was interested in developing an improved and more powerful, but also more restricted, syntax, one which would mark colorless green ideas sleep furiously as ungrammatical (still more recently, Chomsky and many generative linguists have
more or less reverted to the view that this sentence is grammatical, though it is now explicitly labeled as meaningless, or semantically malformed, by a "semantic component" that was lacking from his first grammars).

These changes can be misunderstood. It is not so much that linguists keep on changing their intuitions about this and similar sentences; rather, it has been more a question of finding different (hopefully more complete and more adequate!) ways of capturing and explaining such intuitions in a general, explicit, and formal manner. The reader may recall my first discussion of the sentence (on page 31), where I made the point that it was a borderline case. There I commented that if one wanted to say flatly that the sentence is ungrammatical (because meaningless), one would be confronted with a range of odd, illogical, or senseless sentences, and somewhere one would have to draw lines. Very recent work has been much concerned with the feasibility of drawing such lines. But—and this is the point to remember now—this has not been a matter of distinguishing finite-state, phrase-structure, and transformational grammars: for practical purposes any of these could be formulated so as to mark such odd sentences as grammatical or formulated so as to mark them as ungrammatical.

The second preliminary point is that I could easily have added boxes in such a way that they would generate the conjunctive sentence I have considered at length in the previous chapter. The device in Figure 6 now generates my father loves old men. Obviously I could add another box, with and and similar words in it, with a route from the second box with plural nouns that would lead to the new "conjunction" box and back to that second plural noun box. However, we would have to add three other identical new boxes for each of the noun boxes. We could not, in other words, draw routes from each of the four noun boxes to the "conjunction" box and back again because one might then return not to the noun box one started with but to another, thus creating an ungrammatical string. For example, one could then form *my father loves old men and idea by moving from the "conjunction" box to the second singular noun box, not back to the second plural box. Of course, someone might say that we could have just one "conjunction" box but write it
ture grammars, not just beyond the even more restricted power of finite-state devices.

The reason Chomsky felt the need to criticize finite-state device grammars of the specific sort we have been considering is twofold: (1) Such a view of language seemed the natural result of information theory, a sophisticated mathematical model of communication that developed from World War II studies of telecommunication systems—and which deeply impressed psychologists and linguists in the 1950’s. Hence the model was a natural candidate for consideration, and the generality and sophistication of the model made some feel it was the only candidate. (2) The view of language processing that was suggested by such a model fitted well with the behaviorist preconceptions that dominated experimental psychology through much of this century and particularly during the 1950’s. Hence this view was one that Chomsky found natural to attack.

Still, either in conversation with Chomsky or in reading his works, it would be hard to say to what degree Chomsky came to oppose behaviorism because it suggested inadequate language models and to what degree he came to oppose such models because they realized behaviorism. Some critics, who feel they certainly must accept much of Chomsky’s linguistic work but who feel deeply committed to behaviorism, or feel that such “philosophic” issues are somehow irrelevant, argue that Chomsky’s “important and solid” contributions to knowledge came in his early work, which they happily find unaffected by the views about psychology that they associate with his later work. But I think a close reading of Syntactic Structures, and of the much longer unpublished work from which Syntactic Structures derives, shows that Chomsky’s opposition to behaviorism was present from the start. Behind this biographical debate lies a more crucial issue: can the contributions to linguistic theory be clearly and cleanly separated from the views about psychology? Can one buy the first without some commitment to the second? Chomsky’s answer, of course, is no. There is, in his view, comparatively little of interest in a study of grammar that will show nothing whatsoever about human psychology; moreover, with such limits, adequate grammatical characterization of a human

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language simply cannot be achieved—which is the essence of Chomsky’s criticism of linguistic structuralism.

Information theory began in the military concern with tele-communications: with the need to ensure accuracy, efficiency, and secrecy in communication channels, which meant balancing the need to repeat parts of messages (redundancy) in order to cope with distorting noise in the channel, against the need to be brief (since redundancy is extremely helpful to code breakers and, in any case, redundant messages are more expensive to send). In the telegraph, the earliest and simplest form of telecommunication, messages are realized simply as alternating bursts of electricity in a wire. The only choices are between power on and power off at any given moment, so the message might be diagrammed as a series of dots and blanks that make up a line moving from left to right across the page. At each point, the choice between power on and power off may be thought of as a “bit” of information, a choice between two possible pathways, and possible messages may be more fully diagrammed as a tree whose trunk branches in two, and each branch in two once more, and so on across the page. Our finite-state grammar is a development of this notion with branching represented as a choice between taking the arrowed path to one box or the other, proceeding from left to right across the page (the choice between words within boxes could also be represented by branching but this choice is random and unstructured from the point of view of syntax, specifically in that no syntactical rules restrict the choice—hence one does not need to diagram it in a finite-state grammar).

Information theory assumes that information implies choice between pathways; if only one path can be taken, we gain no information when it is taken. The amount of information is proportionate to the improbability, or unpredictability, of the choice made. If there is no choice—if, for example, there is only one pathway that may be taken from one box to the next, so that the next (and completely predictable) step could be said to have a probability of 100 percent—there is redundancy, and, from the theoretical viewpoint of information theory, no information is conveyed by the step.

As we have seen, syntax has nothing to do with probability of
occurrence. Many syntactically malformed strings of words do occur with some frequency and many perfectly well-formed sentences have a vanishingly small chance of occurrence. As Chomsky interpreted the information theoretic viewpoint in *Syntactic Structures*, the information, or meaning, of a sentence message would be determined by the various improbabilities associated with each “choice” of a new state in the finite-state device. But syntax, or grammaticality in the strict sense, would have nothing to do with such probabilities. Syntax, as displayed in a finite-state device, would simply indicate what steps, and so what sentences, are possible, whatever their probability. Our grammatical device cannot “choose” ungrammatical strings; hence no information is produced by its generation of any grammatical, as opposed to any ungrammatical, string. The finite-state syntactical device would, that is, lay down the framework of possibilities within which probabilities might be determined.

We now have before us the rudiments of a theoretic model of linguistic production and understanding. It would seem to suggest something about the psychology of language use. Though Chomsky has little to say in detail about how such a model might be suggestive in this way, there are some obvious possibilities.

Consider, first, what the model might suggest about how people hear, or hear and understand, sentences. Leaving aside the conversion of sounds into words, contextual clues, and so on, one might imagine the hearer taking in the first word of the sentence (among all the words which his knowledge of syntax tells him might begin a sentence). His syntactical knowledge now tells him that various words are possible second choices, and his semantic knowledge assigns various “information weightings” to these possible choices. The second word is heard and the process continues. In those cases where there is no choice, his linguistic knowledge, his “internalized” finite-state device, will lead him to expect and hear the only possible continuation. Equally, if the hearer’s sense of probabilities makes only one continuation of the sentence at all probable, the hearer’s semantic knowledge allows him to infer, to leap ahead to the end of the sentence. Of course, little of this is a conscious, or clearly conscious, process, any more than most of the compli-

cated maneuvers of daily cognitive life, and this fact does make the use of words like *knowledge* and *infer* subject to criticism, but I will defer a direct and full consideration of this issue until the next chapter. Certainly people do have expectations as they hear sentences, in the sense that they may be very startled by the frustration of their expectations in plays on words, errors, and so on, though they are not conscious of these expectations until and unless they are frustrated.

So far as the speaker’s construction of sentences goes, this sort of model might suggest a somewhat different treatment. While this suggestion might be discounted in the case of the hearer, it is not easy to resist the feeling that a speaker often (always?) has “something in mind” that he wants to say before he starts to construct a specific sentence—“something in mind” that will affect the manner of sentence construction. Whether our scruples are correct or not is not an easy question to answer.

But we can set this question aside in that we might simply imagine our speaker playing the Scrabble® word game. In such a case we could think of him as selecting any first word (that could begin a sentence), then selecting one of the possible second steps, and so on. His ability to construct English sentences (without concern with meaning, use in particular social situations, and so on) could then, one might hope, be represented generatively by a finite-state syntactical device. As one went on to consider all the semantic, contextual, and other factors that enter into everyday speech situations, these factors might be though of as interacting with this basic syntactical ability, with an intellectual capacity that could be explained as an internalization of the finite-state device. Were English a finite state language (that is, one whose sentences could be generated by a finite-state device), then someone who exhibits a basic grammatical grasp of the language, whether in the multi-faceted situations of everyday language use or in the simple game situation, could be said to have the finite-state “software” in question.

How this “software” is realized in the actual “hardware” of the brain is another question. But knowing what the “software” is will help guide the investigation of the physiological “hardware.” Indeed, it would seem as silly to investigate the brain’s
enormously complicated neurological “hardware” without a
very good idea of its functioning “software” as it would be to
try to understand the innards of an electronic computer without
knowing any logic or mathematics. It would be sillier, in fact,
because computers are in no way as miniaturized and as
adaptable as the human brain.

One notes that so far as syntactical knowledge alone goes,
one might not need separate models for speaker and hearer. In
both situations we would seem to make use of the same knowl-
edge, the same linguistic competence. Throughout his work
Chomsky has stuck to this “neutrality” between speaker’s and
hearer’s syntactical knowledge. The factors of actual speech
performance are conceived as additions to this core of gram-
matical knowledge. But in three respects finite-state grammars,
with or without recursive “loops,” differ from Chomsky’s other,
more powerful, models. First, sentences are generated “left to
right”: first word, second word, and so on to the final word.
Secondly, there are no nonterminal symbols involved, which
means in effect that the device provides no structural descrip-
tions of sentences, and, presumably, it also means that such
parsing belongs outside the knowledge of the ordinary com-
petent speaker. Thirdly, the device is finite-state, having as many
internal states as it has boxes.

Such devices have a great deal of simplicity and they lend
themselves to information-theoretic-characterization in the way
that has been sketched. By being relatively simple they also
have an appeal to the behaviorist.

Though behaviorism is a loose collection of partially related
views rather than a fixed position, one point on which any
behaviorist would agree is that human psychology should fix
upon an unprejudiced description of human behavior, particu-
larly a study of how, and within what limits, “programs of re-
forcement” (to use B. F. Skinner’s favored vocabulary) will
change behavior, or “teach” new behavior, in much the same
general sort of way that it will affect animals whose perceptual
apparatus is at least relatively similar to man’s. In all respects
possible, the postulating of any sort of complicated, abstract,
internal processes is to be avoided, certainly insofar as such
talk cannot be reformulated in purely behavioral terms. Be-

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haviorism, that is, is opposed to mentalism. The ideal descrip-
tion, from such a behaviorist viewpoint, is one which charac-
terizes the experimental subject in “stimulus-response” terms.
Such and such a stimulus will be followed by such and such a
behavioral response; more fully, such and such a “program of
reinforcement” for spontaneous behavior will put the experi-
"mental subject in a condition such that new stimulus-response
sequences are “learned.” The ideal, in other words, is control
and predictability. The psychologist “understands” a form of
behavior if he is able to control it, that is, to reinforce or eradi-
cate it.

But finite-state syntactical devices have more specific attrac-
tive features for the behaviorist than simplicity. The left to
right generation of sentences appeals because it suggests that
one might think of the first word as a stimulus which past experi-
ence (past “programs of reinforcement”) causes the “subject”
to “respond” by expecting, or adopting, various second words,
and so on. If a grammar indicates only one path, the stimulus
could be said to lead to one fixed response, whereas if there is
more than one path, this might be regarded as a complex,
weighted response. For an animal example, one might dis-
tinguish the simple case in which a rat has learned that only
one particular path will get him through a maze, and so uni-
formly responds by taking that path, from a complex case where
the rat may have learned that a left turn works a bit better than
a right turn, and both work better than a straight path, though
all three have some probability of working.

The lack of nonterminal symbols is similarly suggestive.
Whether one regards each word (each state) as a stimulus that
leads, with weighted probabilities, to a response, or at a more
general level regards the string of words as a response to situ-
tional stimuli, there is no suggestion of mentalistic states, or
abstractions, that are not realized in explicit sensory events,
that is, in what is heard or characterized in terms of observed
behavior. If English is a finite-state language, it will be reason-
able to suppose that the ordinary competent speaker-hearer of
English need have nothing more stored in his thinking apparatus
than particular words that he has actually heard or seen and
various associations between them which are also derived from sequences that he has actually heard or seen.

This point may well remind one of the general empiricist tradition from which behaviorism derived. An eighteenth-century empiricist like David Hume maintained that our ideas were essentially copies, or manipulated memories, of our sensory experiences, as opposed to the rationalists who maintained that the human mind was not so much a passive receiver of sensations, which it could copy and assemble by the simple process of association, as a complicated and active structure with innate tendencies to develop various abstract ideas that could not at all be identified with particular associations of experience (could not be identified, that is, with what is, or can be, seen or heard or otherwise sensed, such as terminal symbols).

Of course, this whole traditional debate about ideas between empiricists and rationalists has been criticized as too fuzzy to allow hopes for a very clear solution, or experimental or logical resolution; and the debate has subdivided in various ways since the eighteenth century. But it is not hard to see that Chomsky has found a way of narrowing the issue. If it can be shown that a generative device that can generate the sentences of English (considered for the moment just as strings of words) must employ nonterminal symbols, then this suggests some credit for the rationalist position—within, one must remember, this particular way of narrowing the issue.

By nonterminal symbol I have in mind, of course, terms such as Verb, NP, VP, which I introduced in discussing phrase structure, or rewrite, grammars. These were nonterminal in the sense that they did not appear in the sentences generated by such grammars—the derivation of a sentence is incomplete if any nonterminal symbols remain. Of course these symbols do occur in the sentences that grammarians construct when they write about languages; they are not, in that sense, nonterminal symbols in the grammarian's language, as opposed to the language he writes about.

But the point about mentalism, about the need for ideas that are not at all directly realized in experience, still remains. It remains because someone may have an essentially adequate grasp of English without knowing the grammarian's technical terminology. There is a clear sense in which such an individual can be said to internalize a knowledge of these grammatical notions though he has no name for them (that is, he has no terminal symbol for them available). He can be said to internalize these notions if English is (at least) a phrase-structure-rule, or rewrite-rule, language. Though we shall have a definite proof of this shortly, it would seem intuitively evident that people, who lack the grammarian's technical terminology, constantly exhibit tacit use of nonterminal categories. This is simply to say, for example, that such people, in judging the grammaticality of unfamiliar, or even meaningless, sentences (or in finding completions for unfinished sentences) constantly exhibit an understanding that certain word combinations are acceptable (or unacceptable) because they present (or do not) a familiar and acceptable combination of grammatical categories. The familiar example—colorless green ideas sleep furiously—is recognized as "sounding like English" by someone with no technical grammatical vocabulary simply because it has the same abstract character (makes use of the same nonterminal symbols in its generations) as colorless old men love furiously, scruffy street cats yowl horribly, filthy rich capitalists shout savagely, mindless red bureaucrats rule rapaciously. In sense, the actual symbols we have chosen for these abstractions are irrelevant: Verb, NP, VP, and so on are also our terminal-symbol names for the nonterminal symbols whose purely abstract character derives from the functioning of the grammatical device that we internalize in our capacity to speak and understand English. (Hence, as Chomsky has often observed, the selection and definition of the vocabulary of descriptive linguistics, of terms such as phoneme and morpheme as well as the ones we have mentioned, cannot be carried out without making various presumptions about human psychology.)

The importance of deciding whether a device adequate to the generation of English would make use of nonterminal symbols rests in the light this might cast on the question whether our minds essentially must make use of nonterminal abstractions. Much could be said about the proper formulation of this point. But it is clear that a behaviorist view of human psychology would be strengthened if it were established that English could
be generated by a grammatical device employing only terminal symbols. Equally, to show that English is not such a language would seem to support mentalism in suggesting that the human mind makes essential use of abstractions, that is, of concepts which operate without needing to be named and without appearing to the senses in any direct way whatsoever, much less being simple copies of something seen or heard as opposed to essentially internal concepts that function crucially in the mind's acquisition of language.

Much the same general point seems at stake in the question as to whether a finite-state device, pure and simple, is adequate to the generation of the English language. Consider first a finite-state device without loops. Such a device would only produce a finite number of sentences and, simply by the principle that the number of English sentences is not finite, we know that we must finally reject such a grammar. But still, if it were adequate, this would show that (1) someone could know English simply by memorizing all its sentences without needing any knowledge of how they might be generated (or represented more compactly); that is, his knowledge of his language could simply consist of copies of what he had actually heard or seen; and (2) someone could also know English simply in knowing the finite number of states required to generate all its sentences: in other words, the individual would simply learn each state through actual experience, and in this way he would know, given any state, what state could be selected next in constructing sentences. In the first case, one needs no more powerful mental apparatus than memory; in the second, all one requires is a finite number of learned associations of the simplest sort between words. Both possibilities are easily accommodated in the strictest forms of traditional empiricism. Even with loops, which would mean that (1) could not obtain strictly, (2) clearly still remains. All that is added to mental functioning by the loops is the notion that certain kinds of words may be repeated; but one is still operating with the notion of simple associations ("grooved in" by past experience) between copies of past experiences—a notion that was central to traditional empiricism. In David Hume's vocabulary, the words of English would be learned through our senses as "primary impressions" while habituation

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would provide "secondary impressions" of likely associations between these words.

If English requires a more powerful kind of grammatical device than a finite-state device, then the "software" of the mind must be essentially as powerful as the required device, and this will set a lower limit on the complexity of the actual "hardware." Perhaps, in order to sharpen the discussion, I should now move to the question of how Chomsky proved that English is not a finite-state language.

As an aid in explaining Chomsky's proof that English is not a finite-state language, the proof will first be explained for an artificial "letter-word" language and only then for English itself. The proof depends on showing (1) that certain kinds of sentences—"mirror-image" sentences—can be generated by a phrase-structure, or rewrite-rule, device; (2) that these kinds of sentences are found in some artificial languages and in English; and (3) that these kinds of sentences cannot be generated by a finite-state device. Though the proof is not difficult to grasp and Chomsky lays no great emphasis on it in Syntactic Structures, I am not alone in thinking that it is one of the most striking pieces of reasoning in Chomsky's early work. Here I will just expand on the argument as it appears in Syntactic Structures.

I start by considering two artificial "letter-word" languages, each of which can be generated by two simple phrase-structure, or rewrite, rules. These two kinds of languages appear in the several versions Chomsky has given of the argument. For both languages, II and III, the terminal vocabulary consists of a's and b's, and the nonterminal vocabulary of S's. As usual, the convention is that terminal symbols, which appear in the actual sentences that comprise the language, are lower case, while the nonterminal symbols are capitalized. Language II is generated by the following rules:

\[
(\Pi) \quad (a) \quad S \rightarrow a + b \\
(b) \quad S \rightarrow a + S + b
\]

[These rules could be written as one rule if parentheses are employed to show that use of the nonterminal symbol is optional—in other words, the rule \( S \rightarrow a + (S) + b \) is equivalent to both (\Pia) and (\Pib).]
Language II is an extremely simple language. It consists of \(ab\), \(aabb\), \(aaabbb\), and so on: its sentences include all and only those strings which consist of \(n\) occurrences of \(b\) preceded by \(n\) occurrences of \(a\). After an exposure to a relatively small number of the sentences of this language, one is likely to leap to the simplifying assumption that the language as a whole is generated by rules (IIa) and (IIb). But though this language can be grasped easily, its sentences cannot be given by enumeration. Since an infinite number of strings are generated by these rules, this “language” cannot be given by listing its sentences: they must be generated by rules; there is no way to specify the language except through the software description of a generative device.

Though language II is a very simple language and one which can be generated by two simple rewrite rules, it cannot be generated by a finite-state device. Consider Figure 7.

(A) start \(\rightarrow a\) \(\rightarrow b\) \(\rightarrow\) stop

(B) start \(\rightarrow a\) \(\rightarrow a\) \(\rightarrow b\) \(\rightarrow\) stop

(C) start \(\rightarrow a\) \(\rightarrow a\) \(\rightarrow b\) \(\rightarrow\) stop

(D) start \(\rightarrow a\) \(\rightarrow b\) \(\rightarrow\) stop

**Figure 7**

The state device (7A), with two boxes, generates one string: \(ab\). Device (7B), with two additional boxes, generates two strings: \(ab\) and \(aabb\). Device (7C), with yet two more boxes, generates three strings: \(ab\), \(aabb\), \(aaabbb\). One can proceed in this way as long as one likes, adding two boxes (that is, two more states) each time so as to generate one more string. But since the number of strings in the language is infinite, one will never be able to generate the language by expanding a finite-state device in this way. One would need an infinite number of boxes, an infinite number of device states, to generate all and only those strings that consist of some number of \(a\)'s followed by exactly the same number of \(b\)'s.

It is important to write all and only. If one reflects on what is generated by device (7D), one sees that (7D) generates every string that consists of any positive number of \(a\)'s followed by any positive number of \(b\)'s (for example: \(ab\), \(aabb\), \(aaabbb\), and so on, but also \(abb\), \(abb\), \(aab\), \(aab\), and so on). Device (7D) generates all the sentences of language II. The trouble is that it does not generate only the sentences of language II, and hence it is not the grammar of language II. (Similarly, one could generate all the sentences of English by means of a finite-state device with one box, containing the words of English, with a recursive loop that would allow one to pick any number of additional words before stopping each string. This device would generate all possible combinations of English words and thus would generate not only all grammatical combinations but also all ungrammatical combinations.)

This is an instance of the same limitation in finite-state devices that I have mentioned before. The finite-state device cannot “remember” its previous states—what it can do next is solely determined by the particular state (box) it is in, no matter how many or how few recursive “loopings” the device has undertaken. A device such as (7D) cannot remember how many times \(a\) has been repeated so that it might then allow exactly the same number of \(b\) repeats. The only way to ensure an equal number of \(a\)'s are followed by an equal number of \(b\)'s with a finite-state device is by adding boxes in the manner of (7A) through (7C) and so on; in this case, it is not that the device remembers its previous states but rather that now the machine is in a different state after having produced two \(a\)'s as opposed to one (or three) \(a\)'s.

The only way a finite-state device can make sure that some number of \(a\)'s are followed by the same number of \(b\)'s is by having as many \(a\)-boxes as there are \(a\)'s in the string and as many \(b\)-boxes as there are \(b\)'s. Since we are not supposing that there is any particular limit on the length of the sentences of language II, such a language cannot be generated by a device with a finite
number of internal states of the sort we have considered. In
Figure 7 one finds three finite-state devices that generate some
of the sentences of language II and no nonsentences, and one
finite-state device that generates all the sentences of language
II but also countless nonsentences. But no finite-state device can
generate all and only the sentences of language II; language II
is not a finite-state language.

Next consider language III, generated by rules (IIIa) and
(IIIb), which is composed of all strings consisting of any
string of a's and b's followed by the mirror-image or reversal of
that string (for example, aa, bb, abba, baab, aaaa, bbbb, abbbba,
baaab, and so on.)

(III) (a) \(S \rightarrow a + (S) + a\)
(b) \(S \rightarrow b + (S) + b\)

Some thought will suggest that the attempt to generate language
through a finite-state device will prove to be impossible, and for
essentially the same reason as applied to language II.

For example, one might start with two connected a-boxes,
with a loop from the second back to the first. This will produce
aa, aaaa, aaaa, and so on evenly, which is what is wanted. But
if one then adds a b-box after “start” and then draws a line to the
a-boxes, one will produce the “grammatical” string baa; con-
sequently, one will need to add a nonoptional b-box after the
two a’s. After the two beginning b’s, one will then need another
set of a-boxes, followed by two nonoptional b-boxes. To sum
up: one will need two boxes to get aa, aaaa, aaaa, and so on;
four additional boxes will be needed to get baab, babaab,
babaabaab, and so on; six additional boxes will be needed to get
bbaabbb, bbaababbb, babaabaab, and so on. Obviously all such
strings could not be generated with a finite-state language.

The next step is to show that English (and, for similar reasons,
any natural language) contains similar mirror-image sentences
that require for their generation something more powerful than
the finite-state devices we have been considering. Broadly, what
must be shown is that in many English sentences there are de-
pendencies between words on both sides of an indefinitely ex-
pandable intervening phrase (as with language III, one b must
be followed by one b—which thus depends on the prior b—no

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matter how many a’s intervene; similarly two b’s must be fol-
bowed by two b’s, no matter how many intervening a’s; and so
on). It is not difficult to show that English has sentences of this
sort, that is, sentences which are grammatical in virtue of de-
pendencies between words separated by an indefinite number
of phrases having the proper structure. These dependencies
cannot be specified except through the use of nonterminal sym-
ols, which means through rules that make essential reference
not only to words but to phrase structure above and beyond
simple strings of words.

Consider (25), taking the man who said that as an a and is
arriving today as a b:

(25) The man who said that (S₁) is arriving today

Given that (25) without S₁ is grammatical (that is, ab), it is
also true that if (25) replaces S₁, we still have a grammatical
string (aabb); and it does not seem wrong to see the process of
construction as continuing indefinitely, though the sentences
will sound long and a little silly after a time. Thus, the man who
said that—the man who said that is arriving today—is arriving
today is a sentence, and so on. Similarly, someone who knows
that is here (ab) is a sentence; someone who knows that—some-
one who knows that is here—someone who knows that is here—is
here (aabb) is a sentence; and someone who knows that—someone
who knows that—someone who knows that—someone who
knows that is here—someone who knows that is here—is here (aabbb)
is also a sentence, and so on. Or, again, the man knows (ab), the man
the man knows (aabb), the man the man the man knows
knows (aaabb), and so on are all sentences. Of course
this central embedding of identical sentences is not at all com-
mon in English. It is more common to embed nonidentical
sentences of similar structure. Sentences, that is, corresponding
to cabd, ecabdf, gecabdfh, where ab, cd, ef, gh are all abstractly
of the form X + Y and may be embedded within each other by
the rule, \(S \rightarrow X + (X + Y) + Y\). In such cases one still finds
the dependency (between symbols on either side of an in-
definitely expandable phrase structure) that left to right finite-
state devices cannot handle.

I: is, of course, much much more common in English for such
recursive maneuvers to require the deletion, proonominalization
of repeated phrases, and so on. For example, recalling the conjunction problem, if one takes my father loves old men (acb) and my father hates old men (aeb), one can put them together producing my father loves and hates old men only by deleting repetitions of my father (a) and old men (b). The sentence ac and eb, formed from the underlying acb and aeb, has the sort of dependency that rules out finite-state generation. But the notion of underlying structure and deletion already presupposes something more powerful than a finite-state machine and is unnecessarily contentious. Hence, Chomsky chose to make his case for the inadequacy of finite-state devices through appeal to the relatively uncommon cases of embedding in which no deletion is involved.

One can give many more examples of English sentences similar to the mirror-image sentences of language III. In Syntactic Structures, Chomsky uses (25) plus (26) and (27) (with minor changes in notation):

(26) If $S_7$, then $S_8$

(27) Either $S_4$, or $S_5$

Chomsky points out the dependencies of the three sentences: then must always follow if, or must follow either, and is must follow man, and these dependencies hold no matter what the intervening sentence (which may be itself (25), (26), or (27)). Thus, in (25), taking $S_1$ to be (26) and $S_2$ to be (27), we get:

(28) The man who said that if, either $S_4$ or $S_5$, then $S_6$, is arriving (in effect, acefbd)

And so it becomes clear that in English we can have a sequence of the form $a + S_1 + b$ where $a$ and $b$ are interdependent; and we can select in turn as $S_1$ a sequence of the form $c + S_2 + d$, with dependency again between $c$ and $d$; and then we can pick a sequence of the form $e + S_3 + f$, with dependency between $e$ and $f$; and so on. Sequences that violate these dependencies are not English. Hence, in requiring the construction of mirror-image sentences, any device adequate to the generation of the sentences of the English language cannot be a left to right finite-state device without nonterminal symbols. We formulate this as follows:

(C) English is not a finite-state language.

Note that while this argument is a specific realization of Chomsky's principle that the linguist must show how the infinity of sentences that compose a natural language can be generated through finite means, the argument shows more than that a natural language consists of an infinite number of sentences (E). From (E) it follows that a natural language cannot be specified except through specifying a generative device, a device that employs recursion. But from the present argument it also follows that the device must be more powerful than a finite-state device with recursive loops, even though such a device does have the capacity of generating an infinite number of sentences.

I have devoted a great deal more space to this argument than Chomsky did in Syntactic Structures. My reason is twofold. First, my experience has been that people who have little or no familiarity with this general sort of argument may fail to grasp the argument in its entirety, to appreciate its force and limits, if the argument is not explained at length and with some repetitions. People have been confused about it even in print. Secondly, the argument already contains, at least in miniature, the most basic elements in Chomsky's approach to language. The basic philosophic and psychological issues, and Chomsky's way of reasoning about theory, are on the table, at least in embryo.

Of course, from the point of view of a practicing linguist particularly interested in some approximation of part of the grammar of English, absolutely nothing of any importance or interest has been said. But as Chomsky's reasoning about the nature of grammar proceeds—in the argument of Syntactic Structures that English is a tranformational-generative grammar with particular sorts of rules, in the further developments found in the “standard theory” of Aspects of the Theory of Syntax, and in the “extended standard theory” of his most recent papers—the basic principles of this argument are employed again and again, though the applications are much more complicated, and the results of course much closer to an adequate simulation of our grammatical knowledge than this extremely elementary
initial step. The argument that an adequate description of a natural language can only be given through specification of a generative device (whose software the competent speaker of the language must minimally internalize) remains constant, though the specification of the requirements that characterize the device has become much more detailed. Equally constant is the claim that natural language sentences have an abstract or deep structure that cannot be explicated by a physical description of such sentences (as noise) and that is not present in a simple sensory, or observational, characterization of such sequences of noise “bounded by silence” (though deep structure has become ever more abstract and complex as the theory has developed, leading in the past few years to a split between transformational-generative linguists on precisely how abstract deep structure must be).

Since the concern of this book is with introducing the more philosophic aspects of Chomsky’s work, I feel the needs of the account are best served by emphasizing this initial and basic instance of Chomsky’s strikingly original way of reasoning about man’s linguistic capacities. Another aspect of this justification is that this particular argument, which is the first examination of a grammatical model in Syntactic Structures, obviously has psychological and philosophic implications. There is very little to be said for the claim of some linguists that Chomsky’s early work was a ground-breaking contribution to linguistic theory that can be easily separated from the “alien and irrelevant” psychological and philosophic “speculations” of his later work.

II Phrase-Structure Transformational Grammars: Syntactic Structures

Artificial language II of the last section is perhaps the simplest language one can imagine that must, at minimum, be specified by a phrase-structure, as against a finite-state, grammar. Rule (IIc) [which joins (IIa) and (IIb)], that is, can only generate language II by making use of nonterminal symbols in deriving the sentences of the language by progressively rewriting one symbol (S) as two, or three, symbols.

(II) (c) \( S \rightarrow a + (S) + b \)
nomena. But Chomsky bolstered this very general criticism by claiming (1) that structural linguists implicitly assumed, by their practice in describing sentences, that insofar as a natural language might be described by specifying a set of rules, which would constitute the software of a generative device, the rules would be nothing more powerful than phrase-structure rules; and (2) that such a phrase-structure generative device seemed in no way able to provide a concise and revealing characterization of the sentences of English.

What I should like to do now is to show in a very elementary and incomplete way what features of English lend themselves to phrase structure characterization and what features seem to show that such characterization is insufficient for the full description of English grammar. In particular, I will try to show why a device that can generate, and so structurally describe, the sentences of English needs not only phrase-structure rules but also still more powerful transformational rules.

It has not been possible to offer a clear proof, in the manner of the last section, that a phrase-structure device cannot generate the grammatical strings of English (though, ironically, this has been possible with respect to an American Indian language, Mohawk). But it is possible to argue that a transformational grammar may generate the sentences of English in a simpler sort of way and that such a grammar will provide these sentences with more adequate structural descriptions. Because grammars may generate the same strings of terminal symbols (i.e., may agree in weak generative capacity), while they may diverge in the structural descriptions that they provide these strings (i.e., may disagree in strong generative capacity), one might put the point equally well by saying that Chomsky has shown that phrase-structure grammars fail to have a strong generative capacity that is faithful to the most minimal intuitions of English speakers about the surface structure of English sentences.

The sentence my father loves men, for example, can be generated by the simple rules of (20) which is repeated here for convenience.

\[(20)\]

(i) Sentence \(\rightarrow\) NP + VP

(ii) NP \(\rightarrow\) (D) + N

But, as I have tried to show (page 92), when one thinks about expanding these rules to account for the conjunctive sentence my father loves men and women (or my father loves old men and women), particularly when considering many related conjunctive processes that involve grammatical categories other than nouns, it would be clumsy and unrevealing to account for this by separate rules for conjunction involving verbs, nouns, adverbs, adjectives, etc.

It is possible, however, to account for all such forms of conjunction through one generalized transformational rule (again repeated):

\[(24)\quad U + Y + W;\quad U + Z + W \rightarrow U + Y + and + Z + W\]

(Where U and W represent identical terminal strings of symbols and Y and Z are identical nonterminal elements that may be realized as different terminal symbols)

Rule (24) is a generalized transformation in that its input consists of two (or more) structures that could be realized as individual sentences. It covers a variety of conjunctive phenomena by constructing any sentence with a conjunction from two structures that could themselves be sentences and consist of the same words except for the Y and Z which, though they are in the same category, may be different words in the sentence that is finally derived by means of the transformation.

Though the details are complicated, the basic idea behind generalized transformations is extremely simple. Aside from some very simple kinds of sentences, such as those generated by (20), one might say that most English sentences—sentences with conjunction for example—look as if they could have been constructed by taking two or more very simple sentences and then joining them by means of transformations which delete repetitions of words and phrases in a variety of ways. Instead of using phrase-
structure rules to generate simple sentences—or kernel sentences, to use Chomsky’s term for them—and then adding more and more phrase-structure rules to expand these sentences, Chomsky proposes that a simpler and more revealing grammar will first employ a small number of phrase-structure rules to generate kernel sentences and then employ the more powerful transformational rules to join and rearrange these forms. Rule (24), for example, accounts in one general rule for the generation of (29), (30), (31), and (32) from the simple sentences that accompany them. A number of apparently unrelated phrase-structure rules would be needed to generate these sentences from selected simple sentences, but in that case one would not only have more rules but one would have lost a more revealing and more general rule.

(29) My father loves and hates men  
(From: My father loves men, My father hates men)  
(30) My father loves men and women  
(From: My father loves men, My father loves women)  
(31) My father and mother love men  
(From: My father loves men, My mother loves men)  
(32) My father loves and my mother hates men  
(From: My father loves men, My mother hates men)

Once one starts, one sees that generality and simplicity can be got in a great variety of ways by applying a relatively small number of generalized transformations to the kernel strings produced by ten or so phrase-structure rules. One will, for example, need to have phrase-structure rules to generate structures of the form Noun + Verb + Adjective in such a way that grammaticality is maintained (Nancy is old, not *Nancy are old, and so on). Simplicity and generality are served if one has a nominalizing transformation that will convert this structure into Adjective + Noun (old Nancy) while joining it with another structure to make a complete sentence. Sentence (33), which is generated by the tangle of boxes in the state diagram of Figure 6, will be generated in a transformational-generative grammar by nominalizing transformations acting on (34) and (35) to embed them in (36) [with (37) representing something like an intermediate stage on the way to the highly contracted (33)].

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(33) Invisible God created the visible world  
(34) God is invisible (Becomes: invisible God)  
(35) The world is visible (Becomes: the visible world)  
(36) God created the world  
(37) God who is invisible created the world which is visible

Chomsky found (33) (or rather its French equivalent, Dieu invisible a créé le monde visible) in the Port-Royal Grammar (1660), a product of a number of rationalist linguist-logicians whose work derived in good measure from the rationalist philosophy propounded by René Descartes. Chomsky was happy to find that his transformational-generative machinery provided a way of solidifying and further justifying their claim that (37)—composed of the three separate propositions (34), (35), and (36)—underlies the surface form (33).

But it is a singular transformation (one that operates on a single phrase-structure product, not two or more) that is possibly the most familiar instance of the revealing and economic character of transformational rules. Consider the relationship between (38) and its passive counterpart (39):

(38) Jack hit John  
(39) John was hit by Jack

A phrase-structure grammar would need one set of rules to generate (38) and similar forms. But one singular transformation (40) can take the place of all these additional rules because if the active form, which is the input for the transformation, is grammatical, then the passive output will also be grammatical, without the need for additional rules.

(40) NP₁ + Verb + NP₂ → NP₁ + was +Verb + by + NP₁  
(This is a simplified version of the actual rule)

It is almost impossible not to believe that there is a very close syntactical relationship between (38) and (39)—just the sort of relationship that is expressed by rule (40). A sense of this relationship seems to be part of the intuitions of an ordinary speaker of English in just the way that the phrase-structure seg-
mentation of my father loves old men and women into my father—loves—old men and women seems to be part of his intuitions. But there is no way that this relationship can be given clear or adequate expression in a phrase-structure grammar. The singulary transformation (40) shows us how (38) gives rise to (39) by a formal reshuffling of elements. But there is simply no way of getting from (38) to (39) by means of a phrase-structure tree. A phrase-structure grammar rewrites single, nonterminal symbols until none are left; but (40) has three symbols as input, none of which is rewritten as something else, rather being shuffled about, and the subscript numbers "look ahead" to the actual terminal symbols because they require that the same words appear as input subject and output object \( (NP_1) \) and as input object and output subject \( (NP_2) \).

In Syntactic Structures Chomsky wished to emphasize the purely formal character of syntax and our intuitive knowledge of it as ordinary speakers. This formal syntax could be described without bringing in the then nebulous topic of linguistic meaning. Hence there was no provision for a semantic component, in addition to syntax and phonology, in the grammar of Syntactic Structures. Indeed, Chomsky stressed (pages 100–101) that the purely syntactical relationship between active and passive that is expressed by a rule like (40) is not to be explained as a result of equivalence in meaning because some passive transforms are not equivalent in meaning to their active counterparts. In particular, he pointed out that a quantificational sentence such as everyone in this room knows at least two languages is not equivalent in meaning to its passive transform at least two languages are known by everyone in this room. Why? Because what the active form means would be true even if each person in the room has no language in common, while the passive form strongly suggests that two particular languages are known by everyone in the room.

I will return to this example, and the issue of whether transformations such as passive change meaning, later in the chapter. The subject is interesting because in Aspects of the Theory of Syntax Chomsky adopted the principle, which was championed by J. J. Katz and P. M. Postal, that transformations should never be written in such a way as to change meaning. In

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Aspects, a semantic component is added to grammar, with pretransformational syntactical structures providing the input to the semantic component and posttransformational structures providing the input to the phonological component; the assumption that transformations do not change meaning helps make this system elegant and coherent, as we will see in the next section.

In Syntactic Structures, the passive transformation is considered optional. This means that the input structure does not have to undergo the transformation, that is, it will become a grammatical sentence without this step as is the case, of course, with the active counterparts of the passive transforms. There are some obligatory transformations in the grammar of Syntactic Structures—for example the transformation that helps ensure that the subject noun and the verb will agree in having plural or singular forms—but though the four that Chomsky specifies there cover some apparently complex and chaotic grammatical matters in an ingenious and strikingly simple way, I will not say anything more about them.

Aside from the passive, there are five other optional transformations clearly specified in Syntactic Structures. In company with the passive, such transformations will produce all the sentences of (41) from one abstract underlying string, which most closely resembles (41I) because that sentence is derived without any optional transformations.

\[
\begin{align*}
(i) & \quad \text{Harry loves the army} \\
(ii) & \quad \text{The army is loved by Harry} \\
(iii) & \quad \text{Does Harry love the army} \\
(iv) & \quad \text{What does Harry love} \\
(v) & \quad \text{Who loves the army} \\
(vi) & \quad \text{Harry doesn't love the army} \\
& \quad \text{(And so on)}
\end{align*}
\]

It is quite easy to see the strength of Chomsky's argument that transformational grammars are simpler and more revealing than purely phrase-structure grammars. And those linguists who have followed Chomsky's lead in trying to write grammars that are general, explicit, and formal have not made a serious effort to write phrase-structure grammars for natural language; such grammars simply are not in the running any longer. But
serious theoretical questions continue to be raised about simplicity and revealing-ness. Precisely how simplicity is to be measured is a difficult question both when one is talking about a sense of simplicity that is peculiar to human languages (and human language acquisition) and when one is talking about the general sense of simplicity that is an important factor in all scientific theories, whether concerned with language or any other phenomena. While the case for the greater simplicity of transformational grammars would seem overwhelming on any measure, Chomsky has insisted that the crucial notion of simplicity for linguistic theory is one that will ultimately derive from the theory of language acquisition. Though there is a notion of absolute, or general, simplicity, which applies to theories in physics as much as to theories in psychology, this notion is not a crucial one for linguistic theory, however absorbing its study is for the philosophy of science. In other words, Chomsky thinks grammars should reflect what is simple for us, what we find easy to learn and employ, thus meeting the goal of explanatory adequacy. If two grammars generate the same sentences and structural descriptions, thus meeting the requirements of observational and descriptive adequacy in the same way, then to say that one is linguistically simpler than the other is to say that it is simpler, or more easily learned, than the other for human beings.

The problem of measuring how revealing grammars are is more practical and psychological. Most linguists would agree that the ordinary speaker of English does have an intuitive sense of the structure of English sentences, that is, a rough sense of sentences splitting into phrases and some equally rough sense of transformational relationships between sentences. But one cannot place too much weight on these intuitions. In the early years of transformational-generative linguistics, many people, including perhaps Chomsky himself, felt that it would be possible within a few years to produce a grammar of English that would be observationally and descriptively adequate, deriving from a body of sentences and structural descriptions that nearly any ordinary fluent speaker of English would find acceptable. It was thought that borderline cases, where ordinary speakers would not agree on whether a sentence or structural description was acceptable, would not be of crucial importance or interest; the grammar itself, which would be based on the much larger body of clear cases, might decide these doubtful cases. However, in recent years many transformational-generative grammarians have based arguments about parts of the grammar of English, and other natural languages, on very subtle and doubtful evidence about what ordinary speakers are supposed to find acceptable, or unacceptable, in the way of sentences or structural properties of sentences.

A few linguists have waved aside such evidential worries by stating that they mean to talk, not about English, but about their own personal version of English—"my idiolect" as they sometimes put it. The potential indistinguishability of data and theory that this practice suggests reminds me, at least, of the habit of some Freudian psychologists, including Freud himself, of making claims about processes in the human mind simply on the basis of extremely subtle evidence in the mental experience of the psychologist himself. The transformational-generative linguists who are in principle most prone to this practice, often called "generative semanticists," do not command the full sympathy of Chomsky, whose current position is that of the "interpretive semanticists," to use the common jargon.

Some psychological experiments with adults and children, while roughly confirming many of Chomsky's basic claims, have also shown that it is easy to exaggerate the uniformity and depth of ordinary speakers' intuitions about language. But certainly one might say that a portion of these problems are natural to the development of a new theory and methodology. After an initial period during which many scientists assimilate a radically new theoretical viewpoint, it is wholly natural for them to begin to fix their attention on more difficult, ambitious, and subtle problems and to become more aware of limitations in the new program. The general battle for acceptance of the new viewpoint has been won, and internal division and criticism begin. Both the specific linguistic problem of simplicity and that of the characterization of ordinary speakers' intuitions about structure (revealing-ness) are basic to the Chomskyan program of progressively narrowing the characterization of our linguistic software, both to describe the mind more specifically and to gain
some notion of the brain's hardware through this characterization.

Perhaps I might finish this account of the argument for transformational grammars by discussing a phrase whose analysis has captured the imagination of those concerned with language more than any other mentioned in Syntactic Structures. Consider the question of whether there is any ambiguity in (42i):

(42)  
(i) The shooting of the hunters awakened me  
(ii) The hunting of the lions was bloody  
(iii) The painting of the artist is now at an end

Many individuals interpret (42i) to mean: the hunters shot (their guns)—this awakened me. But there is another way to hear the sentence: someone shot the hunters—this awakened me. Two points about this ambiguity are crucial to Chomsky's argument: (1) it is structural, having to do with syntactical construction; and (2) it cannot be accounted for in terms of phrase structure-bracketing.

One way to see that the ambiguity of (42i) is structural is to note that the same ambiguity is present in (42ii) and (42iii). In none of these three cases does the ambiguity depend on the fact that one particular word (in one of the constructions or in any other) has two meanings. If I say, "Meet me at the bank,” what I say is ambiguous semantically because the word "bank” has two dictionary meanings: financial institution or solid boundary of a body of water. But what I say has the same syntactical generation, the same grammatical structure, whichever I happen to have in mind when I say "bank.”

As I have pointed out, the structural ambiguity of old men and women can be represented by bracketing in derivations generated by phrase-structure grammar (though, of course, the same effect could be obtained by just one generalized transformation operation on different underlying kernels). The phrase is bracketed so that it either reads old (men and women) or (old men) and (women). But a moment's reflection reveals that no simple phrase-structure bracketing is going to explain the ambiguity of structure in (42). There is no way to put the parentheses that will suggest the relevant ambiguity.

In the transformational grammar of Syntactic Structures a phrase of the form the + V + ing + of + NP₁ [as in (42)] can be derived transformationally from either of two kernels: either from NP₁ + V (the hunters shoot) or from NP₁ + V + NP₁ (they shoot the hunters). In the first case "the hunters” is, logically and transformationally, the subject of the sentence; in the second case, it is the object. Similarly, (42ii) could derive from the lions hunt..., with "lions” as object. And (42iii) could derive from the artist paints...or...paints the artist.

On the other hand, sentences (43i) and (43ii), while they appear identical in structure to those of (42) in terms of surface bracketing, are not ambiguous.

(43)  
(i) The screaming of the gulls awakened me  
(ii) The bombing of the building awakened me

Within a transformational grammar there is a simple explanation of our intuition (our untutored perception) that (43i) and (43ii) are not ambiguous. The explanation is that neither (43i) nor (43ii) has two underlying kernels, one where the noun of the surface subject phrase is subject, the other where it is object, with the one ambiguous sentence deriving from either kernel by different transformations. In particular, sentence (43i) derives from the underlying kernel the gulls scream in which the noun of the surface subject phrase, gulls, is the deep subject. But they scream the gulls is not a possible kernel (because the phrase-structure rules would not provide the basis for its generation); hence there is no input for the transformation which would carry an underlying string into sentence (43i) in which the underlying object, the gulls, becomes part of the surface subject. For much the same reason there is no ambiguity in (43ii). Sentence (43ii) derives from they (or whatever) bomb the building, in which the building is the grammatical object. But there is no ambiguity because a kernel in which the building is the subject—namely, the building bomb...is not possible. It is difficult to see any way of explaining why the sentences of (42), but not those of (43), are ambiguous without assuming a system of transformations operating on underlying strings.

A similar well-known example, which Chomsky and others have used, is sentence (44):
(44) Flying planes can be dangerous

This sentence is structurally ambiguous—either suggesting that those who fly planes can be so endangered, or that planes, which fly about, can be dangerous—and transformational grammar accounts for this ambiguity in showing that two rather different underlying strings could be transformed into the same sentence. Of course, there is absolutely no suggestion that the ordinary competent speaker of English is conscious of such transformations—either the transformations of Syntactic Structures or those that might appear in the more precise grammars of future research—when he speaks, or hears, such a sentence; what he is conscious of, or can easily be brought to see, is simply that such sentences are ambiguous, and this fact must appear in the structural descriptions provided English sentences in an adequate grammar.

What these examples purport to show is that if one assumes (F1)—briefly, that an adequate grammatical characterization of a language must amount to the specification of a device which will generate (weak capacity) the sentences of the language and assign (strong capacity) them proper structural descriptions—one should conclude that

(H) English is not a phrase-structure language.

The argument may be summarized as follows: (1) the ordinary speaker of English recognizes that (42i), (42ii), (42iii), and (44) are structurally ambiguous, while (43i) and (43ii) are not structurally ambiguous; (2) hence a descriptively adequate English grammar should generate (strong capacity) structural descriptions that show this ambiguity and lack of ambiguity; and (3) a phrase-structure grammar cannot generate structural descriptions that show this (certainly it cannot do so in any simple or natural way, that is, by familiar forms of bracketing, and so on). Our knowledge of the structure of such sentences is of a highly abstract, or mentalistic, character and is in no way equivalent to the straightforward segmentation of explicit surface strings that structural linguists seem to have had in mind. Not only are nonterminal symbols required in the generation of English, but we also require underlying nonterminal strings, or deep structures, as they have come to be called. Considering the enormous generative power that transformations add to grammatical devices, one presumably need not look for some essentially more powerful form of generative device. Hence:

(I) English is a transformational language. (Similar analyses have been produced for a very substantial number of other natural languages, so one might speculate that “A human language” could replace “English.”)

Before I give a general summary of the grammar of Syntactic Structures, I will briefly remind the reader of the point, which I made in the Introduction, that one could say that a crucial factor in the Chomskyan revolution has been the introduction and justification of more powerful modes of description that make the older (structuralist) modes of description appear startlingly as a “special case” of this more powerful mode. In the Introduction I suggested, as a rather extravagant analogy, that one could compare this to Einstein’s discovery that all that seemed possible in a Newtonian physical universe appears as a special Euclidean case within the more powerful descriptive system that Einstein made available through use of non-Euclidean geometry. The argument against the phrase-structure grammar of structural linguistics is one that shows that such a mode of description is a special case—though roughly sufficient to a good portion of familiar linguistic phenomena—within the much more powerful characterizations that transformational grammar can provide. For that matter, the argument that phrase-structure grammars are more adequate than finite-state devices has the same form, as does that against the still less powerful level of descriptive capacity provided by nonrecursive, or loopless, finite-state devices (or by that provided by simple enumeration of sentences).

In summary, the grammar sketched in Syntactic Structures consists of three sorts of rules, which operate in sequence in generating the sentences of English and in providing them with phonological realizations in speech.

1. Phrase-structure rules which rewrite single, nonterminal symbols into, eventually, terminal symbols or words, in this manner creating a tree diagram or phrase-structure bracketing.
2. Transformational rules, which operate upon the phrase
structures produced by (1), deleting, reshuffling, and joining portions of such structures. (Singulary transformations, whose input is single phrase-structure (kernel) strings, are either obligatory or optional, optional transformations including passive, negative, and question transformations. Generalized transformations, which are always optional, join two or more kernel strings. As opposed to the phrase-structure rules, transformations are ordered, in that some must be applied after others—the passive transformation, for example, must apply before the transformation that makes the verb plural or singular, and so on, because it is the noun that is put into subject position by the passive transformation that determines the form of the verb.

3. Morphophonemic rules, which convert the output of (2), the sentences of the language from a syntactical viewpoint, into the actual sounds of speech. (These rules, of which no account has been given here, are similar to the phrase-structure rules. But they allow the rewriting of more than one symbol, and they are “context-sensitive” in that they may indicate that a symbol is to be rewritten in a particular way only if certain symbols precede or follow that symbol. For example, the purely syntactical rules (1) and (2) will generate strings such as take + past-tense; the rule that will convert that segment into the sounds that we write as “took” is a morphophonemic rule.)

If one has grasped the nature of these rules, and the general structure of the grammar that is summarized here, one will not find it difficult to follow the changes that are brought in with the “standard theory” of Aspects of the Theory of Syntax (1965), and in still more recent work. I mention this because the reader may feel that he has been burdened with enough of a technical apparatus, and so he has. Perhaps the major change that takes place is that meaning becomes a respectable and central part of linguistics: to the syntactical and phonological components that may be found in the first version of the theory, Aspects adds a third semantic component. The formulation of this component, and its relationship to the others, will be seen as a major theater of controversy. The phonological component undergoes radical changes in The Sound Pattern of English (1968), which Chomsky coauthored with his MIT colleague Morris Halle. In that book considerable evidence is marshaled for the view that the input from the syntactical component is manipulated by a cycle of phonological rules that have the same power as the transformational rules of syntax.

III The Grammar of Aspects of the Theory of Syntax and Some More Recent Developments

Until the publication of Syntactic Structures (1957) and the appearance of his work in conferences on linguistic analysis at the University of Texas (1958, 1959), Chomsky’s work was not generally available, or availing, among linguists. Indeed, the better portion of his earliest work appeared more in publications devoted to mathematical, logical, philosophic, or psychological topics than in publications aimed primarily at professional linguists. His bulky manuscript, “The Logical Principles of Linguistic Theory” (1955), from which Syntactic Structures was excerpted, is the more amazing in sweep and complexity in that it represents the largely solitary creation of a wholly new way of doing linguistics, and of new areas in linguistic research. Though Chomsky caused some ripples in the local intellectual community while putting together the manuscript with the support of a Junior Fellowship at Harvard University (1951–55), it is now a familiar story that MIT Press declined to publish the manuscript and that the Dutch publisher Mouton published Syntactic Structures because one of their representatives happened to be curious about the excerpted version of the manuscript that Chomsky used for his classes at MIT.

During the late 1950’s and early 1960’s, however, Chomsky had gathered round him a large, excited, and brilliant group of linguists, psychologists, and philosophers, some starting their professional work under the new aegis, others with functioning careers, often converts from structural linguistics, behavioristic psychology, or related radically empiricist views. It would be fascinating to write (or read) the history of the manner in which this “new science” spread among people of the university and research institutions of the Cambridge, Massachusetts, and Boston intellectual community. It spread through mimeographed articles—because print was too slow a process—and through seminars and “personal communication” when even the mimeo-
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Syntactic Structures is that Chomsky’s most significant general views about linguistics, and his views about psychology and philosophy, are explicitly stated or implied in that first work. Another reason is that it is sometimes wrongly implied—as I have mentioned—that his mentalistic and antibeaviorist views about psychology, and his resurrection of philosophical rationalism, stem from a supposedly unfortunate and wildly speculative extrapolation, through questionable analogies, of his original work; my method of exposition should indicate both that this interpretation is misplaced and that there has been a genuine continuity in Chomsky’s thought. A final reason—and here I interject my personal and contentious view—is that the motivating thrust in the developments that led to the standard theory, and beyond to generative semantics, is an attempt to provide a “semantics of natural language” or a “natural logic” which will, among other things, enable the professional linguist to provide, as professional service, authoritative answers to most of the problems that have concerned analytic philosophers and philosophical logicians in this century. And I think this thrust has been in good measure mistaken, that the recent split within transformational-generative grammar has shown the nature of the difficulty, and that this mode of exposition will give the best sort of short picture of the issues.

The story of the major change can best be told by reiterating what it is a change from. In Syntactic Structures, Chomsky emphasized the independence of grammaticality, of linguistic well-formedness, from meaning or meaningfulness, with good reason. What was being stressed was, in effect, the independence—the purely formal, syntactical, and narrowly linguistic character—of grammaticality and of the characterization of the generative device (the minimal psychological software) that is essentially knit with the specification of grammaticality. Chomsky accepted the view that an adequate grammar should specify a language by generating, and providing structural descriptions for, the sentences of the language. Since natural languages do not consist of finite numbers of sentences, they can only be described by specification of the software of a generative device. Given the recursive and abstract character of English, and other natural languages, the minimal software must be a (phrase
structure plus) transformational device, with both nonterminal symbols and nonterminal structures.

Since we have the same generative capacities (at least) of such a device—as is simply revealed in our ability to play Sentence Scrabble® and implicitly in our more complicated everyday linguistic activity—we have the software capacities in question too: we are, among other things, transformational devices that make use of nonterminal symbols and structures (of mentalistic abstractions). Further, the linguist, with a finite corpus from which to derive the grammar of a language, has no determinate way of arriving at the right grammar—at least not without a general explanatory theory of human language and of language acquisition (in that the child, faced with a much more inadequate sample, does come up with an adequate notion of the grammar of the sampled language). And so it follows that an adequate grammatical, or linguistic, characterization of a language is presumably going to involve, eventually, some notion of the software of language acquisition and hence some notion of features universal to human languages. From all this one can derive, as I have sketched, a certain support for mentalism and immutability in psychology, and for the philosophic rationalism that Chomsky has come to champion; equally the opposition to behaviorism and radical empiricism is apparent from Chomsky’s first discussion of a generative device.

But it is notable that Chomsky made it clear that this specification of syntactic structure takes place without any dependence on the notion of meaning, i.e., on a possible semantic component to grammars. In succeeding paragraphs, I will mention some specific replies that Chomsky gave in *Syntactic Structures* to arguments that purported to show that syntax must be based on semantics.

But first I should mention two very general background considerations which had, with little doubt, some force. First, Chomsky started by accepting the problem of describing a language as a structuralist would see it (though he reconstructed the structuralist’s position in generative terms), and this led him to the specification of a device that would generate, and provide structural descriptions for, the sentences of the language. Chomsky tried to show that the generative device

*Three Sorts of Generative Devices* would have to have transformational power, which clearly meant that the agreed goal could not be attained by structuralist means and thus meant that structuralism was inadequate. This line of criticism depended on accepting the (reconstructed) structuralist viewpoint about the goal of a grammatical description of a language. Secondly, if not for structuralist reasons alone, Chomsky felt sympathy for this formal view of what constitutes a grammar. He shared with the structuralists the view that (1) meaning did not lend itself to specification within the formal means that ought to, or even could, be provided for in grammar proper; and (2) that problems of meaning—determining whether sentences were meaningful or “make sense,” whether sentences had the same or different meanings, and what sentences actually mean, their reference and truth conditions—would involve linguists in questions that belonged as much, or more, to logic and to the conceptual and empirical problems of various sciences. At the time, Chomsky took the view (of Nelson Goodman) that meaning was a matter of the reference of words and the utterances in which they served. Obviously a formal system is not going to specify (that is, literally point out) what the various things are that words stand for, or the various situations that satisfy the propositions we put forward.

Chomsky, of course, has since discarded this Goodmanian radical empiricist view of meaning. But Chomsky has retained the view that syntax can, and should be, developed *autonomously*, independently of meaning, and that insofar as the linguist has the subsequent and dependent task of specifying a semantic component, this mandate, at least for the foreseeable future, does not put the linguist in any authoritative position so far as the problems people in other disciplines have concerning the meaning of various terms, that is, concerning the logical properties of theoretical propositions formulated in natural language.

For example, Chomsky often stresses that the structuralists were not in a position to define “utterance,” “phoneme,” “morpheme,” “sentence,” “constituent,” “human language,” and so on, in whatever way they wished; rather, these theoretical terms carry in their definitions various general, empirical presuppositions about man and his languages, and any “method in structural linguistics” that defines these terms makes basic claims about
such matters, whether intended or not. But if linguists are not allowed such arbitrary definitions, neither are ordinary people or specialists in other fields of knowledge. The empirico-theoretical question of the definition of various theoretical terms of linguistic science is not a question of what so and so many people happen to mean, or think they mean, but is a question of linguistic theory. Similarly, in replying to philosophers in Language and Philosophy (1969), Chomsky suggests that linguists are in no particular position at present to make contributions, certainly not authoritative ones, to the debates of philosophers that are posed as questions about the meanings of a few words. The linguist’s special concern is with the systematic specification of the sense of grammaticality that belongs to the ordinary speaker speaking ordinarily (discounting the slips and distortions of performance), which belongs to “what everybody knows” and not to the special talents or standards of particular disciplines.

Leaving these general points aside, I am going to summarize Chomsky’s analysis (and refutation) of three arguments that he suggests are commonly put forward to show that grammaticality depends on meaning (Syntactic Structures, p. 94 and following pages). These arguments are interesting in that they make clear Chomsky’s concern, then, in repelling the suggestion that syntax depended on semantics (or, indeed, had any relevant systematic relationship to it). But the arguments are more interesting in that Chomsky turned them about in the change to the grammar of Aspects, and they were once more turned about into something more like their first form in Chomsky’s most recent position (with the refinements and clarification that come through these sea changes).

The first claim that Chomsky repudiates is the claim that grammatical sentences are meaningful sentences or, in other words, that “syntactically well-formed” is equivalent to “semantically significant,” if not to “semantically well-formed” (=having truth conditions, not being nonsense or logically paradoxical, and so on). To this the short reply is that our familiar acquaintance, colorless green ideas sleep furiously, is grammatical, while it is nonetheless meaningless. And this is not unusual. There are many strings that are grammatical but more or less meaning-

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less, or semantically anomalous in various ways. Of course, Chomsky was not then in the least unaware that the sentence was odd, or that, in that one could make a stricter grammar which would not generate the sentence, it might be labeled “semigrammatical.” Nonetheless, the sentence has some quality of grammaticality about it while being absolutely meaningless. Similarly, there are quite meaningful utterances that are not in the least grammatical. One notes that the supposed correspondence between grammaticality and semantic significance is like the traditional definition of a sentence as “what expresses a complete thought.”

Secondly, Chomsky considered the claim that the syntactical relationship of subject-verb (that is, the NP-VP bracketing in the straightforward, surface analysis of sentences) is equivalent to the universal “structural meaning” of actor-action (similarly for the “correspondence” between the grammatical verb-object distinction and the semantic action-recipient distinction). His brief response was that sentences such as John received a letter and the fighting stopped showed the untenability of this claim. Why? Presumably because the grammatical subject, John, cannot be said to have been the actor, and receiving is not so much something one does as something that is done to one. Similarly, the grammatical subject, the fighting, cannot be said to be an actor, or an actor whose action is stopping. (An amusing instance of a related phenomenon is Joseph Heller’s famous line on the fate of the rebel Dunbar in Catch-22: “They disappeared him”—the sentence is ungrammatical but very apt semantically, for, syntax aside, disappearing is more something that is done to people and things than something that they do.) The reader who recalls that an underlying transformational source for (42i)—the shooting of the hunters awakened me—might be phrase-structure strings somewhat like they shot the hunters, this awakened me, might note that the fighting stopped would presumably derive from underlying strings in which subject terms would be active in a semantic sense: If one could work out grammar so that for each sentence (each transformational output, or surface structure) there were a single, underlying, pretransformational deep structure, then one might maintain that the deep-structure grammatical subject was indeed the actor in a semantic sense,
the logical subject. It is precisely this line of thought that led to the grammar of *Aspects*.

Thirdly, Chomsky considered the claim that an active sentence and its corresponding passive are synonymous (in effect, the claim that the passive transformation preserves meaning). As mentioned above (page 100), Chomsky points out that quantificational sentences do not preserve meaning under the passive transformation: *everyone in this room knows at least two languages* can be true when its passive transform is false, which is a most dramatic failure to preserve meaning. While the passive transformation characteristically does preserve meaning, it does not in many quantificational sentences and possibly in some other cases (I interject that the reason for calling sentences “quantificational” is that they contain words such as “everyone,” “someone,” and so on, which function in the same way as the universal and existential quantifiers of predicate logic). Chomsky stresses (p. 101) that the important point about transformations is that they preserve grammaticality. With many of the transformations (aside from the passive itself) such as the negative and interrogative, it is absolutely clear that meaning is changed by the transformation.

It is a clue to the developments that led to *Aspects* and beyond that while a sentence and its corresponding negative transform preserve grammaticality and obviously do not preserve sameness of meaning, the change in meaning from the sentence to its negative transform is regular, not haphazard, and regular suggests according to rule. What is according to rule presumably can be formalized. Why not add such rules to the description of a language in some way?

In *Syntactic Structures*, Chomsky insists that while there obviously are correspondences between the structures and elements of formal, grammatical analysis and the semantic features and functions of language, these correspondences are “imperfect,” “vague,” or “inexact”; while they belong to the study of language in a broader sense, “important insights and generalizations” about the formal character of syntactical operations will be lost if grammar (syntax) is asked to account for synonymy, meaningfulness, reference, and, generally, logical relationships between sentences.

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To clarify further these points about transformations and meaning, I might say something about the word “transformation.” Some time before Chomsky formulated his theories, logicians made use of the terms *formation rule* and *transformation rule*; and their use of the terms, with which Chomsky was familiar, is suggestive. Logicians work with artificial languages, mostly of a simple and abstract character, which have interesting logical features. In specifying such a language, familiarly, the logician will begin by specifying what are sentences, that is, by providing syntactical rules; but he calls the sentences *well-formed formulas*, and the rules that generate them, *formation rules*. These formation rules have the power of phrase-structure (rewrite) rules (though they are often given in a more compact form). Logicians’ transformation rules do not, however, have much to do with simulating or extending well-formedness; rather, they preserve truth and, in that sense, meaning. They are the rules of valid argument, which transform premises into conclusions in such a way that whatever conditions will make the premises true, will also make the conclusions true.

Speaking roughly, then, it is fair to say that logicians’ transformations preserve meaning (or truth). Within this terminological context it would seem quite clear that Chomsky meant to lay great stress on the generalization that the syntactical transformations of natural language preserve grammaticality (well-formedness) but do not preserve meaningfulness or truth, nor will the specific meaning, or associated truth conditions, of the input necessarily be found in the transformational output. The attempt to base grammar on meaning, to require that grammatical transformations preserve meaning, will lead to the loss of “important insights and generalizations” about purely formal linguistic software.

In the face of this defense of the autonomy of syntax, one still can see respects in which a transformational grammar of the sort *Syntactic Structures* proposes reveals something about meaning. For example, the pretransformational sources of *the shooting of the hunters* do reveal more about meaning than is evident in the grammatical output (facts such as these lead to the practice in *Aspects* of calling pretransformational input sources deep structures, and the posttransformational outputs
surface structures). Though the deep structure in question is justified by purely syntactical arguments, it also happens to account for features of meaning. Again, the change from active to passive usually means that what we might call the logical (or semantic) subject is displaced into object position. What is in subject position in deep structure seems to accord better with the semantic notion of subject. So, once more, though the deep structure in question is justified by purely syntactical arguments, it also happens to account for features of meaning. Again, purely syntactical considerations of generative simplicity seem to justify the notion that (33) *Invisible God created the visible world* is transformationally derived from three separate strings, which as one deep structure would most resemble *God—God is invisible—created the world—the world is visible*, or, after pronounification, (37) *God, who is invisible, created the world, which is visible*. These deep-structure sources seem to reveal more about the meaning or logical structure than is evident in the surface structure (33). So, once more, though deep structures are justified by purely syntactical arguments, they also happen to account for features of meaning, and do so more fully than surface structures.

Hence the simple thought: if one wants to account for meaning, if one wants to add a semantic component to the characterization of a language, would not the input to this semantic component obviously have to be the deep structure of sentences and not surface structure? Hence, also, the inevitable pressure to formulate the structure of the syntactical component so that this deep-structure input will be as apt as possible for its role.

Briefly, one may summarize the three components of the grammar of *Aspects* as follows:

1. A syntactical component, consisting of base rules and transformational rules. The base consists of phrase-structure rules as in *Syntactic Structures*, but those rules that rewrite nonterminal symbols as words are dropped in favor of lexical insertion rules, which allow insertion of words from a *lexicon* in accordance with a series of syntactical features (these lexical-insertion rules, which restrict the selection of word combinations, are what function to exclude *colorless green ideas sleep furiously* in the syntax of *Aspects*). The lexicon has the general job of indicating all and only the phonological, syntactical, or semantic features of particular words that are not predictable from the general rules of phonology, syntax, or semantics. The transformational rules are similar to those of *Syntactical Structures*.

However, in *Aspects* the phrase-structure rules are recursive (that is, the rule *NP → Sentence* is added), allowing the production of whole structures like (37), rather than simply generating simple kernels which the transformational rules optionally combine. The deep structure, produced by these recursive phrase-structure rules, is keyed to the application of various transformations, all of which are obligatory. The net effect of these changes is to ensure that each unambiguous surface sentence will have a single deep structure, which will not differ in meaning in any obvious way from the surface structure except in being more revealing and explicit in determining meaning; hence, the deep structure will be the obvious candidate for the input to the semantic component, which presumably will attempt a formal account of meaningfulness and sameness and difference of meaning or, in general, an account of the logical relationships between sentences.

2. A semantic component, consisting of dictionary entries (presumably from the lexicon, a compendium of what is peculiar to particular words and must be learned individually) and projection rules, so that the syntactical input structures may be assigned a semantic analysis in a formal way. For example, *meet me at the bank* has no syntactical ambiguity, but the dictionary entry for *bank* would mean that the projection rules would assign the sentence two semantic interpretations; hence it is semantically ambiguous. One is invited to assume that this component will simulate, in interpreting the deep structures generated by the base, the competent speaker's intuitions about ambiguity and the logical relations between sentences. The initial work on the structure of this component was largely done by the philosophers J. J. Katz and J. A. Fodor, but their work has been criticized, and there is presently considerable uncertainty about how the component should be put together. Chomsky himself has written little on the structure of the semantic component.

3. A phonological component, consisting of rules through which the surface structures of syntax are rendered into speech sounds.
In *Aspects* these rules can still be regarded as rewrite morpho-
phonemic rules, but since that time Chomsky has explicitly
proposed that a cycle of transformational rules will account much
better for the conversion of surface syntax to sound. Indeed,
Chomsky and Halle have argued for some time that the notion of
the phoneme is suspect, and they propose that the output
of the phonological component should not be strings of phonemes
(belonging to the arbitrary and peculiar “phonemic alphabet” of
the particular language in question) but rather a matrix of dis-

tinctive features that are *universal* to human speech.

As Chomsky writes at the beginning of the 1968 paper, “Deep
Structure, Surface Structure, and Semantic Interpretation”:

A grammar of a language, in the sense in which I will use this
term, can be loosely described as a system of rules that expresses
the correspondence between sound and meaning in this language.
Let us assume given two universal language independent systems of
representation, a phonetic system for the specification of sound and
a semantic system for the specification of meaning. As to the former,
there are many concrete proposals. In the domain of semantics there
are, needless to say, problems of fact and principle that have barely
been approached, and there is no reasonably concrete or well-defined
“theory of semantic representation” to which one can refer.

The structure of these proposals of the standard theory of
*Aspects* and Chomsky’s subsequent work is diagrammed in
Figure 9 (p. 121):

One notable point about this figure is that it makes clear a
strong drive to find the universal in language, to provide
representations that are not dependent on particular languages.
A characterization of a language, in Chomsky’s firm present
position, should specify in (perhaps quite complicated) formal
terms the correspondences that hold in that language between
sound, represented in a universal way not dependent on the
particular language, and meaning, also so represented. Given
that the rules and components relating these two language-

dependent systems are themselves specified in a general, formal,
and explicit way, descriptions of several human languages should
gradually make apparent which rules and linguistic features
are universal to human languages and which are peculiar to
particular languages.

Chomsky frequently distinguishes *formal* and *substantive*
universal of grammar. Formal universals would have to do with
the structure of grammars, of the software that the fluent speaker
internalizes. For example, the split into base plus transformational
subcomponents, assuming it to be universal to human languages,
would be a formal universal. A substantive universal might be
the abstract syntactic features NP and VP: perhaps these might
be shown to be universal to human languages. A third sort of
grammatical universal that has come to seem particularly im-
portant in the years since *Aspects* has negative character: if
particular sorts of rules, sorts of transformational manipulations,
are never found in human languages, one has *universal con-

straints* on the form of grammatical rules. For example, some
claim that there is a universal constraint against moving material
in or out of a conjunctive structure. In English, one cannot pluck
old man out of the conjunction old men and women, so as to
derive *old men are loved by my father and women or *they
are loved by my father and women from my father loves old men
and women by transformations which are acceptable if they
move the whole conjunction. If this were generally true, then
the *constraint* would be universal. Universal constraints have seemed particularly important to transformational grammarians because, as Chomsky has often emphasized, transformational rules are so powerful that unless such constraints are established there will be by far too many ways of writing the grammars of particular languages. It has been established that, given a few powerful and unnatural transformational rules, one can write a perhaps highly unnatural, but nonetheless observationally adequate, grammar for any possible human language. The existence for universal constraints would be one of the most powerful ways of eliminating such excesses and reducing the range of solutions in establishing grammars: to put it another way, if one wants to determine the internal structure of a generative device of considerable power, it is likely to be more helpful to find what the device cannot do than what it can.

But the drive toward universality (and reactions toward its excesses) has extended beyond the standard theory of Aspects, and it has led to conflict and reformulation, particularly in controversy between generative semantics and interpretive semantics.

The general thrust of the generative-semanticist proposal for improving transformational grammar is very simple: if some semantic features of sentences can be specified in their syntactical deep structure why can not all such features be specified? Why split the syntactic and semantic components at all? Why not equate ultimate syntactic deep structure with semantic representation? Or, more speculatively, one can ask, why not take the system of semantic representation to be something like the familiar predicate logic (with perhaps a few additions), and the base to be such a system supplemented with a relatively small number of “atomic predicates,” or semantic primitives, universal to human thought? The words of particular languages, just as their surface syntactical structures, would decompose into extremely abstract and complex syntactic-semantic deep structures; the features constituting the lexical-syntactical peculiarities of a language would be given as a series of transformations relating the syntactic-semantical deep structures (or “natural logic formulas”) of the “universal base” to their particular realizations in the language in question, similarly for the peculiarities of other human languages.

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For example, instead of relating *women are murdered by men* to an Aspects-type deep structure along the lines of *(men (murder) (women) )* which will serve as input to the semantic component, a generative semanticist will suppose that the ultimate syntactical deep structure will be, minus some complicated bracketing, something like *cause to become not alive—men—women* (where *cause to become not alive* is to be understood, not as English, but as the lexical decomposition of the English lexeme “murder” into the non-terminal semantic primitives, or atomic predicates, that are universal to human thought). For another example, the generative semanticist argues that just as an Aspects-type syntax can explain the fighting stopped to be generated from a deep structure in which the logical subject (those who fight) appears, so it ought to be amended to explain that *John received a letter* derives, ultimately, from a syntactic-semantical deep structure more on the lines of *someone sent John a letter*, in which the “real” logical subject appears. In both cases, the step beyond Aspects is that syntax is not conceived of as rules specifying how the words (or *formatives*) of a particular language can be combined; rather, syntax operates first in combining universal conceptual elements into natural logic formulas (the universal base) and these formulas are transformed, by universal and specific rules, into particular sentences, composed of words peculiar, syntactically and phonologically, to the language in question.

Two other ways in which the generative semanticists have suggested extending the notion of deep structure are derived, with considerable change, from the work of the Oxford philosophers, J. L. Austin and P. F. Strawson. Austin (1962) coined the term *formatives* for utterances such as *I promise to return your book tomorrow* which are characteristically present tense, first person, with a verb that names the *speech act* actually done by the person who says the performative (in appropriate circumstances)—a case of *doing*, as opposed to saying, things with words. But Austin subsequently came to emphasize that there was a performative element (or “doing”) in any utterance. To say *I state that I was there* is to do something, namely the act
of stating. To say I was there is also to do something: again, the act of stating. Austin, who probably derived his emphasis on doing things with words from a similar emphasis in the leading British linguist of his generation, J. R. Firth, and who read Bloomfield with sympathy, never wrote anything to suggest that I state that I was there might be, as a matter of syntax, something like the deep structure of I was there.

Austin, though he died before the publication of Aspects, was notably unsympathetic to notions like deep structure found in the work of philosophers. But it is easy enough to see that since generative semanticists are in principle inclined to the view that such a linguistic, presumably semantic, phenomenon ought to appear in syntax, it would be very tempting to suppose that every declarative sentence (used in a declarative speech act) had, as a matter of syntax, a deep structure somewhat along the lines of I say (declare, communicate, etc.) to you that followed by the surface declarative, which is derived by some transformation that deletes the deep-structure performative element. To pass muster, of course, this performative analysis, primarily associated with Chomsky's colleague J. R. Ross, must be supported by specific syntactical arguments. Ross (1970) gives a number of arguments purporting to show that a syntax will generate the sentence of English more simply and revealingly if such deep performatives are assumed. I will not say anything about these arguments—Chomsky has expressed skepticism about them—except to say that they are similar to the much simpler argument that since syntax must generate you suit yourself and not *she suit herself, etc., one can compactly explain the similar status of suit yourself and *suit herself, etc. by assuming that they would derive from the deep structures underlying the longer sentences by some deletion transformation.

Strawson, in various publications, has made popular the notion that part of the logical, or semantic, analysis of sentences should consist of a specification of the presuppositions made by those who issue such utterances. The statement 'John's children are asleep' presupposes that John has children, etc., and states that those presupposed children are asleep. If John's children are awake, what is stated is false; if John has no children, it is not so much that the utterance is false as that it is void, odd,

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or whatever, through the failure of its presupposition. In Strawson's classic essay on the notion of presupposition, "On Referring" (1950), he claims that utterance of The present king of France is bald presupposes, rather than states, that France has a king; whereas it states, rather than presupposes, that the presupposed individual is bald. Strawson was criticizing Bertrand Russell's famous analysis, in "On Denoting" (1904), of such definite descriptions and their logical form (or what was sometimes called, long before transformational grammarians appeared, deep grammar). Russell, in an analysis that may remind the reader of Chomsky's analysis of Invisible God created the visible world, claimed that though the sentence superficially consisted of a subject, the present king of France, and predicate, is bald, its logical form was equivalent to three propositions (1) there is a (present) king of France; (2) there is no more than one king of France; and (3) he is bald. Russell maintained that, in uttering The present king of France is bald, one stated all three of these propositions. Strawson claimed that (1) and (2) were presupposed, and only (3) was stated.

Strawson held that presuppositions belonged to statements (made through the use of sentences). But the generative semanticists have applied the doctrine to sentences directly, maintaining that the full grammatical specification of a sentence should indicate its presuppositions. Among the generative semanticists, George Lakoff has been the most prominently concerned with presuppositions. He is responsible for the remarkable claim, mentioned earlier (p. 31), that (10) is ungrammatical unless, in keeping with the presupposition of the sentence, one is sympathetic to the New Left.

(10) John called Mary a Republican and then she insulted him

In principle, the generative semanticists suppose that the generative device that will generate all and only the sentences of English will provide them, through the steps in the generation of these sentences, with a specification such that one will obtain a full indication of all that such sentences could be said to mean, i.e., all their logical and semantical properties. They have purported to set about proving this supposition, as I have intimated,
through grammatical analyses that seem to the unsophisticated observer to rest on extremely subtle and idiosyncratic (and theory-serving) judgments about ungrammaticality.

George Lakoff, for example, appeals to his audience to find that one of the two following sentences is obviously ungrammatical while the other is, equally obviously, grammatical:

(45) Last night I dreamed that I was Brigitte Bardot and I kissed me

(46) Last night I dreamed that I was Brigitte Bardot and I kissed myself

As one follows his appeals, respecting other sentences involving imaginary situations, to our supposedly immediate, untutored intuitions of grammaticality and ungrammaticality, most of which is equally baffling, the suspicion grows that the theory is wagging the evidence. Lakoff is inclined to accept a rather contentious, and certainly esoteric, doctrine held by some modal logicians to the effect that, when we talk about imaginary situations, or “possible worlds,” it does not make sense, logically, to talk about what might happen to individuals of this world in such imagined worlds—it only makes sense, logically, to talk about what might then happen to counterparts, individuals who are only very similar, that is, to the individuals of this real world of ours. Granted counterpart theory and some fairly recent transformationalist views about the difference between the way in which “me” and “myself” acquire reference, Lakoff would have to conclude that one, but not the other, of these sentences is logically senseless (and could not be represented by a well-formed formula in a counterpart-theory modal logic).

Hence—one finds it terrible not to suspect something of the sort—the pressure to begin to feel that the sentence somehow sounds odd, ill-formed, or ungrammatical becomes enormous (any sentence that one says over and over again is likely to sound odd: if one’s theory suggests that a fluent speaker should find certain sentences odd and ungrammatical and that the speaker’s unreflective, intuitive perception that they are ungrammatical is evidence for the theory, then one will find it very difficult to resist feeling that one’s own unreflective, intuit-
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stood as nothing more than talk about human physical behavior, posed in idioms that don't normally confuse people (excepting Cartesian philosophers), that is, involving no concepts, abstractions, or forms of explanation that essentially diverge from those of the nonpsychological sciences. But Ryle, whose antimentalist answer is affirmative, often writes as if this were just a question of the "linguistic meaning" of what we say, in English, about human beings: if we know the English language (without assuming any covert philosophic principles), we know that what we mean, in talk about psychological behavior, is logically (or linguistically) equivalent to talk about physical behavior.

If we accept the analytic philosopher's viewpoint sketched above, it would seem hard not to conclude that the generative semanticists will simply, in giving the syntax of English, decide the philosophic question as to whether Descartes, properly interpreted, or Ryle is right (i.e., as to whether mentalism or behaviorism is correct, or as to whether rationalism or empiricism in a broader sense is right or wrong). And, presumably, they will similarly decide all other questions of analytic philosophy. Of course, I will concede that it is possible for linguists to provide partial characterizations of the logicosemantic features of languages and discourse, just as it is possible in composition and introductory logic courses to give nonphilosophic (or philosophically uncontentious) characterizations of this sort. But the characteristic feature of questions of logic and meaning that concern philosophers is that they are not of this sort. Rather they inevitably involve empirical suppositions about the general character of the universe and the structure of the sciences, that is they involve, as in effect they must, a resolution and refinement of the loose, adaptable, multipurposed structure of portions of natural language in accord with such theoretical suppositions.

I will say more about these questions when I deal with Chomsky's defense of philosophical rationalism more directly (it will become clear that Chomsky wishes to deny the analytic reconstruction of Descartes just sketched—his defense is of the unreconstructed "metaphysical" position taken as a set of very general empirical and scientific claims about human beings and their psychological characterization). For the moment, let me

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say one thing in anticipation: given that I am generalizing in a crude and somewhat selective way, it makes sense to say that if the basic commitments commonly put forward as generative semantics and as analytic philosophy are accepted, it is reasonable to conclude that linguists’ syntactical characterizations of human languages will provide answers to all (genuine) philosophical problems. The conclusion I want to draw from this—which is, I will try to argue, both in keeping with aspects of Chomsky’s thought and of much recent philosophic criticism of analytic empiricism—is that there is something wrong with the relevant portions of analytic philosophy and of generative semantics. But what I want to do now is to summarize Chomsky’s current interpretive-semanticist position, and, particularly, his specific criticisms of aspects of the generative semanticists’ position.

Simply considering the terms generative semantics and interpretive semantics, one gets a hint that what is at stake is the autonomy, and primary character, of syntax. Chomsky today still echoes the claim of Syntactic Structures that correspondences between syntax and semantics are so complicated that one will do better trying to generate, and so syntactically characterize, the sentences of natural languages (and their phonological realizations) without warping this characterization by including explanations of meaning and use. The semantic component interprets the structures generated by these components; it is dependent on them in the strong sense that it would have nothing to interpret were these components unproductive.

Indeed, in Chomsky’s present view, it seems reasonable to suppose that semantic interpretation will depend not simply on syntactical deep structure (as in Aspects), but also on aspects of surface syntax and even on aspects of phonological structure. There is now a reaction against the pressures, noted in Aspects, to shape syntax to fit semantics, to construct transformations so as to preserve meaning from deep to surface structure, and to formulate the syntactical lexicon in such a way as to radically reduce the generation of senseless, or odd, sentences. Colorless green ideas sleep furiously is once more regarded as grammatical (though semantically anomalous); generally, those who have taken Chomsky’s side in this family dispute have tried to avoid

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depending on judgments of ungrammaticality of a subtle, idiosyncratic, or dubious sort. The change from active to passive is once more recognized to change meaning (at least for quantificational sentences). The way is being sketched to account for aspects of performativeness, presupposition, and various related phenomena as a matter of semantic interpretation at a surface syntactical level, if not in some cases at a phonological level; it is argued, above all, that this way of dealing with language is possibly both simpler and much more revealing—and more definite and testable—than the attempt to cram all this into syntax. In “Some Recent Issues in Semantic Theory” (1970), he writes:

A central idea in much of structural linguistics was that the formal devices of language should be studied independently of their use. The earliest work in transformational-generative grammar took over a version of this thesis, as a working hypothesis. I think it has been a fruitful hypothesis. It seems that grammars contain a substructure of perfectly formal rules operating on phrase-markers in narrowly circumscribed ways. Not only are these rules independent of meaning or sound in their function, but it may also be that the choice of these devices by the language-learner (i.e., the choice of grammar on the basis of data) may be independent, to a significant extent, of conditions of meaning and use. If we could specify the extent precisely, the working hypothesis would become a true empirical hypothesis. Such an effort may be premature. It does, however, seem noteworthy that the extensive studies of meaning and use that have been undertaken in recent years have not—if the foregoing analysis is correct—given any serious indication that questions of meaning and use are involved in the functioning or choice of grammars in ways beyond those considered in the earliest speculations about these matters, say in Chomsky (1957).

(p. 57)

From the point of view of someone interested in the fate of analytic philosophy, in the version I have crudely sketched, the essential point in these extensions (or corrections) of the grammatical theory of Aspects is that we can no longer identify the logical properties of utterances (the basis for semantic interpretation) with any particular level of syntactical (or phonological) structure. Perhaps there is a “natural logic” but it cannot take
its full license from syntax. How a sentence is represented at some phonological level, for example, stress on particular words, can remove ambiguity or determine meaning more fully; equally, various levels of syntactical structure feed the semantic component. Were an analytic philosoper-cum-linguist to say that a sentence was an analytic, or logical, truth, the rejoinder might be: at what level of grammatical structure? However, I should add, Chomsky would still maintain that deep syntactical structure would be the most important level—invisible God created the visible world would reveal its most crucial logical properties, the three propositions of its composition, at the deep syntactical level, whereas the sentence might be said to presuppose God’s invisibility and state his creativity only at some surface structure level.

Chomsky has said, both in the paper quoted above and in other recent papers, that the crucial problem of present transformational-generative grammatical work is that transformational grammars are too powerful. There is not a sufficient number of restrictions on the construction of such grammars, and thus such grammars are not testable against each other (though, of course, they are selected by the evidence, over other sorts of grammars—for example, the transformational grammars of Aspects and Syntactic Structures are inadequate on the evidence, and, of course, phrase-structure and finite-state grammars are certainly inadequate). Many critics, who are quite convinced of the general validity of the transformational-generative approach to language, have made this point; it is a point on which much work must be done. But it is wrong to think of this as a criticism of any stage in Chomsky’s development of transformational-generative grammar. Chomsky has always maintained that this was the crucial area for work in linguistic theory. The fundamental problem of linguistic theory is to describe the essential, as against purely happenstance, features of natural (human) language in as circumscribed a way as possible. In other words, to approach explanatory adequacy by accounting for the choice of a particular grammar on the part of a human language-learner given the data about the particular human language that he is exposed to is to specify the software of man’s language acquisition device.

The problem is not how a universal thinking machine, pro-
which prohibits transformations that move material in or out of various conjunctive structures, is probably universal. But he has emphasized, particularly in his most recent papers, that the confident identification of particular universals is not possible at this point.

CHAPTER 3

Psychology, Philosophy, Politics

Of course, we have been talking about these three topics all along; for Chomskyan linguistics is above all an attempt to characterize a significant portion of human psychology (as, substantially, the study of the software of human nature), and this sort of characterization can be seen as establishing some of the claims of traditional rationalism. The view of man that results might be thought to have political significance.

In this final chapter I want to talk about what Chomsky’s work may mean for psychology, philosophy, and politics; about his views of these subjects, particularly as ramifications and interpretations of his work in linguistics; about the work in these fields that is convergent with his approach; and about various criticisms and misunderstandings that have been made respecting his general rationalist view of man. Psychology, philosophy, and politics are not strange bedfellows, in Chomsky’s view, and this attitude makes many people find Chomsky’s work exciting and important (or infuriatingly pretentious and misguided). If anything has been characteristic of analytic philosophy, or the rather more traditional (and perhaps less subtle) empiricism, and behaviorism, that has been very common among social and psychological scientists of all sorts, it is the hardly questioned conviction that no psychological discovery, no psychological fact, can establish, or refute, any philosophic claim (and the reverse), and that neither can properly determine the answer to any political question (at least in Aristotle’s sense of politics as the practical job of deciding, and achieving, what is good for man, within and between nation states).

In part, of course, this subconscious positivism has been a result of the increasing professionalization of knowledge: our century has seen the concentration of all theoretical scientific and intellectual activity in the university, which is divided into