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Language in Man, Monkeys, and Machines

Rumbaugh *et al.* (*1*) claim to have demonstrated language use—reading and sentence completion—in a chimpanzee named Lana. Since numerous investigators are now studying language use in infrahuman organisms, we should keep under continuing review the criteria for evaluating claims that an infrahuman organism is using language. We propose the following: (i) A strong criterion and a weak criterion of language use in nonhumans can be articulated, the choice of criterion depending on the inferences the investigator wishes to make. (ii) By the strong criterion, only *Homo sapiens* presently uses language; by the weak criterion, man, computers, and some chimpanzees use language. The distinction is based on process and product comparisons, respectively. (iii) Lana has not been shown to use language by any criterion strong enough to exclude rats, worms, and any other conditionable animal.

Since man is the only species whose language utilization is unquestionable, man provides the reference point for judging the equivalence of animal performance with language use. The weak criterion asserting weak equivalence requires only that some of the behavioral products of man and nonhumans are apparently similar. For example, if a convincing case can be made that a chimpanzee behaves in a way that requires labeling, syntax, and semantics, the animal can be said to use some language, by the weak criterion, regardless of how the behavior was induced. Strong equivalence, in contrast, requires that the linguistic performance of nonhumans be accomplished by mechanisms similar to those of men. This criterion entails a far heavier burden of evidence; that is, it must be shown that the organism learns its language by mechanisms similar to those of men, makes similar errors, shows a similar developmental pattern, effects its language use by similar neurological structures, and demonstrates any pattern that can be shown to be true of all human languages (that is, linguistic universals). The appropriate criterion must be chosen by reference to the intent of the scientist. If he is interested only in the symbolic capacity of a particular species such as the chimpanzee, the weak criterion suffices and the term "language" functions as a useful metaphor. However, if the scientist wishes to relate the animal's performance to that of humans, the strong criterion must be met.

The weak criterion of equivalence is the only one that has heretofore been met in the comparative study of language, because highly structured, carefully controlled training procedures must be introduced to overcome the chimpanzee's lack of vocalization and spontaneous linguistic behavior, shortcomings sometimes characterized as trivial. The most successful effort has been that of Premack (*2*), who has trained his chimpanzee Sarah by means of operant techniques. Such training procedures themselves preclude the strong criterion; they are totally unlike the circumstances under which the human child learns language. They require that production and comprehension of symbols and symbol strings be carefully shaped. The animal is reinforced with 100 percent consistency; it is presented with only well-formed strings; and only the well-formed strings for a particular phase of training receive reinforcement. In contrast, human children are inconsistently reinforced; they are presented with ill-formed strings; and their ill-formed productions are often rewarded, especially if they are factually correct (*3*). The training procedure also precludes the opportunity for an animal to make errors similar to those of the human child acquiring language, as well as the opportunity to show the developmental sequence that is universal among human children. However, the weak criterion can be met with nonhumans, and Sarah appears to have met it. Premack gives sophisticated evidence of labeling, syntax, and semantics in Sarah's behavioral repertoire. While this is an impressive accomplishment, it does not warrant generalizations to human language use. The measures necessary to overcome Sarah's linguistic shortcomings are too heroic for useful comparisons to be made. A logical equivalent would be verbally instructing a human to swing through trees with the aid of cables, harness, and nets in an effort to study the ontogeny or phylogeny of tree-swinging in simians.

Rumbaugh *et al.* have failed even to meet the weak criterion; they give no convincing evidence of any language use in Lana. There is no evidence that Lana labels. Her performance of different response sequences for different rewards might be called labeling if the rewards obtained were shown to be appropriate to her known drive states (which they were not). But if this is labeling, then rats that discriminate between the response sequences necessary for food and water in a T-maze can be said to be labeling the sides of the maze as "the food side" and "the water side." Similar labeling could be attributed to any lower animal whose responses correlate with its drive states. Second, there is no evidence that Lana uses syntax. A knowledge of syntax implies the capacity for linguistic productivity; the obvious way to test for its presence in Lana would be to teach her a new lexigram—such as *raisin*—and see if she generates the novel string *Please/machine/give/piece/of/raisin* without shaping. Premack's chimp Sarah has apparently performed successfully in such a test; however, the present authors do not report even attempting it. Correct insertion of the new item in the appropriate string could also be used to

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demonstrate use of semantics. Lana performs the sequence *Please/machine/tickle/Lana*. If she were taught a new relational term such as *hug* and a new object name such as *raisin*, she could be tested for the appropriate placement of these new terms in her old strings. Correct production (without shaping) of *Please/machine/hug/Lana* but not *Please/machine/raisin/Lana* would suggest that she discriminates relational terms from objects. Premack has reported that semantic competence is part of Sarah's repertoire, but there is no evidence for semantic competence in Lana. What capacities can the authors reasonably conclude that Lana has? She can carry out nine or ten partly overlapping response sequences up to seven items long and discriminate those that terminate in reward from those that do not. Lana has definitely learned to perform longer and longer sequences for reward. Training animals to perform longer and longer sequences for rewards is not novel; it has been done with pigeons and even worms, and has a long history in the instrumental conditioning literature. It certainly does not imply language use. The only support for the claim that Lana's performance is "reading" and "writing" of language is in the authors' arbitrary equating of the response sequence to English sentences. There is no evidence that meanings for the terms or syntax for the strings exists anywhere but in the linguistic competence of the experimenters. It is not even clear that Lana utilizes the exact correspondences between response sequences and particular rewards; that she accepted the rewards is unconvincing, since all were positive. The demonstration with Lana has failed in every respect to meet any reasonable criterion of equivalence between Lana's language and man's. Premack's work is linguistically more sophisticated and empirically more convincing. He has successfully met the weak criterion of equivalence, if not the strong one.

By the weak criterion of equivalence, chimpanzees are not the only nonhumans that are linguistically capable. By this criterion, the computer that trains Lana uses language, interpreting Lana's key-press sequences and responding to them. This linguistic performance is limited as computer programs go; there are many programs whose outputs mimic not only some of man's language capacity, but also his abilities to reason, draw inferences, plan, and intend (*4*). The weak criterion of equivalence is sufficient to establish that the machine using these programs indeed reasons, draws inferences, makes plans, and has intentions. Many behavioral scientists might find such claims less palatable than the assertion that an animal uses language, but their logical status is equally good. Evolutionary arguments can be adduced that the strong criterion will never be met with apes; this is a subject for longer papers (*5*). However, since a computer program can be written for any process we understand, the strong criterion of language equivalence is potentially attainable with a computer. Thus, the study of human language may be more rapidly advanced by research programs utilizing computers than by those utilizing chimpanzees.

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Mistler-Lachman and Lachman begin their comment with an error in taxonomy, suggested in the title, and follow up with an error in report. The subject of our study was (and is) a chimpanzee, that is, an ape, not a monkey; and while the taxonomic differentiation between apes and monkeys should never be blurred, it should be honored especially in a critique of scientific investigations.

Their error of report is in their first sentence. "Rumbaugh *et al.* (*1*) claim to have demonstrated language use—reading and sentence completion—in a chimpanzee named Lana." We claimed to have demonstrated reading and sentence completion skills; at no point, however, did we suggest that these specific skills were equivalent to "language use" in the all-embracing sense Mistler-Lachman and Lachman seem to have in mind. We are aware that reading and sentence completion, as defined in the description of our experiment, are merely component skills of general linguistic competence and that there are, indeed, many human language users who cannot read or write and, therefore, would not have the specific skills we claimed for Lana. We reported a computer-controlled training situation "to facilitate objective inquiry into the language capabilities of young apes." And in the conclusion of our article we stated: "Our ultimate goal is to better understand the etiology of language development in man; our immediate goal is to determine unequivocally the anthropoid's capacity for linguistic production, including conversation." Nowhere did we claim that we had achieved even the immediate goal.

We take issue with Mistler-Lachman and Lachman's definition of a "strong criterion" by which alone it could be concluded that an organism other than man has language capabilities. In particular we reject the notion that it must be shown that "the organism learns its language by mechanisms similar to those of men, makes similar errors, shows a similar developmental pattern, effects its language use by similar neurological structures, and demonstrates any pattern that can be shown to be true of all human languages (that is, linguistic universals)." Taking the last item first, we believe Mistler-Lachman and Lachman would be doing the scientific community an invaluable service if they came up with a list of "patterns" that would be considered "linguistic universals" by the scholars who are representative of the concerned fields today. The literature that we know gives us little hope of such an agreement. Regarding the other criterion conditions proposed by Mistler-Lachman and Lachman, they preclude any possibility of demonstrating that language can be mastered, even partially, by a living organism other than man, because they constitute a wholly idiosyncratic and anthropocentric definition. In fact, they also preclude the possibility on which Mistler-Lachman and Lachman base their final conclusion, that their "strong criterion of language equivalence is potentially attainable with a computer." No matter

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how well we might come to understand the language-relevant processes, the computer for which we were to program them would, at best, have "neurological structures" that are functionally similar to man's. Materially, developmentally, and in all other respects, the computer's operative structures will be quite dissimilar. As a functional model we could, of course, accept it, just as we accept the sewing of a sewing machine in spite of the fact that the machine's structure and the way in which it has acquired the sewing capability unmistakably differentiate it from a seamstress. We believe that somewhat more useful criteria for what should be called "language," and how its use may be recognized, could be gleaned from the recent literature on information processing (*2*).

It also seems that Mistler-Lachman and Lachman are taking us to task for not reporting more than we had available in the report they criticize. First, with regard to "labeling" [which, in the language acquisition literature, is better known as "naming" (*3*)] Gardner and Gardner (*4*) as well as Premack (*5*) had already published evidence of a chimpanzee's capacity for learning and correctly using names of objects. Our report was not deemed the place to confirm their results. Lana, too, had begun to acquire that ability (*6*). Second, in our report (*1*) we were not concerned with Lana's acquisition of productive syntactic competence. This is one of the major objectives of our research; given the rate of language development in children, it would be unrealistic to expect evidence for syntactic productivity within the first 6 months of Lana's exposure to the communication system. By 18 months after the start of Lana's training, we have observed several instances of productivity, that is, the appropriate use of lexigram strings that are both grammatically correct and absolutely novel in the user's linguistic experience. Lana has formulated a number of novel uses of words and sentences without any specific prior training or shaping (*7*). Without any specific training, for instance, Lana has come to ask for the names of items never before named, and she has then used the new names in sentences to request that the items be given to her. This is but one of several examples of Lana's acquisition of skills that, although germane to her progress as a user of language, should not be considered indispensable to the skills she had acquired when we published the criticized report.

We object to the allegation that we arbitrarily equated Lana's performance "to English sentences." Having designed Yerkish as well as the computerized correlational grammar that parses Yerkish sentences, we could hardly be unaware of the many ways in which it differs from English. Though we nowhere "equated" Yerkish with English sentences, we contend that Yerkish is a language, easily discriminable as such from asyntactic signaling systems. Mistler-Lachman and Lachman sporadically shift between discussing "language" and the "use of language." This makes it laborious to counter their arguments. They say, for instance, "the demonstration with Lana has failed in every respect to meet any reasonable criterion of equivalence between Lana's language and man's." While we consider Yerkish, qua language, comparable to man's languages, we never set out to demonstrate that Lana's *use* of Yerkish is or could be equivalent to man's use of language. What we believe to have demonstrated in our report (*1*) is that Lana can learn to do some of the things with Yerkish that *Homo sapiens* does with his languages. After a mere 6 months of study we produced evidence that Lana could complete correct sentence beginnings and cancel ungrammatical ones. Since then Lana has demonstrated that she can do considerably more (*7*). We agree with Mistler-Lachman and Lachman that a computer program can be written for any process we understand, but, unlike our critics, we believe that studying an organism that has shown the ability to learn *some* of the processes is at least as conducive to our understanding them as is studying computers that do not carry out processes other than the ones we already understand.

We are fully cognizant of the fact that language is other than rotely learned response sequences. If all that we observe in the years of study to which we have committed ourselves can be accounted for in terms of "training animals to perform longer and longer sequences of responses," we will have failed to demonstrate linguistic competence in the anthropoid ape. We also maintain, at least at this time, that fundamental language processes might be better understood through the use of chimpanzees as subjects. If chimpanzees prove good subjects for language research, it will be possible to conduct experiments, not possible with the human child, that entail radical manipulations of early learning opportunities in relation to the learning of language. Even failing that, to explore and define the linguistic capabilities of the chimpanzee remains a scientifically respected goal.

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