Chapter 2
The Evolution of the Human Brain

Any of us would be hard pressed to fully realize just how long a time span of six million years actually is. That is the approximate length of time it took for the *Homo sapiens* brain to develop once our ancestral line diverged from the line which developed into modern chimpanzees and other apes.

The narrative of our ancient heritage is a story of challenge, survival, and frequent early death over millions of years of hardship. The fossil record from which we get our data gives hints of only a minute portion of actual biological history and the interpretation of these remains is always open to question and change. Any specific fossil remain cannot reveal how many species existed before and after that particular find. Nonetheless there are discernable patterns that can be explored.

One pattern is the frequency of premature death especially of the young and of females who were significantly smaller than the males and also burdened with the care of the young.

Individuals who could not cooperate with their peers or made serious mistakes which caused them to be expelled from their groups were not rewarded by huge golden parachute clauses. Most frequently they were slashed and eaten by animals much bigger, much stronger, and much faster than they. The major protection for our predecessors was within the group and cooperation was at a premium.

Although it is a fascinating story, it is not a pleasant one and those who assume we have finally arrived at some everlasting plateau of perfection (or even some final adequacy) cannot justify such a whimsical belief by anything that our evolutionary past teaches us of the process. Our futures are still in question just as are all other animal forms on earth and evolution moves on even for us. It is reasonable to recognize that we have been in existence an infinitesimally brief period relative to our ancestors and that we could disappear just as quickly (Fig. 2.1).

Several attributes of our ancestors have taken the spotlight as though they were the prime movers in the development of our modern form, divorced from anything social. Considering the ratio of body weight to brain weight, the human brain is the largest in the animal kingdom. However, Richardson (1999: 17) warns that we make too much of this. Until recently, neuroscientists were remarkably vague about

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Fig. 2.1 An endangered Australopithecine infant. Photo used by permission. Sawer and Deak (2007)

the relationship between brain size and intelligence.[1] In order to grasp the complex nature of human thought we need to go beyond the depths of the individual

[1]Neuroscientists are currently confronted with difficulties at this point. Neuroism is still popular and MRIs are not without problems. Investigators often focus on a specific area with some delineated aspect of intelligence. This causes misinterpretations and the illusion that intelligence is the product of an individual brain alone, or some parts of it.

brain and seek the origins of human intelligence in external conditions of social life. Perhaps the climate-given necessity to move from the lush forest to the savannah was the major contributor to the conditions evoking a kind of practical intelligence and emotional control. Defense, hunting, and foraging became vastly more effective when based in an organized group. A collection of separate individuals with large brains and no cooperative skills were far more vulnerable (Richardson 1999: 178). The other social factor that is important in influencing the general intelligence of a species is group size, or the shear number of like individuals with whom an animal deals on a routine basis.

To make sense out of the development of the human brain we also need to look at other factors such as what the natural environment had to offer in terms of food and the tools and technologies of the animal that enabled it to survive and maintain its way of life. It was by the use of tools that our hominid ancestors began the slow process of forging a separation from the harsh and dangerous environment whose demands previously had sapped all the of the hominids' time and energy dictating the terms of their lives. The current consensus is that social intelligence came first and made tool production possible. Ultimately this is a story of human agency. A great deal of this agency had to do with the development of self-conscious control of our biological impulses, a process which is quintessentially social. The evolution of *Homo sapiens* brain is integrally tied to a pressing need to communicate which developed over millions of years into spoken language. Derek Bickerton (2009: 10–11) has moved us away from the traditional abstract notion of adaptation which has always been construed as an asymmetrical one-way street wherein the environment is separated from the organism and acts upon it in old dualistic terms. Bickerton's approach is more transactional. The environment does not just select from our random mutations as is suggested with Richard Dawkins' selfish genes. In Dawkins' picture our forefathers would have kept recombining their genes until some odd mutation made language possible for those who, for some unexplained reason, took advantage of the mutation while so many others did not. But it is unlikely that genes are the whole story of how language occurred. Recently it has come to our attention that at least one species of parrot has as much or more language potential as apes with whom we share so much genetic structure. Language development is certainly based on more than genes.

Organisms do not just adapt to an abstract, independent environment; they respond to their particular niche. This niche is often worked over thoroughly by the species that dwell in it. Sometimes the species substantially change the environment. Bickerton gives numerous examples of this, from beavers who flood valleys to worms that enrich the soil. The actions of these organisms on the environment will then select for new traits in those organisms which will enable them to modify their niche still further, setting up a constant feedback process between organism and environment (Bickerton 2009: 10–11).

We shall now turn to those of our forefathers who prepared the way for *Homo sapiens* and a crude spoken language which eventually produced human culture as our niche.

The *Homo Sapiens* Family Tree

Australopithecines. Our first forefathers were small, slender apelike creatures between three-and-a-half and four feet tall. Females were significantly smaller. Australopithecine's first fossils are dated about 4.4 million years ago, which only means that they existed at least by then and the same uncertainty surrounds their disappearance.

This hominid's pelvis and thighbone, as well as center of gravity imply that they walked up right and they had a brain capacity of about 450 cc which is only a little more than the 400 cc for the average ape and less than one-third the size of *Homo sapiens*. The most important feature they share with us is bipedalism and the fact that their brains were rounder than those of chimpanzees. The face was apelike. In the roughly 2 million years of their existence they branched into at least five different species only one of which, africanus with a brain size of 500 cc, is generally believed to have contributed directly to our hereditary line. There are reservations about this, but there is general agreement that Australopithecine was our earliest direct ancestor.

The fossil remains of Australopithecine africanus were discovered first in Kenya, in an area which was in a transitional stage of forests giving way slowly to the tall grasses of the African savanna. It was in this environmental context that is our earliest direct ancestor. The fossil remains of Australopithecine africanus eventually left the trees for life on the ground except when chased back sporadically by the big cats which dominated the area. Because of their massive jaws and teeth, Australopithecines were believed to be foragers who ate fibrous roots and/or tubers, seeds, and vegetation. According to Novembre et al. (2007), hominid saliva gets more useable calories out of the starchy tubers and vegetable foods than do tree – dwelling chimpanzees. Natural selection could have favored the genes responsible for this enzyme (amylase) for "grounded" hominids because this savanna diet is much more readily available than the ape's diet in the trees. Occasionally, some of these early hominids may have hunted small prey and broke open bones left by other animals with small pebbles from riverbeds. But they were definitely not efficient or frequent hunters even of small animals. Most likely they were scavengers who fed off the leftovers from lions and larger cats. They also used bones for digging their roots and fibers. Tool use was not that different from contemporary chimpanzees. Some have estimated the average life span to be 30 years but children and females were particularly vulnerable to the many larger carnivores. It was still not a safe environment. Being upright meant that some of them could wield clubs for protection and carry food and other objects in their hands.

Eventually they left the forest altogether for the savanna where their upright posture helped to see longer distances for scavenging food and watching for predators. Slowly hominid legs became longer and they developed arches in their feet allowing them to cover more ground than many of their four-legged cohabitants.

According to Massey (2002), Australopithecines carried with them the basic social organization of chimpanzees today with strong ties between babies and mothers which lasted after maturity. Between the adult males, however, ties were weak although they kept their relationships with their mothers. On the group level, ties with other communities were also weak even though female children transferred out joining other groups which kept some loose connections between communities.

Chimpanzee's kinship ties and autonomous relationships are expressed and supported by emotional bonds and mutual grooming while rank is established by threat displays (Massey 2002). Massey points out that grooming releases opiates in the brain which are rewarding and increases group cohesion. Since maximum cohesion means that everyone else must groom everyone, group size is limited by the time which can be spent on grooming. On the other hand, the larger the number of a primate's routine relationships, the more the pressure exists to manage these relationships and a premium is placed on the development of the kind of social intelligence needed for creating and maintaining alignments. Massey underlines the importance of social skills for an animal whose slight frame and size leaves him dependent on forming alliances and coalitions within the group in order to supervise his survival inside his society as well as outside of it.

Early Australopithecines lived in groups a little larger than modern chimps but this size increased with later hominid species. We shall see that the current structure of the human brain was built on this early social foundation. LeDoux (1996) points out that we have a brain which is largely emotional and that emotion is a part of our early sociality which leads to the capacity for anticipating what the other is about to do (Turner 2000a). LeDoux may have just as accurately said that we have a social brain bequeathed to us by these otherwise vulnerable ancestors. Without stone tools his only survival kit was his group. Turner's hypothesis, supported by Greenspan and Shanker (2004), is that most Australopithecine communication was emotional. But on the savanna, negative emotional outbreaks could disrupt the group as well as making noises that attract predators. This created adaptive pressure both for cortical control of emotion and for the so-called basic social emotions of sympathy, guilt, and shame which promote cohesiveness. Australopithecine brain increase was mostly in the neocortex which added an extra layer to the whole brain and made room for more neurons, the cells that make brains work. The actual lobes, or key areas of the brain, remained the same and were not a part of this expansion. Whatever social intelligence Australopithecine possessed did not spill over to tool use and hunting strategies. Communication was confined to physical gestures and vocalization.

In terms of culture or the lack thereof, it is safe to assume that Australopithecines, like modern chimps, paid attention largely to the here and now with faint conscious recognition of the past and very short-term future anticipations. This "episodic" existence characterized Australopithecine life for some 3.5 million years. Despite their long legs and ability to cover long distances, they never ventured outside of the ecological niche of the African savannahs. Recently it has been found that one Australopithecine species, Garhi, also made primitive tools. Nonetheless, in general the little hominids existed for a longtime living contemporaneously with *Homo habilis*, *Homo erectus,* and even Neanderthal.

Homo habilis. Homo habilis lived 2.4–1.5 million years ago. He made the first stone tools and for this reason is referred to as the "handy man." These tools were rocks sharpened on one side to make crude choppers and scrapers. They were not refined instruments and can hardly be recognized as tools. Since they are found in butchering sites, we can infer that *Homo habilis* was more of a scavenger than a hunter. Skeletons were more robust with an average male size of 100 lbs, but they were not much taller than their forefathers. Brain capacity averaged about 550 cc some 100 cc more than Australopithecine. This increased to 800 cc, toward the end of his existence. According to Massey (2000), group size, with its increased demands on social intelligence, increased to 70 or 80 individuals; this number pushed them beyond the 20% of the time available for grooming and interfered with getting on with the rest of life. The importance of emotion as a mechanism for group cohesion was increased once again, as was the need for social intelligence.

Homo habilis existed for 1 million years, but despite this initial advancement in stone choppers the species did not go on to create further refinements in efficiency in his lifetime. For an amazingly long period of time – almost a million years – they made these same tools with monotonous regularity and little change. They never ranged outside of Africa and we find no indication of language capacity. Culture must have remained episodic – confined to the moment with little concern for past or future. Aside from his first use of stone, he neither innovated nor explored.

Some paleoanthropologists think that *Homo habilis* was not that different physically from Australopithecine and could be better seen as a later Australopithecine or an early *Homo erectus* when they became mostly scavengers in the savannas. Brains stabilized during Australopithecine time because a diet of scavenged meat could barely keep up with a fruit enriched forest diet. The equalizer was bone marrow, an extremely efficient food source, which existed in abundance and had no other animal competing for it. Australopithecine Garhi's tools may not have been as sophisticated as those of habilis but they were sufficient to break bones and expose the marrow which could remain eatable for a long time. Bickerton says this set in motion a tripling of our ancestor's brains. He warns, however, against thinking that the increase in brain size caused language. For language, he says, "What you needed wasn't brains or even intelligence so much as the right kind of niche." (Bickerton 2009: 34). Brain size does not drive innovation – innovation drives increase in brain size. Bickerton is convinced that language started 2,000,000 years ago and developed slowly over long periods of time. This is in significant contrast to Chomsky's deterministic Big Bang Theory. His theory posits an explosion in language only 60,000 years ago supposedly caused by a monster genetic mutation.

The more current "high-end niche" theory begins with describing a number of characteristics of the niche that Australopithecines, or at least Garhis and *Homo habilis* inhabited. These species did not have the technology or language skill to be effective hunters but they thrived nonetheless on the meat of large carcasses killed either by other animals or less often by natural causes. The difficulty was that these prey were protected not only by size but also by very thick hides which teeth could not puncture or tear. The usual process of rendering the meat was to wait until the natural gases expanded and ruptured the body exposing raw flesh. The trouble was that by this time many other competitors were anxious to start their long awaited dinner. Many of these competitors were large and lethal. At first it was found that primitive stone flakes could cut through the thick hides with surprising efficiency but the problem remained that these brave scavengers were not alone. What they needed was numbers – numbers larger than their small bands. They had to find a way to recruit new members and convince them that it was in their own interest to join them in mounting an army which could hold the other would-be diners at bay with rocks and stones. This "recruitment" process had to be accomplished with gestures mimicking the animal or even making noises that the animal makes. This is referred to rather esoterically as "displacement" because it uses a smaller number of iconic gestures to refer to a reality which is different from the gestures. These gestures will become important as intermediate phases in the rise of language. Bickerton concludes that the real breakthrough into language had to be displacement rather than the arbitrariness of the symbols which make up fully developed languages. Displacement is critical therefore to his argument that the origins of human language began so long ago. The scenario above is speculative by any criteria. However, a number of paleontologists have independently described parts of Bickerton's story, especially his emphasis on "recruitment." One can say it is logical given what we know about the ecological situations of the times and it fits the conditions that any theory of the origins of language would have to satisfy.[2]

Homo erectus. Things picked up somewhat with the arrival of *Homo erectus* 1.8–1.5 million years ago. But while skill at making stone edges advanced and the use of fire emerged, the new species was still prelinguistic. Without the brainpower or vocal structure for talk, its cranial capacity nonetheless doubled from 550 to 1,100 cc. *Homo erectus* had a wider inventory of tools than earlier hominids and his communicative capacities and general sociality greatly increased. The front of the head expanded and the face flattened to accept the increase in the frontal, temporal, and parietal lobes. This coincided with an increase in female size to accommodate the birth of such large heads. However, children now were even more helpless with longer infancies and they needed more attention and care through adolescence. Women were continually receptive sexually and breasts were enlarged. Massey (2002) suggests that this may have encouraged pair bonding and discouraged continual conflict between males. In sum, social connectivity increased. Cognitive functioning was concentrated on imitation and mimicry involving vocalizations, facial expression, eye movements, and emotional expression. Such attention may have been the beginning of the often-observed tendency of *Homo sapiens* infants to attend to a person's eyes and also to any pictures which resemble the human face. This is an important brain specialization for the development of a truly social brain. Turner (2000b) suggests that primary emotions were rewired via the cortex to produce the social emotions of shame and guilt which gave individuals a personal stake in controlling their own behavior in ways that led to further group cohesion. Some would see this as implying the dawning of a self, but there is

[2]See Bickerton 2009:165) (1) Selective pressures had to be strong. (2) Selective pressures had to be unique. (3) The very first language *had* to be fully functional. (4) The theory must explain why signals should be believed. (5) The theory must overcome primate selfishness. Bickerton insists that no other theory of language satisfies all these conditions.

certainly no archeological evidence that *Homo erectus* had the capacity for symbolically constructed self-consciousness. Nonetheless, after one quarter of his existence, his capacities enabled *Homo erectus* to migrate out of Africa to southern Asia and Europe about one million years ago (Fig. 2.2).

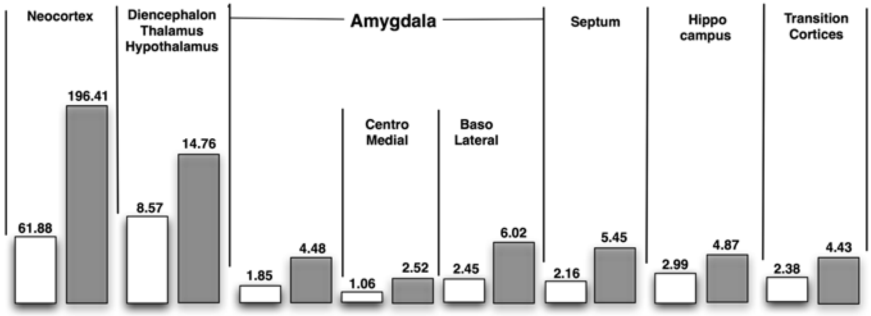

Fig. 2.2 Relative size of brain components of apes and humans (humans – *shaded*)

The brain of *Homo erectus* was also lateralized to create two different hemispheres. The right side of the brain allowed emotional communication. Tools were more refined, symmetrical, and sharper, and his inventory of tools increased to include hand axes, cleavers, and knives. This gave him the capacity to free himself from the dictates of his warm environment and survive in the harsher climates to which he traveled. He used water to migrate to his summer homes in southern France, even to Southeast Asia, and to return to North Africa in the winter and to create mental maps of the regions he covered. With all these strengths *Homo erectus* had an enormous gift for withstanding boredom. After developing his expertise in making tools, he lived with them for one million years without further development (Gazzaniga 1985).

Neanderthal and Homo heidelbergensis. Around 300,000 years ago two other species – *Homo heidelbergensis* and Neanderthal – competed with *Homo erectus* before the latter became extinct. Neanderthal's body was more robust with thicker bones and more muscle. His brain increased to 1,400 cc (which is greater than the size of a sapiens brain (Gazzaniga 1985: 149), but its organization was different with small and constricted frontal lobes. We know that Neanderthal was preverbal because of this and he had a skull structure that could not support vocalization. However, he introduced the first composite tools that were made from at least three different materials conducive to hunting big game. His skill at making sharp stone edges was remarkable and, like *Homo erectus*, he somehow achieved the feat of passing this capacity on through generations despite the absence of speech. He used flint and deer antlers to make tools which were designed to make other tools. It would take years of practice for us to learn how to make the numerous judgments about positions and angles involved in this activity. He also created stone hearths and potholes suggesting the construction of permanent shelters and his social organization of kin-based clans allowed large collectivities. Gazzaniga emphasizes Neanderthal's sense of aesthetics. Certain tools had a nonutilitarian, embellished aspect that went beyond that which was needed for practical use. Burial sites have been found which imply some form of belief in life after death. Despite all these advances Neanderthal lasted only 90,000 years

Homo sapiens. Approximately 150,000 years ago, the first fully modern *Homo sapiens* emerged in Africa. This was one hundred and fifty thousand years after Neanderthal first came on the European scene although some believe that for a short time they both existed in Europe. Around 50,000 years ago, sapiens migrated to Europe and Asia, eventually to inhabit all corners of the earth. By 20,000 years ago they had reached the Arctic. They were in the Americas by 10,000 years ago and in Polynesia by 2,000 years ago. In contrast to *Homo erectus* who lived over a span of a million and a half years and Neanderthal, each of whom spread only to Europe and southern Asia, *Homo sapiens* had populated all the earth in only 50,000 years.

Suggestions About the Origins of Speech

It should surprise no one that the origins of speech are unknown. What we can know in the grossest terms is when the brain developed an anatomical capacity for speech because this is in the fossil record of our skulls. *Homo sapiens*' brain had reached its present size of 1,450 cc, fully expanding the frontal lobes making symbolic thought and deliberate inference possible. The larger left hemisphere allowed more space for the requirements of speech production – namely Broca's area (in the temporal lobes on the left side) which houses the capacity to produce grammatical speech and Wernike's area (behind the temporal lobes) which makes possible the semantic understanding of words and/or the reception of speech. These areas are usually on the left hemisphere of the brain. The left hemisphere contains what Gazzaniga (1985) calls the interpreter of the impulses from the right brain. Rather than living only in the present, the use of verbal symbols allowed *Homo sapiens* to fully transcend the immediate experience given by the senses and to live in an abstract, extra-sensory, and hypothetical world. In turn this provided a basis for what many have referred to as the great leap forward. Rapid cultural change and/or technical innovations are no longer connected with brain size or biological changes. In contrast to tool use which had remained stagnant for a million years with *Homo habilis*, contemporary technological innovation is no longer constrained and can develop dramatically.

According to Gazzaniga (1985), only with *Homo sapiens* did the part of the brain crucial to language become vascularized enough to allow the needed blood supplies. This was especially true in Wernicke's area. This process had indeed been developing in earlier hominids but had not reached the critical stage where it could provide a base for language development. Analyzing the fossil skulls allowed archeologists to trace the distribution of blood supplies for the lateral surfaces of the skull where indentations were made by the blood vessels. Gazzaniga makes the important point that no amount of environmental pressure can push the brain beyond what its physical limits would allow. To free one's self from the dictates of the environment, cognitive ability must be strong enough to allow a distanced perspective and to transcend immediate sensory experience.

Of course, the right brain received the same increase in blood as the left. This meant an important increase in aesthetic sensitivity which is a specialty of the right hemisphere. Like cognition, aesthetic abilities impose something distinctively human which is projected onto the world. Art takes it's meaning from pleasure rather than practical necessities.

One should not assume that brain organization and language were developed for the purpose of rational decision-making. Most scholars now argue that language evolved for social reasons and to enhance human connectivity (see Maryansky 1996 and Brothers 2002). From an evolutionary point of view, language functions primarily as a far more efficient alternative to grooming to achieve the resulting social cohesion. In the past, group size was dictated by how much time could be spent in grooming. When language and/or emotion took the place of physical grooming, the size of a community was no longer constrained by this factor. This is critical to the development of cognitive capacity because as community size goes up, so does the intelligence and social sensitivity needed to deal with the larger number of others which this creates (Massey 2002). The large human brain evolved allowing individuals to negotiate with each other. Small (2008: 113) puts it succinctly: "As we have seen current theories suggest that our large brain did not evolve to solve the relatively simple problem associated with tool use much less the complexities posed by the problems posed by social living." This is still what we use the brain for today – most of the time at least. Intelligence as an offshoot of increased sociality matured only when hunting and gathering gave way to stable settlements. The development of a food surplus made possible by animal and plant domestication led to city life around 10,000–12,000 years ago. Whereas chimps spend 20% of their time grooming each other, humans spend 20% of their time in social interaction, mostly in conversation, much of which is about each other. Two-thirds of human conversation pertains not to technological problems or rational decision-making, but to gossip about other people.

However this may be, the conceptual underpinnings for rationality have existed for less than 3% of hominid's life span at the most. Rationality only developed when some people were released from the constant pressures to feed themselves and from the responsibility of rearing children. As we know from the experience of Socrates, rationality was not always appreciated; nor is it unanimously appreciated today as the recent attacks on evolutionary theory demonstrate.

An important capacity that the neocortex gave Australopithecine was social sensitivity. Social coordination was a paramount strategy for early near-man. *Homo sapiens* reached our current brain size only 150,000 years ago. In the 6 million years before that, from the time when our lineage broke away from the chimps, the human brain almost tripled in size from the chimp's average of 450–1,250 cc for humans.

We need to ask if this growth was slow and continuous or if it occurred in spurts. If the growth was uneven, what spurts correlate with in the environment did this correlated with and was the growth uniform or partial and specialized? Some evolutionary psychologists think that the human cognitive capacities appearing in *Homo sapiens* emerged from our own lineage instead of that of chimps. However, many disagree because this goes against the general character of the evolutionary process reflected in the fossil record as well as critical similarities we share with chimpanzees. These include Chimpanzees use of Machiavellian tactics to gain desired goals which more powerful others would block and capacities for social bargaining. Following the approach of continuity and emergence rather than separating human development from the corpus of evolution, primatologists have been able to go beyond the original Darwinian identification of the environmental selectors that encouraged intelligence.

Traditionally, the advancement of intelligence was thought to subserve tool use. A positive feedback loop emerged where bipedalism freed the hands, which put a premium on tool use that subsequently put a further premium on instrumental thinking. The advancement of fossil dating techniques has put a crimp in this commonsense story since they show that these events occurred millions of years apart. Bipedalism was evident more than 5 million years ago while tool use emerged 2.5 million years ago and the rapid expansion of brain size occurred as recently as 200,000 thousand years ago. End of story!

Current thinking is that the pressure to select for intelligence came from the demands of the social organization. Especially important was the advantage given to those who could anticipate the reactions of others and foresee the consequences of their social actions. These capacities can be seen writ somewhat smaller in today's chimpanzees and especially bonobo which are now being closely studied showing psychological similarities to us that are strong enough to be unsettling (see Greenspan and Shanker 2004: 177–78).[3] They see living in larger, more stable communities as providing more time for early humans to be creative which may have been a factor in our lightening-fast technological ascent. They would reverse the view that technological advances provided a basis for large communities. The real "engine in our evolution," they say, was the signaling of affect which underpins a sense of shared reality – what sociologists see as "intersubjectivity." Considering that humans had tools and shelter long before they could speak gives

[3]In making a case for primate social intelligence the author present a case of a bonobo chimpanzee who could use a computerized board to communicate with his handlers. The important part of the story is bonobo Kanzi's reasoning. The handler (Sue) had been exhausted by many difficulties she had solved the previous day and only had time for 2 h sleep. She arrived at her office out of sorts and looking like it. When Kanzi came up to play as usual, Sue did not have time. Kanzi's mood changed immediately and he began to stare at her prodding her very gently. Then, using the "language computers," he asked if she was mad at him or another bonobo in the facility. Then he offered Sue some cereal he had been eating when she had come in and tried in other ways to do things that seemed like helping. The authors say they had never before seen Kanzi try to solve a problem by trial and error, but he is often quiet before he acts and then adjusts his actions as necessary.

further evidence that thought came before language. After all, without a thought there is not much to say. Anyone who has had a word on the tip of his tongue but failed to dredge it up from memory knows that it is possible to think of a concept without having an accessible word for it. Home sapiens and earlier hominids would not have survived for long without non-verbal logical thinking.

This evidence that thought precedes language is so full of implications that it is worth surveying the evidence cited by Greenspan and Shanker (2004).[4] They point to the hearths and pits around Moscow dated from 20,000 to 25,000 years ago where stone and bone items were manufactured and impressive burial paraphernalia including clothing, tools, and jewelry were found in abundance. The tomb contained remnants of males who were covered with outer cloaks and footwear. One of the male's garments had 3,000 ivory beads and a fox-skin hat covered his head. This suggests a highly complex social structure.

More evidence that logical thinking occurred before language is provided by the fact that early *Homo sapiens* had the wherewithal to build vessels capable of transporting people across the high seas to Australia 60,000 years ago. Greenspan and Shanker say that this endeavor would have demanded a significant advance in the capacity to think logically. According to Rilling (2006), human brain specializations include an overall larger proportion of the neocortex compared to the development of other apes with significant enlargement of the prefrontal and temporal association cortices. The prefrontal lobes enable instrumental behavior, concentration, and emotional control as well as the integration of cognition and emotion necessary for decision-making. Also there is an apparent increase in cerebral connections with cerebral cortical association areas involved in cognition and a probable augmentation of intracortical connectivity in the prefrontal cortex. The increase in the neocortex would increase the association areas. These areas function to produce the experience of a coherent and meaningful world. Association areas allow the different parts of the brain to relate to each other producing the blending of diverse sensory messages into a unified whole.

Hobbs (2006: 81) warns that the first *Homo sapiens* had language readiness as early as 150,000 years ago, but readiness does not suffice to produce speech. To think so would be a clear case of neuroism. The most commonly cited date for the so-called origin of language is about 70,000–35,000 years ago, but this does not mean that all *Homo sapiens* had speech at that time. The origin of speech depends on cultural, symbolic, and anatomical readiness. Artifacts are the best indication for the capacity for symbolism and no solid evidence for such artifacts appears until about 70,000 years ago in Africa and 40,000 years ago elsewhere. Surprisingly, an important anatomical change allowing speech is the reduction of the gastrointestinal tract. This developed with a change of diet from meat to cooked fibers and made

[4]Evidence from contexts comes from at least two other perspectives. First are animal studies including those of Bonobos Greenspan and Shanker (2004). Another recent study is Pepperberg's (2008) work on parrots who seem to understand concepts such as smaller and more just as infants seem to do. The second perspective is that of Lakoff and Johnson (1999) whose work on non-linguistic concepts, produced by the brain, will be addressed in the conclusions of this book.

possible the expanded brain and the enlargement of the channel necessary in the throat which is necessary for speech (Bickerton (2009).

The expanded temporal lobes house Broca's area which is associated with the *production* of speech in front of the left temporal lobe and Wernecke's area further back in the same lobe allowing the understanding of speech. Non-human primates lack a direct path from the motor cortex and the nucleus ambiguous where motor neurons for the larynx are located. This is the seat for learning vocalization and talk. The most significant limitation for apes in learning language, however, comes from capacities enabled by the Broca's center rather than Wernicke's area. Whether these areas are true evolutionary novelties is debatable, but the development of Broca's area responsible for making speech seems likely unique for humans. Chimps understand speech better than they can produce it using computers. This development in *Homo sapiens* includes the evolutionary reorganization of the frontal–prefrontal cortex such that facial and oral motor cortices and their related subcortical speech centers came under cognitive control.

Another evolutionary anatomical change necessary for the production of speech is the capacity of the throat and tongue to make a vast number of sounds. This capacity depends on the "descent of the larynx" which is necessary to facilitate these speech movements and may have started with the genus Homo. The key to this descent is the very small hyoid bone within the larynx. Because the hyoid is so small the fossil evidence for it is scarce. We do have evidence that it was a part of the Neanderthal remains unearthed in Israel.

The weight ratio of brain to body weight is complicated, but can be over-emphasized. The number of cortical neurons and the speed of these neurons may be more important within the boundaries of the average brain sizes for *Homo sapiens*. To complicate matters further, the plasticity of the brain means that its structure can actually change with the learning of new tasks and ways of thinking.

Furthermore, the size of the *Homo sapiens* brain comes at a significant cost. Most familiar is the large head that makes birth so difficult and physically dangerous to the female. In order to make birth possible at all, the infant must be born 2 months prematurely, basically unprepared for life outside of the womb; this condition makes the infant very vulnerable and puts enormous demands on the mother for constant life-sustaining attention. The human infant is born with relatively few innate mechanisms of sustaining life and the demands of socialization are also costly. The drastically prolonged period of human brain development constitutes the basis for an increased ability in learning and memory formation.

The brain is as costly to the individual owner's body as it is to the group. It takes up only one-half of 1% of its cell count but consumes 20% of its calories, 25% of its electrochemical energy, and 15% of its oxygen (Miller 2007: 288). Edelman (1992) tells us "the human brain is the most complicated material object in the known universe." The downside of this awesome complexity is that the large human brain is prone to mental disorder at a much higher rate than are those of the great apes.

If these costs are so significant on so many different levels one is compelled to ask why the increase in brain size persisted so incessantly through the six million years of hominid and human development. There had to be a payoff which significantly counterbalanced these costs. This payoff came in human group life which is essential to human survival with the intellectual capacity for tool use seen merely as a consequence of evolutionary pressures for the development of the social skills needed for social interaction.

Conclusion: Thoughts About Evolution and the Brain and the Function of Beliefs

Evolution as Necessary for Understanding the Human Brain. We know from the split-brain research that the left-brain interpreter is continually at work searching for meaning and trying to make sense of things. Furthermore, the left-brain is especially unreliable about its reconstruction of our past in self-serving ways. What is convenient for us tends to carry with it the "ring of truth." According to Gazzaniga (1985: 136) one of the interpreter's favorite techniques is to over-generalize. In order to show the necessity of evolution for understanding the brain, he tells of George Wolford's work on even more of the left-brain shenanigans. In one of Wolford's projects the participant has to predict whether a light will flash on the top or bottom of a computer screen. The light, however, is manipulated by the experimenter to turn on at the top of the screen 80% of the time in a random sequence. People catch on quickly that the top button is turning on more than the bottom but that does not satisfy the left-brain. It wants to know the whole pattern unhindered by the possibility that the random selection eliminates any realistic possibility of a pattern. Because of this bias, the subjects are only right 68% of the time whereas if they pressed the top button only they would be right 80% of the time.

What makes this even more interesting is that the "lowly" rat and other animals who lack such a left-brain interpreter do not make this mistake and rapidly learn to push the top button all the time. Despite all the problems inherent in conceptualizing intelligence, *Homo sapiens* is surely more gifted in that department than a rat. Rather than searching for deeper meaning, the rat lives in the moment.

Gazzaniga sees this as just one example of why we cannot understand the brain without an evolutionary approach. According to him (1999: 137) "the human brain, like any brain, is a collection of evolutionary adaptations established through natural selection." Animals' brains tend not to lateralize their capacities to one side of the brain or the other but tend to distribute them equally to both sides. In the past, neuroscientists believed that lateralization in humans was an "evolutionary add-on." Boca's and Wernicke's areas were good examples. The new finding only made sense if the development of the human brain had to give up some capacities in order to grow others. An important characteristic of the brain is that it is an ingenious space-saving device. Some approaches to brain anatomy focus only on the structure of brain parts; however, if an understanding of how the brain came to be is the goal, evolution is a necessary part of the story of the brain as an imperfect tinkerer.

The Functions of Beliefs. Surprisingly, prelinguistic infants seem to look for causes in the external world. When experimenters create something unexplainable or capricious for them to watch, they stare more intensely as if they are trying to figure it out. They become bored with the expected event and repeat their scanning when the expected one does not appear. This suggests that the search for cause may well be hardwired in the human brain.

From their beginning, *Homo sapiens*, like infants, searched for causes and asked practical questions like "what if I do this?" They also made inferences like "Well, if that rock rolled all the way down the slope without breaking into pieces it must be good material to use as a tool cutter." Very early in *Homo sapiens*' history, adornments and beads become greatly valued as a signs of status which are socially constructed instead of nature-given. Beads especially were valued for this purpose and traveled long distances in trade routes.

There was some apprehension about death even with Neanderthals as hinted at by their burial traditions, and *Homo sapiens* were probably more concerned about the future and what happens after death. Note that "nothing happens" is not a satisfactory answer for the vast majority. Once you have a concept of self, the past and the future become more dominant and one wants life to continue even after death. Practical questions like what kind of rock will make good tools, procuring help in a hunt for animals and how to keep warm could be verified and put to the test by all humans regardless of their societies. But explanations about why we are here, what will happen to us after we die, and how the earth developed are different and can't be verified by asking does it work? These questions about life's meaning cannot be tested. But they will be produced because of our left-brain's insistence on explanations. Of course, the narratives they created were going to vary from society to society because the human mind divorced from the practicalities of action can conceive of anything. Left with no such grounding, one story is as good as the other.

If others can challenge an accepted and cherished belief, this is perceived as a serious threat, encouraging societies to put pressure on what to believe and how to sanction unbelievers. People who voiced their skepticism were in one way or another considered heretics and had to be destroyed. Socrates and Jesus are obvious examples. Lacking practical proof, the consensus was artificially enforced and it was necessary to have enforcers who were shamans or priests. As long as humans think hypothetically they are going to search for comfort from the pain of anxiety about the future.

As people started traveling they were confronted with different beliefs and since they were taught that all "real" people accepted their particular explanations, it was only reasonable to look down on those who disagreed. The trouble was that their hosts also had the same problem.

Looking at it from this broad perspective, one's own status and ideas about oneself are hypotheticals that depend on these broader beliefs. Beliefs live on by faith in "things unseen," not by practical evidence. We can conjecture that the reason people in primitive societies believe is because everyone they know believes and each has a big stake in conforming. If your self-worth, status, and the meaning of your life are dependent on the validity of these symbolic constructions, it is understandable that you will fight for these hypotheticals. Ernest Becker, in his award winning *Denial of Death,* called these beliefs "hero systems"; a clear example of such a system can be seen today with the Jihadists. Former President Bush defined the wars in Afghanistan and Iraq as crusades – wars of religious beliefs. That, more than access to material oil, made them worth fighting for. Beliefs give us meaning and also give us rationalizations for war. They come out of the search for cause in an animal whose brains are made for practical questioning even when they cannot find consensus on the answers.

Important Developments in the Evolution of the Human Brain

6,000,000 years ago: Australopithecines left the trees and split from Chimps as the first upright hominid.

3,000,000: Rapid changes in climate

2,00,000: *Homo habilis* made crude stone tools, but they were not improved on with subsequent generations. Eventually left Africa and became extinct.

2,000,000: *Homo habilis* entered high-end scavenging. Brain tripled in size.

1,500,000: *Homo erectus* brought stones from highlands to make tools but there was no refinement. Evidence of controlled use of fire is found. Cranial capacity doubled. Communicated through emotional and other gestures. Taught each other by imitation and demonstration, but no generational advancements. He lasted for 500,000 years.

1,000,000: *Homo erectus* moved out of Africa during the Pleistocene Ice Age. Some say this produced a monster genetic mutation.

500,00–200,000: The human brain was greatly expanded.

600,000–100,000: Archaic *Homo sapiens* expanded parietal region. . .maybe an elaboration of the larynx. They began to act in ways specifically human. They made significant technological advances.

300,000: Archaic *Homo sapiens* started burial rites which implies an advanced belief system.

300,000: Several new species of hominids competed with *Homo erectus* but erectus disappeared. One was the Neanderthals whose skull structure prohibited speech, but they made the first composite tools and had permanent shelters. Neanderthal only lasted around 90,000 years.

150,000: *Homo sapiens* developed in Africa but left after 60,000 years to Europe and Asia. These consummate travelers populated the earth in 50,000 years.

130,000: Sapiens began to talk using not only vocabulary but syntax (grammatical rules).

100,000: Sapiens bones found in Israel (connected to Africa) were like ours but they did not talk or behave like us.

90,000: Big Bang! *Homo Sapiens* left Africa. They started a revolutionary way of life. Some say the Big Bang could only be mutation. Technology increased at a great pace independently of brain size. Much debate surrounds this decisive expansion.

50,000: The brain changed, not in size but in it's wiring to make possible an even more complex social life.

43,000: The oldest beads found. This is not trivial. Human decoration was an important sign of identity and status, something humanly constructed rather than given in nature. Tool use refined to arrows and bronze, replaced flint, etc.

38,000: Beads became mass produced and were the objects of long-distant trading.

34,000: More advanced cave art was produced which meant symbols and thinking beyond the immediately present. Cave paintings symbolized as another life. This also transformed the world in a blink of the eye.

1,000–13,000: Some of the greatest Paleolithic works of art were found. Evolutionary thinkers concluded that the artists who created these cave paintings had crossed some qualitative "cognitive divide."

10,000: The emergence of agriculture gave time for other developments transforming the environment in an evolutionary blink of the eye.

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