

## Retarded Development: The Evolutionary Mechanism Underlying the Emergence of the Human Capacity for Language

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The emergence of the human capacity for language depends upon a profound slowing of the rate of human growth and maturation. The human infant matures more slowly than other apes. Motoric helplessness and an elaboration of vocal patterns of communication between infant and adult become the parameters within which the cortex matures. Changes in neural development, functioning and structure are inevitable given the changed conditions of growth. At least three major changes mark the context of infant development: the length of time during which neural development and maturation proceed; the nature of the mother-infant interaction during the prolonged period of juvenile dependency; and the size and complexity of the group into which the infant is integrated. The present paper explores the possibility that the human capacity for language emerges early in hominid evolution. However, I argue that a critical level of social complexity is necessary for the elaboration of this capacity into language and culture. Language emerges to reflect and schematize the patterns of an intangible social interaction.

The human infant has the capacity to learn a variety of languages. This capacity for language does not depend upon an inherent cortical structure but upon a peculiarly extensive and prolonged postnatal neocortical development. Language exhibits a flexibility, a creativity and a freedom from contextual constraints beyond any other animal system of communication (von Glasersfeld, 1977). Genetic programming of interaction and communication tends to rigidly schematize or stereotype the social and communicative exchanges. More complex genetic control, as in the case of bees, produces a more complex communication, but does not relax the mechanical, context-bound nature of the still-limited possible responses.

An evolutionary trend toward less and less genetic control over the structuring of the cerebral cortex (through which thought, memory and communicative gestures are processed) would explain much of what seems puzzling in the learned behavior of higher animals. Innate structures would have to be replaced or restructured by the functioning of the animal during the development of the

neocortex. This concept requires rethinking the traditional relationship between structure and function in neocortical development. However, only a cortical structure generated by participation in culture can account for the creativity of language and culture.

The sociologist Peter Berger has argued that the awareness of one's self as an object in the social world in relation to others and the objectification in language of that social world were a product of the "unfinished nature" of the human infant (Berger, 1969, pp. 4-5). Similarly, the evolutionary biologist Steven J. Gould concluded that the emergence of consciousness upon which language is predicated, "can scarcely be matched as a momentous event in the history of life; yet I doubt that its efficient cause required much more than a heterochronic extension of fetal growth rates and patterns of cell proliferation" (1977, p. 409). The retarded development of the human infant, with its motoric helplessness and compensatory elaboration of vocal communication between infant and adult, dictated the most radical change in hominid social interaction in human evolution. However, in order to understand any interdependence between the retardation of development and emergence of language and culture, the implications of retarded development have to be understood.

### *Neotony as an Adaptive Strategy*

Retarded development, *neotony*, refers to regulatory changes in developmental timing. Neotony is expressed in the developmental profile of modern humans in the *progressive* prolongation of phases of somatic growth and development from conception to senescence. The kind of regulatory change necessary to slow growth and maturation is far simpler than the host of point mutations which more traditional interpretations of evolution presumed responsible for particular structural changes (Bruce and Ayala, 1978; Gould, 1977, pp. 405-409; King and Wilson, 1975).

Retardation in the timing of somatic development is typical of large mammals, particularly the great apes. Large size is one of the consequences of prolonging fetal stages of cell division. To a greater or lesser extent, fetal growth rates continue in mammals beyond gestation into early phases of postnatal development. As a result, some part of mammalian neural development must be completed after birth. The percentage of unspecialized cortex at birth and the length of postnatal neural development appear to delimit behavioral flexibility and capacity to learn in mammals. In human gestation, the earliest phases of growth may be prolonged only hours or days, while later fetal phases are prolonged for months into the first postnatal years. Fetal growth rates continue at least twice as long as in any other mammal, and postpartum maturation is further extended. The pervasiveness of retardation in human development is, I shall argue, the most important underlying physiological mechanism for the emergence of culture, including language.

Under specific ecological conditions, reproductive strategies—the rates of growth and maturation, birth spacing and the length of reproductive maturity—regulate the potential for population expansion or stability (Gould, 1977; Johanson and Edey, 1981; Lovejoy, 1981; Pianka, 1970). Neotony appears to be integral to an adaptive reproductive strategy for species in stable environments, such as the tropical rain forest, which are characterized by abundant yet scattered resources with little seasonal variation in availability. Inter- and intra-species competition for resources favors delays in reproduction to stabilize population size. Selection is for slow development, late sexual maturation, small litter size, increased spacing between births; large size and juvenilized morphology are often secondary consequences. Juvenilized morphology, when it occurs, is the result of a relatively early sexual maturation in the context of retardation of somatic development.

Neotonous regulatory changes can account for the differences in form and behavior between human beings and the other apes, with whom we share similar morphological and genetic configurations. The simple enumeration of putatively juvenile ape features (paedomorphosis) in hominid morphology cannot present a convincing argument for neotony. Several variations in the regulation of growth and sexual maturation might lead to paedomorphosis. Despite such juvenile features as a rounded head, small teeth, lack of canines, hairlessness, lightly pigmented skin, flat face, etc., too many distinctive human physical features (for example, the enlarged brain) are not apelike. The key to a proper understanding of human paedomorphosis lies in the documentation of a general matrix of retardation within which development to adulthood occurs.

Neotony has been a (probably *the*) major determinant of human evolution.

When we recognize the undeniable role of retardation in human evolution, the data of neotony can be rescued from previous theories that made them so unpopular. Human development has slowed down. Within this "matrix of retardation," adaptive features of ancestral juveniles are easily retained. Retardation as a life-history strategy for longer learning and socialization may be far more important in human evolution than any of its morphological consequences. (Gould, 1977, p. 9)

Retardation is a pervasive phenomenon in the growth and development of almost all human systems, somatic and reproductive (Gould, 1977, p. 376n).

#### *Neotony, Closer Birth Spacing and the Hominid Radiation*

Neotony underlies both the fetalization of the human infant at birth and the hypermorphism of parts of the human brain. Other kinds of human divergence from closely related apes, such as bipedal walking, the remarkably rapid recommencement of human female fertility after giving birth, and the loss of estrus, are not easily explained within this matrix.

Human females begin ovulating three to six months after giving birth—potentially reducing the birth spacing to 18 month intervals. Other apes repress

ovulation and/or estrus for at least two or three years after an infant is born. Average birth spacing for chimpanzees is four to five years between births. Gorillas average a birth every six to seven years. Gould's lack of attention to the reduction in birth spacing appears to be a serious oversight. Closer birth spacing would imply a reproductive response to changes in the way hominid populations functioned in their environment—possibly in adaptation to an environmental change.

Changes in diet, locomotor patterns, group size, infant care and division of labor each have a different impact on the potential for population expansion. These kinds of changes might eliminate some of the disadvantages which operated to select against closer birth spacing in other apes.

The evidence that hominids were colonizing a new and expanding niche suggests that closer birth spacing may have had considerable advantages for the rapid growth and success of the population. Although all the large African apes descended from the trees to the ground, only the hominids became bipedal, moved from forest to savannah and changed their diet to include, in addition to fruit, a large proportion of roots, seeds, nuts, insects and small animals (Isaac and Crader, 1981; Mann, 1981). The early hominids crossed an ecological boundary as the Pliocene rain forests retreated and were replaced by woodland and savannah. Their new environment was considerably less stable than the rain forest, although certain seasons offered abundant foodstuffs (Coppens, 1985).

Theoretically, less stable environments select for populations with the potential for more rapid expansion because they must be able to recover from irregular fluctuations in resources which periodically diminish the size of the population. Hominids and several smaller primates (baboons and other monkeys), which were capable of births spaced one or two years apart, colonized and diversified on the edge of the shrinking Pliocene forests and into the expanding savannah (Pilbeam, 1984). The hominid's behavioral flexibility seems to have meditated the environmental instability, since natural checks to hominid population growth appeared to affect them less than other primate populations. Thus, Plio-Pleistocene radiation of hominids into the woodlands and savannah continued. Growth and dispersal seem to have characterized hominid populations from earliest records—their expansion appeared unchecked by reproductive limits or ecological restraints which might have contained comparable animal populations.

Lovejoy (1981) considers these factors in some detail as interdependent variables in the early hominid shift from forest canopy to woodland, and from climbing to walking.

... The existence of successful hominid clades in Pliocene mosaics suggests that both birth space reduction and elevation of survivorship had probably been accomplished. This is without explanation unless a major change in reproductive strategy accompanied occupation

of novel environments by these hominids. Yet neither brain expansion nor significant material culture appear at this time level and were therefore not responsible for this shift. (1981, p. 344)

Lovejoy argues that bipedalism and closer birth spacing were the physiological adaptations which allowed hominid colonization of the woodland-savannah.

I would like to reconsider bipedalism as the impetus for the acceleration of neotony in the evolution of hominids. Early in the study of human evolution, changes in pelvic proportions were linked to bipedalism. Both increase in fetal mass and changes in pelvic proportions have been mentioned in connection with difficulties in parturition. Gould, while declining to argue causation, concedes that "the link of 'early' birth to difficult parturition seems quite reasonable" (1977, p. 369). He posits that the increase in fetal mass in primates is the result of neotony. Retarded development in primate evolution was accompanied by increases in the sizes of both neonates and adults, greater gaps between generations, prolonged infant care and greater spacing between births (Gould, 1977, p. 369).

However, increased fetal size cannot, by itself, account for the proportionately greater retardation in hominids, because retarded development results in a larger adult who in turn can presumably carry a larger fetus (Gould, 1977; Leutenegger, 1982). Hominids display retarded development in the fetus and neonate without proportionate increases in adult size. Increase in fetal size in conjunction with changed and reduced proportions of the pelvic opening as a consequence of the hominid adaptation to bipedal walking would create a discontinuity between adult and fetal size and require both the retarding of fetal growth and the acceleration of birth *vis à vis* the developmental stage of the fetus. Thus, compared to other apes, hominids give birth earlier in the developmental process without significant change in the length of gestation. The combination of a large fetal mass and a narrowed birth canal selected for greater retardation in development, and resulted in a neonate that was large yet developmentally immature. Thus the hominid's response to upright walking was a nearly boneless but well-padded fetus capable of squeezing through a birth canal that a skeletally more mature infant of similar size would indeed find too small.

Utilizing this understanding of neotony and its relationship to adaptive reproductive strategies, the evidence presented by paleoanthropology can, perhaps, provide an explanation of the emergence of culture, characterized by the elaboration of social complexity, tool use and language. This can be done by demonstrating an interdependence between retarded development and a capacity for language, between hominid population expansion and the emergence of culture.

*Neotony: The Relationship Between Neural Functioning and Neural Structure*

Retarded development carried with it a set of potential consequences: enlarged body size and the retention of juvenile proportions in the adult. Features which developed early in ontogeny, such as the brain, express neotony by maintaining rapid fetal rates of growth longer, resulting in larger brain mass, and retain long past birth the more rapid rate of growth compared to the rest of the body. In most mammals, neural growth stops at or soon after birth (Gould, 1977, p. 365). The retention of juvenile growth tendencies and the cessation of growth prior to the full appearance of adult sexual dimorphic characteristics results in the loss of specialization that usually emerges late in ontogeny, such as a muzzle, facial hair and enlarged canines. Stages of rapid growth are prolonged and affect different parts of the body in a sequence that lasts from conception through birth until young adulthood. In each component of the brain, the phase during which cell division and subsequent migration occur predicts the potential increase in neurons or hypermorphy of that component, rather than any crude increase in mass (cf. Abbie, 1958; Adolf, 1970; Gould, 1977, pp. 365-366). Areas of the brain which derive from cells that undergo cell division last will enjoy the greatest hypermorphy and the most noticeable period of neural plasticity (Gould, 1977; Jacobson, 1974, 1979; Lund, 1978). Thus, in comparison to other primates of comparable size some parts of the brain (i.e., the neocortex) are vastly enlarged, while other parts (i.e., the thalamus) remain roughly the same size (Gould, 1977, p. 371).

All primates prolong brain growth into the early stages of postnatal ontogeny. "*Macaca mulata* achieves 65 percent of final cranial capacity by birth, chimpanzees 40.5 percent, and humans only 23 percent" (Gould, 1977, p. 371-372). Leutenegger (1972) estimated the range of *Australopithecus africanus* cranial capacity at birth at 24.9 to 36.9 percent, again assuming the intermediate degree of retardation so common in the interpretations of hominid fossils. Chimpanzees and gorillas reach 70 percent of final capacity early in the first year, while we attain 70 percent early in our third year and 100 percent only after ten years.

The marked postnatal increase in size of the human brain involves no further genesis of neurons, but results from proliferation of glial cells associated with the growth of dendrites and axons in the neocortex (cf. Jerison as cited by Gould, 1977, p. 371n). This postnatal proliferation of connecting fibers pushes the neural cells apart and accounts for at least 75 percent of human cranial volume. This probably represents the major portion of the encephalization which characterizes human evolution.

Because earlier phases of growth proceed more rapidly than later phases, and since increases in cell numbers occur in these early phases, it is possible that the evolutionary increases in brain mass (in numbers of neurons) might have occurred prior to marked encephalization. Thus, it may be argued that a

significant shift in brain-body proportion occurred at the same time as bipedalism and the Australopithecine radiation (despite the fact that major increases in brain volume occur later). Post-Australopithecine encephalization could be considered a function of a continuing trend toward hypermorphism which accompanied the prolongation of postnatal skeletal growth and the proliferation of cortical dendritic branching. However it is the length of the postnatal phase of dendritic proliferation that is most significant for the human capacity to learn—not the increase in the number of cells.

In the human neonate, 90 percent of the cells in the cortex are still immature and without connections to other cells. Animal experiments suggest that these immature cells may still be capable of organizing or reorganizing themselves in response to traumatic injury and/or changes in the functioning of the neonate for a period of time after birth. Lenneberg's (1967) work on traumatic aphasias in children suggests that this phase of major neocortical plasticity lasts three years. A phase of much more limited plasticity exists up to ten years; plasticity becomes negligible, at least in response to major cortical trauma, after fourteen years of age.

Jacobson (1969, 1974) also hypothesizes the delay in neurological development as the basis for a prolonged period of neural plasticity. During their ontogeny, individual neurons develop highly specific synaptic connections. In an early stage of their growth, these connections are modifiable; this flexible period occurs at varying times for different types of neurons. There is evidence of a progressive reduction of the capacity to form new neuronal connections and to modify existing ones, so that those which are generated late in ontogeny and those which mature slowly have the greatest degree of modifiability in the animal. Jacobson feels that human development is so strongly retarded that even adults retain sufficient flexibility to learn new patterns of behavior. According to this theory, "the modifiability of neuronal connections in the adult is regarded as continuation of developmental processes that are much more pronounced in embryos" (Jacobson, 1969, p. 547).

The pattern of the dendritic network may ultimately set the specialized functioning of the cells as seen in memory, as well as spatial orientation and other aspects of perception and cognition, including the complex interconnections among perception, memory, motor control of vocalizing and other areas involved in language production. Lund (1978) suggests that at least some of the specialization of neurons may be the result of the "entraining" of dendritic and axon connections where patterns of early functioning determine the final configuration of these connections.

Lund suggested two possible ways whereby function would determine the structure of dendritic connections: active input might stimulate the formation of synapses, while relatively fewer synapses would be formed by the inactive input. The other possibility was that some synapses are pruned or lost during development and that the less active synapses are particularly susceptible to

permanent loss.

Dendritic growth connecting cortical cells to each other and to other areas of the brain proliferate, perhaps with little pre-determined specificity, over approximately the first ten years of childhood. In this period patterns of human cortical neural connections, which are specifically geared to our mental activities (e.g., language and thought), have ample time to be structured. The prolific growth of dendrites which accompanies early learning may be pruned to emphasize the active patterns. This negative structuring (repression of inactive new and old connections) continues throughout human development, giving us a flexible cortical structure which is different, and which functions differently, at different stages of life.

Lund (1978, p. 283) states that there is a "a fundamental mechanism which is important for the development of all parts of the nervous system, although possibly more critical to some than others." He postulates that there is insufficient genetic material to program the nervous system to a level of optimum functioning, especially since safeguards have to be incorporated that can handle problems of development, temporary disturbances of metabolism and local cell death which might accompany them. While a genetic program might lay down the basic organization of the nervous system, some degree of secondary regulation would be necessary to correct for developmental misalignments and incongruities between the component parts. "Since the primary requirement is that the system functions, the best control is the function itself" (Lund, 1978, p. 284). A similar mechanism might operate to adjust an animal's response to its environment or social context.

Thus, a period of neural plasticity allows the individual's participation in patterns of interaction to generate and restructure synaptic connections. A neurological structure of synaptic connections patterned by the participation of the infant in social activity would facilitate the elaboration of social interaction and stimulate the elaboration of neural structure itself in the individual's subsequent development. Lund concludes,

The basic biological need for functional modulation of brain organization may stem from a requirement to align a crudely made system so that it functions satisfactorily. It may depend on quite a simple pattern of events requiring that active inputs be 'facilitated' and inactive ones be 'suppressed' either by virtue of the relative numbers of synapses they make or by physiological mechanisms. (1978, p. 284)

In human development, where dendrogenesis goes on for such a prolonged period, the stimulation of dendritic branching by activity and the pruning of inactive connections could have a powerful effect on variability in cortical structure. The structure of the multiplicity of connections between cells would be related to patterns of functioning during normal growth (Greenough, 1984; Hall, 1985). If dendrogenesis is responsive to the milieu in which the organism functions after birth, then patterns of social interaction would also order



connections between neurons. When neural plasticity is prolonged after birth and takes place in a context of complex symbolic social interaction, this mechanism takes on evolutionary—if not revolutionary—importance.

Complexity of cognition would then proceed from the proliferation of inter-neural connections more than from the increases in cells (Jacobson, 1974). An increased capacity to learn would be proportionate to the prolongation of dendrogenesis after birth. Language development would be inhibited in apes by: the greater maturity (and, thus, lack of plasticity) of the ape brain at birth; a limitation in the variety of interactions that can go on between the adult and its more quickly maturing offspring; and the stability of the small social groupings of apes which lack the social complexity prerequisite for language. Our present understanding of the great ape's capacity for categorizing and deriving logical relationships (cf. Savage and Rumbaugh, 1977, 1980) suggests that the transition from an ape to a human capacity for language is biologically quite small—perhaps only a regulatory change in the rate of neural development. Differences between hominids and related apes would arise from a combination of the different profiles of neural development and the consequent differences in social functioning. The uniquely retarded human developmental profile may have emerged quite early in hominid evolution during the dramatic shifts from forest to savannah, from arboreal to ground living.

### *The Consequence of Neotony for Language*

I have suggested that the hominid capacity for language is the product of a cortical structure which emerges with and responds to the infant's participation in patterns of meaningful interaction. Cortical neurons specialize, and cortical structure is completed, during a critical period of growth as the juvenile hesitantly participates in activities ultimately under the control of a mature neural organization. The infant participates in increasingly elaborate stages of behavioral and cortical feedback in which each stage is predicated on the assimilation, accommodation and differentiation of earlier patterns of interaction (Piaget, 1963, 1971). Piaget's scheme of cognitive development works quite well here:

... One can conceive of intelligence as the development of an assimilatory activity whose functional laws are laid down as early as organic life and whose successive structures serving it as organs are elaborated by interaction between itself and the external environment. Such a solution... does not place the accent on experience alone but on the subject's activity making this experience possible... [I]t does not consider intelligence as being ready made and given from the very beginning: Intelligence elaborates itself and only its functional laws are involved in organic organization and assimilation... [I]t presents... the idea of a structuring activity, without preformed structures, which engenders the organs of intelligence in proportion to the functioning in contact with experience. Finally, ... it limits the role of chance in groping in [sic] behalf of the idea of directed searching, this direction being explained by the continuity of the assimilatory activity, of the reflex organization and of the elaboration of the most elementary habits to that of the most complex structures of deductive intelligence. But this continuity does not amount to reducing the higher to the lower nor to effecting the inverse reduction; it consists in a gradual construction of organs obeying the same functional laws. (Piaget, 1963, p. 359)

In the hypothesis outlined above, each stage of functioning would establish specialized systems of dendritic connections within the cortical areas then actively undergoing dendrogenesis. The functioning of the infant structures and/or restructures the neural foundation laid by the previous stage of development, and so forth. Social functioning and specialization of cortical structure would exist in human development as an open feedback system. Such a relationship between functioning and cortical structure would be capable of creating more flexibility and variability in patterns of human behavior than those found in any other mammal.

The question of the relation of functioning to structure is extremely important. Lenneberg (1967) attempted to establish a dynamic relationship between function and brain structure. However, he did not consider the possibility that the kind of structure attained during this process might be determined by the kinds of things the infant did while developing. An infant's participation in a pattern of interaction and vocal communication could structure a network of neural connections specialized for acting within and communicating about these very patterns in which it is enmeshed. Thus, the peculiarities of human behavior must be largely explained by exploring changes in social context rather than changes in neocortical structure.

Chomsky argued that the child acquired language, particularly the structure-dependent rules which govern the ordering of phrases, with relatively slight exposure and specific training. He felt the task of learning such a complex system was too difficult for a child without an *a priori* structure for such rules:

... The grammar that is internalized by every normal human can be described as a theory of his language, a theory of a highly intricate and abstract form that determines, ultimately, a connection between sound and meaning by generating structural descriptions of sentences. . . . each with its phonetic, semantic, and syntactic aspects. From this point of view, one can describe the child's acquisition of knowledge of language as a kind of theory of construction. Presented with highly restricted data, he constructs a theory of the language of which this data is a sample (and, in fact, a highly degenerate sample, in the sense that much of it must be excluded as irrelevant and incorrect—thus the child learns rules of grammar that identify much of what he has heard as illformed, inaccurate, and inappropriate). . . . Furthermore, the task of constructing this system is carried out in a remarkably similar way by all normal language learners, despite wide differences in experience and ability. . . .

... I think it reasonable to postulate that the principles of general linguistics regarding the nature of rules, their organization, the principles by which they function, the kinds of representations to which they apply and which they form, all constitute part of the innate condition that "puts a limit on admissible hypotheses." If this suggestion is correct, then there is no more point asking how these principles are learned than there is in asking how a child learns to breathe, or, for that matter, to have two arms. Rather, the theory of learning should try to characterize the particular strategies that a child uses to determine that the language he is facing is one, rather than another, of the "admissible languages." When the principles just alluded to are made precise, they constitute an empirical assumption about the innate basis for the acquisition of knowledge, an assumption that can be tested in a variety of ways. (Chomsky, 1972, pp. 170-171)

Piaget specifically denies the necessity of innateness for Chomsky's assumption of *a priori* intellectual structures.

According to Chomsky, logic is not derived from language, but language is based on a kernel of reason. Transformational grammars, in whose development Chomsky played a leading role, seem to me to be of great interest and to show very clear similarities to the operations of intelligence that have been discussed. Chomsky goes so far as to say that the kernel of reason on which the grammar of language is constructed is innate, that it is not constructed through the actions of the infant as I have described but is hereditary and innate. I think that this hypothesis is unnecessary, to say the least. In point of fact, it is very striking that language does not appear in children until the sensory-motor intelligence is more or less achieved. I agree that the structures that are available to a child at the age of fourteen or sixteen months are the intellectual basis upon which language can develop, but I deny that these structures are innate. I think that we have been able to see that they are the result of development. Hence the hypothesis that they are innate is, as I have said, unnecessary. The main thing that I should like to emphasize in Chomsky's position is that he has reversed the classical view that logic is derived from language by maintaining that language is based on intellectual structures. (Piaget, 1971, pp. 47-48)

Bruner's studies in cognitive development demonstrated that many of the relationships expressed in grammatical constructions developed prelinguistically in nonverbal interaction between children and their parents. It is only after a distinction has been mastered in action that it appears in initial language (Bruner, 1974-1975, 1975; Ratner and Bruner, 1978).

The initial structure of language and, indeed, the universal structure of its syntax are extensions of the structure of action. Syntax is not arbitrary; its cases mirror the requirements of signaling about action and representing action. (Bruner, 1981, p. 50)

Finally, Slobin's (1979) synthesis of developmental psycho-linguistics supports an initial development of language following (and not leading) the child's development of skill in action and thought.

The structural rules of language, then, might be built into a child's brain through its participation in the characteristic content, rhythm and repetition of the pattern of human parent-infant care, group activities and communicative exchanges. A child's syntax would change as its experience became more differentiated and complex. Both the child's and the adult's activity, his or her language, thought and systematic actions, would, then, reflect a specialized neural structure, as Chomsky postulated. This neural structure is not innate; it is generated and fine-tuned in some significant part by participation in and elaboration of increasingly complex patterns of interaction as described by Piaget, Bruner and others (Changeux, 1980).

The assumption of an innate basis for the acquisition of language and knowledge suggests that the mind in its working reflects the structure of the brain.

I have tried to suggest that the study of language may very well, as was traditionally supposed, provide a remarkably favorable perspective for the study of human mental processes. The creative aspect of language use, when investigated with care and respect for

the facts, shows that current notions of habit and generalization, as determinants of behavior or knowledge, are quite inadequate. The abstractness of linguistic structure reinforces this conclusion, and it suggests further that in both perception and learning the mind plays an active role in determining the character of the acquired knowledge. (Chomsky, 1972, p. 99)

The structure of the activities of the mind reflects the structure of the brain because the experience of the individual in an ordered social environment has influenced the generation of both structures. Still, it is necessary to address the question of the possible universality of a deep structure underlying language. Berger (1969) argues that such universality emerges out of "the nature of man's being in the world." There is a commonality of experience generated by the singular developmental profile of the human infant in a social setting which may underlie the universal aspects of language and other elements of culture (cf. Butterworth, Comrie and Dahl, 1984).

### *The Special Quality of Sound*

Sound probably dominated hominid communication as a result of the prolonged and profound physical helplessness of the infant. The implications of the special qualities of sound as a medium of communication are rarely explored as one of the foundations of language.

Sound patterns are heard and produced simultaneously by an individual in communicative interaction with others. This pattern of feedback is different from any other communicative medium; sounds are heard simultaneously by speaker and audience. The nature of speech combines three interdependent activities: the intent governing the speech act; the response of the audience; and the response of the speaker as a self-auditor, comparing what was said with what was intended.

The multiplicity of contextual meaning which differentiates language from animal communication is predicated on the externalization of vocal communicative exchange. Sound patterns are experienced as existing outside the speaker—that is, heard—whether they are produced by the speaker or by some other member of the interchange. With verbal communication, simultaneous interpretations by both the speaker and the audience enrich the meaning of what has been said. Sounds have multiple contextual meanings in acts of communication from their first utterance because of the speaker's unique position of simultaneously auditing his or her own speech and observing audience response. Non-vocal systems of communication do not allow the animal to receive its own signal in conjunction with the response of others (olfactory signals may be an exception).

As interaction (of which vocal communicating is an integral part) comes to be the dominant subject of communication, a system—language—is created, which is simultaneously about itself and about the social action of which it is a part. This generates a communication with dual references: to distinctions

within the system of language itself, and to differentiations in the flow of social activities in which the utterance is employed. Both the multiplicity of contextual meanings and the duality of reference are definitive characteristics of language symbols. Thus the nature of sound is fundamental to the emergence of language as we know it.

### *Population Dispersal and the Emergence of Culture*

A huge literature attests to the strong interdependence between population increase and increasing socio-cultural complexity. Interpretations usually point to technological innovation, including innovations in role or task specialization, as the impetus for population growth.

However, significant arguments have been made for the opposite view. Rindos (1984) argued that population growth was the major stimulus for shifts from foraging to agricultural technologies and from simple technologies (such as swidden or slash and burn) to labor-intensive methods (such as crop rotation and fertilization). Boserup (1965) argued that decreases in population led to loss of technological advances; for example, early European settlers in South America stopped using the plow and turned to simple slash and burn agricultural technologies. Certainly the potential for hominid population growth, as outlined earlier, generates an instability, a pressure for adjustment—by dispersal, natural disaster, social disaster and/or social and technological innovation.

Rindos' model suggested that the pressure of population growth stimulated either dispersal or more intensive exploitation of available resources by technical innovations, which require additional time and energy. These techniques, which emerge from an extant general pool of knowledge about the ecology, include the use of hitherto untapped, hard-to-get-at resources and manipulation of the environment to increase the area and/or yield of favorite resources. The population expansion of the early hominids could very well have been the impetus for cultural innovation rather than, as has been assumed, the result of the invention of new technology.

The earliest traces of hominids are found with other savannah fauna dating to a time when many forest apes became extinct as the savannah expanded into areas that had been rain forests. Initially, dispersal seems to have gone on within a wooded parkland environment from East to South Africa; subsequently, hominids appear to have also exploited the more strictly savannah environment of both sub-Saharan areas. The earliest tools are found in sites from this second radiation, along with a strongly savannah-affiliated fauna (Vrba, 1984). Early tools used for digging, crushing and grinding appear to be concomitant with the hominid radiation in the savannah, where roots, seeds and nuts (less accessible foods than forest fruit and soft greens) were the staple food during a substantial dry season. In fact, chimpanzees have been observed to use both stone and wood tools to crack panda nuts (Schwartz, 1984, p. 592); whereas no

use of tools has been observed among chimpanzees for the purpose of hunting or sharing small game. The tools associated with these early sites do not appear to be the production of an intelligence significantly advanced over that of modern pongids (Wynn, 1981, pp. 539-540).

Hominid dispersal continued to maintain apparently stable population densities up to the Middle Pleistocene, about one half million years ago. At this time all the grasslands and woodlands of the temperate and tropical eastern hemisphere gave evidence of hominid occupation. Some technological innovation accompanied this dispersal: hunting of larger game became systematic, and stone tools showed more regular proportions and apparently were used to butcher game animals (Wynn, 1981). This elaboration of tools for the preparation of meat as well as vegetable foods may be seen as a response to population expansion, increased variability in seasonal availability and the consequent intensification of environmental exploitation.

From the Middle Pleistocene on, hominids experienced rapid growth in population densities and increased in cultural complexity and regional variation. This period is also marked by the appearance of early forms of *Homo sapiens*, physically very similar to modern human beings. Insofar as hominid adaptability loosened biological restraints and enabled hominids to cope with ecological diversity and natural disaster, cultural innovations, including language and technology, were used to cope with social success.

### Conclusion

If we accept neotony as the mechanism laying the biological foundations for acquisition of human language, then we must look at the changes in, and elaboration of, the social order for the emergence of language in human evolution. The prolonged helplessness and neurological plasticity of the infant, the multiplicity of dependent offspring, and the potentially larger groups and populations which result from closer birth spacing must have enormously complicated hominid social organization. Immobilization of the female with young, pair-bonding, food-sharing, increased division of labor and greater attention to the socialization of the young have been mentioned as associated with bipedalism and fetalization of the infant (Gould, 1977; Johanson and Edey, 1981; Lovejoy, 1981, 1984).

Perhaps as important as these factors is the melting away of biological restraints, or natural boundaries, for these adaptable hominid populations. Stability and order must at some point become more self-imposed than in other mammals. The shift in social complexity which makes language necessary requires that we focus on the function of language in human society. Focusing attention on the role of language in the differentiation and elaboration of social space and interaction, rather than upon the naming or signaling of classes of objects, allows us to look for the social context which might generate language.

If language is the symbolic system through which a meaningful order, the human "world" or "reality," is constructed, shared and objectified, then it is out of the pattern of this complexity that language must emerge (Berger, 1969, p. 20). Given a biological capacity, language would emerge as a symbolic system as soon as communication focused on social events and differentiated intangible patterns of social activity.

The increased helplessness of the infant, and the appearance of a second and perhaps a third infant prior to the maturation of the first, made major new demands on the group for feeding, protecting and socializing these new members. Greater group size and greater intra-group contact required greater schematization of patterns of interaction. Classification of roles and differentiation of the flow of events became necessary in order to avoid confusion in social exchanges with strangers.

Evidence exists that some developmental retardation existed among the earliest hominids (Johanson and Edey, 1981; Lewin, 1985; Mann, 1975; McKinley, 1971). The archaeological evidence for the presence of symbolic systems and the elaborate specialization of tools and living space were first found in Middle Pleistocene sites. Most paleoanthropologists suggest that such cultural complexity and language developed together. If the presence of neotony attests to a capacity for language, why does the archaeological evidence suggest that language, itself, probably did not emerge until 200 to 300 thousand years ago? If language is interdependent with growing social complexity, then it would not emerge until group size and population reached a critical density and complexity.

Under conditions imposed by an increased population, interactions could not be habituated by daily repetition; some form of categorization of social experience became imperative. Strengthening of social relationships between mother and infant, the child and its siblings and father, and the complexity of group interactions—an outgrowth of the lengthened infancy and childhood—increased the possibility of generating and naming a shared interpretation of the meaning of the social experience within the group.

As significant intangible social categories, patterns of sharing and socialization, were elaborated in inter- and intra-group activities, they (by the nature of their importance for the regulation of individual and group well-being) became the focus of language. Thus language functioned to schematize and classify this complex symbolic order.

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