

Language in Child and Chimp?

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ABSTRACT: *Recent successes teaching chimpanzees to engage in symbolic communication have again brought into question the Cartesian supposition that language is uniquely possessed by homo sapiens. Despite the very remarkable achievements of Washoe and Sarah, an objective comparison of these chimps' linguistic performances with those of a typical 3-year-old child provides scant evidence for rejecting Descartes' view. An organism uses human language if and only if it uses structures characteristic of those languages. The ability of apes or even 2-year-olds to communicate and use simple names is not sufficient reason to attribute the use of human language to them. The creative or projective aspect of human language cannot be overlooked. Efforts to explain the language deficits of apes in terms of impoverished language experience, anatomical deficits, or cognitive-structure differences are not convincing.*

Today one can scarcely read a daily newspaper or news magazine without encountering a feature extolling the latest linguistic accomplishments of one or another ape. Contemporary introductory psychology textbooks may devote as much space to the achievements of the likes of Sarah and Washoe as they do the language development of children. With increasing frequency, widely read journals such as *Science* publish reports of the transmutation of base primates into noble ones. It is no wonder there is a growing belief among students and scientists alike that modern behavioral science has in fact succeeded in teaching human language to apes.

What Accounts for Our Fascination with This Issue?

The answers to this question are varied. Many people have an intrinsic interest in the antics of apes whether in the zoo, laboratory, or circus. The ancients speculated about the possibility of language in animals and the origin of our own. One recent writer (Linden, 1975) attributes cosmic ecological significance to the current revival of an old issue. Rene Descartes, as is well known, argues in the 17th century that the use of language was the critical feature of *homo sapiens* which distinguished it from the beasts:

For it is a very remarkable thing that there are no men, not even the insane, so dull and stupid that they cannot put words together in a manner to convey their thoughts. On the contrary, there is no other animal however perfect and fortunately situated it may be, that can do the same. And this is not because they lack the organs, for we see that magpies and parrots can pronounce words as well as we can, and nevertheless cannot speak as we do, that is, in showing that they think what they are saying.

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On the other hand, even those men born deaf and dumb, lacking the organs which others make use of in speaking, and at least as badly off as the animals in this respect, usually invent for themselves some signs by which they make themselves understood. And this proves not merely animals have less reason than men but that they have none at all, for we see that very little is needed to talk. (Descartes, 1637/1960, p. 42)

Our exclusive possession of language has always played a primary role in our conception of ourselves in relation to other species.

From another indirectly related perspective, behaviorists in the 20th century see the success in teaching apes human language as a means of vindicating their long-espoused, content-free, species-nonspecific learning principles. Julian La Mettrie, an 18th-century physician, foreshadowed the behaviorist position in his then-infamous *L'Homme Machine*, which was a rejection of Cartesian dualism. First, he argued that language was not the unique feature of man that Descartes claimed. La Mettrie observed that men and animals have at least emotional language in common: "all of the expressions of pain, sadness, aversion, fear, audacity, submission, anger, pleasure, joy, tenderness, etc." Second, he suggested that whatever linguistic deficits animals suffered might be just a matter of impoverished environment, lack of proper training, or both.

Could not the device which opens the Eustachian canal of the deaf, open that of the apes? Might not a happy desire to imitate the master's pronunciation liberate the organs of speech in animals that imitate so many other signs with such skill and intelligence? Not only do I defy anyone to name any really conclusive experiment which proves my view impossible and absurd; but such is the likeness of the structure and function of the ape to ours that I have little doubt that if this animal were properly trained he might at least be taught to pronounce, and consequently to know a language. Then he would, no longer be a wild man, but he would be a perfect man, a little gentleman, with as much matter of muscle as we have, for thinking and profiting by his education. (La Mettrie, quoted in Gunderson, 1971. p. 30)

La Mettrie clearly anticipated contemporary behaviorists in their stress on the continuity across species and in their efforts to explain the linguistic deficits of apes in terms of experiential factors.

Can Apes Actually Learn a Human Language?

The final outcome of current efforts to teach language to an ape remains to be seen. However, several firm conclusions can be drawn at this time. The unsuccessful efforts of the Kelloggs (Kellogg & Kellogg, 1933/1967; Kellogg, 1968) and the Hayes (Hayes & Hayes, 1951) demonstrate that a normal human language environment is not sufficient to enable an ape to learn a human language. It is also apparent now that regardless of the ultimate linguistic potential of apes, they are far more adept at learning visual-manual communication than the auditory-vocal processes natural to human language. Finally, and perhaps most important, there is no question but that the method by which apes must be trained are quite different from the spontaneous, self-organizing acquisition processes employed by children.

Despite these very important differences between human and nonhuman primates it has

be taught to engage in an extensive amount of symbolic communication. Of course, not just any symbolic activity can be taken as evidence of human language ability. Some criteria need to be established in order to evaluate the relation between chimpanzee behavior and human language. We can look at these achievements from two somewhat different perspectives. First, these activities may be compared with some of the fundamental attributes of human language; second, the performance of these apes may be compared with linguistic performances of minimally fluent users of a human language--for example, 3-year-old children.

On The Nature of Language

Human language has been analyzed from a variety of perspectives and interests, including the comparative study of languages, the formal structure of language, and the comparison of communication systems across species. Despite the great diversity in languages, there are numerous features common to all of them. From among these I would like to briefly consider three characteristics that seem most relevant in evaluating the linguistic accomplishments of Washoe, Sarah, or any other organism--namely, the separation of language structure from its functions, the use of names, and the concept of syntactic creativity.

THE SEPARATION OF STRUCTURE AND FUNCTION

Language serves *homo sapiens* in many diverse ways: in communication, as a mode of self-expression, as a means of socialization, and perhaps in aid of thought and creativity. Yet we do not attribute language to humans just because they typically engage in these activities. Fido, drooling and licking his chops as the roast is served, accurately communicates his desire and interest; yet he hardly gets credit for knowing English. The 11-month-old child, whining expressively and reaching for its juice bottle surely conveys its intention; yet we are reluctant to say she is able to talk on the basis of that behavior. Instead, we attribute human language to an individual if and only if we have reason to believe that the individual uses the characteristic structures of a language more or less appropriately. Claims that an organism uses human language or some close approximation must be accompanied by structural evidence that the organism's language is a plausible structural facsimile of a natural human language. To know a language is at least to know the structures of that language.

THE USE OF NAMES

A number of the most frequently cited characteristics of human language are inherent in the concept of name. A name is symbolic, meaningful, and arbitrary and enables displacement behavior. Traditional analyses of human language often went so far as to virtually equate the use of language with the use of names. In this "naming paradigm" of language (Fodor, Bever, & Garrett, 1974), the meaning of a word is a consequence of its arbitrary association with the thing it stands for, its referent. Learning a language means learning the conventional names for things. Psychologists interested in language were quick to see that this paradigm of language was interpretable within a conditioning model of behavior. A meaningless symbol, a word form, acquires its meaning in a process not unlike the way a conditioned stimulus comes to elicit

components of the response previously made to the unconditioned stimulus, the referent. Additional complexities and subtleties of meaning are introduced through the processes of abstraction, higher order conditioning, and generalization. The conditioning model thus suggests an analysis of the difference between proper names and common nouns, a way to generate new meanings from old ("assign learning"; Osgood, 1953), and an explanation of the ability to extend symbols appropriately to new instances. Novel linguistic expressions--if considered at all--were presumed to be sequences of responses elicited by novel sequences of stimuli. The expression *big red apple* might be interpreted as the temporally structured responses to *bigness*, *redness*, and *appleness*. Conditioning was at one time seen as a general phenomenon that could establish meaning of a kind in virtually all species and provide the unifying conceptual apparatus for the learned behavior of all organisms, including language behavior (Mowrer, 1954).

Today, the naming paradigm is widely recognized as a very unsatisfactory model of human language. Its primary defects include an inordinate focus on the word rather than the sentence, a failure to distinguish between meaning and reference, and a complete neglect of the syntactic or creative aspects of human language. Naming plays an important, perhaps necessary, role in human language. It does not, however, play a definitive role. An organism's use of names is surely not sufficient evidence to conclude that the organism is using human language. Should one equate human language to the naming paradigm, it follows that any conditionable creature can learn human language.

SYNTAX AND CREATIVITY

Language was for Descartes the one certain indicator of thought, in that language reflected the human ability to produce and understand entirely new expressions of thought. Then, as now, the syntactic creativity or productivity of human language served, more than anything else, to qualitatively distinguish human language from the symbolic activities of all other species.

This notion of productivity or creativity implies much more than an ability to produce and interpret an infinity of sentences. The number of sentences in a human language is only of minor interest. A language whose nonfinite nature was due only to something like recursive intensification, as in *The banana was very, very, ...very good*, would be of relatively little significance to Descartes or ourselves. What is of primary importance is the projective aspect of human language ability. Users of any human language are able to syntactically project novel yet appropriate linguistic expressions onto any of an almost unlimited number and variety of concepts. For the most part, neither the linguistic expression nor the concept itself need have been ever previously experienced by the user as prescribed in the conditioning model. Indeed, in many cases it is unlikely that *anyone* has ever previously experienced a given combination of concept and corresponding linguistic expression.

Fluent speakers of a human language have available a diverse array of linguistic expressions enabling them to refer to each of a limitless number of persons, propositions, objects, places, desires, beliefs, events, or whatever. For example, a particular place may be syntactically individuated using such expressions as *Urbana*, *there*, *that city in central Illinois*, or *the place we visited last summer*. A particular person may be individuated by such expressions as *Otto*, *him*, *that guy*, or *the person that Bill wanted to leave*. Each of these nominal expressions

may be interchangeably substituted as the noun phrase (NP) constituent in expressions like *NP is where she went to school* or *NP is my neighbor*.

These examples illustrate two universal structural features of human language: hierarchical constituent structure and the use of sentences themselves as constituents within complex nominalizations or syntactically generated "names" (Lees, 1960). Such complex constituents as *the place we visited last summer* or *the person that Bill wanted to leave*, with their own internal clause structure, fall far outside the scope of the naming paradigm or the conditioning model of language, which concerns itself with the assignment of meaning to previously experienced names or symbols. Learning a human language involves learning to use an integrated set of phonological, syntactic, semantic, and referential rules according to which novel and appropriate linguistic expressions may be constructed. It is this creative aspect, enabling the projection of linguistic expressions onto concepts both old and new, that is the most prominent structural feature of human language.

Chimp and Child Compared

How does the linguistic performance of trained chimpanzees compare with that of those more or less fluent users of language, 3-year-old children? The relevant comparisons may be made along such dimensions as use of names, the syntactic structure inherent in the linguistic behavior displayed, and the demonstrated projective ability.

THE USE OF NAMES

Without question, both young children and chimpanzees are capable of an extensive use of arbitrary symbols in referring to objects in their environments. The Kelloggs (1933/1967, 1968), who raised their infant son together with an infant chimp, reported that Gua the chimp comprehended over 100 words during its 2nd year, perhaps more than their son did at that time. The vocabularies of both Washoe and Sarah are roughly comparable in size to those of many 2-year-olds. Sarah, for example, has a vocabulary of about 120 symbols, while Washoe uses about the same number of signs and can understand at least 100 additional signs (Gardner & Gardner, 1974). Whatever limitations there are on the ability of chimpanzees to learn human language, it does not seem that sheer vocabulary size can be much of a causal factor. Even dogs attain vocabularies of similar magnitudes (Warden & Warner, 1928). There seem to be no striking quantitative differences among young primates in their ability to use simple names. Whatever differences there are in language ability must go beyond this, even if one ignores for now the matter of how those names are learned.

SYNTAX IN CHILDREN

Language development in children follows a reasonably predictable schedule with regard to the features of interest--namely, the use of names, the emergence of hierarchical constituent structure, and projective syntax. Sometime around the 1st year, give or take a few months, children start using single morpheme expressions or holophrases in referring to things. From the beginning of their 2nd year and on into the 3rd, there is a continual increase in the length of a

characteristic syntactic patterns of the language gradually emerge. Fixing the precise schedule of these syntactic developments depends on a number of things, including the child's articulatory skill--some children's speech is simply unintelligible--and, importantly, the criteria used by the investigator in making inferences about the presence of certain syntactic constructions (Limber, 1973, 1976).

A traditional analysis of a child's early utterances using distributional criteria (Chomsky, 1957; Hockett, 1958) is generally more conservative in attributing structure to a child than is an analysis based on extensive intentional or semantic criteria (Bloom, 1970; Brown, 1973). Distributional analysis involves postulating structures--rules and categories--to account for recurring patterns in the actual utterances. Units or constituents which appear in similar environments are taken to belong to similar syntactic categories. It is characteristic of human languages that these units may at one time belong to several hierarchically organized categories. The utterance *Stop!* in English is at once a word, a verb phrase, and a sentence. The logic of the semantic analysis is to postulate a base structure that will represent not only the observable syntactic patterns but the child's presumed intention as determined by the utterance plus the situation. Then the investigator postulates a sequence of transformations that generates the observed surface structure. In mapping the intention onto the actual utterances, these transformations serve primarily as filters which remove most of the structure postulated to represent the intentional and contextual information. With young children, the inevitable result is that more linguistic structure is attributed to the individual on the basis of semantic criteria than the utterances themselves would warrant using distributional criteria alone. One can see that in order for constituent structure of any degree of complexity to manifest itself using distributional criteria, it is necessary that at least some utterances of four or more morphemes in length be produced (Limber, 1973). Using semantic criteria, considerable structure may be divined for utterances of even one or two morphemes. Applying semantic criteria, for example, one might well impute much the same grammatical structure to each of the following utterances: *ju, juice, want juice, want drink juice, me want drink juice*. This brings us back to the difference between linguistic function and structure emphasized above. While all of these expressions may be in fact intentionally and communicatively equivalent to one another and indeed to a variety of nonlinguistic expressive behaviors, it is a long and precarious theoretical leap to assume they are linguistically equivalent. Equivalence of function does not imply equivalence of linguistic structure. Getting someone to bring you a drink is surely not equivalent to telling someone that you want a drink. Although inferences as to intent and meaning may prove heuristically useful in the case of children, where it can safely be assumed that the organism is learning a human language, these same inferences may be seriously misleading when applied anthropomorphically to nonhuman organisms, where no such assumption is justified. If we are willing to accept linguistic structures inferred on the basis of meaning or intent, we can anticipate claims of extraordinary linguistic prowess from various regions of the animal kingdom.

By age 3 or 4 at the latest, children regularly produce complex sentences, that is, sentences with hierarchical constituent structure which have embedded sentences or clauses as their internal constituents (Leopold, 1949; Limber, 1973). Consider as an example the following utterances spoken by Laura, a girl of 2 1/2, reported in Limber (1973): *I do pull it the way he hafta do that so he doesn't--so the big boy doesn't come out*. Notice that *he* and *the big boy*

constituent for Laura. This is both in accord with our intuitions and any formal analysis of English. The basic structure of that sentence may be informally schematized as follows: ((NP) (VERB) *it the way* (SENTENCE)...). It should not be surprising to find instances of similar structure in some of Laura's other utterances, for example, *Do it the way I say or I cook it the way mommy makes a cake*. A reasonable inference based on such data is that Laura has already learned a close approximation to the English rule for syntactically individuating the numerous "ways" that actions may be carried out, using the process of attaching a complete sentence, more or less, as a constituent to the abstract noun *way*.

Between ages 2 1/2 and 3, this syntactic device emerges in use with other abstract nouns, for example, *Remember the place we went?* or *That's the kind I like*, and with certain *wh*-morphemes, for example, *I think she wants juice*, *Baby pretend she eat apple*, or *When I was a little girl I could go "geek-geek" like that, but now I can go "this is a chair."* Structures directly analogous to English relativization and normal complementation thus appear typically in most children toward the end of the 3rd year and early in the 4th year. As in mature English, these complex constructions enable the speaker to individuate entities for which no suitable simple name is available and for which linguistic devices of lesser complexity such as pronouns are awkward or ineffective. It is not a coincidence that the earliest relative clauses produced by children typically are clauses characterizing semantically empty nouns like *one*, *place*, *way*, or *kind* (Limber, 1973). As in mature English, children use such complex expressions both to refer directly, as in *I know you're there*, and indirectly, as in *I know what you did*. One can perhaps only come to appreciate the extraordinary referential power of human language by considering how difficult it would be to refer to such things as facts and events within a naming-paradigm-like language in which all possible referring expressions must have been previously experienced by a user--in other words, in a language without a creative, projective capability.

SYNTAX IN CHIMPS

How do the linguistic performances of Washoe and Sarah compare with those of children in regard to syntactic structure and projective ability? The answer is clear and unambiguous; at present, any normal 3-year-old has far surpassed even the most precocious ape in language structure. Whereas virtually all children use hierarchically structured complex sentences by the beginning of their 4th year at the latest, there is little evidence that any ape ever did. The closest possibility, discussed below, is Sarah's use of her conditional symbol. It is even unclear to what extent the performances of the chimps should be construed as analogous to the use of simple sentences in a human language. A major reason for postulating the sentence as a constituent is that the elements constituting a sentence reoccur as constituents within themselves. In any language without complex sentences, justification for "sentence" must be found in recurring patterns of elements which appear across performances or utterances.

Brown (1970, 1973) analyzed the signs of Washoe and found some evidence for internal structure comparable to the structure in the utterances of children at the earliest stages of acquisition. Gardner and Gardner (1974) reported similar results using Bloom's (1970) procedures of employing semantic criteria to analyze Washoe's signs. On the one hand, there is evidence that Washoe's sign combinations are not totally unstructured or random combinations; on the other hand, it is difficult to justify, even using semantic criteria, that these patterns in

Washoe's two to four sign sequences are a result of syntactic rules rather than the semantic constraints inherent in any communication system. Washoe's combinations, like the utterances of children between 1 and 2 years old, are just not of sufficient complexity to suggest anything like the recursive hierarchical constituent structure in the language of 3-year-old children. As Fodor et al. (1974) concluded in their analysis of Washoe's sign sequences, there is no evidence so far that Washoe represents the semantic relations in those sequences as syntactic relations between parts of a sentence. Washoe, like most children during their 2nd year, has achieved a considerable degree of proficiency in using arbitrary symbols to communicate. This is not to say, however, that Washoe or most 2-year-old children use a human language.

In contrast to Washoe's productive use of sign language, Sarah's training (Premack, 1971a) was much more systematic and constrained. In addition, Sarah's training was in the interpretation of symbols rather than in their production. Two aspects of Sarah's performance are of particular significance here: her use of a conditional symbol and her use of the "name of" symbol. Premack's introduction of a conditional symbol, schematized as ((S₁) implies (S₂)), comes closest perhaps to testing a chimpanzee's ability to deal with a structure analogous to an interesting complex sentence. Sarah was trained on this symbol using a number of values for S₁ and S₂. She was then given a series of transfer trials on the symbol with values for S₁ and S₂ that she had not encountered in connection with the conditional symbol but had previously correctly interpreted when presented alone. Example sentences from Premack (1971b) are ((*Red is on green*) implies (*Sarah take apple*)) and ((*Sarah take apple*) implies (*Mary give Sarah chocolate*)).

Sarah's performance on this particular symbol does indicate that she is capable of a certain degree of structure analysis. Since Sarah apparently can deal with a fairly large number of potential S₁ or S₂ instances, there is no reason to assume that she has memorized the substitution sentences as a unit and merely learned to substitute unanalyzed units into the conditional symbol itself. Instead, it seems likely that she is able to perform an analysis of each constituent sentence, S₁ and S₂, and integrate the interpretation of those constituents with the significance of the conditional symbol. This in itself does not entail that Sarah treats those S₁ and S₂ constituents as recursively embedded constituents, but asking her or anyone to process sentences of the form (S implies (S implies S)) is hardly sensible. It does suggest that at the very least, Sarah has learned a fairly sophisticated substitution in frames technique.

Sarah's use of the conditional symbol and others, including her "compound sentence" and "negation," led Premack (1971b) to conclude that in about 18 months, she had acquired a language competence apparently comparable in many respects to that of a 2- to 2 1/2-year-old child. Premack's conclusion may not be unreasonable if one keeps in mind the respects to which chimps and 2- to 2 1/2-year-old children are not comparable. However, certain features of Sarah's training situation suggest that one should be conservative in estimating her human language ability. Sarah's ability is assessed entirely through comprehension tasks. Premack (1971a) reported her performance on these tasks to be about 80% correct on both training and transfer trials. While this may seem impressive considering that Premack is defining what is correct, Sarah does have a substantial probability of getting a trial correct simply by guessing from among the limited number of alternatives provided her.

Moreover, forced-choice comprehension tasks with children, and presumably with chimpanzees, are prone to a variety of Clever Hans effects or the possibility that the subjects are

known to correctly interpret nonreversible passive sentences but not reversible ones--that is, *The car was kicked by the girl* but not *The boy was kicked by the girl* (Bever, 1970). Sinclair-deZwart (1973) demonstrated similar phenomena in other tasks. While Premack himself has been sensitive to these problems, secondary reports of Sarah's achievements frequently have not. Often, the claims made on behalf of these linguistic apes in the popular media far exceed the evidence.

PRODUCTIVITY IN CHIMPANZEE LANGUAGE

All chimpanzees, it seems, quickly learn to use symbols, generalizing them appropriately to new instances and in situations far removed from the original circumstances of training. Washoe reportedly combines previously learned signs into apparently novel sign sequences. However, as noted above, these sequences are of insufficient complexity to infer that they are rule-governed rather than simply patterned by the situation as vaguely prescribed in the naming paradigm. Since Sarah is limited to comprehension tasks, productivity for her is linked by Premack to her use of the "name of" symbol.

Premack's premise, underlying all of Sarah's language training, is that language acquisition is a mapping of preexisting conceptual structure onto linguistic symbols. If an organism does not have the requisite conceptual structure, that structure must be installed in the organism before it can be mapped onto a linguistic symbol. Therefore, it was only after Sarah mastered the names of a number of concepts that she was given training on the "name of" symbol. This was accomplished by training Sarah to select the "name of" symbol for an appropriate object-name symbol pair and the "not name of" symbol for an inappropriate pair. Training was tested using the well-established interrogative symbol, by asking, for example, What is the name of the object? Out of four alternative symbols, Sarah selected the correct one on about 80% of the trials, her typical above-chance but imperfect performance. Premack uses the "name of" symbol to illustrate Sarah's ability to productively generate new names. By this he means that the "name of" symbol can be used to form new symbol-object associations, completely bypassing explicit conditioning procedures. New names are acquired by simply placing the "name of" symbol between a familiar object, previously not names, and a new neutral symbol. Class names including the "color of," "size of," and "shape of" can also be used in this procedure. For example, Premack introduced the symbol for the color "brown" by using the previously known symbols "color of" and "chocolate."

Premack's conception of productivity is quite different from the one discussed above as characteristic of human language. Sarah still requires that the word and the object to be named be experienced contiguously. The "name of" symbol serves to express the appropriate relationship between the symbol and object without further training. Sarah's use of this symbol does not imply that she can generate new names on her own for concepts not explicitly paired with their names, although she can of course generalize the names she has learned to new instances of object classes. Premack (1971b) mentions that in Sarah's language she can only *use* words, not make them up. That, however, reflects a very basic qualitative difference between the human use of language and whatever it is that Sarah does. Notice that it is not her symbol system itself that limits Sarah's performance in this regard. A human restricted to Sarah's

symbols could indeed productively generate new names for previously unnamed concepts in, for example, the domain of color names. Suppose a human subject knew the various symbols, as does Sarah, for "color of" and a variety of other object names and color names. For any object, O, we might ask our human subject, "What is the color of O?" If our subject in fact knows the color and has a symbol for that color name, we would expect an accurate reply at least 80% of the time. That is what Sarah does. Now, suppose we ask our human the familiar color of an object for which he does *not* have a previously established color name. He will in all likelihood be able to syntactically individuate that color by generating a correct complex "name" in Sarah's language as follows: "The color of O is the color of K," where K is the name of a previously known object having the same color as object O.

A demonstration that Sarah could indeed spontaneously generate a name even for a color of an object would be far more impressive evidence for a humanlike language ability than anything she or any other chimpanzee has accomplished thus far. As far as I can determine, Sarah has not performed in this fashion; perhaps just as important for an understanding of chimp language, it does not seem that she was ever encouraged to do so.

Why Don't Apes Use Human Language?

The evidence that apes can be taught a human language is hardly compelling. Despite some interesting accomplishments by Washoe, Sarah, and their trainers, nobody as yet is liable to mistake the language of any ape for the language of a normal 3-year-old child. La Mettrie's proposals to eliminate the language gap among primates have not yet proven feasible despite a number of contemporary efforts. What can explain these differences?

HISTORICAL ACCOUNTS

Most of the potential answers to this question were staked out during the 17th and 18th centuries:

1. *Anatomical differences*. Descartes, of course, knew that differences in behavior were related to differences in anatomical structure. Yet as the previously quoted passage indicates, Descartes ruled out an anatomical explanation for the lack of language in animals on an empirical basis. Specific morphological features of the vocal apparatus appeared neither necessary nor sufficient to explain the vast linguistic differences between humans and animals. Descartes himself may have made anatomical comparisons among various animals to investigate just this point.

2. *Nonmaterial differences*. The anatomical parallels Descartes observed among mammals, including humans, were very important to him, for they seemed to preclude any simple material explanation for the lack of language in animals. These parallels thus supported the nonmaterial explanation of human language inherent in Cartesian dualism. Animals did not use language because they did not have a soul, that is, the power to reason (Gunderson, 1971, p. 36). The soul was, for Descartes, a theoretical construct designed to explain obvious and reliable differences in behavior between humans and all other creatures.

3. *Experiential differences*. In *L'Homme Machine*, Julian La Mettrie objected to Descartes' dualistic doctrine that animals but not humans were physiological machines. La Mettrie. we

have seen, specifically attacked the empirical foundation for that dualism, arguing that language was not intrinsically unique to humans. This, however, left La Mettrie without an explanation for the obvious fact that only humans used language. Undoubtedly, La Mettrie would have liked to attribute those differences to anatomical differences, yet he was also compelled to reject anatomical differences as the basis for these language differences. Whereas Descartes knew little, if anything, about primate anatomy, La Mettrie had access to several comparative studies confirming an extremely close resemblance between human and primate vocal apparatus (Vartanian, 1960). If these physiological machines were built in the same way, why didn't they function in the same way?

La Mettrie tried to explain the discrepancy by suggesting that animals simply did not have the necessary environmental or educational experience needed to learn a language. Like contemporary psychologists such as Skinner (1957), Osgood (1968), or Piaget (1967), La Mettrie denied the Cartesian contention that human language demanded an explanatory account distinct from that required for other behavior.

CONTEMPORARY ACCOUNTS OF PRIMATE DIFFERENCES

On the basis of their information, both Descartes and La Mettrie believed that anatomical differences alone were insufficient to explain the lack of language in animals. Today we know that there are indeed differences both in peripheral anatomy and the central nervous system that might be called up to explain the language differences among primates. In addition, enough is known about the genetic basis for behavior to make it plausible that as yet unidentified genetically determined neural factors differentiate morphologically similar species. Here, in brief, are several widely accepted explanations for the language differences among primates:

Vocal tract differences. Keleman (1948), after careful morphological study, concluded that the chimpanzee vocal tract could not produce the full range of human speech sounds. Several factors led to his conclusion, including the overall tract configuration and relative position of the larynx and his belief that a chimpanzee would be unable to maintain phonation for the duration required for human speech. Similarly, Lieberman, in a recent series of investigations (Lieberman, 1968; Lieberman, Klatt, & Wilson, 1969), proposed that nonhuman primate vocal tracts are inherently limited in the range of vowel-like sounds that they can produce. Those primate tracts are said to lack a variable pharyngeal region suitable for producing the full complement of vowel sounds. The implication is that the primates could not produce human speech even if they had something to say.

This explanation of the linguistic deficit of apes on the basis of an articulatory deficit fits nicely into the motor theory of speech perception developed by Liberman and his associates (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). It follows from that theory that any organism with a vocal tract different from a human one would have great difficulty in extracting the relevant acoustic cues from a human speech signal in order to ever break into the system. This would explain why chimpanzees raised in human environments fail to learn even rudimentary human language; they lack the relevant auditory-articulatory transformations. Several investigators (Kellogg, 1968; Yerkes & Learned, 1925) have remarked on the chimp's lack of mimetic interest in human speech sounds. There is certainly no reason to attribute this to any peripheral auditory deficits in those primates relative to humans (Dewson & Burlingame.

Can the morphology and position of the larynx in a vocal tract explain the linguistic differences among primates? Despite the simplicity of this peripheralist account of human language, there is reason to be skeptical about it. Both Keleman and Lieberman utilized young primates in their investigations. Keleman himself observed that it might be possible that a mature chimpanzee would have a different laryngeal position than that found in his specimen of age 2, just as a mature human tract differs from that of a young infant. Lieberman's analyses are based on the spontaneous vocalizations of captive 2- and 3-year-old gorillas, a 2-year-old chimpanzee, and 1- to 6-year-old rhesus monkeys. Moreover, Lieberman's argument as to the articulatory deficits of nonhuman primates is based on a seemingly tenuous backward chain of inferences from an incidental sample of vocalizations to conclusions about the articulatory *potential* of the tracts generating those vocalizations. One wonders how well those same inferential techniques would reconstruct the articulatory potential of a myna bird (Klatt & Stefanski, 1974) from its incidental chatter or reconstruct the potential of deformed human tracts from nonspeech vocalizations of those tracts.

Observations on humans with deviant vocal apparatus also militate against a peripheralist explanation of human language ability. Lenneberg (1962) reported a case of an individual with a congenital inability to speak yet who learned to understand English. Even more to the point are the many instances of "vicarious articulation" reviewed in Drachman (1969) and in Luchsinger and Arnold (1965). Here we have cases of individuals overcoming extraordinary deformations of their vocal tracts--for example, loss of the entire larynx or tongue--and still producing intelligible speech. In some cases, this adaptation may occur within weeks after the loss, generally a result of surgery. A remarkable case reported by Drachman (1969) concerns a young girl born without a tongue and having a number of other oral defects. This girl successfully acquired a language with vowels that Drachman (1969, p. 320) describes as astonishingly clear. From an X-ray film taken of the girl while speaking, it appears that she has acquired sufficient control of the facial and mouth floor musculature to provide for a wide range of supraglottal tract shapes. Another case involved a boy who at age 3 lost his larynx and learned to provide a sound source by drawing back the root of his tongue and making it vibrate against the rear of his pharynx.

The obvious implication of such cases is that human language ability, and specifically speech production, involves more than just a standard vocal tract. Engaging in this complex activity not only requires having something to say but also the specific rules for encoding that intention and a vocal apparatus for generating the appropriate signal. As the above cases indicate, humans can recruit an extraordinary range of articulatory gestures in order to produce the desired signal. Drachman (1969) reminds us that this remarkable adaptive capability is not unique to a few freakish cases but is available to all humans whose vocal tracts vary as they grow, eat, smoke, or suck their thumbs. Lindblom and Sundberg (Note 1) demonstrated this adaptive ability experimentally by systematically disrupting the normal resonant characteristics of the vocal tract by means of a block inserted between the speaker's teeth. To achieve an adequate target vowel, the speaker had to compensate for the abnormal tract shape produced by the presence of the block. Lindblom and Sundberg determined, from examination of the formant frequencies at the moment of the first glottal pulse, that the target-vowel formants were achieved before the speaker had time to utilize his own auditory feedback in adjusting the tract.

All these factors should make anyone wary of claims that the morphology of the human vocal tract is the essence of human language. A normal human vocal tract in itself is neither necessary nor sufficient to account for the linguistic ability of humans. This, of course, was Descartes' conclusion.

Central nervous system differences. Today we know of a number of global differences in neuroanatomy among primates. Human cerebral hemispheres may be twice the weight of those in other primates. Furthermore, the human brain is only approximately 40% mature at birth, in comparison to a corresponding figure of about 70% for other primates. This suggests a later evolution of certain portions of the human brain, particularly in the associative areas of the cortex. According to Geschwind (1969), the greatest growth in humans relative to other primates is in the inferior parietal region, the region of the angular gyrus. This region, between the association cortex of the three nonlimbic modalities, is said to be poorly developed in other primates.

Two fairly specific hypotheses concerning the neuroanatomical basis for primate language differences follow from these observations. One is simply that human language ability is a function of brain size, greater size implying greater language capacity. Lenneberg (1967) convincingly disposed of this possibility by showing that nanocephalic dwarfs whose brains were small relative to those of nonhuman primates did in fact acquire language. Thus, the typically larger size of the human brain is neither necessary nor sufficient to explain language in humans.

The other hypothesis concerns the role of the angular gyrus region and is credited to Geschwind (1969). It is Geschwind's proposal (also see Lancaster, 1968) that the intermodal associations involved in learning and using names are mediated by the structures in the angular gyrus region, which serves a kind of way station for the formation of intermodal associations without limbic mediation. Thus, naming can be in part be understood as a process of rapidly associating a visual or tactile object with a symbolic auditory representation. Moreover, this association and subsequent response can be relatively independent of the state of the limbic system, those portions of the cortex directly implicated as centers of emotion. The essence of Geschwind's proposal is that a unique characteristic of human neuroanatomy enables human language to be used to refer to objects independently of affect. In contrast, nonhuman primates have communication systems closely linked to limbic functioning.

There is some interesting support for Geschwind's hypothesis. Recall that La Mettrie noted that humans and animals shared a common emotional language: expressions of fear, pain, and pleasure. Descartes, too, was aware of this and sharply distinguished between language reflecting the passions and language reflecting rational thought. Only the latter distinguished man from beast. Contemporary comparative studies (e.g., Marler, 1965) have confirmed the fundamentally emotive or affective nature of nonhuman primate communication systems. It is reported that only rarely do messages in these systems directly convey information about the physical environment. Even in those few cases in which such nonaffective information does seem to be transmitted, nonhuman primates show no ability to separate the informational components from the emotional or affective charge (Bronowski, 1967).

Geschwind's hypothesis is consistent with a study of evoked vocalization in macaques, in which Robinson (1967) elicited naturalistic vocalizations by electrical stimulation of various limbic sites. There was no evidence that the neocortex participated in any of these vocalizations.

systems, involving facial expression, gesture, and vocalization, are apparently quite similar in form and function across all primates, including human (Bastian, 1965; Lancaster, 1968). These similarities across species and the little evidence there is concerning the development of these systems within species (Eibl-Eibesfeldt, 1973; Freedman, 1975; Sackett, 1966) suggest that such systems are far more genetically structured and admit of considerably fewer degrees of freedom than human languages. Finally, this interpretation of the neuroanatomical differences among primates is in accord with the difficulty a number of investigators have found in establishing intermodal transfer in nonhuman primates (Blakemore, & Ettliger, 1966; Ettliger, 1967).

Neuroanatomical differences, however, cannot account for all of the language differences among primates. Even if Geschwind's hypothesis is correct, it does not take human language much beyond the naming paradigm. Syntax and the creative aspect of human language remain unexplained. Indeed, otherwise-normal blind children acquire the full range of human language structures with no serious difficulty. Moreover, the performances of Washoe and Sarah indicate that the intermodal-association naming issue has been circumvented to a large extent by using reinforcement techniques and by concentrating on visual rather than auditory associations. Sarah's use of the "name of" symbol, in particular, suggests that Premack's training procedure has had the effect of establishing a kind of "learning set" whereby associations between symbol and object may be formed with little need for explicit reinforcement. Davenport and Rogers (1970) reported evidence of intermodal transfer in chimpanzees and orangutans but only after these animals received extensive training. All of this suggests that perhaps the differences in brain structure noted by Geschwind are related to the human ability to learn features of their language independently of the limbic system--that is, independently of external reinforcement--rather than being directly involved in the use of language. Speculatively, the angular gyrus region may be involved in the human ability to organize its linguistic environment on its own, whereas the apes' environment must be explicitly structured for them with reinforcement procedures calling attention to normally unanalyzed contingencies.

The evidence relating anatomical structure to linguistic function may be summarized as follows. While we certainly know much more about the details of primate anatomy today than did either Descartes or La Mettrie, it is apparent that we have little precise knowledge as to how those anatomical structures embody linguistic functions. Differences in vocal anatomy seem insufficient in themselves to explain the linguistic deficits of apes, since humans with gross vocal-tract deficits may learn and use language. Nor is it unusual throughout the animal kingdom to find different anatomical structures realizing the same biological function. Differences in cortical structures exist, but the functions attributed to those structures grossly underdetermine the basic features of human language. It may be no exaggeration to say that the various anatomical differences discovered among primates since the 18th century have little more explanatory force as to the basis for human language than Descartes' explanation involving the soul. The major consequence of recent biological discoveries seems not to have increased our understanding of human language as much as it has served to incorporate materialism into a priori assumption rather than leaving it the open question it was for Descartes.

Descartes would surely not be surprised at the impoverished level of the apes' language compared to that of humans. Since he believed that language reflected thought, the cognitive or conceptual limitations of a creature would show up as linguistic limitations. Animals say very little because they have very little to say. Versions of this Cartesian view are tacitly held in part by a variety of contemporary psychologists.

Recall Premack's premise that language learning is the mapping of preexisting conceptual structure onto linguistic symbols. The training of Sarah involved finding a suitable symbolic system for her and an effective procedure for associating elements of the symbol system with already existing conceptual elements. From this perspective, the naming paradigm appears as an eminently suitable language model, as it is not the complexity of languages or symbolic systems that varies among species but rather their underlying conceptual structures. Getting an ape to use language like a human would entail establishing a conceptual system comparable to that of a human and then mapping that system onto a set of symbols. If Premack's premise is valid for both humans and apes, then linguistic differences among the primates simply reflect conceptual differences among them once they are all given equal access to an appropriate symbol system.

A variation on the cognitive-limits explanation is implicit in the theory of language development proposed by Piaget and his associates. Within the Piagetian framework (Piaget, 1967; Sinclair-deZwart, 1973) reports how young children interpret word strings without syntax and argues that the semantic strategies used reflect the underlying conceptual structure upon which language development is based. She proposes that the child first learns to associate the linguistic symbols with elements of the action schema on an intuitive basis and then gradually learns the formal syntactic basis for making those associations through some kind of inductive procedure. The Piagetians, like the behaviorists, stress that no special theory of language development is necessary.

The notion that language ability is constrained by cognitive structure has much to recommend it. It makes little sense to think of learning a human language outside of some particular conceptual and social context. Organisms unfamiliar with baseball or linguistic theory or language are not likely to use or understand terms like *balk* or *A over A principle* or *name of*. Furthermore, we know that children many not utilize certain linguistic structures that depend on specific cognitive structures until those cognitive structures have developed. For example, a child's use of time-related language structures is related to the development of an adequate conception of time (Clark, 1971). Finally, it would certainly simplify the requirements on any theory of human language acquisition if the naming paradigm was even approximately true, that is, if human conceptual structures were more or less isomorphic to the structures of human languages.

A certain level of cognitive structure is surely necessary for learning and using any human language. Yet it is no simple matter to pin the linguistic deficits of apes on any general, independently specifiable, conceptual deficits. The arguments relating linguistic function to conceptual structures are probably less convincing than those relating linguistic functions to anatomical structures. The problem faces in two directions. On the one hand, we do not know what conceptual deficits to attribute to apes to explain their failure to learn human language. The cleverness of chimpanzees is documented in many situations. Moreover, it seems that children come to clearly surpass the intellectual abilities of chimpanzees only after acquiring substantial

from learning to use complex linguistic expressions dealing with color names, actions, or locative clauses? From what I make of various accounts of chimpanzee activities (e.g., Hayes & Nissen, 1971), there is no question as to apes' ability to deal with and discriminate among colors, actions, and places. They do have the relevant underlying conceptual structures. Why then don't they learn how to syntactically individuate those concepts as do 3-year-old children?

On the other hand, what kind of general conceptual advantages can we attribute to children in order to explain their remarkable linguistic skills? Lenneberg (1967) argued that development of language bears little relationship to either absolute brain size or variation in intellectual ability. Of course, one frequently used index of human intelligence is vocabulary size, but as mentioned above, chimps and children have relatively comparable vocabularies just at the time when children begin to show their syntactic superiority. Premack (1971b) has remarked that Sarah might easily learn up to 400 symbols if that was his research objective¹. One might look to advocates of a purely conceptual theory of human language learning for some suggestion of what specific conceptual structures enable children (but not apes) to learn a language. The Piagetian theory as summarized above involves two basic components: the child's action schemas and its general inductive capacity. As for the schemas, I know of no evidence suggesting that sharp differences exist in action schemas among any of the primate infants. If anything, the manipulative skills of young chimps outpace those of infants. That leaves only inductive ability to differentiate children from apes, that is, to explain why children but not apes are able to go far beyond presyntactic language into the characteristic structures of human language. Induction is the inference of a valid general rule from one or more instances. Now it may well be true that children do exceed apes in inductive ability. But without an account of the origins of potential rules and the means by which one rule is selected over another, induction is very little of an explanatory advance over the Cartesian soul. Virtually the entire problem of language learning has been packed into an unexplained inductive procedure.

To sum up, cognitive explanations for primate language differences lose much of their intuitive appeal upon close scrutiny. The linguistic differences between young chimpanzees and young humans appear to be far greater than the cognitive differences. Those cognitive differences that emerge along with the development of language are as likely to be consequences of language as antecedents. Moreover there is little reason to presume that any fine-grained isomorphic relationship exists between conceptual structures and linguistic structures. Very complicated thoughts may be couched in very simple syntax, and very simple thoughts may be propounded with great syntactic complexity. Perhaps most importantly, there does not seem to be any substantive suggestion as to the nature of those general cognitive capacities differentiating the language-using primates from the others.

¹Since completing this paper, I have read a report on the progress of Neam Chimpsky (Nim), a young chimpanzee learning American Sign Language at Columbia University (Terrace, Petitto, & Bever, Note 2). Nim has acquired an extensive vocabulary in the range of 200 signs. Nothing as yet in Nim's behavior changes any of my conclusions about language in chimpanzees, although the Terrace et al. report is remarkable for its detailed presentation of data and the clear recognition of the importance of using structural or distributional criteria in assessing chimpanzee language.

Biologists recognize that there may be substantial genetically controlled differences in specific abilities even among closely related species (e.g., Manning, 1972). While there is as yet no direct evidence for a genetic explanation for the human use of language, indirect arguments have been forcefully presented by Chomsky (1965, 1972) and Lenneberg (1967). The hypothesis is that human language is a species-specific capacity that is essentially independent of intelligence; children are genetically predisposed to learn any one of the many human languages. Evidence for this hypothesis involves the inadequacies of pure induction to explain any kind of learning, the speed and uniformity of language acquisition by children in diverse environments, and the existence of important similarities across all human languages. Lenneberg's (1967) arguments draw upon Chomsky's hypothesis, certain biologically unique aspects of humans, the uniformity of language development, and certain parallels between human language and other species-specific behaviors. Chomsky's hypothesis is indirect in that he asks what else other than genetically encoded linguistic knowledge could account for the known facts of language development:

We must postulate an innate structure that is rich enough to account for the disparity between experience and knowledge, one that can account for the construction of the empirically justified generative grammars within the given limitations of time and access to data. (Chomsky, 1972, p. 79)

Chomsky offers little in the way of specific details as to the nature of this innate structure, but it is not likely to be anything derivable from the peripheral anatomy (Limber, 1974), which is of course also genetically controlled. Instead, he suggests that this knowledge involves, *inter alia*, something as to the nature of potential linguistic rules and an evaluation metric for deciding when the child's internalized grammar is reasonably in accord with the grammar behind the utterances of its experience.

Chomsky's "what else" argument has received additional support from the recent efforts to train apes to use language.² Gardner and Gardner (1971), in particular, strikingly confirm the difficulties inherent in relying on pure inductive or trial-and-error processes for the acquisition of even overt physical gestures:

It became obvious that most of the signs that we wanted to teach to Washoe could not be taught in a reasonable amount of time if we had to rely on trial-and-error alone. As for shaping, the odds of a reasonable approximation to an appropriate sign occurring in an appropriate situation under conditions that would permit us to administer an appropriate reward were entirely too low. The method of guidance proved to be much more practical for the introduction of new signs than any other method. (p. 133)

Some may interpret the achievements of Washoe and other trained apes as disproving Chomsky's hypothesis. Presumably, such individuals also would consider the successful training of a dog to move about on hind legs as evidence against the hypothesis that humans are genetically predisposed to walk. I believe all such achievements must be interpreted within the context of simulation of human behavior. In other words, the Gardners found it necessary to provide a physically structured environment just to enable Washoe to learn her signs. Imitation played an unexpectedly small role in this regard, although an excellent sign-imitation technique played an unexpectedly small little about human linguistic behavior. (See Fodor's [1968] discussion of the "Turing Game.") Making these achievements even less informative than computer simulation is the fact that the program underlying chimpanzee simulation is inaccessible. I discuss the matter of chimpanzee simulation and the related issue of behavioral alchemy in a forthcoming paper.

role in Washoe's training. Despite the chimpanzee's often-mentioned tendency to mimic physical activities, Washoe apparently did not reproduce signs on her own with suitable fidelity or frequency to make imitation a fruitful means of teaching her many new signs (Gardner & Gardner, 1971, p. 136).

What else other than some genetic predisposition or a priori knowledge allows children to forego such explicit structuring in learning the appropriate motor control of their articulatory organs? It is hardly surprising that Washoe has not demonstrated acquisition of syntactic rules. Why should we expect Washoe to be any more likely to spontaneously generate an appropriate rule than an appropriate sign? How would one ever use the method of guidance to present an abstract rule to an ape? If it is not possible to convey the rule directly to an organism without language, the trainer ultimately must depend on the appropriate rule arising naturally in the organism's mind. C. S. Peirce (1878/1965), in his important work on induction, long ago anticipated the essence of Chomsky's argument:

It seems incontestable, therefore, that the mind of man is strongly adapted to the comprehension of the world; at least so far as this goes, that certain conceptions, highly important for such comprehension, naturally arise in his mind; and without such a tendency, the mind could never have had any development at all. (p. 348)

Concluding Remarks on Language, Thoughts, and Apes

One curious aspect of the literature dealing with teaching human language to infrahumans is a lack of concern for the actual structures of human language. No one, however, expects children to learn an abstract subject like algebra--for which children have relatively little evolutionary preparation--without years of formal instruction from teachers who have mastered the subject themselves. Why then should anyone expect so much more from an ape? A primate egalitarian like La Mettrie might well wonder to what extent the modest language achievements of the apes to date reflect the view of human language implicitly held by their tutors rather than any intrinsic limits on infrahuman language ability.

This lack of concern for the structural nature of language issues from several sources. These include a failure to distinguish between language function and structure, a belief in content-free universal laws of learning, and uncritical acceptance of the naming paradigm of language. The behaviorist paradigm, with its reliance on bar-press counters and cumulative recorders, has thrived primarily in artificial situations where the structural or topographic nature of a response approaches irrelevance. There is also a widespread intuitive belief that anything which seems easily accomplished--like learning a first language--cannot be much of a problem. This egocentric attitude is common throughout psychology, particularly where consciousness has long been a primary criterion for important psychological phenomena. William James, for example, opened his *Principles* (1890) by asking if such "machine-like" activities as walking, piano playing, or talking, which can be carried out while the mind is absorbed in other things, should be included within psychology. James here is simply echoing Descartes: "The greater part of our motions do not depend on the mind at all ... respiration while we are asleep ... and even walking, singing, and similar acts when we are awake, if performed without the mind attending to them" (cited in Vendler, 1972, p. 163). Indeed, the neglect of language within psychology (cf. Mowrer, 1954) in large part can be traced to both the automatic, unconscious character of human language and the behaviorist belief that all behaviors are pretty much alike.

It should be no surprise that Descartes, with his focus on thought and consciousness, appears little interested in the complexities of human language. Descartes, in fact, had reason to minimize these complexities in order to maximize the importance of thought. Frequently he remarked to the effect that it would be easy for any creature to invent language if indeed it had something to say. If that invention were made out to be a difficult intellectual task, there would inevitably be the suggestion that at least some creatures were able to think but had not yet invented a language. Moreover, if language invention were difficult, how could even the insane, the dull, and the stupid do it? Descartes, to be sure, would not

abilities uniquely possessed by various animal species, such as the web spinning of spiders or the navigation of birds, which were purportedly accomplished by the disposition of their organs rather than through reason.

Descartes, like certain contemporary psychologists, seems to have taken linguistic structure for granted as a relatively insignificant consequence of other factors. There are, of course, several quite different interpretations of the place of human language in human behavior. Chomsky's hypothesis has already been discussed. Even if we were to update the Cartesian soul in terms of hypothetical neural programming, Chomsky's hypothesis is quite distinct in that he explicitly postulates a specific *faculte de langage* as being responsible for human language ability rather than the Cartesian universal instrument of reason. Chomsky's *faculte de langage* is clearly intended to be a different ability than that of general intelligence or reason.

Even more radical in terms of the Cartesian position are those traditions that give language an important causal role in the development of human reason. Chomsky's hypothesis is essentially neutral on this point. Not so for the many advocates of linguistic relativity of determinism such as Humboldt (1905), Cassirer (1953), and Whorf (cited in Carroll, 1956), who attribute different cognitive structures to different linguistic structures. Descartes predictably eschews this interpretation: "For who doubts whether a Frenchman and a German are able to arrive at identical conclusions about the same thing though they conceive entirely different words?" (cited in Vendler, 1972, p. 180). In yet another tradition, Soviet psychologists (e.g., Vygotsky, 1962) have long argued the importance of language as a primary causal factor in human cognitive development. Finally, it has been suggested more than once that human consciousness itself is intimately connected with evolution of human language (e.g., Jaynes, 1973; Wright, 1877/1971).

Evaluation of such propositions has proven extremely difficult. Lenneberg (1967), for example, concluded that linguistic relativity is untestable. Language differences are inevitably confounded with cultural differences. Comparisons made between normal and deaf children are of questionable value. One neither knows what deficits accompany deafness nor how much language a child has internally available despite hearing loss and inability to speak. For such reasons, the empirical evidence bearing on the causal interaction between thought and language remains equivocal. Perhaps the advent of conversational chimpanzees will permit an adequate experimental investigation of this fundamental issue. Experimental comparisons of alternative color coding systems (e.g., Brown & Lenneberg, 1954) between animals with and without specific symbols are feasible even within the naming paradigm. Would a chimpanzee that had learned names for items have a symbolic edge in a problem-solving task over an otherwise comparable animal that had not learned names? Such investigations may well advance our understanding of human psychology far more than any research heretofore involving infrahumans.

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