Review Article

Derivation of Human Constructs of Reality

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One of the most intractable issues is the question of how humans attained the facility of creating models of reality. Whilst it is evident that such models always suffer from inherent constraints or shortcomings, the primary topic addressed here is the process facilitating their formulation rather than their validity. This is investigated by exploring the context and timing of this significant development in hominin history. The context is provided by the domestication theory, according to which the change from robust to gracile subspecies of *Homo sapiens* was by unintended self-domestication rather than a 'speciation' event. Its numerous deleterious effects included a relatively rapid decrease in brain volume. Archaeological evidence implies that a cultural imperative most probably triggered the domestication syndrome through selective breeding. However, it also prompted the establishment of burgeoning systems of extracranial memory traces, compensating for diminishing brain volume and facilitating the expansion of cognitive resources. Competence in using external memory traces became an evolutionary selection criterion. The unique linkage they could provide between the human brain, our sentience and the external world rendered the establishment of constructs of reality feasible. Nevertheless, it provides no proof for their cogent veracity.

Introduction

In this journal, I recently presented an example of how meaning can be imposed on non-meaningful information through pareidolia[1]. The most profound case against the human imposition of meaning on the world is Plato's famous allegory of the cave. Written about 2390 years ago, it presents a dialogue between Socrates and Plato's brother, Glaucon (*Republic*, Book VII, 514a–520a). In it, Plato compares the human ability to perceive reality to that of prisoners chained lifelong inside a cave and

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subjected to shadow displays they assume to be reality. The weightiest of the various possible interpretations of the allegory is that it illustrates the inadequacy of human constructs of reality.

Such cosmic models overlook specific key issues. To experience and comprehend objective reality, sensory and cognitive facilities of vastly greater scope would be required than those that are at our disposal. Like any other species, humans only have faculties that natural selection favours. For instance, capacities in tune with those of other species we interacted with in the past would have been relevant. However, there was no evolutionary advantage in comprehending objective reality. Therefore, we have no reason to assume that we possess the tools required to detect reality. Indeed, an 'autopoietic'[2] false model of logically consistent reality could be maintained indefinitely by an intelligent species[3]. This is Plotkin's[4] 'imagined world made real'. 'The world is not understood by the brain, it is modelled by the brain; and the model need not be accurate'[5].

This is not the only validation we have of Plato's assessment. It appears that most conspecifics exist in the belief that their individual reality is the correct version or even that all people share it. However, this is an impossibility. The worldview of each human being derives from their life experiences and their sequence and intensity. Thus, the variables are different for each person, so there have been as many constructs of reality as 'sentient' humans possessing consciousness for perhaps some tens of millennia.

Another complication is that science, remarkably, has remained unable to determine by what processes our brain translates incoming sensory data into a unified model of the world. We have some understanding of how such data are converted into neural format and transferred to the brain. However, it remains unknown how the brain reconstitutes this information to present us with the cohesive reality construct we possess. Here, our epistemological helplessness becomes most apparent and consequential in the sense of challenging all we know.

What renders these considerations even more intriguing are the potential explanations for our perceived realities occasionally contributed by non-sciences. Currently, the simulation hypothesis enjoys a certain popularity. This is based on the notion that perceived reality derives from a simulacrum, a computer simulation created by 'posthumans' wishing to explore their origins. Philosopher Nick Bostrom[6] argued "that the belief that there is a significant chance that we will one day become posthumans who run ancestor-simulations is false, unless we are currently living in a simulation". His work makes a sustained case for such a simulation: our cosmos is just a tiny piece of the totality of physical existence because it is a simulacrum. He thus provides a potential explanation for the puzzle of Plato's allegory.

However, the severe limitations of our perceived cosmos can be explained without involving posthumans or their computer-game-like, ancestor-seeking imposition. Consider that all, rather than some humans, lack colour vision (as do many animals, including cats and dogs). They would have no knowledge of the existence of colour. At some point, they discover that some animals react differently to identical shades of reflected grey or bichrome light. Unable to explain this peculiar sensitivity, they would not realise the existence of the colour spectrum. That raises the question: how many such properties exist in the physical world that we cannot be aware of? Alternatively, imagine we only perceived a two-dimensional world; how would we establish that there is another spatial dimension? How could we know how many others there are or how many other kinds of dimensions that our sensory faculties or instruments cannot detect?

Through his digital-centrism[7], Bostrom's simulation of a theory makes no allowance for such possible hyperdimensionality, string theory or quantum mechanics. Are our emotions and dreams also simulated, and how does one simulate free will? The simulation would have to be highly detailed in every respect and cover the last few million years to avoid detection by modern scientists of what they would perceive as 'anomalies'. It would have to record every synaptic reaction in every human brain that ever existed. It also needs to file each human consciousness in every second of every human's life. That alone would be an incredible feat, as we do not even understand how consciousness works[8]. Bostrom assures us that his posthumans will have the truly astronomical computer resources this would entail. However, I remain sceptical that they could simulate even a single human with their planetary-mass computer capable of 10^{42} operations per second—and that would still leave 8.7 million other species (plus those still to be discovered or having gone extinct) and 200 billion trillion stars to account for. Moreover, it must account for the physical evidence of all our ancestors, their artefacts and vestiges.

Ultimately, the simulation idea is not a scientific hypothesis. It is unfalsifiable because it deals with future events and does not satisfy Occam's Razor. It presents a Möbius strip-like time curve of retrocausality. Ultimately, it is a metaphysical notion that explains nothing because it merely defers the issue of 'first cause', replacing deities with posthumans. Most of all, this hypothesis is redundant because a testable theory explaining our constructs of reality is already available, and it is based on empirical evidence rather than computer games. That theory is briefly presented in this paper. However, before attempting this, its context needs to be established.

The domestication of humans

Numerous animal species have domesticated animal, plant or fungi species for various purposes. In vertebrate genera, the domestication syndrome[9][10] is manifested by a suite of physical and behavioural characteristics that also distinguishes 'modern' humans (*Homo sapiens sapiens*) from the preceding robust subspecies of *H. sapiens*, including Neanderthals and Denisovans. Human auto-domestication[11][12][13](apologies for excessive self-citation throughout) is expressed by many changes, including a decline in prognathism, cranial robusticity and body strength; dental reduction, atrophy of specific brain regions, abolition of oestrus, introduction of menopause and probably by skin depigmentation. Most of the changes from robust to gracile hominins were genetically detrimental, such as the introduction of neuropathologies and thousands of Mendelian disorders. These changes were accompanied by such strong selection in favour of infantile physiology and behaviour (neoteny) that many authors perceived a speciation event. They are also suggested to have introduced the ability to create reality constructs. Although earlier indications of domestication can be observed in hominins, in Europe, the change is especially pronounced in the period from about 40 ka (thousand years) to 30 ka. Numerous intermediate human remains, combining gracile with robust traits, derive from that time across Eurasia.

This timeframe coincides with the widespread introduction of figurative palaeoart and other developments signifying the induction of essentially modern cognition and consciousness. These are thought to have developed from the exploratory behaviour prompted by neoteny. Significantly, while we have no evidence that any Upper Palaeolithic cave art in Europe is the work of adults, the three types of palaeoart that permit estimation of the makers' age are, without exception, made by juveniles[14][15]. For instance, Guthrie's[16] survey of 201 measurable Pleistocene hand stencils determined them to be children's work, especially adolescents. He reports the largest specimen to be by a 20-year-old. Moreover, most footprints found in these caves, certainly over 90%, derive from children or teenagers, and very few can be attributed to adults[14].

These observations coincide with the proposal that the 'art' production of the isolated Andamanese Jarawas is nonfigurative and contains significant elements of Asian mainland graphic traditions of the early Holocene when the island population became isolated by rising sea levels[17]. However, it has been demonstrated that at least some of their juveniles draw figurative imagery perfectly well. As in some other cultures, the figurative is regarded as the less mature of the two art genres. This pattern suggests that both the proliferation of figurative art during the earlier pervasive neotenisation of humans and the apparent preoccupation with female sexuality might be attributable to adolescents. Be that as it may, the female human representations imply the establishment of culturally determined concepts of female attractiveness or desirability. Whereas none of our closest extant relatives show in their mating behaviour any preference for youth, skin or hair colour, body ratio, cephalofacial appearance, facial symmetry or notably neoteny in females, all known cultural traditions of humans have identical, strong and universal preferences in that regard and female attractiveness is universally more important than male[18][19][20][21][22][23][24]. Since culturally governed mating choices determine these preferences in all extant humans[25], it is inescapable that they were established at some point in hominin history. The domestication theory suggests that to have occurred around 40 ka ago.

The significance of these observations is the long-term effect of mating partners being selected on such arbitrary, culturally established characteristics. Reproductive success determines the phylogenetic direction in all animal species, and preferential mating introduces the domestication syndrome through selective breeding. Consequentially, the induction of concepts of female attractiveness precipitated auto-domestication in humans during the Late Pleistocene. The effects of the pleiotropic process appear so rapidly that archaeology erroneously explained them as instantaneous replacement. Robust humans were said to have been substituted by, in many ways, superior gracile groups invading from Africa. However, the changes from robust to gracile human morphology took many millennia and, in some respects, domestication is continuing today. The changes were initiated by the females, who were far more gracile about 30 ka ago than their male contemporaries, who took another 20 ka to match their condition (Figure 1).

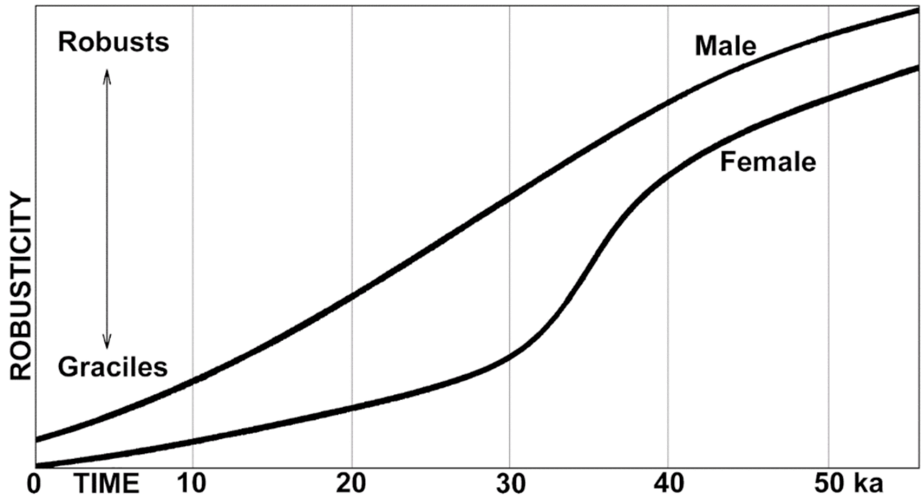

Figure 1. *Male and female relative cranial rubusticity/gracility in Europe during the final Quaternary.*

Since the self-domestication theory was proposed in 2008, there has been much incidental development in genetics that can be applied to testing that theory. We now know that graciles and some robusts are of the same species[26][27][28], which some authors had recognised previously[29][30][31][32]. In 2008, the genetic markers of domestication were unknown. Since then, dozens of overlapping genes have been revealed by selective sweeps in the genomes of modern humans and other domesticates, such as horses, dogs, cattle and cats[33][34][35]. Other genetic research supporting the domestication theory concerns the apparent absence of neuropathology in Neanderthals. The NRG3 gene, associated with schizophrenia, seems absent in them. Selective sweeps in regions associated with psychosis yield recent aetiologies[36], and the same applies to severely deleterious alleles in modern humans, such as RUNX2, CBFA1 and THADA, the microcephalin D allele[37] and the ASPM allele[38], which are all under 20 ka old. Moreover, none of the 17,367 genes in two Neanderthals are listed among the 15 genes known to overlap between at least two domesticates[39]. A build-up of deleterious alleles can be observed across numerous animal and plant domesticates[40][41][42][43]. Single-nucleotide polymorphisms (SNPs) are the most likely culprits in encoding these detrimental amino acid variants[44].

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The roles of exograms

A crucial development coinciding with human self-domestication is the proliferation of exograms[45]. One of the many effects of auto-domestication, the reduction in brain volume[46], is among the expressions of the domestication syndrome. That atrophy happens to coincide with a time of rapidly increasing demands on the brain during the early Upper Palaeolithic. It was compensated for by the unprecedented rise of exograms in that same period. Selection for the ability to work with memory traces external to the brain mitigated the need for ever more brain tissue. Like the persistent use of any reference system, sustained exogram use changed the human brain's structure, chemistry and operation. Most significantly, competence in employing exograms in memory became a defining selection criterion of human modernity[47]. Today, it is the most dominant characteristic of humans, governing our cultures, lives and societies.

Exograms are external memory traces. Their naming derives from engrams, protoplasmic alterations of neural tissue once believed to occur upon stimulation of the brain[48]. Despite extensive searches for many decades, they were never found, and especially Lashley[49] eventually realised there is no single biological locus of memory, but many (amygdala, associative cortices, auditory cortex, cerebral cortex, hippocampus, visual cortex[50][51][52][53][54][55]. The investigations by Penfield[56] and Gregory[57] led to the notion of memory traces stored external to the brain and of forming a 'surrogate cortex'[58][59][60]. Bednarik[61][3] applied the model to certain forms of rock art, interpreting them as projections of neural structures accessible to the sensory perception of conspecifics. The cognitive processes supported by exograms are not accessible to species with purely biological memory systems[62]. A memory storage system based on exograms can be visited and manipulated at will, can be of any medium, can have almost unlimited capacity, and is subject to unlimited iterative refinement. In contrast to the putative engram, an exogram is semi-permanent and reformattable, and the processing power is economical and flexible[63][64].

These factors illustrate the momentous advantages exograms introduced in cognitive human evolution. The idea of such memory traces external to the brain was already explored by Plato (in *Phaedrus*, 274c–275a). Exograms can occur in myriad possible forms, ranging from symbols whose meanings are accessible to all adepts (but not to the modern beholder; adepts possess the required cognitive scaffolding of internalised random-access memory) to much more personal memory prompters (e.g. the familiar chip on one's coffee mug). For instance, beads and pendants recovered

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from all three phases of the Palaeolithic era[65] were likely 'symbolic': they had publicly known meanings. We can identify such objects from their form, the microwear of the supporting string, traces of their production or their relative position on buried human remains. However, the identification of beads does not reveal their meaning. The archaeological record suggests that manuport fossils are another form of early exogram. The concept of symbol could have arisen from them, as they combined the properties of the referent (the signified) and referrer (the exogram): one thing can represent another[13]. However, any object, mark or feature can act as an exogram; some random examples are music, imagery, maps, record-keeping devices, rhythms and rhymes, rituals, instruction manuals, billboards, software programs, tracks, knots, writing systems, languages, calendars.

Fortunately, a few forms of exograms can survive from the early times of hominin evolution, which means we can trace their possible use back through time. These forms are specific modes of palaeoart, the phenomena of art-like manifestations from our distant past. They include rock art (petroglyphs, pictograms), mobiliary ‘art’ (engravings, ‘plaques’, figurines), pigment use, manuports and, as mentioned, beads and pendants. A reasonably comprehensive survey of this material reveals that none of the three main theatres of hominin evolution can be regarded as a source area for the use of exograms[66]. According to current information, pigment use appeared first in southern Africa, engravings apparently in western Eurasia, and cupules, a form of percussion petroglyphs, occurred first in eastern Eurasia. However, there appears to be better agreement concerning the frequency of such finds as a function of time. Apart from one extremely early manuport[67], palaeoart reports are exceptionally rare in the Early and Middle Pleistocene but begin to increase in number with the Late Pleistocene. Then, around 40 ka ago, by MIS 3b, the number of such finds began to rise exponentially.

An imagined world made real

Exograms can be assumed to have had a profound effect on human cognition. This is because they are considered to be the only tangible connection between our brain, faculties of sentience and the external world[13]. Without them, we are like the prisoners in Plato's cave: at the mercy of sensory recordings translated into neural signals in our brains by a process we do not understand. We know—or we should know—that there is no reason why natural selection should have chosen to equip us with the means of determining reality. We have no idea how many aspects of reality we cannot know about because we lack the equipment to detect them. Evolution is entirely dysteleological, and while understanding the world would have been helpful to our survival, there was no mechanism in place for acquiring such understanding. Without exograms and domestication, our evolution would have continued to mirror that of any other organism's. It would have been governed entirely by the well-understood processes of evolutionary selection.

During the Late Pleistocene, humans unintentionally domesticated themselves, acquiring the domestication syndrome characteristics. Their resulting neoteny facilitated the proliferation of already developing exogrammatic phenomena to the point of rendering the formulation of constructs of reality possible. Ultimately, this was through the unique linkage exograms could provide between the human brain and the external world, which no species had acquired previously. However, this does not suggest that this 'autopoietic' reality provided a valid model. An autopoietic construct possesses sufficient processes within it to maintain the whole self-generating feedback system[68][8]. However, it can only be as valid and whole as the information on which it was based. Therefore, realistically, it cannot be expected to present more than a partial account of reality. The same applies to the billions of such models held by humanity today. Some of their interpretations are likely to be valid (particularly those that seem unfalsifiable), but a complete account of reality remains profoundly elusive.

This theory not only provides a coherent and rational explanation supported by empirical evidence but also explains Bostrom's[6] reality simulation model, which lacks such support and is ultimately untestable. That model dodges the issue of how we discovered our realities by proposing they were bestowed on us by superior beings, which still fails to explain *how* or *when* we acquired them. The creation of constructs of reality was essentially a by-product of our competence in employing exograms. It occurred at a particular time in the evolution of hominins that provides the first evidence of the integrated system of a self-reflective human brain generating volitional decisions through excitatory/inhibitory neural functions. That window should be expected to coincide with when the final robust humans began their metamorphosis to graciles by self-domestication. We know that self-awareness, consciousness and theory of mind are all available to certain non-human species[69]. The acquisition of such a level of executive control can be expected to leave relevant evidence on the archaeological record. The developments at the beginning of the last third of the Late Pleistocene provide that evidence: the harnessing of the power of exograms and the many forms of proof of domestication. Indeed, the skilled and consistent use of exograms most separates us from other species. As the human memory became increasingly encoded in externally stored memory traces, the brain's role resembled that of a central processing unit of all our memory expressions, facilitating culture's burgeoning complexity while our brain volume declined rapidly[70].

In summary, despite its incredible advances in recent centuries, science remains unable to explain some of its most profound questions. How does the human brain process the sensory data it receives and convert it into the seamless autopoietic creations we experience as reality? How did humans acquire consciousness? Or how did they attain the ability to form constructs of reality? Here, I have focused on the last-mentioned query but have not been able to provide a comprehensive solution.

Nevertheless, by placing the issue into its correct context, I have provided adequate information to locate the development chronologically and to name its causal factors. By becoming integrated into the memory system, external features rendered encephalisation redundant while facilitating volitional manipulation and communication (e.g. through symbols). As competence in using exograms became an evolutionary selection criterion, it also invited the volitional formulation of reality constructs. It is hardly conceivable that such momentous changes left no marks on the archaeological record. Most archaeologists will likely agree that the best candidate is the transition occurring around 40 ka ago, at least in Europe. I have not here detailed my belief of where the perception of reality occurs in the brain, but I have suggested elsewhere that the parietal lobe might be a worthy contender[13].

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