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The Development of Language as Purposive Behavior*

We have come to this meeting to discuss *Origins and Evolution of Language and Speech*. The two conjunctions in the title indicate that we are dealing with a composite subject. The items in each pair are certainly related, but they are also different. At the risk of being considered a nit-picker I shall pursue these differences for a moment. Formulating them has helped me a great deal to clear my head and will, I hope, justify some of the things I am going to say later.

To begin, we may say that there could hardly have been an evolution of speech, or language, if there had not been an origin. We can even generalize and say there is no evolution without an origin. When we think in terms of the *theory* of evolution, we tend to focus on the way it functions and then it seems quite natural that it must have been operative from the very beginning. Yet, it is fairly clear that for something to evolve, something must be there—and this something would be called the source, or the *origin*, of everything that evolved from it. I am not making this point in order to stir a metaphysical wasp's nest. I am making it because I believe it has to be made if we are to understand one another. "The origin of speech" refers to an item, an event or state of affairs, which we consider to have been the starting point for the "evolution of speech". When we say "speech", we inevitably have in mind vocal sounds that have a certain function—not just incidental vocal noises that are produced in a haphazard way. Yet, to have an *evolution* of speech, a species must have been producing haphazard vocal noises, the raw material as it were, that could then acquire the function of speech. This raw material is at the origin, and the subsequent changes, transformations, and additions that eventually brought it to what we now call "speech", is its evolution. We could, of course, also investigate how that species came to produce haphazard vocal noises; but if we included that study under the heading "evolution of speech", we should have to include the study of how that species came to have the physiological structures that happen to produce noise, and so on, I'm afraid, right back to a study of how anything came to be alive. A theorist, as Hebb once suggested,[1] is in one way like a bricklayer: if he wants to get on with his building, he has to accept bricks as bricks. If he becomes interested in the structure of bricks and how they are made, he ceases to be a bricklayer. So much for the distinction between origin and evolution.

With the two terms of the second pair in our title, things may not go so smoothly. For a considerable time, linguists have implicitly and even explicitly equated "language" with "speech". They did so quite naturally because "language" had always

implied human language, and human language was presumed to have manifested itself in speech long before it found other channels, such as hieroglyphs and alphabets. But there is another, less ingenuous reason. The bulk of linguistic research, having chosen to follow Bloomfield (rather than Sapir) developed a militant disregard for the *function* of the phenomenon it was studying. Interest was focused on those manifestations that could be called directly observable or physical. Phonology thrived and semantics, the study of meaning, which is at the core of the communicatory function of language, was thwarted[2]. Maybe it was necessary to follow that narrow path almost to its dead end before one could begin to take to heart Sapir's admonition that a speech-sound, "even when associated with the particular movements of the 'speech organs' that are required to produce it, is very far from being an element of language. It must be further associated with some element or group of elements of experience, say a visual image or a class of visual images or a feeling of relation, before it has even rudimentary linguistic significance"[3]. Today we have a rather well-developed theory of communication which should help us to keep apart *signals,* such as speech-sounds and other transmittable and perceptual items, from the messages or meanings to which they are linked by a given code. From this point of view, then, *speech* would be a collective term for the vocal signals humans use *to transmit messages;* the messages, on the other hand, are the meaning or content that is semantically tied to the signals, and it is only when we consider this whole complex of signals, semantic nexus, and meaning, that we should use the term *language*. As a system of communication, language is not at all restricted to vocal signals but can be implemented by visual or tactual signals (e.g. American Sign Language, Braille, etc.).

Though many of you may not be inclined to accept so radical a division, some such division has to be made, if we want to investigate the *evolution* of language. For if we maintained that language is no more than the production of certain sounds, we should inevitably get into the embarrassing position of having to concede that a parrot or a myna bird that has a repertoire of a dozen sentences differs from us only quantitatively, in that he can make fewer speech-sounds or combinations of sounds than we can. Though that difference is true enough, we could not help feeling that there is some qualitative difference as well. The difference, I suggest, is that, no matter what the bird *says,* he is not *telling* us anything; which is to say, he is not sending a message [4]. That is why, whatever the bird says, our response is likely to be "Amazing!" or "How clever!". We ourselves, on the other hand, would be concerned, to say the least if, under normal circumstances (i.e., except in foreign-language lessons and certain cocktail parties), all our utterances elicited that kind of response and no other [5]. Our concern would be similar in kind (but not in degree) to the concern we feel when we turn the steering wheel of our car, and the car continues to move in a straight line; i.e., when an activity we have learned to consider instrumental in achieving a certain result, suddenly fails to achieve that result. It is in this sense that communication must be considered "instrumental", "goal-directed", and therefore "purposive" [6].

In a later section of this paper I shall try to show that the semantic connection between signals and their meaning, though a necessary condition, is in itself not a sufficient condition for the application of the term "language". For the moment, the point I want to make is that, just as we cannot have evolution without a raw material

that can evolve, we cannot have speech without the development of language, and we could not have language unless there was something to be communicated and a motive for communicating it [7]. And since we are speaking of evolution in terms of an established theory, we must also assume that the ability to communicate did in some way enhance the survival of organisms that developed it. If these two assumptions are to have any theoretical (let alone practical) value, we shall have to show that there is a way of thinking about pre-linguistic organisms that strips any miraculous aspect from the appearance of language and explains it as just one more step in the natural evolution of complex survival mechanisms.

Purpose and Negative Feedback

I have deliberately introduced the term "communication" in the context of the modern *theory* of communication [8], because if we do not carefully restrict its meaning there will be no end to our misunderstanding. The literature of animal communication, for instance, is a blatant example of how human communication breaks down when the central term in a discussion remains, as Sebeok has recently said, "an undefined prime" [9]. One of the reasons why "communication" was either left thoroughly opaque or defined with such generality as to include *any* kind of organismic interaction [10], is that the concept of "purpose" had been declared out-of-bounds for scientific explanation. The reaction to Aristotelian teleology has been so vigorous and sweeping that many of the arbiters who decided what was to be "scientific" and what not, failed to notice that some scientists were creating a new approach to teleology and that purposiveness of which we are all subjectively aware.

In 1943, Rosenblueth, Wiener, and Bigelow published their pioneering paper that provided not only a hard definition of "purpose" but also an extremely successful model for the actual construction of "goal-seeking" devices [11]. Three years later, in a conference sponsored by the same Academy that has called our meeting, Wiener explained the function of "negative feedback" with an example of a grasping motion: "I regulate my motion by the amount by which my task is not yet accomplished. This makes it possible to accomplish the same task regardless of my initial position and the object to be picked up" [12]. A remembered "image" or "representation" of the picked up object is the goal in this example. A comparison between it and the sensory signals that indicate the actual situation gives rise to negative feedback, i.e., an error-signal, by means of which the motion of the hand can be adjusted. The gist of Wiener's contribution is this formulation of the feedback loop which demonstrated that purposive behavior could come about without infringing the principle that says no organism "can call on the future to influence the past" [13].

It was precisely the lack of a functional model, such as a feedback system, that compelled Hofstadter, a few years earlier, to ascribe only descriptive but not explanatory power to his brilliant analysis of "objective teleology" [14]. The subsequent development of control theory and the application of the feedback model in the study of cognitive behavior gave Hofstadter's logical exposition an almost prophetic quality. He sums up his description of objectively observable teleology: *Thus the unitary attribute of the teleological actor is not the possession of end alone, or sensitivity alone, or technique alone, but of all three in inseparable combination.* (Hofstadter's emphasis.) He goes on to say that, "although they cannot be separated in

the unitary attribute, they may nevertheless be analyzed independently by the use of a plurality of acts of the same agent" [15]. If we substitute the modern cyberneticist's terms for the three components, we have *reference value* (for "end"), *sensory function* (for "sensitivity"), and *effector function* (for "technique"). That is to say, we have the three components of the basic feedback loop which, we know, can never be constituted by anything less than these three components, because the operation of the loop depends on their circular arrangement in which there is no one point that we can isolate as initial cause, nor one that we can isolate as terminal effect. It is a unitary arrangement in the way it *functions* and not only in the way we describe it; and since it has been implemented in functioning mechanisms, we can hardly deny its explanatory power.

An activity, thus, will be called "purposive" if it serves to reduce or eliminate the discrepancy (negative feedback) between the value of a sensory signal and the reference value in such a "teleological" unit. Clearly this is a way of looking at behavior that is in one important point very different from the traditional behaviorist view. While S-R theories (with or without mediating links) posit a linear connection between sensory stimulus and behavioral output, in a feedback system it is never the sensory input itself that determines the output of a behavior, but its difference from the relevant reference value. (Which, if that should be necessary, explains why food is not much of a "reinforcer" for a well-fed animal.)

The simple feedback loop, of course, can serve as a model only for the simplest kinds of behavior, such as avoidance, seeking, and pursuit of conditions that are characterized by a single one-dimensional reference value each. Several such loops, with different sensory functions, may be found in one organism, but that does not raise the functionally primitive level of that organism's behavior. Two important features have to be added if feedback theory is to provide models for more complex behaviors. The first is an hierarchical arrangement of feedback loops, such that the reference value of one loop can be set and changed by the effector function of another. Systems of that kind have been described by DuBrul [17], Ashby [18], McKay [19], and recently in great detail by Powers [16]. The technical intricacies do not concern us here. The important point is that a system of that kind, if it is equipped with some sort of memory that records "disturbances" (sensory signals that do not match the reference value), "activities" (effector functions), and such "perceptual" changes (sensory functions) as occur within a specified space of time *after* an activity, then it can begin to optimize reactions to disturbances on the basis of what-has-followed-what in the past. At that stage, the system, in fact, has already the basic components that are required for "learning" or, as Maturana would say, to operate as an *inductive* system [20]. For induction, whether it is conscious in the form of a conclusion we draw, or unconscious in the form of a behavior that becomes established because of its success, springs always from the same root: a more or less regular recurrence in past experience.

A human observer of such "learning organism"', who experiences the organism and its environment as separate entities, can say that the organism is adapting its behavior to the environment. From the point of view of the kind of system we have described, however, there is no possibility of discriminating an environment because all the system can so far do is associate or correlate neural signals.

Though it might be tempting to see what epistemological conclusions we could draw from this cybernetic model about the "reality" of what we perceive as *our* environment [21] we had better pursue the evolution such a model would have to undergo to achieve the capability of communication. Rather than attempt to spell out that evolution step by step—which seems quite impossible, given the present state of the art—let us ask what further capabilities an organism would have to have in order to develop behaviors that we, the observers, would call "communicatory".

Learning and Representation

Using its "inductive" method of exploiting regularities of the past in order to employ, in the case of a specific disturbance, the particular activity that has most often eliminated that disturbance, presupposes the capability of coordinating "data" that originate in different channels. The simplest discrimination tasks require such a capability, for whenever we say that an organism has *learned* a certain response, it implies that the organism has associated a given stimulus (event in a sensory channel) with a behavior (event in an effecter channel or, to be more precise, a "reafferent" channel). We know very well that relatively primitive organisms can do that. We also know that the stimuli to which these organisms react (especially in the wild) are frequently not single perceptual signals but compounds of several features, such as color, sound, smell, and so on. That means that the organism is already able to coordinate neural signals from different *sensory* channels. Besides, it must be able to record or in some way maintain these patterns of coordination, for there is no doubt that it can learn to recognize them when they crop up again. In fact, most of an organism's learning and individual adaptation to its environment would seem to be dependent on such a capability.

From the observer's point of view, the organism can now not only discriminate but also recognize objects. This recognition of objects (which is not to be confounded with Piaget's more demanding paradigm of "object permanence") manifests itself in the fact that the organism has learned to respond with specific behaviors to specific objects and does so in a reasonably reliable way whenever it perceives them. Objects, and the behavioral responses that have become associated with them, will fall into several different classes: objects that are usually eaten, objects that are actively avoided, objects that are climbed on, and so on. For the observer, all these objects are clearly in the organism's environment. For the organism, however, there cannot be any such thing as an "environment". It operates with clusters of sensory signals that have been coordinated because they were in some way relevant to the reduction or elimination of a disturbance in some feedback loop. They have no "existence" in their own right. They are part and parcel of a cluster of activities that have been compounded because, in the past, they effectively counteracted a disturbance. In other words, what the observer calls an "object", is for the organism an inseparable component of an activity cluster. Nevertheless, at this point the stage is set for a momentous step that opens the way to a new kind of operation. No doubt, this step, like every other in the process of evolution, is fostered by the selective pressure of the environment; but for the functioning of the organism, it constitutes a discrete novelty like the opening of a new pathway in its processor.

An object, a cluster of sensory signals, now becomes a reference item in its own right. It sets up its own feedback loop, and this feedback loop, in the same "inductive" manner as the established ones, begins to select activities that are effective in transforming a somewhat different cluster of *actual* sensory signals (i.e., a "percept") until it matches the reference item. In order to become a reference item, the object has to be cut loose from its original context where it was a more or less relevant *sensory* adjunct to an activity cluster, and it must become something very like a "representation". This is the same development that every normal child goes through on his way to acquiring the concept of "object permanence", when he begins to "externalize" his perceptual constructs [22]. Operationally this transfer is perhaps not so astonishing. The learning process already required that the organism be able to retrieve a recorded action program and to implement it in an effector channel as an actual activity. The transfer of a recorded cluster of sensory signals to a channel other than the one in which the cluster originated is no different in principle. The revolutionary aspect is that this cluster of sensory signals is now placed in the position of a reference value and that the feedback loop which it controls becomes a phase in the activity cycle of an already operating feedback loop. To use a fashionable word, it becomes "embedded" in another loop and, whenever it is called into action, its specific reference item temporarily supersedes the reference value of that other loop.

DuBrul has expressed the same idea in somewhat different terms: "Information from a new monitoring feedback circuit has captured the final common path" [17]. He proposes a neurological hypothesis as to how such a development might come about. I am in no way competent to evaluate its plausibility. Instead, I shall cite a well-known example to show that some such development must have taken place: the termite-fishing chimpanzees that Jane van Lawick-Goodall has filmed [23]. The remarkable feature is not that a chimpanzee, at some time, incorporated the use of a twig into the presumably already established activity chain (or program) of termite-finding and -eating. Such incorporation of items, modifying or extending an organism's repertoire, must obviously happen very frequently. But when the chimpanzee "chooses" a twig, breaks it from the shrub, strips off the leaves, and takes it to the termite heap where it is going to be used for "fishing", then a totally new feedback loop controlling the *modification* of the twig, has been embedded in the larger loop that controls the finding and eating of termites. It does not matter much if the activities which are now put into the service of the subsidiary feedback loop had already been coordinated and recorded as program in some other operational chain. What does matter is that they are now detached from that original chain (say, tearing leaves off a branch in order to eat them) and inserted into an activity chain where they reduce feedback that is negative in relation to a different reference value (tearing off leaves in order to transform a twig into a stick-like tool) [24]. The reference item of this embedded loop is also qualitatively different from those of the primary loops, in that it is constituted by an individually coordinated cluster of perceptual signals and not by one of the original homeostatic values that control the organism's biological functions. In this sense we could, indeed, call this new reference item and the cycle it controls "artificial".

I do not intend to suggest that, in the course of evolution, tool-making is necessarily the first complex activity that requires the embedding process and a

representational capability as part of an organism's operational repertoire. There may well be others, but in tool-making examples, such as the "fishing twig", the requirement is particularly clear because the chimp's manifest assessment of shape, length, and flexibility is not guided by a perceptually present model.

The Communication Situation

What I have called a "momentous step", then, consists in the acquisition of two operational possibilities. One, the embedding of one feedback loop in another; and, two, the creation of a reference item that is, in fact, a representation, i.e., a cluster of recorded signals which, though originally composed of perceptual material, need no longer be identical with the signals that are at present available in the channels of sensory perception.

Both these capabilities are certainly necessary for communicatory behavior. But even if we can show that an organism has acquired them, their mere presence does not explain the emergence of communication. This can become plausible only if we can envisage situations in which development of the new capability would constitute a significant advantage. In addition, the envisaged situations must be plausible in the light of what can actually be observed.

Before trying to conjure up such a plausible situation, let me put into exact focus the activity whose emergence we are looking for. Fifty years ago, Malinowski said: "Speech is the necessary means of communication; it is the one indispensable instrument for creating the ties of the moment without which unified social action is impossible" [25]. Cherry, in his classic work, adopted this point when he defined the term "communication": "The establishment of a social unit from individuals, by the use of language or signs. The sharing of common sets of rules, for various goalseeking activities" [26]. He adds that there are many "shades of opinion," but even so, one might assume that the many authors who have cited him as an authority on communication would not altogether disagree with his definition. Since I have the impression that this is not so, I quote another passage from Malinowski which expresses the point I want to make even more clearly: "In its primitive uses, language functions as a link in concerted human activity, as a piece of human behavior. It is a mode of action and not an instrument of reflection" [27]. Malinowski, as a rule, makes no distinction between "language" and "speech" and rarely uses the term "communication". In the present context, that does not matter, because what he says of language goes for communication as well. I should also like to stress that, though once "language" *has* developed, it will quickly acquire its function as an "instrument of reflection" and an almost indispensable tool of thought, this function can hardly be held responsible for its evolutional inception.

According to the view I am proposing, communicatory behavior is a *mode of action,* its function is to link concerted activity, and it is indispensable because without these links there could be no *unified social action*. Thus it is an *instrument* which is to say, a *tool*. Malinowski also gives a number of examples. The natives of the Trobriand Islands, whom he studied, go fishing and they use large nets that have to be spread by a number of men in several canoes. Their action has to be coordinated and synchronized. The men's hands are busy, so they have no choice but to communicate by vocal signals. It seems clear that this kind of concerted activity could not have been

developed *without* a communication capability. The example, of course, in no way demonstrates the origin of communication, but it does show the kind of situation in which the ability to communicate makes possible activities that enhance survival and that, under certain circumstances, might even become crucial for survival. On the strength of that, we might tentatively say that communicatory behavior *could* develop in situations where cooperation requires not merely the additive activity of several individuals but some form of sequencing, or organization, in the sense of a division of tasks. The communication experiment of Mason and Hollis shows that this is indeed possible and does happen [28]. Rhesus monkeys developed their own signals to inform a partner monkey of the location of food which the first monkey could see but not reach, while the partner could reach but not see it. Though the experiment is an elegant demonstration of the monkey's communicatory potential, we cannot derive anything beyond that for an evolutional hypotheses. The necessity of cooperation was contrived and utterly unlike any need for cooperation that might arise in a natural setting.

I do not know whether there is any real evidence for the spontaneous inception of collaborative behavior among relatively sophisticated organisms. There are, of course, anecdotes, but they amount to nothing compared to the wealth of documentation we have on aggressive, agonistic, and competitive behavior. Yet, from the point of view of the feedback model, there would seem to be only a small operational difference between the development of cooperation and that of antagonism.

A Possible Beginning of Cooperation

Having described an organism as an hierarchical system of feedback loops, in each of which certain activities have been "inductively" selected as effective, it is not too difficult to envisage situations where the accidental addition of a new element could lead to a novel function. Wherever a number of individuals of the same species share, for instance a hunting area, the following episode, as seen by an observer, may not be unlikely: an individual pursuing a prey does not get to make the kill because another individual has come upon the scene and successfully killed the prey. If no already acquired behavior patterns prevent them from sharing the prey, both individuals will feed on it. If we translate this sequence of events into the terms of the feedback model, we get somewhat different operational sequences for the two individuals. For the *second* one, a "normal" well-established cycle has run off: an internal disturbance, "hunger", has led to certain activities and they have been effective once more, in that they resulted in eating behavior which successfully eliminated the original disturbance**.** For the *first* individual, however, there is an anomaly. The episode begins with "hunger" as originating disturbance, which leads to the well-established sequence of activities, but the "normal" course of the sequence is impeded, some of the activities are frustrated. Yet their result—eating behavior that eliminates the original disturbance—is nevertheless achieved. Since it is a basic feature of a learning feedback system that it records its activities and consequent changes of disturbances, the anomalous activity chain will be recorded as a thoroughly effective one. In place the of the impeded activities, however, the record will contain some elements that have never before been associated with the activity-chain that is controlled by the "hunger"

disturbance. These novel elements, for instance (in observer language), "approach and making contact with a conspecific individual", may already have been coordinated as components of some other activity-chain. If the episode recurs and repeatedly leads to the elimination of the "hunger" disturbance, it must become an operational alternative to the original activity chain controlled by the nutritional feedback loop. Preying in pairs and groups will be the result, and with this, the necessary conditions for the development of cooperative preying will have been created. On the other hand, if in the same episode, the first individual is prevented not only from making the kill, but also from feeding on the prey, the sequence of activities will be recorded as a "failure". In this case the novel elements, i.e., the activities involving the conspecific, are associated with the failure and will lead to avoidance or to competitive behavior in the future.

In both cases, what has happened is similar to the transfer of the twig-stripping activity of the chimpanzee's ordinary feeding cycle to his "termite-fishing" cycle. The transfer in our hypothetical case, if anything, would be more probable, because the perceptual item involved (i.e., another organism of the species) would certainly have been coordinated into a recognizable object very early in the organism's ontogenic development, and is perhaps already well established as an object in its own right. By this I mean that a cluster of sensory signals, first coordinated as a recurrent pattern in the context of a specific activity, has been recognized in the context of other activity-cycles and has thus come much closer to becoming an externalized "permanent object".

Similar episodes will happen in defense against predators. Whenever one individual acts and, by this activity, reduces not only his own disturbance but also the disturbance of other individuals, this will inevitably lead to the formation of relatively cohesive groups, because the reduction of disturbance in these very simple situations will be reciprocal for some time. Organism A today happens to be instrumental for B, and tomorrow B is instrumental for A. Once this begins to take place, it is highly probable that particularly efficient individuals are more often the actor who reduces the common disturbance. Thus they become the focus of the group's cohesion—with all the implications for the gradual development of dominance and patterns of social equilibration [29].

At the same time, however, the situation of reciprocal instrumentality has the potential of developing into collaboration. Its realization on a scale greater than the accidental synchronization and integration of the actions of two individuals, may well require a drastic change in the environment that suddenly creates a serious and persistent disturbance in many or all the individuals. Among humans, crises that dramatically increase collaborative efforts are a commonplace. Theoretically, it would seem extremely probable that, if environmental pressure rises for a species that has already evolved the operational mechanisms I have outlined, the cooperative situations will become more frequent and they will quickly come to involve more than two individuals. And once that stage has been reached, it will not take long before some form of communication will arise [30]. It would be communication by means of *ad hoc* signs, similar perhaps to the idiosyncratic signs invented by the monkeys in the Mason and Hollis experiment. In the natural environment it is, however, likely that such *ad hoc* signs will be extremely difficult to discriminate and recognize for the

human observer [31]. But whatever their individual form and mode of transmission, they would be genuine communicatory signs, because operationally they have the same purposive instrumental function and status as the "termite-fishing" tool of the chimpanzee.

Signs, Symbols, and Language

Communicatory signs are, of course, still very far from language. The distance between the two tends to be obscured by the wide-spread gratuitous application of the term "language" to a variety of behavioral manifestations that should be classified as signaling systems because they show none of the characteristics that we normally expect in a language. If we are to investigate the development of language it will be indispensable that we assess that distance and specify what intermediary points are necessary to bridge it. Before we can do this, however we shall have to adjust some of the concepts that have been used in attempts to describe language without reference to its purposive instrumental function.

Charles Hockett's "design features" (DF) are probably the most elaborate scheme to specify the characteristics of human language, and since they have been widely discussed in the literature, I shall use them as points of departure. They originated as a set of 13 descriptive criteria which were to help an observer to recognize "language" when he found it [32]. Since they were first shaped in an attempt to characterize *spoken* human language, they explicitly exclude all communication systems that are not implemented in a VOCAL-AUDITORY CHANNEL (DF1). Other design features (DF's 2, 3, 4, 5, 9) concerning the purely technical aspects of signals, transmission, and reception, strengthen this somewhat anthropocentric restriction. The remaining 7 DF's, however, focus on characteristics of communication systems in general and they constitute a very valuable approximation to the criteria we should want to use in order to distinguish communication from interaction, and language from signaling systems. The first of these, DF6, is SPECIALIZATION, by which Hockett intends that a sign is constituted, not by the mere energy change that is transmitted (i.e., the *physical* signal), but by the information or semiotic content the physical signal carries. This point, first formulated by Wiener and later applied to animal communication by Haldane [33], has been accepted, as far as I know, by everyone who has come to investigate communication. It is an indispensable point because it rules out any form of direct mechanical interaction in which the receiver's reaction (or consequent state) can be thermodynamically accounted for in terms of the amount of energy received. Hockett's formulation, however, does not help us to discriminate communicatory signs from others that are no more than a perceptual event from which an observer draws an inductive inference (e.g., the sight of smoke, from which he infers the presence of fire; or a thundering sound, from which he infers a stampeding herd and that he had better get out of the way). If such inductive inference is not excluded, "communication becomes a vacuous term. There have been many attempts to patch the leak with subsidiary criteria but none has proven satisfactory [34]. It does not seem possible as long as one refuses to consider the basic purposive nature of communicatory signs. Susanne Langer analyzed this problem long ago [35] and the definitions she provided for "natural" and "artificial" signs are applicable to animal communication with only a very minor change [36].

The fact that communicatory signs must be related to their meaning, not by an inferred connection (causal, correlational, part-whole, etc.), but by an altogether different kind of link, is partially implied by Hockett's DF7 and DF8, SEMANTICITY and ARBITRARINESS. But the discussion in which he states that English words, such as "unicorn" or "and", *lack* obvious semantic ties, shows that his SEMANTICITY is derived from the traditional theory of reference, which requires "real" objects as referents. The semanticity of signs is, indeed, an essential condition for communication, but the only limitation on the semantic ties and the items which they link to signs is that they must be the same for all users of the sign, i.e., their use must be *conventional*. This is inevitably so for all artificial signs if they satisfy the condition of ARBI'I'RARINESS (DF8), which prescribes that the meaning of a sign must *not* be derived from some perceptual analogy, or "iconic" relation, to the item it signifies (such that it could be inferred from the physical characteristics of the sign). This condition entails that a prospective communicator has no way of acquiring the proper use of a sign, except by agreement with the other users (when the sign is being newly created) or by learning it from them through CULTURAL TRANSMISSION (DF12). I can see no reason why specific *signs* and their semantic content should not be passed on by *genetic* transmission. This seems particularly plausible in the case of signs that originated as "incipient movements" [37], i.e., as a part of a chain of movements that comes to signify the whole sequence (e.g., a resting dominant male's raising its head *as though* it were about to get up and charge). Once such an incipient behavior is performed, not as the first step of the sequence to which it belonged, but as a means of obtaining the result of the *whole* chain (e.g., to restore the desired distance when another individual has come too close) it is on the way to becoming an "artificial" sign. In Hockett's terminology it would, of course, be an iconic sign, but from the point of view of communication theory it is irrelevant whether the semantic link between sign and meaning is iconic or arbitrary—what matters is that this relation is a conventional one and thus, by definition, the same for sender and receiver.

Hockett's DF10, DISPLACEMENT, is one of the two most relevant for the characterization of *linguistic* communication. He explicates it by saying: "We can talk about things that are remote in time, space, or both, from the site of the communicative transaction" [38]. Once more we agree, but the statement covers only half of what a viable criterion of "language" would have to contain. It is the remnant of the stimulus-response dogma that cripples this DF: the implication that a linguistic expression or sign cannot be used unless it refers to a specific occurrence (instance) of its "referent". Though at one time Hockett says that DISPLACEMENT implies "the ability to discuss today what happened yesterday or what may come to pass tomorrow," he then explains it in terms of information storage, and states; "Any delay between the reception of a stimulus and the appearance of the response means that the former has been coded into a stable spatial array, which endures at least until it is read off in the response" [39]. If we can read off today (response) what will be encoded tomorrow (stimulus), then the future would, indeed, by determining the present. Not for a moment would I suggest that this is what Hockett intended. But I *would* suggest that it comes out that way because he was bent on avoiding terms such as "concept" or "representation". They would have smacked of mentalism or, worse, teleology—and that was taboo.

Language allows us to talk, not only about things that are remote in time and/or space, but also about things that are nowhere and never happen at all. DISPLACEMENT has to become "symbolicity". To turn into a symbol, the sign's one-to-one relation to a perceptual "referent" must be severed [40]. That is to say, the sign must be semantically tied to a representation that is independent of the perceptual signals available at any time (not only at the time and place of the sign's use). Thus, the semanticity of a *linguistic* sign is constituted, not by a tie that links it to a "thing", but by one that links it to a representation or concept [35]. The fact that a sign, be it verbal or non-verbal, has acquired symbolicity, does of course not preclude that it still be used as a perception-bound sign whenever there is a perceptual input that corresponds to the representation it designates; nor does it preclude that it be used by the sender to trigger a conventional active response in the receiver (as in the case of an 'imperative'). But what gives a sign the status of symbol is that it *can* be used without such a "stimulus" and without triggering the active response. The sign for tiger, for instance, will be a symbol when it can be used without reference to a present, past, or future perceptual instance of a tiger and without the receiver taking such steps as he would if he did perceive a tiger.

The difference between symbolicity and displacement comes out clearly if we look at the "language of the bees" [41]. In Hockett's terms, the bees' signs ("dancing") *always* manifest DISPLACEMENT because their messages concern distant locations [42]. In my terms, the bees do not qualify for symbolicity because they have never been observed to communicate about distances, directions, food sources etc. without actually coming from, or going to a specific location.

The last feature (DF11) that is essential for the characterization of "language" is OPENNESS (or "productivity"). "New linguistic messages are coined freely and easily and, in context, are usually understood." The technical particular that provides for OPENNESS is, DUALITY OF PATTERNING (DF13), i.e., the fact that the sign system shows "patterning in terms of arbitrary but stable meaningless signal-elements and also patterning in terms of minimum meaningful arrangements of these elements" [38]. The first of these two patternings concerns the composition of *signals*, i.e., the physical sign-vehicles. Hockett would call "language" only those communication systems that use a compositional code in which signals are assembled out of smaller recurrent units (phonemes, cenemes, etc.). This characteristic clearly is of enormous importance if we consider the economy of a coding system. From the evolutionary point of view it constitutes a spectacular advance. It involves the acquisition of special signal-composition mechanisms and, consequently, an increase of operational complexity and memory Space. As a criterion, it would exclude semiotic systems that have no alphabet and use only ideograms. From the communication point of view, this seems an unnecessary restriction.

The second type of patterning covered by DUALITY, however, is indispensable as criterion to distinguish linguistic systems from other sign systems. To be considered a "language", a system must "provide certain patterns by which these elementary significant units (morphemes or meaningful signs can be combined into larger sequences, and conventions governing what sort of meanings emerge from the arrangements. These patterns and conventions are the *grammar* of the language" [39]. Though linguists have tended to consider "syntax" merely a set of rules that

govern the combinability of words (i.e., signals), Hockett makes clear that the crucial point is that *new meanings* emerge from the combining of signs. Thus, in addition to the conventions that establish and fix the meaning of individual signs (lexical semantics), there must be a second set of conventions (grammar) that establishes and fixes the semantic function of sign combinations (syntactic or relational semantics). Since the single meaningful signs that are available to the user at a given time are always a closed set (lexicon), OPENNESS can be achieved only by the rule-governed meaningful combination of the available signs.

To sum up this discussion of linguistic communication, I would suggest three criteria to distinguish "language", all of which are necessary but individually insufficient:

(1) There must be a set (lexicon) of communicatory signs, i.e., perceptual items whose meaningfulness (SEMANTICITY) is constituted by a conventional tie (semantic nexus) and not by an inferential one.

(2) These signs must be symbols, i.e., linked to representations (SYMBOLICITY) therefore they *can* be sent without reference to perceptual instances of the items they designate, and received without "triggering" a behavioral response in the receiver. As symbols they merely activate the connected representation.

(3) There must be a set of rules (GRAMMAR) governing the combination of signs into strings such that certain combinations produce a new semantic content in addition to the individual content of the component signs.

Conclusion

In the preceding sections I have presented some ideas and definitions which, I believe, are essential for an investigation of the evolution of language from a communication-theoretical point of view. To conclude this sketch, I should like to sum up the salient points and, in doing so, show very briefly how they might be fitted into a more or less coherent hypothesis.

To discuss "Origins and Evolution of Speech and Language" it has to be clear that evolution requires raw material at its origin and that "speech" and "language" refer to different parts of a communication process. Restricting "speech" to designate the specific signal-system that uses an acoustic channel and human vocal-auditory transmission and reception apparatus, I defined "language" as a semiotic system with three criterial characteristics: A *lexicon* of signs, *symbolicity,* and a *grammar* that governs semantically productive combination. Linguistic communication, thus, is a more sophisticated system than communication by simple signs, regardless of the mode of transmission and the physical aspects of the signals. For speech to evolve, there had to be organisms producing incidental sounds at the origin. For language to evolve, there had to be organisms with a certain information processing capability and, above all, with something to communicate.

The organism is seen as an hierarchical organization of feedback loops, the "primitive" and oldest of which control chains of activities that have been "inductively" selected for their effectiveness in eliminating disturbances relative to reference values that control the organism's basic biological functions.

An analysis of tool-making shows that it requires the operational capability, in the active organism, to isolate recorded clusters of sensory signals and to detach them

from the original chain in order to set them up as reference values of a new feedback loop that becomes embedded in an existing one. This detaching of recorded sensory coordinations constitutes the formation of a *representation* and is the cybernetic equivalent of Piaget's analysis of the ontogeny of the "permanent object" concept.

If the meaning of linguistic signs is always a representation, it is clear that the semantic nexus that links signs to their meaning cannot be established until the organism has the operational potential of forming, representations. Also, the sending of communicatory signs is considered an instrumental activity, serving (like all other activity) the elimination of a disturbance. This suggests that the acquisition of communicatory signs requires much the same stage of operational evolution as does toolmaking.

Incentive to communicate may arise in situations where several organisms are led to cooperative efforts by the occurrence of reciprocal elimination of their disturbances. Such situations are likely to happen in predation and in defense against predators (when A beats off a predator, the disturbance is eliminated also for B, C, etc.). I suggest that the recurrence of such situations will lead to cooperative activity and, eventually, to cooperation that requires degrees of organization and synchronization attainable only by means of communication.

Since there is at present no evidence concerning the natural evolution of a communicatory signaling system towards the symbolic and combinatorial system of human language, it is, I believe, premature to advance a detailed hypothesis as to how this feat was achieved. The work of the Gardners, Premack, Fouts, and our group at the Yerkes Center [43] has shown that chimpanzees have the operational mechanisms to handle both combinatorial and symbolic processes. That chimps have not been observed to use these capabilities in the wild may be due to the fact that, in the absence of a language *common* to observer and observed, these capabilites are difficult to discover without experimental testing. On the other hand, it may simply be that the great apes have so far managed to survive quite well without the linguistic tool of social and cognitive organization. Our human species has certainly demonstrated the power of that tool. But evolution, presumably has not yet come to an end – and if, today we look at what we have done with the help of that splendid tool, one may begin to wonder whether, at some future time, it will still seem so obvious that language has enhanced the survival of life on this planet.

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[5] This frustration, if speech-sounds are not interpreted as a *message*, is already observable in children at the stage of language acquisition, whenever the adult receiver fails to interpret their signals correctly because they do not conform to the adult code. In these cases it also becomes very obvious that a smile, a pat on the back, or saying "good," is not much of a "reinforcement" compared to the addressee's *understanding* a message and reacting according to the sender's expectation.

[6] For a full exposition cf. Mackay, D.M. (1972). Formal Analysis of Communication Processes. In R.A. Hinde (Ed.), *Non-Verbal Communication,* 3–26; and Thorpe, W.H. (1972), *ibid*. 27–47.

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[13] *ibid.* p. 203. It was the assumption that "purpose" necessarily involves a temporal inversion of the cause-effect sequence that mars the otherwise excellent analysis of purposive behavior by the early behaviorist philosopher,

R.B. Perry, A Behaviorist View of Purpose, *Journal of Philosophy* (1921), *28*(4):85–105).
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