Some anthropological objections to evolutionary psychology.

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Evolutionary psychology is an attempt to explain human culture as the product of human psychology, but it also asserts that the properties of the human brain itself have been determined by a series of adaptations, over millions of years, to the conditions of the Pleistocene in East Africa. Tooby and Cosmides (1992), two of the leading evolutionary psychologists, make a powerful critique of what they call the Standard Social Science Model (SSSM), especially familiar to social anthropologists. This claims, in particular, that there is no such thing as human nature that provides us with innate cognitive or behavioural dispositions: we are basically blank slates, totally malleable. All human thought and behaviour are therefore learned, conditioned by the unique culture in which we have grown up, but our culture itself is not influenced by any innate human psychology. Tooby and Cosmides, however, draw attention to the many universals in human thought and behaviour which are clearly not dependent on culture, and give other good reasons for regarding the SSSM as seriously flawed.

Some years previously (Hallpike 1976, 1979), I had also criticised the SSSM in rather similar terms to those of Tooby and Cosmides, and to this extent I therefore agree with their critique of its many absurdities. Unfortunately, the cure which they advocate, evolutionary psychology, merely substitutes a new set of fallacies, as we shall now see.

Evolutionary psychology also criticised sociobiologists 'for attempting to apply evolutionary theory directly to the level of manifest behavior, rather than using it as a heuristic guide for the discovery of innate psychological mechanisms.' (Cosmides and Tooby 1987:278-9) By 'innate psychological mechanisms' they meant that the human (and every other) brain is basically a computer, a computer being a device that processes information according to precisely specified rules in order to produce solutions to definable problems. It is not a general-purpose problem-solving device, but divided into different specialized departments or 'modules', each dedicated to different kinds of problems, such as tool-use, social exchange, child-care, and so on. The design and functioning of these modules was shaped by natural selection during the several million years of the Pleistocene in East Africa, the ‘environment of evolutionary adaptation’ (or EEA):

> …selection operates over thousands of generations. For ninety-nine percent of human existence, people lived as foragers in small nomadic bands. Our brains are adapted to that long-vanished way of life, not to brand-new agricultural and industrial civilizations. They are not wired to cope with anonymous crowds, schooling, written language, government, police, courts, armies, modern medicine, formal social institutions, high technology, and other newcomers to the human experience.’ (Pinker 1997:42)

But before going further into the details of evolutionary psychology, it is worth pointing out some fundamental objections to the theory that are obvious from the outset. In the first place, if one is claiming that the traits of a species are very specific adaptations to a particular environment, it is obviously essential to know in detail what that environment is like. While, however, we are quite well informed about physical conditions in East Africa one or two million years ago, by the standards of ethology and of social anthropology we know virtually nothing about the social relations and organization of our ancestors in those remote epochs, and even less about their mental capacities. We cannot, in particular, even be sure that they even possessed grammatical language, and this general level of ignorance is quite incompatible with any informed discussion of possible adaptations.

The second problem is that this extreme adaptationism[1] ought to have high predictive value about subsequent human behaviour since the EEA, especially during the last 10,000 years of maximal social and cultural change. For example, if our environmental preferences had been significantly shaped by the EEA, we would expect humans, in their subsequent expansion all over the globe, to choose environments with a discernible resemblance to the savannah of East Africa, (e.g. Orians 1980, Orians and Heerwagen 1992)[2] and to avoid those that differed markedly from it, like rain-forests, deserts, the arctic, islands in the Pacific Ocean, and high mountain ranges. We would also expect them, after millions of years of simple, egalitarian hunter-gatherer existence in small groups, to be strongly resistant to the formation of large-scale, highly stratified societies, and, again, to have great difficulty in mastering modern electronic technology, just to mention a few glaring examples of major cultural change. Yet we know very well that in these and innumerable other respects, human habitats, social organization, culture, technology and modes of thought have diverged in wildly different ways from the model of man in the EEA, so that evolutionary psychology has no predictive value at all in these essential respects. It is not enough to say, as do Cosmides, Tooby, and Pinker, that our brains are not hard-wired for these more modern tasks: the more basic question is how we could ever have developed these forms of behaviour and thought at all.

Thirdly, this raises the methodological objection that in Darwinian theory, biological adaptations can only be to existing circumstances, never to those that might exist in the future. This fundamental point about human abilities was first made by A.R.Wallace, Darwin's co-formulator of the theory of natural selection, who had extensive first-hand acquaintance with hunter-gatherers of south-east Asia. He noted that on the one hand their mode of life made only very limited intellectual demands, and did not require abstract concepts of number and geometry, space, time, and advanced ethical principles, or music, yet they were potentially capable of mastering the advanced cognitive skills of modern industrial civilisation. Since, as noted, natural selection can only produce traits that are adapted to existing, and not future, conditions, it 'could only have endowed savage man with a brain a little superior to that of an ape, where he actually possesses one little inferior to that of a philosopher'. (Wallace 1871:356) How, then, can this 'excess' intellectual capacity be explained by natural selection?

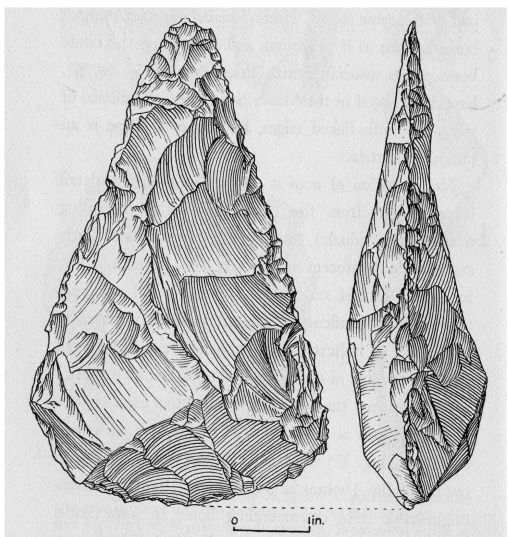
1. *Reverse-engineering.*

Pinker, like Cosmides and Tooby, argues that if we want to discover why each of our mental modules, like any anatomical feature, has a distinctive structure, it is standard biological procedure to work out what it does, its function, and therefore what problem of survival it was selected to solve. This involves what he calls 'reverse-engineering':

> We all engage in reverse engineering when we face an interesting new gadget. In rummaging through an antique store, we may find a contraption that is inscrutable until we figure out what it was designed to do. When we realise that it is an olive-pitter, we suddenly understand that the metal ring is designed to hold the olive, and the lever lowers an X-shaped blade through one end, pushing the pit out through the other end. (Pinker 1997:21-2)

While we can obviously understand in principle how birds' wings generate lift and thrust, without having to know anything at all about their evolutionary history, it would be argued that to explain the differences between the wing designs of various species we do need to know the specific problems that each type of wing was 'designed' to solve in its evolutionary history. Reverse-engineering, however, is not as straightforward as Pinker supposes.

Let us give it a simple test by considering the case of the Acheulian handaxe, and how we might discover what it was used for. It is probably the most celebrated of all stone tools, made from about 1.4 Myr ago to around 100,000 years ago by *Homo erectus*, archaic *Homo sapiens*, and the Neanderthals. Manufacture gradually became more refined, but the basic design-type was retained. It was first made in East Africa, and later appeared in the Near East, Europe, and India, and there are many thousands of specimens, varying from a few inches in length to over a foot. Archaeologists by now should therefore have been able to apply reverse-engineering to this well-known artefact and have a very good idea what it was for.



(From Oakley 1964:116, Fig. 32)

On the contrary, the interpretation of the hand axe is one of the most controversial subjects in Palaeolithic technology. As Thomas Wynn has rightly said, '…it would be difficult to overemphasize just how strange the handaxe is when compared to the products of modern culture. It does not fit easily into our understanding of what tools are, and its makers do not fit easily into our understanding of what humans are.' (Wynn 1995:21)

In the first place, while hand axes vary considerably, why on earth should they normally have an edge all the way round, instead of just on one side or end? As anyone who has held a hand axe knows, 'The sharp edge of the hand axe, when used with force, was, (and is) capable of inflicting as much damage on the user as on the material being worked.' (O'Brien 2009:2). This in itself is an extremely odd characteristic to find in a tool, and while there is considerable variation in size, they are all, with the rarest exceptions, very awkward and uncomfortable to hold in either hand. It is also clear from the many specimens I have examined that they could not have been hafted in any way.[3]

Perhaps, however, we have fallen into the trap of what Noble and Davidson (1996:168) refer to as 'the fallacy of the finished artefact', the belief that the artefact as we find it on an archaeological site is like the hoes and rakes that we buy at our local garden-centre, which the makers have obviously intended as the finished tools. It might be that we are mistaken in treating the hand axe as a 'finished artefact', because the knapping of flint involves striking a 'core' to produce a series of flakes that are typically much sharper, though smaller, than the core, and may be it was these flakes which were actually wanted (for many purposes, such as cutting meat, scraping, and skinning), and not the core. It is therefore possible that the hand axe functioned primarily as a useful core for striking flakes, to be carried about until needed, rather than that the flakes were struck from the core specifically to produce the hand axe. Wynn (1995:12) disagrees, however, on the grounds that some of the flakes removed for trimming would have been too small to be useful, and the degree of bilateral symmetry is unlikely to have been produced simply by the striking of flakes.

But even if we conclude, with Wynn and other archaeologists, that hand axes were not just intended as convenient sources of flakes and had a purpose, that purpose remains enigmatic. The flakes struck from them would have been much sharper and better for cutting up meat than the axes themselves, whose bifaced edges are inherently blunter than flake edges and would make very poor knives. To be sure, experiments have shown that the hand axe *can* be used for scraping, skinning, and digging up roots, and it was long supposed that it was a general-purpose tool for these activities.

> But *Homo erectus* possessed other tools suitable for these purposes – tools that precede and continue alongside the hand axe in the archaeology of record. Compared with these, the hand axe was costly to produce in terms of time, labor, and skill, and required larger blocks of fine-grained, faultless stone such as flint or basalt. (O'Brien 2009:2)

The shape of the hand axe, therefore, seems to have been imposed on the material without any regard to convenience of use:

> The idea that function somehow determines form has been popular since the nineteenth century, at least, but is almost certainly wrong. A huge variety of forms can be employed to accomplish any task, and because the task itself cannot make the tool, whoever does the task must make a choice…It is necessary to conclude that early hominids chose to make handaxes, and that only part of that choice included a consideration of task. Here the recent emphasis on reduction sequences has been very revealing; *much of the form of a stone tool results from the way it was manufactured and the fracturing characteristics of the raw material.*[my emphasis]. These are unrelated to function. (Wynn 1995:14)

'Another proposal, advanced to explain why excavators find hand axes standing on edge, *in situ*, is that the hand axe acted as a stationary tool, one edge embedded in the earth while the exposed edge cut or scraped an object passed over it.' (O'Brien 2009, 2). On the other hand, the fact that large numbers of hand axes have been found in stream beds has suggested to some archaeologists that they could have been used as projectiles to bring down members of herds which had gathered to drink in the water. O'Brien reports experiments in which hand axes were successfully thrown in the manner of a discus, or overhand like a knife.

There are also sites where hundreds of hand axes, many impractically large, and also apparently unused, have been found in close association together. Kohn and Mithen (1999) have suggested that some large hand axes were status symbols, made and displayed by males in search of a mate, to demonstrate that they possessed sufficient strength and skill to pass on to their offspring. Once they had attained a female at a group gathering, it is suggested that they would discard their axes, this perhaps explaining why so many are found together.

It has therefore proved impossible for archaeologists, after more than 150 years, to establish the purpose(s) of the most important of all Palaeolithic tools, present abundantly on many different types of sites, and in many different locations. The reason for this is obvious. The olive-pitter is made by people like us, members of modern industrial culture, but we know virtually nothing about the culture of those who made hand axes, or about their mental processes, so we cannot assume that they resembled ours. (Indeed, it should be noted that even in surviving nineteenth century workshops, there are often old tools whose purposes have been forgotten, and cannot be rediscovered because the day-to-day procedures in which they were involved have long disappeared.)

The obvious conclusion is that reverse-engineering is only possible if we already have a very good understanding of 'the form of life' from which an artefact comes, which is certainly not the case with the EEA. But if we can't reverse-engineer something as well-defined as a hand axe, and identify the adaptive problems it was intended to solve, how likely is it that we shall succeed with the much more nebulous manifestations of the early human mind and patterns of behaviour?

2. *Problem-solving and the environment of evolutionary adaptation.*

The idea of evolution as problem-solving is central to evolutionary psychology, notably in its treatment of the EEA. This approach is based on what they take to be the paradigm case of human adaptation, vision, (as expounded by David Marr, 1982), which they believe to have been programmed by selection over millions of years to solve such problems as depth-perception, and the maintenance of colour-constancy under different conditions of illumination. Evolutionary psychologists believe that all species face a range of such adaptive problems, like the physical obstacles in an assault course, a standard set of tests which species must either pass, or fail and die out. But, whatever their evolutionary history, vision and the other primate senses operate in an unconscious, automatic and 'pre-programmed' way that makes them highly implausible models for such patterns of conscious behaviour as early man's struggles to find adequate food and water, for example. While finding these are, indeed, very general problems of survival that all animals must solve, the specific methods of doing this, unlike those of the eye, must have involved highly flexible strategies, working in many different but still viable ways. In this scenario, why, though, should we expect to find any rigidly programmed adaptive strategies at all, incorporated by natural selection into the human behavioural repertoire? The Masai, for example, use Honeyguide birds to lead them to wild bees' nests, whereas the Konso put scented hives in trees to attract the wild bees to nest in them. Indeed, in what sense is it true that they 'had' to find honey at all, as long as they got something to eat, or that early humans 'had' to master the control of fire in order to cook their food?

No other primates mastered fire, (or, for that matter, learned to make stone tools), but they can't be said to have 'failed' these tests, since they have survived perfectly well without either stone tools or the ability to cook their food. The human mastery of fire for cooking, like that of obtaining honey in East Africa, must have been the result of *exploratory* behaviour – such as sampling animal meat burnt in a forest fire – and then developing this enjoyment by further experiments in the control of fire, but which were only possible because of the special properties of the human mind. Like the collection of honey, it was not the solution to a pre-ordained 'problem', but simply an innovation that in the outcome happened to increase human fitness[3].

Knowing the physical environment, as in the case of East Africa in the Pleistocene, is therefore not enough to be able to predict what sort of human adaptations to it are likely to have occurred: there are, for example, plenty of rivers and lakes in East Africa, but without knowing a good deal about the mentality of *Homo erectus* we cannot say anything about fishing as an adaptive 'problem'. If they could only imagine eating land animals, or were disgusted by fish, or could not envisage any means of catching them, then fishing could not have been a 'problem' for them. (I discuss the notion of adaptive 'problems' at length in Chapter 7.)

Not only, then, has 'reverse engineering' shown itself to be an unworkable programme, but it cannot be sufficiently emphasized, at this stage in the critique of evolutionary psychology, that our ignorance about early man in general is profound. Even in the case of the earliest *Homo sapiens sapiens* from around 200,000 years ago we do not know if they had the ability to speak, and if so, what sort of things they might have said to each other, what made them laugh, what they quarrelled about or how they maintained peaceful relations within the group. Nor do we have any idea when they first had personal names, or when they could form the ideas of 'mother', 'father', or 'mother's brother', or when they developed the idea of some sort of official union between adult men and women, or if they exchanged women between bands, or how hunting co-operation was organized, or what sort of leadership existed. Nor do we know when man first had ideas of magic and symbolism, gods, ghosts, and spirits, or when or why he first performed religious rituals and disposed of the dead in a more than merely physical manner.

Evolutionary psychologists constantly emphasise the enormous length of time needed for natural selection to operate, and the necessity for the environment to be essentially stable in order for adaptations to become established. As already noted, their standard example is vision, and they portray the pattern of human life in the EEA as essentially stable too, but by comparison with the physical environment this is quite untrue. It is obvious that there must have been major changes in human social organization throughout the EEA from *Australopithecus* to modern *Homo sapiens*. These would have involved the ending of male dominance – if it had existed – and of sexual competition for mates; the evolution to hunting from scavenging; the development of co-operation and sharing, especially in hunting; the loss of body hair and its consequences for grooming and mother-infant relations; the development of pair bonding with the changes in child-rearing which this would have produced; the use and control of fire, and its consequences for pair bonding; and above all, the development of grammatical language, which would have swept through the existing culture and undoubtedly produced enormous changes, probably of the sort that we find in the Upper Palaeolithic. Not only are there are basic uncertainties about the order of these changes, and the time scales involved, but they would also have involved significant mental changes such as increases in delayed gratification, planning and foresight, practice, imitation, and the length of the causal chains that could be conceptualised, to name some of the most important. (See in particular the papers in de Beaune *et al*. 2009 for more details on this.) All this would also have made it very difficult for stable adaptations to have become established.

The control of fire for cooking, and the emergence of grammatical language, are good examples of the problems involved for the strict adaptationist scenario when it is faced with radical changes in the modes of interaction with the environment.

(a) *The control of fire and cooking.*

One of the most important innovations was the control of fire and the origin of cooking. Some of the most profound social effects of this would have been on the pattern of co-operation and reciprocity especially in the male/female bond. We do not know at what point in human evolution men began to form stable and protective unions with women and the children produced, but it would have been a fundamental change from a social organization in which males competed with one another for females in the typical primate fashion.

If males had contributed the meat they gained from hunting, and the females contributed the plant foods they gathered, a stable system of reciprocal exchange could have been created between male and female partners. Individuals could have still eaten their own food, however, because it was raw. Cooking, however, would have introduced an important change because it put an end to this self-sufficiency. The plant foods typically collected by women are a more reliable source of food than meat obtained from hunting (or scavenging), and cooking this is most easily performed at a home base. So it is easy to see why women would have been the first regular cooks, a task which is also much more compatible with child-care than hunting, but men would also have become dependent on them

> Cooking takes time, so lone [female] cooks cannot easily guard their wares from determined thieves such as hungry males without their own food. Pair-bonds solve the problem. Having a husband ensures that a woman's gathered food will not be taken by others; having a wife ensures the man will have an evening meal. (Wrangham 2009:154)

This also means, however, that a man without a wife to cook his food is at a serious social disadvantage, and in hunter-gatherer society women are most valued because they can cook, rather than for sexual purposes. As Wrangham points out, it is a cross-cultural universal that the wife provides her husband with a cooked evening meal, which gives him the freedom to spend the day in his own activities, and to give hospitality to his friends. But whereas a man is obliged to share his catch with the rest of the community, a married woman has ownership of her gathered food, and is only obliged to share it with her husband and children, or her close kin. The nuclear family and its hearth thereby became a unit that was not normally obliged to share its food with non-family members.

> Cooking need not be a social activity, but a woman needs a man to guard her food, and she needs the community to back him up. A man relies on a women to feed him, and on other men to respect his relationship with her. Without a social network defining, supporting, and enforcing social norms, cooking would lead to chaos. (ibid.,171)

But we have very little evidence about when cooking became the norm. There is no archaeological evidence to support Wrangham's theory that the discovery of fire and cooking occurred with the Habilines around 2 Myr ago, and his argument rests entirely on the biological evidence of diminished tooth size, smaller mouths, and smaller guts, appropriate for a cooked food diet. This biological evidence, however, is not decisive. There are, for example, many types of animal tissue, such as brains, liver, intestines, and other organs which are soft and easily chewable in the raw state, and are highly nutritious, while muscle tissue can easily be cut up into bite-sized portions by the use of sharp stone flakes which were available to the earliest, Oldowan, technology of the Habilines. The extreme technological conservatism of *Homo erectus*, however, and the difficulty of maintaining fire captured from natural sources such as lightning strikes, let alone discovering how to make fire artificially, seems to make their conquest of fire for cooking rather unlikely. If cooking fires had been the norm at this early date, it also seems strange that there is no sign of them at all in the archaeological record during the Lower Palaeolithic. The archaeological evidence seems to indicate a much later date in the Middle Palaeolithic, at least that of archaic *Homo sapiens* around 400,000 years ago, before use of fire for cooking might have become the norm (see in particular James 1989, Noble and Davidson 1996:205-6).

(b) The emergence of language and its consequences.

We have seen that the whole enterprise of evolutionary psychology assumes we can identify the range of 'problems' that our Palaeolithic ancestors had to solve. The impression is given that the environment of the EEA was basically static, and that human evolution was simply a process of cumulative adaptation to this environment, whereby more and more modules were evolved over millions of years to produce the characteristic human mind. A fundamental issue here, however, is the problem of when language first emerged. By 'language' I mean not only the ability to use sounds as symbols in a non-iconic way, but to make grammatical statements that, at a minimum, included assertions of truth and falsity, asking questions, and some ability to refer to the past and the future. Some have argued that language in this sense developed as far back as 2 Myr ago, with *Homo erectus*, while others maintain the opposite view that language has only developed quite recently, some time in the last 100,000 years and probably in the last 50,000 years or so. If something like the second view turns out to be correct, this would mean that for the duration of the EEA our ancestors lived in a basically pre-linguistic state, and the consequences for evolutionary psychology would be enormous. In the first place, it is impossible for us to imagine what a pre-linguistic form of human society would have been like, with all the negative consequences for a programme of reverse-engineering which that involves; and secondly, it would imply that the major developments in human culture occurred *outside* East Africa and the EEA, during the subsequent period of world-wide human dispersal.

It might indeed have been possible for *Homo erectus* to produce a rich variety of social sounds, continuing and elaborating a well-known disposition of primates in general, who have been referred to as 'the noisiest of mammals'. But expressing a wide range of emotional states is not comparable in social importance with language, and here we need to consider the main effects of language on human society.

> Perhaps the most important point to recognize is the profound significance which major changes in linguistic communication patterns could have had in almost all spheres of human behaviour and organization. . .Whallon (1989) in particular has drawn attention to the crucial importance of what Bickerton (1981) and others have called 'displacement' in linguistic communication – the ability not only to refer to immediate events and situations but to discuss the possible outcome of future events and scenarios and to discuss (and presumably draw

lessons from) events and experiences in the past. As he points out, this could have implications for the ways in which human groups planned and organized all aspects of their behaviour – not only food procurement, technology etc., but also the integration and coordination of their activities with those of other individuals and groups. It would also have influenced their ability to learn from past experiences, to build up a store of information, rules, and beliefs to control future events, and, in short, to accumulate formalized culture in the full sense of the word. . . *If one were to attempt to identify any single development in human evolution which could, potentially, have revolutionized the whole spectrum of human culture and behaviour, then the emergence of complex, highly structured language would perhaps be the most obvious candidate.* [my emphasis] (Mellars 1989:364, and see also Mellars 1991).

Without language there would have been no way of communicating group norms and concepts of reciprocity, sharing, and cheating, or of individuals informing each other which members of the group had violated those norms – there would have been no personal names either – nor could deviant individuals be subjected to communal pressure by verbal abuse or ridicule. There could have been no formal kinship categories or rules, and no way of expressing such ideas as property or hunting rights. There could have been no symbolism, no ritual, no idea of magic or supernatural beings, no myths, and no shamans. There could have been no group planning, no reinforcement of social ties through conversation, and no discussion of technology and other problems of survival, and of possible new ways of doing things. If life in the EEA was in fact pre-linguistic, not only is it impossible for us to imagine what it would have been like, but when language did emerge it would have involved a complete recasting of the human mind, and any 'modules', if such existed.

What are the main arguments for the emergence of speech with the earliest Homo, 2 Myr ago?

(1) Relatively great increases in brain size between *Australopithecus* and *Homo habilis* (Tobias 1988).

(2) The appearance of the human form of Broca's area in the first Homo, and the significance of Broca's area in the articulation of speech (Falk 1987, Holloway 1969, Tobias 1988).

(3) Oldowan tools (the precursors of the Acheulian) were made by right-handed people, and hemispheric lateralisation of the brain implies the possession of language (Toth 1985).

Taking these points in order, first, Noble and Davidson point out that

At the time shortly after 2 Myr when the range of cranial capacity expanded, the range of stature also expanded dramatically…brain size and body size are closely related, so it should be small surprise that the range of cranial capacity increased at the same time as the range of stature…the major increase in relative brain size – in encephalisation – seems to be much

> later than Tobias is suggesting. (1992:157) [In any case] . . .brain size, absolute or relative, does not seem to be a reliable or sufficient indicator of the sorts of abilities that might, in evolutionary terms, have led to the emergence of a distinctive human behaviour such as language. (ibid., 154)

In this connection, Lenneberg also observes that nanocephalic dwarves, with the same brain and body weight as chimpanzees, nevertheless have at least the same verbal skills as a normal 5-year old child (1966:82-84).

Secondly, the fact that a particular region of the brain is now associated with a particular function does not imply that this explains its evolutionary origins. It has been shown that 'gyri', or protuberant parts of the brain such as Broca's area simply increase as brain size grows in relation to the volume of the cranium (Jerison 1982). If the emergence of Broca's area in its human form was initially the result of such a process, this suggests that 'The first appearance of the shape by which Broca's area may be identified has more to do with the expansion of cranial capacity than with the functions that were performed by this bit of neural tissue.' (Noble and Davidson 1996:169).

Thirdly, Toth's claim that the makers of Oldowan tools were right-handed would not now be accepted. The data and arguments are complex, and the details can be found in Uomini 2009:42-5, and Noble and Davidson 1996:169-71. Tool-making itself did not require language for its transmission, and it has been shown by experiment that the techniques not only of the Acheulian hand axe but the Levallois point – associated with the Neanderthals – can be communicated non-verbally (Uomini 2009:54).

Dunbar has argued, however, that language emerged in the context of archaic *Homo sapiens*: 'By the later part of the Middle Pleistocene (about 250,000 years ago), groups would have become so large that language with a significant social information content would have been essential' (1992:190), and that early language would have been associated with 'codified kinship systems and religion'. The teleological argument that the evolution of language would have been 'essential' is curiously unDarwinian, but his reasoning is that in primates there is a clear association between neocortex size and group size, because of the increased cognitive demands of maintaining social relations as groups grow in size. Social relations among primates are maintained by grooming, and the time spent on this increases with group size, so that beyond a certain size the time available is insufficient to maintain relations. Therefore ‘language evolved as a form of bonding mechanism to use social time more efficiently’ (ibid., 184).

The immediate and obvious objection is that the evolution of language would have taken a very long time, and while our ancestors were waiting for this to occur a much simpler solution was available: if there was insufficient time for grooming, groups would simply have grown smaller until there was sufficient time for these activities, thus removing any selective pressure for language that there might have been.

The neocortex size of archaic *Homo sapiens* of the Middle Pleistocene indicates, according to Dunbar’s calculations, that they lived in groups of about 148, and he also claims that

> There is considerable evidence that groupings of this size occur frequently in modern and historical human societies. Census data for 20 hunter-gatherer populations support this prediction by revealing an average group size of 153 individuals (range 90 – 220), intermediate between the widely recognized smaller band-type groups of 20 – 50 individuals and the larger tribal groupings in excess of 500 individuals. The smaller and larger groups are well established in the anthropological literature…; in contrast, the intermediate level groupings, though often discussed, have not been widely censused. (ibid., 185)

In the first place, his claim that archaic *Homo sapiens* in the Middle Pleistocene lived in groups of around 148 is contradicted by the archaeological evidence, and the consensus of archaeologists is that such groups were actually very small, possibly even smaller than those of modern hunter-gatherers. Secondly, his claim that modern hunter-gatherers live in ‘intermediate’ groups of about 153 has no support at all in the anthropological literature. While he claims the existence of census data from ‘20 hunter-gatherer populations’, he provides no sources for this remarkable claim, which also seems inconsistent with his admission that such groups ‘have not been widely censused’. In any case, such large face-to-face groupings, other than occasional meetings of a seasonal nature, would have no purpose in hunter-gatherer life.

Furthermore, if language had emerged at this time, it is hard to understand why the revolution in human thought processes that it must have entailed has left no mark on the archaeological record. To explain this, Mithen, following Dunbar, believes that early man did acquire language 250,000 years ago, but that the human mind was divided into multiple intelligences (something like modules), namely Social Intelligence, Natural History Intelligence, and Technical Intelligence, ‘each dedicated to a specific domain of behaviour, with very little interaction between them’ (Mithen 1996:164). But ‘the subject matter of the earliest language was social interaction: it was in effect a “social language”.’ (ibid., 159) This social language, however, was allegedly incapable of being used to discuss topics involving Natural History and Technical Intelligence, which is why there were no changes in the archaeological record. It was only very much later, he claims, roughly 60,000 – 30,000 years ago, that the 'cultural explosion' of the Upper Palaeolithic, involving symbolism, art, and the great proliferation of technology, occurred. 'This can be explained by the collapse of the barriers that had existed between the multiple intelligences of the Early Human mind.' (ibid., 199-200), and this new cognitive fluidity could now be expressed in language that connected every part of the mind. He dismisses the idea that it was the emergence of language itself – fully grammatical language, of course – that could have been responsible for this cultural explosion, but his reasons for doing so are unconvincing.

In the first place, the idea that language was originally restricted to social topics, and could not have referred to Natural History and Technology, is arbitrary and quite unworkable. What kind of language could have had words for gift, insult, and mother's brother, but not for food, wood, stone, water, earth, hand axe, lion and elephant? Indeed, since we are ourselves physical objects, and are anatomically like animals, how could one talk about social topics without bringing in Technology and Natural History? How could one say 'The man hit the boy', but not 'The man hit the tree', or talk about human blood but not animal blood, or human body-parts and not those of animals? Can we really imagine a hunter scraping a spear to a point and hardening it in the fire, and then, when he had finished, wondering what it was for? Technological Intelligence only makes sense in a close relation both to Natural History Intelligence and Social Intelligence, and language, when it developed, must from the beginning have been able to refer to all areas of consciousness, so all that experience would have become closely interrelated. The obvious conclusion is that, as Mellars and others have pointed out, it was the development of grammatical language *itself* which produced the cultural explosion of the Upper Palaeolithic, not any final (and mysterious) coalescence of those entirely speculative Three Intelligences that Mithen proposes.

The developments of the Upper Palaeolithic include, most significantly, symbolic motifs, and symbolism in particular is impossible without language.

> The most plausible candidate for this cultural stimulus [of the Upper Palaeolithic] is the invention of language, an activity that is virtually synonymous with our symbolic reasoning ability – and that would certainly be impossible in its absence…In this connection it is important to remember that by the time demonstrably symbolic behaviors had emerged the

> structures that permit speech were already in place, and had been for maybe as much as several hundred thousand years – having initially been acquired in some other context entirely. (Tattersall 2009:114-15)

The colour white, for example, may stand for purity, or milk and motherhood, or, as among the Konso of Ethiopia (Hallpike 2008), for death, because of the colour of bone and cotton, which ripens in the dry season, the season of death, in opposition to the rainy season, the season of life. But without language it would be impossible for anyone to specify precisely which of these associations was the operative one. So while Neanderthals and early *Homo sapiens* may have used ochres as body-paints, this was not necessarily symbolic at all. To count as symbolism, the colouring would have had to stand for some other association, as when Konso dancers at a *shilleeta*, a dance of mourning, paint their bodies white, the colour associated with death. Modern women, on the other hand, wear lipstick for purely aesthetic reasons, and it has no 'meaning' beyond this. So Mellars, for example, refers to 'the very sparse evidence for almost any form of complex, clearly symbolic behaviour amongst Neanderthals and other archaic human populations' (1989:364). The fact that we do not find any symbolic forms before the Upper Palaeolithic is particularly strong evidence that grammatical language had not developed, and consequently that the EEA was probably pre-linguistic.

Our conclusions are therefore that the EEA was marked by a series of basic transformations, of very uncertain date, in human social organization relating to such fundamentals as sharing and co-operation, planning, pair-bonding and the family, the control of fire and the use of cooking, and language, which would have required a number of major mental readjustments to a sequence of new circumstances, quite unlike the unvarying problems of vision and the other physical senses. The greatest of these transformations by far would have been the development of grammatical language, but it seems increasingly likely that this occurred as the EEA was coming to an end, or afterwards. If this is so, then first, any massive modularity as postulated by evolutionary psychologists must have been comprehensively disrupted, and secondly, it is impossible for us to have any clear grasp of the problems our ancestors may have faced in their pre-linguistic stage for the purpose of reverse-engineering.

3. *The modularity of the mind.*

A key concept of evolutionary psychology is therefore the mental module, and we must now look in some detail at what this involves. The idea is particularly well exemplified in David Marr's ground-breaking neuropsychological study *Vision* (1982), which is constantly referred to by evolutionary psychologists as the most convincing example of a mental module. Our retinas receive visual information in the form of millions of tiny pixels of constantly shifting shade and colour, and our brain has to discover from this enormous volume of data how to create internal representations of the physical world that give us accurate information about its basic properties, in order that we can survive. For example, it must be possible to distinguish objects from their backgrounds; objects that are light in colour, such as snow, from those that are dark but brilliantly illuminated, like coal; to interpret 3-dimensional images and perspective; to recognise the same object despite changes in our view of it; and to recognise faces.

The difficulty is that the information supplied to the brain is ambiguous, and as it stands it would not be possible for it to construct the necessary reliable representations of the physical world. How, then, does the brain achieve this?

> The answer is that *the brain supplies the missing information*, information about the world we evolved in and how it reflects light. If the visual brain 'assumes' that it is living in a certain kind of world – an evenly lit world made mostly of rigid parts with smooth, uniformly colored surfaces – it can make good guesses about what is out there. As we saw earlier, it is impossible to distinguish coal from snow by examining the brightnesses of their retinal projections. But say there is a module for perceiving the properties of surfaces, and built into it is the following assumption: 'The world is smoothly and uniformly lit'. The module can solve the coal-versus-snow problem in three steps: subtract out any gradient of brightness from one edge of the scene to the other; estimate the average level of brightness of the whole scene; and calculate the shade of gray of each patch by subtracting its brightness from the average brightness. Large positive deviations are then seen as white things, large negative deviations as black things. If the illumination really is smooth and uniform, those perceptions will register the surface of the world accurately. Since Planet Earth has, more or less, met the even-illumination assumption for eons, natural selection would have done well by building the assumption in. (Pinker 1997:28-9)

A whole range of similar assumptions about the basic structure of the world can also be shown to be built in to the rest of our visual processing system. To operate effectively, then, our visual system operates like a computer, which processes data according to a programme innately hard-wired into our brain to solve basic problems about how the world is: it gives results that are normally correct, and would have been of no selective value if it could not do so.

A good argument can be made that the rest of our senses operate in this modular, computational manner, and Chomsky, Fodor and many others also claim that our faculty for language must also be modular because, for example, children can learn to make grammatically correct statements which they have never been taught – the same ‘poverty of the stimulus’ argument that is applied to our ability to compute what the world is like from inadequate visual data.

Fodor has said that ‘Roughly, modular cognition systems are domain specific, innately specified, hard wired, autonomous, and not assembled.’ (1983:37) Domain specific means that it handles only one type of data; the rules for processing this are innate, not learned; they are associated with specific neural structures in the brain; the module does not share resources with other cognitive systems (it is autonomous); and it is not put together from a stock of more elementary sub-processes. It is not hard to see why our perceptual systems, in particular, should be modular. They each deal with distinct forms of data, in very large quantities that must be processed with great speed, by precise and complex computational rules that are appropriate to one sort of data, and produce outputs that are basically right. There has also been an enormous amount of time for natural selection to operate in constructing these modules, since the laws of optics, acoustics, gravity, chemistry, and so on have never changed. The function of these modules is to deliver information in a usable form to central, general cognitive processes such as reasoning and memory, but the actual modular processes themselves are encapsulated, and are not accessible to our conscious thought.

All complex systems that have to interact with an environment may be expected to develop similar sorts of modular device. They occur, for example, in social systems, and analogous cases would be the telephone switchboard and the mail-room in a university, which handle only one type of input, in large quantities which they have to process rapidly, by a fixed set of rules, and make it available to the departments and faculties whose members have no knowledge of how this done. Plenty of similar examples can also be found in some of the machines that we construct, such as the automatic transmissions, braking systems, and cruise controls of automobiles.

We should also note that modules must pay a price for their special qualities: they are inflexible and cannot learn except by the very slow process of natural selection: ‘Change the problem slightly and the brain cannot solve it.’ (Pinker 1997:29). A good illustration of this is the optical illusion which, by manipulating the built-in assumptions of the visual module, can produce an output that does not correspond with reality. Yet, even when we measure two lines one of which appears shorter than the other, as in the Müller-Lyer effect, and find they are the same length, we still cannot stop ourselves seeing them as of different lengths.

The claim that our perceptual systems, and probably language as well, are modular in structure seems very reasonable, therefore, so the key question is how far the rest of the brain could be modular as well. Here we should remember that the essence of modularity is computation, and this requires three things: a distinct problem to be solved; a precise set of rules for doing so; and some means of assessing if the answer is right or wrong.

Tooby and Cosmides, and Pinker, make very strong claims for the pervasive or 'massive' modularity of the human mind, in which Marr's work on vision is taken as the paradigm case:

> Many psychologists have been forced by their data to conclude that both human and non-human minds contain – in addition to whatever general-purpose machinery they may have – a large array of mechanisms that are (to list some of the terms most frequently used) functionally specialized, content–dependent, content-sensitive, domain-specific, context-sensitive, special-purpose, adaptively specialized, and so on. Mechanisms that are functionally specialized have been called (with some differences in exact definition) adaptive specializations by Rozin (1976), modules by Fodor (1983), and cognitive competences or mental organs by Chomsky (1975, 1980). (Tooby and Cosmides 1992:93-4)

According to Pinker, 'The mind is organized into modules or mental organs, each with a specialized design that makes it an expert in one arena of interaction with the world. The modules' basic logic is specified by our genetic program.' (Pinker 1997:21). So,

> Just as one can now flip open Gray's Anatomy to any page and find an intricately detailed depiction of some part of our evolved species-typical morphology, we anticipate that in 50 or 100 years one will be able to pick up an equivalent work for psychology and find in it detailed information-processing descriptions of the multitude of evolved species-typical adaptations of the human mind, including how they are mapped on to the corresponding neuro-anatomy and how they are constructed by developmental programs. (Tooby and Cosmides 1992:69)

While, however, there is undoubtedly some cognitive specialisation in the brain, there must be a limit to this:

> It would simply not be feasible to construct a brain that allocates a specific psychological module to every conceivable event an individual might encounter, as the costs in terms of neural circuitry and information processing would be huge. There is no intrinsic virtue to mental specificity: general solutions will be favoured when they can do a good enough job at low cost…Domain-general processes are no more incompatible with evolutionary theory than domain-specific processes. (Laland and Brown 2002:182-3)

Indeed, when it comes to many areas of mental functioning, we find that our evolutionary psychologists are willing to accept a much vaguer and more slippery notion of modularity than that of vision, their favourite case which they use to justify the whole notion of modularity. For example,

> Don't take the 'module' metaphor too seriously, either; people can mix and match their ways of knowing. A concept like 'throwing', for example, welds an intention (intuitive psychology) to a motion (intuitive physics). And we often apply modes of thinking to subject matters they were not designed for, such as in slapstick humor (person as object), animistic religion (tree or mountain as having a mind), and anthropomorphic animal stories (animals with human minds). (Pinker 1997:315)

Cosmides and Tooby in similar fashion regard modules as able to merge together in some undefined way to form 'faculties'. For example,

> . . .humans have a faculty of social cognition, consisting of a rich collection of dedicated functionally specialized, interrelated modules (i.e. functionally isolable sub-units, mechanisms, mental organs etc.) organized to collectively guide thought and behavior with respect to the evolutionally adaptive problems posed by the social world. (Cosmides and Tooby 1992:163)

We shall see in more detail later that these fairly radical changes in the notion of the module make it more or less unworkable, but before we come to this, there is the further problem of how the massive modularity of mind they propose could work without an essential contribution from central or general cognitive processes.

Cosmides is reported to have held up a Swiss Army knife at a conference and said, 'The human mind is like this knife', which might have invited the response 'And how does your knife know whether to use the blade or the scissors?' In other words, there must be some parts of the mind, which we may call central or general systems or processes, that have access to the information from all the modules and can take decisions on the basis of all their information. Could these central systems and their decision processes also be modular?

As Fodor says,

> Even if input systems [modules] are domain-specific, there must be some cognitive systems that are not. The general form of the argument goes back at least to Aristotle: the representations that input systems deliver have to interface somewhere, and the computational mechanisms that effect the interface must ipso facto have access to information from more than one cognitive domain. (Fodor 1983:101-2)

Let us take a form of thought that is highly rational and central to our well-being, which is science. How far can this be described as computation? It is, of course, possible to formulate algorithms for solving equations, or deduction, and for statistical inferences from bodies of data, or induction, but it is impossible to formulate algorithms for the most crucial aspect of science which is the formulation of hypotheses for testing, which is non-deductive inference or abduction. As Karl Popper said,

…the work of the scientist consists in putting forward and testing theories. The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to a man – whether it is a musical theme, a dramatic conflict, or a scientific theory – may be of great interest to empirical psychology, but it is irrelevant to the logical analysis of scientific knowledge. (Popper 1972:31)

Abduction, which has given us modern physics, chemistry, and biology has also given us alchemy, astrology, Marxism, Behaviourism, and memetics.

Popper quite rightly saw the resemblance between the imaginative basis of new ideas in the sciences and the arts. Metaphor, which is fundamental to abduction and, indeed, to human thought in general, is not a computational exercise, nor is the writing of poems, plays, and novels, music, painting or sculpture. Religion, politics, and social life in general are not computational exercises either, because, as in the arts, there are no problems or clearly defined set of problems that any of these activities has evolved to solve during the Pleistocene; there are no set of rules for doing so; and no agreed criteria for deciding if the output is right or wrong. Fodor says about analogical thinking in general:

It is strange that, while everybody thinks that analogical reasoning is an important ingredient in all sorts of cognitive achievements that we prize, nobody knows anything about how it works; not even in the dim, in-a-glass-darkly sort of way in which there are some ideas about how confirmation works. I don't think this is an accident either. In fact, I should like to propose a generalization…It goes like this: the more global…a cognitive process is, the less anybody understands it. *Very* global processes, like analogical reasoning, aren't understood at all. (Fodor 1983:107)

On all these very obvious grounds, therefore, it seems clear that large parts of the mind cannot operate like a computer and therefore, *a fortiori*, cannot be modular.

Tooby and Cosmides, however, strongly oppose such conclusions, and advance some arguments designed to show that central or general, non-modular, cognitive processes are more or less impossible, or are at least of very limited power and significance. Their attack on the importance of general cognitive processes, 'domain-general, content independent mechanisms', is based on two related arguments, 'combinatorial explosion' and 'the frame problem'.

'*Combinatorial explosion*' is the term for the fact that with each new degree of freedom added to a system, or with each new dimension of potential variation added, or with each new successive choice in a chain of decision, the total number of alternative possibilities faced by a computational system grows with devastating rapidity. For example, if you are limited to emitting only one out of 100 alternative behaviors every successive minute (surely a gross underestimate…) after the second minute you have 10,000 different behavioural sequences from which to choose, a million by the third minute, a trillion by six minutes, and 10^{120} possible alternative sequences after only one hour, a truly unimaginable number… The system could not possibly compute the anticipated outcome of each alternative and compare the results, and so must be precluding without complete consideration the overwhelming majority of branching pathways. What are the principles that allow us to act better than randomly? Combinatorial explosion attacks any system that deals with alternatives, which means any system that is flexible in response or has decisions to make. (Tooby and Cosmides 1992:102-3)

We saw that our sensory modules, such as vision, deal with the infinite number of possible interpretations of data by imposing a 'frame' of innate assumptions on these data, automatically ruling out enormous numbers of possible interpretations, defining what goal is to be achieved, and providing the criteria to distinguish success from failure. It is this 'frame problem' that must be surmounted by any computational system, and Tooby and Cosmides claim that it is inherently impossible for domain-general processing systems to achieve this. It follows that the narrower the frame, the more effective the module will be:

When the class of situations that a mechanism is designed to solve is more narrowly defined, then (1) the situations will have more recurrent features in common, and therefore (2) the mechanism can 'know' more in advance about any particular situation that is a member of this class. As a result, (3) the mechanism's components can embody a greater variety of problem-solving strategies. This is because mechanisms work by meshing with the features of situations and, by definition, narrowly defined situations have more features in common…In contrast…as problem domains get larger and more broadly defined, a smaller and smaller set of residual strategies is left that remains applicable to the increasingly diverse set of problems. (ibid., 104)

These arguments are persuasive when applied to the special conditions of sensory modules and language, but let us see how they might apply to a practical problem of human daily life – washing and drying one's hands. This is clearly an adaptive practice, and I shall assume for the sake of this thought-experiment that over many hundreds of generations natural selection has hard-wired the necessary computational frame of a hand-washing module into our brains. A sub-set of the problems that the module has to deal with involves the use of public washrooms where, unlike in the home, many strangers are interacting, and it would be very easy to transmit infection. The basic method of hand-drying built into the module would surely be to use some sort of towel, but in public washrooms towels, whether of cloth or paper, need constant replacement, and this is expensive. The module is sufficiently flexible to allow the alternative of hot-air blowers to eliminate the towel problem, (we all know that heat dries), but though they work, electric heating is expensive too. The celebrated English inventor James Dyson approached this problem by abandoning the idea of heat altogether. His Air Blade hand-dryer works by projecting a very thin but very powerful blast of air onto the hands from an elongated slot, which removes water without heat. How did he think of this?

> His secret is to mess up. 'When we start a project, we deliberately do the wrong thing. If you do the right thing, the logical thing, all you are doing is following the same path as everybody else. The hand dryer is quite a good example – you would have thought that you need heat to dry hands, but we scrape the water off instead.' (*The Times*, 10 October 2009, p.35)

This actual account of adaptive problem-solving in the real world is as far as possible from the scenario depicted by Tooby and Cosmides, because it is an example of abductive inference at work, and abductive inference as we have seen is inherently non-algorithmic, non-computational. It can *redefine the problem itself*, and in doing so obviously cannot be working from a set of pre-ordained rules. 'Deliberately do the wrong thing' is not an instruction that one could give to a computer.

Tooby, Cosmides, Pinker and other evolutionary psychologists have therefore manoeuvred themselves into the same sort of impasse as someone who maintains that it is aerodynamically impossible for bumble-bees to fly. Since bumble-bees *can* fly, there must be something wrong with the aerodynamic theory, and since abductive inference is clearly an inherent and essential part of human thought, and often works very successfully, the obvious conclusion is that there is something wrong with evolutionary psychology, and that the human brain, in some very important respects, does not in fact work like a computer at all, or at least any computer that we know of.

We can reach the same conclusion by a different and shorter route. We recall that Pinker claims that the modern mind is adapted to the Stone Age, not to the highly complex modern world of industrial civilisation. The problem is, therefore, how it was ever possible for us to have developed modern civilisation at all, which might seem as implausible an outcome as koala bears, who are adapted to a diet exclusively of eucalyptus leaves, suddenly developing a taste for bacon and eggs.

While Tooby and Cosmides recognise the general problem here, their attempt to get round it does not succeed:

> The solution to the paradox of how to create an architecture that is at the same time both powerful and more general is to bundle larger numbers of specialized mechanisms together so that in aggregate, rather than individually, they address a larger range of problems. Breadth is achieved not by abandoning domain-specific techniques but by adding more of them to the system. By adding together a face recognition module, a spatial relations module, a rigid object mechanics module, a tool use module, a fear module, a social exchange module, an emotion-perception module, a child-care module, a social inference module, a sexual

attraction module, a semantic inference module, a friendship module, a communication-pragmatics module, a theory of mind module, and so on, an architecture gains a breadth of competences that allows it to solve a wider and wider array of problems, coming to resemble more and more a human mind. (Tooby and Cosmides 1992:113)

Even if we accepted this as a broadly accurate description of how the human mind works, it still, however, could only be the human mind as it had evolved in the milieu of Palaeolithic hunters and gatherers. However many modules are tacked together, they can still only solve the kinds of problems that have been recurrent in their evolutionary history. *Ex hypothesi*, they will be unable to solve problems they have never encountered before, which are just those problems listed by Pinker in his remarks on the demands of modern civilisation, so that the theory of massive modularity remains inherently unable to explain the emergence of the modern mind and its associated civilisation.

4. *Some examples of mental modules.*

We are now in a position to look in detail at some of the modules that have been proposed.

(a) The Social Exchange module

Cosmides and Tooby begin by drawing attention to the enormous antiquity of social relations in our ancestry:

Our ancestors have been members of social groups and engaging in social interactions for millions and probably tens of millions of years. To behave adaptively, they not only needed to construct a spatial map of objects disclosed to them by their retinas, but a social map of the persons, relationships, motives, interactions, emotions and intentions that make up their social world. (Cosmides and Tooby 1992:163)

So the claim is that just as our visual module could evolve over millions of years to solve specific problems of representing our physical environment, so another kind of module also evolved over millions of years to solve the standard problems of social interaction. The parallel is a false one, however, because the laws of optics have always been the same, and we cannot change the properties of the physical world, but our social world is one that we construct from our interactions, and it has changed drastically in the six million years or so from the Common Ancestor, as we saw in section 2. Cosmides and Tooby nevertheless claim that

Humans have a faculty of social cognition, consisting of a rich collection of dedicated, functionally specialized, interrelated modules (i.e. functionally isolable subunits, mechanisms, mental organs, etc.), organized to collectively guide thought and behaviour with respect to the evolutionarily recurrent adaptive problems posed by the social world (ibid., 163)

They claim, in particular, that the Darwinian theory of social exchange in general is well developed, and that since our ancestors have engaged in social exchange for at least several million years (ibid., 164), we should be able to detect evidence for 'special design' of an exchange module to solve the recurrent problems involved.

> Standards for recognizing special design include factors such as economy, efficiency, complexity, precision, specialization, and reliability, which – like a key fitting a lock – render the design too good a solution to an adaptive problem to have arisen by chance. (ibid., 165)

The proposed exchange module is based on Hamilton's concept of kin-selection (inclusive fitness) and Trivers' reciprocal altruism (reciprocity between non-kin), and Game Theory and the Prisoner's Dilemma are basic conceptual tools. As is well known, the problem of altruism is central to the evolutionary theory of exchange, which has to explain why, and in what circumstances, an individual should be willing to benefit another individual at some cost to itself. The theory was developed to account for such behaviour in all species, not just man, and assumes that interactions occur initially between strangers. Not surprisingly, mutual suspicion, and the possibility of cheating and its detection, and cost/benefit analysis are major problems for a theory of altruism, so conceived, as we can see from many design features of the Social Exchange module proposed by Cosmides and Tooby. Some examples are:

> 1. [Design features] must include algorithms that are sensitive to cues that indicate when an exchange is being offered and when reciprocation is expected.
> 2. They must include algorithms that estimate the costs and benefits of various actions, entities, or states of affairs to oneself.
> 3. They must include algorithms that estimate the costs and benefits of various actions, entities, or states of affairs to others (in order to know when to initiate an exchange). . .
> 5. They must include algorithms that compare these estimates to one another [in order to determine whether the benefits to oneself of performing these exceed the costs]. . .
> 10. They must include algorithms that can detect cheaters (these must define cheating as an illicitly taken benefit). . .
> 12. They must include algorithms that store information about the history of one's past exchanges with other individuals (in order to know when to cooperate, when to defect, and when to punish defection).
> 13. They must include algorithms that can recognise different individuals (in order to do any of the above). (ibid., 177)

Very strong claims are made for the scientific potency of this approach:

> By studying the ecological context in which this problem [of altruism between non-relatives] manifested itself for our Pleistocene ancestors, one can derive additional constraints. All these constraints in the evolution of social exchange – those that apply across species and those that apply just to humans – allow one to develop a task analysis or, to use Marr's term, 'a computational theory' of the adaptive problem of social exchange, which we call 'social contract theory'. (ibid., 178)

One would first of all reply that Cosmides and Tooby, far from ‘studying the ecological context’ in which our Pleistocene ancestors dealt with altruism and other aspects of social exchange, know nothing whatsoever about it, nor have they researched the ethnography of modern hunter-gatherers to develop their ‘task analysis’ of their proposed module of social exchange. We can at least be sure that our Pleistocene ancestors did not live as swarms of anonymous strangers, like birds or fish, but in very small groups whose members had grown up together from birth, constantly gossiping about one another (if they possessed language), and where the opportunity for cheating without being detected was essentially zero. In this kind of society

> …those individuals who follow elementary strategies of selfishness and cheating are not only rapidly detected, but punished by sanctions ranging from contempt and low status to expulsion from the group or death. Correspondingly, rewards go not to the obvious spongers and cadgers and delinquents, but to those who are perceived (rightly or wrongly) to contribute most to the welfare of the group. (Hallpike 1984:133-34)

So while the literature on hunter-gatherers refers to a few individuals who are despised for their laziness or meanness, cheating is not, contrary to Cosmides and Tooby, a significant problem. I am assuming, of course, that we are talking of groups possessing developed language, and it is possible that in pre-linguistic groups whose members could not inform each other of cheats, the problem might have been more significant, but this simply illustrates the fallacy of assuming that throughout the EEA we are dealing with a constant human mind and a constant set of problems.

Again, in this type of small-scale hunter-gatherer society, we must distinguish between the exchange of gifts and of services:

> It seems to be a universal principle that givers of things thereby become superior in status to the receivers; contrarily, a person who performs a service for someone else does not render himself by doing so the recipient’s superior, but, quite the opposite, his inferior. [I refer here to ordinary physical acts of assistance, not to the use of superior knowledge or social power.] …if that person for whom one has done the service does not reciprocate, one will be left at a permanent disadvantage. This is quite the opposite to the case of gift exchange, since a person who does not reciprocate a gift can be laughed at as a poor fellow, a mean person, and all the resources of shame and ridicule can be brought against him…
>
> Consequently, we can expect to find that gift exchange will be the norm in societies which are weakly integrated, mobile in group composition, and with ambiguous boundaries between the categories of ‘we’ and ‘they’, since lack of reciprocity is no loss to one’s pride. Correspondingly, because of the vulnerable position in which the performance of a service places one’s pride, we will expect to find exchanges of assistance only in situations where there is every chance that they will be reciprocated; that is, in societies whose groups are closely knit, stable, and enduring in membership, and where the distinction between ‘we’ and ‘they’ is unambiguous, in a situation of mutual trust. (1975:118-19)

Modern hunter-gatherer societies, our closest approximation to our Pleistocene ancestors, are in fact weakly integrated and atomistic. There is frequent reference to reciprocal gift-giving, but this is essentially low-cost, such as the tools and ornaments which all possess, and is essentially symbolic and low-benefit, like men in our society who stand each other rounds of drinks in a bar, and doesn't make any significant contribution to individual welfare. On the other hand, while there are a few hunter-gatherer societies, notably the Eskimo, where all are required to hunt, with severe punishment for defectors, outside the nuclear family any mutual assistance involving significant cost is notably absent.

For example, Howell says of the Chewong of Malaysia, 'Although they do not compete, they do not help each other…It is a rare sight to witness someone asking someone else for assistance. Similarly, offers of assistance are also rare.' (Howell 1989:38) Holmberg says that among the Siorono of Bolivia, 'Unconcern with one's fellows is manifested on every hand', and describes how everyone ignored the cries for help of an elderly cripple who had lost his way back to camp after dark, and was left to die. (Holmberg 1969) Gardener says of the Paliyans that 'they live and work in parallel rather than in joint fashion and exhibit little co-operation outside their rather loose nuclear families. They are hesitant to become emotionally involved with others and equally reluctant to unite toward practical goals. There is a very strong expectation of autonomy.' (Gardener 1966:394) According to Woodburn, 'The Hadza [of Tanzania] are strikingly uncommitted to each other; what happens to the individual Hadza, even close relatives, does not really matter very much.' (Woodburn 1968:91) He discusses, in this connection, the frequent occurrence in the hunter-gatherer literature of the abandonment of the sick, and gives a Hadza example of a paralysed boy abandoned by his mother and other close relatives only a few miles from water, to which they could have carried him without too much difficulty. Everett also stresses the importance of autonomy among the Piraha of Brazil, so that women, for example, may be expected to give birth alone, with no assistance. In one case, a woman was in agony with a breech birth, but no one went to her assistance, despite her cries, and during the night she and the baby died. (Everett 2008:90)

Where significant sharing of food is involved, especially the meat obtained by hunters, how this is to be done does not have to be calculated afresh every time, but is typically regulated by a rigorous protocol. For example, among the Netsilik Eskimo,

> The internal organization of the winter sealing camp is reflected by the seal-meat sharing pattern, rigidly maintained at that season…Ideally, there were twelve [sharing partners], and they were chosen by the hunter's mother either shortly after birth or during his childhood. Whenever a hunter killed a seal his wife cut up the animal and gave the appropriate parts to each of his partners' wives. (Balikci 1970:133, 135)

Meat sharing by tropical hunters and Australian Aborigines is also governed by similarly strict rules.

The social realities of hunter-gatherer life are therefore very different from those assumed by Cosmides and Tooby in their social exchange module. In particular, cheating is not a significant issue because it is inherently self-defeating in small groups where everyone knows everybody else; reciprocal exchange of gifts is basically symbolic, rather than involving any significant costs and benefits, while mutual assistance that might involve significant costs is clearly not the norm; autonomy, self-reliance, and toughness are stressed instead. In the only situations where sharing, or the delayed exchange of food is involved, the sharing is typically governed by very strict rules, with no need for the kinds of algorithms that Cosmides and Tooby envisage. Indeed, it is striking that Cosmides and Tooby ignore one of the most important aspects of social exchange, which is that in all societies it is governed by clear rules and norms, whose effect is that individuals do not have to approach every situation *de novo*, and reason about it from first principles as laid down in their brains by natural selection. This is particularly easy in the simple life-style of hunter-gatherers, where the same set of situations and kinds of decisions recur constantly, unlike more complex societies.

Nor can the social exchange module as set up by Cosmides and Tooby in any way stand by itself, as they themselves make clear:

> Anyone examining his or her own human experience will immediately identify large areas of the psychology of social exchange, such as the psychology of friendship, that are not captured well by the models introduced so far. More important, the other components of our evolved faculty of social cognition – for example, the psychological mechanisms that govern sexual relations, coalitional partnerships, status, revenge, threat, and parenting – will have to be mapped out and integrated with the psychological mechanisms governing social exchange before social exchange can be fully unravelled. Each component of the faculty of social cognition can only be incompletely understood when taken in isolation. (Cosmides and Tooby:210)

It will be recalled that earlier, Cosmides and Tooby invoked David Marr's work when they were talking about 'developing a task analysis', a 'computational theory', to take account of the various ecological constraints on exchange, in the same manner as Marr's work on vision. But by this stage, however, the rigorous talk of modularity has become markedly watered down. As they themselves concede, social exchange has to take account of a whole range of other considerations in a manner that is thoroughly unmodular, and in many further respects the social exchange 'module' does not behave as mental modules should. For example, it is obvious that our social interactions do not require us to process anything like the mass of data, or with the same speed, as vision, the exemplar that they are constantly holding up. Again, unlike the entirely sub-conscious processes of vision, our thought processes while thinking about social exchange are normally fully conscious, they can be refined by learning, and they can adapt to changing circumstances in our lives.

This is most obvious when we consider the radical transformations that have overtaken hunter-gatherer society since the beginning of agriculture and the domestication of animals. The growth over the last few thousand years in social size, inequality and ranking, formal social institutions especially legal systems, trade and markets, and the commodification of labour are just some of the major areas of social relations that would have required major restructuring of any social exchange module that might have evolved up to that point. But one of the main points stressed by evolutionary psychology is the great length of time which is necessary for natural selection to work, and which in their view was made possible by the millions of years of our social existence in the Pleistocene. We can conclude from the discussion so far then, that the model of social exchange given by Cosmides and Tooby does not meet the minimal requirements of a mental module, and that even if such a module had evolved by natural selection, it cannot explain how it could have survived the development of language in particular, nor how we have been able to live in a succession of social orders that have become increasingly different from the society of the Pleistocene. But if the social exchange module is unfeasibly broad and complex, in contrast we can look at a couple of modules that seem rather more focused – mathematics and tool-use.

(b) *The Mathematics module.*

According to Pinker, 'Mathematics is part of our birthright' (1997: 338), but this is only true in a very rudimentary sense. When collections of objects are less than ten, a wide variety of species such as pigeons, ravens, parrots, rats, monkeys, and chimpanzees can recognise changes in the numbers of objects in a collection, compare the sizes of two collections presented simultaneously, and remember the number of objects presented successively. Koehler (1951) reports a raven that could distinguish 2, 3, 4, 5 and 6 spots on the lids of boxes, and Pepperberg (1987) states that her African Grey parrot could name the number of objects seen on a tray. Mechner and Guerrekian (1962) taught rats to press a bar from 4 to as many as 16 times for a reward, though the number of bar pressings was not exact in many cases but only an approximation. Woodruff and Premack (1981) showed that chimpanzees could grasp the simple fractions ¼, ½, ¾, and estimate that 5+1=6, or 3+4=7. Matsuzawa (1985) succeeded in teaching a chimpanzee, over many years, to associate the signs for 1 – 9 with the appropriate collections of objects. (It should be noted however that these associations between number signs and collections were isolated, and did not form a series produced by the algorithm of successive additions of 1, as they do in human counting.)

A sense of what has been called 'numerosity', then, of the differences in quantities of small size, is widespread, and in this sense the human 'mathematical birthright' is not distinguishable from that of many animals and birds. It is therefore important to recognise that

> …the most basic numerical skills do not require *any* numerical symbols. It is, for example, possible to discriminate the relative numerosity of two sets of objects without the help of numerals (e.g. that a collection of 4 peanuts is numerically larger than a collection of 2 apples.) (Brannon and Terrace 2002:197)

So many simple cultures, especially hunter-gatherers but including some shifting cultivators such as the Tauade of Papua New Guinea (Hallpike 1977), may only have words for single, pair, and many. Indeed, the hunter-gatherer Piraha of South America are described by Everett (2008) as having no number words at all, not even the grammatical distinction between singular and plural.

We can get a good idea why this should be so from the example of a Cree hunter from eastern Canada: he was asked in a court case involving land how many rivers there were in his hunting territory, and did not know:

> The hunter knew every river in his territory individually and therefore had no need to know how many there were. Indeed, he would know each stretch of each river as an individual thing and therefore had no need to know in numerical terms how long the rivers were. The point of the story is that we count things when we are ignorant of their individual identity – this can arise when we don't have enough experience of the objects, when there are too many of them to know individually, or when they are all the same, none of which conditions obtain very often for a hunter. If he has several knives they will be known individually by their different sizes, shapes, and specialized uses. If he has several pairs of moccasins they will be worn to different degrees, having been made at different times, and may be of different materials and design. (Denny 1986:133)

What needs to be emphasised here, therefore, is that in hunter-gatherer societies especially, it is perfectly possible to survive without the need for verbal numerals or for counting, and that consequently there would have been no selective pressure for arithmetical skills to evolve in the specific conditions of the EEA, and for any specific module to develop.

Furthermore, arithmetic is only a small part of mathematics, which also includes algebra and geometry, and many modern branches of mathematics such as topology and graph theory also have nothing to do with numbers. Mathematics is often said to be the science of *patterns*, and the mathematician Keith Devlin has said that it requires a number of abilities. These include: the ability to handle abstraction, as when *n* stands for any number; the ability to follow a causal chain of facts or events; logical reasoning ability, as in geometrical proofs; relational reasoning ability, such as 'greater than', 'less than', 'equal to'; and spatial relations. (Devlin 2000:11-12) These, however, are general abilities that are not confined to mathematics, and have been called upon at different points in mathematical history. Perhaps the best example is the application of logical proof to geometry which occurred in Greece during the fifth and fourth centuries BC, and could not have been the result of any kind of mental module, since other mathematical cultures in Babylonia, China and India did not take this step.

As we all know, mathematics has only flowered in the last few centuries, far too brief a time-span for natural selection to have had the least effect, and Devlin very reasonably concludes: 'Whatever features of our brain enable (some of) us to do mathematics must have been present long before we had any mathematics. *Those crucial features, therefore, must have evolved to fulfil some other purpose*.'[My emphasis] (Devlin 2000:3) This is a vital point which we shall take up more fully in the final section.

Again, when members of societies such as the Tauade are sent to Western-type schools they can learn not only to count but to master the wider aspects of mathematics as well. 'How, then' Pinker asks, 'can people use their Stone Age minds to wield high-tech mathematical instruments?' This, of course, is Wallace's question, and Pinker tries to answer it by again watering down the concept of the module:

> The first way is to set mental modules to work on objects other than the ones they were designed for. Ordinarily, lines and shapes are analysed by imagery and other components of our spatial sense, and heaps of things are analysed by our number faculty. But

> to…disentangle the generic from the parochial (for example, disentangling the generic concept of quantity from the parochial concept of the number of rocks in a heap), people might have to apply their sense of number to an entity that, at first, feels like the wrong kind of subject matter. For example, people might have to analyse a line in the sand not by the habitual imagery operations of continuous scanning and shifting, but by counting off imaginary segments from one end to another. (Pinker 1997:340-1)

But surely the whole point of a module is that it *can't* be set to work on data for which it was not designed by natural selection? – that is what gives it its efficiency. He continues:

> The second way to get mathematical competence is similar to the way to get to Carnegie Hall: practice. Mathematical concepts come from snapping together old concepts in a useful new arrangement. But those old concepts are assemblies of still older concepts. Each sub-assembly hangs together by the mental rivets called chunking and automaticity: with copious practice, concepts adhere into larger concepts, and sequences of steps are compiled into a single step. (ibid., 341)

Our vision module, however, *does not need to practice*, copiously or otherwise, and it does not have to construct its skills by 'snapping together old concepts', or using 'mental rivets' such as 'automacity' and chunking sub-assemblies into larger assemblies. If these phrases mean anything at all, they are what natural selection is supposed to have done over millions of years This illustrates yet again that evolutionary psychologists quietly abandon the module concept under pressure from the facts, and replace it with a much vaguer notion of some kind of mental faculty.

The same conclusions we have reached about mathematics apply to our understanding of probability. Pinker is clearly quite right when he says that 'we would expect organisms, especially informavores such as humans, to have evolved acute intuitions about probability.' (Pinker 1997:343) But while animals as well as humans understand probability in the sense that their survival depends on being able to learn that some sorts of events are more frequent than others – that prey like to visit a particular waterhole in the evening rather than the morning, or that predators often hide in a particular type of long grass, for example – this has nothing to do with the mathematical concept of probability, which is quite different from simple intuitions of relative frequency. Probability *theory* has actually proved extraordinarily difficult for humans to grasp, and as is well known, it only developed very late in our history from the 17th century onwards, in a small section of the population, and most certainly could not have been favoured by natural selection.

So while the alleged 'mathematics module' is perhaps rather more focused than the 'social exchange' module, it has no claim to anything resembling its antiquity, and in so far as it can be said to address an identifiable set of problems, these are at most only a few thousand years old, and in many cases only a few hundred – far too brief a period for natural selection to have had a chance to operate. But at least tools have been around for a good deal longer than that.

(c) The Tools module.

I think by this stage we are beginning to get the basic picture of modules as they are used in evolutionary psychology, and we can deal with the notion that there is a tools module very briskly. While Cosmides and Tooby claim that a tools module exists, they say nothing about it, and Pinker says only that by 18 months, children know that tools have to come in contact with their materials, and that tools' rigidity and shape are more important than colour and ornamentation (Pinker 1997:327), which are quite trivial insights that affect our general interaction with objects, not just tool use. But stone tools are our best evidence about life in the EEA, and the persistence of the Acheulian hand axe for more than a million years essentially unchanged might seem to be good evidence for a tool-making module: a very narrow and stable problem-domain, allowing a standard solution like the hand axe, is just where one would expect a module to develop. While there were subsequent changes in stone tool design, these took many thousands of years, and so do not completely undermine the idea that tool making could have been basically modular. The acid test of this hypothesis, however, comes from those cases where lithic technology has survived in an unbroken historical tradition from the Palaeolithic into modern times, such as Papua New Guinea (see for example Blackwood and Hallpike 1978:64-78) The techniques involved a good deal more grinding than flaking, as well as the use of wood, vegetable fibres, and bone, but overall would have had considerable continuity with the EEA.

How, then, can evolutionary psychologists explain the fact that, despite an ancestry exclusively devoted to stone tools, and other archaic materials, with no experience at all of metals or machines, New Guineans have been able to go to technical school and learn to be motor mechanics in a single generation? The tools and techniques involve the use of metals (particularly the use of heat), rotary motion, and screw-threads, so that the dismantling and repair of machines like the internal combustion engine have no resemblance whatsoever to the tools and skills of the traditional material cultures of Papua New Guinea and the making of stone adzes.

Since the whole point of the modular theory of mind is the exquisite precision with which the module has been adapted by natural selection, over millions of years, to specific problems of survival in the particular environment of the EEA, the existence of New Guinean motor mechanics proves conclusively that tool use cannot be modular. We have also concluded that there could be no such things as mathematics or probability modules, nor a social exchange module, nor any of the modules in the long list that Cosmides and Tooby have proposed.

5. Is *the modern human mind a computer adapted to the Stone Age?*

The 'massive modularity' theory of the human mind proposed by evolutionary psychology therefore seems to be radically flawed.

In the first place, our knowledge of the EEA is far too slight to allow the reverse-engineering which evolutionary psychologists regard as essential for explaining the specific design of each module. Since we cannot even reverse-engineer the Acheulian hand axe, the ambition of reverse-engineering aspects of human psychology is obviously quite unrealistic. Secondly, if natural selection requires constant conditions for very long periods of time in order that adaptive solutions can stabilise, then the major changes that we know must have taken place in the form of ancestral human life in the EEA would not have provided such stability. The emergence of language, in particular, would have required a fundamental reorganization of the human mind, and the strong probability is that this only occurred at the end of the EEA, or later. Thirdly, there is no reason to suppose that, outside the senses and perhaps language, the human mind is predominantly organized on the basis of modules at all. The primary importance of non-computational modes of thought such as abduction and metaphor, in particular, would seem to make the whole notion of 'massive modularity' impossible. Fourthly, the actual concept of 'module' as used by evolutionary psychologists themselves is not rigorously defined, and is often watered down when the going gets tough, despite all the hard-nosed appeals to vision as the paradigm case of mental modularity. Fifthly, the subsequent history of the human race in the last ten thousand years, since the beginnings of agriculture and then literate civilisation, displays forms of thought, behaviour, and social organization that are wholly different from anything that could have been predicted from what we know about the conditions of life in the EEA. They *cannot*, therefore, be explained as adaptations to such conditions.

Finally, the assumption of evolutionary psychology that our cognitive abilities are the result of a series of small Darwinian adaptations over millions of years is also quite unproven:

…since nothing at all is known about *how* the architecture of our cognition supervenes on our brains' structure, it's entirely possible that quite small neurological reorganizations could have effected wild psychological discontinuities between our minds and the ancestral ape's. This really is *entirely* possible; we know nothing about the mind/brain relation with which it's incompatible. In fact, the little we do know points in this direction: Our brains are, at least by any gross measure, very similar to those of apes; but our minds are, at least by any gross measure, very different. So it looks as though relatively small alterations to the neurology must have produced very large discontinuities ('saltations', as one says) in cognitive capacities in the transition from the ancestral apes to us. If that's right, then there is no reason at all to believe that our cognition was shaped by the gradual action of Darwinian selection on prehuman behavioral phenotypes. (Fodor 2001:88)

A good illustration of this is the FOXP2 gene, the distinctively human version of which has emerged in the last 200,000 years, and which has powerful effects not only on mastery of language but on the central nervous system (e.g. Konopka et al., 2009).

It is therefore obvious that the vast range of our modern intellectual competences cannot possibly be adaptations to ancestral conditions during the Pleistocene in East Africa. This central point was first raised, as we saw at the beginning of this paper, by A.R.Wallace, and he was quite right. Pinker, however, derides Wallace as 'a lousy linguist, psychologist, and anthropologist':

He saw a chasm between the simple, concrete, here-and-now thinking of foraging peoples and the abstract rationality exercised in modern pursuits like science, mathematics, and chess. But there is no chasm…Prospering as a forager is a more difficult problem than doing calculus or playing chess…all people, right from the cradle, engage in a *kind* of scientific thinking. We are all intuitive physicists, biologists, engineers, psychologists, and mathematicians. (Pinker 1997:301)

Wallace was, in fact, a considerably better anthropologist than Pinker, and cross-cultural developmental psychology has also reinforced Wallace's claim that there are indeed major differences between many of the thought processes of non-literate tribal peoples with simple technologies, and those of educated members of modern industrial societies. I have also described these differences with a wealth of ethnographic detail in *The Foundations of Primitive Thought* (1979), and *The Evolution of Moral Understanding* (2004). This whole literature on cross-cultural developmental psychology in fact gives a far better picture of modes of thought in primitive societies than anything to be found in evolutionary psychology, where it is barely mentioned.

Pinker claims that 'Prospering as a forager is a more difficult problem than doing calculus or playing chess'. Is he suggesting that they needed to apply probability theory to the movement of game, or use physics to calculate the trajectories of spears, or chemistry to develop their arrow poisons? Obviously not, and is only engaging in empty rhetoric. Strangely, however, he then takes an entirely different line of argument, admitting that our modern cognitive abilities are not adaptations at all, and are the result of capacities that were originally evolved for very different purposes. They are, in a word originally proposed by Stephen J.Gould, 'exaptations'. Whereas 'adaptations' are characters evolved under natural selection for the better performance of some task, there can also be characters that have proved to be useful, but which were not initially selected for such a use:

We suggest that such characters, evolved for other usages (or for no function at all) and later 'coopted' for their current role, be called *exaptations*. . .They are fit for their current role, hence *aptus*, but they were not designed for it, and are therefore not *ad aptus*, or pushed towards fitness. They owe their fitness to features present for other reasons, and are therefore *fit (aptus) by reason of (ex)* their form...Adaptations have functions; exaptations have effects. (Gould and Vrba 1982:6)

Pinker accepts the idea of exaptation, and argues, with some plausibility, that one of the reasons we can do science, mathematics, and other cognitively demanding subjects, is because of our ability to use metaphors based on concrete experience to stand for much more abstract relations and concepts, a capacity that is itself based on language:

Location in space is one of the two fundamental metaphors in language, used for thousands of meanings. The other is force, agency, and causation. (Pinker 1997:354). . . Many cognitive scientists (including me) have concluded from their research on language that a handful of concepts about places, paths, motions, agency, and causation underlie the literal or figurative meanings of tens of thousands of words and constructions not only in English, but in every other language that has been studied…These concepts and relations appear to be the vocabulary and syntax of mentalese, the language of thought. Because the language of thought is combinatorial, these elementary concepts may be combined into more and more complex ideas. (ibid., 355).

So,

The ubiquity of metaphor brings us close to a resolution to Wallace's paradox. The answer to the question "Why is the human mind adapted to think about abstract entities?" is that it really isn't. (ibid., 358)…Even the most recondite scientific reasoning is an assembly of down-home mental metaphors. We pry our faculties loose from the domains they were designed to work in, and use their machinery to make sense of new domains that abstractly resemble the old ones. (ibid., 359)

But this admission of 'the ubiquity of metaphor' fatally undermines any possibility of 'massive modularity', and Pinker is also abandoning one of the central claims of evolutionary psychology: that our modern cognitive capacities can be explained as adaptations to the EEA, so that the whole programme of reverse-engineering is also rendered pointless. Instead, to understand the human mind, we must rely on the study of modern humans and how the brain actually works, not on speculations about its adaptive origins in the remote past. As Gould and Vrba have summed up the matter:

Most of what the brain now does to enhance our survival lies in the domain of exaptation – and does not allow us to make hypotheses about the selective paths of human history. How much of the evolutionary literature on human behaviour would collapse if we incorporated the principle of exaptation into the core of evolutionary thinking? This collapse would be constructive because it would vastly broaden our range of hypotheses, and focus attention on current function and development (all testable propositions) instead of leading us to unprovable reveries about primal fratricide on the African savanna or dispatching mammoths at the edge of great ice sheets – a valid subject, but one better treated in novels. . . (Gould and Vrba 1982:13)

Notes

1. Evolutionary psychology is an extreme example of what biologists refer to as 'the adaptationist programme'. 'The fact that few evolutionary psychology studies refer to the findings of modern evolutionary biology reinforces the suspicion that evolutionary psychology has become detached from recent developments in evolutionary thinking, which over the past 30 years have increasingly stressed a wide range of processes…The contemporary reality is that evolution is a much more complex phenomenon than that portrayed in evolutionary psychology textbooks…' (Laland and Brown 2002:187)

2. One of the least impressive claims of evolutionary psychology is Orians' theory that we have a genetic disposition to favour landscapes resembling the savannah of East Africa. For example:

…we enjoy being in savannah vegetation, prefer to avoid both closed forests and open plains, will pay more for land giving us the impression of being a savannah, mould recreational environments to be more like savannahs, and develop varieties of ornamental plants that converge on the shapes typical of tropical savannahs of Africa, the probable site of our evolutionary origins. (Orians 1980:64)

One would first of all reply that his evidence for this alleged pan-human preference is remarkably ethnocentric, since the 'we' here really means Americans, being entirely based on North American data. Secondly, earlier in his paper he has also said that '…many animals develop strong behavioural attraction to the types of habitats and particular places *where they were born and raised* [my emphasis]. These behavioural tendencies are strongly developed among humans.' (ibid., 55) Since humans live in many different habitats, how then could they all nevertheless be expected to display a universal and innate preference for a savannah environment they have never seen? Thirdly, he supposes that there is much more uniformity in the East African savannah than actually exists. Remains of *Homo erectus*, together with Acheulian artefacts, and of *Australopithecus boisei*, dating from c 1.3 – 1.9 Mya, have been found in the Konso-Gardula area of Ethiopia (White 1992), where I conducted fieldwork in 1965-67. There is certainly some savannah on the plain between the Konso Highlands and Lake Shamo, but there are also large rivers bordered by dense vegetation, lakes, and mountains, some of which would have been covered in juniper forests. It is not unreasonable to suppose that early humans would have found useful resources in all these neighbouring habitats. Finally, and perhaps most conclusively, if a species has a genetic disposition to favour a particular type of habitat, this disposition can only have been fixed in the species by selection because it was adaptively necessary in some way(s) for the survival of members of that species. Innumerable examples of this suggest themselves in the animal kingdom. Since we know that in fact human beings can flourish in a very wide variety of habitats in terms of temperature, climate, deserts, forests, prairies, high mountains, small tropical islands, and so on, we can obviously have no inherent preference for any particular type of environment. How, then, could natural selection nevertheless have endowed us with a mere aesthetic preference for landscapes resembling the savannah of East Africa, when this clearly has nothing to do with our survival?

3. I would like to thank the Director of the Pitt Rivers Museum, Oxford (Dr. Michael O'Hanlon), and his staff, for allowing me to examine a large sample of their collection of hand axes.

4. Tooby and Cosmides do distinguish, admittedly, between the totality of the physical environment, and what they call 'the developmentally relevant environment': 'There is nothing "in" the environment that by itself organizes or explains the development, psychology, morphology, or behavior of any organism. "The" environment affects different organisms in different ways. We find the smell of dung repellent; dung flies are attracted to it.' (1992:84). Nevertheless, their 'default mode' is to think of evolution as a process in which organisms do solve pre-defined problems of survival in their relations with their environment, the paradigm case being vision.

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