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ABSTRACT

A comparative approach to the study of communication can be seen as extremely valuable for a thorough understanding of human communication. In its broadest sense, communication is a biological phenomenon, defined as the interchange of information between an organism and its environment. Communication systems of living organisms differ qualitatively and in relation to their fundamental differences and environments. Moreover, they cannot be ranked on a superiority scale. Both cultural and noncultural factors may influence communication abilities and behavior. Although the formal rationalist method of investigation presented by Chomsky and Miller poses some problems, it can be applied in studying animal communication systems and does allow for the exploration of numerous possibilities. This procedure, followed in working with the common loon, has proved highly productive and has provided material for further study. (JM)

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On the Need for the Comparative Study of Communication: Some Conceptual and Methodological Considerations*

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Introduction

This conference has the established goal of seeking new ways to "humanize the information sciences." We wish to suggest that "humanize" is far too narrow a concept, and that the "information sciences" (particularly the field of speech communication) might do well to consider broadening their vision to use a term such as "biologize." It will be the position taken in this paper that we cannot really understand human communication without an understanding of the communication systems of other species; and, further, that a rich and productive means of devising new methodologies and conceptual frameworks for studying communication is in cross-pollination between the fields concerned with human communication and the biological disciplines. Consequently, we will discuss some of the reasons for a reluctance in our field to move to a broader comparative approach, and a few of the benefits--to our field and to others--of comparative work. In particular, our discussion will focus on the implications of the notions of evolution for the conceptualization of communication in different species, especially man.

I. Evolution and Communication

"Communication Continuity"

Disregard of animal communication systems by scholars of human communication has stemmed from some serious problems of both misuse of comparative work and misinterpretation of evolutionary theory. Too often comparative approaches have been objected to and perceived merely as <u>reducing</u> man's communication systems (especially language) to those of "lower" species, either in terms of basic concepts or evolutionary history. This objection fails to positively affirm the fundamental function of comparative analysis, which is to discover both similarities and differences. However, it does point to a serious temptation (reductionism) in the comparative approach. Interestingly, this objection usually comes from an anthropocentric position; as should be apparent when one recognizes the qualitative differences among species of divergent lineages and different environmental demands, it is equally important to note that the communication systems of other species should not be reduced to that of man.

Reductionism has been most apparent in the one area of "comparative communication" that has been developed, that is, in the description of human communication in terms of closed mechanical systems, information theory, and Shannon and Weaver (1949) type models. The problems of applying information theory and related machines models to human communication have been frequently discussed, and it is not our intention to review them here (cf. R. Smith (1962), for example). Instead, we would like to criticize its reductionism on grounds usually omitted by other critiques--that is, in terms of the awkward implications regarding the evolution of language and communication that flow from information theory.

Since information theory is predicated upon the concept of entropy, it would seemingly be unable to account for any of the emergent aspects of evolution. Instead, the "most"--and this is perhaps stretching information theory unjustly--that can come from its concepts is the presumption that all communication systems can be ranked on a simple unitary scale of communicative complexity. Differences among communication systems are reducible to differences in number of structural characteristics, channel capacity, and so forth. Qualitative differences are ignored, and any discussion of the evolution of communication or evolutionary relationships among communication systems of living species within the information theory framework implicitly assumes that some species are merely simpler versions of other species. This assumption might well be called the "theory of communication continuity," and Lyons (1970) has expressed awareness of apparently the same concept at work in a non-information theory context: "It has often been argued, and perhaps more frequently assumed without argument in recent years, that human language must have evolved from some more primitive form of communication akin to one of the signalling systems employed by other animal species" (229)*. Bronowski (1967) has explicitly supported the "communication continuity" view:

> The distinction between human language and animal communication has been debated by many writers; indeed, the main lines of the argument were laid down in the last century. Since then, a great deal has been learned about animal behavior which has given the topic a new and solid interest. At the same time, fossil evidence has been found which changes the traditional conception of the evolution of the human brain.... These findings and speculations give a different philosophic depth to the discussion of human and animal nature.... <u>It is not implied...that there is any break in evolution between human speech and its origins in animal behavior</u>. (374-375; emphasis ours.)

The assumption of "communication continuity" appears to be quite analogous to the psychological notion of "mental continuity" that stemmed from behavioristic views of intelligence and learning. The notion of mental continuity--that there are no fundamental differences in intelligence among species, and, hence, that all living organisms can be ranked on a unidimensional scale of mental complexity (with man at the top and the sponge at the bottom)--has been under attack during the past few years by Hodos and Campbell (1969), Hodos (1970), and Lockard (1971), among others. Evidence contradicting the mental continuity position and supporting the existence of important qualitatively different mental and learning abilities has been put forth by Rozin and Kalat (1971) and

*As it applies to the presumed evolution of verbal from human nonverbal communication, Birdwhistell (1970) has critiqued this notion, which he calls the "'Closer to Nature' temptation."

Shettleworth (1972). An example of the disturbing consequences of experimental work for advocates of the mental continuity view was provided by Hodos (1970), where in a particular test of learning plasticity, pigeons (who should be the inferior species in a mental continuity view) performed better than New World monkeys. (Numerous other examples can be found in Stettner and Matyniak (1968).) We submit that similarly disturbing results for the communication continuity notion occur if it is tested against empirical evidence. For example, the communication systems of primates would supposedly surpass the systems of "lesser" species such as birds. However, if one uses structural complexity as the criterion, bird song in most Oscine species is far more complex than New or Old World monkey calls; furthermore, in our own research (unpublished), we have found that the structural complexity of a set of calls of the common loon--a nonpasserine and early evolved avian species--is greater than that of some birdsong. If one uses vocal plasticity, then the Indian hill mynah appears to far surpass any New World monkey. Of course, there are other criteria by which the "higher" animals surpass the "lower" ones. The point is that the communication systems of living organisms differ qualitatively, and do not fall on a simple scale that ignores fundamental differences.

"Speech Superiority"

All too often, underlying the objections to reductionism in information theory and comparisons with other species is an assumption that is more often expressed in conversation than in writing, but is evident in the work of authors that we will discuss below. This assumption--which we shall call the "theory of speech superiority"--is basically at loggerheads with the communication continuity view in that it correctly emphasizes qualitative differences; but simlar errors in reasoning regarding evolution are involved.

Simply, the "speech superiority" position holds that all communication systems of "lesser" species are qualitatively vastly inferior to the systems of man, most specifically language. Crudely put, the view is that language (and/or human communication in general) somehow both encompasses and surpasses all other systems; hence, by studying man, we would implicitly study the other forms as well (but not vice versa). Or, the other systems are so qualitatively inferior as to be uninteresting.

In the first place, it is difficult to make such judments without considerable comparative evidence, and very little work has been done thus far. But secondly, such judgments are questionable on evolutionary grounds, as well as being premature. We shall highlight some of these questionable aspects in discussing the positions of Smith (1967) and Marshall (1970).

A sophisticated--but inconsistent--presentation of a speech superiority position is found in a biological theory of communication presented by Smith (1967). Smith's position is that most current communication theories are reductionistic--that is, that all phenomena may be reduced to and ultimately explained in terms of a single elementary set of physical (mechanical) constructs (a position with which we generally agree). Hence Smith takes an "emergent," "holistic," "organismic" position, treating communication as a central biological phenomenon involved with information exchange.

Up to this point, Smith's view is solid. However, despite his emphasis on emergence and anti-reductionism, later in his work we find an ordering of living systems as demonstrating the evolution of communicative complexity from simple organisms and chemical communication, to insects, lower vertebrates (fish, reptiles, and birds), to the higher vertebrates (primates), and man and speech. For such conclusions about the evolution of communication to be drawn implies that he views some living species as primitive to others, falling into place on some linear scale of evolution. It is the case, on the contrary, that no _living_ species is descended from any other living species. Species today represent divergent lines of evolution that _long ago_ branched off, evolving in parallel and not representing an evolutionary sequence (Hodos, 1970). Inferences about the phylogenetic development of communication or other behavioral systems cannot come from animals representing _divergent_ lineages; and species that have come from the same stem have usually evolved so specifically to new environmental requirements as to be unrepresentative of any evolutionary sequence. For example, although amphibians evolved before reptiles, living frogs and toads are not ancestral to reptiles since both amphibian and reptilian species have changed greatly since the time of branching. Since mammals probably originated from another branch of reptiles, it is unreasonable to consider either birds or crocodiles as representing communication systems ancestral to man's (cf. Hodos, 1970). Comparisons of species representing divergent paths can give insight only into the pressures of adaptation on communication systems (cf. Hodos and Campbell, 1969): Some possible evidence for the evolution of behavior and communication patterns and systems can come _only_ from studying species that represent a common evolutionary lineage and which have not diverged too greatly. For example, since both birds and living alligators and crocodiles came from the same "archosaurian-stem reptiles," the modern crocidilia, as surviving archosaurs, are reasonable representatives of the reptilian ancestors of birds (Hodos, 1970 ; 29). Studies of hedgehogs, tree shrews, bushbabies, and some Old World monkeys _may_ yield some information about the evolution of man's communication systems.

Furthermore, Smith assumes that there is an evolutionary "goal," and that this goal is toward increasing complexity and specialization. Evolutionary trends in the direction of simplicity have been discussed in some depth by Simpson (1967) and Mayr (1969). Thus, ironically, although the initial view presented by Smith stresses qualitative differences, his rank ordering of living systems as demonstrating an evolutionary movement toward complexity is itself reductionistic and seriously misleading.

Although the position taken is the inverse of Smith's, Marshall (1970) has followed the same assumptions in his reasoning. Marshall's position seems to be an update of the "distinctive features" approach put forth by Hockett (1959; 1960a, b; 1963; Hockett and Asher, 1964). Hockett eventually listed 16 features that supposedly distinguish language from other systems, implicitly suggesting that organisms could be placed on a vertical scale according to the number of features possessed. Many of these features applied to other species; naming, for example, is evident in the behavior of some antiphonal bird species (cf. Thorpe, 1966). However, only man's system contained all 16 features, of course, and the scale totally ignored features (such as chemical coding) attributable to other species' systems but not to man's. (Hockett and Altmann (1968) eventually revised the design features approach toward "frameworks" which removed language as the standard against which all other systems were judged. The original distinctive features approach, which emphasized "speech superiority," was--and still is--quite influential, however.)

Marshall reduced the number of presumably diagnostic features to five, which supposedly do not characterize the communication systems of other species (one of the _supposedly_ unique characteristics is naming).

From this comparison of the systems of living species, he argues against the view that language evolved from animal forms of "informative signalling." So again we find the derivation of conclusions regarding evolutionary sequence from an improper ordering of living systems in some evolutionary sequence. Furthermore, Marshall's position is that language is superior to other communication systems, a view which completely fails to acknowledge that qualitatively different systems have evolved to meet different adaptive requirements.

It is readily apparent that there are qualitative differences among species; such a point is obvious in evolutionary theory's implicit assumption of discontinuities resulting from "the divergence of evolutionary lines and the extinction of many intermediate forms" (Hodos and Campbell, 1969:339). Hence it is ultimately unreasonable to rank communication systems, as it is unreasonable to rank apples, oranges, and bananas, since each has been adapted to different environmental conditions. Comparisons among species can be made; but to then infer that one kind is inferior and thus more primitive in some evolutionary sense suggests an untenable view of evolution.

"Comparative Communication"

Interesting and valid comparisons among species can be made if notions such as "rudimentary" and "inferior"--in any evolutionary sense--are dropped. In fact, it is only by comparison--if only against an implicit and unarticulated "model"--that any phenomenon is defined and understood. Quite simply, it is as important to say what something is not as what it is; and, as Sebeok (1968) pointed out, in exclusively studying human communication, we have restricted ourselves to a sample of one. The conceptual inadequacy of the "communication continuity" and "speech superiority" points of view would not be apparent except through knowledge of and comparison with the communication systems of other species, grounded in an understanding of evolution.

An important consequence of the often ill-reasoned debates comparing human and other animal, insect, or mechanical communication systems has been to more clearly perceive what is uniquely human. Equally important, we can perceive--when our anthropocentricism is held in check--what is uniquely the property of another species. At the same time, we may perceive what is shared or similar among several species. Several examples will serve to reveal these points: (1) The steady growth of Hockett's list of design features as characteristics (though not exclusively) of human language is a direct consequence of comparative work. (2) The significance of the important linguistic notion of "open-endedness" is more clearly understood when compared to another kind of "open-endedness" in the communication of bees. (3) The adoption of and attempted adaptation to human communication of Shannon and Weaver's cybernetic model contributed to a great growth in conceptualization (especially in the rebuttal attempts).

Conceptual Framework for "Comparative Communication"

Briefly sketched, the comparative study of communication, at a highly abstract level, can be grounded in a theoretical basis such as that put forth by Smith (1967) (but without the questionable assumptions criticized earlier in this paper). In this view, communication--in its broadest sense--is a biological phenomenon, and is defined as the exchange of information by an organism with its environment. Quite likely, information will have to remain a primitive term.

Placed into an evolutionary framework, this phenomenon of communication manifests itself in qualitatively different patterns, abilities, and systems in different species. The communication process of each species as it is expressed in communicative behavior is itself subject to selection pressures.

Communicative behaviors are adaptive. Thus when we compare communication among species, we are discussing qualitatively different processes; for example, communication in the chimpanzee is not merely a simpler version of communication in man. However, in some sense, at an abstract conceptual level, we are talking about the "same" phenomenon--one that serves certain adaptive functions (such as integration and differentiation (Smith, 1967)) for all organisms. Communication in man is the "same" phenomenon as communication in the chimpanzee <u>only</u> in the same way that we can talk about intelligence in man and in chimpanzee and mean the "same" thing--that is, as "an aggregate of special abilities, each one evolved as a response to ecological factors posing problems" (Lockard, 1971:173).

Communication in any species can thus be seen as a set of special abilities and related behaviors evolved to deal specifically with information and the integration and differentiation of the organism and other organisms, upon which the process of <u>natural and cultural</u> selection have acted. Some similar behaviors from unrelated species may have resulted from similar selection pressures; similarities among related species may have come from phylogenetic sources. Differences may be due to either evolutionary divergence or different adaptive pressures. Depending on our purposes, we can then refine the definition to require that communication behavior associated with these functions be recognized as significant by another organism, or that it be intentional, and so forth. These refinements, however, are clearly arbitrary and pragmatic.

Aspects of this view are not new to zoologists. An adaptive-evolutionary approach has been taken by ethologists for years (cf. Tinbergen, 1951; Lorenz, 1965). Frequently, however, communication behavior has been definitionally restricted to a rather limited class called "sign stimuli," which, through the process of ritualization, has achieved specific communicative value. The narrowness of this view of communication is largely due to the bias towards innateness on the part of the most influential ethologists, but this bias and narrow definition of communication are clearly not necessary consequences of an adaptive-evolutionary view. As mentioned previously, <u>both</u> cultural and noncultural factors may exert selective pressure on communication abilities and behavior.

II. Rationalist Methodology and Biology

Thus far in this paper we have discussed how a knowledge of certain concepts from other disciplines and a comparative approach to communication are necessary for an adequate understanding of human communication. Cross-pollination can work the other way, too; for example, Marler's (1970) conceptualization of the ontogeny of song in male white-crowned sparrows has clearly benefitted from "similarities" in this process to that of a language acquisition in a child. But in addition to exchange of concepts, some methodologies appropriate to investigation in one field may be profitably used in another field. In this section, we would like to discuss how a formal, rationalist "method" of study set forth by Chomsky and Miller (1963) can be applied to the study of communication in nonhumans, and discuss some of the problems involved in this procedure.

In determining the significance (structural and social) of certain features of animal communication systems, biologists have employed a procedure roughly analogous to the field linguist's technique for determining linguistic units and sequences, but lacking explicitness and clear conceptual grounding (cf. Falls, 1963; Emlen, 1971). The formal analysis put forth by Chomsky and Miller can provide the absent theoretical basis and rigor.

Strange as it may seem at first, a rationalist viewpoint does not contradict our earlier adaptive-evolutionary position; in fact, it is quite compatible, particularly if one reads "predisposition" for the "innate ideas" that are often referred to, and recognizes the developmental interplay of predispositions and environment. (As pointed out earlier in this paper, radical behaviorism, as manifested in a communication continuity view, does contradict our position.) Essentially, the rationalist program attempts to devise theories for the system being studied that (1) distinguish units from nonunits; (2) specify the order of occurrence of the units (acceptable and unacceptable sequences); (3) list the range of possible hypotheses that account for (1) and (2); (4) provide a way to consistently structurally describe any given sequence of the phenomenon; and (5) provide an "evaluation procedure" (in contrast to the "discovery procedure" sought by traditional empiricists) that ranks these theories according to criteria such as simplicity, elegance, and "naturalness " (cf. Chomsky, 1965). The accuracy of decisions made in steps (1) and (2) is determined by testing each theory's predictions (as to units and acceptable sequences) against the responses of a "native informant." Hence the output from this procedure is tied directly to empirical testing.

When adapted to the study of a nonhuman communication system, the program set for by Chomsky and Miller does not commit one to believing that an animal's communication system is <u>like</u> a language, but it allows numerous possibilities to be explored. The program, when tied to its empirical consequences, provides a rigorous method of formulating hypotheses and testing them, plus providing a means to analyze how powerful a theory is needed to account for the data. For example, if in examination of data "representative" of the system under investigation we find evidence of embedding, then it would appear difficult to account for such behavior by behavioristic theory. The point is, whereas a behavioristic perspective--so often employed in animal studies--commits one to a simple theory and does not allow the possibility of a more powerful one (cf. Lashley, 1951), the Chomsky and Miller approach, when tied to field testing, allows all avenues to be explored and suggests some means for determining the best theory.

Epistomological and Methodological Considerations

When applying the formal procedure to studying nonhuman subjects, there are some important difficulties to consider. The human observer is thought not to be fully competent in the communication system of the animal being studied: hence, the usual problem of objectivity in language study is more complicated in the study of animal communication. As with the investigation of language acquisition in children, the animal cannot be simply treated as a cooperative native informant. At some point (in fact, at the point of testing hypotheses against observable behavior), the investigator must decide that the animal's behavioral responses are acceptable indicators of the meaning of a call, or other vocal emission. However, clearly the decisions as to what behaviors are same or different, and fall into which categoreis of responses ultimately rest on the intuitions of the human observer. He is confronted with explaining and justifying his intuitions of the structure and meaning of the communication system of another species. Here we are not worried about what are usually called "anthropomorphic interpretations," but are concerned with more fundamental issues related to possible differences between Man and other species, and the problem of understanding (or even positing) "other minds."

The investigator can operate with an animal "native informant" only by making several assumptions: (1) The animal's responses are not contrived--probably a fair assumption for most species, except primates--or that contrivance can be identified. (2) The human observer is capable of understanding the meaning of the system. He is intelligent enough, and enough "like" the species to comprehend what he observes. (3) The observer is capable, through his own or technical means, of "tuning in" to the modality employed--or can at least find evidence that such heretofore unnoticed systems are involved. (4) The investigator is capable of sufficiently approximating the parsing system of the animal, whether at a macro taxonomic level or a more refined level; he will not force date into categories in which they do not belong, nor improperly exclude it from consideration, nor devise "unnatural" categories. This is particularly relevant when the animal's perceptual abilities are qualitatively different (as with bats) or superior, as with birds. (The sensitivity of birds to sequencing is at least ten times that of humans, thus suggesting that a more complicated sequence-dependent system is possible than might otherwise be expected, were the researcher to depend solely on his natural perceptual abilities (cf. Greenewalt (1968) and Marler (1969)).

With these assumptions in mind, we can employ the following procedure, as a beginning for understanding the communication system under study:

1. Perform a formal analysis of the system--calls, song, other vocalizations, pheramonal systems, or whatever. Following the principle of "complementary distribution," observe what occurs together, does not occur together, and sometimes occurs together. From this can be established what on the surface appear to be reasonable divisions and categories of phenomena. The smallest finite categories constitute discrete "symbols"; they serve as "The indivisible atoms from which longer messages must be constructed." (Chomsky and Miller, 1963: 273) In devising such a classification system, the possibilities of both horizontal and vertical arrangement should be kept open; that is, elements may be organized hierarchically, so that larger units may be broken into smaller ones, or may not be. It is possible that the smallest possible elements may be entire call or song; or, it may

be that there are distinct levels of the system, each with its own set of elements and rules, connected "logically" (explicitly) to each other.

2. Determine the acceptable sequences of elements, and clearly distinguish them from unacceptable sequences. This may be done either by listing sequences, by providing an operational test that distinguishes acceptable sequences from unacceptable ones, or writing a number of "rules" which summarize the acceptable sequences. (Until a coherent, encompassing view of the animal's communication system is attained, all three methods may be useful at certain points.) In completing this step, the problem is, the animal's responses cannot occur--to our eyes anyway--in a purely structural context. Clearly we cannot expect the animal to make choices between alternatuves on a purely structural basis, if for no other reason then we would have no means for understanding his responses. Mere difference in behavior can indicate that the frequency hurts the ears, that low tones are pleasing--or simply, that a perceptually noticable change has occurred.

Hence a "bioassay" techinque (cf. Emlen, 1971) must be adapted to our rationalist program, as a means of disambiguating the responses of the animal. In this technique the units under study are embedded in a social context. For example, in attempting to identify which features were related to individual recognition in the song of the male Indigo bunting, Emlen used the "degree of territorial response" as a measure of what features were signigicant. He reasoned that more and stronger aggressive behaviors would be elicited from a territorial male as more features related to territory and individual recognition were included in the stimulus. By systematically varying these features, the set of relevant characteristics and their important sequences could be determined. Thus only be embedding the procedure in a known social context where responses to stimulus characteristics can be measured against expected normal responses can we get at structural meaning.

We might more thoroughly discuss the problems of this procedure (as it is thus far developed) by posing the following question: What does it mean if the behavior exhibited by the animal for two alternative sequences,' or two contrasting features, is not noticably different for either alternative?

1. The categorization rule (code) may be fallacious. Evidence against this decision comes primarily from the success or failure of the process up to this point. If the animal's behavior has been noticably different with each systematic variation of features, then one could conclude, pragmatically, that the code is in order, and leave it at that.

2. However, if the evidence is as described in 1., then an "error" exists in the code to the extent that it postulated a further difference that does not appear to be supported. Again, one could make one of several decisions:

a. The animal's behavior may vary, or does vary, systematically in accordance with the two alternatives, but the observer's perceptual devices do not allow this to be perceived. This remains an open question; at the moment, it is of no usefulness to opt for this choice, for there is nothing that can be done about it. Similarly, to say that the animal's behavior is not understandable or is contrived is not particularly helpful. Yet these remain open possibilities, and indicate that decisions ultimately rest on intuitions. At the same time, however, the pragmatic uselessness of these choices allows selection of another alternative. Options b., c., and d. may now be explored.

b. There are alternative codes that work equally well to this point, constructing the same set of features and sequences, but one or more of the alternatives is more accurate in that it does not predict any further category refinement. (That is, the codes predict similar consequences but "for different reasons.")

c. There are alternative codes that operate on different principles and reorganize the data so that alternatives are different.

d. The error in the current code is merely indicative of that point where differences that we perceive are meaningless to the animal. One would then rewrite the code to match the data. Admittedly this is ad hoc to some extent, but it surely indicates one of the points where a purely formal analysis may give way to empirical evidence; and, although the code is thus a bit ad hoc (when adjusted), the adjustment is justified clearly on the basis of the prior, principled decision to use an empirical test to determine the value of the code.

What is now required is some means by which we can select among the three remaining options, b., c., and d. In choosing between b. and d., as the options are now put, we should opt for b., for it formally accounts for the situation in a neat and explicit way. However, if the animal appears to do "nothing," we have no real way of distinguishing between vagueness within a class and the proper boundaries of the class. Hence it is always possible that the class is vague, or, more interestingly, is ambiguous, rather than being the smallest meaningful unit as explained in the alternative code. In this one sense, b. and d. cannot be distinguished.

Choosing between c. and d. can be done by testing the alternative codes against the animals responses to see whether the responses do support the categories and sequences established by the alternative codes. Whichever code achieves the greatest response discrimination would be favored, since it accounted for the most data.

Choosing between b. and c. is done the same way as choosing between c. and d., unless d. has been rewritten in accordance with the results of testing it in the field. Then one would presume that c. would be preferred, for it is explicit and not ad hoc.

The situation is more ambiguous if we encounter two codes that predict the same empirical consequences (or the alternate situation where we have two codes that equally well account for the data). If both codes predict the same consequences, then at least within our current context, we have no way of determining which alternative is "right," because there is apparently no test that distinguishes between them. Hence, we may legitimately choose either alternative. However, we may wish to provide certain standards (for judging between rival theories) that appeal to other concepts, such as simplicity, elegance, or "naturalness"--a particularly confusing notion when one is working with another species. Further, theories can be ranked according to how well each is internally ordered and externally ordered (how well it fits with other theories of other relevant phenomena). A code dealing with units and sequences and hierarchical organization of calls must coordinate with neurological, physiological, and anatomical data, particularly with the parameters ("fidelity criterion") that such data impose.

This discussion illustrates some of the points where decisions made in explaining the communication system of an animal may be questioned. Yet it is felt that if such decisions are made following this program and its guidelines (how one would make "naturalness" explicit is not known), and on the basis of coordinating the code with relevant and well documented facts, then the decisions and subsequent code will be fairly strong.

We have begun to follow this formal procedure in our own investigations in comparative communication, working with the common loon, and have found it to be highly productive. In conjunction with this program, which works directly off the communication behavior, we are also employing a complementary procedure designed to describe the communication in terms of social consequences. This procedure has been followed by ethologists for some time, (Hinde, 1970; Beer, 1963, 1964) and, unfortunately, depends upon intuitions a great deal. However, it does provide us with a general taxonomy of loon vocalizations (categorized according to social consequence), which will help us to provide a social context for the "bioassay technique" used in determining structural meaning. Thus far, we have come up with some hypotheses regarding units and sequences, and can begin field testing these in the next few seasons. A problem which we must resolve in the field testing is that until it is possible to identify what is merely individual variation in calls, it is hard if not impossible to determine what are significant differences in units and sequences and what are not. Hence we will be concerned with identifying those features that code individual identity (cf. Beer, 1970; Emlen, 1971), again by using the basic rationalist procedure in conjunction with the bioassay technique.

Summary

In this paper we have discussed two views of communication that have been of particular architectonic significance in defining the field of study of speech communication. Involved in both the "communication continuity" and the "speech superiority" positions have been some questionable assumptions regarding the nature of evolution and evolutionary relationships among species. Once these assumptions are removed, the comparative approach to the study of communication can be seen to be extremely valuable, and is, in fact, necessary for a complete understanding of human communication. Adaptation of methodologies from one field of study to another can also be highly productive, as in the use of the formal, rationalist program of investigation in studying animal communication systems.

Bibliography

Beer, C. G. (1970). Individual recognition of voice in the social behavior of birds, in Lehrman, D.S., Hinde, R. A., and Shaw, E. (eds.), Advances in the Study of Behavior, Vol. 3. New York: Academic Press. Pp. 27-74.

________ (1963). Ethology - the zoologist's approach to behavior. I. Tautara (Biol. Soc. Victoria U. Wellington, N.Z.). 11: 170-77.

________ (1964). Ethology-the zoologist's approach to behavior. II. Tautara (Biol. Soc. Victoria U. Wellington, N.Z.). 12: 16-39.

Birdwhistell, R. (1970). Kinesics and context. Philadelphia: Univ. of Penn. Press.

Bronowski, J. (1967). Human and animal languages, in A symposium to honor Roman Jacobson. Vol. 1, The Hague: Mouton & Co. Pp. 374-94.

Chomsky, N. (1965). Aspects of a Theory of Syntax. Cambridge: The MIT Press.

________ and Miller, G. A. (1963). Introduction to the formal analysis of natural languages, in Luce, R. D.; Bush, R.R., and Galanter, E. (eds.). Handbook of Mathematical Psychology, II, 9-14. New York: Wiley. Pp. 269-321.

Emlen, S.T. (1971). An experimental analysis of the parameters of bird song eliciting species recognition. Behavior. Vol. 71. Pp. 130-71.

Falls, J. B. (1963). Properties of bird song eliciting responses from territorial males. Proc. 13th Int. Ornith. Cong. 259-71.

Greenewalt, C. H. (1968). Bird song: acoustics and physiology. Wash. D.C.: Smithsonian Institution Press.

Hinde, R. A. (1970). Animal Behaviour. New York: McGraw-Hill Book Co.

Hockett, C. F. (1959). Animal "languages" and human language, in Spuhler, J. N. (ed.), The evolution of man's capacity for culture. Detroit: Wayne St. U. Press. Pp. 32-9.

________ (1960a). Logical considerations in the study of animal communication, in Lanyon, W. E. and Tavolga, W. M. (eds.), Animal Sounds and Communication. Wash., D. C.: Amer. Inst. of Biol. Sciences. Pp. 392-430.

________ (1960b). The origin of Speech. Scientific American. Vol. 203. Pp. 89-96.

________ (1963). The problem of universals in language, in Greenburg, J. H. (ed.), Universals in Language. Cambridge, Mass.: M.I.T. Press. Pp. 1-29.

__________ and Asher, R. (1964). The human revolution. *Current Anthropology.* Vol. 5. Pp. 135-168.

__________ and Altmann, S. A. (1968). A note on design features, in Sebeok, T. A. (ed.), *Animal Communication.* Bloomington: Ind. Univ. Press. Pp. 61-72.

Hodos, W. (1970). Evolutionary interpretation of neural and behavioral studies of living vertebrates, in Schmitt, J. (ed.), *The Neurosciences: 2nd Study Programs.* N.Y.: Rockefeller Univ. Press. Pp. 26-39.

__________ and Campbell, C. B. G. (1969). Scala naturae: why there is no theory in comparative psychology. *Psychological Review.* Vol. 76. Pp. 337-50.

Lashley, K. (1951). The problem of serial order in behavior, in Pribram, K. (ed.), *Brain and behavior 2: perception and action, selected readings.* Baltimore: Penguin Books. 1969. Pp. 515-40.

Lockard, R. B. (1971). Reflections on the fall of comparative psychology: is there a message for us all? *American Psychologist.* Vol. 26. Pp. 126-79.

Lorenz, K. (1965). *Evolution and modification of behavior.* Chicago: Univ. of Chicago Press.

Lyons, J. (ed.). (1970). *New horizons in linguistics.* Middlesex, England: Penguin Books Ltd.

Marler, P. (1969). Tonal quality of bird sounds, in Hinde, R. A. (ed.), *Bird Vocalizations.* Cambridge, England: Cambridge U. Press. Pp. 5-18.

__________ (1970). A comparative approach to vocal learning. *Journal of Comp. and Physio. Psych.* 71: 1-25.

Marshall, J. C. (1970). The biology of communication in man and animals, in Lyons, J. (ed.), *New Horizons in Linguistics.* Middlesex, England: Penguin Books Ltd. Pp. 229-41.

Mayr, E. (1969). *Principles of systematic zoology.* New York: McGraw-Hill Co.

Rozin, P. and Kalat, J. W. (1971). Specific hungers and poison avoidance as adaptive specializations of learning. *Psychological Review.* Vol. 78. Pp. 459-86.

Sebeok, T. A. (1968). *Animal communication.* Bloomington: Indiana U. Press.

Shannon, C. E. and Weaver, W. (1949). *The mathematical theory of communication.* Urbana: U. of Ill. Press.

Shettleworth, S. J. (1972). Constraints on learning, in Lehrman, D. S.; Hinde, R. A., and Shaw, E. Advances in the study of behavior. New York: Academic Press. Pp. 1-68.

Simpson, G. G. (1967). The meaning of evolution. New Haven: Yale U. Press.

Smith, D. R. (1967). Communication: process and function a study of the origin and nature of communication. Kansas University. Unpublished Ph.D. dissertation.

Smith, R. (1962). General models of communication. Presented at 1962 Summer Conference N.S.S.C., Purdue University.

Stettner, L. and Matyniak, K. (1968). The brain of birds. Scientific American. 218(6): Pp. 64-76.

Thorpe, W. H. (1966). Ritualization in ontogeny. II Phil. Trans. Royal Soc. London Ser. B. Biological Sci. Vol. 251(772) 1966. Pp. 351-8.

Tinbergen, N. (1951). The study of instinct. London: Oxford U. Press.