Sebastià Serrano

Humanisation process and language

One of the star themes over the last few years has been the construction of the mind as the long-term product of brain activity, and the role played by language in this process. If we go back six million years, our direct ancestors would not have been very different from modern-day chimpanzees with regard to communication skills and social organisation.

Our distant ancestors set out on a path that was to involve irreversible biological changes linked to cognitive activity and behaviour. These changes involved incredible feedback processes, finally turning us into sapient beings —*Homo Sapiens*. We have termed this process humanisation and in order to reconstruct it we have often had to proceed blindly, given that there are so few traces remaining of the first three quarters of the story and the difficulty of interpreting what little we know.

The point of departure for this process was bipedal locomotion, driven by great changes in the ecosystems in which our ancestors lived. Our arboreal primate ancestors originally lived in densely wooded areas where they had access to abundant foliage and fruit. However, within several thousand generations, environmental changes forced them to live on the hostile savannah, where social relationships and ingenuity were to prove vital to their survival. By walking upright, our primate ancestors began biological changes that, combined with cognition and cultural changes, were to turn them into the only hominid species some thirty thousand years ago. It was the species to which we belong. Let us reflect on the possible consequences of these changes in the process of humanisation, in which language played a decisive role.

We know very little of the first third of hominids' six million years of evolution. What we do know is that they walked upright and that indications of changes —in comparison with chimpanzees— are to be found in fossilised jaw bones. Here, there are signs of a gradual reduction in the size of canine teeth, which would seem to indicate that ecological changes had an impact on the diet of the first *Ardipithecus* and later, *Australopithecus*.

However, we do not know what changes took place in their social organisation or their forms of communication. Nevertheless, there are many signs dating from 3-4 million years ago that *Australopithecus* had adapted very well to life on the savannah. We have almost complete skulls of *Australopithecus*, and while nothing of the soft tissues has been preserved, analysis of the endocranial slabs by Tobias and Holloway (among others) suggests a certain distinction between those areas of the brain that correspond to the Broca and Wernicke areas in *Homo Sapiens*. In our species, these areas are directly related to language and a certain degree of cerebral lateralisation.

What we can be certain about is that there was a continual reduction in the size of canine teeth, even though this was an unusual adaptation among primates. Most of the large primates have big multi-purpose canine teeth which serve to threaten and fight competitors and/or provide defence against predators. Thus, such teeth serve as both sword and shield yet much of the humanisation process involved shrinkage of a feature typifying the large primates The explanation for this is long and involved but some of the details are relevant to this discourse. One can also conjecture on whether the reduction in the size of canine teeth was related to other changes in the social life of the group, such as a lessening of competition and strife among males seeking access to females. However, it seems more likely that our ancestors' increasing use of their hands to perform tasks and to shape tools played a key role in the humanisation process. Indeed, resort to fists or even the use of the first wooden weapons may have played a part and one can even speculate on the use of hands to seal agreements, which in turn would require some kind of symbolic communication. Competition between *Australopithecus* males would have been particularly strong, if we consider the pronounced sexual dimorphism found in this species.

This leads us to interpret the reduction in canine teeth in relation to changes in diet rather than to changes in forms of competition and ways of fighting. Such an interpretation would be consistent with the development of increasingly robust, enamelled teeth suitable for crushing food. This represents an adaptation for chewing fibres or tougher food that required thorough mastication before it could be swallowed. In other words, large incisors and large molars are contradictory since such a combination hampers jaw movement. In contrast, chewing teeth and molars confer greater jaw mobility and enable the development of faces, which in turn permit facial expression. Such ability to express emotions facilitated the first non-verbal communication, and later verbal communication. Increasingly multi-purpose teeth, and a more mobile mouth (which in turn helped reconfigure the face) provided necessary (though possibly still insufficient) elements for making communication more symbolic. To this we can add indications (although they are no more than that) of increases in brain mass and brain reconfiguration, which would allow the transition to the Stone Age.

In this context, I should like to remark on changes in the physical configuration of both males and females (particularly the latter) that were to affect the deployment of various communication skills, ways of attracting the opposite sex, and the social order. These changes played an important role in the emergence of *Homo Sapiens*. One of these was the regression of hair and was linked to the use of sweat glands to cool the body. This development resulted in a smoother, more tactile skin and a more expressive body. Another change was the disappearance of female "heats", along with external signs of ovulation. This change would forever divide these females from those of other mammalian species (which to this day continue to make great display of their fertility as a sign of identity). Moreover, these female ancestors exhibited large pendulous breasts through most of their lives, regardless of their lactation periods. We believe these body changes were linked to biochemical changes facilitating communication and the emotions required by changes in the social order, which in turn required increasingly sophisticated communication systems.

The process of humanisation not only involved bipedal locomotion but also remodelling of the mandibular system and, to a certain extent, of the body in general. These changes facilitated an increase in the brain's size and complexity. In this last regard, no substantial changes are found before 2.5 m years B.C. Paleo-anthropological finds reveal brain casings exhibiting non-allometric growth —in other words, an increase in brain weight that is disproportional to changes in body weight. The increase in brain size was dramatic, rising by over 50% and producing brain sizes in the 600-800 cm^3 range. This should be compared with the brain of *Australopithecus*, which ranged between 400 cm3 and 500 cm^3. Moreover, the cave in which the later skulls and bones were found included well-crafted tools. This is why the new species was dubbed *Homo Habilis*. For the first time we can appreciate a technology —termed M1 or Olduvai by the experts— which involves a manufacturing process and uses requiring complex cognitive activity. The first finds were made at Olduvai Gorge and, a little later, at Hadar —almost next door to where the now famous "Lucy" lived almost a million years earlier. What happened in the aeons between Lucy and the appearance of the first specimens of Homo Habilis? How did this dramatic increase in brain size occur?

Perhaps part of the answer lies in the endocrine moulds taken from the skulls of *Homo Habilis*. It seems that the primary cerebral areas in the first Homo species remained the same with respect to *Australopithecus* and indeed chimpanzees, with possibly a very slight reduction in the primary visual area. By comparison, there was considerable growth in the pareto-frontal and pre-frontal lobes. This means that a kind of selection process operated on the neo-cortical expansion, particularly in those areas involving association, rather than simply an overall increase in brain size. We now know that associations underlie complex cognitive functions and the behaviour patterns to which they are related. Furthermore, the pre-frontal lobes are directly linked to memory of work —information retrieval depends on the context and the behaviour to be followed— and with executive functions such as planning, initiation or inhibition of communication activity, the ability to put things in sequence, mental flexibility, creativity and imagination. It is therefore hardly suprising that the pre-frontal lobes have been considered as the directing brain, the executive brain, indeed as the brain making civilisation possible.

At this juncture, the key question is what drove the rapid growth of the pre-frontal lobes and association areas of the brain that led to hominid evolution and the emergence of a new species —*Homo Habilis*. Our hypothesis links the development of the pre-frontal areas of the brain with the use of signs based on some kind of symbolic language. This would explain the dramatic non-allometric growth in those parts of the brain linked to planning, programming activities, attention, concentration, and learning. In this respect, it is highly likely that the expansion of the pre-frontal lobe was not the cause

Perfil i T (T and Profile),
Antoni Tàpies (2005)
paint on paper, 50 x 64 cm

of a proto-language but rather its consequence. This would have occurred in Lucy's kin or in the related *Australopithecus*, with cognitive abilities superior to those exhibited by modern chimpanzees. As a result, the species had passed a threshold into symbolism, thus beginning an incredible feedback process that led to growth in the pre-frontal lobe, which in turn facilitated better articulation, greater auditory discrimination, flexibility and sequencing. This would then have further driven growth of the pre-frontal lobe, the pareto-temporal areas and neighbouring limbic areas involved in making associations.

> "The new social order would have required a symbolic repertoire, which should be considered as a proto-language"

Earlier, we referred to the interaction of ecological, dietary, and social factors in producing the biological changes characterising the humanisation process. In no case is this interaction so clear-cut as that concerning the brain's enlargement. We know that hominids adapted to life on the savannah and that meat formed part of *Australopithecus'* diet. In the beginning, meat was probably just another foodstuff but, once its advantages became apparent, it is likely that they sought it at every opportunity. Meat not only provides a rich source of proteins and scarce minerals —including phosphorus, which is so important for brain functions— it also supplies a lot of calories. For example, 100 grams of meat provides 200 calories, while the same quantity of fruit only provides a little over 60 calories. A 100 grams of grass only provides between 10 and 20 calories. A large brain requires a calory-rich diet.

Accordingly, these hominids needed to devise strategies for finding meat, hence the need for altruism and mutual help that would have required pacts and compromises between males and females. Thus giving females and children access to meat would have helped the males guarantee perpetuation of their family line. All in all, such considerations would have produced a social structure constituting one of the first hominid societies, and which differed greatly from chimpanzee society. The new social order would have required a symbolic repertoire, which should be considered as a proto-language. The repertoire would have been very limited in the beginning and would have taken a great effort to learn. The slow expansion of this repertoire and the natural selection fostering this process would have tilted the balance in favour of brain growth in general, and growth of those areas linking biology and the emerging culture in particular.

The first tools that have been found date back 2.5 m years. They are a good example of how those hominids, which we label *Homo*, had occupied the ecological niche of meat-eaters. This must have happened quite some time after social negotiation of reproductive activities allowed the first family planning, changing the social order order in the process. This revolution is evidence of synergy between biological and social changes, which in turn helped create a new brain architecture that was increasingly dedicated to language functions. As a result, language developed from a limited, fairly inflexible repertoire to an increasingly powerful mental tool capable of representing the individual, the environment, and the world in general. Between 1.8 and 1.5 m years ago, the brain grew further, passing the 1,000 cm^3 barrier. This growth was entirely allometric, given that it accompanied a general increase in body size. The jawbone underwent considerable modification, and sexual dimorphism virtually disappeared. Man's tools became much more refined, making it reasonable to consider *Homo Ergaster*, who emerged 1.8 m years ago, as our real ancestor.

Around half a million years ago, there was a further increase in brain size, this time of a non-allometric nature. Once again, it affected the frontal lobes (i.e. the pre-frontal lobes and associated areas including neighboring limbic spaces). This development can be seen in *Homo Heidelbergensis*, of which the famous Skull 5 from Atapuerca (some 400,000 years old) is a good example. The brain is a modern one and what separates it from that of contemporary *Homo Sapiens* can probably be ascribed to culture. The pre-frontal brain had a plethora of connections and the synaptic area provided links to all the limbic zones. It is worth noting that the first increase in size of the pre-frontal lobes would have been linked to vocalisation and how this conveyed meaning. The process involved taming the voice —an essential prerequisite for weaving the rich tapestry of language. We believe that the vocalisations of primates (chimpanzees) are not controlled by the cerebral cortex but rather by older neural structures sited in the encephalic trunk and in the limbic system, and which are involved in expressing emotions.

This growth was also linked to a considerable increase in the limbic nuclei involved in creating pleasure sensations and friendly behaviour —amounting to an investment in sociability. The growth in the pre-frontal lobes was accompanied by increasing motivation, concentration, and learning. Meanwhile, the links between motor activity and memory became ever stronger. Throwing an object at a quarry required complex calculations to be made by the brain circuitry, which quite conceivably executed a common algorithm for this purpose and which permitted verbal communication. There are considerable parallels between the brain activity controlling the movements of hands, arms, the tongue and larynx. The last few years have seen hyoide bone finds at Atapuerca and Kebara. This anatomical element would have been necessary to fix the larynx in place and, together with the buccal cavity, satisfy all of the conditions needed to deploy language. Refinements in mental, social and emotional calculations facilitated the emergence of a syntax as a set of principles and procedures allowing organisation of lexical lists to form long chains of words that could be easily spoken and understood. It is even possible that this complete, elaborated language in use a quarter of a million years ago was a further selection factor in forging the final link in the chain —*Homo Sapiens* II

Sebastià Serrano is an essayist and a professor of General Linguistics at the University of Barcelona.