Evolution of Human Consciousness

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Some three and a half billion years ago, life had arisen through a process of abiogenesis[2] from non-life matter, when out of the thick chemical soup of huge molecules in the primordial ocean of the earth, a single molecule had made its singular transition across the barrier between non-life and life, by learning to self-replicate and thereby triggering the entire process of life. Since then, evolution has produced an astounding and amazing variety of species in plants and animals, of unbelievable size, shape, colours, power and complexity, filling the planet with 'life's ever branching and beautiful ramifications', as Darwin put it, and culminating finally in the *Homo sapiens*. Evolutionary biologists believe that consciousness was an off-shoot of this process of biological evolution only,[3] as the German biologist Ernst Mayr had said, "it is quite certain that human consciousness did not arise full-fledged with the human species, but is only the most highly evolved end point of a long evolutionary history."[4] According to them, evolution has produced consciousness as one of many techniques for 'fruitfully processing external stimuli'. As the American evolutionary biologist D S Wilson said, "Conscious intentional thought is the only latest gadget in a toolkit of psychological mechanisms that evolved to transform environmental information into adaptive behaviour, many of which operate beneath conscious awareness."[5]

Many historical accidents, genetic mutations and evolutionary experiments have produced our consciousness. The evolutionary account of the origin and development of consciousness remains, in fact, one of the most powerful and consistent theory of consciousness, though, like all other theories, it also has its own share of negative points. Our biological evolution has come to an end many millennia ago, and we can now only evolve in consciousness. As Ornstein says, "It gives us the capacity to imagine a future, to change the world", while adapting ourselves, like all other animals, to the conditions of the world.

Consciousness is a continuum that encompasses the entire living world, and each child of evolution exhibits consciousness in varying degrees. Trees respond to sunlight and gravity, they also have senses and feelings which can be detected and measured, and this argument is equally applicable to algae, fungi, lichens and bacteria. In the animal world, some animals have specific senses much more developed than even humans. Insects have compound eyes with thousands of separate lenses vis-à-vis the single eyes of mammals and birds, dogs and snakes have acute sense of smell much stronger than humans or other

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[2] Burns, B P, Understanding the Origins of Life on Earth, *Journal of Cosmology*, 2009, 60-62.

[3] As opposed to this idea, there are those (Hoyle F and N C Wikramasinghe, *Astronomical Origins of Life: Steps Towards Panspermia,* Klewer Academic Publishers, 2009) who believe that life is present everywhere throughout the cosmos and has come to Earth from space; they also believe that consciousness is a universal integral feature of the entire cosmos.

[4] Mayr, E, *What Evolution Is*, Basic Books, New York, 2001, 282.

[5] Wilson, D S, Darwin's Cathedral: Evolution, Religion, and the Nature of Society, The University of Chicago Press, Chicago, 2002, 121.

animals;[6] dolphins, whales, and bats can navigate and track their prey using echo location; fishes have 'Lateral Line' - a precision organ along their sides which allows them to sense movements through water at long distances, which they use to evade the predators; birds can see in the ultraviolet and sense the earth's magnetic fields for navigation and migration purposes. There are hundreds of similar examples. Similarly intelligence in varying degrees is shared and displayed by a wide variety of mammals; some animals including the primates possess remarkable degrees of intelligence – they are also able to communicate effectively among themselves, even though they may not possess a complex language like ours. Animals also display emotion towards their offspring, domesticated animals display recognition, bonding and emotion towards their owners. Sentience in no way is an exclusive preserve of the humans. Unfortunately, we have not yet been able to invent a machine that can detect and measure consciousness in living beings. It is indeed difficult to draw a line separating conscious creatures from the unconscious - nervous systems of insects may not be as complex as ours, they may have very different senses – so their picture of the world would be unlike ours. But it cannot be doubted that they have some sense of consciousness, certainly enough for their own survival and proliferation.

Evolutionary biologist therefore do not ask which animals possess consciousness, they rather try to answer the question, when and why, and through which processes, has consciousness evolved? Is it an adaptation driven by Darwinian natural selection, or is it a by-product of evolution? Consciousness obviously evolved at a much later stage in the course of evolution from 'non-conscious processes', hence these questions acquire significance.

American cognitive Scientist Dennett identifies three evolutionary processes that in his opinion has produced consciousness**. First** is the development of the instinct for preservation of interest of an organism in self-replication, or the *selfishness* of an organism. In this his ideas are based on those of the British evolutionary biologist Richard Dawkins. In his "The Selfish Gene" (1976), Dawkins had proposed that genes are not selfish in the sense that they are not driven by any motive, but genes that are passed on to the offspring of any organism are the ones that only serve their own implicit interest in being replicated, not necessarily those of the organism. Similarly, according to Dennett, a creature also seeks those circumstances and events that favour its interest in self-preservation and in doing so, instills a primordial '*selfishness'* in it. This selfishness motivates it to protect itself against unforeseen dangers by sensing its environment, thus the next natural and logical step –the **second** evolutionary process concerned with the development of consciousness - was to develop a nervous system which will progressively become more and complex to track, anticipate and protect itself from the environmental dangers and to gain control over it. Being 'anticipation machines', brains thus 'produce future': "The clam's shell is fine armor, but it cannot be kept closed; the hard-wired reflex that snaps the shell shut is a crude but effective harm anticipator/ avoider."[7]

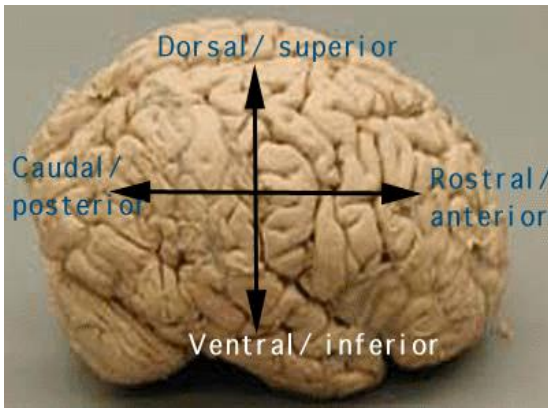
With the evolution of multicellular organisms, cells specialised in sensing light, sound, heat, vibration etc. emerged. These cell would gradually evolve into sensory organs. With the development of sensory organs,

[6] A snake has a special organ called the Jacobson's organ, which is a patch of sensory cells located within its nasal chamber that detects heavy moisture-borne odour molecules. It flicks its divided tongue to collect these odour particles from the air and delivers them to its Jacobson organ to sense and track prey.

[7] Dennett, Daniel, *Consciousness Explained*, *Ibid*, 177.

the organism's ability to gather information from the environment increased exponentially. Information confers distinct advantage for the purpose of survival, hence to make the information gathering system increasingly more sophisticated, the sense organs had to become more and more complex. Eyes, apart from being sensitive to light, also react in different ways to different frequencies, and can detect the source of incoming light. Ears became complex; larynx, or the vocal apparatus evolved with language. The brain also evolved side by side, and as the cerebral cortex matured in its structure, functional areas specialised in different tasks would evolve. Language, emotion, feelings memory, attention, recognition, intention etc. would emerge gradually in the process and impart a new dimension to the cognitive aspects of human existence. To integrate all the information gathered through the senses, nervous system has to evolve in all its complexity. The canvas of consciousness was thus slowly getting filled with many ingenuous new devices. The purpose was to anticipate the future and prepare for it in a way that would bring advantage to the species as a whole.

Anticipation is all about effective gathering and processing of information, short-range anticipation would instill reflex responses like ducking, something that is observed even in newborn infants as a gift from evolution. Recognition of patterns with an axis a symmetry was another, because most animals - potential predators - possessed such an axis of symmetry, and their early recognition would enable the primitive ancestors of humans to avoid a potential danger. Thus very early in evolution, these responses were hardwired into hominid brains.



Once information gathering and processing through the sense organs, the nervous system and the brain has become established as a routine for the purpose of survival, a 'new behavioural strategy began to evolve; the strategy of acquiring information for "its own sake"'.[8] The developed eyes and ears and other sense organs allowed the primates or early hominids an uninterrupted scanning of the world. The result, as Dennett says, was "the birth of curiosity or epistemic hunger". From gatherers and beneficiaries of information, they became '*informavores'*, 'hungry for information about the world they inhabited'. As Dennett says, this evolutionary development led to the distribution of labour inside the brain, between the dorsal and ventral brains. While the dorsal brain took up the task of collision detection – continuous scanning of the environment for identify approaching or receding objects so as to avoid collision and also for the other reasons, the four F's of fight, flight, mate or feed, the ventral brain specialised in identifying the objects with all their details through a relatively slower process of analysis of the information gathered. In primates, this "specialization got twisted, and evolved further into the celebrated right-hemisphere/left hemisphere specializations: the global, spatiotemporal right hemisphere, and the more concentrated, analytic, serial left hemisphere."[9] In the process, the brain would develop its plasticity -

[8] *Ibid*, 181.
[9] *Ibid*, 181.

neuroplasticity, or the brain's ability to change throughout life, its amazing ability to reorganise itself adaptively by making new neuronal connections at every stage of life - with the resulting ability to learn. This ability to redesign itself could occur only through the process of natural selection that would impart a distinct evolutionary advantage to a species that had developed the ability to learn new behaviours.

Chimpanzees happen to be our closest genetic relative. Humans and chimpanzees had shared a common ancestor some 6 million years ago before they drifted apart genetically. Since that fateful time, over the course of endless millennia of evolution, human brains have grown to about four times the size of the brains of their closest cousins. The evolutionary increase in the relative size of the brain, and hence complexity, involving a shift of function from non-cortical parts of the brain to the cortex was essentially completed some 150000 years ago, much before the development of language and its attendant complexities. Most of our cognitive developments took place during the last 40000 years, and these developments hence could not have been due to anything other than the newly acquired plasticity, or the ability of the brain to learn continuously, even while committing mistakes. These cognitive abilities are the ones responsible for man's almost infinite adaptability and resilience which ultimately made for his undisputed ascent in this planet.

This physical evolutionary process was accompanied by an equally powerful process –linguistic and cultural evolution. This was preceded by what Dennett calls the process of "auto-stimulation", the onset of 'thinking'. Language developed primarily as a response to the need for close coordination and cooperation in the early hominid groups, when increasing vocalisation was proved to confer distinct advantages to our hominid ancestors to seek help and fight enemies and predators in a hostile, inhospitable environment. As Dennett says, communicating with oneself was a natural consequence of communicating with others, which served the same purpose and achieved the same utility. Evolution would then hardwire this "private talking-to-oneself behaviour" into the hardwire of the brain through a slow gradual process, so that thinking became an integral part of our cognition, along with memory. Cultural evolution, the third important evolutionary development towards consciousness, was but a natural corollary.

Human consciousness is a thus a product not only of natural selection, but also of linguistic and cultural evolution. Just as gene was the unit for genetic evolution, Dennett uses the term 'meme' as the hypothetical unit that propagated this cultural evolution, defined first by Dawkins. Just as the genes or DNA molecules replicate and thus carry the evolutionary process forward through such replication, memes also are simple ideas which constitutes 'a unit of cultural transmission, or a unit of imitation'. "Just as genes propagates themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme-pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation. If a scientist hears, or reads about a good idea, he passes it on to his colleagues and students. He mentions it in his articles and his lectures. If the idea catches on, it can be said to propagate itself, spreading from brain to brain."[10] Memes obey the laws of natural selection and they are sheltered securely inside the human mind (brain), transmitted to another through the human communication channels, and with electronic channels of today, they have the ability to spread at the

[10] Dawkins, Richard, *The Selfish Gene*, Oxford University Press, 1976, 206.

speed of light. They are replicators that need not always be beneficial, just as genes, and like genes, memes could be varied; just as there could be a 'meme for faith', there can also be a 'meme for tolerance', and a 'meme for intolerance'. A cultural trait would spread among the human population only if it is advantageous at a given time. Our cultural existence as "thinkers" – remember "I think therefore I am" - is defined by the memes, just as our physical entities are defined by the genes. Evolution of the memes has thus the ability change the wiring inside our brains which contributed to the evolution of consciousness in no small way – according to Dennett, "Human consciousness is itself a huge complex of memes" that can "best be understood as the operation of a "von Neumannesque" virtual machines implemented in the parallel architecture of a brain….. The powers of this virtual machine vastly enhance the underlying powers of the organic hardware on which it runs..."[11]

Thus, in summary, "All three media - genetic evolution, phenotypic plasticity and memetic evolution - have contributed to the design of human consciousness, each in turn, and at increasing rates of speed."[12] He cautions that along with genetic engineering and neuroscientific engineering, with the potential of revising our genome and nervous system respectively, we have already fashioned the possibility of a fourth evolutionary force waiting to be unleashed in the realm of memes.

Theories of consciousness have not developed as much from evolutionary biology as from religion, philosophy and psychology or cognitive studies. Another evolutionary explanation comes from Michael Graziano, Professor of Psychology and Neuroscience at Princeton University. Graziano developed the Attention Schema Theory (ATS) in 2011 suggesting that consciousness arose to help the nervous system handle the information overload more efficiently, in response to which the brain evolved mechanisms for processing a few select signals at the expense of others. Consciousness is thus "the ultimate result of that evolutionary sequence" which is present in a range of vertebrate species. Graziano defines the mechanism of this as "selective signal enhancement", in which neurons compete with for each other all the time and signals emitted by a select group of neurons suppress other neuronal signals and become the dominant determinant of animal behaviour.[13]

A study of the nervous systems across the animal kingdom will help understand how this process had evolved over time. The hydra, a small relative of jellyfish, has a very simple nervous system, actually a nerve net which gives a uniform response when poked anywhere; it shows no sign of "selectively processing some pokes while strategically ignoring others". Hydra had split from other animals about 700 million years ago; hence selective signal enhancement must have evolved well after that. The arthropod eye, in contrast, "sharpens the signals related to visual edges and suppresses other visual signals, generating an outline sketch of the world". This advances selective enhancement dates to about 600 million years ago, when a complex, multicellular life was beginning to evolve. The central coordinating mechanism of the brain was still far away in evolution, but the next evolutionary advance was a centralized controller that could coordinate between the senses - an area in the top of the brain called 'tectum' meaning 'roof' in Latin, developed in all vertebrates, but absent in the invertebrates, from which

[11] Dennett, Daniel, Consciousness Explained, *Ibid*, 210.
[12] *Ibid*, 208.
[13] Graziano, Michael, "A New Theory Explains How Consciousness Evolved", June 6 2016, http://www.theatlantic.com/science/archive/2016/06/how-consciousness-evolved/485558/, accessed 19/12/2016.

we can bracket its evolution to around 520 million years ago, when the first vertebrates had evolved and were competing with a multitudes of invertebrates in the oceans during the Cambrian Explosion.

With the evolution of reptiles around 300 million years ago, a new brain structure called the 'wulst' emerged. The human cortex has its origin in the reptilian wulst. Brain has always been an add-on mechanism and evolved by adding on new devises to the existing ones. The cortex is nothing but an upgraded tectum and we still have it buried under the cortex; it continues to perform the same functions as in fish and amphibians.[14] The cortex now started taking in the sensory signals and coordinated sensory movement with much more flexibility. In addition to directing 'overt attention' in response to sensory signals coming from a source that was the primary purpose of the tectum, cortex now evolved 'covert attention', giving the brain the ability to shift attention to a different object or to information stored in memory or to a 'thought', mediated *via* the neurons, synapses, and signals. As Graziano says, "Covert attention is the virtual movement of deep processing from one item to another. The cortex needs to control that virtual movement….it does so by constructing an attention schema—a constantly updated set of information that describes what covert attention is doing moment-by-moment and what its consequences are."[15] The schema is an abstraction; just as a car driver doesn't need to understand the internal working of the engine in order to be able to drive, the attention schema also does not need to know the neuronal processes in order to shift covert attention to different subjects. This, according to Graziano, is the origin of consciousness: "We say we have consciousness because deep in the brain, something quite primitive is computing that semi-magical self-description."

ATS was first developed as a theory to explain one's covert attention, and hence consciousness, and was adapted to be extended to the 'attentional states of others', to be aware of the consciousness of others as well, in other words to explain social cognition and awareness. It was like a theory of the mind to understand the 'possible contents of someone else's mind'. Birds and mammals show this attribute in varying degrees, like a dog looking at another and showing signs of recognition. Graziano reasoned that this social cognition must have its origin in the common ancestor to birds and mammals, i.e., in the reptilian wulst. Thus, "300 million years of reptilian, avian, and mammalian evolution have allowed the self-model and the social model to evolve in tandem, each influencing the other. We understand other people by projecting ourselves onto them. But we also understand ourselves by considering the way other people might see us. ….. the cortical networks in the human brain that allow us to attribute consciousness to others overlap extensively with the networks that construct our own sense of consciousness."[16]

From "Cogito Ergo Sum" of Descartes, we have since come a long way to realise that the conscious mind encompasses extremely complex layers of information including memories, knowledge and awareness about self as well as the external world lying all around us. Awareness and sentience are but adaptive strategies which are highly functional, and consciousness has followed an evolutionary trail.[17] It is

[14] When we hear a sudden sound or see a movement in the corner of the eye, the remnant of the tectum directs our gaze toward the source quickly and accurately.

[15] Graziano, Michael, *ibid*.

[16] *Ibid*.

[17] In the 1980s, the Cambridge psychologist Nicholas Humphrey had put forward a competing hypothesis that consciousness emerged because among the prehistoric ancestors of humans, those who could predict the behaviour of others would get a distinct n evolutionary advantage. The power of introspection that developed as a result was

inextricably tied to language – but language does not explain it wholly. It is also manifest in and inseparable from aspects like self, freewill, emotion, intelligence, memory, thinking - though we still cannot explain how these other aspects impart a meaning in our minds to the objective reality which our senses perceive. In fact, any theory that ignores the evolutionary perspective of consciousness ultimately runs into difficulties and contradictions; they cannot provide a satisfactory account of human behaviour. Despite the cognitive uniqueness of every individual, we all perceive colour, shapes and sounds the same way, fall in and out of love the same way, feel anger and hatred the same way, enjoy and live our life, and think and behave in much the same way. We behave rationally most of the time, and lose our rationality completely at times to overpowering emotions without any logic. We reckon the endless possibilities of the mind, and use them for creative purposes in myriads of ways. In such universal behaviour of the species as a whole, the characteristic signature and stamp of evolution can be clearly and unmistakably recognised.

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the beginning of consciousness. But the theory ran into difficulty because 'introspection is a poor guide to behaviour'. Susan Blackmore, *Consciousness*, *Ibid*, 125-6.