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Cognition and Material Culture: the Archaeology of Symbolic Storage

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Chapter 2

Hominid Enculturation and Cognitive Evolution

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Hominid cultural stages may be classified by applying strict cognitive criteria to existing chronological data. When several of these factors converge during a given time period, we have reason to propose a major cognitive-cultural 'transition' during that period. There are four proposed stages: 'episodic', 'mimetic', 'mythic' and 'theoretic'. Each hominid transition introduced a new level of cognitive governance, and consolidated a permanent, semi-autonomous layer of hominid culture. Previous cognitive structures were always retained at each transition, and it is this which has yielded the rich, multi-layered cognitive-cultural structure of the modern mind.

Human culture has become a major player in shaping cognition through its enormous epigenetic influence, which gives it the power to exploit latent cognitive potential. Hominids have capitalized upon this evolutionary opportunity to an extraordinary degree with the invention of external symbolic technologies, which, along with all of material culture, now have a determining influence on human cognition.

What is a truly 'modern' mind? One might argue that humans haven't changed very much since the Old Stone Age. The cultural remnants of the Magdalenian period, or even the Aurignacian, feel fully modern in the sense that there is a cleverness there, a tendency toward innovation and symbolism, that we instantly recognize as similar to our own. Strip away our accumulated technology and institutional structure, and there but for the grace of historical accident, as we might say, go ourselves. A corollary of this belief is that within the past 40,000 years there has not been any significant evolution of human cognition. The strongest form of this idea is that our modern cultural explosion has been driven by a mind that hasn't changed significantly since our speciation. Perhaps the most compelling evidence of this is the fact that many individuals have moved from the New Stone Age to post-industrial society in a single generation.

However, although the latter demonstration is fairly easy to make, it can lead to simplistic conclusions about the so-called constancy of human cognition, because it overlooks the potentially radical cognitive effects of enculturation. There is a close relationship between cognitive skill, especially what might be called latent individual capacity, and the process of enculturation. Individuals do not leap into modernity on their own, but rather must make the transition through a process of intense cultural embedding. That embedding process, especially if it occurs in early childhood and is sufficiently all-encompassing, might lead to the successful enculturation of the individual into a society very different from the one into which that person was born. But this process involves much more than 'programming' an individual brain with arbitrary cultural content. Members of a given culture become part of a collectivity, defined not only by specific languages and writing systems, but also by specialized representational strategies and thought skills. This constitutes the core of what is commonly known as 'higher' cognition. The power of enculturation to release latent capacity in this realm is sometimes astonishing.

The radical effects of enculturation are perhaps best demonstrated in primates because the results are so clear and unconfounded by subjective human cultural biases. Consider the chimpanzees: in the wild these animals do not show any linguistic capacity, and have very limited use of tools. When first raised in human households they were not able to acquire gestural capacity or other essential human cognitive skills such as the sharing of attention. Yet raised in an artificial culture designed by Savage-Rumbaugh and her colleagues (1993), pygmy chimpanzees have shown capacities that were formerly thought to be completely out of the reach of their species. They can learn to make Oldowan stone tools, and to modify them and use them purposefully. They can understand sentences of naturally-spoken English, including reversible sentences in which some grammatical competence is necessary to grasp the meaning. They can acquire a large lexicon of visual symbols — several hundred in some cases — and use them appropriately. They can also use visual symbols to communicate with other symbolically-competent chimpanzees to coordinate their collective activity in solving various problems and challenges; in this they are more effective at social coordination than their wild-reared conspecifics.

In sum, after undergoing this radical process of enculturation pygmy chimpanzees do not act, think, or communicate like the same species. They do things they could never achieve in the wild, obviously without changes to their genome. This raises an interesting possibility: humans may also have fundamental characteristics of mind that would not be evident outside a very specific cultural context. Savage-Rumbaugh's chimps may be regarded as 'overachievers' in the sense that they did not create the culture that revealed their latent capacities. But then again, neither did most humans create the cultural environments that mould their cognitive destinies. Perhaps most individual human beings are also cognitive overachievers carried along by various cleverly contrived cultural environments (we will worry about who did the contriving later). Historically, certain strategic kinds of cultural innovation might have released significant, and previously unseen, cognitive capacities.

This is not to minimize the role of genetic change in hominid cognitive evolution; for radical enculturation to work, the potential to copy strategic elements of the target culture must be there, in the genes. Once again, the primate example is perhaps clearest: pygmy chimpanzees have the capacity to absorb certain elements of human culture, but they evidently have serious limitations as a species that prevent them from being able to copy all the critical components of human culture, let alone invent them. The species has a zone of potential for cognitive growth, but it has to remain within that limited zone. Early hominids descended from an ancestor that closely resembled the pygmy chimpanzee, and presumably shared most of its intellectual limitations, but they must have undergone major genetic change before they acquired the capacity not only to copy, but also to invent essential elements of modern human culture. Both enculturation and genetic change can be said to have shared a continuum of influence on the evolution of hominid cognition, the two factors interacting in evolution. Seen in this way, human cognitive evolution has never really stopped; but its centre of gravity has shifted gradually from the genome to a cumulative process of enculturation.

The precise time course of hominid cognitive evolution may never be known, but the period during which the evolutionary momentum appears to have switched most strongly toward culturally-driven cognitive change seems to be the Upper Palaeolithic. It may be difficult to establish whether the explosion of cave paintings, amulets, sculptures, engravings and notational artefacts that marked the Upper Palaeolithic was sustained throughout the entire period, or periodically disappeared and reappeared, but there is little doubt that, over the long run, the process of representational invention accelerated in that era. As the process became somewhat more secure, and as human population density increased, it accelerated at an ever faster rate. There are, however, many unanswered cognitive questions about this critical time: How was spoken language evolving? Was its evolution closely tied to other forms of symbolic invention? What were people thinking about, and what types of thought-processes dominated? Were their prevalent belief systems essentially similar to those of New Stone Age peoples, or were they different in important ways? Human knowledge during this period was presumably accumulating, but how fast, and in what areas? Did the transition from hunting and gathering to agriculture, and from the latter to urban society, impose sufficiently traumatic selection pressures that further biological evolution continued to play a major role on the cognitive level, as we know it did in the case of the immune and digestive systems? Or did the interaction between enculturation and cognition eventually become independent of biological evolution?

The great value of archaeological reconstruction to cognitive science is that it forces us to ask these questions. Any theory of human cognitive structure and function has evolutionary implications, whether or not they are made explicit. It is important to make such assumptions explicit; testing various scenarios conceptually might help us choose between various theoretically possible orders and hierarchies of emergence, and thus throw light on modern neuropsychological structure. Conversely, we might actually come up with better hypotheses about cognitive evolution itself. But this won't happen unless theories of origin try to reconstruct underlying cognitive change as well as what was happening on the cultural surface.

Modularity and the notion of emergent cognitive architecture

Archaeological researchers have developed various theories of cognitive evolution to help interpret their reconstructions of the hominid past. Their efforts are enormously stimulating to read, yet this kind of cognitive theorizing has often stood in splendid isolation from modern cognitive research, and when it has tried to become connected to the cognitive mainstream, it has tended to prefer very old ideas. To take a few examples, in no particular order, there are Wynn's (1989) use of Piagetian notions about operational intelligence and formal geometry to interpret the cognitive implications of stone tools; Davidson & Noble's (1989) rather unique proposals, based loosely on the theories of Vygotsky and Ryle, about the linkage between depiction and language; and White's (1989a,b) theories on the cultural meaning of the earliest human body ornamentation, and the implied cognitive shift that took place as human culture moved beyond bare subsistence. The theoretical synthesis recently proposed by Gamble (1994) also contains a number of ideas that bear directly on the origin and special nature of human cognition, but these are not drawn from modern cognitive science or evolutionary psychology.

In fairness, this may be due to a difference in focus. Archaeology is time-oriented, and precise chronology is important, indeed central to the discipline. But evolutionary psychology has traditionally been less concerned with precise chronology than with emergent structure. Mind, despite its apparent formlessness, has structure, just the way an organism or a corporation has structure. One term commonly used to describe this structural arrangement is 'modularity'; the mind appears to be composed of many semi-autonomous modules or organs, each performing its own special function. Brain modules can be damaged independently of one another: for instance, a patient may lose the power of speech, while retaining visual recognition, or *vice versa*. This implies that the brain modules performing visual functions are autonomous from those performing speech. There are a large number of similar dissociations in the clinical literature.

Mental modules seem to have emerged in a certain evolutionary order, and have a direct link to the emergence of specialized brain structures. This idea was foreseen in MacLean's (1973) evolutionary model of the human brain, which postulated Reptilian, Palaeomammalian, and Neomammalian components. The Reptilian brain was conceived of as a cluster of component modules in the upper brainstem, midbrain and basal ganglia. These regions are concerned mostly with basic drives, reflexes, and reactions that first appeared far back in evolutionary time, with the emergence of reptiles. The blueprint of the Reptilian brain has survived in all higher vertebrates, and its survival in humans is a vestige of our descent from reptiles. MacLean's second cluster, the Palaeomammalian brain, includes those areas of the limbic system and cortex that support the most ancient mammalian instincts and emotional reactions; the blueprint of these complex structures also survives in the human brain. His third cluster, the Neomammalian brain, was superimposed on the preexisting Reptilian and Palaeomammalian acquisitions, and consisted mostly of the neocortex, which became especially large in humans. Maclean made no effort to specify the subcomponents of our specifically 'human' intelligence, or the stages that led to its evolution. Some recent theories, however, have tried to specify how the uniquely human features of brain and cognition evolved from the Miocene apes (Bickerton 1990; Bradshaw & Rogers 1993; Calvin 1993; Corballis 1991; Donald 1991; Dennett 1991; Gibson & Ingold 1993; Greenfield 1991; Lieberman 1991; Pinker & Bloom 1990; Pinker 1994).

Although many mental functions may be modular, consciousness itself does not appear to be modular, and appears to involve integration across many subsystems. For this reason, perhaps, the place of consciousness in any evolutionary scenario is special. Most of the basic operations of the mind and brain operate outside of consciousness. In fact, the defining characteristics of cognitive modules — specialized design, isolation from irrelevant information, mandatory operation — are the opposite of those that mark conscious thought, which tends to be general-purpose, open to many kinds of information, and voluntary in operation. In contrast, the operations of brain modules are usually inaccessible to conscious introspection (Fodor 1983). A good example of their isolation from consciousness may be illustrated with the example of human speech: speakers blithely produce sentences at output rates that are near the physiological limits of the system without any awareness of where the words or sentences are coming from. In a sense, speakers find out what they have said when everyone else does; just prior to speaking a word or sentence in a normal conversational context, there is no awareness of precisely what is about to be said. This principle of inaccessibility applies equally to a variety of other mental operations. Given the existence of many isolated and essentially unconscious subsystems the unity of consciousness poses a major theoretical puzzle, and it is not known how the products of dozens of semi-autonomous modules are integrated into one seamless stream of consciousness.

One popular theory is that consciousness occurs somewhere else, outside the modular hierarchy. That hypothetical place in the mind, the locus of consciousness, has been called the 'central processor', where modular outputs supposedly come together in awareness. In this common conceptualization of the mind, the central processor can range freely over the specialized outputs delivered by modules — sounds, objects, sights, feelings, places, words — comparing and unifying these various elements into a single stream of personal experience. Thus the central processor is at the apogee of mental operations, and the more rigidly-constrained 'modules' of the mind seem to be arranged in complex nested hierarchies that feed their outputs into the central processor. An analogy might be made to the role of the CEO's office in a corporation: it receives inputs from all sorts of lower-level organizational structures. Like the CEO's office, the putative central processor must know as much as possible, and be relatively unbounded; that is, remain open to a wide variety of influences, rather than being narrowly dedicated to a specific task. Its primary function is related to what some call 'large-scale neural integration' or the synthesis of knowledge across many different neural subsystems. This principle applies to many different mammalian species, since all mammals share basically similar nervous systems. However, this specific modular arrangement — the architecture of mind — appears to be quite unique in the human species.

In this theoretical context, hominid cognitive evolution might have involved a gradual expansion of the powers of the primate central processor, or the evolution of new specialized modules, or both. The idea that humans might have simply expanded their powers of large-scale integration and thus increased the capacity of their central processor has some support from both gross neuroanatomy and artificial intelligence research. First, there is important negative evidence from neuroanatomy: the most obvious distinction of hominid brains is their relative size, rather than their anatomical structure; the rapid increase in hominid encephalization produced no dramatically new structures in the human nervous system, and Passingham (1982) has stated that the modern human brain has exactly the proportions and structure that might be predicted of a very large primate brain by extrapolating earlier primate expansions. Second, computers can be made to perform qualitatively new cognitive operations with a merely quantitative increase in capacity; thus a larger brain might be expected to acquire novel operational capacities as it crossed a threshold of critical mass. Finally, archaeological evidence of cultural progress generally follows evidence of brain expansion with a considerable delay, rather than appearing at exactly the same time. For example, Acheulian tools appeared several hundred thousand years after the expansion of the hominid brain in early *Homo erectus*. This suggests that there was a general-purpose brain expansion early in the history of this species, driven by something other than tool-making, that produced delayed effects on tool-making through gradual enculturation, rather than through the action of a specialized hominid brain adaptation for improved tool-making. Hence even major new capacities, like speech, might have emerged from a quantitative expansion of existing primate integrative capacities, allowing for a sufficiently long delay to allow a degree of cultural experimentation. Savage-Rumbaugh and her colleagues (1993), who have had such success in demonstrating the symbol-using capacities of enculturated pygmy chimpanzees, have recently expressed some support for this possibility.

The contrary view is also credible: cognitive evolution must have occurred at least partly at the modular level. Human cognition has some unique features that seem to demand such an explanation. The prime example is language; as Chomsky (1993) pointed out, human language has special features that require a specialized brain module, and some recent evolutionary proposals have reflected that view (Bickerton 1990; Pinker 1994). In these proposals language must reside in a set of novel, uniquely human brain capacities that are specialized for generating language. Although this idea is still controversial, at least one aspect of language is bound to have a modular explanation: human vocal skill constitutes a dramatic break with our primate heritage and seems to depend on several neural modules that are specific to speech capacity (Lieberman 1984; 1991). Some other aspects of human higher function appear to demand specialized adaptations: left-hemisphere thinking skills, including aspects of sequential motor control, have properties that seem to involve new computational principles (Corballis 1991; Greenfield 1991) and thus imply new evolutionary modules.

On the other hand, such an approach leaves the evolutionary theorist with a dilemma; how do we establish continuity in what appears to be a discontinuous adaptation? There have been various attempts to solve this problem, by scaffolding language on top of various other, more fundamental alterations in the apparatus of mind. But the question of conscious integration remains unsolved, along with the even more perplexing question of the nature of the underlying semantic system that supports, drives, and ultimately invents languages. The machinery of language evidently gains free access to a variety of other cognitive subsystems; and this feature suggests that, to some degree, language is also non-modular in design. This implies that eventually the problem of human cognitive evolution must be addressed at the level of central processing capacities, whether or not the solution takes a traditional or a radically different form.

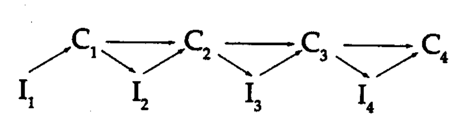
In the first section of this paper I proposed the idea that both enculturation and genetic change contributed to the cognitive capacities that are manifest in modern humans. In the second section I introduced the notion of modularity and neuropsychological structure. By combining these ideas it becomes clear that the structural changes that characterize hominid cognitive evolution must have been intricately involved with hominid culture throughout the evolutionary process.

A conceptual basis for the cognitive classification of hominid culture

Cognition and culture are in many ways mirror-images, especially in the human case. Cognition is traditionally identified at the level of single individuals — this might be termed the assumption of the 'isolated mind' — and in other species this assumption seems largely justified, since non-human species do not have a capacity for intentional representation, and are thus unable to transmit acquired knowledge across generations. (They may transmit patterns of conditioning, but this is merely a function of environmental reinforcement, not of intentional representations.) Knowledge acquired during the lifetimes of individuals remains locked inside each brain, tied to the experience of one individual, and there is no way that this knowledge can become public, or serve as the basis for gradually building a shared representational culture.

In humans there is a collective component to cognition that cannot be contained entirely within the individual brain. It is the accumulated product of individually-acquired knowledge that has initially been expressed in a form comprehensible to other members of a society, tested in the public domain, filtered, and transmitted across generations. The gradual process of embedding separate minds in an evolving culture, so that individuals increasingly fall under the sway of that culture, might be called 'emergent enculturation'. This process is the reverse face of the evolution of representational skill at the species level. The byproduct of such a development is the public representational domain; that is, a realm of expression where knowledge and custom can be created through the interaction of individual minds, and thenceforth shared by all members of the culture. The story of human cognitive evolution revolves around this radical shift from the 'isolated minds' of other mammals, towards the 'collective' mind that typifies humans living in symbol-using cultures. Collectivity depends ultimately on individual capacity; but this is a reciprocal relationship; enculturation has become more and more important in setting the parameters of human capacity at the individual level. Galloping hominid enculturation undoubtedly interacted with brain evolution; it is self-evident that the ability of individuals to cope with a rapidly-evolving representational culture would have had immediate, and at times drastic, fitness implications. Thus the hominid brain and cognition evolved in symbiosis with an emerging process of enculturation.

This symbiosis, specific to humans, might be envisaged as a series of changes progressing in parallel at two levels: individual and cultural:



(C = Successive cultural environments)
(I = Individual representations)

The culture establishes the environment within which ontogenesis will take place; and the developing individual also contributes to the cultural environment. The representational environment changes to a degree during a person's lifetime and dramatically across generations. The level of intellectual capacity visible in behaviour is thus a product of both factors, enculturation and capacity. Nothing quite like this process takes place in other species. There may be common patterns of learning in other species (even molluscs have 'customs' in this sense) and there are parent–child interactions in most complex animals, but these can be accounted for in terms of basic conditioning and learning theory, and should not be confused with the shared representational cultures of humans.

Other species start at basically the same level with each new generation; not so humans. Semantic content and even the cultural algorithms that support certain kinds of thinking can accumulate, and the symbolic environment can affect the way individual brains deploy their resources. This process of enculturation must have started very slowly, presumably with very gradual increments to a primate knowledge-base, but has evidently accelerated in an exponential manner in the modern period. The more rapid the change at the level of culture, the more crucial is the individual's capacity to 'copy' the current state of the representational culture, and also to contribute to its enrichment.

Since hominid enculturation is a special process that feeds back into the capacities of individual minds, I have chosen to classify hominid cognitive change in terms of the properties of the representational culture. Hominid cultures are classifiable not only in terms of their underlying cognitive support systems, but also in terms of their governing styles of representation. Many dimensions have been used to develop systems for classifying hominid cultures including diet, territory, tool-making, technology, food, kinship systems and shelter. These types of classification typically do not address cognition directly, although they might single out aspects of behaviour that are directly influenced by cognition.

The cognitive dimension is surely one of the most fundamental in setting the parameters of a culture; in fact, most other classifications of culture implicitly assume certain levels of cognitive development in the members of the culture. The cultural surface may be marked simultaneously by various changes, like the presence of better tools, different dwellings, complex social organization, elaborate decoration, and the presence of symbols; but the representational engine generating the changes observable at the cultural surface lies deeper, in the cognitive system, as it is deployed both in the brains of individuals and in the representational systems shared by the collectivity. It is not immediately obvious what cognitive dimensions are most important.

Language appears to be the most salient dimension; the emergence of language might have encompassed all major cognitive evolution in hominids. But one might also single out, in the Behaviourist/ Connectionist tradition, a generally-improved 'learning' capacity, or capacity for forming new associations (see Jerison 1973). Thus hominid cultures could also be classified on the basis of their 'associative' or 'linguistic' capacity. Fetzer (1993) has suggested a third approach, based on Pierce's classification of symbol-systems, that lists five levels of symbolizing capacity into which all cultures might be placed. There are several other possible semiotic and cognitive systems of classification, but none seems to do justice to the collective dimension of cognition, or deal adequately with the apparent qualitative changes that marked the succession of hominid cultures, as they progressed from one stage to the next.

In order to develop a useful cognitive classification of culture we must keep four factors in mind. The first might be called an *individual* factor: culture reflects the cognitive capacities of the individuals making up a collectivity. For instance, social complexity demands the individual capacity to remember and service many relationships, and to 'read' complex situational cues (such as those used in tactical deception by monkeys). The second is a *distributed* factor which is, by definition, larger than the individual, and involves interactions with the social and physical environment. The distributed cognitive factor produces effects that are not easily predictable from the study of isolated individuals — for instance, languages, systems of writing, or human communication networks. The third factor, imposed by evolutionary theory, is a *fitness constraint*. Major changes in hominid cognition and culture had to meet the same kinds of constraints regarding reproduction, survival strategy, and so on, as any other aspect of evolutionary adaptation. The final factor is a *comprehensiveness constraint*, which precludes any proposal based on a narrow-band adaptation in some special domain — for instance a theory that focused on the human opposed thumb, erect posture, encephalization, or tool-making, in isolation. Any classification that attempts to be more than a pragmatic one-dimensional label must take into account both individual and distributed cognitive factors, and fitness constraints, and achieve an acceptable fit to a range of chronological data on the nature and rate of anatomical, behavioural, and cultural change.

The primate cognitive functions that underwent radical change in hominids might include: (1) the range of voluntary non-verbal expression; (2) iconic and metaphoric gesture; (3) mutual sharing and management of attention; (4) self-cued rehearsal; (5) refinement and imitation of skills; (6) generative (self-cued and innovative) imagery; (7) improved pedagogy, and other means of diffusing skill and knowledge; (8) greatly increased speed of communication; (9) increased memory storage; (10) a capacity for voluntary (explicit) retrieval from memory; (11) new forms of representation (including words and larger narrative structures); (12) autobiographical memory; (13) shared representational control of emotions and instinctual reactions; (14) more complex overall structure (architecture) of representation and memory; and (15) the integration of material culture into the process of explicit knowledge representation.

The list could be made longer. Astonishingly, these massive changes were apparently achieved with about a 1 per cent change in DNA. This fact alone hints at the special nature of human cognitive evolution; much larger genetic distances between species can exist without correspondingly massive cognitive differences, and usually behaviour maps the physical inheritance of a species with exquisite precision. Chimpanzees are genetically much closer to humans than they are to most other primates, and yet their cognitive profile is far closer to that of other primates than it is to that of humans. This suggests that we need to invoke something more than genetically-entrenched changes in individual capacity in the case of hominid cognition.

Cognitive fundamentals of the enculturation process

The features special to human culture and cognition are complex and interrelated, and it appears unlikely that they evolved in parallel, each for a separate reason. There must be a simplicity to the underlying cognitive processes that support the emergence of complex human cultural features; our tentative list of changing primate functions must therefore be reducible to a much shorter list of cognitive fundamentals, sufficient to support the kinds of changes broadly encompassed within our structural model. In fact, this shortlist need contain only three items:

1. New, and *consciously retrievable*, kinds of representations must emerge at the top of the representational hierarchy;
2. these representations must be *inherently public* ways of modelling or expressing knowledge;
3. a novel, *semi-autonomous layer of culture* dependent on the first two factors must be in evidence.

My criterion for establishing major evolutionary 'transitions' in cognition (as opposed to minor changes) was that all three of these criteria had to be met in any proposed period of major change.

Memory retrieval is the first requirement. Self-triggered retrieval from memory is sometimes called 'explicit' memory, and in many ways it is the signature of human cognition. There are really only two possible routes to explicit memory: either an explicitly accessible address system was imposed retroactively on pre-existing primate memory systems, or a whole new set of inherently accessible representations was created. The first possibility seems highly improbable, given the complex design of the nervous system, and therefore I have opted for the second possibility, that a new kind of representational process supported the evolution of explicit memory capacity. This process, by which knowledge can be re-coded into retrievable, or autocuable form, has been studied extensively in modern human infants, and is known as 'representational redescription' (Karmiloff-Smith 1992). A new representational process with this fundamentally novel feature of self-retrievability implies a new storage strategy in the brain. Moreover, recoded knowledge, whether verbal or non-verbal, is driven by *public* representational systems; humans simply do not develop such representations without some social involvement. Public systems are necessarily based on output (knowledge representations that cannot be 'expressed' in outputs stay locked inside the individual brain), and therefore involve the *production systems* of the brain. The result of an expanded range of voluntary outputs is an increase in the variability of behaviour and thought, and this is manifest in an explosion of public culture. These principles hold for each stage in human cognitive evolution; thus, for each putative stage or transition, we should look for a major change in each of these three parameters.

Major hominid transitions

Using these criteria, I have re-interpreted the major anatomical transitions in human evolution in terms of cognitive/cultural changes. Table 1.1 summarizes some of the main features of the proposed model (Donald 1991; 1993a,b,c; 1994; 1996). Cultures are classified by their dominant, or governing representational style. The starting point is ape culture; and the representational style of apes can be called

Table 1.1. *Proposed successive stages or 'layers' in the evolution of primate/hominid culture, using a cognitive criterion for classification. Note that each stage persists into the next, and continues to occupy its cultural niche; thus fully-modern human societies incorporate aspects of all four stages of hominid culture. The upper Palaeolithic seems to be situated pretty clearly in the oral-mythic cultural tradition, but it set the stage for later expansions.*

Stage	Species/period	Novel forms of representation	Manifest change	Cognitive governance
EPISODIC	primate	complex episodic event-perceptions	improved self-awareness and event-sensitivity	episodic and reactive; limited voluntary expressive morphology
MIMETIC (1st transition)	early hominids, peaking in *Homo erectus*; 4M–0.4 Mya	non-verbal action-modelling	revolution in skill, gesture (including vocal), non-verbal communication, shared attention	mimetic; increased variability of custom, cultural 'archetypes'
MYTHIC (2nd transition)	sapient humans, peaking in *Homo sapiens sapiens*; 0.5 Mya–present	linguistic modelling	high-speed phonology, oral language; oral social record	lexical invention, narrative thought, mythic framework of governance
THEORETIC (3rd transition)	recent sapient cultures	extensive external symbolization, both verbal and non-verbal	formalisms, large-scale theoretic artefacts and massive external memory storage	institutionalized paradigmatic thought and invention

episodic, because its representational style is concrete and reactive, that is, bound to environmental events. Apes are remarkably intelligent and socially complex, yet they have a very limited and stereotyped range of expressive outputs. This applies even to Savage-Rumbaugh *et al.*'s (1993) recent demonstrations with bonobos; they can comprehend a surprising amount of gesture and speech in an episodic context, but they do not themselves invent such representations or transcend specific context. Thus apes have never invented a public representational arena that can be transmitted across generations. Their problem is primarily one of output rather than comprehension.

This limitation must initially have been overcome by means of an archaic adaptation that is a conceptual 'missing link' between the episodic cultures of apes and human preliterate oral cultures. This early change was a revolution in motor skill that connected action to the remarkable social-perceptual skills we inherited from apes. Early hominids, possibly *Homo habilis*, but certainly *Homo erectus*, must have had the ability to rehearse and evaluate, and thus refine, their own actions. The implication of such a supramodal capacity to review and rehearse action was that the entire skeleto-motor repertoire of hominids became voluntarily controllable under the supervision of conscious perception, an ability I call non-verbal action-modelling, or mimesis. This greatly increased the morphological variability of explicitly retrievable, conscious hominid action.

The result was, I believe, the rapid emergence of the non-verbal background of human culture, a layer of 'mimetic' culture, that still persists in the form of numerous cultural variations in expression and custom (most of which people are unaware of and cannot describe verbally), elementary craft and tool use, pantomime, dance, athletic skill, and prosodic vocalization, including group displays. The mimetic dimension of human culture is still supported by a primarily analogue mode of representation, similar in its imagery-driven operating principles to that described by Paivio (1991), and it generated a variety of manufactured artefacts as well as dramatic changes in hominid living patterns. Mimetic culture supports limited public storage and transmission of knowledge by non-verbal means — sharing of attention and gaze, uses of custom and gesture, reenactments, certain directed group behaviours, and so on. These gradually created a new class of non-verbal representations that could change and accumulate, albeit very slowly, over generations. This very slow-moving prototype of human culture was a successful adaptation that could have endured on its own, without what we strictly define as language, for well over a million years.

A second hominid cognitive transition led from mimetic culture to speech and a fully-developed oral-mythic culture. This emerged over the past several hundred thousand years, culminating in the speciation of modern *Homo sapiens*. Oral culture is a specialized adaptation that complements, but does not replace the functions served by mimetic culture. I have labelled this layer of culture 'mythic' because its governing representations consist of a shared narrative tradition — an oral, public, standardized version of reality permeated by mythic archetypes and allegories, that can exert direct influence over the form of human thought and convention. The central structures of oral-mythic culture emerged as the hominid capacity for language became universal. Its introduction involved a whole new class of representations and corresponding storage media in the brain. It also introduced a level of culture that still remains firmly at the centre of human social existence. Language also introduced a much more powerful means of explicit recall from memory than the imagery-driven retrieval enabled by mimetic representation; linguistically mediated recall is by far the most salient form of explicit memory retrieval known to modern humans. In many ways, the essence of language lies in its power to address and organize knowledge, and make it accessible to further reflection.

These two changes set the stage for the later explosion of material culture in modern humans. Thus there were, in the human evolutionary succession, two archaic stages that gave humans their distinctive *non-verbal* intellectual skills, as well as their *verbal* intellectual capacities. The second transition also undoubtedly led to a further expansion of non-verbal capacities. In fact, oral-mythic culture encompassed all the mimetic capacities of humans; mimetic culture endured as its own semi-autonomous realm of ritual, custom and other non-verbal forms of expression. But typically in such cultures, despite the strong presence of mimetic representations, it is the oral realm that dominates. This complex culture, grafted onto an underlying cognitive architecture that remained basically primate in structure, provided the cognitive inheritance of all humans who lived in the Upper Palaeolithic.

The transition from preliterate to symbolically-literate societies began in the Upper Palaeolithic and has been marked by a long, and culturally cumulative, history of visuosymbolic invention. It has also been marked by a radical new development: the externalization of memory storage. External memory (as opposed to internal, or 'biological' memory) involves completely new memory media with properties that are fundamentally different from those of biological memory. Table 1.2 illustrates some of these properties. If we were speaking of computers, we would have no difficulty accepting that a system that could use the storage properties listed in the right column of Table 1.2 (external memory) would have radically different capabilities from a system limited to those in the left column (internal or biological memory). Note that I am speaking of the cognitive capabilities of the whole social system, as well as those of individuals embedded within the system.

External symbolic technologies enabled humans to create qualitatively new types of representations, eventually yielding powerful evocative devices like paintings, sculptures, maps, mathematical equations, scientific diagrams, novels, architectural schemes, government economic reports, and so on. These elaborate devices serve an important cognitive engineering function: they set up states in the individual mind that cannot otherwise be attained. Note that this is not to say that either symbolic invention or external memory could trigger new innate mental *capacities*. Rather, the new representational possibilities emerged from a developing symbiosis with the external symbolic environment, the basis for a particularly radical form of enculturation.

This symbiosis with symbols supported the growth of a novel, semi-autonomous realm of human culture, based largely on an institutionalized literate élite. The algorithms that developed into paradigmatic thought have been cultivated gradually over thousands of years of experience with symbolically-driven cultures. Theoretic skills include a wide range of thought-algorithms that are by no means innate, and are inconceivable outside the context of a highly symbol-dependent society. I call this third stage 'theoretic' culture, because where the superstructure of external symbolic control has become established to a sufficiently high degree, it has become the governing mode of representation. Paradigmatic or logico-scientific thought, a style of thinking quite different from the narrative thought skills of oral culture, is not innate to the human brain or even to the larger culture; rather it consists of algorithms that evolved in a close iterative symbiosis with external symbols.

Table 1.2. *Properties of internal and external memory compared.*

Internal Memory Record (engram)	External Memory Record (exogram)
fixed physiological media	virtually unlimited physical media
constrained format, depending on type of record, and cannot be re-formatted	unconstrained format, and may be re-formatted
impermanent and easily distorted	may be made much more permanent
large but limited capacity limited size of single entries (e.g. names, words, images, narratives)	overall capacity unlimited single entries may be very large (e.g. novels, encyclopaedic reports; legal systems)
retrieval paths constrained; main cues for recall are proximity, similarity, meaning	retrieval paths unconstrained; any feature or attribute of the items can be used for recall
limited perceptual access in audition, virtually none in vision	unlimited perceptual access, especially in vision
organization is determined by the modality and manner of initial experience	spatial structure, temporal juxtaposition may be used as an organizational device
the 'working' area of memory is restricted to a few innate systems, like speaking or subvocalizing to oneself, or visual imagination	the 'working' area of memory is an external display which can be organized in a rich 3-D spatial environment
literal retrieval from internal memory achieved with weak activation of perceptual brain areas; precise and literal recall is very rare, often misleading	retrieval from external memory produces full activation of perceptual brain areas; external activation of memory can actually appear to be clearer & more intense than 'reality'

Like oral-mythic culture, this level of culture is dominated by a relatively small élite with highly-developed literacy-dependent cognitive skills, and its principal instruments of control — codifed laws, economic and bureaucratic management, reflective scientific and cultural institutions — are external to the individual memory system. This type of representation has gradually emerged as the governing level of representation in modern society.

Theoretic culture is still in the formative stage, and even the most recent post-industrial human cultures must encompass all these collective cognitive mechanisms and cultural levels at once. Recent research on child development supports this notion; the cognitive enculturation of modern children is highly complex, as they are led through a tangled web of representational modes and complex institutionalized algorithms (Nelson 1996; Karmiloff-Smith 1992). In effect, we have become complex, multilayered, hybrid minds, carrying within ourselves, both as individuals and as societies, the entire evolutionary heritage of the past few million years.

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References

Bickerton, D., 1990. *Language and Species.* Chicago (IL): University of Chicago Press.

Bradshaw, J. & L. Rogers, 1993. *The Evolution of Lateral Asymmetries: Language, Tool Use and Intellect.* San Diego (CA): Academic Press.

Calvin, W.H., 1993. The unitary hypothesis: a common neural circuitry for novel manipulations, language, plan-ahead, and throwing?, in Gibson & Ingold (eds.), 230–50.

Chase, P.G., 1993. Middle Palaeolithic symbolism: a review of current evidence and interpretations. *Journal of Anthropological Archaeology* 6, 263–98.

Chomsky, N., 1993. *Language and Thought.* Wakefield (RI): Moyer Bell.

Corballis, M.C., 1991. *The Lopsided Ape: the Evolution of the Generative Mind.* Oxford: Oxford University Press.

Damasio, A.R. & H. Damasio, 1994. Cortical systems for the retrieval of concrete knowledge: the convergence zone framework, in *Large-Scale Neuronal Theories of the Brain,* eds. C. Hoch & J.L. Davis. Cambridge (MA): MIT Press.

Davidson, I. & W. Noble, 1989. The archaeology of perception. *Current Anthropology* 30, 125–55.

Dennett, D., 1991. *Consciousness Explained.* Boston (MA): Little, Brown.

Dennett, D. & M. Kinsbourne, 1992. Time and the observer: the where and when of consciousness and the brain. *Behavioral and Brain Sciences* 15, 183–206.

Donald, M., 1991. *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition.* Cambridge (MA): Harvard University Press.

Donald, M., 1993a. Human cognitive evolution: what we were, what we are becoming. *Social Research* 60, 143–70.

Donald, M., 1993b. Précis of *Origins of the Modern Mind. Behavioral and Brain Sciences* 16, 737–91.

Donald, M., 1993c. *An Evolutionary Perspective on Cognition and Literacy.* Kingston: Queen's University Mathematics, Science and Technology Education Group.

Donald, M., 1994. Representation: ontogenesis and phylogenesis; a commentary on Karmiloff-Smith's *Beyond Modularity. Behavioral and Brain Sciences* 17, 714–15.

Donald, M., 1996. The role of vocalization, memory retrieval and external symbols in cognitive evolution: a reply to additional commentaries. *Behavioral and Brain Sciences* 19, 155–64.

Edelman, G.M. & L.H. Finkel, 1984. Neuronal group selection in the cerebral cortex, in *Dynamic Aspects of Neocortical Function,* eds. G.M. Edelman, E.W. Gall & W.M. Cowan. New York (NY): Wiley, 653–95.

Falk, D., 1987. Hominid paleoneurology. *Annual Review of Anthropology* 16, 13–30.

Fetzer, J., 1993. Review of Merlin Donald's *Origins of the Modern Mind. Philosophical Psychology* 6, 339–41.

Fodor, J., 1983. *The Modularity of Mind.* Cambridge (MA): MIT Press.

Gamble, C., 1994. *Timewalkers: the Prehistory of Global Colonization.* Cambridge (MA): Harvard University Press.

Gibson, K. & T. Ingold (eds.), 1993. *Tools, Language and Cognition in Human Evolution.* Cambridge: Cambridge University Press.

Graf, P. & D. Schacter, 1985. Implicit and explicit memory for new associations in normal and amnesiac subjects. *Journal of Experimental Psychology: Learning, Memory and Cognition* 11, 501–18.

Greenfield, P.M., 1991. Language, tools and the brain: the ontogeny and phylogeny of hierarchically-organized sequential behavior. *Behavioral and Brain Sciences* 14, 531–95.

Jerison, H., 1973. *The Evolution of the Brain and Intelligence.* New York (NY): Academic Press.

Karmiloff-Smith, A., 1992. *Beyond Modularity: a Developmental Perspective on Cognitive Science.* Cambridge (MA): MIT Press.

Kimura, D., 1976. Neuromotor mechanisms in the evolution of human communication, in *Neurobiology of Social Communication in Primates,* eds. H.D. Steklis & M.J. Raleigh. New York (NY): Academic Press.

Lieberman, P., 1984. *The Biology and Evolution of Language.* Cambridge (MA): Harvard University Press.

Lieberman, P., 1991. *Uniquely Human: the Evolution of Speech,* *Thought and Selfless Behavior*. Cambridge (MA): Harvard University Press.

McGrew, W.C., 1992. *Chimpanzee Material Culture: Implications for Human Evolution*. Cambridge: Cambridge University Press.

McGrew, W.C. & L.F. Marchant, 1992. Chimpanzees, tools, and termites: hand preference or handedness? *Current Anthropology* 32, 114–19.

MacLean, P.D., 1973. *A Triune Concept of the Brain and Behavior*. Toronto: University of Toronto Press.

McNeill, D., 1991. *Hand and Mind: What Gestures Reveal about Thought*. Chicago (IL): University of Chicago Press.

Mellars, P., 1989. Technological changes across the Middle–Upper Palaeolithic transition: economic, social and cognitive perspectives, in Mellars & Stringer (eds.), 338–65.

Mellars, P. & C. Stringer (eds.), 1989. *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans*. Princeton (NJ): Princeton University Press.

Nelson, K., 1996. *Language in Cognitive Development: Emergence of the Mediated Mind*. Cambridge: Cambridge University Press.

Paivio, A., 1991. *Images in Mind: the Evolution of a Theory*. New York (NY): Harvester Wheatsheaf.

Passingham, R.E., 1982. *The Human Primate*. New York (NY): Freeman.

Pinker, S., 1994. *The Language Instinct: How the Mind Creates Language*. New York (NY): Morrow.

Pinker, S. & P. Bloom, 1990. Natural language and natural selection. *Behavioral and Brain Sciences* 13, 707–84.

Premack, D., 1987. *Gavagai*. Cambridge (MA): MIT Press.

Savage-Rumbaugh, E.S., J. Murphy, R.A. Sevcik, K.E. Braake, S.L. Williams & D. Rumbaugh, 1993. *Language Comprehension in Ape and Child*. (Monographs of the Society for Research in Child Development 233, v. 58.) Chicago (IL): University of Chicago Press.

White, R., 1989a. Production complexity and standarization in Early Aurignacian bead and pendant manufacture: evolutionary implications, in Mellars & Stringer (eds.), 366–90.

White, R., 1989b. Toward a contextual understanding of the earliest body ornaments, in *The Emergence of Modern Humans: Biocultural Adaptations in the Later Pleistocene*, ed. E. Trinkhaus. Cambridge: Cambridge University Press, 211–31.

Wynn, T., 1989. *The Evolution of Spatial Competence*. Champaign-Urbana (IL): University of Illinois Press.