

Chomsky's Nativism: A Critical Review

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Is grammar innate? Noam Chomsky holds that it is, or, more accurately, that the hypothesis that it is innate is the only coherent and plausible one that has yet been proposed to account for the acquisition of language. Extrapolating to broader issues, he has championed a retreat from behaviorism and empiricism to cognitivism and rationalism, from approaches that seek to determine the relationship between an organism's behavior and the environment to those that wish to discover the organism's "essential nature," of which behavior is an incomplete expression. His arguments, which are detailed, polemical, and persuasive, are evidently inspiring to a thriving school of linguists and to many laymen with an interest in language and philosophy. It is important to assess his position carefully, not only because he concludes that little is to be gained by pursuing the analysis of verbal behavior with the assumptions and methodology of radical behaviorism but because he claims to have achieved considerable success with very different assumptions and methodology. Success in explaining complex behavior deserves our attention whatever the approach.

When we examine Chomsky's position, however, we find that, not only are his objections to other approaches weak, but the success of which he speaks has been achieved by rendering other problems more difficult, if not

completely insoluble. This paper outlines Chomsky's position, emphasizing his argument that the brain of the newborn infant must be organized to extract rules of grammar from samples of speech. This position is criticized on two grounds. First, it places too heavy a burden on evolutionary principles. Second, the putative innate mechanisms must respond to stimuli, to actual physical events, but it appears to be impossible in Chomsky's system to characterize these events. Finally, Chomsky's sophisticated arguments against behavioral accounts of language are rejected on grounds that he has confused properties of his formal system with properties of human beings. The notion that language consists of an infinite number of sentences must be abandoned when we move from the rarefied atmosphere of formal analysis to the world of stimulus and response classes.

CHOMSKY'S ASSUMPTIONS

Chomsky shares a number of fundamental assumptions with behaviorists and other experimental psychologists. He believes that organisms are a joint product of their genetic endowment and individual experience and that the experimental approach of the natural sciences is appropriate for the study of language. He is tentatively monistic; while he freely uses mentalistic terminology, he does so for the sake of convenience, believing these terms to be abstractions of physical structures or processes in the body, presumably the brain (see Chomsky, 1980b, for a recent review of his position). His goals, however, are different from those of behaviorists. He is not particularly interested in verbal behavior itself, influenced as it is by the

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idiosyncratic history and circumstances of the speaker; rather, he is interested in the "essential nature" of human beings that enables us to acquire a language. Specifically, Chomsky wishes to discover those elements of our nervous systems implicated in language that are genetically coded, hence "universal." Chomsky calls these elements "universal grammar," a name that suggests his view of the task accomplished by these innate mechanisms: providing a set of rules to be used in speech production and comprehension.

Chomsky is not dogmatic about the nature of universal grammar, so defined. He concedes that it may prove to be some general-purpose reinforcement mechanism, but this strikes him as implausible. Just as cells in the visual cortex are organized in special ways not characteristic of cells controlling, say, digestion, those elements of the nervous system responsible for our ability to acquire language should not be expected to be organized in the same way as those implicated in learning to ride a bicycle. The language system, the visual system, and no doubt other systems, he asserts, may be modular.

Chomsky's interest in species differences is not what makes his views controversial. Species differences, of course, are of as much interest to behaviorists as to linguists. A child learns to speak, and the family dog does not. No one doubts that this is due to genetic differences, and any illumination of these differences will contribute to our understanding of the behavior of organisms. Direct evidence of the genetic contribution to human behavior is hard to acquire, however. Programs of genetic engineering, surgical intrusions of the nervous system, and well-controlled behavioral experiments are, for ethical reasons, seldom possible. We must usually make do with speculation and extrapolation from indirect evidence. It is Chomsky's particular speculations and his rejection of alternative speculations that are controversial.

A TERMINOLOGICAL QUIBBLE

To begin with, we may object to Chomsky's terminology, particularly his use of the term "universal grammar" to refer to unspecified innate properties of the nervous system. A writer is free to define his terms as he chooses, but as Winograd (1977) has pointed out, the reader who has agreed to Chomsky's definition finds, in subsequent discussion, that he has agreed to some kind of innate grammar in the traditional sense of the term, i.e., a set of rules. This lends a spurious cogency to Chomsky's argument. Additionally, Chomsky freely uses mentalistic terms such as intention, belief, purpose, will, and mind without defining them. Occasionally he indicates that he is merely talking about properties of the nervous system, but he does not tell us where in the nervous system we will find the mind with its intentions, beliefs, and will. As a consequence, his discussions remain abstract and metaphorical, apparently awaiting the day that someone can operationalize his terms without endangering the formal system that has been erected on this terminological quicksand.

Even within the formal system itself, Chomsky's terms are not always clearly defined. A language, we are told, is "a set (finite or infinite) of sentences, each finite in length and constructed out of a finite set of elements" (Chomsky, 1957, p. 13). Subsequently, we learn that human languages are infinite sets of sentences. But what is a sentence? Chomsky uses two definitions of *sentence*, a formal, precise one and an informal one, and he does not consistently use either one. The informal definition is simply that which native speakers agree to be a sentence when they are not encumbered by "irrelevant" problems of memory, motivation, time, or patience. This is a relatively small set owing, apparently, to the ubiquity of these encumbrances. By the formal definition, a sentence is any string of symbols characterized by the grammatical rules devised by the

linguist. At the very least, these grammatical rules must be consistent with the set of sentences defined by consensus. Thus, the formal definition is derived from data provided by using the informal definition, and both definitions depend ultimately upon the grammatical intuitions of native speakers. However, Chomsky does not provide us with criteria for deciding when a judgment of grammaticality is to be considered valid, an important omission considering that these judgments are notoriously variable.

ARGUMENTS FOR A GENETICALLY DETERMINED GRAMMAR

One could argue that these terminological issues are irrelevant to evaluate the substance of Chomsky's position, particularly his argument that there is an innate language module. So let us turn to this critical argument. As noted above, his unit of analysis is the sentence, and his data are his judgments, and presumably the judgments of others, that particular sentences are or are not "well-formed." (He is not concerned with prescriptive rules of grammar, such as proper use of the objective case, but with regularities in language that are respected by native speakers without formal training.) Thus, (1) is a well-formed sentence, while (2) is not:

(1) *Is the man who is hungry here?*

(2) *Is the man who hungry is here?*

Similarly, (3), (4), and (5) are well-formed, while (6) is not, though its meaning is reasonably clear:

(3) *Each of the men likes the others.*

(4) *The men like each other.*

(5) *Each of the men expects John to like the others.*

(6) *The men expect John to like each other.*

What is it, Chomsky asks, that prevents people from uttering sentences such as (6)? Surely no one has been taught such things in grammar school.

It can hardly be maintained that children learning English receive specific instruction

about these matters, or even that they are provided with relevant experience that informs them that they should not make the obvious inductive generalization, say, that "each other" takes some plural antecedent that precedes it. Children make many errors in language learning, but they do not assume, until corrected, that "The candidates wanted me to vote for each other" is a well-formed sentence meaning that each candidate wanted me to vote for the other. Relevant evidence is never presented for most speakers of English, just as no pedagogic or traditional grammar, however compendious, would point out these facts. Somehow this is information that children themselves bring to the process of language acquisition as part of their mode of cognition. (Chomsky, 1980b, pp. 43-44)

A similar problem is raised by "question formation":

We select some noun phrase in a sentence, replace it by an appropriate question word, place the latter at the beginning of the sentence, and with other mechanical operations, form a question. Thus on the model of the sentence, "John saw a man," we can form "Whom did John see?" Or, to take a more complex case, on the model of the sentence, "The teacher thought that his assistant had told the class to study the lesson," we can question "the class" and ask: "Which class did the teacher think that his assistant had told to study the lesson?" But consider the following example of roughly comparable complexity: "The lesson was harder than the teacher had told the class it would be." Here, if we question "the class," we derive: "Which class was the lesson harder than the teacher had told that it would be?" Evidently this is not a well-formed question, though its intended sense is clear enough and perfectly intelligible, with a little thought. It is difficult to imagine that people capable of these judgments have all had relevant training or experience to block the obvious inductive generalization. Rather it seems that some specific property of the human language faculty—hence a general property of language—leads to these consequences, a property that derives from our modes of cognition. (Chomsky, 1980b, p. 42)

When we analyze the structure of language at a certain level of abstraction, according to Chomsky, we discover that there are general principles of grammar that are violated in sentences such as (6), for example, the principle that a reciprocal expression such as "each other" may not refer to

an antecedent outside of the clause in which “each other” occurs unless the latter happens to be the subject of an infinitive (Chomsky, 1980b, p. 174), as in (7). Note that (8) is ungrammatical according to this principle:

(7) *The candidates expect each other to win.*

(8) *The candidates expect each other will win.*

Because children quickly learn to respect such distinctions with little, if any, formal instructions, and because no one has proposed a satisfactory explanation of these facts in terms of a theory of learning, Chomsky assumes that fundamental elements of the grammar of human languages must be expressed somehow in the genetic code. He suggests that universal grammar, triggered by relatively brief exposure to a particular language, is able to extract or construct a grammar for that language. Universal grammar presumably contains those fundamental principles that are common to all human languages and constrains the particular grammars that can be acquired.

Grammar is seen as fundamental; “language” is an epiphenomenon influenced by motivational variables, memory, nonlinguistic concept learning, and other things. The task of the linguist is to characterize abstractly grammars of various languages as they would be spoken by ideal speakers in a homogeneous verbal community in an attempt to discover principles of grammar of wide generality, if not universality. Work of this sort has been in progress for several decades and, according to Chomsky, has met with considerable success. He concedes that conclusions are tentative and will undoubtedly be refined or replaced, a state of affairs to be expected in any empirical inquiry. Nonetheless, linguists are becoming increasingly able to characterize universal grammar and hence to offer hypotheses about the capacities that newborn infants bring into the world as a product of their genetic endowments.

In the current form of Chomsky’s

theory, a given sentence is presumed to be “represented in the mind” at several levels. It begins as a declarative sentence, with expressed (as opposed to “understood”) subjects, verbs, direct objects, and so on. Elements of the sentence may then be deleted or rearranged subject to various constraints such as those governing reciprocal expressions like “each other.” At this level the sentence includes “traces” of deleted and rearranged elements in their original positions as well as the rearranged elements in their new positions. Finally, the surface structure, the sentence as it appears at the behavioral level, is generated by representing phonetically all elements except trace elements. This scheme accounts for intuitions about relatedness among sentences, ambiguities, and many fine distinctions about what is grammatical and what is not.

This picture is incomplete, of course, but Chomsky asserts that it stands in sharp contrast to alternative theories which do not even attempt to explain the kinds of grammatical judgments people are capable of, judgments which have served as grist for the theories of linguists. Chomsky writes:

The critic’s task is to show some fundamental flaw in principle or defect in execution or to provide a different and preferable account of how it is that what speakers do is in accordance with certain rules or is described by these rules, an account that does not attribute to them mental representation of a system of rules (rules which in fact appear to be beyond the level of consciousness). If someone can offer such an account of how it is that we know what we do know, e.g. about reciprocals, or judge as we do judge, etc., there will be something to discuss. Since no such account has been forthcoming, even in the most primitive or rudimentary form, there really is nothing to discuss. (1980b, p. 130)

CHOMSKY’S CHALLENGE

One need not be disconcerted by this challenge. Chomsky is charging his critics to provide an alternative explanation for hypothetical behavior, the

behavior of judging particular sentences grammatical or ungrammatical. He evidently believes that everyone will respond in the same way and for the same reason, that is, that there is an independent variable called "grammaticality" that controls the behavior of anyone asked to judge utterances. Since judgments of grammaticality are in fact highly variable, he insists that we consider only the behavior of an ideal speaker in a homogeneous verbal community.

Analogous idealizations have been adopted in other sciences. When many variables interact, it is common practice to consider each in isolation. Hence the physicist assumes point masses, frictionless surfaces, and perfectly elastic collisions. However, these idealizations are useful only if the variables being omitted are unimportant for an understanding of the phenomenon under study. If one's verbal behavior and judgments about utterances are in fact a function of the individual's particular experience within a specific community, then considering the intuitions of an ideal speaker in a hypothetical community will tell us nothing. Faced with disorderly data, Chomsky removes to a hypothetical world where order emerges. It is not surprising that no one has proposed an alternative account, for this is a world of Chomsky's own making. Order has not been demonstrated; it has been assumed.

However, even if we satisfactorily demonstrate that instances like those provided by Chomsky are not universal the task remains of explaining why certain novel expressions "sound right" to someone while others do not. From a behavioral point of view the task is formidable, requiring that we know a great deal about the individual's reinforcement history—more than it is usually possible to know. We would have to determine appropriate units of behavior and the individual's history with respect to these units. We might find, for example, that "each other," though two words, is a single operant or that the frame "X . . . Y . . . each

other" is a single operant, where X and Y have certain prosodic, temporal, functional, and perhaps formal features but are otherwise free to vary. (We would resist the temptation to call X "a plural noun phrase" and Y "a verb," for that merely raises the question of what the formal, functional, prosodic, and temporal characteristics are of plural noun phrases and verbs.) We might find that "each other" is a component of half a dozen larger units or that it is under intraverbal control of a number of stimuli. In the latter case a number of different operants would be formally identical.

Once relevant units of behavior and their controlling variables were identified it would be possible to speculate whether a particular utterance would sound natural or strange to an individual. Since the value of such a prediction by no means justifies the effort to gather the relevant data, it is unlikely that anyone will answer Chomsky's challenge. (We can, of course, invent contingencies to explain any given example, but he would regard this as empty.) Nonetheless, there are alternatives to Chomsky's account that depend, not on internal representations or underlying competence, but on the individual's long history with relevant verbal operants. It is hard to see how it could be otherwise, for we have no intuitions about strings of grammatical symbols by themselves or about sentence tree diagrams. Despite Chomsky's suggestion that intuitions about a full range of uses of the term "each other" follow from learning that it is a reciprocal expression and not the name of a tree, surely we have no intuitions about strings of nonsense syllables drawn from bins labeled "noun," "verb," "reciprocal expression," and so on. Knowing grammatical categories is no help in judging utterances "by ear."

As for a "flaw in principle" that Chomsky exhorts his critics to cite, there appears to be none. There are no objections in principle to the notion, however vague, that the nervous sys-

tem is innately designed to extract a grammar from a sample of speech, but we can question the extent to which this serves as a parsimonious explanation of verbal behavior. Rather than shedding light on the problem, it renders it more mysterious.

Chomsky begins by characterizing grammar in formal terms. Having achieved some success at this he then simply imputes the formal apparatus to the speaker as an innate mechanism. This is a tidy solution to a complex problem, and it might even be true, but note that, as it stands, it is a homunculus theory, and as such, it is unsatisfactory until the homunculus has in turn been explained. The genetic endowment is a convenient source of homunculi for every behavioral phenomenon we don't understand. If we ask nothing further of such an explanation then it is a universal solution. There are no limits to our invoking it. Two questions immediately arise to which Chomsky has provided no satisfactory answer. First, how did universal grammar get selected, and second, how does universal grammar get "triggered" by a verbal environment?

UNIVERSAL GRAMMAR AND EVOLUTION

Certain grammatical conventions serve a communicative function and might be learned because they do so. Other principles are arbitrary and seem to have little point, such as that concerning reciprocal expressions. Of this principle, Chomsky (1975, p. 175) writes, "It is often a difficult problem even to discover examples that bear on the hypothesis in question." It is principles such as this that Chomsky argues must be innate: The examples are few and the grammatical rules are arbitrary and unnecessary. But this is an argument that cuts both ways; the same evidence that he adduces to support his position can be used in a parallel argument against it. If a grammatical principle is an arbitrary restriction without practical consequences in the

ontogenic environment and hence cannot be accounted for in terms of communicative contingencies (Chomsky, 1980a, p. 41), then it clearly cannot confer a selective advantage to an organism endowed with it. Chomsky acknowledges this problem but points out that a child has only a few years to construct a grammar while the principle of natural selection has had many thousands of years (Chomsky, 1980c, p. 44). This will not suffice, however. If the rules are arbitrary it doesn't make any difference how long selective forces have been at work. Natural selection is simply not an appropriate mechanism to explain universal grammar.

This conclusion does not trouble Chomsky. He writes:

It is, in fact, perfectly possible that the innate structure of mind is determined by principles of organization, by physical conditions, even by physical laws that are now quite unknown, and that such notions as "random mutation" and "natural selection" are as much a cover for ignorance as the somewhat analogous notions of "trial and error," and "conditioning," "reinforcement," and "association." (Chomsky, 1969, p. 262)

Again, Chomsky might be right that there are additional principles involved, but this hardly offers support for his position. Rather, it adds a further burden of proof. In addition to explaining the origins of grammar, he must now formulate and explain the workings of new evolutionary principles or "physical laws now quite unknown."

Perhaps not wanting to depend on unknown principles, Chomsky has suggested another solution:

[Universal grammar] may well have arisen as a concomitant of structural properties of the brain that developed for other reasons. Suppose that there was selection for bigger brains, more cortical surface, hemispheric specialization for analytic processing, or many other structural properties that can be imagined. The brain that evolved might have all sorts of special properties that are not individually selected; there would be no miracle in this, but only the normal workings of evolution. We have no idea, at pres-

ent, how physical laws apply when 10^{10} neurons are placed in an object the size of a basketball, under the conditions that arose during human evolution. (Chomsky, 1980a, p. 321)

It is certainly true that not everything coded by the genes must be adaptive. Hair color, eye color, and blood type are all genetically determined and are not obviously adaptive, but neither are they universal. When a trait is not actively selected for, we expect variability, not universality. Moreover, to the extent that arbitrary structures require energy and resources, we would expect them to be selected *against*.

The chances that a universal grammar was an accidental by-product of other properties of the nervous system, an unexpected bonus when the human nervous system exploded in size, seem remote indeed, given how abstract and complex the putative innate rules are. Moreover, in the absence of suggestions about the structure of which grammar is a by-product, and what the relationship between them is, Chomsky's answer is no answer at all. We might just as plausibly assert that language is an accidental by-product of other behavior acquired in the first few years of life.

Chomsky (1980a, 1980b) repeatedly asserts that the problem of explaining the genetic basis of universal grammar is no different from the problem of explaining the origin of any physical organ, say, the liver. No one ever asserts that we learn to have arms rather than wings, or that we learn to have a heart, he argues. No doubt there are many things that we don't know about the origin and development of the physical organs, but to be confident that the genetic endowment exerts considerable control, surely it is sufficient to note that such structures are adaptive and that they are, in fact, physical structures.

A hypothesis about behavior need not specify physiological correlates or evolutionary origins to be useful, but a complex structure with no adaptive significance is anomalous. In contrast,

functional analyses of verbal behavior (e.g., Skinner, 1957) require few, if any, principles in addition to those already known to apply to nonverbal behavior; moreover, these principles are clearly adaptive (Skinner, 1966), and apply with appropriate qualification down the evolutionary ladder. Humans have the necessary vocal musculature and are particularly sensitive to secondary reinforcement, social contingencies, and, apparently, private stimuli generated by other behavior. These are quantitative differences from other organisms that are both adaptive and easily accommodated by evolutionary principles. These differences alone may be sufficient to account for verbal behavior in humans.¹ Chomsky, in attributing grammatical competence to the newborn infant, has not solved the problems of language acquisition; he has simply transferred them to the shoulders of the evolutionary biologist, where they remain as intractable as before.

THE STIMULUS CONTROL OF INNATE BEHAVIOR

An additional difficulty facing Chomsky's position is perhaps more fundamental. Let us assume that he is correct, that humans are innately equipped with a neurological module that extracts an acceptable grammar from a small and degenerate sample of speech, triggered perhaps by critical experiences and with parameters set by

¹ The development of vocal musculature sensitive to reinforcement contingencies may be especially significant. First, it is a response system that is free from the demands of locomotion, orientation, and the manipulation of objects. Primates usually have plenty to do with their hands other than sign with them. Second, and perhaps more importantly, when we speak, we stimulate ourselves exactly as we stimulate others, and we do so essentially instantaneously. This immediate and faithful stimulation, which is not characteristic of, say, sign language, is no doubt important both in maintaining somewhat uniform contingencies throughout the community and in facilitating the acquisition of verbal operants. Under some conditions, reinforcement will be "automatic."

developments in "other cognitive domains." Subsequent performance is a hodgepodge of behavior, an epiphenomenon, determined in part by the grammatical module and in part by many other factors. The problem that now arises is the relationship between "degenerate speech" and the device that extracts a grammar from this speech. The putative device is an input-output device. In go samples of speech, and out comes the grammar, or perhaps a set of candidate grammars, most of which will be winnowed out later. Setting aside the improbability that such a device is an accidental by-product of, say, increased cortical surface, we must determine the functional relationship between this input and output. This can be considered a kind of problem in stimulus control, since each verbal stimulus controls a particular response of the device, as in a reflex. However, unlike the reflex, the relationship between stimuli and the grammar is arbitrary. Languages vary from culture to culture, and within a language there is no relationship between the sound of an utterance and its grammatical structure. Clearly there is no physical property of the stimulus that suffices to identify its part of speech. Nothing about the word *house* enables us to conclude that it is a noun, or that it might be a "subject."

The input to this device, then, must be the product of a grammatical analysis rather than raw stimuli. At the very least, words must be classified into their parts of speech. But parts of speech have formal definitions; they do not have operational ones. Nouns are often uttered in the presence of "things" and verbs in the presence of activity, but many nouns are not "things," and many verbs are not perceptible actions. Perhaps when a child utters a particular word in the presence of a particular class of objects (or state of affairs) and is reliably reinforced for doing so, that acoustical signal is represented and tagged with an "N." Thus every grammatical distinction might be traced to a particular set of reinforce-

ment contingencies. This is unsatisfactory, since we still do not end up with a class of symbols that coincides with the concept *noun*. We do, however, end up with a repertoire of behavior that coincides precisely with Skinner's concept of *tact*. Once grammatical distinctions are traced to contingencies of reinforcement, the innate grammar is no longer doing any work. On the other hand, if they cannot be traced to reinforcement contingencies, then the child (or the innate mechanism) has no way of generating a grammar.

Chomsky's allusions to imprinting and fixed-action patterns as examples of complex innate behavior (1959, pp. 41-43) suggest that he fails to appreciate that these behaviors do not occur spontaneously but are elicited by specific stimuli. Herring gull chicks do not "peck at their mothers' bills to get food"; they peck at red spots. Ducklings do not "follow their mothers"; they are reinforced by proximity to objects similar to the particular object that was bustling around when they hatched. If we wish to say that a particular behavior is genetically determined or "wired in," it must be possible to specify the environmental events that elicit, release, or trigger it. Not only has Chomsky failed to do this for his hypothetical grammar-generating device, he apparently thinks it cannot be done:

Although one might propose various operational tests for acceptability, it is unlikely that a necessary and sufficient operational criterion might be invented for the much more abstract and far more important notion of grammaticality. (Chomsky, 1965, p. 11)

Furthermore, there is no reason to expect that reliable operational criteria for the deeper and more important theoretical notions of linguistics (such as *grammaticality* and *paraphrase*) will ever be forthcoming. (Chomsky, 1965, p. 19)

If there are no stimuli, objective criteria, or even a set of operations by which we (or our innate language acquisition devices) can identify such theoretical entities as *grammatical sentence*, *subject*, *noun phrase*, and so on,

then it is a mystery how we can reflexively generate rules characterizing permissible relationships among these entities. Chomsky has been able to formulate precisely his theoretical ideas because they have remained abstract, but useful theories cannot remain abstract forever. If there is no way to use them to predict, control, or describe actual events, then they are empty.

THE UNIT OF ANALYSIS AND THE NOTION OF INFINITY

The choice of a unit of analysis in behavior is critical. The orderly relationship between behavior and its controlling variables deteriorates if we consider units that are too broad, too long, or too narrowly specified (Skinner, 1935). If one defines one's units a priori rather than empirically, it is possible that behavior will appear to be infinitely variable and to bear little relationship to environmental events. Chomsky commits this error by choosing the sentence as a unit of analysis. He does not defend this choice; he appears to regard it as self-evident, despite the fact that people often do not speak in sentences and in appropriate contexts regard single words or phrases as "well-formed." As noted above, the sentence is a formal unit, not a behavioral one, though Chomsky pays little heed to this distinction. Since the speaking of sentences, however defined, typically does not display the same dynamic properties as, say, key pecking in pigeons, he concludes, not that he has erred in his choice of units, but that principles formulated in the experimental analysis of behavior are of only peripheral interest in the study of language.

Of special significance to Chomsky is the notion that humans have the capacity to speak and understand an infinite number of grammatical sentences, though actual performance is limited by motivation, memory, time, and other resources. There is no limit to the number of adjectives we can insert be-

fore a noun, or to the number of times we can repeat the word *very* for emphasis; nor is there any limit to the number of sentences or clauses that we can add or insert in other sentences, as in (9) and (10):

(9) The rat the cat the dog chased killed ate the malt.

(10) Anyone who feels that if so many students whom we haven't actually admitted are sitting in on the course than ones we have that the room had to be changed, then probably auditors will have to be excluded, is likely to agree that the curriculum needs revision. (from Chomsky & Miller, 1963, p. 286)

Although native speakers gape in dismay when asked if (10) is a grammatical sentence, the authors assure us that this "is a perfectly well-formed sentence with a clear and unambiguous meaning, and a grammar must be able to account for it if the grammar is to have any psychological relevance" (p. 286). However, it is obvious that such sentences are not behavioral units but are strings carefully constructed to be consistent with grammatical rules. It is true that there are an infinite number of such strings, but their relevance to verbal behavior is doubtful. Nevertheless, Chomsky uses the notion that there are an infinite number of grammatical sentences to dismiss the use of the term *probability* in discussions of language and particularly to criticize Skinner's analysis of language as a repertoire of verbal operants:

It is unclear what sense there would be to the assertion that a person has "learned" a sentence that takes twice as long to say as his entire lifetime. . . . On empirical grounds, the probability of my producing some given sentence of English—say, this sentence or the sentence "Birds fly" or "Tuesday follows Monday," or whatever—is indistinguishable from the probability of my producing a given sentence of Japanese. Introducing the notion of "probability relative to a situation" changes nothing, at least if "situations" are characterized on any known objective grounds. (Chomsky, 1969, p. 267)

But what does it mean to say that some sentence of English that I have never heard or produced belongs to my "repertoire,"

but not any sentence of Chinese (so that the former has a higher "probability")? (Chomsky, 1971, p. 20)

According to Chomsky this follows from the fact that most sentences are unique and hence have a probability near zero.

Chomsky is making an extraordinary leap from asserting that a grammar can generate an infinite number of sentences to asserting that humans have the competence to generate and understand an infinite number of sentences. This is clearly not an empirical fact. It is not even a valid generalization from the empirical fact that behavior is variable. Let us suppose that we have arrived at a definition of *sentence* that allows us to determine when a sentence has been uttered. We have no justification for predicting future variability until we analyze the variables of which a sentence is a function. If we can show that these are infinitely variable, and that human behavior tracks the full range of this variability, then we are perhaps justified in predicting the infinite variability of sentences. However, behavior and its controlling variables are not divisible into an infinite number of orderly pairs, a point made by Skinner as early as 1935. We can illustrate the point by considering the "language" of honey bees.

As is well known, a bee, having returned from successful foraging, will fly in a pattern with a distinctive orientation, depending on the position of the sun and the location of the food source. Other bees, observing this pattern, will successfully locate the food source. As a circle has an infinite number of diameters, so there are an infinite number of orientations of a pattern of flight. Undoubtedly no two bee "sentences" have ever been identical. However, this variability is irrelevant if it is not functionally related to the location of the food. Clearly no honey bee can discriminate an infinite number of patterns, either as a "speaker" or as a "listener." Although an abstract characterization of bee communication could generate an infinite number of

"sentences," it is likely that bees generate or respond appropriately to more than a hundred or so. (Note that since bees have other ways of locating flowers, this number would be more than sufficient to satisfy the contingencies of natural selection.) To argue that bees have the "competence" to interpret an infinite number of patterns is to confuse a property of our formulation with a property of the organism.

We can make a similar argument with respect to human language. Sentence (11) is indiscriminable from (10) in normal discourse.

(11) *Anyone who feels that if so many more students whom we haven't actually admitted are sitting in on the course than ones we have that the room had to be changed, that probably auditors will have to be excluded, is likely to agree that the curriculum needs revision.*

If the two sentences are in print, we can detect a physical difference in them, given a pencil and enough time, but we do so in a purely mechanical way, analogous to comparing signatures in a forgery case. We clearly do not do so on the basis of grammar. Once again, talk of competence is mere invention. There is no behavioral justification for calling these strings different stimuli, or, if emitted, different responses. Nonetheless, they are different *sentences* as defined by Chomsky. Evidently the sentence is an inappropriate unit of analysis of verbal behavior. Dropping it in favor of an empirically defined unit not only avoids the problem that only an infinitesimal fraction of all sentences are discriminable, it accommodates the awkward fact that people often do not speak in sentences at all. Moreover, it obviates the need to find a translation between the formal apparatus and actual data. That is, we no longer need to find an operational definition of "sentence" to match the formal one.

But when we have abandoned the sentence as a unit of analysis and the notion that language consists of an infinite number of sentences, the argu-

ment against an analysis of language as a repertoire of verbal operants breaks down. It now makes sense to say of a string of phonemes that would take twice as long to say as one's lifetime that it simply is not a unit of behavior, and it now makes sense to ask whether a particular unit is in one's repertoire.

BACK TO THE VERBAL OPERANT

By choosing the sentence as his unit of analysis, Chomsky has been led to maintain that grammar is central to language and that grammar must be genetically determined. Since extracting a completely adequate grammar from samples of speech is an achievement that has eluded many years of effort by linguists, surely it could not be accomplished by every 3-year-old unless the job were, in important respects, genetically coded.

As we have seen, this offers only the illusion of an explanation, since we must now explain the origin of the code in the genes, a task for which evolutionary principles are ill-suited. Moreover, any innate device must respond to actual physical events, not metaphors or abstractions; unless grammatical terms can be defined physically or operationally there is little reason to believe that such a device is possible. Chomsky and his colleagues have analyzed formal properties of language in commendable detail and have found a wealth of curious regularities that deserve explanation. However, they have not advanced the functional analysis of verbal behavior at all.

When we turn from the sentence to the verbal operant as a unit of analysis, we avoid many of the problems faced by a formal analysis. Our terms are empirically defined, and the principles invoked are clearly adaptive. Chomsky's arguments notwithstanding, novelty and diversity are not problems for a functional analysis. The tremendous diversity in language, like the tremen-

dous diversity of living organisms, is a function of selecting contingencies in a diverse environment.

Methodological problems remain. Owing to ethical constraints, it may never be possible to account for verbal behavior to the satisfaction of the most cautious critic. At the moment perhaps the best we can do is to continue the work that Skinner and others have begun; analyze complex verbal contingencies informally while attacking experimentally the more tractable problems in verbal behavior.

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