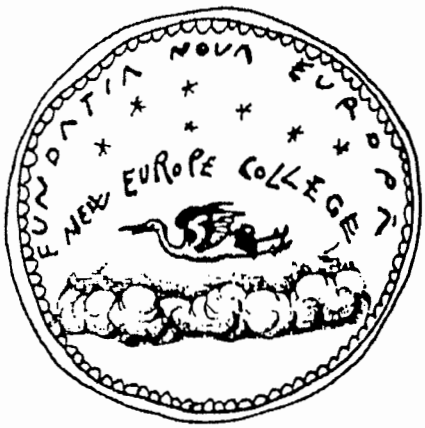
New Europe College Yearbook 1995–1996



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HUMANITAS

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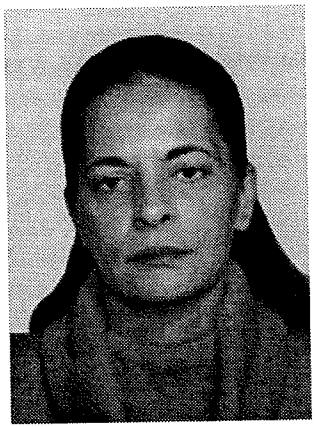

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Biological Roots of Human Vocal Communication

The Speech: Human's Exclusive Gift

Motto:

'If we were to find a pygmy chimpanzee that imitated all human cognitive and linguistic abilities, we should probably ask ourselves what sort of genetic disorder led him to be so short and hairy.'

SNOWDON, 1990

The title of this paper may seem both old-fashioned and too daring. To walk down such a 'beaten track' which bears the imprint of famous philosophers and scientists may be regarded at first sight as something of little relevance. Library shelves are full of books which witness the human interest in, and knowledge about, our most precious gift: speech. To a novice this in itself should be an inhibiting signal; however a basis for challenging established views does also exist.

'...the general scenario of the bipedal posture, freeing up the hands and leading to tool use, gesture, and on to language is still popular' (5), although:

— Cross-cultural studies show that even sophysticated modern languages are a poor medium of instruction as regards tool manufacture or use (5, 21, 86), visual observation and imitation being far more effective. 'Gesture may be superior to speech in showing how to do things and there may be syntactic commonalties between gesture and language, with gesture closely following speech patterns.' (5)

— Hunting has also been suggested as an explanation for the development of language (a necessity in forming hunting teams), but many other social animals hunt in teams, without being excessively vocal. Except for the planning stage, hunting is an activity in which silence (i.e. not alerting the prey) is of value.

— Language as an integral component of the social life of humans is another explanation which cannot be supported if at the same time we consider it as an uniquely human trait, because 'some might argue that our societies are not intrinsically so very much more complex than those of other primates.' (5)

In Wind's multifactorial feedback model, notable factors include 'hand and arm use, changes in posture and anatomy of the vocal tract (partly driven by

changes in posture and flexion of the basicranium), pre and postnatal development, a switch from an arboreal to a terrestrial life, increases in brain size, social relationship, tool use, number of descendants, neoteny and changes in facial structure, including nose and jaw reduction. While the ultimate origin of human language must remain speculative, hints to possible origins may be derived from studies of its ontogenetic development in the child, from its break-down in the aphasia's, and from its appearance *ab initio* in, for example, sign language for the deaf, pidgin and Creoles' (cf.5, p. 318).

Our 'unique patterns of behavior' are known to have precursors among higher non-human primates: 'cooperative hunting, food sharing, nest construction, territoriality, bipedal locomotion, tool construction and use' (35). On a more cognitive level, we can add the capacity for general learning, the ability to recognize oneself in mirrors, symbolic play, some interest in 'painting', insightful problem solving and learning, counting (at least up to five), the ability to categorize, differentiate and generalize, and the cross-modal transfer... 'Nevertheless, language was not just *discovered*, like writing. The latter has to be learned, with effort, whereas a major genetic component ensures the relative effortless acquisition of the former, even though learning is also involved. We can in fact process visual representations even faster than the spoken word; it would be interesting to speculate on our alternative evolutionary and technological history had our ancestors evolved a visual rather than auditory channel of communication.' (5)

Few things are more diverse in human social life than languages. An extreme example is Papua New Guinea, an island of about 900,000 square km in land area (much of which is inhabited), where around 1,000 different languages are spoken. What could be the reasons for such a 'Babel'?

Often, despite the fact we talk about the same topic and use the same language, we refer to very different things. At other times, without knowing one single word of our interlocutor's language we still can understand at least 'what it is about'.

Apparently all spoken messages include a set of features as body and facial gestures, inflections, tonality and melody of language, which add information to words and make possible cross-cultural, sometimes even cross-specific understanding. These contrasting aspects lead (at least the biologists' minds) to certain parallels with what is known and largely accepted as a major concept of biological evolution: '*common features reflect (most of the time) common origin.*' Vocal communication in particular includes a number of aspects which indicate that we can rely neither on mere coincidences or analogies nor on the 'de novo' emergence of structures and functions. As some authors observe 'it is most unlikely that human communicatory behavior arose in our hominid ancestors by one-shot genetic salt, and that apes, so close to us genetically, would show no trace of it. Any differences are likely to be quantitative rather than qualitative' (Dingwall, 1988; Raijmakers, 1990, cited by 5). Pinker and Bloom (76) note that

'evolution often makes innate and automatic those functions which hitherto have had to be performed by general learning and processing mechanisms at a deliberate, conscious, effortful level, thereby freeing up the organism to undertake another simultaneous task.'

A common definition of communication, given by T. Sebeok in his book 'The Play of Musement' (89) involves the 'movement of information in time from one place to another. From this point of view, it is of little consequence whether the trafficked ware consists of random noise, to 10/10 bits of information inherent in a strand of DNA programmed, to rebuild itself, or some configuration of signs, like a sonata by Mozart, charged with high aesthetic value. If information is available, it can be communicated.'

In a narrower sense, by human communication we usually mean speech and even more, languages with all their richness and symbols. The capacity of '*Homo loquens*' to use the language 'has always been the first candidate in the search for a feature characterizing the distinguishing feature of man' (102). At the beginning of the twentieth century the 'Linguistic Society of Paris' established a rule barring from its sessions all lectures which dealt with the origin of speech. Sapir (83) considered language to be '*a purely human and non-instinctive method of communicating ideas, emotions and desires by means of a system of voluntarily produced symbols.*' Times have changed since then, but there is still disagreement over whether there is a continuum of vocal and/or gestures and facial forms of communication ranging from non-human primates to humans. In recent studies on human-animal relationships (33, 95, 96) done on children and adolescents, the most frequent answers to the question concerning the human/animal differences were: 'speech' and 'thinking or intelligence'.

It is not surprising that humans of different cultures, ages, or levels of instruction try to delimitate our species from the rest of the animal kingdom, invoking and even exaggerating these 'human gifts'.

Any attempt to investigate in a comparative manner the human and animal communication systems is blocked not only by beliefs, but also by a tremendous amount of information coming from very diverse fields of science (primatology, animal and human ethology, anthropology, linguistics, semiotics, prosody, phonology, computer technology, etc), each one having distinct theories, terminologies and methods. Not to mention the different schools existing in each of these fields, often more severe in criticizing one another than other related sciences. Under these circumstances, it is hardly surprising that scientists still debate, for instance, the definition of semiotics, which ranges from 'activity', 'movement', and 'project' to 'field, 'approach', method', 'discipline', 'doctrine', 'metadiscipline', 'theory' and 'science' (104). Despite this debate, we still need to find a category, a definition, an explanation, for semiotics as well as for any other thing existing or imagined.

The crossroad of biology and semiotics was first analysed in the work of the German biologist Jakob von Uexkull early this century (99). Born in 1963 as one of the subdivisions of semiotics, **zoo-semiotics** is defined as 'that segment of the field which focuses on messages given off and received by animals, including important components of human nonverbal communication, *but excluding man's language, and his secondary, language-derived semiotic systems such as sign language or Morse code*' (89). This exclusion, sustained mainly by linguists and anthropologists, is contested by some primatologists and ethologists. As Robbin Burling (1993) points out, there are different perspectives in looking at the origin and evolution of language, 'forward from the anatomy and behavior of our earliest hominid ancestors — the most plausible model for non-human primate anatomy and behavior — or back from language itself. It is natural for primatologists and linguists to start from opposite directions — primatologists looking forward, linguists looking backwardbut between the starting point and the ending point lies a great gulf of unknown' (8).

One major problem is that of defining what we mean by *language*. If we refer to it as being 'a *system of communication,* then obviously many species have languages. If, on the other hand, language is defined as a *system of arbitrary vocal symbols* then not only very highly developed animal codes, but also human sign languages must fail to qualify as language' (102, p. 150). The anthropocentric way of comparing animal/human 'languages' seems to be, in my opinion, unsuccessful from the starting point. Certainly we cannot find equivalents as long as we do not take into account the differences between the biology and the culture of the two 'subjects'. Such comparison is similar to that between infant speech and that of a specialist in computers or medicine.

Language is a 'system of arbitrary vocal symbols', as Trager defined it (102), but **is it entirely arbitrary? Are all the words so much different from one language to another unrelated one to justify assuming their random construction? And if not, what could be the common factors facilitating the use of similar to identical sounds in denominating the same reality?**

One of the most recent scientific debates on theories and hypotheses was provoked by a series of lectures delivered by Robert Burling at the University of Michigan in 1991, and published in 1993 under the provocative title 'Primate Calls, Human Language, and Nonverbal Communication', together with a number of comments by well-known scholars active in this area of science (8). As it contains many contradictory arguments regarding the origin and development of language, I will try to construct my own discourse based on this rich material.

The author synthetically formulates four basic 'propositions':

'1. Human beings have at least two fundamentally different forms of communication. One includes language along with some other closely related signals.

The other (which I will refer to as our 'gesture-call' system) includes most of our nonverbal communication. Human language is almost as different from human nonverbal communication as it is from primate communication.

2. Both the messages communicated by human gesture-call system and the means by which they are communicated are very much like the gesture-call system of other primate species. Our system deserves to be recognized as constituting the primate communication of our own particular species.

3. That human language emerged as an elaboration or evolutionary outgrowth of our gesture-call system seems implausible. If it did not emerge from our own gesture-call systems its emergence from some other gesture-call systems is no more plausible.

4. If language did not emerge from a gesture-call system we must ask what other starting point it might have had. Since language is inseparably bound up with human cognition, the obvious place to look for hints about possible antecedents of language is in the cognitive abilities of primates. I will conclude by suggesting that we are likely to learn more about language origins by studying how primates use their minds than by studying how they communicate' (8. p. 25–26).

The alternative I would like to suggest to the above-mentioned statements is based on the reconsideration of already existing data and focuses on the similarities and universalities manifested in the communication systems of non-human and human primates rather than on differences (on which too many of the studies and theories are centered). I would also like to re-open the debate on the order in which certain language and paralanguage characteristics emerged during the evolution from non-humans to Homo sapiens. I will also refer to some personal findings concerning primate communication.

1. There are no strong reasons to consider speech and the gesture-call systems as being 'fundamentally different'. Animal vocal emissions are perceived and described by us as songs, screams, shouts, yells, grunts, growls, yaps, and so on.

2. The human nonverbal communication system is largely inherited, most of its repertoire being universal. We admit that monkeys share with us a range of facial expressions such as frowns, pouts, threat grimaces, smiles, eyebrow flashes, as well as expressions of disgust, fear, mirth, surprise, all of them immediately and mutually intelligible. The nonverbal communication system also contains some culturally established components which vary from one group to another.

3. In oral speech, verbal and nonverbal behavior are simultaneously expressed, nonverbal gestures and expressions contributing to the normal perception and understanding of verbal information's content. Without the nonverbal or paralinguistic component, speech is perceived as 'neutral', artificial, or mechanical.

4. There are reasons to consider the possibility that human vocal communication originated in both vocals and gestures of primate behavior.

5. The dichotomy between an ape's mind and communication systems seems simplistic. To admit that an ape's mind is performant but then claim apes do not use it in one of the most important aspects of their life as social beings is not logic. Why then should the mind of apes have such potential?

As a major example of non-equivalence of primate calls and human words or sentences, Burling refers to the observations made by Cheney and Seyfarth on the vervet monkeys'vocal repertoire (11). Noting that their book is 'representative of the best modern work on primate communication', Burling says: '...I doubt that I am the only linguist to feel in the course of reading their book, that *they struggle almost obsessively to ferret out language-like aspects of primate calls... I am struck by their painstaking attention to vocal communication at the expense of other forms of communications... I am surprised by the willingness of so many primatologists to deal with vocal communication* as if it constituted an autonomous system while failing to give the same serious treatment to gestural communication' (8, p. 26–27).

It should be observed that the results of Cheney and Seyfarth (11) are based upon a body of data, starting with the studies of Strusaker (94), who reported in 1967 that vervet monkeys emit different calls at the sight of different predators. Later studies were done on various primate species 'vocalization, as well as on listeners' behavioral reactions to different types of calls. Playing-back recordings of these calls, Seyfarth, Cheney and Marler (90) reported that they evoke different avoidance behavior patterns, even in the absence of any predator. The same authors (10, 90) mentioned at least six acoustically different alarm calls used by the vervets for predators such as leopards, small cats, martial eagles, pythons and baboons. Each of these vocal signs releases a different and appropriate escape response: running up in the trees at the hearing of loud leopard-like alarm calls, or looking up in the air in the case of more grunt eagle-like alarm calls. Vervet monkeys are also able to recognize the specific meaning of the alarm calls of other species, reacting for instance in a very appropriate way to the distinct calls emitted by the common superb starling *Spreo superbus* announcing the presence of aerial or terrestrial predators. When these calls are played, the vervets respond by looking up or down.

The vervet monkey is not the only primate whose vocal repertoire is known to be adapted to situational factors. Studies in the wild of chimpanzees, gorillas, bonobos and on many other species of monkeys (35, 38, 44, 47–52, 63, 65, 67, 68, 70, 71) brought to light new information about the variety and the functionality of vocal communication in infra-human primates. Marler and Tenaza (66) reported that the repertoires of the gorilla and the chimpanzee show close correspondence, despite their ecological differences, testifying in their opinion to the role of phylogenic in primate vocal communication.

'The chimpanzees may call to mark territorial boundaries, to signal alarm on the appearance of a predator, to summon help from an ally or to locate lost individuals. Some calls can occur in monosyllabic isolation or may be combined multi-syllabically with changes in inflection, consisting in hoots, screams, pants and whispers of varying intensity' (5).

Goodall (35) claims 34 discrete calls but it is unclear if they are expressions of the emotional state or are carrying also information upon the social and/or physical environment, or if they signal even deliberate intentions. 'So far they seem to vary in pitch, tenseness, phrasing, duration, volume, format frequencies, vowel quality, intonation patterns and number of repetitions. They may possibly convey information on age, sex, identity, emotional state, size and makeup of a party, the nature and intention of agonistic situations, interest in being sociable, feeding conditions and intentions to hunt, patrol, or nest, the presence of neighbors, and the location distance, and the direction of travel. However, as yet this is still hypothetical (3), there is no evidence that chimpanzees' communications (natural or acquired) depend in any way on the common sense, tacit knowledge or shared assumptions between listener and speaker, which are so much a feature of our discourse, and which are such a problem for machine translation or even speech decoding' (5).

As an argument that the vervet calls are far from being 'words', Burling shows that a certain call of the repertoire 'cannot be extended to a context in which it would mean '*Have you seen any leopard?*' or '*Don't worry the leopard has gone*' (8, p. 27). These quotations reflect that even today it is still difficult to find a 'common language' for scientists dealing with a common or tangential area of research. It seems unproductive to refer to subtle and complex samples of speech, if we really are trying to find some connections between primate or other animal calls and human language. The difficulty of putting things together arises mainly from the fact that often we do not take into account that:

— as *cultural animals*', we are also biological beings;

— our environment changed dramatically, especially as a consequence of our own human activity, constraining us to adapt by all means, inclusive a more and more complex language. For the other primates, the direction of the natural (physical and social) environmental pressure was much more stable over thousands and thousands of years. In this context, what we should compare is primate vocal and paravocal communication with some kind of '*proto-language*'. There is no real trace of such an incipient form of language, but we still can imagine what could be biologically important to be transmitted as information for early hominids. If we want to compare vocal signals in human and non-human primates we should not oppose animal 'screams' to Shakespeare's meditations but only naturally equivalent situations. What humans do when warning somebody about an imminent danger is not so different from what vervets do. We simply scream: 'shark', or 'leopard',

or ' earthquake', or 'simply danger', because the most important thing for the survival of our congeners is to react promptly and adequately to the environmental situation. All other comments such as those cited by Burling are after-facts. I do not know precisely how vervet monkeys react when the danger is gone, but I suppose that, like other primate species including humans, they do possess behavioral ways of diminishing the stress: some specific sounds, social grooming or other forms of body contacts.

In Burling's view, sustained and contested with equal passion, differences between the human language and the gesture-call systems reside in the following:

— language is seen as a *digital* form of communication characterized by linguistic contrast, while gesture-calls vary in form and meaning along a continuous scale, constituting an *analogical form;*

— language, as well as other types of communication included in the same term *have to be learned*, and for that reason they are *different from one community to another;*

— there is no evidence of volitional control of vocalization in infra-human primates.

The first assumption can be considered partly true. If we compare, for instance, one of the words on the first page of *The Concise Oxford Dictionary of Current English* such as 'abandon' with a word on one of the last pages of the same dictionary, say 'youth', it is quite clear that there is no continuity. But if we analyze words such as 'sea' and 'see' then we have to accept that there is some continuity, at least in the way they sound. In comparison with this example, the vervet calls are in full contrast to one another despite the fact that they might fail 'to be language on other counts such as necessary association with certain stimuli', as David Amstrong noted (2).

From the point of view of biological survival the information needed to distinguish between these should be more valuable than to understand the meaning of a sentence such as 'I see the sea'. On the other hand, if we are able to understand the meaning of such a sentence, then why not admit that non-contrasting sequences also found in primate calls are significant in communicating information?

Burling's second assumption is, in my opinion, also partly true. *Learning* plays a decisive role in speaking a certain language. From this point of view, many of the primates calls seem to be very uniform, but, even if the animal's repertoire of calls is basically a 'congenital endowment' — experiments of Winter (103) have shown for instance that, infant monkeys, even deprived of social contacts, possess essentially a full complement of species-specific calls — how can be an alarm call for warning 'leopard!' genetically based in the absence of the leopard notion? How could monkey infants in their natural habi-

tat know without being exposed, and learn that a leopard is a leopard and not a snake, or at least that their relatives behave in a certain way in response to a certain call? The call-systems of the primates, as well as of other animal species, though fairly fixed and unchangeable, can code a wide range of data and transmit them to con-specifics in an informational useful manner. The uniformity of the call-repertoire might reflect limits in emitting sounds and also a certain uniformity of the environmental events which must be communicated by vocalization. As long as these types of calls are not broadcasted at random, but are strictly connected to specific targets, releasing specific behavioral complex reactions, it seems more plausible that vocal ability and the innate program is coupled with learning.

Several studies demonstrate the existence of troop dialects in macaques and other primates (36, 64, 82) and the necessity of acoustic exposure to con-specifics for a completely normal development of calls (72), suggesting some vocal plasticity as well as the existence of a 'proto-culture' (social learning and transmission from one generation to another). The results of Masataka and Fujita (69) on the ability of monkey infants of one species, fostered by adults of another macaque species, to learn and reproduce calls specific to the foster parents is considered by Burling (8, p. 34) as 'an unusual finding'. He supports his affirmation with one of the conclusions of Snowdon (92) namely that 'there is not conclusive evidence for vocal learning in monkeys'.

Speaking about innate and learned behavior in the vocal communication of monkeys and apes, we need to make a digression and present some of the most important results obtained in laboratory studies. In contrast with field studies, where usually spontaneous vocalization is recorded and interpreted in connection with the subjects general behavior, the experimental investigations have dealt mainly with the ability of infra-human primates to emit sounds, even words, or to manipulate other symbols equivalent to human words. 'Ape-language began with what seemed to be a very simple and intriguing question: can apes learn to talk?... The behavior of these animals seemed so intelligent that many scientists were repeatedly puzzled as to why they could not learn to speak' (84).

The famous projects of Kellog and Kellog (57, 58) and of Hayes (41, 42) on trying to teach English to infant chimpanzees resulted in failure because, after several years of training, the subjects were not able to pronounce more than four words despite the fact that they attained a passive vocabulary of around 100 words.

In 1969, Gardner and Gardner (31) trained the chimpanzee Washoe to use the 'American Sign Language' (ASL). In three years he acquired an active ASL vocabulary of 132 words. This successful result stimulated research on other primates and a later study on gorillas, done by Patterson (74), proved their ability to learn, in about four years, some 220 ASL words. As Nöth pointed out in 1990,

'the most significant results of these projects are the discoveries concerning the degree to which apes are able to generalize and abstract in the use of signs. The gestures used by Washoe were not only context-dependent indices of imitative icons (for which apes are proverbially famous), but true symbols, arbitrary signs used in the absence of the referential object, occasionally even in creative generalizations and sometimes for no other purpose than naming the object' (102). The most important criticism brought to these projects is that apes trained by humans could detect some nonverbal cues from their trainer, the so-called 'Clever Hans phenomenon' (88).

Premak (78, 79, 80) used, with the chimpanzee Sarah, a specially created artificial language in which plastic tokens of various shapes and colors were used as the equivalents of words. The research focused on the ability for syntax and logic. Acquiring some 130 symbols, Sarah was able to use and understand quantifiers to describe colors and shapes, 'to construct sentences and questions in correct word order' (102).

Rumbaugh and Savage-Rumbaugh (81, 84, 85) used another artificial symbolic language in which the symbols consisted of geometrical configurations embossed on the keys of a computer keyboard with 124 keys, each of them being equivalent to a human word. The subject, again a chimpanzee, had to manipulate the keys in a correct syntactical order. To avoid any influence from the non-verbal behavior of the trainer, no direct contact with the subject was possible, the 'conversation' being screened and the experimenter offering the rewards from a distance. 'Apes can learn words spontaneously and efficiently, and they can use them referentially for things not present; they can coordinate their joint activities to tell another thing otherwise not known; they can learn rules for ordering their words; they do make comments; they can come to announce their intended actions; and they are spontaneous and not necessarily subject to imitation in their signs' (85). Despite all these results, objections were raised about the fixed place of the keys on the keyboard which could facilitate simple positional learning.

In other recent studies done on bonobos *(Pan paniscus)*, Savage-Rumbaugh et al (1990, 1994) mentioned that the two young individuals studied showed much evidence of *naturalistic* (as opposed to trained) acquisition of spoken English, comprehending many quite complex statements the first time, without the need for gestures. Early exposure to naturalistic spoken English seems to be the critical factor, just as with human children who, in some respects, scored lower until the age of 3–4 years. 'On the other hand, there seems to be no evidence as yet that the trained apes spontaneously teach each other their new-found skills. Moreover, the chimpanzees can learn to sign, to draw and to communicate via gesture in the laboratory but cannot *create* or *maintain* these behaviors *naturally*, out of laboratory. These considerations lead some critics to say that, finally, rather

than tapping the language *per se*, the studies address capacities for categorization, association, problem solving, and communication' (8).

Here we are confronted with two different aspects of language: **speaking and understanding.** Apes cannot produce vocal sounds such as *i, a, u,* or the phonemes *g* or *k* due perhaps to limitations in their vocal tract anatomy, their central nervous system or volition. As a species they prefer visual signaling via facial expression, gestures, and postures to acoustic signaling. But some humans, due to their vocal or brain limitations also cannot perform sounds specific to the human language. What should be the phylum for integrating them? Humans, because they lack tails and body-hair, or non-humans because they lack speech?

Non-human primate research proves that there is a great difference between what apes and monkeys can perform vocally and what they can understand trans-specifically. 'Our closest animal cousins, the common chimpanzee and the bonobo (pygmy chimpanzee), can achieve surprising levels of language comprehension when motivated by skilled teachers. Kanzy, the most accomplished bonobo, can interpret sentences he has never heard before, such as 'Go to the office and bring the red ball', about as well as a 2.5 years old child. Neither Kanzi nor the child constructs such sentences independently, but they can demonstrate by their actions that they understand them' (9).

Studies on non-human primates intelectual abilities use performance as a reference point but it is very important to keep in mind the fact that the ape subjects task in any one of these studies was a very artificial one. Compared to that, the task of a native English speaker to learn Chinese is simple. Despite criticism of these results, it is difficult to ignore that by different techniques and with different subject species, the conclusions are pointing in the same direction, proving that the brains of monkeys and apes are capable of so much more than their vocal tract.

Back to Burling's paper, we may reconsider his sharp distinction between the **'two fundamentally different forms of communication',** based on some features (contrast versus continuity, auditory-vocal channel versus other channels of the propagation of information, etc.), taken into account by linguists and anthropologists. Reactions to this assertion are extremely diverse, starting with B. G. Blount (8, p. 39) for whom the two forms of human communication **'are more likely of being complementary systems, one embedded in the other',** and ending with that of W. C. Stokoe (8, p. 43) for whom **'the difference is not between language and non-verbal communication but between language and the communication of creatures without language.'**

The debate is also continuing as to which of the two systems is older. For Mary le Cron Foster (8, p. 39), 'vocal language is an older system than gesture

signaling. Our perception of the operation of iconicity in it fades as the function of analogy became classificational rather than sensory-perceptive'...? In C. A. Callaghan's opinion (8, p. 39), 'it is quite probable that gesture-language evolved before spoken-language.'

Burling suggests parallels which he finds 'more promising... between primate calls and human nonverbal communication.' Commenting upon the distinctive grunts that vervets exchange with one another (these include one kind of grunt that a vervet monkey makes when approaching a superior and another used when approaching an inferior) which are described by Chenney and Seyfarth in their book (11), the author considers that these grunts' presumably, help to smooth the relations among the animals, offering reassurance about each animal's knowledge of its place in the hierarchy. Should they however be compared to language? I suggest that when humans use signals that are most similar to these vervet grunts we do not count them as part of language... Until these (two types of communication) are recognized as distinct, comparisons with animal communication will always be difficult' (8, p. 28). He also notes that 'our own language is vocal. Vocal communication is so crucial to us that we may exaggerate its role among animals. We too easily forget to acknowledge that sound is only one part of their multi-channeled communication system' (8, p. 27).

I should say first that, if some barrier blocks our judgement on such an important topic, rational efforts should be made in order to get over it. Verbal communication in humans, just like oro-facial (vocal and mimic) communication in other primates and non-primates, seems to be adapted for two different purposes:

— **long distance interactions** or conditions in which direct interaction is screened (in the darkness, in thick vegetation, etc.). In such circumstances the call-system, i.e. the vocal-auditory channel is dominant. Human warning calls as well as those used for locating other members of the group are short. Perhaps most important features of such calls are the intensity of the sounds, the intonation and the structure of the words — long vowels alternating with strong consonants, which provide sound reverberance. Asking for help or warning of a danger is entirely possible and effective using screams consisting of such a combination of sounds instead of clear words. The signals eliciting alert responses should consist of these long phonemes. It would be useful to analyze the accentuated phonemes in the alarm calls of humans in different languages.

In humans but also in non-human primates, as well as in many other animal species vocalization has advantages and disadvantages. By vocalization they can communicate and locate their mates or infants or congeners, but at the same time, they can be easily located by predators or enemies.

— **close interaction**, where visual cues are more accessible. In this situation somebody can gain much more information by combining speech with body

and facial gestures and postures. Apparently the dominant channel switches to the visual one — and this should be more a kind of comparison and integration of acoustic and visual information. Loud calls, just like loud human speech, has an agressive meaning if it continues to be performed in the proximity of congeners. From this point of view, it is not surprising that the vocal repertoire of vervet monkeys turns from calls to grunts, while they are in close contact, because different types of information about the self and the environment must be offered. I do not think the differences between this kind of vocalization and our whispers are so dramatic even if the word should be the same, as at warning 'leopard'.

By way of contrast to the parallel between primate calls and human non-verbal behavior, I suggest one between primate vocal-facial gestures and human speech. To support it, I would first bring into discussion the age of the two systems. Almost all the authors dealing with primate and human communication recognize the striking resemblance between non-human and human primates' facial expressions. Many human-ethological studies also demonstrate that, despite the great diversity of human cultures, very many facial gestures are universally present, and have the same meaning (23–26, 36, 45, 53). As early as 1872, Charles Darwin (18) pointed out a number of cross-cultural similarities in human expressive movements, which in his view originated in a common phylogenetic root. Despite being repeatedly challenged, 'in a number of cases comparison with other primates revealed some behavioral patterns, very probably phylogenetically old, as is the case with expressions of smiling and laughing, for which homologues are found in the *horizontal bared-teeth face* and *relaxed open-mouth face* respectively of the chimpanzees and some monkeys' (46). A review of chimpanzees' facial expression, reflecting/signaling specific emotions/psychic states is to be found in the studies of A. Jolly (53), and of Chevalier-Skolnikoff (12). Results of child development studies equally point out that 'by the time children utter their first words, they already have a well-developed gesture-call system' (8, p. 49). In his very detailed study on the gestural behavior of the deaf-and-blind-born children, I. Eibl Eibesfeldt (20) discusses basic similarities between the expressive behavioral patterns of his subjects and the expressions of non-deprived children. These facts cannot be explained entirely by learning acquisition because of the severe channel impairments. The author also notes differences in the expressive behavior: the deaf-and-blind-born often lack minute gradations; the superposition of various expressions occur, but are less refined than the composite expressions of normal children, fact which seems to be the result of adjusting behavior by imitation and learning.

Combining these data together with many other results, we may recognize that the nonverbal expressive behavior was the first step in close communication in primates.

The ability of 'the smartest ape' to articulate a richer repertoire of sounds did neither cancel nor replace the nonverbal expressive behavior, but built up on it. In other words, as long as emitting sounds and combining them into 'proto-words' requires not only brain and vocal cords, but also mouth movements, it would be very uneconomical and unwise to 'invent' them at random. These arbitrary signs will change facial expressions, making other congeners doubt the truth of intentions and emotions of the emitting individual. It would be much easier and more efficient to produce those sounds which best fit an appropriate oro-facial expression. To support my hypothesis, in addition to results on primate behavior discussed above, I will now turn to data provided by studies on comparative anatomy and physiology. The amount of information is enormous and I only want to mention those results which attest, in non-human primates, the existence of macro- and micro-level equivalencies of human brain speech areas and of related structures involved in the production and reception of vocal-acoustical-visual information:

— **Lateral asymmetry** of functions depends on a complex of genetic, structural and functional factors and is also influenced by hormonal and maturation elements. The most important and intriguing level where lateralization is expressed is that of the brain hemispheres. This asymmetry is considered to be the anatomical support of the highest human brain activities such as tool use, language and intellect (37). But lateral asymmetry is far from being uniquely human, occurring frequently as a characteristic of many animal species. There is good evidence for homologous lateralization, at least in the processing of non-human primate vocalization (62). Heffner and Heffner (43) showed that lesions of the left temporal lobe of Japanese and Rhesus macaques induced loss of ability to discriminate species-specific calls. Some behavioral studies also show that there exists a right ear preference for inter-individual vocal communication i.e. left hemisphere (39, 75). Morphological asymmetries in the temporal areas corresponding to those in humans were also found in chimpanzees' brain (105).

— **Specific speech areas** i.e. Broca, Wernicke, are known to exist in the human cortex. As Wilkins and Wakefield (101, p. 163) underline, 'the claim is not that language relies exclusively on these areas but rather the more modest one: that these areas are necessarily, but not exclusively, involved in language.' The existence of these cortical areas is, among others, one of the basic material arguments of Chomsky's nativist theory of language (14). 'According to Chomsky, our language ability, as he sees as both species-and task-specific, derives from an innate language-specific neural mechanism or mechanisms. He sees the latter as discreet modules for such separate components as syntax, the lexicon, and so on, with no prior evolutionary history, no prior preadapting counterparts in earlier species suddenly appeared, full blown as Athena from the head of Zeus' (5, p320). In other words, 'language acquisition is guided by a language instinct — crudely, a genetic determined region in the brain' (40).

There are several reports concerning the presence in the brain of non-human primates of regions cytoarchitectonically homologue to our Broca and Wernicke speech areas. Galaburda and Pandya (30) as well as Deacon (19) claim to have found such homologues in the Rhesus monkey, together with the arcuate fasciculus which links the two major areas. 'Phonation and vocalization in monkeys is at least partly under the control of limbic centers, such as the anterior cingulate, as indeed may also be true for humans. Thus, emotional signals like crying and laughing seem to employ similar subcortical circuitry to those mediating animal calls with lateral evolution of the cortical system' (5). Doreen Kimura (60) has found that aphasic patients whose aphasia resulted from damage to left lateral brain areas also have difficulties in executing novel sequences of hand and arm movements (apraxia). 'By electrically stimulating the brains of patients being operated on for epilepsy, George A. Ojemann of the University of Washington has also shown that at the center of the left lateral areas specialized for language lies a region involved in listening to sound sequences. **This perisylvian region seems equally involved in producing oral-facial movement sequences-even non-language ones. These discoveries reveal that parts of the 'language cortex', as people sometimes think of it, serve a far more generalized function than had been suspected. It is concerned with novel sequences of various kinds: both sensations and movements, for both the hands and the mouth'** (cf. 9).

'The response of vervet monkeys to an alarm call, though different for each type, is invariant and, presumably, limbically controlled. Words by contrast, are typically produced without limbic involvement (as far as is known), are uttered in a dispassionate fashion, are not stimulus bound, and do not evoke a stereotypical behavioral response in the hearer' (cf.100, p. 134–135). But as Deacon notes, 'our own older limbic vocalization circuits are still important in initial speech activation, in prosodic and emotional expression. Indeed they activate our few remaining species-specific calls; for example laughter, crying, shrieks, sighs, groaning and sobbing. Generally cortico-cortical connections in the monkey's perisylvian regions predict the spatial pattern of functionally connected areas in human temporal, parietal and frontal lobes. This suggests that language functions, during evolution, have recruited cortical circuits that were already present, perhaps for different purposes, in our primate ancestors. Quantitative changes in particular populations of neurons may be more common than novel rerouting of neural connections or the '*de novo*' creation of new brain structures in vertebrate brain evolution. Deacon again emphasizes that there is no evidence for a *de novo* appearance of speech areas in the brain of early hominids; any differences between us and our ancestors are likely to be quantitative rather than qualitative' (cf.100, p. 328).

As can be seen, material proofs of at least 'primordial structures existing in non-human primates brain are not missing as well as some references about

the common neural pathways controlling speech and non-language oro-facial movements.'

— **The auditory boundaries** of infants and adults of non-human primates coincide with the phonetic boundaries present in humans. Based on this overlap, Kuhl (61) argues that 'there may be no special speech-specific mechanisms, and that speech production evolved to match the properties of the ear.' According to Kuhl, the auditory system may have played a key role in shaping the acoustics of language and the mechanisms that produce it. Thus even if early hominids could not produce a full range of 'our' kind of speech sounds, and this is itself a disputed proposition, they may still have been able to perceive and discriminate a full range. If Kuhl is proven right, we may have to conclude that the uniqueness of human speech lies not at the phonetic level, but rather at the levels of syntax and semantics' (cf.5, p. 331).

— Most of the **oro-facial muscles** implied in speech are equally involved in nonverbal facial gestures, and have homologues in the anthropoid apes (23, 45, 53). As noted by Savage-Rumbaugh and Mc Donald (1988), 'the chimpanzees facial anatomy is very similar to our own except for a large protruding jaw and brow ridges; the nerves and muscles moving the various facial structures are practically the same as ours and, when accustomed to the chimpanzees slightly different facial architecture, we soon learn to read its expression accurately, particularly in the case of the pygmy chimpanzees (bonobo). This subspecies has a much smaller brow and jaw and may in fact be more closely related to us.' (cf 9).

Another set of important information comes from studies on infant and children's general and vocal behavior. An early phylogenetic origin of language in mother-infant contexts has been suggested by several authors (32, 73). Children are born with a capacity for learning the language to which they are exposed in the first years of life, without predisposition for a certain language. In order to understand how the speech-learning process functions, we have to take into account not only the acoustic input, but the entire context in which the 'maternal language' is taught and perceived. It is quite clear that no infant is able to learn a language from an audio-tape, even if it implies a very sophisticated method of teaching. Usually it is the mother's 'job' to talk with the infant. This kind of communication ('baby talk' or 'motherese speech') is very special and efficient; Eibl Eibesfeldt in his 'Human Ethology' explained some of the characteristics:

'1. Raising tone frequency relative to normal speech by one octave.

2. Exaggeration of intonation structure, whereby the melodic form conveys specific information (D. N. Stern et al 1982). Mothers use rising melodies when they elicit their child's visual contact. Yes/no questions have similar frequency

curve. Why-questions and demands utilize falling melodies. Sinusoidal and Bell curves are used when mothers wish to maintain the infant's interest.

3. Emphasis of important elements.

4. Clear, simple speech.

5. Grammatical simplification.

...Facial expressions are also modified specifically for children. Mothers exaggerate expressions and change them slowly' (21, p. 207–209).

To these characteristics I would add:

— repetition of the word until imitation occurs in the child;

— affective reciprocal rewarding;

— close body and visual contact while 'teaching' the infant.

The 'motherese speech' seems to be universally present in humans, suggesting that it has some important functions in facilitating language acquisition by infants as well as in bonding the dyad.

As Ann Cutler remarks (16, 17), 'Human speech and perception is truly remarkable in his robustness and flexibility. What is equally remarkable is how IN-flexible human speech perception is with respect to the needs of a polyglot environment. Adult language users find learning new languages extremely hard; increased exposure to foreign languages does not alter this situation at all.'

Could this lack of flexibility in adult language learning be the result of a very different approach (grammar based rather than visual and acoustic input), compared to that of infants?

Analyzing the role of each of the 'motherese language' characteristics, we may propose that:

— The raising of the tonal frequency can be considered an almost reflex reaction when:

a) we are in contact with beings or things that elicit our kindness and delicacy: small children but also small animals, beautiful little things such as flowers, etc.

b) we want to communicate our real or pretended fragility and need for protection (children talking to adults, women to men, subordinate to leaders, etc.).

It is probably a way of gaining confidence by making 'a slam voice', more similar to the natural tonality of children's voice (59). The raising of tonal frequency alone is not efficient in establishing friendly contacts, as long as screams (angry speech) also imply a raise in tonal frequency.

— Exaggeration of intonation structure, with an accent on the melody of speech, is one of the most interesting characteristics of the 'motherese speech'. The fact that this 'melody' is accentuated, even exaggerated might reflect a special, innate mechanism of perceiving it in infants. Such a behavior would not be maintained, were it not efficient in facilitating communication. Adult speech melody is also extremely important in the emotional decodification of

messages. This melody may be the key element in understanding 'What it is about' in an unknown language because, despite the great variability of identical words, when we have to communicate information in different languages, the melody seems to be very much the same. Perhaps some common features can be found in the melodic shape of vocal emission in deaf and/or dumb children and adults who try to express feelings.

Turning from language-melody to music, I would like to emphasize that 'music is more immediately effective than is visual art. It is directed toward our emotions, with primary leitmotifs presented as releasers in more or less veiled form' (21, p. 691). By primary leitmotifs one understands the fact that 'people can accurately categorize heroic, hunting, war, mourning, lullaby, and love songs with a high degree of certainty (R. Eggebrecht 1983; M. Schröder 1978)' (cf. 21, p. 690). Eibl Eibesfeldt also mentions the findings of Sedlacek and Sychra (1963) 'who showed that non-Czech speaking persons correctly interpreted the mood in which a Czech sentence was spoken' (21, p. 690).

'The sense for musical harmony is based upon the biologically determined ability to extract a single tone from a chord' (91). 'This perceptual ability is based on a constant calculation of harmonic intervals between the individual partial tones and thus requires a special abstraction ability, since the actual tone frequency does not have to be physically present in the chord itself. Parallels to analogous central information processing strategies in recognition and estimation of human verbal sounds suggest phylogenetically acquired learning programs' (97, cf. 21, p. 694).

These findings can also support other hypothesis: if speech melodies (and also music, vocal or instrumental) have several universal traits then it should be possible that in the genesis of vocal/verbal communication the melody came the first, perhaps as grunts, calls, etc. Such a hypothesis would explain its universality despite the languages 'explosion'.

The rhythm of sound emissions can express the emotional state of the animal (chimpanzees vocalizations in agonist interactions, distress calls of infants, etc.).

Also tonality and the harmonic intervals could be important information carriers.

Going one step further, one may find some parallels with the vocal melody of non-human primate calls. Major versus minor tonalities (intervals) known as one of the landmarks used to decipher the 'primary leitmotifs' could perhaps be found in non-human vocalizations as well. It would be important to establish whether they have the same emotional meaning as in the case of humans, but such investigation requires very sophisticated sound and video-analyzing systems.

This argument does not depend on the other three characteristics of 'motherese speech' enumerated by Eibl Eibesfeldt, namely emphasis of the important

elements, clarity and simplicity of speech, and grammatical simplification nor on my remark on the repetition of the word in order to elicit vocal imitation, because they follow a more general learning scheme.

Facial exaggeration of expressions, their long-lasting display, the close body and visual mother-infant contact and affectionate reward for spontaneous or volitional vocalization/verbalization, are aspects usually included in the 'non-verbal' communication category. I already discussed the hypothesis of the close connection between oro-facial gesture and words, with the possible origin of speech from paralanguage behavior. The spontaneous, perhaps innate need of adults to accentuate facial expression and to present it in a very explicit way to the infant could sustain such a hypothesis. 'Kuhl (1988) notes that the infants are born with certain predispositions; they prefer looking at faces than at equally complex visual stimuli (Fantz and Fagan, 1975), they prefer viewing faces judged attractive by adults, indicating that facial attractiveness is innately assessed (Langlois et al. 1991), they imitate (within 72 hours of birth) facial expressions or actions presented to them (Meltzoff and Moore, 1983), and they prefer to listen *motherese speech* to *adult speech*' (cf. 5, p. 330). With adults too the acquisition of a new language is more efficient if the exposure involves not only acoustic but also visual contacts.

Some of the experiments on infant speech perception used measures such as time of non-sucking or fixation time of visual-acoustic stimulus in familiar and non-familiar ambiance —'habituation paradigm' (22, cf. 17).

'Research with these methods shows that infants can discriminate speech sound contrasts both from their own and from other languages. Thus, they can discriminate contrasts which they have never heard; and they can discriminate contrasts which adults fail to discriminate because mature language users identify speech sounds only in terms of the categories of their native language' (17). Recent studies point out that vowel perception and discrimination between the native and non-native vowels develop earlier (around the age of 4 to 6 months), while consonant perception and discrimination occurs around the age of 10 months (77). The authors give an acoustical explanation, saying that vowels have longer duration than consonants and have more marked periodic structure, which corresponds to the infants preference for 'periodicity bias' (16).

A complementary explanation for the earlier perception of vowels comes from the fact that *their duration is longer than that of the consonants* giving more time to the infant 'to analyze' them not only acoustically, but also visually. The duration of exposure to the vocally emitted sound (vowel in this case) is longer and the time for the infant to hear and to observe the facial expression (mouth shape) in pronouncing it is also longer. Before performing real words, very small infants move their mouth spontaneously, or trying to imitate the movements observed. When an infant is seen performing such movements, the

adults most frequent reaction is to 'respond' by imitation, adding the corresponding sound.

Another question is the following: is the *motherese speech* 'deformed' and exaggerated, or is it more probable that adult speech evolves by reducing some of the emotional informational cues or by replacing them with a richer vocabulary? The use of *motherese speech* is sometimes criticized, the 'positive emotional function of this means of expression' (Mannelore Grimm, 1983 cf. 21) being neglected. 'If it is reduced to a purely academic consideration, based theoretically on the linguistics of speech, this argument is untenable. Unless one would wish for speech development without considering the affectivity of words' (21, p. 207).

As regards the acoustic perception and discrimination of vowels and consonants, it might be interesting to analyze the most basic linguistic repertoire of infants in their first year of life which contains a lot of repetitive syllables as: baba, caca, dada, gaga, lala, mama, nana, papa, tata, etc. Many of them, before being real words, are simple spontaneous vocal exercise results. This may be the reason why they became important words denominating close relatives, physiological or psychological needs in almost every language. Some of these words often change the last vowel into an 'i' or transform a non-accentuated into an accentuated vowel, forming in some cases the diminutive of the initial word. One should also note the words repetition as a means to express the plural as in Pidgin languages, Indonesian, Papuan and perhaps in languages in many other parts of the world. This aspect might also explain why, in various situations when a message has to be underlined, this is done by repetition of syllables or words (yes, yes; sure, sure; etc.) or by repetitive gestures such as shaking the head or the arm.

Taking into account all these, one way to understand how speech might have originated implies several combined studies to answer the following questions:

1. Which are the non-human primates' oro-facial distinct expressions most frequently used in close interactions with congeners?
2. What are the clearest meanings of these expressions, considering the context and the consequences of their being shown?
3. What are the specific (or equivalent) muscles involved in these mouth movements?
4. What are the human mouth movements (and specific/equivalent muscles) involved in pronouncing sounds and groups of sounds?
5. What are the most striking equivalences of mouth movements in humans/non-human primates while gestural/vocal communicating?
6. Is there any correspondence between these motor equivalences and the phonetic structure of specific words across languages?

For the first four questions, as mentioned before, a great number of studies already exist. For the last two, there are no comparative interspecific data, but only some human trans-cultural linguistic studies focussing mainly on related languages. I have only one reference, concerning the biophysiological origin of the word 'mama', which does not involve interspecific, but only transcultural comparison.

Starting from the etymology of the word 'mama/mamma'

Greek: mámma = mother, mother-breast

Latin: mamma = female breast, mother

middle-high German = mamme, memme = mother breast, mother, woman

Wulf Schiefenhövel (personal communication), points out that 'one theory suggests that the 'm' phonem is equivalent to sucking in / directed inwards, involving the lips and the other parts of the mouth of the milk suckling baby'. Indeed, if we check the way infants name their mothers, in many languages of the world, we can observe that their mouth is moving in a very similar fashion to the movement they are performing while in suckling or asking for breast feeding:

ma – (Prakit, Hindi and many other modern vernaculars, also *amma, ama*)
mi, me – Talaing
ma – Palaung, En, Yin, Kla Muk, Malay
mi, ma, mia – SE Papuan
mo – Pak, Sasar, Teqel
mama – Savo
moa – Wa
mwe – Son
ma-e – Dana
mai – War
may – Kurdu
u-ma – Mundari
a-ma – Malay, Fasu, Kewa, Beami
me – Tai
mei – Li, Laqua
mama – 'nursing mother' Samoa
ama – 'female guardian, female authority' Tagalog

It is interesting also that in many languages the words for face, mouth include the same phoneme (the same mouth movement)

mukha – face, mouth Sanskrit, Philippines, Indonesian, Malay
muham – mouth, Prakit
mukh – face Bengali
muh – mouth, common in modern vernaculars
muka – face, Malagasy

maka – face, Polynesia
mata – face, N. Guinea
meka – tongue Amboyna
mocha – mouth, Kherwari, Santali
mua – mouth, Katorr
main – mouth, Son
mu-lut – mouth, Malay, Indonesian
muru – mouth, Central Papuan
mangai – mouth, Maori
mana – mouth Vaturana, Florida
muu – mouth, Manggarai
mut, mit – mouth, Formosa
mingir – mouth, Awyi
magota – mouth, Kiwai
mongot – mouth, Kati
manga – mouth, Kapau
(The list of words is selected from Internet based information).

While in some instances the correspondence may be coincidental, it is obvious that, as a whole, such a high rate of coincidences between various language groups is very unlikely. When we add the known European equivalences it becomes evident that some of the words are not created at random.

Very similar movements of the mouth are performed when pronouncing 'papa' which in some languages is denominating the father (bapak, Indonesian), in others food. In Romanian, where 'papa' means food, the word is used only for speaking with infants and very young children, or in 'motherese speech' but not in adult speaking.

It is not my intention to argue that all words are conceived in this way, and I would like to stress that I am interested only in those words or vocal expressions which are of great biological significance, analyzed from 'proto-language' perspective.

In recent years, in studies concerning decoding the multimodal verbal and nonverbal systems of human communication using speech, facial expression, and body gestures in relation with artificial intelligence, human-computer conversation, very sophisticated programs are developed for searching human-computer interaction and dialogue, natural language processing collaboration theory and technology, speech act theory, knowledge-based simulation applications to mobile computing and information management (15). It is possible to make accurate and complex measurements using computer technology (4, 6, 7, 27, 28, 29, 54, 55, 56) such as the one used by J.Schubert (87) for analyzing verbal, vocal and visual aspects of political speech. (Some samples of

Romanian and English spontaneous speech in situations considered to be biologically meaningful have already been analyzed with such modern equipment. In the near future a twinning project will probably help us conduct more detailed study using the existing audio-video recordings.

To summarize briefly, the main aspects of this paper include the following:

— Despite strong opposition, there is a host of data coming from diverse fields of science, suggesting that human language did not appear de novo, but has, in addition to cultural roots, important biological ones.

— In order to investigate the precursors of human vocal communication in infra-human primates' systems of communication, it is essential to choose carefully those samples which are equivalent in humans and non-humans, e.g. information with biological meaning.

— Starting from the observation concerning the universality of most of the primates' gestural behavior, it should be possible to design a hypothetical 'proto-language' including assumptions as which words correspond to specific facial expressions.

— Supplementary arguments can be traced in infant incipient speech, as well as in cross-cultural linguistic studies on 'motherese speech' and children's vocalizations.

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