BIOLOGICAL ASPECTS OF LANGUAGE

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It is more than a little presumptuous for a biologist to be addressing a conference of linguistic specialists on language - a subject in which I have no special knowledge. Perhaps I can present some thoughts from the outside looking in.

It is customary to marvel at the power of speech in man and to regard it as one of the most important attributes which set us apart from the rest of the animal world. There is no doubt that with the evolution of verbal language we have been able to communicate information between individuals and between generations with speed and precision and this has been a highly significant factor in cultural evolution. However, I suspect that in our usual anthropocentric manner we underestimate the efficiency of non-verbal communication in the so-called "lower" animals.

Before discussing some of these modes of communication, let us clarify some of our concepts concerning language as a medium for social communication. The key words here are "social" and "communication", for speech is a social activity - it is only meaningful in terms of a group and thus lies within the sphere of interest of the social psychologist. It is an aspect of animal behaviour. We can profitably examine the communication aspects of language in terms of information theory which postulates that for the transmission of information we require a transmitter, a code and a receiver.

As biologists we can learn quite a lot about transmission and reception from studies of anatomy, physiology and behaviour. I presume that the study of the code is one of the prime functions of the linguist. Transmission involves not only the larynx and associated parts of the upper respiratory tract, it also involves encoding the message and thus implicates the brain and central nervous system.

Several anatomical studies have been made of the sound-producing organs of monkeys and apes most closely related to man. In many of the great apes, the vocal apparatus is more complex than in man. In the orangutang the larynx is reported to be not structurally suited for the production of delicately modulated or controlled sounds.

By and large, however, we find homologous structures in the larynx of monkeys, apes and men. Furthermore the structure of the mouth and facial muscles are sufficiently similar in some apes to make speech sounds theoretically possible. Despite this we have no reliable records of monkeys or apes being trained to speak. This emphasizes the vital role of the brain in speech. It would seem that the inability of our nearer relatives to speak is a neurophysiological problem rather than a structural one. Several different kinds of birds can mimic human speech very effectively. Their production of consonants is better than vowel production. Nevertheless, analysis of the sounds made by parrots and mynahs indicates a surprisingly good imitation of human vowels.

It is worth noting that the organs of sound production in birds (e.g. the syrinx) are quite different in structure from those of man. This rather weakens arguments from structure. Birds are intelligent animals with quite advanced behaviour patterns. Although they can communicate by song language there is no evidence that they can converse intelligently in human language. Once again the limitation seems to lie in the central nervous system.

The brain is involved in encoding for transmission as well as unscrambling the messages received by ear. Furthermore, it is needed to conceive the need for a message as well as to understand the meaning of the decoded message. Thus behaviour is involved at all levels. One could perhaps regard speech as merely a convenient device used by one brain to influence another brain not too far away (under natural conditions). The message is present in both the transmitter and receiver but not in the transmission itself which is meaningless until it is decoded. Decoding of speech is quite a complex process involving the conversion of atmospheric pressure fluctuations (sound waves) into a series of electrochemical changes in receptors in the inner ear and the channelling of patterns of neurone discharges through various levels of the brain. For meaning to emerge, these patterns must be compared with patterns already established in the brain. The quanitty of information received is defined as the difference between the initial uncertainty before receiving the message and the final uncertainty after the message is received. This basic theorem leads to the quantitative treatment of information.

The auditory pathway is not the only sensory channel to the brain. Under normal (primitive) conditions we would expect this pathway of communication to be reinforced by additional visual or even olfactory information. Facial expressions and gestures with the hands are important elements of communication - even in our non-human relatives. Some authors have suggested that they represent a pre-language form of communication. Scents of one sort or another are important vehicles of information in the languages of love or fear. Man, however, appears to be evolving away from dependence on this channel. How much we miss by communicating by telephone or radio! No wonder it is more difficult to get the messsage across.

Interestingly enough the language of smells is highly developed in some invertebrate animals – especially in the social insects where smells are used in navigation, recognition, mating, alarm and attack. The sensory receptors involved are extremely sensitive. A male silk moth can detect a female by smell from several miles away and can fly to her. The sex attractant has been isolated and tested in the laboratory and it can be shown that the receptors in the male antenna respond to incredibly low concentrations (10^{-12} g). The information conveyed in these languages is highly specific and effective but rather lacking in modality. It is biologically very important for the preservation and perpetuation of insect societies but, though it may be more precise, it lacks the flexibility of human language.

We know quite a lot about the regions of the human brain involved in speech: partly through the correlation of pathological changes in the brain with speech defects and partly from observing the effects of electrical stimulation on different parts of the brain exposed during operations. Compared with the higher primates we can see some innovations in the human central nervous system. One is the dominance of the left cerebral hemisphere and also an anterior-posterior polarization of function in relation to language. Anterior lesions disturb motor aspects of language, while posterior lesions in the left hemisphere region involve more sensory aspects of language. When it comes to studying brain function, however, we must generally conclude that comparative structural studies are of little help. Species-specific behaviour is not a function of observable structures but involves the organisation of processes diffused through several parts of the central nervous system. Language is a social event which involves the central nervous system at all levels.

Compared with the anthropoid apes, it would seem that man has not evolved new brain structures to permit speech, but rather there has been an enhancement of some pre-existing capacities – a familiar situation in many aspects of physiological and morphological evolution.

There are many functional similarities between brains and computers. Like a computer, the human brain requires to be programmed for speech and (like many other forms of behaviour) it would seem probable that part of this programming is carried out hereditarily before birth while the rest occurs during language acquisition in the early years of life.

I have indicated several aspects of language which involve the brain but I must point out that our knowledge of brain function at the cellular and organ level is still quite rudimentary. There is still a large gap between the hypotheses of the experimental psychologists and the findings of the neurophysiologists. As this gap closes, we should approach a better understanding of the functional role of the brain in language communication.