TENSIVE COURSE IN BIOLOGICAL ANTHROPOLOGY
1st Summer School of the European Anthropological Association
16–30 June, 2007, Prague, Czech Republic

EAA Summer School eBook 1: 43-46

THE HOMINIZATION PROCESS OF HOMO SAPIENS

Ajeet Jaiswal
University of Delhi, Delhi, India

The Hominization process consists of evolutionary transformation of hominoids into Hominids. It is a process that has occurred in the hominoid-line since its divergence from the last common hominoid ancestor shared with any living ape. Initially the term has a restricted meaning and implied emergence of modern man, different from all other forms. Currently, however, the term is broadened and includes all those aspects of structural and behavioral changes that occurred in the Hominid line finally leading to man.

All such changes can be broadly grouped into following heads.

1. Bipedalism
2. Hand manipulation and tool use (manual dexterity)
3. Modification of jaw and teeth.
4. Enlargement of brain
5. Changes in vocal tracts, language and speech

Bipedalism

Analysis of postcranial elements of A. *africanus,* A. *afarensis,* A. *ramidus* (Tim et al. 1994) and A*. anamensis* (Leakey et al. 1995) clearly establishes bipedalism to be one of the oldest of all hominid characteristics. The age of most primitive australopithecines. A. *ramidus* is estimated to be 4.4 mya, perhaps one million years after separation of ancestral lines leading to great apes and man. The branch point between ape and human accestors is estimated to be 5-6 mya. According to Stanford (1995). A. ramidus was a biped, its lower body was clearly adapted for walking on the ground, though they may have continued to use trees for gathering fruits and for shelter at night. Postcranial elements of A. *afarensis* is well documented. The kind of limb and pelvis show many bipedal adaptations. illiac blades were short and broad, ischium was short, anatomy of hand and ankle joints were favourable, big toe was parallel. In all such features afarensis was more human like than ape like.

In addition to post cranial elements, the Laetoli (Tanzania) foot prints of A.afarensis*, austratopithecine* to have existed around 3.77 mya, is another proof of bipedalism. It shows a convergent big toe, heel strikes, arches etc similar to humans in many aspects.

There are, however, certain features possessed by afarensis such as shorter hind limbs, longer foot, longer toes etc. which suggest that australopithecine blpedalism was different from, and costlier than human blpedalism.

Such differences in the locomotor behaviour can be explained due to the habitat supposed to have existed in eastern Africa-woodland, bushland and dry savannah with patches of forest along rivers and lakes. Thus they had to live somewhat less on the tree and more on the ground.

Hand anatomy and tool use

The earliest evidences of hand manipulations different from apes and sufficiently similar to Homo can be found in A. *afarensis* approximately to human proportions but differ from those of humans in having fingers more curved suggesting greater power grip. A precision grip greater than chimpanzee but lesser that the Homo is suggested. A. *afarensis* was spending more time on the land than on the trees hence hand-anatomy had started foreshadowing the characteristics of hands of Homo and different from those of apes. Hominids with their manipulative hands, precision grip and contemplating brains, had been able to expand their ecological niche so far beyond the physical capabilities inherent in their makeup, one that no other animal has ever had the potential to achieve.

The classical view of anthropologists has been that the use of tools led to the distinction between human and ape-that the split between the pongidae and the hominidae resulted from the acquisition of tool-use by one of the ancestral hominoid populations. Others now feel that environmental influence and adaptation to nonarboreal ecological niches were more important for early hominid evolution. However these divergent views are ultimately resolved, it is interesting to learn how far back human technology and culture can be traced.

Recent paleoanthropological findings is that the use of tools, antedates the origin of the big-brained *Homo sapiens* by at least a million and a half year. There is now indisputable evidence of the occurrence of modifies stone tools 2 million years old found in association with the bones of *Homo habilis.* In other words, tool-use and tool-making developed before hominid brain capacity had undergone remarkable increase. The old idea that a large brain and associated high intelligence were prerequisites for tool use is no longer tenable. The use of tools by primitive hominids may, in fact, have been a major factor in the evolution of the cerebral cortex and higher intelligence, for once the use and making of tools began to favour survival, there would be high selection pressure for neural mechanism promoting improved crafting and use of tools. The elaborate brain of *Homo sapiens* may be a consequence of culture as much as its cause. Hominization process, with respect to cultural attainments, had set in much before the modern man appeared on the earth. Oldwan industry of earliest *Homo habilis* clearly proves the point.

Homo erectus had not only perfected stone tools considerably but had also learned how to control and use fire, as revealed by radioisotope dated hearths in caves, With fire humans could cook their food they could keep themselves warm in cold weather; they could ward off predators and they could light up the dark to see. The hearth no doubt promoted the development of social organization and allowed an opportunity for the beginning of communication through spoken language.

Neanderthal people practiced ritual burial in Europe and the Near East at least 60,000 years ago, suggesting that religious beliefs had developed by that time. By 40,000 years ago or a little later, Cro-Magnon people began constructing their own dwellings and were living in communities. The domestication of animals and plants, development of agriculture and the dawn of civilization followed in relatively quicker that characterize modern humans. The cultural attainments in terms of tool making and tool use that characterizes modern humans had thus set in at least 2 mya for which there exist sufficient proof in archaeology since the time of Homo habilis.

Modification of jaws and teeth

Apes are characterized by larger, thick enameled teeth large jaw and jaw muscles, large canines, high cuspid molars and a higher ratio of cheek teeth area to body weight of Australopithecines, Paranthropines and habilines differed from apes in some features. A. *ramidus* had teeth which resembled those of Homo in some features. They were smaller with thin enamel and canine were smaller. The dentition in general resembled to those of Chimpanzee in some aspects. Similarly, A*. afarensis* dentition had some ape like and some Homo features. The incisors were chimpanzee like but canines were low crowned and incisors like *A. africanus* had dentition similar to those to afrensis except that the cheek teeth were slightly bigger. In *Paranthropus*, front teeth were smaller than those of afarensis and africanus but cheek teeth, jaw and jaw muscles were more massive in them. In Homo habilis, teeth were more or less similar to those of *A. afarensis.*

Dental variation among these hominids are peculiar. There is gradual reduction in the sizes of the front teeth, where as there is gradual increase in the sizes of cheek teeth in case of *Paranthropus*.

Such variation in hominid dentition is explained by the climatic changes that occured around 2.5 mya, opening up more and more savanna. It is hypothesized that species composition of both plants and animals changed and Paranthropus had to survive on low quality food which required prolonged mastication. Larger teeth, jaw and jaw muscles in Paranthropus developed due to such responses.

Around 2 to 2.5 mya, originated *H. habilis* which is clearly associated with tools. These forms, however, do not show enlarged cheek teeth, jaw and jas muscles. It is supposed that habilines ‘prepared” their food outside mouth, hence larger cheek teeth, heavy jaw is absent in them. The enamel is also not as thick as in the Paranthropines.

To conclude, Paranthropines, while displaying a hominid pattern in general, have larger cheek teeth because of ecological reasons. With the advent of tools, the teeth were put to different selection pressure and hence *H. habilis* has smaller cheek teeth in comparison to Paranthropines. Gradually there is reduction in the cusp height of the teeth, a prominent feature of the apes. The ratio between cheek teeth area to body weight was high in Paranthropine where as it is constant for later hominids. Hominization process in dental morphology thus consisted of reduction in sizes of teeth, jaw and jaw muscles, reduction in cusp height of teeth, and constant cheek teeth area. These features are seen to begin with in australopithecines and *H. habilis.*

Enlargement of Brain

Earlier Palaeoanthropologists believed that evolution of human brain occurred after bipedalism and changes in the dentition were complete. Recent endocranial cast or endocast studies indicate that encephalisation process progressed along with other changes that characterize Hominids. In the latter stages of hominid evolution, the brain evolution consisted more of relative growth of brain and body size i.e. allometric growth rather than simple reorganization

Endocast studies of Homo habilis clearly indicate that its brain volume is significantly greater that those of australopithecines. Body weight of these hominids have been estimated from fossils and the encephalisation quotient determined by computing brain sizes relative to their body sizes. These data show that absolute and relative brain sizes increased during hominid evolution. Furthermore, the increase is not gradual. The period between 4 to 2 mya show insignificant change in brain volume as *afarensis* and *africanus* showed a brain volume below 450cc whereas those of *H. habilis* between 2 to 1.5 mya in the range of 650-700cc. The Hominization process that involved evolution of hominid brain can be said to have resulted during this period, between 2 to 1.5mya.

Speech and Language

Speech. The speech apparatus of humans consists of two physiological components: the subglottal system that includes lungs and associated muscles which provide the power for speech production, the larynx which communicates the subglottal system to upper supralaryngeal tracts itself which modulates acoustic energy generated by first two system.

The human supralaryngeal airways differs from that of other primates. In human beings the palate has moved backward and larynx downward to achieve unique constructions of supralaryngeal airway different from other primates. Moreover, the round human tongue moving in space defined by the palate and spinal column can generate frequency patterns that define vowels and consonants.

The area of brain specialized for language and speech are in the region surrounding the sylvian fissure of left hemisphere. This area contains the cortical centres for auditory perception and motor control of face, mouth and larynx for speech production. These motor area for speech and areas for sound perception are closely located to the language areas, the Broca's area (immediately in front of motor area) and Wernicke's area (immediately behind and to the side of the auditory area).

The structures and neural control mechanism necessary for the complex patterns of human speech seem to have evolved during the last 1.8 mya. The comparative anatomy of the living primates and hominid fossils suggest that evolution of supralaryngeal vocal tract probably started in early African populations of *H. erectus* (Liebeman, 1992). However the hominization process took sometime to complete. There is definite proof that hominids from the Israeli sites of Skhul and Quafzeh had definite human supralaryngeal airways, Neardertals, the non hominid supralaryngeal airways. Endocast studies of such forms indicate that their neural mechanisms had not appropriately developed, whereas those of from Skhul and Quafzeh were capable of producing human speech.

Language. Language is an adaptation unique to humans but its biological basis is very difficult to define. The American linguist Noam Chomsky has proposed that a unique "language organ" or language acquisition device (LDC) evolved within the human brain. Although there is no anatomical evidence for a new "organ" it is clear that there exist certain areas such as Broca's area and Wernicke's area for language.

Since language leaves no fossil record, the evidences for its origin are circumstantial. Comparative linguistics was used to estimate a date for a single common language. The recent approaches however have used anatomical and archaeological information to suggest a date of origin for language.

Anthropologists differ in the exact time of origin of languages. One group argues for a relatively recent origin and correlates it with the appearance of modern *Homo sapiens* with modern sized brains and fully descended vocal tracts. The tools and artistic culture that flourished in late Paleolithic coincides with development of language and communication. Another group traces origin of language to *Homo habilis* when first appearance of tools and beginning of enlargement of brain took place.

The two conditions have different consequences for the nature of mind. If origin of language is considered late linguistic changes in brain become secondary to the non linguistics changes, allowing only little to the languages to influences the structure of brain, if its origin is considered early, it is logical to think that it passed through multitude of forms and had major language on evolution of brain and vocal tract. The diverse language adaptation and its deep integration in human nature point to its ancient origin and it has been suggested that earliest language were singing, accompanied with gestures.

Acknowledgment
I would like to thank the following people and institution for their advice and support. The University of Delhi gave us permission to carry out this research and logistical support. We thank to the Head of the department and staff of the Department of Anthropology, University of Delhi, India: Prof. A.K. Kapoor, Prof, Satwanti Kapoor, Department of Anthropology, University of Delhi, Delhi, India. Without their help, this work would never have been completed. On this occasion, we would be like to deliver our gratitude to all the experts who have been playing an important role in the evaluation phase .Thank you very much.

References

Britanica 2005 – Software
Britanica 2006 – Software
Craig B. Stanford (1996),The Hunting Ecology of Wild Chimpanzees: Implications for the Evolutionary Ecology of Pliocene Hominids, *American Anthropologist*, Vol. 98, No. 1, 96-113
Leakey, M.G., Feibel, C.S., McDougall, I. & Walker, A. (1995). New four-million-year-old hominid species from Kanapoi and Allia Bay, Kenya. *Nature* 376, 565-571.
Lieberman, D. E. (1995) *Curr. Anthropol.* 36, 159-197.
Lieberman, Hampton, Littlefield & Hallead (1992) Race in Biology and Anthropology: A Study of College Texts and Professors,Journal of Research in Science Teaching 29,301-321.
White, T.D., Suwa, G & Asfaw, B. (1994). Australopithecus ramidus, a new species of early hominid from Aramis, Ethiopia. *Nature* 371, 306-312
www. Evolution.com
www.googles.com
www.hominization.co.in

Mailing address: Ajeet Jaiswal
University of Delhi
110007 Delhi, India
epgajeet@redifmail.com