** WHY SOME APES BECAME HUMANS **

Competition, Consciousness & Culture

Een wetenschappelijke proeve op het gebied van de wijsbegeerte

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door
Pouwel Slurink,
geboren 2 september 1958 te Heerlen

Promotor: Prof. A.A. Derksen (KUN)
Manuscriptcommissie:Prof. W. van Haaften (KUN)
Dr. J.M.G. van der Dennen (RUG)
Dr. H.C. Roskam (RUL)

Pouwel Slurink
Lijsterbesstraat 98
6523 JW Nijmegen
024 – 3563317
P.Slurink@kpnplanet.nl

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0.1 Introduction

Philosophical perplexities are the prize of an increased intelligence, as extraterrestrial exobiologists would probably agree. Organisms finding themselves on whatever piece of grit circling around whatever center of gravity-driven nuclear fusion (perhaps our own sun) will probably always need some time to realize their precarious situation. It would be very implausible that an organism that per accident would evolve an ability to do something like thinking or reflecting would immediately hit upon the right frame-work to understand its origin and position amongst other things.

Such an understanding can only emerge if a knowledge capacity has evolved with the right categorical structures and, even then, it can only emerge as a result of philosophical and scientific puzzle-solving during millennia. Probably it can only arise *despite* a lot of resistance, both within the psyche of the thinking organism in question as within the society in which it probably will live - as a social environment seems to be a condition for the evolution of intelligence. Therefore, it is not surprising that humans have always tended to cherish somewhat too noble and premature conclusions about their descent, their being and position in the world. Nor is it surprising that we feel sometimes startled, alienated and confused by new discoveries about ourselves, our ancestors and the series of accidents that made us what we are.

After all, our cognitive apparatus didn't arise *in order to* enable us to achieve truth or even philosophical sophistication. As `survival machines of our genes' we and other animals can do perfectly well with only a modest degree of correspondence between our cognitive token-systems and our environment. Certain delusions, including an amount of self-deception, could simply be adaptive, and certainly the way in which things are perceived and in which the most urgent practical information is selected, must have been adaptive in the past. After all, why should a non-perspectivistic, non-applicable truth matter? For an organism that is `designed' to perpetuate its own genotype, the world beyond the horizon of everyday life could just as well be a stimulating fantasy. Why should we frustrate ourselves by reflecting on the many less elegant survival tricks that enabled our ancestors to live on in our genes? Why should we not cherish a more flattering self-image if it tends to be more reassuring and stimulating?

Moreover, both the mind and its evolution aren't easy to understand. Apart from some hints in Empedokles, Epicure and Hume, it took a long time before philosophers started to understand that the organic world is evolving and that this complex mysterious process is perhaps driven by the unintuitively simple mechanism of the differential reproduction of successful variants. And it took a still longer time before philosophers started to realize that their favorite object of discussion, the mind itself, is just such an evolved property that one can only understand by understanding evolution.

Finally, philosophers have always preferred to believe in a relatively *simple* world - one that one can start to understand simply by assuming a thinking attitude like Rodin's thinker. But the idea that one can solve philosophical problems by reflection only could be comparable to the idea that one can understand the workings of a television by watching only. Classical philosophical problems could simply result from the inability of an evolved self-conscious organism to make sense of its own design-features intuitively. Let us look at some of these problems:

- The problem of goal-directedness: how can goal-directedness arise in a world characterized by simple linear causality and a universal tendency towards decay instead of order?
- The problem of human uniqueness: how unique are we as a species and to what extent are we separated from all other animals?
- The problem of knowledge: how is it possible to know something? If an idea and the reality to which it `refers' are not identical or similar, on what then is the claim of knowledge based?
- The mind-body problem: how is it possible that mind and body interact apparently without being made of the same stuff?
- The problem of self-consciousness: what is the self that we are aware of, if we claim self-awareness? Is it the body or the mind or some combination of the two?
- The problem of freedom and self-determination: how can we both be determined by heredity and circumstances ànd believe that we are the creators of our own life? How can our actions be based on both emotions and on reasons? If some behavioral `patterns' are characteristic for particular characters, does this mean that they are predetermined?
- The problem of values and a meaning of life: how do values arise in a world of facts? Is there a meaning of life apart from what we desire? To what extent are values and meanings purely subjective chimarae and to what extent are they intersubjective or objective?
- The quest for the roots or foundations of society. Why would we live together? Is living together something which comes naturally or which is forced upon us by convention or law? Were we originally enemies that have to be forced to live together peacefully or are we by nature social animals?
- The problem of good and evil: do we call something `good' because we want it, or do we want things, sometimes, because they are good? Is there a `good' that must be acknowledged as good by all rational creatures or is there just a battle of interests in which all parties defend their own good?
- To some extent all these questions come together in the problem of our origins, identity, and ultimate destiny. Paul Gauguin painted three questions in the corner of one of his paintings (exhibited in Boston): "D'où venons-nous - Que sommes-nous - Où allons nous?" These questions are fundamental to some extent, because one can claim that to *understand* human life, one first has to get its story right.

The pages that follow are all written on the basis of the premiss that the theory of evolution offers us the `right story' to understand and to solve most of these issues, although not all their details. One can only understand knowledge and consciousness as adaptive properties that somehow enabled `survival machines' to cope with the challenges posed by the environment in which they had to survive and propagate their genes during their history. *A neglect of this historical dimension will always result in explanatory gaps.*

For example, if one studies teleology the way Aristotle did, one never gets to understand why teleology arose in the first place. If one studies love without phylogenetic analysis, one will never understand why it is often directed at young `beautiful' people and why it often leads to jealousy, insanity, poetry, suicide or children. If one wants to study knowledge, but claims that one isn't interested in the *original adaptive function* of it - an updated version of the *harmonie préétablie* of ideas and things that Kant considered to be impossible -, one will never grasp its dual nature: both subjective - that is essentially perspectivistic and limited - and referential. A glance at the history of epistemology and the history of the philosophy of science shows that if one doesn't look at this original function of knowledge, it is very tempting to fall into one-sided claims like the claim that all knowledge corresponds with objects or that all knowledge is relative to the knower. Therefore, a detailed analyses is needed that shows how knowledge evolved as part of the evolution of biological decision systems and how from this basis in one particular kind of ape science grew into a collective representational system that is continually revised and updated and that is, as a result, less limited and bound to one particular perspective, its specific delusions and idiosyncrasies.

Of course, if it is true that we need the theory of evolution to solve philosophical questions, it is strange indeed that philosophers in the twentieth century didn't pay more attention to it. Why did they hope so stubbornly that they could do without a naturalistic analysis of the mind and why did they continue to think that an introspective or intuitive analysis would be enough? Apparently, our desire to understand is often stronger than our ability to see the limits of our current frame-work, especially if this frame-work happens to be `folk psychology' or the series of concepts that have arisen as a way to describe and manipulate our own psychological processes.

One wonders why `folk psychology' is so successful even though it doesn't give insight in the wiring and working of our minds. Perhaps the success of folk psychology reflects the necessity of an `evolutionary design' for a mind that looks relatively simple from `within': its categories could simply be convenient `handles' on our own psyche as they have arisen as a result of linguistic variation and selection. A car may also look relatively simple as long as we only drive in it and we don't need to repair it. If a car looked very complex from behind the wheel, we could make mistakes while driving. Therefore `folk automobile-theory' doesn't see more than a window, a couple of mirrors, a clutch, a wheel and a dashboard with some indicators. Similarly `folk psychology' simplifies the workings of our own mind and gives us a comfortable sense of oversight and insight which is sometimes used as a starting-point for empiricistic, rationalistic, and phenomenological philosophers.

It seems to me that our minds *look* deceptively simple and that the reason is that all their complexity was put away smoothly behind our `phenemenologically privately open-to-inspection dashboards': the reason being that *we should be able to concentrate on a limited collection of survival tasks.* A certain degree of integration and simplicity was achieved as a result of the continually smoothing forces of selection. A clear overlook is for the organism that has to take the right - adaptive - decisions simply a *sine qua non*. A simple, straightforward model of agency is probably the most adaptive way to judge one's conspecifics. As a result, many philosophers of the past have underestimated the complexity of mind and tended to stress one aspect of its functioning, be it the sensory input, the processing according to categorical forms, or the creative, interpretative manner in which it `constructs' a world. As a result, also, many philosophers seem to have thought that mental phenomena - love, the moral emotions, awareness, human agency - are relatively `elementary', `transparent' and `*sui generis'* instead of being emergent properties of a complex neural circuitry that seldomly is open to inspection and which is a result of a series of ecological and social circumstances that mostly has wiped out its own traces.

With that we come to another problem that stands in the way of an understanding of the mind: the fact that it is a product of *history.* Evolutionary histories are always the product of a series of accidents that are very difficult to reconstruct, because most of the times the traces have been erased by the series of events itself. While it has been suspected for more than a century that our species must be very closely related to gorillas and chimpanzees, it has been possible only recently to compare DNA of the different species: the discovery that the common ancestor must have been relatively young (5 to 7 myr) has been made only in the early eighties. While already one skull of a Neanderthal had been found by the time Darwin published his *Origin of Species,* paleontological findings that slowly start to map out the actual course of human evolution are only piling up since the 1974 discovery of `Lucy', *Australopithecus afarensis.* No wonder that the different theoretical models that explain the divergence of *Pan*, *Australopithecus* and, later, *Homo,* are still speculative.

In the third part of this book I will do an attempt to integrate some of the existing models and to show how they could be made compatible with paleontological data. Of course, much *hubris* is involved, but this may be justified with reference to the playfulness and curiosity without which there would be no progress. Above that, philosophers have always been amateur and arm-chair scientists, because they were always concerned with our position in the world.

The general purpose of this book, thus, is to defend the possibility of a general evolutionary reconstruction of the human mind as a somewhat exceptional animal mind. Because of the complexity of the issues involved, and because of the deceitful nature of the mind in general and the human mind in particular, an evolutionary understanding of the mind isn't possible without some philosophical acrobatics. Those who exhibit the required limberness to rise above the traditional dichotomies and presuppositions, however, will be rewarded by vast panoramas and completely new perspectives.

0.2 Teleonomy, adaptation and `Why?'-questions

This brings me to the original meaning of the word `theory', Θεωρία, a way of viewing things. Of course, I do not believe scientific theories are *just* ways of viewing things. Although they never can be definitely `proven', it can be shown that one theory has much more explanatory and predictive power and more unifying possibilities than another theory. Often these virtues can only be discovered, however, by people who make a particular theory *their* way of viewing things.

Seeing things from an evolutionary perspective requires a fundamental *paradigm shift* or *Gestalt-switch,* even a kind of `conversion'. Human life can not longer be seen as a self-evident phenomenon, that is merely `given'. No longer can it be seen as self-evident that something like `life' arose on this spinning ball of grit. No longer can it be viewed as self-evident that multi-cellular organisms evolved, of which some are mobile, and of which some use environmental clues to orient themselves. And for us, humans, the strangest thing of all, and the most difficult to understand, is why we ourselves evolved, as eusocial predatory apes that use symbols to communicate and to transcend their immediate ecological and cognitive horizon.

Therefore, the central questions of this book can all be rephrased as `Why?'-questions. Why are we here? Why does our mind, at least sometimes, represent the world? Why are we conscious of ourselves, our emotions and our position of the world? Why do we have culture? Why do we have scientific theories and why do we fight over them? I will try to give an inventory of the ways in which these questions, arising from the evolutionary perspective, affect epistemology, the philosophy of mind and the humanities.

Traditionally, for example in the aristotelian tradition, `Why?'-questions were often part of a frame-work in which the whole world had a `purpose'. The moment this teleological view of the universe came to be doubted, metaphysical-minded philosophers kept asking for ultimate reasons. Thus philosophers like Leibniz and Heidegger can ask themselves why there would exists something rather than nothing. Perhaps there is no answer to such kinds of questions. More likely, such a questions themselves are misguided, because it suggests that all causes are ultimately reasons or that all causes do ultimately arise from one universal `foundation'. Certainly the metaphysical `Why?' is posed from a perspective which is fundamentally at odds with the perspective which I will try to defend.

Happily enough, a much more concrete, non-metaphysical way of asking `Why?'-questions has arisen from within the theoretical framework of modern evolutionary biology, as it was first developed by Darwin and Wallace (fig. 0.1). It presupposes a theory according to which complex nonarbitrary structures do not arise accidentally, that is: purely as a consequence of one-shot dice-throwing. Rather, according to evolutionary theory, complexity can arise as a result of both chance and the cumulative effects of selection on self-replicating systems. As a result of such a process, goal-directed structures can arise. This goal-directedness has been designated `teleonomy' (Mayr, 1988) to distinguish it from Aristotelian teleology. During the process of evolution on our planet, at least some brands of such teleonomic structures have evolved into lineages of complex organisms, characterized by an integrated hierarchy of functional elements, some of which are called organs. Often `Why?'-questions refer to the evolutionary logic behind the evolution of such new functional elements. In other words, `Why?'-questions refer to the *function* or *adaptive meaning* of a particular organ, sub-system or behavior within the teleonomic whole of the organism.

In this century, it was especially ethology which demonstrated the autonomy of `Why?'-questions. Tinbergen, for example, starts his *Study of Instinct* (1951) by pointing out that behavior results from many causes, which are described by physiology and psychology, but that one still needs the `Why?'-question to *make sense* of a particular behavior within the survival strategy of a particular animal. At a later stage the distinction was made between *proximate* and *ultimate* causes. It is to these ultimate causes that the `Why?'-question refers if we ask, for example "Why do birds sing?". The presupposition of such `Why?'-questions is, of course, that birds do not sing purely *accidentally*. The complexity of the required syrinx and its neurophysiological controls make such a hypothesis unlikely. The idea is that bird song evolved as a result of a series of adaptations, that is: as a result of the chronic differential reproductive success of those birds that had characteristics which ultimately caused some birds to sing. Only because this process of `natural selection of favored races' of birds `in the struggle for existence' led to structures which impossibly could have resulted from pure chance can we ask why birds sing.

It seems to me that such `Why?'-questions enlarge our scope enormously and enable us to place humans in their proper perspective (fig. 0.5). Even in epistemology and in the humanities only `Why?'-questions can enable us to shake off the intellectual laziness which seduces us to take phenomena, like the structure of the human larynx and the enormous human brain, for granted. In that sense simple questions like "Why do we need knowledge or theories?", "Why do scientists fight over theories?" may imply more than a small theoretical revolution.

From an evolutionary perspective, then, a whole new look arises on the `design features' that constitute the human mind. The traditional philosophical questions listed above collapse into one big question as to the `Why?' of the human mind, its symbol- and culture-creating capacity, its tendency to fight over ideas, etc.. Instead of starting the philosophical enterprise by asking our list of philosophical questions *a priori* we will have to start with acquainting ourselves to evolutionary biology and human evolution. First we have to know why knowledge evolved, why our ancestors increasingly became dependent on it and why culture arose. Only then, perhaps, can we start to answer those questions which were traditionally called `philosophical'.

0.3 Overview

A word about the structure of this book. Part I is concerned with central problems of modern philosophy: knowledge and consciousness. Instead of trying to start with an answer on the question `What is knowledge?' and `How does knowledge arise?' it focuses on the question `Why?', `Why has knowledge evolved' and `Why did consciousness evolve?'. I will try to show that this transition from transcendental analysis to evolutionary explanation has many advantages. It does not offer the ultimate foundation for knowledge that philosophers have dreamed about and it cannot be definitively `proven', but it is almost inevitable as a result of its superior explanatory power: It simply offers more than other theories. Only the theory of evolution can explain *why we are in need of knowledge* and why knowledge has the limitations it has. Only from the theory of evolution can we explain why science can be successful and what social mechanisms underlay the variation and selection of theories.

The same goes for the problem of consciousness (chapter 3). Traditional theories of consciousness were either remnants of traditional dualistic concepts in a sophisticated skeptical epistemological guise or byproducts of a critical epistemology. Before the theory of evolution came to rescue, philosophers simply had no idea how to approach the problem of consciousness properly. They were continually posing the wrong questions. Even some modern theories about consciousness are still one-sidedly concerned with either the phenomenal aspect of our subjective experience or with the `fact' that this subjective side is produced by a physical body. It seems to me that both these approaches still neglect the possibilities of a radical evolutionary approach. One can first better try to give a answer to the `Why'- question instead of starting with an investigation into the nature of consciousness, because an answer to the `Why?' - question may give indispensable clues for an answer to the question about the nature of consciousness.

Part II applies the same strategy to the foundations of the social sciences. Instead of starting with definitions of human uniqueness and culture, one can better start by analyzing why extreme social and cultural characteristics evolve and what keeps them in existence. This is the sociobiological approach and I will start with an introduction to sociobiology, because this discipline is often misunderstood. I will then try to show that the phenomenon of human culture should not be taken for granted, but that it is much more illuminating to ask why it evolved and what keeps it in existence. Instead of asking `What is human culture' I propose to ask `What drives human culture?'. By comparing (in chapter 5) different models of the genes-mind-culture triangle I will try to evaluate their respective explanatory power and try to find a proper model. There are good reasons to suppose that this is not a model in which `human nature' is a kind of *tabula rasa* that can be filled in by a particular culture. From an evolutionary perspective it is to be expected that human nature encloses specific sense organs, cognitive filters, processors, evaluating mechanisms, needs, learning modules, decision procedures etcetera. Yet, it would be a misunderstanding to think that this means that culture is purely `genetically determined'. It is at least part of the adaptive value of the human capacity to create culture that it enables humans to adapt to a spectrum of different environments. In chapter 6, I will present three case studies which hopefully will clarify the way in which cultures interact with the environment via conditional strategies that are inherent in human nature. Thus, the fact that cultures are often fundamentally different does not mean that humans are completely different, only that they have actualized different possibilities inherent in human nature.

Yet, just as phenomena like knowledge and consciousness are only properly understood from an evolutionary perspective, it is to be expected that we will only understand human culture if we know why and how humans evolved. It is in the words of G.C. Williams (1966) not unreasonable "to anticipate that our understanding of the human mind would be aided greatly by knowing the purpose for which it was designed". Part III therefore finally asks "Why *did* humans evolve from a primordial stock of apes and why did they, that is we, become dependent on an extrasomatic `superorganic' realm of symbols called `culture'?". A correct answer to this question would resolve many problems in philosophy and the humanities. For that reason it can be considered to be *the* question that most deeply transforms our philosophical perspective.

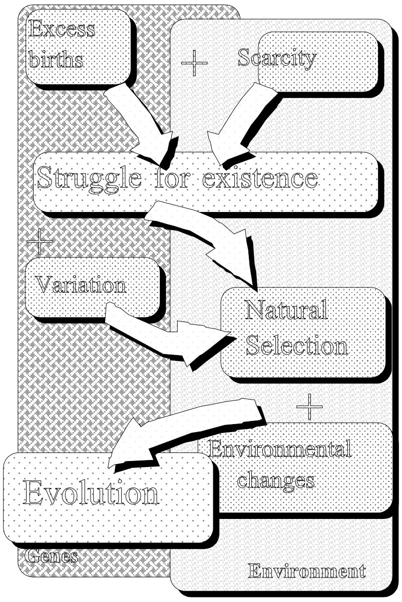

Fig. 0-1. The mechanism of evolution by natural selection (see text).

0.4 Evolution in five figures

Philosophers are distrustful of cartoons. They prefer massive monuments of words. Yet, I believe that their distrust of figures sometimes masks the vagueness of their ideas. Figures are very risky as they reveal once's thinking errors without mercy. Thus, it is with some trepidation that I present the general theoretical background of this book as a `cartoon' in seven figures. These figures are simply meant to give an idea of some of its presuppositions and orientations. They are not meant as a summary or as a substitute for more extensive discussions.

Figure 0-1. This figure was originally designed by Wallace (Strickberger, 1990). I have modified it to show that evolution is always *interaction.* Evolution can even be defined as the ongoing result of the interaction between genotypes and a continually changing environment via the various more and less successful phenotypes. The differential reproduction of phenotypes was called natural selection by Darwin. Natural selection can be viewed as a kind of sieve. Only those phenotypes are able to reproduce that `fit' a particular way of live in a particular environment. Variations that happen to improve the `fit' between an organism, its survival strategy and its environment are cumulatively favored. The result is called adaptation. Thus the bills of both ducks and hawks are adapted both to the specific `niches' (roughly, food specialisms, specific roles in an ecosystem) that they occupy in particular environments.

Of course, very few agree that the mechanism of natural selection alone can explain all aspects of living phenomena. Even Darwin himself thought that many phenomena in nature can only be explained with the assistance of an additional mechanism, sexual selection, that sometimes works contrariwise (I will further discuss this topic in chapter 4 and in part III).

In the time of Darwin there was only a very superficial knowledge of the continuous climatological, tectonic and even astronomic influences on the biosphere (Darwin knew something about ice ages, however). Only a much more detailed knowledge about the history of the earth and life could reveal the way in which evolution is often driven by external forces (more about this in chapter 7).

Figure 0-2. The process of the natural selection of adaptive characteristics should not be seen as a goal-directed process (Slurink, 1991). This is because something can only be called adaptive given the particular niche that an organism occupies and given a particular environment. Because there are many possible niches in any ecosystem and because environments are continually changing, evolution is not a road to one `finish', but a bush with many branches, some of which may even lead to more `primitive' forms (for example, the ancestors of fleas had wings, the ancestors of many wind pollinated plants were pollinated by insects).

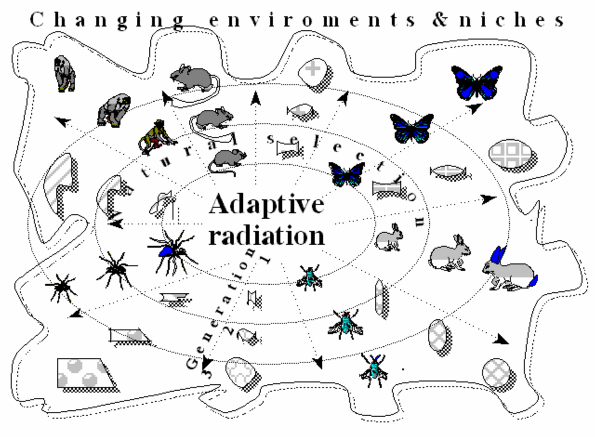

Fig. 0-2. As a result of variation and selection organisms tend to diversify, different lineages adapting themselves to particular niches.

If we start to study evolution in the field, simply by starting to study the enormous diversity of plants, fungi, insects or whatever, what strikes us is the tendency of related organisms to adapt to specific niches. Apparently it often pays (in terms of reproductive success) to specialize: one can then become `good at' one's specific survival strategy and one can, at the same time, avoid competition. The resulting phenomenon is called *adaptive radiation.* More than anything else it shows that evolution is not a goal-directed process. Rather, natural selection working on isolated populations creates diversity, because for each characteristic of a given lineage each environment may have another adaptive optimum[1].

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[1] Some Dutch philosophers are convinced that evolution should be seen as a goal-directed process. They defend this idea, however, by de-anthropomorfizing the concept of goals to such extent that it is hardly clear what they mean (Hulswitt, 1998). For me the concept of a goal either includes an element of predetermination or of premeditation. For a discussion of these issues, see Slurink (1991).

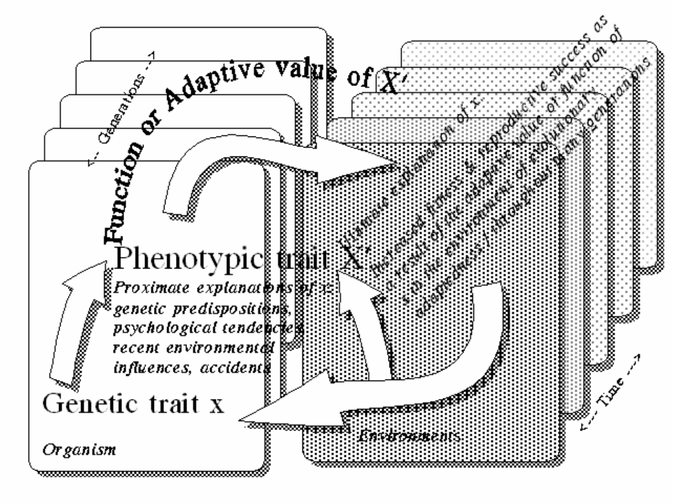

Fig. 0-3. Proximate explanations refer to a limited number of generations while ultimate explanations refer to a large number of generations in which particular adaptive traits did confer increased reproductive success.

Figure 0-3. This was originally inspired by a figure in the book of Looijen (1998) about reductionism and holism in biology and ecology, but I changed it drastically. It shows how properties of organisms can and must be explained on different levels at the same time. `Reductionistic' explanations may refer to genes that code for particular proteins which cause a trait x to be expressed in a particular organism. A complete *evolutionary* explanation is not reductionistic, however, or is reductionistic in a completely different way (evolutionary reductionism, Alexander, 1987). It has to refer to the causes that a particular mutation is able to gain foothold in a particular population in an particular environment: to explain that it has to refer to the survival value, function or fitness effects of x. Property x will increase in the population if it increases the adaptive fit between the organism and its environment. Individuals possessing the relevant gene or genes have more reproductive success and will consequently help to spread it/them through the population. Despite the fact that x may result from one single gene its adaptive value is tested as part of the whole organism. The function or adaptive value of x is therefore a holistic property. Particularly in ethology, evolutionary explanations are often called `ultimate' and contrasted with `proximate' explanations, which simply refer to the chemical, physiological or psychological causes of some behavior or trait.

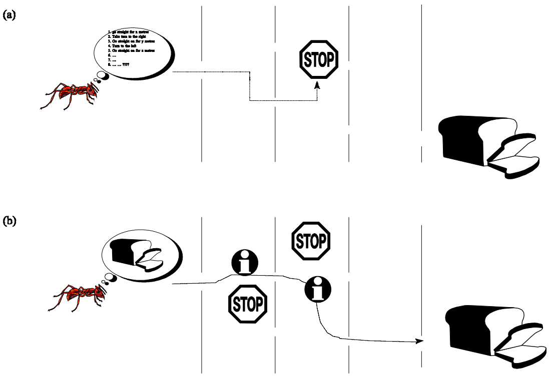

Fig. 0-4. (a) An organism following a precisely genetically instructed course may be hindered by small obstacles (`stop'), (b) which a more flexible goal-directed and information-gathering organism is able to evade.

Figure 0-4. Although itself not working towards a specific goal, natural selection *does* produce goal-directed systems. Goal-directed systems are systems that remain directed at a particular goal, independent of their current position (e.g., Ruse, 1981). Often they can adapt their course, to some extent, depending on their current position. This makes them very flexible. For example, in figure 0-4 (a), it requires a long series of precise instructions to get an organism with a precisely genetically instructed course to get a piece of food: "go straight on x meters, then turn to the right, go straight on for y meters, then turn left, go straight on for z meters, etc.". Still, a relatively small obstacle (`stop') can bring the system to a stop. In figure b the system is oriented towards a goal, but is not programmed with precise instructions to follow a particular route. The system creates its own route on the basis of at least some incoming information and on the basis of its directedness towards a series of goals. As a result it is able to avoid obstacles in a flexible way.

Biological goal-directedness or teleonomy does not, of course, always imply complex information-processing. Ultimately, it is determined by a simple subtraction sum. Goals that somehow lead to extinction are `rejected' by natural selection; goals that promote reproductive success tend to spread their own genetic base. As a result, goals that are produced by evolution tend to be coupled to crude biological `necessities' like survival and reproduction. Yet, in many mobile species much information has to be processed before even these goals can be attained.

Again, even in the minds of such mobile organisms, and even in complex mobile organisms, all this does not imply that the `ultimate' goals produced by natural selection are represented in the mind of an organism that happens to process all this information. Even consciousness did probably not evolve to promote self-knowledge, but only to solve specific problems. The goals of which an organism is conscious are likely to be `proximate' goals. Such goals are only intermediate direction signs that guide the organism through the problems of a specific sex-age class.

Figure 0-5. This figure is based on a figure by Wilson, which was also used by Barash (1986). It is an attempt to visualize the differences in focus among ethologists (a), primatologists (b) and students of human behavior (c). Ethologists study the behavioral repertoire of many species and subsequently place human behavior in a very wide context. Primatologists gain a more detailed insight in human life by comparing humans to the other apes. Students of human behavior study humans even more closely. Often they take the range of human behavioral variation for granted, however, forgetting that it represents only a small subset of the real variation in animal behavior. According to Wilson and Barash in going from (a) through (c) "we gain greater resolution but lose perspective, and vice versa".

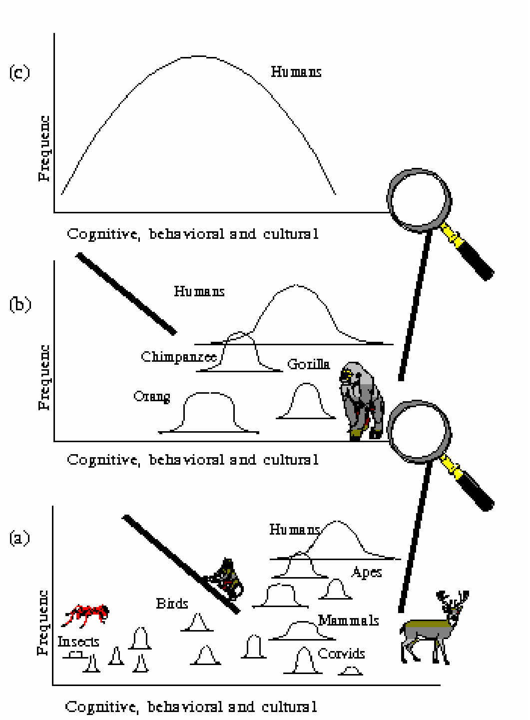

Fig. 0-5. Differences in focus among ethologists (a), primatologists (b) and students of human behavior (c). In going from (a) through (c) "we gain greater resolution but lose perspective, and vice versa" (Barash, 1986).

Obviously (a), (b) and (c) are not incompatible; all three approaches are perfectly legitimate scientific enterprises. In principle, the whole scientific enterprise would be hopeless if one would see from perspective (a) things that are not true from the perspective (c). It would be a good heuristic principle, therefore, to discuss theories about human cognition, motivation and behavior on all three levels and to keep them compatible with results of investigations at all three levels.

In all, these five figure suggest a

theoretical frame-work from which we can work on our `Why?'-questions. I hope to show that the mechanism of evolution, visualized in figures 0.1-0.3, can be used to explain a wide range of phenomena, including knowledge, consciousness and culture. While explaining these phenomena, we have to keep in mind figure 0.2 constantly to remind us of the fact that evolution is not a linear process. If there would be only one lineage and only one environment, evolution could in principle be a linear process. One trip into the field or into the forest reminds us of the fact, however, that all organisms have their specific survival strategies coupled to a very specific part of the environment. Even the so-called non-specialists often need specialized skills to be able to be unspecialized: one only needs to look at the multifunctional bills of corvids, gulls and starlings to understand their opportunism.

In explaining behavior, specifically, we have to keep in mind figure 0.4. In no way does evolution imply that behavior is always rigidly preprogrammed. Of course, flexibility and learning have their price: for many relatively simple organisms they would simply cost too much time. Hence, a wasp will simply fly in the direction of the light, even if this implies bumping into windows. Only if this maladaptive behavior would cause the death of extremely large numbers of wasps during thousands of years would there be a chance that some wasps would evolve with the ability to overrule and correct their tendency to fly in the direction of light.

In many birds and mammals, the balance seems to have shifted in another direction and learning has apparently started to pay. That does not imply infinite flexibility, however, which would be incompatible with the concept of teleonomy. Often learning simply means that a particular behavioral programme can be improved by exercise and can be adapted to a particular environment. But even if the behavior of an animal would be extremely flexible, it would still need a general orientation to a series of goals which would assure that it wouldn't go extinct. The simple reason is that organisms which lack at least a general goal-directedness and do not somehow propel their own kind have been going extinct and are going extinct all the time.

All this does not imply that I am defending a kind of `biological determinism' if biological determinism implies that the behavior of organisms is always preprogrammed in a robot-like fashion. If biological determinism implies that the behavior of all organisms, including humans, results from a series of physiological and psychological mechanisms that have been selected to ensure survival and reproduction, I am happy to be called a biological determinist.

Finally, figure 0-5 reminds us off the specific angle of the evolutionary approach. It does not simply see humans as `just animals' or `just apes'. This would not make much sense because `the' animal and `the' ape does not exists. All animals and apes are products of unique evolutionary trajectories, and so are humans. As figure 0-5 shows, humans could be unique because they display an extraordinary range of cognitive, behavioral and cultural possibilities. That does not imply, however, that we could not learn a lot by comparing human behavior to that of other animals, and especially to that of other primates. Such an approach is not incompatible with a more detailed study of human behavior in specific contexts, but simply has another resolution. There will be things which we can only see by watching humans closely or even `from the inside' and there will be things which we can only see by keeping some distance. If you want to see that the tower of Pisa does not stand entirely straight, you shouldn't study its interiors only or study it through a microscope. On the other hand, a study under the microscope of some of its materials may well be worthwhile to study the chances that it breaks at some point. Perhaps figure 0-5 can remind us of the necessity to switch back and forth between several perspectives. This flexibility of perspective and this attempt to integrate several perspectives is what defines naturalism.

0.5 Naturalism versus Transcendentalism

Finally, an attempt to visualize two different approaches to philosophy: the naturalism defended here and transcendentalism. (Again, figures should not be taken as a substitute for more extensive discussions.) By transcendentalism I do not only mean the type of philosophy exemplified by Kant and Husserl, but also other philosophies that take the concepts with which we understand our position in the world as somehow absolute, *a priori*, uninfluenced by other knowledge. Transcendentalists are those who believe in *a priori* conceptual analysis, who continually demand definitions before a particular ontological realm is discussed. Many `transcendental' philosophers are critical minds, who sincerely believe that one can analyze concepts or presuppositions without having to delve into the progress made by science. Often they value consistently and conceptual clarity high, but sometimes they overrate intuitive plausibility. They often forget that meanings, too, are theory-laden and that long chains of deductions are easily contaminated with extra presuppositions. The idea that meanings are somehow absolute or `given' has been called `meaning realism' by Ruth Millikan (1984). It seems to me that meaning realism presupposes a kind of transcendental or platonic realm in which the meanings of concepts are stored and kept pure, apart from the rest of our knowledge.

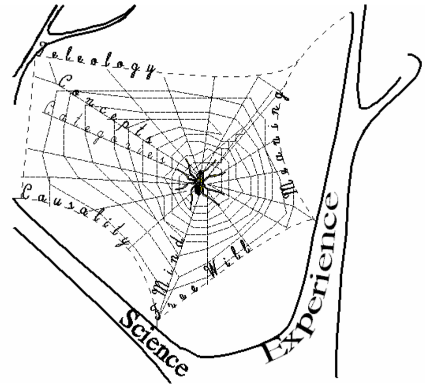

Fig. 0-6. The naturalistic philosopher as a spider in its web.

Naturalists do not believe in such a `transcendental dictionary'. There is no collection of presuppositions apart from our knowledge about the world, rather presuppositions come and go while we are continually molding new hypotheses. While consistency and strictness are to be valued highly (apparently the world is to some extent structured and intelligible), the intellect of man is far too limited to be able to understand itself and its position on the basis of deductive reasoning alone. Attempts at building philosophies on the basis of `self-evident' truths and strict deductions fail, because they start already with apparently `pure' concepts that nevertheless contain fragments of old hypotheses and because they contain deductions contaminated by inconspicuous presuppositions. The safest way to free your thinking of false presuppositions is to realize the dynamic nature of all concepts and the hypothetical nature of all thinking, while at the same time keeping contact with many different realms of reality in which specific hypotheses are continually tested and corrected. For the naturalists, science is a way of enlarging the `field' of ordinary experience by means of new instruments and new mathematical techniques. Often it reveals the limited nature of ordinary experience and therefore it is often able to correct the hypotheses which arise out the naïveté of this context. Even more sensational is the potential of science to actually solve philosophical problems of the past, of which I hope to give some examples in this book.

But can we trust science? While a scientific theory which is able to predict and explain many phenomena is not necessarily true, a *history* of success can hardly be an accident. Especially when a theory is confirmed in different fields, on the basis of different methodologies and different sets of data, it should be taken seriously to the extent of its `robustness' (multiple derivability, Wimsatt, 1981). Thus, good theories should not only exhibit consistency, conceptual clarity, verifiability, predictive and explanatory power, in the end robustness and convergence are the best signs that one is heading in the right direction. If theories would be untrue, despite their having all those virtues, including robustness, this world would in the end proof to be unintelligible and we would be toys of Descartes' demon: we would not stand the ghost of a chance against him. The world is a risky place and whoever is curious or yearns for wisdom has take as many chances as whoever wants to live in it. Wisdom is not the fruit of fear and prudence only, but it results from a mixture of curiosity, experimentation, folly and learning by experience.

I have depicted the transcendental and naturalistic approaches in Figure 0-6 and 0-7. The idea is that we are in the midst of a web of meanings, which connects us to the world. Just like a web spider is almost blind, we have eight sensitive paws with which we feel all minute chances in our web and in the world around us. We are continually obliged to spin and weave new conceptual connections and to restore old indispensable ones. Perhaps our eight paws can be called consistency, simplicity, conceptual clarity, verifiability, predictive power, explanatory power, robustness and plausibility. There is no way in which we can leave our web or in which we can secure the threads that we weave apart from a small collection of affixtures outside. Figure 0-6 thus shows the naturalistic philosopher as a spider in its web.

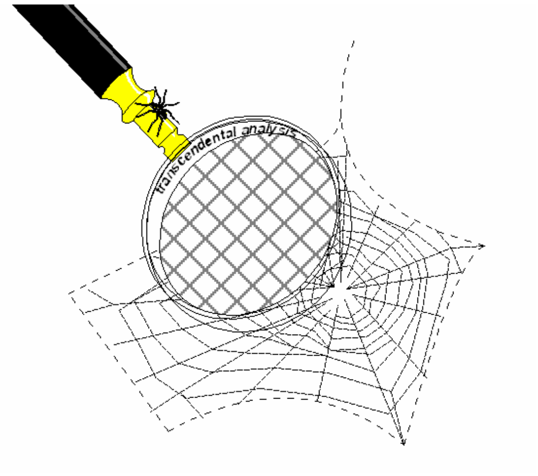

Fig. 0-7. The transcendental philosopher as a spider with a magnifying glass leaving his web of meaning to inspect it from above.

In figure 0-7 something strange has happened. The spider thinks he can leave his web and can inspect its quality from the outside. Even stranger, he thinks his web is all that matters and he forgets that it is connected to the outside world and that it has a purpose. In his imagination he is hovering above his web, which he considers to be a universe apart, and he is endlessly correcting threads and connections. Of course, he has a magnifying glass at his disposal which is as big as his web and much bigger than his own modest physical appearance. Sometimes the spider in the midst of this web thinks it needs only *one* thread connecting it to one branch. It will be clear that this is a caricature of the transcendental philosopher, who thinks that concepts can be analyzed apart from their connections to the world of experience and that of science or who thinks he needs only one connection.

In contrast to transcendentalism, naturalism is an attempt at multidisciplinary conceptual integration which is directed at minimizing the risk of error by spreading the weight given to different chains of reasoning. As long as knowledge originating from different realms of reality reinforces each other the web is safe: it will probably survive even if one or two of its threads break.

It will be clear that I do not conceive myself as a transcendentalist. Yet, although it is based on dubious assumptions, although it contributes hardly to progress and sometimes even frustrates progress, transcendentalism often is functional in reminding us of the fact that human knowledge is still very limited. Transcendentalists are good in finding weak points within the naturalistic frame-work and with that they point to issues which need further work. To phrase it in a somewhat biblical way, transcendentalistic philosophers often see the mote in one's brother's eye but do not see the beam in their own eyes (Math. 7, 3). Let us be thankful for that, continually, because without their help we might not be able to remove that mote.

I

* Why knowledge & consciousness evolved *

At least since Socrates and Plato naturalistic and materialistic philosophies have been judged epistemologically naive by many philosophers. Idealistic, rationalistic, transcendental and phenomenological philosophers claimed that scientific theories are in need of a `foundation' beyond science: their `presuppositions' and concepts had to be proved valid `a priori', independent of specific theories. Without such a foundation and justification scientific theories were supposed to be circular: scientists would essentially be finding what they expected to find and would be unable to discover realities that did not fit their conceptual frame-work. The discovery that knowledge does not arise directly and exclusively from the senses often seduced philosophers to neglect the testimony of the senses as if interpretations of the world which explain many observations are not superior to interpretations without such `empirical' support.

The rise of evolutionary epistemology marks a stage in the history of both materialism and naturalism in which the reproach of naivité is no longer justified. Not that evolutionary epistemology claims to offer the kind of extra-theoretical foundation that `foundationalistic' philosophers are looking and asking for. Evolutionary epistemology shows, however, that circularity can be very fruitful if it leads to theories that integrate more and more facts. In that case, circularity is a property of an upward spiral of progress, a feedback loop in which new concepts and presuppositions on the one hand and new facts and discoveries on the other hand mutually clarify and fertilize each other. If knowledge is viewed as based on pattern-matching (Masters, 1993), it is clear that it grows with the sheer quantity of observations which have given rise to the recognition of particular patterns, despite the fact that it can never completely transcend its conjectural origin.

Chapter 1 introduces evolutionary epistemology as a model which explains the possibility of knowledge as a correspondence or `fit' between objects and representations. This correspondence or fit is explained as a product of natural selection: our cognitive apparatus has evolved to guide us through the world by means of representations, ideas and concepts. We are capable of knowledge of the world, because we are like all animals in need of orientation. Our internal representation of the world is not designed to be ontologically adequate, however, but to ensure decisions that promote survival. Our `innate structures of experience' constitute an evaluative perspective in which information concerning the world is sieved and transformed in a way that enables us to reach evolutionary optimal decisions. This way, evolutionary epistemology explains the contrasts between science and our natural experience of the world.

This version of evolutionary epistemology gives a plausible perspectivistic model about the relationship between ideas and things and it enables us to see both the scope and limitations of the human knowledge apparatus, which originally evolved both to orient and to guide: orientation presupposes a minimum of adequate representation, guidance and motivation sometimes may require simplification, bias, misrepresentation and self-deceit. Certainly, truth is not a self-evident ingredient of our destiny.

Chapter 2 tries to give a systematic treatment of the diverse properties of our cognitive ability. The evolutionary epistemological approach to the various properties is compared to other approaches, especially the transcendental philosophy of Kant (the sequence of subjects of whose KRITIK DER REINEN VERNUNFT was used in this chapter in a creative way). Kant tried to criticize the human capacity for knowledge by giving an analysis of its strengths and weaknesses A PRIORI - before its actual use.

However, any A PRIORI analysis of the human cognitive faculty and the transcendental veil in which it casts the world is bound to be speculative. It would be an illusion to think that such an analysis could be uninfluenced by the advancement of knowledge in a particular age (Kant's analysis, for example, is clearly inspired by the success of Newton's physics and by its felt inadequacy as a final interpretation of the world). The only way to discover the limits and possibilities of our knowledge apparatus is by integrating all research in its function and range. A naturalistic `criticism of pure reason' (KRITIK DER REINEN VERNUNFT) starts therefore with the assumption that not all our knowledge is deceptive. From there it tries to sort out what we currently know about all the processes that constitute or underlay knowledge between `sensory input' and `intelligent, informed output'. On the basis of this knowledge A POSTERIORI it can explain phenomena like the `theory-ladenness' of observation, the `value-ladenness' and `social construction' of scientific models without (mis-) using them as a starting-point for a relativistic epistemology. It was already accepted that this procedure implies some kind of circle, but this circle has the character of a spiral in which the phenomenon of knowledge is explained backwards by means of a process of `bootstrapping' during the gradual accumulation of knowledge about the world of which our knowledge capacity forms a part.

Such an analysis of knowledge has the advantage of being able to profit from advances in many disciplines without being overly distrustful or trustful. Chapter 2 is an attempt to indicate what kind of knowledge has implications for epistemology. I aim to show that the new evolutionary and naturalistic approach throws another light on traditional subjects and also points to a series of properties of the cognitive apparatus that were mostly neglected in the past. For example, Kant wrote on the senses (§ 2.1), on the stereometric frame-work of observation (§ 2.2), on innate/A PRIORI cognitive expectations (§ 2.4) and on the tendency to transcend experience (§ 2.6); but NOT on the value-ladenness of experience (§ 2.3), the social construction of reality (§ 2.5) and the trial and error character of all knowledge (§ 2.7). Although this has been proclaimed by other philosophers before, for me the most important insight from evolutionary epistemology is that knowledge does not exist for the sake of knowledge and consciousness does not exist for the sake of consciousness. As one of the `fathers of sociobiology', C.G. Williams wrote, only by asking for its function, can we hope to understand the human mind.

This brings us to chapter 3. Traditionally, epistemology has always been an applied philosophy of mind, mobilized to combat skepticism and to give a foundation for a philosopher's attitude towards science. This has had the effect that both epistemologies and philosophies of mind often concentrated one-sidedly on the information-aspect of knowledge. From an evolutionary perspective the other side of knowledge becomes more important, the one that has to do with decision-making. Consequently, in chapter 3 consciousness is not only viewed as a focus of perspectivated information about the world, but above all as a locus at which an organism is MOVED by properties of the world which *are relevant with respect to its well-being, prospects and possibilities. Consciousness is the radical subjective side of knowledge which enables organisms to access the relevance of information with respect to decisions that have to be taken - which* FORCES *them to take information seriously.*

In chapter 3 sociobiology and evolutionary psychology (more extensively defended in chapter 4) are cross-fertilized with value-driven decision-system theory as developed by G.E. Pugh. Sociobiology and evolutionary psychology are used to defend that consciousness is thoroughly perspectivistic and related to the interests of the individual or even of its genes. Value-driven decision-system theory explains the necessity of a decision system in which different behavioral options can be compared and `weighed'. It is proposed that consciousness constitutes a cognitive and motivational straitjacket which `subjectively forces' animals to act in an adaptive - inclusive fitness maximizing - way. `Innate structures of experience' are needed to supply values that enable animals to weigh different behavioral options: they supply heuristic approximations of the survival values of different experimental behavioral strategies (which may be explored during play). They may constitute something like Melzack's `genetically prewired neuromatrix'.

In all, the results of this evolutionary approach to mind are somewhat more critical than German-Austrian evolutionary epistemology: it stresses the way in which information is transformed into subjectivity to narrow down the list of behavioral priorities for the organism. The model thus suggests a functional (and realistic) interpretation of qualia: they guide organisms through a wood of behavioral options in a plurality of possible situations. This view of consciousness has also consequences with respect to the `question of animal awareness'. Play behavior is viewed as behavior in which animals not only improve their motor skills, but in which they also train their general level of control and improve their skills in decision-taking. Dreaming is interpretated as a result of the ability to form scenarios and to weigh and compare virtual situation-specific behavioral sequences, using the experiential `values' which qualia are supposed to be. Therefore both play behavior and dreaming could provide diagnostic criteria for the ability to experience and to suffer. Animals that can play and dream are to be viewed as conscious beings that deserve special treatment. (Within this view, consciousness is also not dependent on a capacity for language, although language certainly must have enormously expanded the horizon within which organisms experience and thus evaluate their world with its promises and possibilities.)

The general upshot of part I is that knowledge is a through and through `biological' phenomenon. This does not mean, of course, that it is a purely `genetical' phenomenon and that learning does not play a role. It means that knowledge and even learning are ADAPTIVE *phenomena, `designed' by variation and selection to enable organisms to interact efficiently with their environment. As an adaptive phenomenon, knowledge is at the same time a holistic property, tested as a whole by natural selection. Thus an evolutionary approach does not turn us into reductionists.*

One of the nice properties of evolutionary epistemology is that it makes us more aware of the relationship between animals and humans. A series of questions becomes important, which is entirely beyond the scope of epistemology. Are humans just other animals? If animals and humans are so similar to each other, can we still view humans as animals with a series of unique characteristics, for example those that cause us to create culture? Such questions are addressed in part II and III.

1

* To know in order to survive: explaining knowledge and its limits from an evolutionary perspective \

Wie weit auch unser *Intellekt* ein Folge von Existenzbedingungen ist -; wir hätten ihn nicht, wenn wir ihn nich *nötig* hätten, und hätten ihn nicht *so*, wenn wir ihn nicht *so* nötig hätten, wenn wir auch *anders* leben könnten.

Friedrich Nietzsche (1940: II, 258)

Wohl kann man die Formen, also gewissermassen den leer ablaufenden Mechanismus der Erkenntnisleistungen, zum Gegenstand der Untersuchung machen, `reine' Erkenntnistheorie treiben. Man würde dabei so verfahren, als ob man etwa die Mechanismen eine Photokamera, sagen wir eine Leica, in ihren inneren Gesetzmäßigkeiten untersuchte, ohne dabei in Betracht zu ziehen, daß der ganze Apparat zum Photographieren da ist und von der Firma Leitz/Wetzlar im Dienst dieser Funktion aus einfacheren, früheren Typen entwickelt worden ist. Vor allem aber wird man bei einem solchen Vorgehen weder über die Leistung noch über die Leistungsgrenzen des untersuchten Apparates dasjenige erfahren, was zu wissen nötig ist, will man die Leistung verstehen und verbessern lernen, um jene Grenzen zu erweitern.

Konrad Lorenz (1959)

... in spite of its triviality, the proposition that *animals can know something* completely revolutionizes the theory of knowledge as it is still widely taught.

Karl Popper (1990)

1.1 EVOLUTIONARY EPISTEMOLOGY: ITS NATURE AND LIMITS

Scientific progress is often the result of integrating independent facts or models in new explanatory frame-works (Kitcher, 1981; Wimsatt, 1981). Newton combined the idea of a falling apple with that of rotating planets and Darwin combined insights into the breeding of different races of domestic animals with knowledge of geology, fossils and the variety of species. Although such connections of ideas may seem almost inevitable *in retrospect,* they were undoubtedly very hazardous and highly speculative at the time that they were first made. The same goes for the first *scientific* theory explaining the nature and scope of knowledge, evolutionary epistemology, which has been developed independently by many thinkers on the basis of evolutionary theory (Roy Wood Sellars, 1922; Lorenz, 1973; Campbell, 1974, 1990, Vollmer, [1975] 1983; Riedl, 1981; Millikan, 1984, 1993; see also Giere, 1985, Ruse, 1986, Bradie, 1986; Rescher (ed.), 1990; Radnitzky & Bartley III (eds.), 1987; Hahlweg & Hooker (eds.), 1989, Rescher (ed.), 1990; Goldman, 1990; Popper, 1990; Callebaut, 1993).

Evolutionary epistemology connects two concerns that traditional philosophers are inclined to see as belonging to different categories: the biological process of adaptation through natural selection and the traditional philosophical problem of the possibility of knowledge. It addresses the same question which inspired Plato to his doctrine of a pre-existential contemplation of the eternal ideas, Leibniz to his doctrine of a God-given *harmonie préétablie* between ideas and things, and Hegel to his belief in the ultimate spiritual nature of all reality: how can ideas `in our minds' *ever* `correspond' or `refer' to objects and relations `in the world'? Evolutionary epistemology answers this question by postulating that not all of our knowledge is deceptive and by explaining the partial adequacy of our cognitive faculties as the product of variation and selection. *Some of the ways in which we structure our experiences and some of the ways in which we acquire knowledge are adequate, because they have already enabled our ancestors to become our ancestors* (Vollmer, 1983: 102) - it is supposed that a long series of their relatives became extinct as a result of their lack of an adequate representation of their environment. Knowledge is explained as a sensitivity to particular physical characteristics of the environment which are processed into an internal representation that helps the organism to orient itself and to attain its goals in that environment.

Of course, evolutionary epistemology - which is presented by Gerhard Vollmer as a `Copernican turn' in epistemology - has problems which originate with the very concepts it unifies. Some of these problems come with the notion of *adaptation* - to understand evolutionary epistemology it is absolutely essential that one has to accept that adaptations are always accidental and imperfect evolutionary improvisations which are often compromises between different requirements. Other problems originate with the concept of *knowledge*, which, of course, is not a self-evident empirical `phenomenon' like a falling apple or the moon. Philosophers have quarreled for already twenty-five centuries about what knowledge really is and how it is possible. The idea that evolutionary biology is going to solve this problem immediately, at first encountered knitted eyebrows and venomous mockery (e.g. Putnam, 1982; Nagel, 1986: 78-81). In this chapter I will defend the idea that evolutionary epistemology is simply an inevitable consequence of developments within our current world view and that this epistemology has far-reaching implications for our *philosophical* meditations on the nature of knowledge. It is not claimed that all epistemological problems are solved in one stroke: a more detailed analysis of the origin of the more specific human knowledge-forms is essential.

As some of the most important originators of evolutionary epistemology have indicated, evolutionary epistemology is a *scientific* theory based upon presuppositions that it shares with other scientific theories: one of them being the `postulate of reality' (Monod, 1971; Lorenz, 1973; Vollmer, 1983; Meyers, 1990)[1]. It is neither an *a priori* analysis of the possibility of knowledge, nor an absolute justification of our knowledge-forms. It does not have *decisive* arguments to defeat the antirealistic skeptic and it can't function as a demarcation between theories that are scientific or not. Above all it has to be stated that it has only *conditional* normative implications. In that sense it cannot satisfy the criteria which traditional epistemologies *wanted* to satisfy.

In the following I will indicate why evolutionary epistemology is nevertheless of such importance. My starting-point will be that evolutionary epistemology is, above anything else, *a scientific theory about our natural daily experience of the world*. It is precisely from an analysis of this normal experience that light is thrown on the different properties of

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[1]. To be honest, it has to be admitted that there exist anti-realistic versions of evolutionary epistemology, which however seem to be born more from an (over-) reaction to naive realism than to the critical or hypothetical realism defended here.

knowledge which have confused philosophers for centuries. To those properties belong, among other things, the perspectivistic and subjective nature of knowledge, the underdetermination of our models of the world by sensory data and the both social and competitive nature of science - all aspects of knowledge which have been exaggerated by one philosophical school or another and which have been seen as a reason to abandon the belief in the `objectivity' or the `realistic referential' character of knowledge-claims. Indeed, all these properties do not make it easy to transcend our primary experience of the world and the intuitions which it engenders - as a result of which it becomes difficult to maintain the ideal of knowledge as something beyond subjectivity, speculation, and social construction. Yet, as a result of the scientific study of the evolution of knowledge and its limitations, it sometimes is possible to overcome them. It is via this maneuver that evolutionary epistemology as the evolutionary justification and critique of our inherited knowledge capacities has important normative implications.

In the last decades evolutionary epistemology has become increasingly popular. The reason for this popularity is simply that it promises a more complete and integrated picture of knowledge than the more traditional epistemologies were able to offer. Evolutionary epistemology can explain, for example, in what respect traditional models and foundations of knowledge like empiricism and rationalism were right and to what extent they were exaggerated and one-sided. No doubt its biggest virtue is, however, that, contrary to traditional epistemologies, it can explain what knowledge *is*, why it is so difficult to achieve and its `foundations' remain hypotheses within a web of hypotheses.

Inevitably the popularity of evolutionary epistemology also meant that many different versions of it were proposed, some of which could more adequately be called `evolutionary information theory', the `evolutionary account of science' (`Evolutionäre Wissensschaftstheorie', Oeser, 1987; Callebaut, 1993) or `universal selection theory' (Campbell, 1974; Plotkin, 1994; Cziko, 1995; Buskes, 1998). In this chapter I will stress the importance of `orthodox' Lorenz-Vollmerian evolutionary epistemology, sometimes called `bio-epistemology' (Hahlweg & Hooker, 1989; Callebaut, 1993), because only this version can explain why organisms have an interest in adequate representations of their surroundings. The orthodox version is rendered by Vollmer thus:

> Our knowledge-apparatus is a product of evolution. The subject structures of knowledge are matching with the world, because they have been adapted to this real world during the course of evolution. And they correspond (partly) to real structures, because such a correspondence made life possible[2] (Vollmer, 1983: 102).

Because this version stresses the adaptedness of our evolved knowledge structures, it explains on the one hand why there is a partial `fit' between our ideas and the world and, on the other hand, why there is such a discrepancy between ordinary experience and scientific insight.

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[2]. Unser Erkenntnisapparat ist ein Ergebnis der Evolution. Die subjectiven Erkenntnisstrukturen passen auf die Welt, weil sie sich im Laufe der Evolution in Anpassung an diese reale Welt herausgebildet haben. Und sie stimmen mit den realen Strukturen (teilweise) überein, weil nur eine solche Übereinstimmung das Überleben ermöglichte.

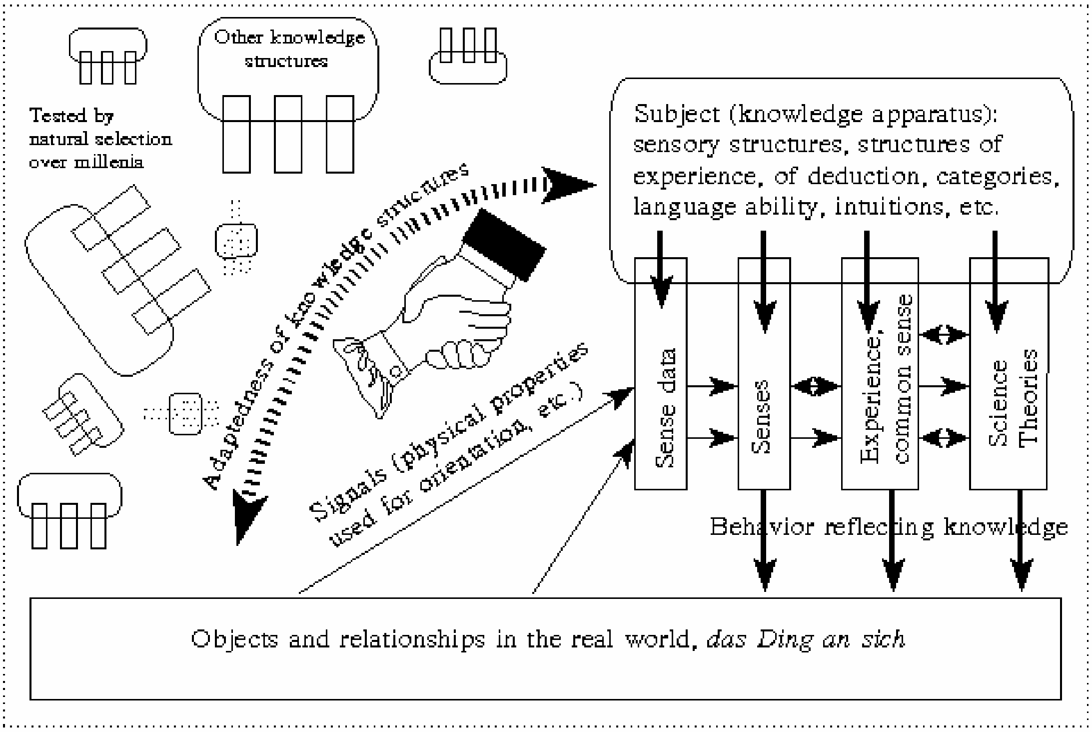

Fig. 1-1. The gap between the subjective *a priori* and the world is bridged by the natural selection of knowledge structures. Changed after Vollmer [1975] 1983: 120.

Figure 1-1 has been adapted from the work of Vollmer ([1975] 1983: 120) to visualize the idea. Within the traditional Kantian perspective there is a dualism between the subject with its sense structures, its subjective interpretative framework for ordering experience (the categories), its ideas etc. on the one hand - and the objective, outside world of *Dinge an sich* on the other hand. In evolutionary epistemology this bridge between subject and object is crossed, because the subject is no longer viewed as an unworldly `transcendental' monad, but as the descendant of a long series of monadic structures that were more or less successful to the extent that their subjective *a priori* structures offered them some grip on the outside world in which they had to survive. The result is a partial `fit': the Kantian *a priori* is phylogenetically *a posteriori.* Of course, it does not have direct access to the real world, but its senses, categories, ideas, all have been selected on their ability to orient and to guide. I have further stressed the transition to a postkantian realism by placing the dualism between subject and object as viewed by Kant and other traditional epistemologists in a larger framework (dotted lines) in which a plurality of knowledge-structures are tested over millennia by means of variation and selection. Our subject is part of a series which continually emerges from nature's assembly lines. Introspection may sometimes yield the idea that we are at the transcendental edges of our universes, but in fact even the ways in which we think have already been prefabricated long ago and in that respect we are even as subjects fully embedded in the stream of life. Thus, transcendentalism and philosophical solipsism are simply products of a too limited point of view. There is a natural link between this kind of evolutionary epistemology and some kind of realism - the question is which.

1.2 WHAT EVOLUTIONARY EPISTEMOLOGY IS *NOT*

a.A naturalistic equivalent of a `transcendental deduction'

First, however, it is important to make clear what evolutionary epistemology is *not* (Vollmer, 1987; 1988). However strange it may appear, it is apparently allowed to accuse evolutionary epistemology without references of visions that its representatives do not hold. For example, Hilary Putnam in his article *Why Reason Can't Be Naturalized* (Putnam, 1982; compare also Nagel, 1986) claims that evolutionary epistemology should enable us to separate true and false statements or to *justify* certain methodologies or opinions. Evolutionary epistemology is supposed to claim that a belief is rational if it aids survival. Naturally it is easy to ridicule such a self-created strawman: as Putnam himself indicates, there is no contradiction in the idea that very irrational beliefs help people to survive or that rational beliefs lead to the extinction of those who cherish them (Putnam, 1982: 6).

Evolutionary epistemology, thus, does not equate rationality with fitness or survival. This would, of course, not be compatible with modern evolutionary theory. Sociobiologists have stressed, for example, that self deception about one's own altruism, that is to say a false representation of the own altruistic investments, can be very functional in reciprocal altruistic relationships, because it allows the individual to deceive the other more convincingly (Trivers, 1985). According to Trivers it would be naive to suppose that the complexity of the nervous system correlates with its ability to reconstruct the world accurately (Trivers, 1976). According to his ideas, self deception and repression are expected to be common among individuals of our species who are completely dependent on reciprocal altruism (more on these issues in chapter 4).

In other contexts a lack of knowledge rather than knowledge, and a *misrepresentation* of reality could be adaptive. Flohr (1987) shows, for example, referring to Lorenz and Vollmer amongst others, that a combination of properties of our cognitive apparatus - the tendency to reduce uncertainty, the tendency to think in opposites and the desire to belong to a group - can easily lead to political prejudices. No doubt there would be less prejudice and fewer extremist opinions in the world if there had never been certain advantages to having a clear and simple world-view, the correctness of which would not be the absolute priority. As Flohr remarks, our thinking has evolved to solve practical matters and not to approximate the truth optimally.

All in all, evolutionary epistemology is not a naturalistic equivalent or replacement of the `transcendental deduction' or justification of our categories that, among others, Kant envisioned (see § 1.4). The program of `justification and critique' that follows from evolutionary epistemology is not based on the hope of constructing a rigid system of deductions which guarantees an absolutely certain foundation for all knowledge, but is more comparable to a snowball in which a multitude of plausibilities is gradually pushed firm into a practical certainty.

b.A naive version of the correspondence theory of truth

Evolutionary epistemology is not founded on some naive `metaphysical' realism, as Putnam and in his wake Ruse (1986: 197) hold. According to Putnam and Ruse evolutionary epistemology would imply that we could *compare* contents of knowledge with objects as if we still had another route to the `thing in itself' than that of our ultimately perspectivistic knowledge. Ruse especially delights in a caricatural discussion of Lorenz' essay of 1941, which is a classic of `orthodox' evolutionary epistemology. In this essay Lorenz is indeed reacting to the Kantian dogma of the unknowable *Ding an sich* and he speaks somewhat rashly about the `fit' between our categories and the structures of the world. At the same time, however, he calls our categories evolutionary `working hypotheses' (`Arbeitshypothesen') which often prove to be true in normal life, but which in science sometimes prove to be inadequate (Lorenz, 1941; Riedl, 1981).

Therefore, the question is whether Lorenz' model really implies such a naive version of the correspondence theory of truth. The `fitting' of categories and reality about which he speaks is not the same as the `similarity' between the two to which Locke refers[3]. The fit between categories and reality can be experienced by the knowing organism *from within* the *feedback loop* between knowledge apparatus and reality. An external point of view is not necessary. Goldman is therefore justified in his claim that the metaphor of a mirror which is rejected by many - Putnam and Rorty among others - can be better replaced by the metaphor of clothing. An article of clothing also has to fit, but need not resemble the person wearing it: it is even unclear what resembling would mean here. Different parts of the body can be dressed with different garments, just as different categories and theories can `cover' the same part of the world at the same time (Goldman, 1986: 151). Goldman christens his version of the correspondence theory `correspondence$_2$'. Correspondence$_1$ presupposes that the real world *independent* of our knowledge is already structured according to categories and concepts and that `true' knowledge *reflects* this structure into language. Correspondence$_2$ leaves the possibility open, however, for different systems of categories: from each viewpoint a slightly different net of categories may be thrown out over the world (see Goldman, 1990, for his version of evolutionary epistemology).

All in all, Ruse is unfair in disposing of the whole European evolutionary epistemology with a couple of misleading citations of Lorenz' essay of 1941 which might be interpreted as referring to Goldman's *`correspondence$_1$'*; the more so since he is evidently doing this to be able to claim more originality for his own version of evolutionary epistemology - `Darwinian epistemology' - than it deserves and to safeguard it against philosophical critics like Putnam and Nagel. For that matter, in more recent essay Ruse is simply using the concept of evolutionary epistemology again and there he sometimes openly admits to being a realist (Ruse, 1987), albeit a `common-sense realist' (like Putnam in his most recent cloak; Ruse, 1990).

That evolutionary epistemology is not a naive realism comes out in the emphasis on the *perspectivist* nature of knowledge[4]. When Lorenz reacts against the doctrine of the

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[3]. On the one hand Locke cuts the direct referential relation between ideas and things: the object of knowledge is not the thing but the idea. Next, he tries to re-establish the connection by introducing a mysterious kind of `resemblance' between ideas and primary qualities. "The ideas of primary qualities of bodies are resemblances of them, and their patterns do really exist in the bodies themselves, but the ideas produced in us by these secundary qualities have no resemblance of them at all" (Locke, 1690). This way he creates the problem of correspondence which was characterized by R.W. Sellars as the `Lockian impasse', dominating epistemology for centuries. "Ideas were taken to be the primary objects of knowledge and yet there was the belief in a material world beyond, which some ideas copied" (Sellars, 1959: 717-722). See chapter 3.

[4]. Lorenz explicitly denies that he identifies *Erscheinung* and *Ding an sich,* "die empirische Realität für das absolut Existente". "Die Beziehung zwischen der Erscheinungswelt und dem An-Sich der Dinge ist ... nicht durch ideale, das heißt außernatürliche Formgesetze in grundsätzlich unerforschbarer Weise ein für allemal festgelegt, noch weniger kommt den aufgrund dieser `Denknotwendigkeiten' gefällten Urteilen eine selbständige und absolute Gültigkeit zu... Die Aussage, daß [die Gesetze der `reinen Vernunft'] absolute Gültigkeit zukomme, ja daß jedes überhaupt denkbare vernünftige Wesen, und sei es ein Engel, den gleichen

unknowable *Ding an sich* he does not claim he can compare *Ding an sich* and *Erscheinung*. This would presuppose a point of view in which reality is not caught within a net of categories, which for Kant apparently would be possible for God and the angels alone[5]. The only thing that he needs to maintain is that the way in which the world appears to us has been determined by categories which have helped our ancestors to orient themselves for millennia and which as a result are very likely to be adequate ways of structuring and integrating sensory input.

In the interpretation of evolutionary epistemology the Kantian `Erscheinung' is therefore a perspective on the `an Sich' from a particular *a priori*-structure, which is certainly not the only one possible. Evolutionary epistemology is in fact claiming to *be able to study the relationship between particular perspectives and the survival program of which they form a part*: this I take to be the message of Lorenz in the text cited by Ruse. Again, this does not imply a triadic relationship of categories - world - (transcendental) epistemological point of view, as Ruse interprets Lorenz. It does not imply that we are Kantian, `transcendental acrobats' hovering *beyond* all particular perspectives and inspecting the ontological limitations and adequacy of our own senses, categories and ideas in a kind of analytic vacuum. Rather, it implies that *from our perspective* we are able to know with our categories to obtain knowledge about the relationships that other perspectives and cognitive structures have with the world - as a result of which we are able, subsequently, to learn things in general about knowledge, truth and deception, the ways in which they are part of different survival strategies, and the qualities of our own cognitive apparatus.

The presupposition that we are able to know (at least to some extent) how others know is also necessary for the skeptic, as long as he wants to convince others. Writing down one's opinion does not make much sense if one does not believe that the person who is going to read it has a relationship to the same world. In the same way our interaction with animals often presupposes a certain degree of knowledge about a shared world on the part of the animal. The moment a pheasant flies up in front of me I have to assume that the bird somehow has a representation of me, the nature of which is another matter. The fact that it starts flying before I even spotted it, means something about its different cognitive abilities and the way these help it in the world that it has to share with me. The different representations of the world of birds and people need not correspond `better' or `worse' with the world, but they are *different* perspectives on the *same* world.

c.A proof for the existence of an `outside world'

Evolutionary epistemology does not claim to *prove* the outside world as Ruse seems to impute to Lorenz. The only thing Lorenz claims is that the *function* of the knowledge apparatus only becomes clear from realistic premisses: *only if there is an environment can*

Denkgesetzen gehorchen müsse, erscheint uns als anthropozentrische Vermessenheit" (Lorenz, 1941: 102-103).

[5]. Intellektuelle Anschauung scheint allein dem Urwesen, niemals aber einem abhängigen Wesen zuzukommen. KRV A 123.

the knowledge apparatus be adapted to that environment. Evolutionary epistemology does not therefore give a justification for realism, but is itself founded on realism (Meyers, 1990)[6]. It is not so much a foundation for hypotheses on reality, but rather a keystone for the building of hypotheses which form the scientific world-view: a hypothesis woven into the web of other hypotheses which tries to explain why a knowledge apparatus arose in the first place and why it has the peculiarities that we often take for granted. Contrary to many other philosophical hypotheses evolutionary epistemology is therefore a very `robust' hypothesis (Wimsatt, 1981) - one that can be reached by following several independent lines of reasoning and one that is reinforced by several independent scientific disciplines. It not only stresses the limits of our cognitive faculties, but tries to explain them from an encompassing theory about our position in a real world in which our cognitive faculties arose as small lights to guide our ancestors along the paths they took through the jungle.

What kind of realism, then, is compatible with - but not *proved by* - evolutionary epistemology? In spite of the apparent disagreement between people like Ruse and Vollmer, I think a closer look reveals an area of agreement. Ruse claims that an evolutionary approach to cognition is only compatible with `common sense' realism (Ruse, 1986; 1990). Lorenz and Vollmer claim that evolutionary epistemology shows that our innate categories have evolved to cope with the `mesocosmos' - the realm between micro- and macrocosmos. They are probably inadequate to some extent to form a proper conception of both micro- and macrocosmos. As Ruse seems to forget that the theory of evolution presupposes realism at some level (Meyers, 1990), the best position seems to be a kind of inferential, conditional and hypothetical realism, which starts from the assumption that our cognitive faculties have indeed evolved to cope with mesocosmic objects like bananas, trees and stones - rather than with superstrings, quarks, black holes and supernovas - and that it includes a disposition to makes inductive inferences (Goldman, 1990[7]) which, if applied properly, can yield hypothetical truths even outside the narrow domain for which it has evolved. From this then follows the program of an `evolutionary justification and critique of our inherited information processing algorithms' (Chapter 2).

d.A circle?

From the perspective of traditional epistemology evolutionary epistemology is a circle: epistemology should give an ultimate justification, and evolutionary epistemology is itself founded on an - uncertain - scientific hypothesis and is therefore in no way able to give a foundation for all other scientific hypotheses. From the perspective of evolutionary

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[6]. From the foregoing it should be clear that evolutionary epistemology does not give an absolute foundation for our knowledge at all, but instead starts from a certain amount of knowledge (organized in the theory of evolution) and from there tries to explain knowledge, its possibility and very essence.

[7]. "It is plausible that the human brain was selected in part because of its capacity for and disposition to such inference [inference to the best explanation], and that the survival value of this disposition lies in part in the fact that such inference tends to produce or preserve truth in belief." (Goldman, 1990: 40).

epistemology, however, the demand for such an absolute justification is absurd: the only certainty which can accompany a set of scientific hypotheses is their mutual consistency and their empirical success. What other indications for the reliability of knowledge could we imagine for an evolved mass of cells?

The fact that we already *start* from the theory of evolution implies that for the naturalist a theory that offers the best explanations of many independent areas is worth the inherent risk of a gamble[8]. The naturalist knows that even the skeptic needs a theory on which his skepticism is based, but that this theory is probably unable to free him of his most elementary prejudices. The skeptic who demands absolute proof and ultimate justifications should realize that his choice of skepticism is not justified better than the road chosen by the naturalist - and that it offers fewer possibilities of viewing the world from a somewhat different perspective that enables us to discover new dimensions of it. Those wanting absolute certainty get no further than a simple repetition of their skeptical starting-points. On the other hand, those starting from principles that have proved to be fruitful in scientific practice may run some risk of falling or slipping down on the road towards insight, but may end up close to the top of a philosophical mountain from which they see their skeptical fellow-philosophers struggling behind, hopelessly lost down in the valley.

In this context evolutionary epistemologists have repeatedly argued for the necessity to discriminate between virtuous and vicious circles. Gerhard Vollmer even gives a long list of circles in which knowledge can be increased using a kind of bootstrapping (Vollmer, [1983] 1988). Thus, we can define a virtuous circle as a circle which helps us to increase our knowledge as a result of a feedback mechanism in which assumptions lead to new insights and hypotheses which lead to correct predictions and observations. We are in a virtuous circle as long as our inferences are consistent with inferences from other contexts or deeper levels (Goldman, 1990: 45). Assumptions are thus never completely `proven', but nevertheless confirmed continually as long as we are on the right track. There is nothing wrong with assumptions, as long as you have the right ones. Vollmer points to the fact that even traditional epistemologists need some assumptions, `for example, the existence of knowledge and the possibility to communicate' (Vollmer, 1988: 236).

To some extent, then, the rise of evolutionary epistemology marks the transition from a foundational epistemology based on some version of the correspondence theory of truth to a cumulative knowledge-integrating epistemology in which the correspondence^2 theory of truth is married to a coherence^2 theory of truth stating that "coherence between explanations can be a *sign* of correspondence^2 to reality". As is shown by Lorenz' essay about

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[8]. Of course an *inference to the best explanation* could also prove to be wrong: the tricky thing is that no one knows for sure how to recognize the best, let alone the right explanation. In this context William Whewells idea of a `consilience of inductions', recently referred to as `triangulation' and `robustness' (Wimsatt), could help. The more independent successful models support a particular integrating super-theory the less it seems likely that this is `just a coincidence'. Of course, logically, it could, but logically the world could also be five minutes old of which the first one was used for the nightmare we call history. Regarding Whewell and the way in which he inspired Darwin, see Ruse (1986); regarding the inference to the best explanation see de Regt (1994). Recently, an example of the `consilience of inductions' in the form of the `triangulation-argument' came to public attention as a result of a letter from the Pope to the Papal Academy of Sciences in which Pope John Paul II admits that the theory of evolution is supported by the study of independent phenomena (Oostveen, 1996).

`Gestaltwahrnehmung als Quelle wissenschaflicher Erkenntnis' (Lorenz, 1959) science would be impossible without some kind of pattern recognition - that is, an empirical dimension -, but it would not be able to offer insight without a theoretical explanatory framework that has to be continually adapted to fit all observations and experiences. Traditional epistemology was probably inspired by the success of the deductive method in Euclid and in the natural sciences, but apparently this deductive method cannot as easily be used to give a foundation for knowledge in general (Ortega y Gasset, 1971). According to Wimsatt any theory becomes stronger as long as it can be derived from a plurality of independent facts. "Fallible thinkers should avoid long serial chains of reasoning" he claims, because chains of reasoning are, contrary to ordinary chains, weaker than their weakest link. Contrary to ordinary chains, a failure of one link in a chain of reasoning does not cause a release in tension on other links and contrary to ordinary chains what matters is not actual failure but the probability of any failure. As a result "small probabilities of error in even very reliable components may cumulatively add up to almost inevitable failure" (Wimsatt, 1981: 132).

He sees a corrective medicine for this cumulative effect on the probability of error in `multiple derivability' or `robustness', a principle he traces back to Peirce and Whewell. "With independent alternative ways of deriving a result, the result is always surer than its weakest derivation" (id.: 132). Of course, evolutionary epistemology is a very good example of the way in which knowledge from different domains can be brought together in a new integrating hypothesis which reinforces the different theories that have been swallowed up by it and which may have consequences for all separate domains (what Whewell called a `consilience of inductions').

e.An alternative demarcation criterion or guidelines for scientific `evolution'

A number of philosophers, including Putnam, think that the specialization of philosophy lies partially in its normative mission. At a particular moment in the debate such philosophers will admit that the naturalist is right in most of his claims, but although his theory is scientifically interesting, they will argue next, it is *philosophically* without any worth, because it is not possible to deduce norms from it (Putnam, 1982, Siegel, 1989).

First, it should be noted that the idea that the normative dimension is the proper `specialism' for the philosopher is relatively new. Traditional epistemologists from Bacon to Kant were both trying to give models of how our minds *are* and how they *should be* working. Only after that the new discipline of psychology started to take over the more descriptive and explanatory parts of this enterprise, did the philosophers start to retreat on the more normative domain (Nisbet & Ross, 1980). The question, however, is whether this division of labor is fruitful and whether the study of the normative dimension can ever become a separate specialism. Norms are not created separately from facts: they arise as a result of the application of knowledge in function of particular goals[9]. Even those goals are

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[9]. The idea that morality ultimately derives from desires can be found in Taylor (1984). Very clear expositions on the ways in which scientific knowledge can be used to achieve `independently arrived at, predetermined goals' are given by Beckstrom (1985, 1989, 1993). His message is that science does not *create* the goals it may help us to achieve. In my opinion, however, science will not only influence the ways in which we achieve our goals, but will inevitably transform those goals to some extent. Theoretically, in the long run the goals that somehow promote the fitness of their defenders will win, but, of course, one cannot base a morality on its probable fitness-results. "The promise that evolutionary biology holds for social planners rests in looking backward, once goals have been selected, to natural history for facilitative guides and not in working forward from natural history to establish the goals" (Beckstrom, 1989: 36).

not given completely independent of particular knowledge, because it would not make much sense to strive for goals which are unattainable. "As in the ethical sphere, `ought' implies `can'"(Goldman, 1978).

The most important way in which actual knowledge about the way in which the mind works has a normative value concerns an understanding of its limits and inherent biases. An inventory and explanation of the many possible sources of error resulting from these limits and biases can enable us to avoid them or to be aware of them. Evolutionary epistemology shows that our knowledge originally evolved within a specific context and that this natural context imposes certain limitations. For example, both Lorenz and Vollmer point to the fact that our imaginative powers have been adapted to the proportions of the mesocosmos, the scale between micro- and macrocosmos. Yet, it is clear that we will also need this limited imagination to understand both micro- and macrocosmos: as a result of evolutionary epistemology we will probably be better aware of the problems involved.

By showing what knowledge really is, evolutionary epistemology can also prevent the excessive requirements that follow from definitions of knowledge in terms of `justified true belief' - a problematic definition going back to Plato's *Theaetetus* (201c), which relatively recently was discovered to involve the `Gettier problem' (cf. Gettier, 1963). It may point to the degree in which our knowledge about the world is underdetermined by sheer sensory stimuli, for example, and to what degree organisms are guided by evolutionary successful `working hypotheses' (Riedl, 1981). When even the processing of visual stimuli on our retina, in our laterate geniculate nucleus and in our visual cortex has a `hypothetical-constructive' character, it would be absurd to demand an absolute foundation in sense-data for the whole of our knowledge.

From all this it may be clear that evolutionary epistemology is not able to provide *a priori* principles for the achievement of reliable knowledge. It does not point to a complete series of signposts on the route towards truth, but rather tries to learn from past crashes. It is not possible to devise categorical norms preceding actual science. All norms that we are striving for are hypotheses themselves and are deduced from the goals of reliable knowledge in combination with experiences gained from the feedback relationship between knowledge and world about the many ways in which misconceptions can arise. Because our knowledge about the way in which we may err is continually in motion, the norms which lead us towards the ideal of reliable knowledge are continually in motion, too[10].

1.3T WO ALTERNATIVE APPROACHES

To avoid any misunderstanding it is important to distinguish between evolutionary epistemology proper and two other models which currently enjoy increasing popularity and which we could call evolutionary information-theory (Engels, 1985: 143; Vollmer, 1987)

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[10]. Comparable remarks are made by R. Giere in his reaction to Siegel (Giere, 1989: 377-384). He claims that norms connect research strategies with the goals of the research which may differ by research domain and may be sometimes more `instrumental' and sometimes more `realistic'. The best goals cannot always be fixed *a priori*.

and the evolutionary account of science (Callebaut, 1993: 287; Buskes, 1998). Although both models are extremely promising and enlightening, it is important to note that they are not identical to, nor necessarily included in, the kind of evolutionary epistemology I am defending here. Apart from that, I aim to show that they may be misleading in some respects, especially if they are not properly founded in evolutionary epistemology proper and in a complete model of the interaction between different levels on which we may find variation and selection in nature.

a.Evolutionary information-theory: adaptation as knowledge

First, we often read, even in Lorenz, that not only is the cognitive ability a product of evolution, but that the whole process of evolution can be considered a process of knowledge acquisition (Wuketits, 1986; Popper, 1990). Since adaptation is always adaptation in response to a given environment one could say that know-how with respect to its natural environment is stored in the organism. Evolution by natural selection is learning by trial and error. The adaptedness of an organism is the product of `experience' which is deposited in DNA. Recently Plotkin (1994) has claimed that *"all adaptations are knowledge"* (Plotkin, 1994: 116).

Vollmer rightly observes that the concept `knowledge' has broadened here in a confusing way (Vollmer, 1987: 85-90). Knowledge as internal representation - which is a somewhat less pretentious definition than `justified true belief' - is replaced by knowledge as causal track. By this definition we should, strictly speaking, ascribe to worn shoes a knowledge of their owner or to a bolt knowledge of the matching nut.

There are good reasons, however, to remain closer to the everyday use of the concept of `knowledge'. First, by calling all information `knowledge' we ignore an important difference between knowledge and information: knowledge is the deposition of an *active* interaction between an information-gathering capacity and the world in a memory which actively tries to categorize its input. A knowing subject recognizes the object *as x* (Vollmer, 1987; consider also Plato's *anamnesis*). A continual comparison between incoming and already processed information takes place. In later chapters I will discuss the connectionistic interpretation of this process.

Second, knowledge is always an interaction with the world and as a result of that it is always *up to date*, contrary to `information' in DNA. DNA always lags behind changes in the environment and the resulting changes in behavior. If an organism has been adapted to certain temperatures over millennia and an ice age starts suddenly - as we will see, this is what happened to our ancestors - its DNA `knows' nothing and it will cost at least several generations before the number of those individuals that are better adapted to colder temperatures start to increase. Their adaptedness, of course, does not mean that their DNA `knows' anything, but it codes for a somewhat more adequate portion of certain proteins or for completely new proteins which have proved to improve the overall functioning of the organism.

Knowledge as the product of a capacity to learn in the course of one generation has precisely evolved to enable an organism to adapt itself to circumstances which could not be predicted by DNA. The genetic program of a digger wasp simply cannot be designed to contain information about the exact location of its hole: therefore the wasp needs to *acquire* a kind of `map' of its environment. In my opinion the concept of knowledge could well be used to refer to this map, because the digger wasp is able to correct it in interaction with its environment (Tinbergen, 1958; this volume, chapter 2.5). Therefore, there are good reasons to reserve the concept of `knowledge' for *internal representations of discernable entities or structures* and thus to use it to refer to information stored in some actively working neural network rather than for `information' as it is contained in a sequence of bases in a coiled-up super-acid.

The big advantage of thus separating information theory from epistemology proper is that it reminds us of the fact that knowledge has evolved in only some lineages: it is one of the many survival strategies and one that has only blossomed relatively late in the history of life (let us say, since the evolution of multicellular organisms, the last 600 million years).

b. *The evolutionary account of science and theoretical virology: is all knowledge adaptive?*

The second program which is often presented as evolutionary epistemology is the evolutionary account of science (Callebaut, 1993; Buskes, 1998). The basic idea is that Darwinism is a universal principle and that variation-selection-retention processes not only happen `between' organisms, but also `within' organisms (Campbell in Callebaut, 1993: 296). According to Plotkin there is a universal `g-t-r heuristic' which returns on the level of genes, individual learning and culture: on all these levels variants are generated, tested and differentially regenerated (Plotkin, 1994).

Many trial and error processes take place on the level of individual development. For example, our immune system is based on an enormous diversity of lymphocytes of which only those which `fit' with particular antigens are clonally reproduced and then used as antibodies. Our genes probably do not work as complete predetermining programs either, but perhaps only determine the growth and death of cells in particular parts of tissue. For example, we start our lives with many more brain cells than we will use during our lives. Cells that are not used simply die and cells that are used develop all kind of connections: clearly an example of the g-t-r heuristic at work. As a result, neurobiologists are starting to see the brain as a `Darwin machine' (Calvin, 1990; see also Edelman, 1992).

On the level of culture, many theorists have also started to use the g-t-r heuristic as an explanatory frame-work. The inheritable cultural traits can be called `memes' (Dawkins, 1976) or `culture-genes' (Lumsden & Wilson, 1981). Because theories are also memes, this kind of reasoning can lead one to interpret the evolution of science as the result of a process of variation and selection (e.g. Hull 1988a, b, but see also Kuhn, 1964: 172 and Popper, 1990[11]). Bradie (1986) makes a clear distinction between this kind of evolutionary epistemology as it refers to theories (EET) and the evolutionary epistemology which refers to mechanisms (EEM). The first (EET) can be called the `evolutionary philosophy of science' (Oeser, 1987), the `evolutionary account of science' (Callebaut) or `theoretical virology' (because according to this paradigm memes behave like viruses and spread themselves as infectuous diseases, particular cultures being a kind of epidemics).

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[11]. Kuhn writes "The analogy that relates the evolution of organisms to the evolution of scientific ideas can easily be pushed too far. But with respect to the issues of this closing section it is very nearly perfect. The process described in Section XII as the resolution of revolution is the selection by conflict within the scientific community of the fittest way to practice future science. The net result of a sequence of such revolutionary selections, separated by periods of normal research, is the wonderfully adapted set of instruments we call modern scientific knowledge" (Kuhn, 1973: 172).

To some extent, the models about the variation and selection of scientific models have the same defect as many others about the variation and selection of inheritible cultural traits. Just like these, they fail to give a precise account of the many ways in which the evolution of ideas is determined by the specific structure of the human mind as it is *already* a product of evolution (Bonner, 1980). The mind is not a *tabula rasa* which can in principle entertain whatever ideas arise as a result of chance in it. Neiter is it a passive recipient of whatever ideas or traditions it is immersed in while it is raised (Cronk, 1993). Individuals are very selective in inheriting those ideas, paradigms and traditions that they find useful in dealing with the problems and questions that they encounter in their lives. They sometimes publicly entertain ideas in which they do not really believe, but which enable them to manipulate other people's behavior and thoughts. Creativity, in fact, must have evolved because it enabled individuals to mould their own ideas, traditions and life styles *in spite* of the traditions in which they were raised.

Therefore, despite the fact that there are many analogies between the evolution of ideas and organic evolution (e.g. see Buskus, 1998), there is one important difference: organic evolution has no goal and moves in all directions, whereas the evolution of ideas and hypotheses is at least partly driven by curiosity and a conscious desire to know how the world is structured. Although many ideas can be described as kinds of mental parasites or mind viruses, which simply owe their success to properties that stimulate humans to pass them on (Goodenough & Dawkins, 1994; Szpir, 1995), it is exactly in the realm of science that we can often see how ideas are continually changed and manipulated to form a coherent picture. One may compare scientific ideas or theories with genes, but one should not forget that they are not passed on in the field, but in the laboratory, in which they are continually `genetically' *manipulated* intentionally, not just to improve their capacity to make copies of themselves but to unveil aspects of the world.

c.Universal selection theory and the ultimate level of testing

Apparently the intentionality of the individual scientist *does* matter somehow. If we call all adaptations knowledge, we well might forget that knowledge is one adaptation amongst others, and a special one at that; and if we suppose that scientific evolution is analogous to organic evolution, we might forget that a theoretical virology would predict not only memes or ideas that refer to the world but also many purely *parasitic* memes. (That is why I prefer the term theoretical virology above other terms). If science should be defined from an evolutionary perspective we should, therefore, pay attention to the specialized `selection rules' working within the scientific community, telling the scientists, for example,"`Take nothing from traditional authority!', `Feel free to disagree, even with scientific authority!' and `Limit your persuasion of fellow scientists to what you can demonstrate visually and what you can show by simple logic!'" (Campbell in Callebaut, 1993: 300). In other words: we should pay attention to the ways in which scientific ideas are bred *in contrast with*, for example, religious ideas. Apparently the values and selection rules within the scientific community are designed to separate non-referential mind-viruses from ideas that uncover aspects of the world (more about that in § 2.6).

How are these values and selection rules derived? Of course, they are partly a result of cultural evolution, but a process of cultural evolution in which competition in `truth catching ability' led to the variation and selection of values and rules giving scientists a critical use of their own evolved inferential capacities. If scientists could not fall back on their `common sense' and their `realistic instincts' they would never be able to "cut nature at its joints", and neither would they be able to acquire such rules so quickly. Therefore, the individual scientist should not be viewed as a *tabula rasa* on which all kinds of ideas can be imprinted and scientific evolution should not be interpreted as just `blind variation and selective retention' (even Campbell does not do this, see Callebaut, 1993, for an overview). The individual scientist enters the world of science with his innate structures of experience which have proved their worth over the millennia. As an already accomplished observer and puzzle-solver he critically starts sorting out the scientific ideas that he can use and fit together to fulfil his innate curiosity and sense of wonder from the mental garbage and mind viruses that he has acquired culturally. Of course, this is a long-term process of trial and error, but the important point is that it does not start from scratch. The very possibility of science is based on certain evolved properties of the human brain (Ruse, 1986) and if scientists really had to start from scratch they would probably never get off the ground. Science is not just one possible process of the variation and selection of ideas, but it is the *collective effort to find, select and integrate those ideas that together may reveal structures of the real world.* The success of scientific ideas depends partly on the ease with which they can be understood, on their appeal to our need to give meaning to our lives, on their stimulating power, etc., but most scientists realize that it *should* only depend on their predictive, explanatory and integrative power, because they feel that only these virtues may guarantee referential qualities - and that is what science is all about.

All in all, the truth of both evolutionary information theory and the evolutionary account of science lies in their appeal to a *universal selection theory*, that is to the g-t-r heuristic, but this appeal may be misleading, because there is such a difference between the variation and selection of different forms of DNA, of different individuals and different ideas. Nature has only equipped individuals with a need to know, and only individuals can discern the truth of certain ideas. Of course, that is not incompatible with the idea that *within individuals and their ontogenies* a considerable amount of trial and error takes place. It is within the individual that many ideas are tested in order to select those that together orient it in the real world.

I will return to the variation and selection of ideas and mind viruses in part II. At the present moment it suffices to say that traditional evolutionary epistemology is not an attempt to apply principles derived from genetics to the history of ideas, but simply a discipline which studies the evolution of our cognitive abilities in the hope of finding out whether, when, to what extent, and why we can trust them.

1.4 TRANSCENDENTAL PHILOSOPHY AND THE ECOLOGICAL CONTEXT OF KNOWLEDGE

From all this it should be clear that the methodology of evolutionary epistemology is quite different from all attempts at transcendental epistemology. Evolutionary epistemology starts completely *a posteriori* with a biological approach to our knowledge capacity and does not try to separate the questions relating to the origin and the justification of knowledge. For evolutionary epistemology knowledge is not merely knowledge *about* the world, but also knowledge *within* the world: knowledge can be studied like other natural processes. Some will ask whether this approach is a step backwards - back to a naive realistic approach in which the subject is treated as one of many objects.

The attempt to separate epistemology from the rest of the scientific world view is, however, doomed to fail. The origin of this `transcendental deadlock', the uncoupling of ideas and things, lies in the Cartesian quest for absolute certainty, and in the case of the rationalists and transcendentalists, in the belief in a `transcendental ego', a self the identity of which is not gradually constituted as a result of a body, but separated from it. In the seventeenth and eighteenth century people could not imagine why our subjective experiences would fit real objects, particularly because physics had just showed that some of our subjective experiences - e.g. of secondary qualities - were deceptive. Descartes and Leibniz invoked God as an invisible guarantee: for them it was the question why the transcendental ego, the thinking `monad', would have ideas corresponding to the physical world in which it was `thrown'. Empiricists, like Locke and Hume tried to use sensory stimuli and had to drop the transcendental ego, but it became increasingly clear that it is impossible to conceive the contents of our minds as a proof for that what they *seem* to reveal and Hume ended up with a mind which was just a `bundle of perceptions', a cinematic succession of impressions without any certainty with respect to their reference to a real world.

In my opinion the epistemology of Kant was an attempt to solve the mystery of the relationship between the contents of consciousness and reality in a situation in which such an answer just was not available. Like Locke, Kant started by accepting Newton's kinematics as true, he concluded that empiricism was not able to give an adequate foundation to it and thought a natural or God-given *harmonie préétablie* unsatisfactory, because it would rob concepts of their necessity, and absolute validity and `a priori' meaning:

> If someone would propose a middle road `3' between the two routes mentioned, namely, that they are (1) nor transcendental first principles *a priori* of our knowledge, (2) nor a creation from experience, but (3) subjective, with our very existence implanted talents to think, which have been arranged by our Creator in such a way that their use corresponds exactly with the laws of nature, according to which experience runs (a kind of system of preformation of pure reason), then against this middle road it would be decisive that in that case the categories would lack necessity, which belongs to their essence (Kant [1877] 1924, henceforth KrV: 228-229 [B 168], numbers added)[12].

Therefore he separated the `fact' of knowledge from its `justification', `empirical realism' from `transcendental idealism'. His so-called transcendental justification really only implies that we - to paraphrase Nietzsche - are only able to understand a world that we have constructed ourselves (Kant, ibid.: 216 [A 126]; Nietzsche 1977, henceforth UaW: 620 [3: 618]). The world of experience and that of mechanics, *die Erscheinung*, is already a product of `the frame-works of observation' and our categories which are the only ways for a finite subject to structure the chaos of sensory impressions. Our cognitive ability is not directed towards the objects, but the objects are represented according to our knowledge, the activity of a transcendental subject which can only know the world by uniting the multitude of

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[12] Wollte jemand zwischen den zwei genannten einzigen Wegen [the categories arise from experience or they `produce' experience] noch einen Mittelweg vorschlagen, nämlich, daß sie weder selbstgedachte erste Principien *a priori* unseres Erkenntnis, noch auch aus der Erfahrung geschöpft, sondern subjective, uns mit unserer Existenz zugleich eingepflanzte Anlagen zum Denken wären, die von unserm Urheber so eingerichtet worden, daß ihr Gebrauch mit den Gesetzen der Natur, an welchen die Erfahrung fortläuft, genau stimmte, (ein Art von Präformationssystem der reinen Vernunft) so würde ... das wider gedachten Middelweg entscheidend sein: daß in solchem Falle den Kategorien die Notwendigkeit mangeln würde, die ihrem Begriffe wesentlich angehört (Kant [1877] 1924, henceforth KrV: 228-229 [B 168]).

impressions according to its own logical principles (the `transcendental apperception'). Strictly speaking, this is not a justification of knowledge, but rather a `transcendental' relativization (of course, Kant would not agree):

> The particularity of our faculty of reason, that it creates a unity of *a priori* pre-sensory perception only by means of categories and precisely by means of this kind and number, is just as impossible to explain as why we have precisely these faculties of judgement or why time and space are the only frame-works of our possible experience (KrV, B145-146)[13].

In the end, this analysis rests on the presupposition that the transcendental subject has some kind of existence apart from the multitude of impressions which it has to order. Without its ordering activities the world would be a chaos.

> The organization and regularity in the appearances which we call nature would not be found in it, had it not be brought it in by ourselves or by the nature of our minds (KrV, A 125)[14].

With respect to our cognitive ability Kant evades conclusions which he could have reached by interpreting it as a part of the world. While he places our knowledge apparatus outside the realm of the *Erscheinung*, however, he at the same time actually makes a *model* of it - on the basis of the supposed properties of the world of the *Erscheinung* which are products of its transcendental activities. Because he is unable to explain why the knowledge apparatus would be able to describe space without consultation of the senses, he concludes that it places the `chaos' of incoming sensory stimuli in a frame-work of `forms of observation' (space and time). Because he is unable to explain why the knowledge apparatus is able to discern entities, units, sequences, causal relationships, etc., he concludes that they are imposed on the world by itself. In other words, he constructs a model of a knowledge capacity which enables us to practice geometry and physics; in short `synthetic knowledge *a priori*' about a phenomenal world *without the necessity of a real world which is unlocked by these disciplines.* His presupposition is the *lack* of a `harmonie préétablie' between knowledge and real world (Ding an sich). His inevitable conclusion is a very specific model of a very creative knowledge ability which secretes phenomenal worlds which may be objects of Euclidean geometry and Newtonian physics.

The presupposition behind his whole analysis is the idea that the self and its (absolutely valid) categories are somehow prior to the world and do not gradually arise as a result of our cognitive activity *within* the world. This is also the reason that Kant put so much emphasis on the `synthetic unity of consciousness' as a prerequisite of knowledge. Without this

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[13] Von der Eigentümlichkeit unseres Verstandes aber, nur vermittels der Kategorien und nur gerade durch diese Art und Zahl derselben Einheid der Apperzeption *a priori* zustande zu bringen, läßt sich ebensowenig ferner ein Grund angeben, als warum wir gerade diese und keine andere Funktionen zu urteilen haben, oder warum Zeit und Raum die einzigen Formen unserer möglichen Anschauung sind (KrV, B145-146).

[14] Die Ordnung und Regelmässigkeit also an den Erscheinungen, die wir Natur nennen, bringen wir selbst hinein, und würden sie auch nicht darin find können, hätten wir sie nicht, oder die Natur unseres Gemüts ursprünglich hineingelegt (KrV, A 125).

`synthetic unity' he is afraid that both the self and the world would evaporate into a mere succession of chimeras, Hume's `bundle of perceptions' visiting the empiricist madhouse of impressions, which is exactly what happens in the philosophy of Nietzsche in which Kant's transcendental ego and *das Ding an sich* are both deleted. Kant did not seriously consider the possibility that there is also an option of viewing a dynamic self which gradually emerges in a body during its cognitive, reconstructive interaction with the world in which its structures and relations can at least be partially represented adequately. He was too afraid that, if the categories were not somehow `necessary', they would loose their absolute validity, that all our knowledge would be just hypothetical and that the self would just be discovered to be a dynamic and transitory natural phenomenon - which would have all kinds of unpleasant consequences for his cherished notions of God, freedom and immortality.

One of the most important philosophers who understood that the Kantian approach presupposed a dualism between a disembodied, transcendental subject and the world was Friedrich Nietzsche. Nietzsche, however, just abolished the Kantian *Ding an sich* and concluded that there is really nothing more than *Erscheinung*, the floating world of the senses. Just like Kant he criticized a naive belief in the presuppositions of the natural sciences, but unlike Kant he did this from a semi-biological point of view:

> Natural science is becoming conscious of one's own inheritance, registration of fixed and rigid laws of experience (UaW, II: 277)[15].

It is a pity, however, that he didn't take the one extra necessary step to become an evolutionary epistemologist: avoiding to become a self-refuting relativist by finding a framework from which one can *study* (via hypotheses, anomalies and new hypotheses) the way in which both the possibilities and limits of our experience is determined by the conditions under which we were `designed'. He was not able to do so, because he was still to preoccupied with absolute, transcendental (`a priori') foundations and `proof' to be able just to start from *within* a particularly successful scientific paradigm:

> The most popularly believed *a priori* `truths' are for me *provisional assumptions*, for example the law of causality, very well trained habits of belief, so incarnated that *not* believing them would ruin the species. But are they truths as a consequence of that? What a conclusion! As if truth is proved by the fact that man continues to exist! (UaW, II: 295)[16].

While this citation shows that Nietzsche tries to give categories like causality a pragmatic meaning, instead of an absolute, transcendental one, it shows at the same time that he is still requiring some kind of proof or absolute foundation. For him, the fact that our categories are

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[15] Naturwissenschaft is Sich-bewußt-werden, was man alles als Erbgut besitzt, Registratur der festen und starren Empfindungsgesetze (UaW, II: 277).

[16] Die bestgeglaubte apriorische `Wahrheiten' sind für mich - *Annahmen bis auf weiteres,* z.b. das Gesetz der Kausalität, sehr gut eingeübte Gewöhnungen des Glaubens, so einverleibt, daß *nicht daran* glauben das Geslecht zugrunde richten würde. Aber sind es deswegen Wahrheiten? Welcher Schluß! Als ob die Wahrheit damit bewiesen würde, daß der Mensch bestehen bleibt! (UaW, II: 295)

`hypotheses' (`Arbeitshypothesen' with Lorenz) implies a radical skepticism, not just the ordinary uncertainty that is part of all science. The same ambiguity can be pointed out in many passages in the work of Nietzsche, in which we can often find both a pragmatic and a platonic meaning of `knowledge' and `truth' in one and the same sentence (Danto, 1964; Slurink, 1992):

> *Knowledge is the forgery in which the manifold and countless is changed into the same, similar and quantifiable.* As a result, *life* is only possible thanks to such a *device to deceive.* To think is to forge and to change, to feel is to forge and to change, to will is to forge and to change -: in all lies to force to assimilate: which implies the will to make things the same (UaW, III: 280)17.
>
> The whole knowledge machinery is a device for abstracting and simplifying - not designed for knowledge, but for the power over things (UaW, I: 165)18.
>
> There are many kinds of eyes. Even the Sphinx has eyes -: as a consequence there are many kinds of `truths', and as a consequence truth does not exist (UaW, I: 171)19.
>
> *Truth is that kind of mistake* without which certain kinds of living beings could not live. Its value for *life* is what is decisive in the end (UaW, II: 301)20.

Evolutionary epistemology is able to unravel these paradoxes by just sticking to the pragmatic, hypothetical meaning of knowledge and by realizing the perspectivistic nature of all knowledge-claims (by means of the label `truth'). It does not offer the absolute validity of categories, nor an absolute foundation of knowledge, but it does offer an, albeit hypothetical, frame-work for a critical investigation of knowledge. As we will see in chapter 2 it does not prove that we are right in expecting causal relations in the world. What it does, however, is showing that apparently such an expectation was adaptive in the past: it enabled our ancestors to predict and control part of their environment. In that environment one could become sick as a result of eating spoiled meat, but no one ever spoke about cyclotrons and quantum jumps. The best evolutionary epistemology can do is simply explaining why we are so stubborn in our expectation of causality and why we even sometimes expect causal relations in cases were they are absent.

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[17] *Erkentniss ist Fälschung der Vielartigen und Unzählbaren zum Gleichen, Ähnlichen, Abzählbaren.* Also ist *Leben* nur vermöge eines solchen *Fälschungsapparates* möglich. Denken ist ein fälschendes Umgestalten, Fühlen ist ein fälschendes Umgestalten, Wollen ist ein fälschendes Umgestalten -: in dem allen liegt der Kraft der Assimilation: welche einen Willen voraussetzt, etwas uns gleich zu machen (UaW, III: 280)

[18] Der ganze Erkenntnis-Apparat ist ein Abstraktions- und Simplifications-Apparat - nicht auf Erkenntnis gerichtet, sondern auf *Bemächtigung* der Dinge (UaW, I: 165)

[19] Es gibt vielerlei Augen. Auch die Sphinx hat Augen -: und folglich gibt es vielerlei `Wahrheiten', und folglich gibt es keine Wahrheit (UaW, I: 171).

[20] *Wahrheit is die Art von Irrtum*, ohnen welche eine bestimmte Art von lebendigern Wesen nich leben könnte. Der Wert für das *Leben* enscheidet zuletzt (UaW, II: 301).

Kant's and Nietzsche's epistemologies are, of course, only two of the many positions that one can take if one keeps separating epistemological models from other theories about the world. First, in such models, again and again *errors slip in, because their presuppositions about our knowledge capacity are not corrected using knowledge about knowledge capacities in general* (an example is the empiricist idea that knowledge necessarily is the product of simple constituents, like sense-data; or the rationalistic idea that the meaning of concepts somehow precedes the actual cognitive interaction in which they are constituted). Second, again and again an inevitable *aporia* arises, because the world is only given to us in the form of contents of consciousness and because these are to some extent `bloße Gedankenformen' (cause of the persistent return of forms of idealism, named the `Lockian impasse' by R.W. Sellars, because according to him Locke started to make *ideas* instead of things the objects of knowledge; Slurink, 1996). As long as the knowledge capacity is not seen as part of the world, as an organ that helps to orient particular organisms in particular ecological environments, it will always be possible to place the world behind its representations `between brackets' and to speculate wildly about the `transcendental horizon' in which the world befalls us. As long as we lack the proper frame-work which enables us to realize that mobile goal-directed organisms simply *need* to some extent adequate orientating knowledge about their environment, we are able to delight in almost infinite epistemological reflections about the absence or presence of a mysterious relationship between the contents of our consciousness and the represented, presented or perspectivized world. As long as we lack a model of the ways in which neural networks gradually acquire generalized concepts as a result of `vector-coding' and the emergence of `prototypes' (Churchland, 1989), we will always fall back on models in which the `meanings' of concepts are somehow absolutely given apart from the population of objects to which they refer and the population of subjects which need them to classify and discuss them (called `meaning rationalism' by Millikan, 1984).

However, a theory about needs and neural networks is no longer *a priori*. Such a theory is based on other theories, theories which it would rather try to justify. With that, the program of an independent epistemology which justifies all other theories is abandoned. The philosophical tree of Descartes with its roots firmly placed in metaphysics, giving support to the stem of physics and which feeds the many branches of the special and applied sciences, is discovered to be dependent on photosynthesis in its leaves, can die as a result of the poor soil and can be replaced by better trees with better roots21. There is no foundation of the edifice of knowledge, certainly not a `transcendental ego' which encompasses it all, only a network woven of interconnected theories which are only able to float together (perhaps the arrogant metaphor of a tree should be dropped altogether and be replaced by that of a floating water plant, a Frog-bit or a Water Soldier, for example, plants that forms net of offshoots and roots searching for the bottom, but also can be blown away easily). Certainty can no longer be reached by trying to support them all from one Archimedean point, but by always supporting the whole set of theories on those theories that reinforce each other most, that is, it is replaced by `robustness' (Wimsatt, 1981). The risk of error is lessened by

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[21]. "Ainsi toute la philosophie est comme un arbre, dont les racines sont la métaphysique, le tronc est la physique, et les branches qui sortent de ce tronc sont toutes les autres sciences ..." Lettre de l'autheur a celuy qui traduit le livre (les principes), 1647, edition Tannery, IX-2, 1971, xxxx From the description of Descartes it follows that metaphysics especially encompasses epistemology and knowledge of clear concepts (like God) and that knowledge about man only comes after metaphysics and physics.

creating models about the circumstances in which errors might easily arise or are to be expected. The demand for an absolute sound foundation - which is implicit in the definition of knowledge as `justified true belief' - is replaced by sophisticated gambling and a subtle calculation of probabilities.

This implies anything but a return to a naive realism without justification, but searching for absolute certainty while everything points to the impossibility of such a program, would be naive in the extreme. The choice of the theory of evolution as a frame-work that allows for predictions about knowledge makes such a return to a naive direct realism simply impossible: it forces us to explain why an organic ability to orient has enabled us to attain apparent evolutionary luxuries, like self-knowledge and science. The realism of evolutionary epistemology shows vague similarities to the problematic realism of Leibniz' monadology, in which individual monads on the one hand have no `windows', yet on the other hand reflect the universe in their hyperindividual way. However, in this case a God-given *harmonie préétablie* between the contents of consciousness and reality is out of the question (Vollmer, 19833, talks about a `harmonie postétablie', but he might as well have dropped the notion of harmony also). Only the organic need for orientation and information creates a link between `representation' and reality - and this link can only be risky.

With that we see that within this approach a separation between the question relating to the justification of knowledge and the question relating to its origin is artificial. Kant's attempt at a `transcendental justification' simply presupposed a transcendental self as the source of order. This hypothesis, however, doesn't sound plausible for anyone who takes the embodied self, often coping with an unmanageable, harsh world, seriously. Only the ecological context in which knowledge has evolved, and the need of the organism to orient itself in this context, guarantees the adequacy of knowledge. There is only one explanation for the fact that we do not err continuously: erring is, literally, perilous.

1.5. KNOWLEDGE AS A WAY OF COPING WITH INCREASINGLY COMPLEX ENVIRONMENTS

Instead of trying to sort out the transcendental requirements for knowledge simply by abstracting from the actual way in which it is acquired, evolutionary epistemology tries to find out how knowledge as a process of `organismic orientation' arises using a genealogical analysis. Because the theory of evolution enables us to generalize about processes of variation and selection in every suitable corner of the universe, the perspective of evolutionary epistemology can be described as genealogical and exobiological (studying knowledge as a phenomenon that evolves under some cosmic or planetary conditions; Ruse, 1989). The central question is no longer only "How is knowledge possible" in the sense of "What are the requirements of knowledge on the side of the subject?", but "Why does knowledge sometimes evolve (on some planets, in some organisms), what is it and what is its function?". Instead of viewing knowledge as a monolithic, indivisible ability which is supposed to be unique to the human species, the evolutionary approach predicts that there exist many types of specialized intelligence, and that mobile organisms in whatever corner of the universe will exhibit those cognitive skills that they need to accomplish their survival strategy.

From an evolutionary point of view, human intelligence is only one example of a whole range of cognitive possibilities which should not be viewed as a succession of improvements, but as branches of the `tree of life' (a point often stressed by Gould; Gould, 1996). It is not advisable to study this type of intelligence in isolation, because it is a complicated integration of a large number of independent capacities which one can better study individually in much simpler organisms. To find out what knowledge *presupposes,* the best one can do is to study how knowledge arose during evolution.

a.Goal-directed systems

First, if one starts to think about the evolutionary origin of knowledge, one soon realizes that knowledge always has to be a capacity of a goal-directed system. The essence of knowledge is *selective representation of aspects of an environment into an information processing system* and it is unclear why something like that would arise if it were not in the interest of the organism that had to invest the energy to build that system. Therefore, knowledge has to serve a goal.

How did goal-directedness arise? Most philosophers of biology agree that living organisms owe their goal-directedness to the genetic `program' which is coded in the sequence of bases in their DNA (Mayr, 1988; Slurink, 1991). The notion of a program as the information required to give structure to a causal process closes the gap between physics and biology (one is reminded of R.W. Sellars' notion of `guided causality'; Slurink, 1996). Such programs are replicated generation after generation and change as a result of the differential replication success of the different variants which accidentally arise as a result of mutation and recombination. Variants that generate organisms that behave adaptively in a particular environment, will increase in that environment: the g-t-r heuristic in its most elementary form. Life is thought to have arisen as a result of the variation and selection of much simpler self-replicating molecules or `autocatalytic sets' which only evolved into the program-bearing molecule DNA - which is able to code for all kinds of proteins - much later. Present-day organisms therefore can be seen as `survival machines' which help the descendants of these primeval replicators to spread (Dawkins, 1976, 1982; chapter 4). The genetic program that somehow orchestrates the complex process of growth is the product of past selective forces and is tested again and again in entirely new and unpredictable circumstances. In that sense, living organisms are biological guided `missiles' with, as their only goal, the spreading of their internal guiding program, which as a result of trial and error has been shaped in such a way that it has a good chance of hitting the mark.

b.Guided mobile parasites

Modern classifications of organisms, based on genetic analyses, class them into three main groups, archebacteria, eubacteria and the eukaryotes, which evolved much later. Within this classification plants and animals are just two branches of the eukaryotes, the organisms with a nucleus in their cells which also include microsporidia, flagellates, ciliates and fungi (Edey & Johanson, 1989). Yet, nothing prevents us from making a division which looks like the common-sense division in plants and animals and which distinguishes between organisms that "directly extract their energy from their environment or from radiation of the nearest star" and organisms that live "parasitically, by eating other organisms". Mobile animals are part of the `parasitic' group, because their mobility on the one hand costs, and on the other hand furnishes much energy. It is this mobility which gives rise to the need for up-to-date information with respect to the environment.

If organisms are biological missiles, the most simple mobile forms are similar to ballistic missiles, like the Russian-Iraqi Scud rocket bombs which were used in the last Gulf war. Their course is completely preprogrammed. Even if they are able to react to their environment this reaction is purely automatic: a midcourse correction is impossible. The more an organism has to perform complicated tasks, like locating sources of energy or sexual partners, the more the risk increases that such preprogrammed reactions are inadequate. Midcourse corrections become increasingly necessary and with that an internal recognition system that enables the missile to recognize its goals: compare guided missiles such as Cruise missiles and Patriots, which are able to change their course at the last minute.

Of course, even Cruise missiles and Patriots are still too simple to offer an analog of the behavior of most animals. In many cases the `internal recognition system' has to be flexible and adaptable within the lifetime of one generation, because the animal has to learn to cope with new food sources and new enemies. Despite that, even relatively complicated animals are often equipped with a series of *inflexible* standard reaction circuits which ensure the successful accomplishment of their fundamental survival tasks. Vision in frogs offers a good example: the frog seems to be designed in such a way that its reactions are already more or less determined by the ways in which its sensory input is processed. For example, there are special fibers called bug-detectors between the retina of a frog and its optic tectum, that react only to small moving objects and which will stimulate the frog to jump forward or to extend its tongue (McFarland, 1994: 237). Other fibers respond to either the onset or the end of illumination and still others are called `moving-edge detectors', because they respond to the movement of a linear shape. As well as this, frogs show a tendency to start jumping towards blue areas, something which can easily be tested in the laboratory and which is thought to stimulate them to jump into the water in nature (Muntz, 1964). Together, a series of such sensi-motor circuits probably determines most frog behavior, although it is still possible that learning processes can refine some of its standard reactions, to some degree.

c. Learning

The moment an organism is no longer dependent on one source of food, standard preprogramming becomes increasingly inadequate. A framework is needed which enables the organism to develop preferences and to learn from experience. Perhaps a good example is offered here by insect-eating birds. The existence of warning colors and mimicry in the insects that are eaten by those birds, points to the ability of such birds to associate a bad taste with a particular color pattern. It seems that such a bird need not taste a bad-tasting caterpillar very often in order to learn to avoid it, otherwise mimicry (imitation) of its warning colors by other non-poisonous species would not pay (Wickler, 1968). On the part of the birds, this system requires at the very least an extensive memory and an inborn value system on the basis of which an ontogenetic development of taste is possible.

With respect to the natural sources of danger the same contrast between relatively fixed action patterns and more flexible reaction systems can be noticed. A cockroach has two cerci on its abdomen which are directly connected to its leg muscles via one big neuron. It does not need a brain to flee - the smallest touch of its cerci makes it dart away in a split second (Evans, 1966). The longer an organism lives and the longer it needs to be protected against a diversity of potential threats, the more an increasingly extended and accurate warning system is worth the metabolic investment. By finetuning this warning system with habituation and learning processes it can prevent that the alarm from going off continually and ensure that the organism has the time to feed and rest. This explains, for example, why many animals are able to accustom themselves to human observers.

To optimize the course of the organic missile it should be possible to consult and `weigh' at any moment the most up-to-date information with respect to a diversity of different possible sources of food and danger. For example, the organism can be provided with an ability to form an internal map of its environment on which a number of food sources can be indicated and on which at the same time the risks can be noted that are connected with feeding in this area (plus the chances of meeting a sexual partner there, etc.).

The relationship between the food source and the current position can be represented by an arrow or vector and the thickness of that vector may correspond with the organism's hunger divided by the risks of feeding at that spot. The sum of all these vectors can produce the `vector of the will' which determines the actual course of the organism in the here and now. Of course this `vector of the will' may be corrected at any moment as a result of new, incoming information.

The more complex the possibilities and demands of a particular environment, the larger the need for learning processes that continually update an extensive internal representation of all these possibilities and demands. No wonder that the relatively smart primates have evolved in the tropics, in forests with an enormous variation in sources of food and danger. It is important to note, however, that *learning processes are not possible for a tabula rasa*: very specific sensory structures are needed that scan the environment for particular information; innate values and selective systems are needed which direct the attention and isolate important aspects. If one wants to learn anything, one cannot start by trying to learn everything. Learning is not a luxurious pastime, but fills the gap between innate talents and factual skills that have to be mastered. Learning is only possible if a framework is given which directs the attention and shows the organism what to learn. Because organisms with the wrong framework become extinct, those that survive will probably have a framework which causes them `not to forget' goals such as survival and reproduction.

d.Subjectivity

The resulting internal representation of the environment *should not* be `neutral' or `objective'. In the first instance the information that the organism gathers is purely for its own use: if it is convenient to attach labels to it which improve a hyperindividual decision, so be it. Things have continually to be judged positively or negatively to allow a calculation of the vector of the will (even scientists sometimes still divide the world into pests and useful organisms).

With that we come to, in my opinion, one of the most important consequences of evolutionary epistemology. Animals are not primarily information-processing systems, but *decision systems*. Knowledge is not acquired for the cause of knowledge, but to enable the `right' decisions. Truth, and its non-social predecessor, adequacy of representation, have survival value. That means at the same time that knowledge is always perspectivistic and strategic[22]. Knowledge is acquired from the perspective of a being with interests, which values the world according to those interests. Knowledge has to enable the organic missile to maneuver, which increases the chances of it hitting its target (the explosion results in a new generation of missiles).

In his impressive study *The Biological Origin of Human Values* G.E. Pugh (1978) shows how decisions can be optimized in both artificial and organic decision systems by attaching values to the entities represented in it. A decision system so designed is no longer

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[22]. This does not imply relativism or anti-realism. J. Ortega y Gasset had already criticized Nietzsche's premature conclusion about perspectivism and showed that a perspectivistic `ratiovitalism' actually *presupposes* a world shared by all perspectives (Ortega y Gasset, 1923). Similar conclusions can also be found in Meyer's essay `Evolution as a Ground for Realism' in which he claims that the theory of evolution "makes humans and their abilities *the result* of a prior world and so precludes interpreting the world as dependent on human cognition. The world seems to be prior to mind from the explanatory point of view rather than the other way around" (Meyer, 1990: 114).

dependent on a preprogrammed set of standard reactions, but is able to devise completely new and optimal solutions to each new situation it encounters. Pugh discovered the flexibility of what he calls the *value driven decision system* when he was working for the American Defence Ministry to develop a computer program that could generate optimal bomber flightplans. In a value-driven decision program values were attached to the destruction of targets, to the bombers and to the crew. For each flight route the value of the target could be multiplied by the chance of successful destruction and the value of the bomber and its crew could be multiplied by the risk that they would be lost. The program could then automatically select the route with an optimal balance between these variables. Pugh realized that in organisms all kinds of variables are not expressed in numbers, but claims that *subjective qualitative* representations (feelings) guide the behavior of the organism. The difference between "epithelium fourth finger left, 150° C" and something expressed as `Ouch' is that the latter does not give much chance for contemplative detours. This could be at the same time an indication that animals feel something like `Ouch' if they seem to express it (in chapter 3 much more on Pugh).

It becomes clear, now, why at the moment an animal can no longer trust a set of fixed action patterns its learning ability has to develop together with a symphony of subjective experiences (feelings). In a relatively flexible decision system they guarantee that all aspects of a problem are weighed carefully from the perspective of the interests in the function of which the system has to decide. As `innate structures of experience' (Slurink, 1989: 23; this volume, chapter 3) they display the strategic aspect of the internal representation which the animal has of its environment. At the same time they may serve as a signal for conspecifics, whether expressed by sound, color, scent, posture or by using tail or face.

e.The social transmission of information and the social function of intelligence

An evolutionary approach may open our eyes to yet another aspect of knowledge. It is striking that although not all social species are intelligent, many intelligent species are social. Apparently a social environment creates unprecedented possibilities for the development of cognitive capacities (Byrne & Whiten, 1988). The moment a relatively clever species is forced by predators to live in groups, a situation may arise in which information relevant to survival may become the subject of new forms of interaction. Information can have an exchange-value and as a result social learning and culture may arise: social learning as opposed to individual learning refers to learning from other individuals, and culture is here defined as the non-genetic transmission of information via behavior, especially learning (Bonner, 1980).

	Bossou, Guinea	Taï Forest, Ivory Coast	Gombe, Tanzania	Mahale, Tanzania, M-group	Mahale, Tanzania, K-group	Kibale, Uganda	Budongo, Uganda
Hammering nuts	XX	XX	--	--	--		
Pounding with pestle	XX	--	--				
Fishing for termites	--		XX	--	XX		
Wiping ants off stick manually	+	--	XX	--	--	--	--
Eating ants directly off stick	XX	XX	+	--	--	--	--
Removing bone marrow	--	XX	--	--	--	--	--
Sitting on leaves	+	X	--	--	--	+	--
Fanning flies	--	X	+	--	--	--	X
Tickling self	--	--	X	--	--	--	--
Throwing	XX	XX	XX	XX	--	+	+
Inspecting wounds	--	+	+	--	--	XX	--
Clipping leaves	XX	XX	--	XX	XX	X	XX
Squashing parasites on leaves	--	--	X			--	--
Inspecting parasites	--	--	+			--	XX
Squashing parasites with fingers	--	XX	+	--	--	--	--
Clasping arms overhead	--	X	--	XX	XX	XX	--
Knocking knuckles	+	XX	X	XX	XX	--	--
Rain dancing	-	X	XX	XX	XX	XX	X

Table 1.1. 18 Examples of cultural variations that occur in some groups of chimpanzees, but not in others. Taï Forest and Bossou are in West Africa; all other locations in Central Africa. XX = customary; X = habitual; + = present; -- = absent. Habits that are absent for ecological reasons or about which no information exists are unmarked. **Hammering nuts** : To crack open nutritious coula nuts, chimpanzees use stones as rudimentary hammers and anvils. **Pounding with pestle**: With the stalks of palm trees acting as makeshift pestles, chimpanzees can pound and deepen holes in trees. **Fishing for termites**: Chimpanzees insert thin, flexible strips of bark into termite mounds to extract the insects, which they then eat. **Wiping ants off stick manually**: Once the ants have swarmed almost halfway up sticks dipped into the insects' nests, chimpanzees pull the sticks through their fists and sweep the ants into their mouths. **Eating ants directly off stick**: After a few ants climb onto sticks inserted into the nest, chimpanzees bring the sticks directly to their mouths and eat the ants. **Removing bone marrow**: With the help of small sticks, chimpanzees eat the marrow found inside the long bones of monkey they have killed and eaten. **Sitting on leaves**: A few large leaves apparently serve as protection when chimpanzees sit on wet ground. **Fanning flies**: To keep flies away, chimpanzees utilize leafy twigs as a kind of fan. **Tickling self**: A large stone or stick can be used to probe especially ticklish areas on a chimpanzee's own body. **Throwing**: Chimpanzees can throw objects such as stones and sticks with clear - though often inaccurate - aim. **Inspecting wounds**: When injured, chimpanzees touch wounds with leaves, then examine the leaves. In some instances, chimpanzees chew the leaves first. **Clipping leaves**: To attract the attention of playmates or fertile females, male chimpanzees noisily tear leaf blades into pieces without eating them. **Inspecting parasites**: Parasites removed during grooming are placed on leaf in the chimpanzee's palm; the animal inspects the insect, then eats or discards it. **Squashing parasites with fingers**: Chimpanzees remove parasites from their grooming partners and place the tiny insects on their forearms. They then hit the bugs repeatedly before eating them. **Clasping arms overhead**: Two chimpanzees clasp hands above their heads while grooming each other with the opposite hand. **Knocking knuckles**: To attract attention during courtship, chimpanzees rap their knuckles on trees or on other hard surfaces. **Rain dancing**: At the start of heavy rain, adult males perform charging displays accompanied by dragging branches, slapping the ground, beating buttress roots, and pant hooting. From Whiten & Boesch, 2001, 52-53.

As examples of culture Bonner cites the `discovery' by blue tits that they can obtain cream by pecking through the foil of milk bottles delivered to the front door step of millions of British homes and the hysterical anxiety engendered by people in a particular group of African elephants as a result of the activities of a hunter who was hired to exterminate that group several generations ago, but who only killed one elephant at a time, often in the presence of conspecifics. Other examples include the acquisition of two different styles of opening mussels by oystercatchers which proved not to be genetically transmitted, the transmission of song dialects in birds, migration routes in a variety of birds (Ehrlich et al, 1994) and possibly also in the monarch butterfly, the acquisition of knowledge referring to particular predators via mobbing in blackbirds (experimentally proved, see Bonner, 1980 for references), the instinctive imitation of the pecking behavior of the hen by the chickens by which they seem to `inherit' her experience with respect to the `meaning' of different spots at which she is pecking (Suboski, 1994), the spread of the habits of potato-washing, wheat-washing, potato-seasoning and fishing in a colony of Japanese Macaques on the island Koshima (e.g. Watanabe, 1994; De Waal, 2001), the social acquisition of specific predator-related alarm calls in vervet monkeys (Cheney & Seyfarth, 1990), the social learning of feeding habits in house mice (Valsecchi et all, 1994), mother-pup transmission of feeding techniques in golden hamsters (Prato Previde, 1992), mother-pup transmission of feeding and toilet habits in domestic cats, the transmission of information with respect to rich feeding areas by starlings and ravens at sleeping places and the existence of completely different cultures relating to gestures and tools in chimpanzees (McGrew, 1992; Gardner & Gardner, 1994). In the chimpanzee at least 39 rituals have been documented that vary across cultures and of which the variance cannot be explained exclusively as a result of different ecological factors (Whiten & Boesch, 2000; table 1-1).

Apparently, the social transmission of information, especially among animals which live in groups consisting of different generations, is not uncommon in a variety of animal species, because in such groups young animals can involuntarily pick up geographical knowledge or knowledge relating to food or predators or acquire certain patterns of behavior (bird song, foraging techniques) by imitation. The importance of such knowledge should not be underestimated: very often individuals that are deprived of such knowledge stand no chance of surviving in the wild. As a result, much extra training is needed if one wants to bring animals that have raised in captivity into the wilderness (De Waal, 2001; recent experiences include a variety of species, even vultures and condors).

Of course, all this has enormous consequences with respect to social structures. Sometimes the social structure of a species even seems designed exclusively to promote learning: in the South-American long-tail pipra, *Chiroxiphia linearis*, for example, `masters' and `pupils' together `perform' their sound-and-color shows for females. While only the `masters' are rewarded for such performances, every `master' once had to start as a `pupil'. It may take as long as eight years to become a master (Perrins, 1991; Attenborough, 1991). Of course, such a system could only evolve, because females for some reason consistently have preferred masters over pupils in the past (more on sexual selection, see chapter 4).

Living in groups not only enables animals to learn from each other, but also forces them to outsmart each other. The tension between cooperation and competition within a group of mutually dependent animals poses unprecedented new demands on the ability to make subtle social maneuvers, which presupposes an internal representation of the ranks of the various group members, including the self. The ability to form such internal representations of one's own rank seem to be present in some insects, including crickets and bumble-bees, who will become psychologically `down' and timid as a result of repeated defeats during a series of conflicts (Wilson, [1975] 1980: 123). In many vertebrates blood serotonin seems to be an indication of a relatively `dominant' self-image and monkeys can be made more dominant just by giving them Prozac, which increases their serotonin (McGuire, 1994; Masters & McGuire, 1994). Apes, especially most chimpanzees and orang-utans (and only one gorilla) have been taught to recognize themselves in mirrors and this ability could probably be explained as an effect of the social need for a self-image (Gallup 1994; Parker *et al.*, 1994), although others explain it as the result of the evolution of large body size in an arboreal ancestor of the great ape-human clade (Povinelli, 1994)[23]. If the social-origin theory is true, the image that we have of ourselves would originally have functioned as a means of understanding and manipulating the image that others have of us. Self-knowledge may have co-evolved with a series of human characteristics from the white of the eye to a desire for body ornamentation, which increase the clarity with which our internal states and intentions are communicated to conspecifics[24]. One is reminded here of an idea already expressed by many philosophers, even non-naturalists like Sartre, that our self-image is closely related to the image that others have of us.

f.Object manipulation and tool use

An alternative and probably complementary model relating to the evolution of intelligence concerns the need for sophisticated object manipulation, which is quintessentially expressed in tool use. The category of `one-ness', about which Kant concluded that it is necessary to integrate a collection of sensory impressions into a representation of one object, is at least as old as the cuttlefish. The cuttlefish shows what Piaget calls `object permanence', because it is able to follow a prawn around a corner. If, however, its vertical lobe is removed, it is no longer able to do so (Boycott, 1965). Many insects and spiders show an ability to `remember' and manipulate objects, too. Female spider wasps, for example, `remember' where they have left their spider prey while re-opening their burrow. Female sand wasps use small pebbles and clods of earth as a `door' to lock and re-open its burrow. Sometimes, such small objects are even used to pound the closure in order to shut the opening better (Vauclair, 1996). Various birds

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[23]. Frans de Waal supposes that other primates may also have self-consciousness and relates the ability of self-recognition in chimpanzees to their narcissism or `chimpocentrism' (de Waal, 1988).

[24] The white of the eye reveals the direction in which one is looking and - with that - one's intentions clearly; contrarily, body ornamentation increases one's *level of control* over the way in which one's internal states and one's social ambitions are communicated. As a result, the white of the eye has perhaps to explained with reference to Zahavi's `handicap theory' (Zahavi & Zahavi, 1996): it demonstrates that one has nothing to hide by giving conspecifics easy access to one's mind. Together with the desire for body ornamentation it should perhaps be placed in the context of an arms race of information and deception about oneself between conspecifics (see § *i* and part II of this book) in which some signals simply cannot be faked.

and mammals use some kind of tool to get to their food: famous examples are the woodpecker finch and the sea otter, the former using a twig as extension of its bill, sometimes trimming it to the proper dimension, the latter swimming on its back with a stone on its belly used as an anvil to open shells and mussels. An example of a relatively simple form of `tool use' that can be observed in Dutch forests is the `anvil' which is used by the great spotted woodpecker *(Dendrocopus major)* during winter to get to the inside of the fir-cones of pine trees. The woodpecker will look for a natural crack in a tree or chisel itself one, will get a fir-cone, hanging upside-down cutting its stem and fly it to the tree with the `anvil'. Next it will put the cone in the `anvil' and remove its seeds. One can often find piles of `used' cones under trees with such `anvils', used by woodpeckers.

An even more remarkable example of tool use is offered in the use of bait by green-backed herons, a species which can be seen both in Japan and the United States. A Japanese observer has discovered that it uses bait as diverse as live insects, berries and twigs with which it lures hungry or curious fish. Like the woodpecker finch it has been observed trimming oversized twigs to the proper dimensions (Ehrlich et al., 1994).

Mammals are certainly the most intelligent tool users, however. Elephants, both in the wild and in captivity, use various objects to clean their bodies or to chase away insects (Rensch, 1957). At Shark Bay, Western Australia, a series of female solitary dolphins consistently wear a sponge on their snout. It is presumed that it protects the wearer from rough encounters with rocks, sand, or the spines of poisonous fish as she probes at the bottom of the sea for food (Connor, 1994). Among the many primate species that show some level of tool use, capuchin monkeys are especially skilful in getting food out of containers or tubes by using sticks (Byrne, 1995). Chimpanzees in a variety of African populations have been observed to use up to 11 different kinds of tools per area (this number is reported from Gombe; McGrew, 1992). In West Africa chimpanzees use hammers and anvils to crack nuts. Often they will look around for the most suitable tools to do the job (Boesch & Boesch, 1992). The authorities agree, however, that as tool users orang-utans have even more insight than chimpanzees, perhaps as a result of their arboreal life-style. They selectively collect leaves and use them to ward off the sun or rain, in the same way that we use parasols. They use sticks as probes, rakes and levers and sometimes bend, break or chew on them to manufacture more efficient and specialized utensils (Gilbert, 1996). Recently, it was also found that they engage in honey-dipping, using a stick, in the wild. All this indicates that human technological skills have not come completely out of the blue. As orang-utans are currently thought to be less related to us than either gorillas or chimpanzees, it is at least possible that orang-utan dexterity has evolved independently from ours, although on the basis of the same anatomical and mental preadaptations (e.g. form of the hand).

g.Communication and language

Similar remarks can be made about the evolution of language. While it is certainly true that the peculiarities of human language are unique and that "a language instinct unique to modern humans poses no more of a paradox than a trunk unique to modern elephants" (Pinker, 1994: 342), evolutionary theory leads us to expect that nothing, at least nothing with complex design features, arises out of nothing or purely accidentally. Many animals display various abilities that are probably preconditions for the evolution of language, like complicated communication systems and an enormous ability to learn.

For example, many bird species have a whole series of different calls of which it is sometimes possible to decipher the meaning. As an amateur bird observer, I once made a list of the various calls and sounds of black woodpeckers *(Dryocopus martius)* and I ended up with a list of at least twelve distinct calls. According to researchers of the University of Wageningen, domestic chickens have a `vocabulary' of about twenty-seven different calls (Koene, 1995). Some mammals, including wolves, seem to have even more communicative abilities.

Often birds and mammals do not simply have alarm calls, but display different alarm calls that refer to quite specific dangers. The blue tit, for example, uses two alarm calls, one for distant predators and the other for nearby predators (Klump & Curio, 1983). Again, domestic chickens are well known in this respect. The barnyard bantam is said to emit a high-pitched "Kuk kuk kuk" if a weasel invades the yard, but a single, long call if a hawk circles above it. These different calls can also be generated simply by showing them either a ground or a flying predator on television (Evans, Evans & Marler, 1993). Vervet monkeys have different alarm-calls for leopards, snakes and eagles and also four different calls for various social situations (Cheney and Seyfarth, 1990; Vauclair, 1996). Primates are not necessarily the champions, however. The Australian miner, a bird, seems to display ten different alarm calls, each for a different type of predator (Short, 1993).

As a result of such `protolinguistic' abilities, many animals can been trained to obey human commands or even to communicate with them. Of course, such abilities had already been noted by such `amateurs' as the horse-breeder Henry Blake, author of the book *Talking with horses* and the elephant-trainer J.H. Williams, author of the book *Elephant Bill,* but most of these stories did not convince the scientific community (Crail, 1981). Bernard Rensch of the University of Münster's Zoological Institute was one of first scientists who tried to check some of these stories. He travelled to India to study the communication between working Indian elephants and their human companions. According to Rensch the elephants were able to discern 21 to 24 different commands, given in Urdu. Characteristically, these commands are taught by tying the new apprentice between two already trained elephants (Rensch, 1957). Some of the commands were as similar as "Lie down on your belly" and "Lie down on your side".

The report by Rensch inspired among others the pet-loving youngest daughter of Thomas Mann, Elisabeth Mann Borghese, to teach one of her dogs, the English setter Arli to type about sixty different words on a specially designed typewriter (Crail, 1981). The problem, again, seemed to be that Elisabeth Mann had few scientific credentials, although she is reported to have been relatively self-critical (Crail, 1981). In the meantime, however, a couple of scientists have started experiments which are so well designed that no one can claim they arise from uncritical amateurism: one of those scientists is Irene Pepperberg of Northwestern University. In a lengthy experiment Irene Pepperberg taught an African Grey Parrot named Alex more than 100 words by enabling the bird to share the interaction between a human trainer and a human trainee, who both worked as a model for the bird's responses and as its rival for the trainer's attention (the model/rival approach, Pepperberg, 1990). Alex appeared able to count to six and also to master the concepts of `same' and `different' in quite complicated tests.

Of course, the linguistic abilities shown by dolphins and apes are much better known, although they are still often down-played by neo-behaviorists and linguists (e.g. Pinker, 1994: 334-342) and although not all researchers have been careful in their methodology (Rivas, 2002). It is certainly not true that the experiments by the Gardners c.s. show that chimpanzees are able to learn American Sign Language as fast and as fluently as a child, but only that they seem at least to display a rudimentary ability to understand, remember and creatively combine a series of symbols (Gardner & Gardner, 1994) and to learn at least some symbols from each other (Fouts, 1994). Typical examples of creative new combinations that the Gardners claimed to observe in their chimpanzees are `drink-fruit' for lemon, `water-bird' for swan, `open food drink' for refrigerator and `dirty good' for toilet. Critics such as my friend Esteban Rivas suggest that the evidence for such combinations is largely anecdotical and that they might well be purely accidents by animals prepared to do anything to get food. But there is also a report about the chimpanzee Lana which is claimed to have called a cumcumber a `banana which-is green', an overly ripe banana, a banana which-is black', and a citrus orange, an `apple which is orange' (Rumbaugh, Savage-Rumbaugh & Sevcik, 1994). I find it hard to believe that all these observations are only accidents or chimarae in the heads of researchers (see Rivas, 2002).

If one requires chimpanzees to learn language *in the same way and as fast as* human children, one will probably be disappointed, but the only thing we expect from evolutionary theory is some continuity from apes to humans. Linguists have often repeated that the utterances of apes do not show any understanding of significant word-order, that is `grammar' (e.g. Bickerton, 1990), but the experiments of Savage-Rumbaugh with the bonobo Kanzi *do* clearly show some ability to connect different meanings to sentences with a different word-order. For example, Kanzi was able to discriminate between the sentences "Go to the colony room and get the orange" and "Get the orange that's in the colony room" if an orange was placed in front of him: only in the case of the latter sentence did he go directly to the colony room to fetch the orange that was placed there (Lewin, 1991).

Remarkable achievements in `grammatical understanding' are also reported from dolphins (Herman *et al*. 1984; Connor & Peterson, 1994). Louis Herman taught two dolphins, Ake and Phoenix, simple languages, one derived from American Sign Language, the other a self-created system in which objects and actions were represented by whistle-like computer-generated sounds. In both languages word-order mattered and both dolphins succeeded in grasping differences in similar sentences with different word-order. For example, Ake would understand the difference between *person surfboard fetch* (take a surfboard to a person) and *surfboard person fetch* (take the person to the surfboard). Both dolphins were also able to understand sentences that required them to use their imagination to creatively change the existing situation. Phoenix, for example, interpretated *bottom hoop through* by diving to the bottom of the tank and by lifting the hoop in such a way that she was able to swim through it. Both dolphins interpretated *water toss* by swimming towards the stream of water flowing into the pool and `tossing' it in the same manner in which they used to toss frisbees, balls and other things (Conner & Peterson, 1994: 194).

h.Adaptations required for speech

Of course, no other species is as able to use language as we, but even here this is not the result of a mysterious ability to *transcend* biology. We are *adapted* to use spoken language, as most linguists agree. We are able to speak as a result of the position of our larynx, the shortness of our jaws (Lieberman, 1984; 1991) and the semi-voluntary control over our respiration (Walker & Shipman, 1996) and our tongue. The pattern in which these changes took place points to strong selection pressures which forced our ancestors to share information with each other and to influence each other more and more by means of language. In part III I will investigate the forces that could be responsible for such a change with special emphasis on the model of Richard Alexander, who stresses that our ancestors at the time that they became `ecologically dominant' were increasingly forced to compete with conspecifics and thus to more intra-group cooperation. Recently, the ethologist-psychologist Robin Dunbar (Dunbar, 1993; 1996; Aiello & Dunbar, 1993) has shown that in primates group size often correlates with relative brain size and that our human relative brain size correlates with a group size of about 150 individuals that may have forced individuals in the past to find new ways of maintaining their multitude of contacts. Language could well have evolved as a replacement of grooming which plays a role in coalition-forming in primates. By means of language it is possible to `groom' more than one individual at the same time and to maintain mutual trust and solidarity in a relatively big group. It is no accident that standard human groupings of people `knowing each other' and human brains are about three times the size of chimpanzee groups and brains (Dunbar, 1996). It is can be no accident that humans are both intensely social and intensely linguistic animals.

At any rate, from an evolutionary approach one would not expect the properties of linguistic expressions to be solely determined by the possibilities of the oral cavity, the larynx and brain centers like those named after Wernicke and Broca (and their vicinity) to catch *any* matter of fact in easily transmittable codes. Our natural language often appears completely inadequate to express physical and chemical processes or relationships, apparently because it is not `designed' for such matters (Vollmer, 1983, 153-157). Language is much more than a medium for a transfer of information relating to purely objective facts. The shared world of experiences of those who communicate by means of language determine what is conceived or even construed as `facts', what such facts mean and how they should be evaluated: a point exaggerated by the social constructivists, but something that one would expect from a completely realistic evolutionary perspective. Our brains are not designed for a detached study of the universe and linguistic expressions are primarily social events (Dunbar, 1996). In this respect there is no fundamental difference between what we do with our mouth, tongue and larynx, what squid do with their body colors and wolves with their tails (Hart, 1996).

Our language is at the same time a superior medium for cooperation and for maintaining social networks and a superior means of manipulating and deceiving each other. Linguistic expressions are usually soaked with evaluations and manipulative representations. As Trivers remarks, the difference in costs between true and false statements is trivial, "at least as measured by energy expended in speaking" and as a result of that "verbal reality is likely to be a poor guide to social behavior (Trivers, 1985: 4)".

i. Why truth matters

This brings us to the subject of deception. As any amateur ethologist or commercial psychologist knows, deception looms everywhere. Information and deception go hand in hand at almost all levels of nature. The moment you have caterpillars, butterflies and wasps with warning colors, defensive mimicry by non-dangerous or non-distasteful species can evolve. Wasps are often imitated by beetles, hover-flies and even butterflies and sometimes the mimes are more abundant than their models. A nice example of the complexity to which a system of deception can develop is offered by some American fireflies. Here a system of originally sexual signals is `misused' by predators that mimic the mating signals of other species for the purpose of preying on them. Because the mimics are often females, males of the mimicking species *(Photuris)* may mimic the prey *(Photinus)* in order to find their own females. On the other hand, males of one of the prey species, *Photinus macdermotti*, sometimes mimic female *Photuris* signals while approaching a female, in order to chase away sexual rivals (Lloy, 1986).

Of course, there is a big difference between deception simply by giving wrong signals, deception by hiding one's intentions and deception based on a `theory of other minds' (Mitchel & Thomson, 1986). It is often unclear what kind of deception is involved, for example, in birds giving false alarm calls (e.g. Munn, 1986). At any rate, in chimpanzees and in the organ-utan there is an enormous variation in the way in which deception is used which suggests that it is based on an understanding of the standard reactions of their victims (De Waal, 1986). The sheer ubiquity of deception in chimpanzees probably gives us a clue to the complexity of human communication and the enormous importance given to sincerity, integrity and honesty in human affairs as well as to the weight attached to the concept of truth.

The problem with human language is that it is not only an ideal device for giving information, but that it is also ideal to deceive and manipulate. Of course, there are ways of discriminating utterances that are deceptive from those based on a shared interest in certain information, but a subtle manipulator can also use this knowledge. It is therefore to be expected that a kind of arms race between deceptive and deception-unmasking strategies will evolve and that almost all parties will at least pay lip-service to the ideal of truth. Ultimately, all parties have to take into account the real order of things; in that sense it is adaptive to have an internal representation of the real world.

1.6 CONCLUSION: ANIMAL REASON, OUR ULTIMATE GUIDE

What would be the central message of evolutionary epistemology for contemporary philosophy? Traditional epistemology has been the victim of a misconception for centuries. For a long time philosophers have thought that human uniqueness can be defined *in opposition to* the properties of other animals. Opposite man and his mind stood a series of mindless automatons, the animals according to Descartes c.s.. As a result of this simplistic dichotomy most traditional epistemologies have ignored the possibility that our knowledge and subjectivity are continuous with the animal need for orientation and guidance. Attempts at founding the edifice of knowledge were continually based on unverifiable presuppositions concerning the origin of reliable knowledge like empiricism and rationalism and therefore resulted again and again in what I called a transcendental deadlock (§ 1.4). Because knowledge was not placed within the ecological context in which it arose, and because one was often fixed more on an ideal of perfect knowledge than on the limits and perspectivity of real knowledge, time and again one was confronted with the impossibility of reducing all knowledge to indubitable foundations. Sometimes this resulted in a healthy skepticism, but more often it resulted in a relativism or idealism in which the possibility no longer existed to correct prejudices on the basis of the best available knowledge.

Modern cognitive ethology was needed to put an end to the simplistic dichotomy between animal and human cognition (table 1-2.). Although a series of philosophers showed some interest in animals, only a small minority took them seriously enough to give them impact on their epistemology.

	Insects	Fish	Birds	Mammals	Dolphins/apes	Man
Language-based cumulative culture						x
Self-recognition with mirror					x	x
Proto-linguistic abilities			x	x	x	x
Imitation, social learning		x	x	x	x	x
Complex communication systems	x	x	x	x	x	x
Tool use	x	x	x	x	x	x
Cognition, individual learning	x	x	x	x	x	x

Table 1-2. Modern (cognitive) ethology puts an end to simplistic dichotomies between animals and man and reveals a new kind of *scala naturae* in which many cognitive abilities are spread throughout the animal kingdom.

Hume is an example of a philosopher who explicitly refers to the possibility that it is our resemblance to other animals rather than our difference from them which guarantees to some extent the adequacy of our knowledge. In *An Enquiry Concerning Human Understanding* there is a section entitled `Of the reason of animals' in which he analyzes the inductive habits we share with animals as a result of instincts (Hume [1748] 1974). Yet, even Hume is so fixed on the ideal of certainty and non-perspectivity, that he does not realize the importance of his remarks and interprets himself as a skeptic.

From this we can learn that a non-discriminatory skepsis with reference to *all* knowledge may actually foster misconceptions. The best remedy for error may consist of simply trusting the oldest and most solid preconceptions which encompass and clarify the broadest realm of experiences - from direct everyday experience to sophisticated knowledge derived from well-designed experiments. In the last analysis, the knowledge apparatus which underlies our everyday experience has been tested in real life situations for countless generations. Looking for a better foundation for human knowledge is simply a manifestation of recklessness, because it implies that only man, above all other animals, could step outside the feedback relationship between knowledge ability and reality (it was R.W. Sellars who took knowledge as a feedback relationship, e.g. Sellars [1932] 1966). Only man was supposed to be able to transcend reality and to compare his internal `picture' of the world with it, which is, of course, impossible.

Paradoxically and ironically it is not our *difference* from, but our resemblance to other animals which guarantees the partial adequacy of our knowledge. Reason, which has been placed by many philosophers in opposition to nature, has arisen as a capacity that enabled animals to make decisions which were favorable for the survival of their genes. Reliable information about the environment is a first requirement for such decisions. For that reason we may expect that the sense-organs and brains of animals together construct a representation of the environment which partially corresponds to its actual physical properties. At the same time, this correspondence has to enable the `right' decisions: therefore, we may expect the knowledge apparatus to paint a world in the colors of the interests of the animal for which it is designed.

Only after people started to look beyond their immediate animal horizon by means of the scientific construction of models, did the epistemological conflicts of the last four centuries arise. Essentially these are constituted by a conflict between two different evolutionary legacies: on the one hand the unreflected and uncritical sense of reality which always seduces us to take our picture of reality for reality itself, and on the other hand our ability to integrate information from different sources into a coherent reconstruction of non-observable facts. Empiricism and rationalism can be viewed as attempts to reconstruct our knowledge on the basis of one of these principles: one trying to start with the sense-organs, the other with our reasoning powers, both of which are aspects of our natural and fallible knowledge system.

Science can be seen as the challenge posed to our natural imagination by our ability to reason on the basis of unusual observations. Science gave rise to doubts concerning the credibility of our natural world experience and forced consistent thinkers to doubt it. The moment one starts to doubt whether it is the sun that sets or whether it is really just the earth that spins round or whether some qualities of objects, like colors, are simply products of our sense-organs while others, like extension, are supposed to be real, one might as well start to doubt the rest of one's beliefs. Almost any other intelligent animal which had been raised above its natural experiential horizon as a result of new measuring-instruments and mathematical models would include a few desperate individuals which would creep into a corner to secrete epistemological webs and get into a chronic transcendental deadlock.

After a couple of centuries of futile attempts at giving knowledge an absolute foundation, it is time to accept that such foundations do not exist. The skeptic is simply right: every proof is based on presuppositions to which everyone agrees and which one may always doubt. The skeptic forgets however that he too cherishes certain presuppositions and that it is for that reason very risky to cherish presuppositions that cannot be corrected by scientific progress. Starting from the best knowledge we have at this moment, there is no reason to believe that there are any fundamental certainties to which a special warranty is attached which excludes further doubt. Errors always remain possible for a finite brain and the only assurance that our brain is able to make the correct inferences is constituted by the fact that our ancestors have until now succeeded in finding each other on the surface of this planet, contrary to many of their brothers and sisters. That implies that truth and error are related, in the same way that success and failure, life and death are two sides of the same coin. There is no *a priori* warranty against error and we will always have to come up against more dead ends before finally finding the right path. No science exists without the courage of gambling.

Starting from the insight that our knowledge ability is an animal orientation-organ evolutionary epistemology solves a series of problems which were ignored by other epistemologies.

First, it throws light on the gap between `natural' and `scientific' world experience, a problem which recurs in such completely different philosophies as those of Husserl and Wilfrid Sellars. In the interpretation of evolutionary epistemology the first kind of experience - resulting in what Sellars calls `the manifest image' - offers us the world as we have *needed* it for the largest part of our evolution; the second kind of experience - resulting in `the scientific image' - is the result of attempts to construct models which are less bound to a specific subjective perspective and which may orient us in an ever wider environment. (One is also reminded of Locke's distinction between primary and secondary qualities which ultimately led to Berkeley's idealism, because no one could *explain* and therefore `justify' the strange dichotomy between physics and ordinary experience.)

Second, evolutionary epistemology is the only epistemology explaining *why* knowledge exists. Mobile organisms just need information from their environment to guide and orient them. It is the only epistemology capable of offering a non-circular definition of knowledge. Knowledge is, according to this definition, the use of properties of the environment for the construction and continual adjustment of an internal model which enables a self-steering being to act in a goal-directed way.

This definition implies that knowledge refers on the one hand to real structures of the world, but that it has, on the other hand, a subjective steering side. The tension between the necessity of orientation (the correspondence to real structures) and that of `steering' (the subjective evaluating of information in order to be stimulated to make fitness enhancing choices) results in the perspectivity of knowledge, which makes philosophers time and again waver between realism and idealism or skepticism. In this way evolutionary epistemology can combine a certain relativism and perspectivism with respect to the structures of our knowledge (our categories are perhaps not the only way of `cutting nature at its joints') with realism. The force of an evolutionary approach thus lies in the possibility of a naturalistic `justification' and `critique' of the structures and strategies of our knowledge - even as different evolutionary epistemologists, like Vollmer and Ruse, have tried one-sidedly to place one of those complementary aspects central.

With that evolutionary epistemology also breaks with the contemplative and individualistic image of knowledge entertained by most traditional philosophers. As Nietzsche started to realize in his later years, knowledge is essentially a simplifying schematization of our environment to enable us to act[25]. Knowledge is never only the achievement of one individual, because a long evolutionary and biocultural evolution was needed to achieve the epistemic feedback between the individual brain and the world.

Because knowledge is an orienting schematization of structures of the world in a subject, it is essentially incomplete. Each schematization is only a summary of those structures as it is produced from a particular viewpoint in function of particular needs. Science is an attempt to come to less perspectivistic knowledge by trying to document ever more encompassing regular patterns in the world around us and by making explanatory models of the causal interactions involved, but science, too, can only make the world to some extent understandable by simplifying and abstracting from the real complexity of natural processes (which goes also for chaos-theory, `sandpile theory' and other theories on complexity). While trying to understand, we remain only a part of the world and we cannot understand it `from the outside', as if we could compare it with another universe in which different conditions apply. Knowledge is not only knowledge about the world, but it will always remain knowledge *in* the world.

Thus the gap between our natural experience and the scientific world view becomes less absolute than was sometimes supposed. The schematizations of cosmic connections which are made by science do indeed reach further over our immediate horizon than our natural world experience, but they remain schematizations from an organic perspective which can only understand by actively to abstracting and ordering its experiences. As the English word `to grasp', the Dutch and German words `begrijpen' and `begreifen' and the French `comprendre' reveal, the archetype of understanding remains the primate hand which isolates an object in its field of vision and grasps it (Lorenz, 1973). Knowledge is not passive receiving or reflecting, but an active attempt at gaining control over structures of the world. As parts of the world, however, we are unable to grasp the whole and we can only indirectly grasp our own `hand'. The inevitable conclusion is that, despite our measuring instruments, we can never grasp more of the world than fits into a primate hand or brain.

Therefore, knowledge will always remain reconstruction and model making from a particular perspective. Even if our categories grow in interaction with the world, it is plausible that there remains an element of arbitrariness in them. Perhaps we could discover the degree to which our categories are arbitrary by discussing our world experience with intelligent beings from other planets, who happen to have other categories. The only hope that communication with these beings is possible would be that they have evolved in the same world (Ruse, 1989).

Evolutionary epistemology thus makes an end to the illusion of an epistemology based on indubitable certainties and at the same time to the illusion that our most elementary concepts are the only ones possible and have fixed meanings independent of the rest of our knowledge (Millikan, 1984). There is no knowledge without perspective,

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[25]. Alas, as said already, Nietzsche talks about `knowledge' in two different ways: first in the sense of a platonic grasping of essences, secondly in the sense of a pragmatic schematization - often both meanings occur in one sentence: "Der ganze Erkenntnis-Apparat ist ein Abstraktions- und Simplifikations-Apparat - nicht auf Erkenntnis gerichtet, sondern auf *Bemächtigung* der Dinge" (Nietzsche [1940] 1977: I: 165). Regarding Nietzsche's paradoxical position see Danto, 1964; Slurink, 1992.

there are no privileged truths from which other truths are deducible, there is no *a priori* means of discerning adequate from less adequate representations. Only in an actual interaction with the environment can a living being discover that its representations or concepts have to be corrected - if it is lucky it has not to pay for its error by dying. Epistemology is no longer the *first* scientific discipline, the one preceding all others, but in some sense the *final* one. We need all scientific knowledge to understand what scientific knowledge is. Epistemology is knowledge about the world, applied to man and his knowledge about the world. The scientific world view is an immense circle starting with hypotheses about non-organic and extra-human nature and from there also gradually understanding man and his ability to form scientific hypotheses. Evolutionary epistemology is the point at which the circle is closed and the dragon eats its own tail.

2 ---------------------------------------

* A critique of evolved reason: seven peculiarities of human reason \\

> Er is unwahrscheinlich daß unser `Erkennen' weiter reichen
> sollte, als es knapp zur Erhaltung des Lebens ausreicht
>
> Friedrich Nietzsche

A. STUDYING THEORY-LADENNESS, VALUE-LADENNESS AND THE SOCIAL CONSTRUCTION OF REALITY

Every now and then in the history of philosophy, the fact that knowledge transcends the mere `collection' of sensory data is rediscovered. Again and again, that discovery is overinterpreted, however, sometimes in the direction of relativism, sometimes in the direction of a model on the evolution of ideas in which these `unfold' more or less autonomously, not guided by a real interaction with the world. In antiquity Plato's doctrine of ideas can be seen as a reaction to (amongst others) Cratylus' `empiristic skepticism' and Protagoras' doctrine about man as the `measure of everything'. Plato's doctrines, however, gave rise to all kinds of dualistic and idealistic worldviews which have perhaps led to as much confusion - albeit perhaps not to as much moral disorientation - as the philosophies to which Plato reacted in the first place. In modern times rationalism and the philosophy of Kant arose partially in a discussion with empiricism, but they resulted in the idealistic and systems of Hegel and Fichte in which the baby of a critical epistemology is thrown away with the bathwater of empiricism.

In the philosophy of science these oscillations around the concept of knowledge are also repeated. As a reaction to the logical positivists the `theory-ladenness of observation' was stressed by Popper, but his attempt to save the `rationality' of knowledge by an appeal to the possibility to falsify theories that are really `scientific' failed. The critics pointed out that even in a clear falsification, it is not always clear what part of a theory is really falsified. As a result of that, falsification can seldom be a sufficient reason to reject a whole theory. Consequently, "the logical asymmetry between falsification and verification disappears. It may be true, as Popper claims, that we cannot conclusively verify a hypothesis, but we cannot conclusively falsify it either" (Woodward & Goodstein, 1996; see also the discussion of Kuipers, 1994, and Derksen, 1994).

Again, skeptics, relativists and constructivists emerged. For them, the discovery of the `theory-ladenness of observation' is often a kind of starting-point. The `value-ladenness' of much scientific knowledge as well as `the social construction of reality' became extra arguments to question the objectivity of scientific knowledge.

Evolutionary naturalism can offer a somewhat more balanced approach and could thus avoid following the zigzag-movement which seems to be characteristic of much epistemology. In this chapter I will try to show how the `theory-ladenness of observation', the `value-ladenness of theories' and the `social construction of reality' need not result in our being completely `locked up' in our theories. The `theory-ladenness of experience' and the `social construction of reality' can itself actually be thematized and studied scientifically and the models used in doing that can be gradually improved in a completely rational way, precisely because they are `theory-laden' in a heavy way. For example, an evolutionary account of observations actually makes us *expect* that observation is never completely reliable, while at the same time making it reasonable to believe that, at least in the sphere of `normal, everyday use', observation functions well in guiding us through the world of mesocosmic objects. Similarly, an evolutionary account of science makes us *expect* that scientists will compete with each other by launching opposing theories, but at the same time can make plausible that theories with more adequate representations of the world are at least sometimes better weapons in this scientific `struggle for life'. In this way neither the `theory-ladenness of experience' nor the `social construction of reality' need be detrimental to the cause of science and can be perfectly well integrated in a naturalistic, not *scientistic*, `scientific world-view'.

One of the most important things that can be showed from the evolutionary perspective is that the concept of `theory-ladenness' is really a collective noun covering a whole range of phenomena which often pose quite different challenges to the pursuit of knowledge. A short analysis of some of the different evolved `biases' of our `knowledge-apparatus' is well worth the trouble, because it will enable us to discover to what extent the `design-features' of our mind allow it to discover objective structures and properties of the world. In this chapter I will try to give such an `evolutionary justification and critique' of our evolved knowledge capacity. I will start from four provisional theses or presuppositions (some would say, dogmas) which are gradually made more plausible in the course of this and other chapters:

- First (a), *our mind is not a tabula rasa which can observe anything or learn anything with the same ease and speed, but rather a specialized learning device suitable for some tasks rather than others - it is a `knowledge-apparatus' with specific `design features'* (e.g. Lorenz, 1973; `thesis of innate biases and learning mechanisms').
- Second (b), *during each stage of its evolution our `knowledge-apparatus' has been tested on its ability to process information in order to survive: as a result it should primarily be viewed as a biological `decision system', "designed by DNA to perpetuate DNA"* (Wilson, 1975; Pugh, 1978; `thesis of the adaptive nature of knowledge').
- Third (c), *much of the `design features' of our `knowledge-apparatus' can be understood as a result of its evolution from much simpler neural networks which at each stage of their evolution must have functioned in their own right: new properties always emerge from a gradual rearrangement of older ones, which of course does not exclude relatively rapid, dramatic `innovations'* (`thesis of step by step emergence').
- Fourth (d), *in order to study the possibilities and limits of our `knowledge-apparatus' we should transcend transcendentalism and base our `criticism of reason' on its scientific study. Like the baron Münchhausen we can pull ourselves up from the marsh by our own hair (this kind of bootstrapping is called the Münchhausen-operation by Derksen, 1985). Science is able to transcend to some extent the limits posed by the specific `design features' of our minds and posed also by the narrow natural purpose of knowledge as a result of the particular way in which knowledge is culturally transmitted, selected, recombined and cumulated in our species. By observing and understanding our own selective observation and biased processing of information, we are able to overcome this selectivity and bias to some extent and make a judgement about the margins which are left for adequate representations of the world* (thesis of scientific self-justification and -critique).

Let me defend and explain these four `dogmas' (§§ a to d).

a.Not a tabula rasa

The first `dogma' follows directly from evolutionary theory: it would be implausible for our mind to be a kind of blank slate which could be inscribed with almost anything. Creatures with such minds would not know what to watch for or where to start to learn. They would probably die as a result of starvation or been caught and eaten by predators during their first day of independence, or else end up paralyzed by indecisiveness during the next couple of days. Even if we are, as a result of our unique evolutionary trajectory, relatively unspecialized apes, we would need a collection of specialized modules to ensure our most urgent needs for food and safety. Without an urge for social recognition and status and without a `sexual imperative', our genes would still become extinct within one generation.

It is an implausible presupposition, however, that we are an unspecialized species. Even ecological and cultural flexibility does not stand in opposition to specialization. Or much celebrated capacity for culture is partly based on our capacity to learn language which requires, as we saw in chapter one, a series of highly specialized organs and neural networks. It is also based on our extended phase of playing and learning and on our social talents, more specifically, our talent for forming relatively large kin groups and extended systems of `reciprocal altruism' (see part II). All this requires a specialized power of perception and attention and a highly selective memory.

If we compare minds with computers, it becomes clear that the evolution of an *un*specialized type of intelligence presupposes a series of highly specialized modules. If we use serial computers as an analogue to nervous systems - an approach recently criticized as unrealistic (e.g. Churchland, 1989, 1995) - it is already obvious that a program with a lot of possibilities requires much more programming than a program with which one can do only one or two things. The more realistic analogue with computers which use parallel distributed processing (PDP computers) shows the same thing. In connectionistic language: a completely unbiased neural network will learn anything very slowly, but the moment certain synaptic weights are given specific values or the moment certain `recurrent connections' are installed, the learning capacity of that network can be enhanced enormously (see here-after § c; figures 1-3).

The fact that evolution always starts with more specialized types of intelligence, before building more flexibility or `openness' into a system, makes it more plausible that this flexibility and `openness' (i.e. being less determined by a limited set of prefixed options) is simply based on a specific combination of specialized functions. For example, the famous creativity of our species is at least partly based on the versatility of the human hand, and the much-vaunted variety of social structures in our species is at least partly based on the expressivity of the human face. It is perhaps no accident that earthworms and cows are not as creative and erratic as we are.

The idea that learning *presupposes* specialized `innate learning mechanisms' was already familiar to biologists and ethologists as far back as Darwin and Lorenz. It entered the behavioristic study of animal learning in laboratories with studies that showed that rats could only learn to associate sickness with the flavor of a food they had eaten, while pigeons could only learn to associate sickness with visual clues (Marler, 1970). Perhaps it finally invaded the human sciences as a result of the problems faced by linguists who had to explain the speed with which children are able to infer the meaning of their parents' utterances simply by hearing a limited collection of them in association with particular circumstances. During his career Chomsky was forced to postulate some kind of innate learning device, and other linguists followed. From there it entered the *philosophy of mind* via Fodor's thesis on the specialized learning modules that together constitute the framework of the mind (Fodor, 1983). Many social scientists are not yet familiar with the idea, however, as a result of the legacy of Freud, the behaviorists, Piaget, cultural anthropology, sociology and probably as a result of the general spirit of an age of progress, or rapid change, in which there is a strong cultural pressure to stress the malleability of the human spirit.

Despite this legacy, nowadays even developmental psychologists see the necessity of combining both the idea of innate dispositions (nativism) and that of ontogenetic development (constructivism). Many abilities that were within the doctrines of Piaget supposed to be characteristic only of children of particular ages proved to be present much earlier (Karmiloff-Smith, 1992). As I will demonstrate in later chapters, the comparative study of animals and man and the sociobiological models explaining their behavior, point in the direction of the inheritance of *conditional* psychological mechanisms. These are turned off and on depending on ecological and social circumstances and direct also the sequence of learning processes. All in all, nature and nurture should no longer be considered to be opposites: only in some cases, nature has resorted to the help of nurture, because it was unable to predict in advance all details of the situations that an organism would have to cope with.

b.The adaptive nature of knowledge

After this preliminary defence of `dogma 1', I will give a preliminary *explanation* of `dogma 2', which will be defended more extensively in part II. `Dogma 2' is really only one step further than `dogma 1'. Why would an organism *need* information? As was seen in chapter 1, evolution would not have bothered building `costly' neuronal tissue if this tissue did not enable organisms to react more appropriately to their environment or to weigh their behavioral options more wisely. Information, in the final analysis, is not acquired for the sake of information, but only for the sake of adequate decisions. That means that our brains are only `information-processing', because they are `biological decision systems' which do become extinct if they make the wrong decisions. Only those decision systems survive that leave a copy of their inherited building program.

Such a decision system, however, is in need of information on the basis of which it can make `right' decisions - that is, decisions which perpetuate the DNA coding for that system. For that purpose it is equipped with sense-organs of which can be expected to particularly sift out information from their environment which promotes their genetic survival. Of course, the problem is in discriminating potentially important information from `noise' in an essentially unpredictable environment: one never knows beforehand what may become important. On top of that, ecological flexible species - rats, sparrows, starlings, crows and humans - need relatively large amounts of information, because they continually need to adapt to new food sources, new ways of living and new dangers or predators. This is the reason that such species can display singularly high levels of apparently superfluous curiosity which enables them to collect information about their environment that they may need at some point in the future (in mammals this seems to be enabled by the association areas on the cortex; in birds it has evolved independently as the hyperstriatum; Savage, 1995).

Information needs to enter the decision system in such a way that it is thereby enabled to survey relevant possibilities and make priorities among them. All kinds of physical characteristics of the environment can be used as clues to potential dangers and opportunities. Of course, those characteristics are not chosen on the basis of a comparison of their advantages or disadvantages, but simply by an almost infinite (i.e. half a billion of years) process of variation and selection of tissues with particular properties. If certain characteristics of the environment are predictive of particular threats or possibilities for an organism, a mutation which makes one of its tissues sensitive to this characteristic may be advantageous. This means that this sensitivity is from the very first moment based on the interests of the organism in question. Sense-organs are not expected to offer disinterested information; it is rather to be expected that the organism is programmed with a particular *interest-determined interpretation* of its sensory input: it will be shown how this can lead to particular forms of `theory-ladenness' or `value-ladenness'. Sensory information may be transformed, colored and schematized as long as it is `adequate enough for survival' with respect to the environment in which the organism has to perpetuate its genes (Überlebungsadequät; Vollmer [1975] 1983). The moment this is no longer the case, the organism in question risks extinction or genetic death.

If we see the genetic code as a `program' orchestrating the growth of an organism in interaction with its environment, we could interpret the process of genetic variation and subsequent selection as a kind of `evolutionary programming'. The fact that humans are very complicated products of a gene-environment interaction displaying a, to some extent, completely autonomous nervous system, does not implicate that the properties of this nervous system are not largely the product of such a process of `genetic preprogramming'. If this is true (which, of course, still has to be proved) and we are preprogrammed too, it is to be expected that the world which we experience consciously is a product of our brains on the basis of a selective measurement of relevant physical properties of the environment. As was seen in chapter 1, *as far as our knowledge-structures `fit' to real-world structures this could be interpreted as an adaptation, obtained by natural selection, and this adaption is at most `adequate for survival':* this is exactly the thesis of the adaptive nature of knowledge.

c.Descended from much simpler minds

But how should such genetic preprogramming be envisioned? Of course, DNA shows some resemblance to a `program', because its sequences of bases contain `codes' for proteins, but there is still an enormous gap between DNA and actual neural tissue as it interacts with the world. In fact, referring to `genetic preprogramming' may be misleading, because it suggests a dichotomy between `preprogramming' and `learning' where one actually finds learning processes taking place within a frame-work of evolved biases. `Genetic preprogramming' could suggest to some an inflexibility which does not correspond to our experiences with humans and other animals. In addition, it suggest a dichotomy between `hardware' and `software' as if evolution is making a multi-purpose machine suitable for specific purposes. The theory of evolution suggests, however, that we have not evolved from multi-purpose machines, but from `survival machines' (Dawkins, 1976).

At this point it is important to realize that our minds have descended from life forms with much simpler neural networks which must have functioned at each stage of their evolution in a competitive world. If we have unique properties, these must have emerged from an accumulation and integration of properties which served our ancestors in their unique survival strategies. The study of such much simpler neural nets is therefore a more adequate starting point for studying intelligence generally than studying specialized symbol manipulating devices which are able to produce language-like sentences.

If we are looking for ways to simulate and study intelligence with computers, there are several reasons to expect more from the analogy with parallel distributed processing (connectionism) than from the analogy with serial processing (classical artificial intelligence):

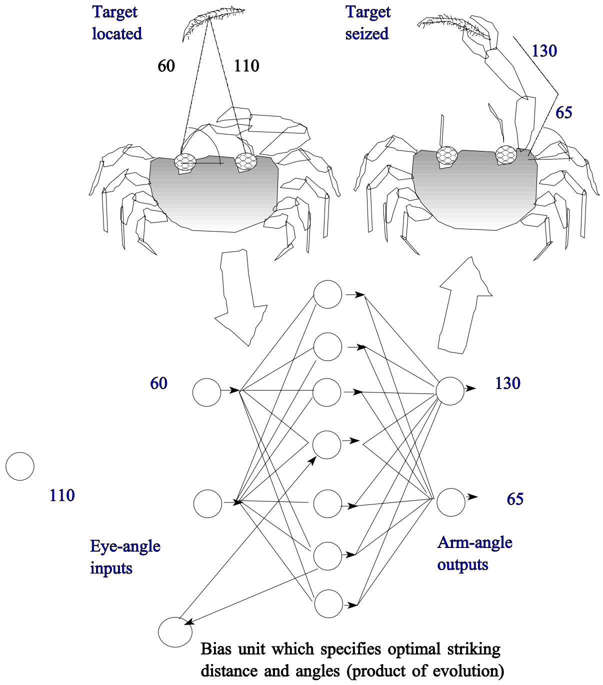

Fig. 2-1. As a crab grows into a skillful hunter, the weights of the hidden units between its sensory input and its motor output are gradually adapted (redrawn after Churchland, 1995).

- *First*, preconceptual integration of information is (in some lineages) a consequence of evolution, not its starting-point. The first multicellular organisms that evolved sensors or even specialized neural networks were not necessarily equipped with the means to integrate all the information they offered: in various parts of their bodies different processes could go on, as long as they remained to some extent adaptive to the whole. Parallel distributed processing thus seems much more likely to correspond to the processes within real neural networks than serial processing.
- *Second*, in the `struggle for life' speed is essential, insight is at best a side effect. As was seen with the example of the cerci of the cockroach which are directly linked to its leg muscles (chapter 1), reaction speed is not always served by consultation with the brain. Even in complex organisms with a lot of central information processing a lot of autonomous subcircuits and automatic reflexes can be found which ensure that life goes on whatever is ordered from `above'.
- *Third*, neural networks are much more resistent to damage than devices which depend on serial computing, because the former are characterized by a multitude of input-output connections while the latter are characterized by only one long string which can break at any point (Churchland, 1989; 1995).
- *Fourth*, and most important, parallel distributed processing offers a realistic analogue for types of learning and biased learning within neural networks which are entirely independent of mathematical and linguistic symbols. These may be based on very simple `algorithms' like trial and error, but can nevertheless result in an almost infinite variation of input-output relations.

Very briefly, the principles are as follows:

1. A neural network is characterized by adjustable `synaptic weights' on its layer(s) of `hidden units' between the input and output layers. Animal brains can be seen as neural networks that have to adjust their synaptic weights in such a way that perceptions lead to the `right' actions: a crab, for example has to coordinate its observations of an edible object and

its subsequent attempt at seizing it. In figure 1 these are represented by the eye-angles at which the crab sees an edible target and the arm-angle at which it is able to seize it successfully at its observed location.

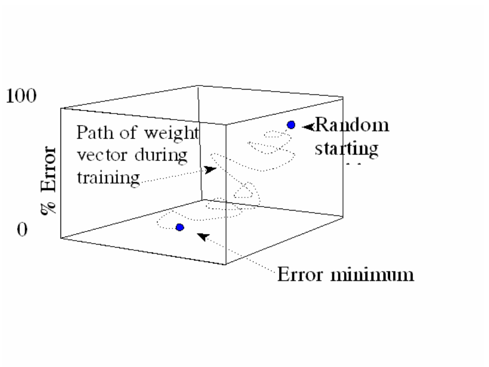

Fig. 2-2. Learning as it takes place in one hidden unit. As a result of a specific algorithm the synaptic weights are gradually given the right values (after Churchland, 1989).

2. Any pattern of inputs can be related to any pattern of outputs by varying the synaptic weights until the `error rate' drops to a global error minimum (figure 2; the learning process often sticks, however, to a mere *local* minimum). Of course, different `learning algorithms' have a different success in successfully adapting the weights of a given hidden unit. Ultimately, variation and selection has not only `designed' the most successful learning algorithms, but is also the principle used by the most successful ones.
3. Conceptual distinctions can also be seen as output. Sensory input, for example a series of echoes as perceived by a bat, has to be classified in order to be used in an adaptive way: the bat has to distinguish echoes of edible objects from those of non-edible ones, for example (figure 3). In this view, conceptual distinctions derive ultimately from behavioral distinctions.
4. A neural network can be biased into learning this rather than that by adding extra connections between the output layer and the hidden units (see the `bias units' in figure 1). The resulting network has a lot of extra qualities which correspond to the qualities of real nervous systems in which one can also find recurrent pathways.

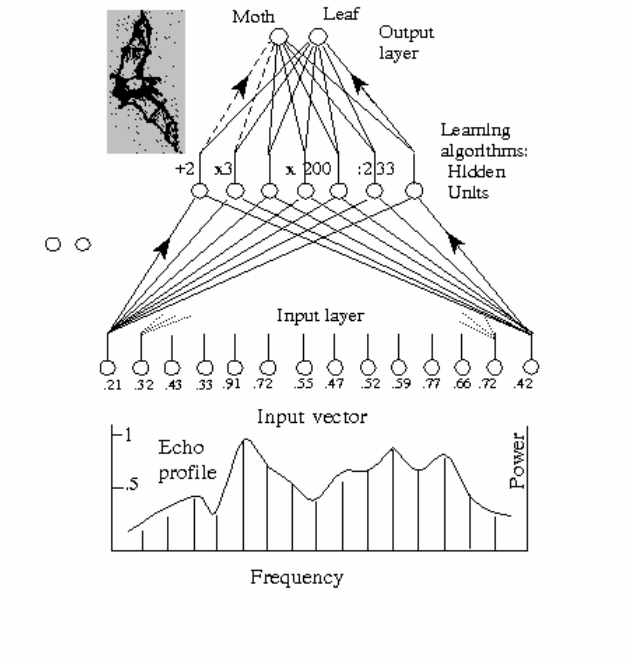

Fig. 2-3 In order to be able to eat, a bat has to distinguish moth echoes from leaf echoes. If properly trained its neural network produces the right `conceptual' outputs from a variety of acoustical inputs.

It should be noted that much of the current literature on neural networks (Churchland, 1989; 1995; Aleksander, 1996) stresses the ability to implement almost any input-output relation in a neural network by training it sufficiently. Although it may be important to stress this to convince everyone of the enormous possibilities of parallel distributed processing (and the ability of PDP computers to pass the `Turing test'), it should be stressed that most experiments in nature are immediately followed by a death penalty. The necessity of very specific input-output relations makes the evolution of `multi-purpose' machines implausible and it is therefore to be expected that neural networks of living organisms are biased in many ways by the preprogrammed growth of particular recurrent pathways which bias the training processes in particular directions. As Pugh has shown with respect to the `value-driven decision system' (on which more in the next chapter) the adequacy of decisions is proportional to the amount of pre-installed values and the extent of relevant representation (Pugh, 1978).

d.Critique and justification

The remainder of this chapter is needed to defend and elaborate `dogma 4', the thesis of scientific self-justification and -critique. The claim is that the process of cultural transmission which enables us to take part in scientific knowledge creates enough elbow-room to judge the reliability of our evolved knowledge-forms and strategies. By actually studying the prerequisites for knowledge and the ways in which animals and humans acquire knowledge, it should be possible to demonstrate a number of seductions and pitfalls, the awareness of which could actually improve our scientific success. The `evolutionary justification and critique' that is here envisioned is partly inspired by Kant's *Kritik der reinen Vernunft* (Kant, [1877] 1924), but - as will already be clear from chapter 1 - it differs completely from it in at least three respects:

- *First*, while Kant talks about a *Kritik*, what he really does is create a very bold and speculative model about the constructive force of reason and the transcendental subject which cannot really be corrected by new scientific research, because it claims to be *a priori* and thus beyond empirical research. (This same point can also be used in discussion with `neo-' or `crypto-transcendentalists' like Heidegger with his speculative distinction between `Vor-handenheit' and `Zuhandenheit' which are supposed to be two `modes' that predetermine the kind of knowledge that they generate and which Heidegger apparently claims to understand *a priori* (Heidegger [1927] 1979). As we will see, the Kantian notion of *a priori* is slightly ambiguous in that it refers on the one hand to aspects of knowledge which are not given in experience and, on the other hand, to rules which are universal and which necessarily apply to all experience: this makes us doubt whether the Kantian *a priori* is purely `logical' or to some extent merely `anthropological'.
- *Second*, while Kant seems to know quite a lot about the way in which the transcendental subject structures our world with its categories and forms of sensitivity, *die Erscheinung*, much of the *Kritik der reinen Vernunft* seems to be based on the *presupposition* that knowledge of the world, *das Ding an sich*, is impossible, even *via* our perspectivated, subjectively colored knowledge: in this context it is useful to refer once more to the passage in B 168 of the KrV (cited in § 1.4) in which he explicitly denies the possibility of a `harmonie préétablie' between our knowledge structures and the world. Instead of becoming a relativist, however, Kant uses his critique of human reason only to relativize physics and metaphysics. By denying the possibility of knowledge of the world - knowledge via *Erscheinungen* about *Dinge an sich* -, he also blocks all roads to the improvement of reason via the feedback of gradually improved models about the world. He shows too great a tendency to take Euclidean geometry and Newtonian physics as necessarily applying to the world of human experience, purely because they emerge from human *Anschauungsformen* and categories.
- *Third*, while Kant thus claims to give a *Kritik* he only asserts that "such-and-such are our forms of observation and categories and thus-and-thus does the world that we experience emerge from them" (see KrV b145-146 cited above). In fact despite his belief in the transparency of the act of the `transcendental apperception', he lacks an Archimedean

point to really start a critical investigation into the way human reason works. The only way in which you could partially criticize your own reasoning powers is by having good reasons to trust them in some respects as well: thus a good *critique* should start with at least a partial *justification*.

On all these three points the evolutionary justification and critique of our evolved knowledge structures differs from Kant's *Kritik der reinen Vernunft:*

- *First,* what I will do in this chapter is not meant to be an *a priori* analysis, but it has of course implications for the way in which we view our evolved *`a priori'*, the categorical frame-work in which we experience the world, which precedes experience. The idea is that it is simply impossible to analyze the universal and necessary `formal' presuppositions of knowledge apart from actual `contents': the Kantian dichotomy between form and content is, once more, misleading. Actual knowledge about our mental functioning and the ecological context in which our mind evolved may strengthen or weaken our belief in our categorical biases via a feedback relation.
- *Second,* the analysis which is given here is completely based on our current models about the world. These are not claimed to be the ultimate ones, but only the best currently available. Trying to improve on them is as risky as rebuilding a ship in the open sea - to re-use Neurath's metaphor. A theory of knowledge based on a scientific theory - e.g. the theory of evolution - is, of course, fruitful or worthless depending on the truth or falsity of that theory.
- *Third*, an evolutionary `justification and critique' of our evolved knowledge capacity can only point to some limits and pitfalls of human knowledge, because it trusts other aspects of it.

In the following, I give a short inventory of the properties of our knowledge-apparatus in the hope of throwing light on its strengths and weaknesses with respect to its ability to acquire objective knowledge of the world. I will especially focus on seven peculiarities of our cognitive equipment: 1. the specialized nature of the senses; 2. our limited sense of space and time; 3. the value-ladenness of our experience; 4. our innate cognitive biases and expectations; 5. the social construction of reality; 6. the way in which language and its compulsive systematism transforms our knowledge; and 7. the impossibility of transcending the conjectural nature of knowledge. For each, I investigate whether such a peculiarity should be seen as a handicap or offers a unique opportunity to attain true knowledge of the world.

B.SEVEN PECULIARITIES OF HUMAN REASON

1.THE SENSES: THEIR FUNCTION AND ECOLOGY

Our senses have evolved during particular phylogenetic phases to guide us through particular environments. Although we are an ecologically flexible species descending from a genus which has gone through spectacular changes over the last million years, they still reflect to some extent the `survival strategies' and `niches' of our ancestors. The way in which they filter, transform and color information shows that they have evolved in the function of (genetic) survival.

As a result of variation and selection, the sensory equipment of animals is designed in such a way that it mostly collects information that is needed in their specific ecological niche. This information is apparently conceived such that it predetermines them to particular behaviors. A good example is offered by the ears of noctuid moths which are adapted to the sonar system of their predators, bats (Roeder, 1970; McFarland, 1994). Noctuid moths have tympanic membranes on two sides of their body which are connected to two types of sensory neurons. One of these is sensitive to low-intensity sounds and to cries from bats that are relatively far away. With these cells it can detect whether a bat is approaching and from what direction; they enable the moth to fly away before the bat has even detected it. The other type of receptor, however, is sensitive to the loud sounds of a bat which is very close. Its impulses disrupt the flight control mechanisms of the central nervous system of the moth, causing it to fly erratically and to drop toward the ground. This behavior, or the lack of it, makes the flight of the moth unpredictable for the bat and will often enable the moth to escape at the very last moment.

The ways in which sensory stimuli give rise to particular action patterns is revealed most obviously in situations in which those stimuli occur *outside* their original ecological context. For example, sometimes we can observe that flying water insects, like water bugs and water beetles, are attracted to reflecting surfaces of metal which glimmer in the dark. Apparently, their sense organs are particularly sensitive to such shining surfaces (emitting polarized light) which in nature represent the surface of ponds and lakes in most cases. Kittens are particularly attracted to small glimmering objects, like pellets of silver-paper, with which they can play fanatically, `hunting' them down, catching and `devouring' them, but without actually swallowing them. Apparently, small glimmering and fast-moving objects, which in nature are most often represented by insects, already have a particular `meaning' to them. (At one point, when I entered the room with a big sheet of rustling and glimmering silver paper my cat Loris looked terrified at it and sneaked out of the room as soon as possible, apparently afraid of such a huge insect.)

If we want to understand why we experience the world the way we do, we also have to understand the world in which our sense-organs evolved, sometimes called the `environment of evolutionary adaptedness' (EEA; Bowlby, 1969). Our sense-organs have evolved to suit our ancestors maximally. But which ancestors, where and when did they live? Most of the time, at least during the Miocene, our ancestors were living in tropical forests, and only in the last two-and-a-half million years (Pleistocene) did they finally completely abandon the trees. Of course, those last million years left their traces in our sensory equipment. At the same time, it is to be expected that the fundamental structure of our sensory system had been laid down long before that. Are there any indications for this?

First, it should be noted that we are to some extent typical primates with respect to the role of the different senses. Traditionally it is assumed that primates are predominantly more visual and tactile than olfactory and auditory:

> The great primate specialization has been to elevate sight and touch to leading senses at the expense of smell and hearing which, while maintaining their importance in the life-style of the animal, play subservient roles (Napier & Napier, 1985: 34).

a. Hearing

The Napiers try to prove their claim by comparing the mobile ears of most mammals with those of the primates. In most primates, including humans, the ears are largely immobile, while we can often observe that the ears of many other mammals, like those of cats and deer, can scan the environment like radar saucers independent of the direction of the head.

While hearing in primates has undoubtedly become less important as a means of orientation and of detecting both prey and predators, it has remained important as a means of communication, which can be observed in many species of monkeys and apes. For example, indri's, howler monkeys and gibbons all use howling and singing as a way of advertising their presence and defending their territories. Male orang-utans keep in contact by means of impressive calls and chimpanzees display at least thirteen different categories of calls, some of which reflect their frame of mind. Our enormous sensitivity to rapid successions of sounds of different loudness and pitch did not, of course, come completely out of nowhere. The tendency to attribute emotional meanings to different sounds and their loudness was probably part of the basis on which language could evolve and it certainly is a prerequisite for our sensitivity to music or the art in which the possibilities of the sense of hearing are explored (Pugh, 1978). (In chapter 5, I discuss the hypothesis that the arts are a kind of social status display, which is inspired by the fact that they often prove the artist's skill or fluency in a particular sensory domain apart from his general vitality, sensitivity and power of perception.)

While we are undoubtedly very sensitive to sounds, our `acoustical window' to the world is adapted to hearing within particular distances and frequencies. At best, we are able to hear sounds between 20 and 20,000 Hertz and there are whole worlds of sound which we miss. The echo-location system of bats is based on sounds of about 50,000 Hertz; dolphins hear sounds well over 100 kHz (Conner, 1994). On the other hand, alligators, whales and elephants use infrasonic sounds to communicate. Elephants make loud infrasonic sounds with their intestines with a loudness of about 85 to 90 dB and with a frequency of 14 to 24 Hertz. The sounds can carry as much as ten kilometers and the researcher Joyce Pool has discriminated around twenty-five different signals at this frequency (Lariviere, 1991). The song of whales can carry much farther through the ocean and are loud enough to be heard through the bottom of small boats.

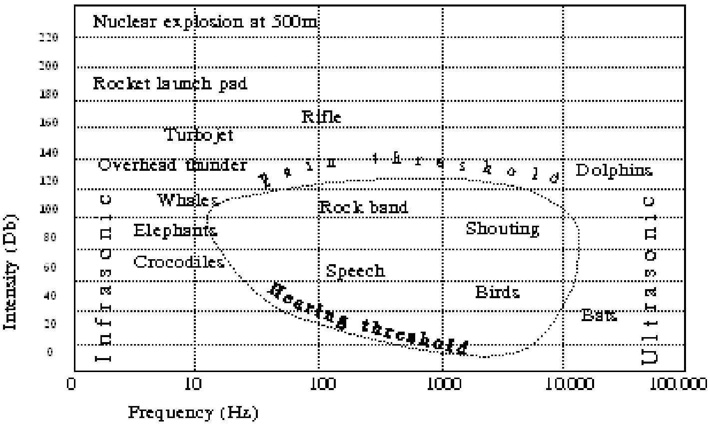

Fig. 2-4. The human `acoustical window' and the frequencies at which other species communicate or orient themselves.

All this means that our acoustical system is designed for specific purposes and that the acoustical systems of other species have other purposes, like echo-location and communication over large distances. The reason that it is so difficult to decipher the communications systems of elephants and whales is that we not only need sophisticated equipment to register their sounds, but that they are phylogenetically so distant that it becomes hard to imagine what emotional states they communicate about and for what purpose.

b. Vision

With respect to the rest of the senses, we are typically diurnal primates with a strongly developed sense of stereoscopic vision, including color vision, which is absent in nocturnal primates. Our eye-sight, together with that of apes and only some monkeys, is further enhanced by our possession of a fovea, a small depression toward the center of the retina in which a large concentration of cones can be found. (Cones are the photoreceptors that provide the basis for color vision in opposition to rods which function better in twilight, but which are not so discriminatory and do not allow for color vision.) It has proved to be a prejudice, however, to suppose that color vision is a privilege of primates. Color vision seems to be `widespread throughout the animal kingdom' (McFarland, 1987: 77), although it is not always based on three types of cones with three types of sensitivities (trichromatic vision), but sometimes on only two (grey squirrel) and sometimes on more than three (some reptiles, birds; pigeons have six chromatically distinct types of cones; Shepard, 1992).

Although in the sixties it was still sometimes assumed that color-terms were largely culturally determined (Whorf, 1965), the idea that they are not has grown more likely since the studies of Berlin and Kay (1969). Berlin and Kay asked native speakers of twenty languages to classify a series of colored chips within their own language. It appeared that there exists an evolutionary continuum in which languages gradually refine their distinctions between colors in a universal order: white/black → red → green/yellow → blue → brown → purple/pink/orange/grey. This sequence matches the order of acquisition of color terms in children (Lumsden & Wilson, 1981). Additionally, in most cultures colors were clustered in four principal groups, corresponding largely with what we call red, green, yellow and blue. The same four colors are also already recognized by four-month-old infants (Bornstein *et al.,* 1976).

If we study the actual way in which vision is embodied in the eyes and the brain, the impression that our brain is a *tabula rasa* disappears quickly. Rather, what we find is a series of specialized centers which are already interconnected in such a way that a particular processing of information is much more likely than another (Harth, 1995; Crick, 1994). The retina is structured in such a way that contrasts are enhanced as a result of `lateral inhibition'. If cells on the sensitive layer that are firing to the next layer give a negative signal to the cells surrounding their primary targets, the effect is that fuzzy patterns may be sharpened (figure 5; Harth, 1993: 59).

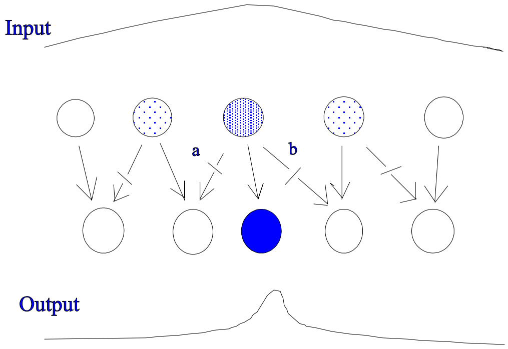

Fig. 2-5. Lateral inhibition. A fuzzy pattern (input) is sharpened into a clear contour (output) as a result of sideway connections (a and b) that inhibit rather than excite (After Harth, 1993).

Half-way between the retina and the visual cortex we find the lateral geniculate nucleus (*LGN; corpus geniculatum laterale*) which is also connected by descending pathways from and to the visual cortex. Such descending pathways can be conceived as neural connections which are specially designed to `bias' the way in which input is partitioned into `prototypes' (Churchland, 1995). If the descending pathways to the LGN are conceived as `positive feedback loops' they could amplify minimal fluctuations in the input so that features not initially present may be generated in a bootstrap fashion. This has brought Harth (1995: 71) to the suggestion that the LGN works as a kind of `sketchpad on which the cortex expresses its fancy by drawing and erasing':

> "I envision the mechanism involved in the control of the LGN to act like a *positive* feedback. Suppose you are looking for a coin you dropped on a beach. Assume that, to aid you in the search, the cortex instructs the LGN to suppress the images of pebbles, leaves, shells, and so on, and to enhance anything small, round, flat, and metallic, in short, anything that looks like a coin. In this selective positive feedback, a mere suggestion of a coin would be made to look even more coinlike to call attention to itself, until closer scrunity reveals that the search has been successful or that what you are looking at was not a coin after all"... (Harth, 1995)

This passage reminds one of the common experience of birdwatchers who will often see protruding side-branches as birds. Many visual illusions illustrate the same process. "We may think of what goes on in the LGN as a *competition* between the *reality* that is conveyed from the eyes and the *fancy* that comes down from the cortex" (Harth, 1995: 68). (This interpretation of the function of the visual cortex is, of course, still speculative; according to Hubel it "has the function of increasing the disparity - already present in retinal ganglion cells - between responses to a small, centered spot and to diffuse light"; Hubel, 1963).

Finally, in the visual cortex itself, we can find many specialized cells which are only sensitive to lines of a particular orientation (Hubel, 1963), to edges or boundaries of particular shapes, sizes, positions or to movements of particular velocities (Hubel, 1963; Thompson, 1975). These specialized cells are responsible for many of the effects which are known from visual illusions. For example, it has been found that some neurons react specifically to movements relative to a particular background. Such specialized neurons seem to be responsible for the strange illusion which one sometimes has when viewing a passing train from a train that itself is not moving: one thinks first that the one's own train moves, and, after the train has passed, one thinks that the opposite platform is moving in the opposite direction.

I do not want to suggest that these specialized functions are completely innate. One can actually study the extent to which they are innate by comparing patients with different forms of blindness or by studying the temporal sequence in which the diverse connections arise during ontogeny. It has been found that there is a critical period in which particular areas have to be stimulated in order to acquire their functions. If one closes one eye of a cat at birth for one week this can result in partial blindness as a result of underdeveloped projections into the visual cortex. Studies of the temporal sequence in which connections arise seem to indicate that the growth of the brain is to some extent genetically orchestrated, but that it is also a trial and error process, in which many wrong connections have to be weeded out if they do not synchronize with neighboring cells (Shatz, 1992).

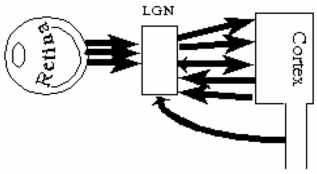

Fig. 2-6. The visual pathways: the LGN is both `informed' by the cortex and the retina (and by the brainstem).

The innateness of particular organization of the visual system does, of course, only make sense with reference to the ecological context in which it arose. Our retinas are sensitive only to one small bandwidth of electromagnetic waves, those which pass easily through the atmosphere and which are relatively low in energy: wavelengths between 380 and 760 nm. Bees (another trichromatic species) are sensitive to wavelengths between 300 and 650 nm as a result of which they build a completely different visual world, without red but *with* ultraviolet which is barely visible to us.

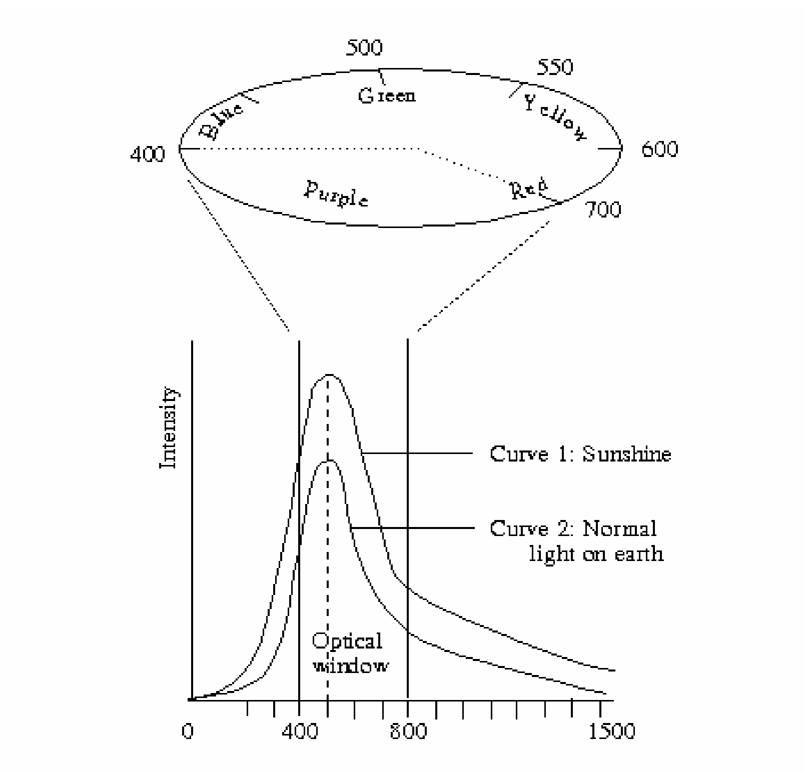

Fig. 2-7. The wavelenghts of visible light are those that maximally penetrate the atmosphere. A linear sequence of quantitatively different wavelengths is `translated' into a circle of qualitative different colors (after Vollmer).

Even with respect to the wavelengths of light, vision is not a passive reproduction of the environment, however. Within our specific `optical window' we `translate' the quantitative succession of wavelengths into a qualitative *circle* of colors (Newton's color circle) by viewing waves longer than 700 and shorter than 380 both as red or purple. Thus, whereas we are able to make subtle discriminations within our optical windows our power of discernment decreases towards its borders.

All this means that *the phenomenological quality of `redness' is the product of the adaptive way in which electromagnetic radiation of two particular series of wave-lengths is lumped and `phenomenologically labelled' within our trichromatic neural network.* Qualitative distinctions between quantitatively distinctive types of electromagnetic radiation apparently enabled our ancestors to distinguish between materials as a result of their distinctive way of reflecting light. The electromagnetic waves with wavelengths between 380 and 760 nm were particularly useful, because these waves are not so short that they can damage valuable tissue (like gamma, röntgen, and UV radiation) and not so long that they do not allow for precise measurements (like radio waves). Most importantly, however, these waves are the ones which, together with radio waves, pass through our atmosphere: röntgen and UV radiation, for example, are absorbed high above the earth. That means that our eyes are particularly sensitive to those wave-lengths of which most radiation is really available in our biosphere (Vollmer, 1983: 98). Our visual system is most sensitive to colors between yellow and green of which most light is available. Perhaps it is not an accident that bananas advertise their ripeness in yellow and perhaps our ancestors evolved their color vision most by distinguishing ripe from unripe bananas.

In his recent analysis about the adaptedness of color vision Shepard (1992) not only looks at the color circle, which represents only one dimension (hue) of the three-dimensional `color space', but also at lightness and saturation. He proposes that the three-dimensionality of human color vision (hue, lightness and saturation) may represent an evolutionary accommodation to the "essentially three degrees of freedom of terrestrial transformation of the solar wavelengths passed by the earth's atmosphere": light-dark variation, yellow-blue variation and red-green variation. According to him, trichromacy should be seen as a more or less optimal system of analyzing light along these three dimensions and that is the reason that it has developed independently in, for example, bees and humans. It has evolved from a more primitive form of dichromacy which is still latent in the population and occurs in approximately 8% of the population, primarily in males, which has enabled researchers to identify and localize the responsible genes (Nathans, Thomas & Hogness, 1986).

According to Shepard there are reasons to believe that it is not only trichromacy that is innate, but that the cortical qualitative representations of colors are also innate. Shepard and Cooper (1982) compared the way in which normally sighted, color-blind and totally blind individuals represent colors. They found that red-green color blind individuals are often able to *imagine* the differences between red and green although they had never been able to actually see the differences. "One particular articulate protan [refers to *protanopia*, this form of color blindness, P.S.] insisted that although he could not distinguish the (highly saturated) red and green we showed him, neither of these papers came anywhere near matching up to the vivid red and green he could imagine" (Shepard, 1992: 517).

Whether or not Shepard is right, the evidence points in the direction of the hypothesis that color-terms are certainly not platonic ideas, but *neither* are they purely subjective and arbitrary names. They are to some extent universal and represent the ways in which speakers of different languages try to cope with the innate qualitative different experiences with which they register radiation of different wave-lengths and intensity. One could claim that they represent a laborious `translation' of our qualitative, physiological and subjective `translation' of the `messages' inherent in the reflection and refraction of light on different terrestrial surfaces in the approximately 5000 different cultural systems of languages. If we chose this terminology there proves to be at least two levels of `translation' between the physics of light and color terms, but this need not to be fatal for some rough version of `correspondence'. (In his `critical realism' Roy Wood Sellars used the metaphor of `translation into another medium', see Sellars, 1922; 1959; 1966; and also Slurink, 1996a).

This example shows that we are able - contrary to what Kant thought - to study the process of knowledge both on the side of the object - different materials reflect or emit different types of electromagnetic radiation - and on the side of the subject - studying the neurological basis of vision, the unique phenomenological experiences that we have as a result of them, and their interaction with a system of culturally inherited knowledge. Most importantly, it shows that we are able to study *their interaction*, which constitutes knowledge as a subjective-objective process which takes off perspectivistically, but in which information accumulates as a result of a feedback relationship via external structures.

The dominant role of vision and touch which was pointed out by the Napiers has had its consequence for the history of Western ontology. As Heidegger points out, the history of philosophy is from the beginning primarily oriented on vision as the route to both `being' and `beings' (between which he makes a platonic distinction; Heidegger, [1927] 1979: 147; Stegmüller, 1978). In many languages, including Greek and German, words which refer to insight and theory refer also to vision: cf. the Greek `theoria', Germanic words such as `insight', `inspection' and `Einsicht' and the phenomenological `Wesenschau'. As a result of the phenomenon of hallucination, dreaming and the possibility of visualizing abstract phenomena, which have been used by writers since Homer and Plato to strengthen the belief in some kind of dualism, materialistic philosophers often had to require that `real objects' were not only visually observable, but were `tangible' as well. Apparently, vision is slightly mistrusted, at least by some philosophers, as a relatively new sense-organ, which sometimes ignores the official enquiry procedures to convince the ontological jury in our heads. It is only reasonable to require the testimony of more than one sense-organ if one wants to bring in an ontological verdict. It is perhaps no coincidence that materialistic philosophers have from the very start invoked the sense of touch as the sense that should supplement vision as the criterion of objectivity, as lovers who not only want to see their beloved but touch her as well. Bat and dolphin philosophers would perhaps also require the `objective' testimony of their sonars.

c. Taste

The adapted nature of our sensory apparatus is even more apparent in our most atavistic senses, taste and smell. In contrast to vision, touch and hearing, taste and smell are often narrowly linked to particular types of behavior and often work unconsciously, which perhaps betrays their respectable age. They often exert their influence in the traditionally profoundly important domains of food and sex. Both are relatively simple senses which represent the world by means of a relatively limited number of sensors. We have four or five types of taste sensors on the taste-buds of our tongues, which may be called the sweet, salt, sour and bitter receptors. The sweet sensors seem to be concentrated on the tip of the tongue, the salt sensors on the sides towards the front, the sour sensors on the sides towards the back and the bitter sensors on the extreme back. Perhaps this order is caused by the degree to which these tastes exclude each other. The sweet sensors are perhaps concentrated on the tip of the tongue, because they allow for a first rough assessment of the amount of carbo-hydrates in a piece of food and because this assessment ought not to be disturbed by the assessment of other qualities. The bitter sensors are probably in the extreme back, because the bitter taste of poisonous food easily drowns out other tastes.

What do taste sensors perceive? As I have already suggested the phenomenological qualities of different foods correspond to some extent with the amount of specific nutrients or poisons in the tasted substance. The nature of these phenomenological qualities, however, is dictated by our specific survival strategy. One could even claim that these phenomonological qualities are the ways in which nature `dictates' our food choice. We call sugar sweet, because our ancestors needed the carbohydrates in ripe berries and fruits. We even project adjectives like `delicious' back onto those fruits, as if everyone should like them. Cats, however, probably find those same fruits horrible. Compared to them, both humans and dogs are omnivores. That sweet substances are repugnant to cats demonstrates most clearly that they are carnivores. The world that we taste with our taste sensors is thus clearly the world of an omnivorous primate which is largely vegetarian but likes to supplement its food with meat.

d. Smell

With respect to odors much less is known, but one theory postulates seven basic types of receptors which are presumed to correspond with the shapes of the molecules involved (Amoore, 1963).

> "When a molecule of the right shape happens along, it fits into its neuron niche and then triggers a nerve impulse to the brain. Musky odors have disc-shaped molecules that fit into an elliptical, bowl-like site on the neuron. Pepperminty odors have a wedge-shaped molecule that fits into a V-shaped site. Camphoraceous odors have a spherical molecule that fits an elliptical site, but is smaller than that of musk. Ethereal odors have a rod-shaped molecule that fits a trough-shaped site. Floral odors have a disc-shaped molecule with a tail, which fits a bowl-and-trough site. Putrid odors have a negative charge that is attracted to a positively charged site. And pungent odors have a positive charge that fits a negatively charged site. Some odors fit a couple of sites at once and give a bouquet or blend effect" (Ackerman, 1991).

The total number of specialized olfactory receptor types could, however, be much larger and is still an area of wild speculations.

It can easily be shown that even a relatively small amount of receptor types can nevertheless lead to an enormous discriminatory power (Churchland, 1995). If we assume that each receptor type is able to discriminate five distinct levels of activation and if we assume that there are four taste receptors and seven smell receptors, we are able to discriminate at least 5 x 5 x 5 x 5 = 625 (5^4) different `patterns' of taste and 5^7 = 78,125 different distinct aromas. If we realize that the flavor of foods depends upon both taste and smell, as a result of which thousands of different aromas can be combined with hundreds of different tastes with each morsel on our tongues, it becomes a mystery immediately why the noble art of gastronomy is excluded so often from the list of other arts, including painting, literature and music.

Of course, empirical data are somewhat more difficult to find, but they also suggest that the sense of smell is underestimated in the above citation of the Napiers as well as in many epistemological treatises in which the senses are discussed. Empirically it has been found that human subjects can discern at least 60 different categories of odors if they have some training and if the odors are sufficiently complex (which makes them, strangely enough, more easy to discriminate). It is sometimes even claimed that experiments show that the human sense of smell is not much worse than that of other animals: it would in some cases be even better than that of rats (Kirk-Smith, 1994). The truth is that humans and other animals all have their own range of scents to which they are sensitive. According to Morris (1986) dogs are about as sensitive to the scent of flowers as we are, but they are about a million times more sensitive to the scent of butyric acid (a component of sweat) than we are. Bloodhounds can follow the four day old track of a human person over a distance of 150 kilometers. Sometimes dogs start to bark in the presence of a cat owner, because they will simply smell the scent of the cats on that person. Whereas humans have about five million olfactory cells, a dog has 220 million cells (Morris, 1986).

In spite of that, the number and sizes of the glands that are responsible for odor production in humans suggest that we have some kind of pheromone system, too, although we are largely unaware of it as a result of the lack of projections to the neocortex via the thalamus, which is characteristic of both vision and hearing (about 1,000,000 and 28,000 fibers respectively; Hubel, 1963; Thompson, 1975). The olfactory bulb is, however, connected to many centers in the limbic system, including the amygdala and hypothalamus. The limbic system determines many aspects of our emotional lives and memory and this could explain why odor experiences can be very strong and long lasting (*A la Recherce du Temps Perdu* was inspired by the memory of the smell of a madeleine dipped in tea during the youth of the author).

The presence of a largely unconscious olfactory communication system is also suggested by specific anosmias, in which certain individuals are unable to perceive particular odors as a result of a genetically determined absence of particular receptor types (one could translate it as `scent-blindness'). Most specific anosmias which have been found so far relate to particular odors produced by the human body. "Musk (alpha-pentadecalactone), isovaleric acid in vaginal secretions and stale axillary sweat, 1-pyrroline in semen and male pubic sweat, trimethylamine in menstrual sweat and androstenone in male axillary sweat and stale urine" (Kirk-Smith, 1994).

One of the reasons for the underestimation of the role of smell in human behavior was the apparent absence of the so-called vomeronasal organ (Jacobson's organ) in adult humans. This organ can be found in many mammals, for example cats, and is designed for the detection of pheromones. Uncastrated cats, like my cat Loris, who comes across the smell of a conspecific on some shrub, will sometimes start sniffing at it as in religious ecstasy, looking somewhat stupid, with an opened mouth. Because in cats the vomeronasal organ is also connected to the palate, cats use both mouth and nose to review an odor and assess its composition and source. Although most of us are clearly not as obsessed with odors as cats, recent studies have found that almost all adults do still have a vomeronasal organ, and one that is functional. It consists of a small pit in the nasal septum and its sensitivity to specific odors has been found to be dependent on one's sex (Miller, 1996).

In recent years several researchers have tried to `decipher' the human olfactory communication system and also tried to explain the paradox of our lack of self-understanding in this respect. Odors seem both to play a role in mate acquisition and in the subsequent bonding process. Much research has centered on the effects of adrostenone (smelling like urine) and androstenol (musk-scented). Kirk-Smith (1994) discovered that women were attracted to sit on an androstenone treated seat in a dentist's waiting room, whereas men avoided it. More often, androstenol is viewed as a possible candidate for a male pheromone. Women exposed to androstenol for a month (placed on their upper lips each morning) rated themselves as more submissive than a placebo group in the middle of their menstrual cycle (Benton, 1982). At the same time men were discovered to avoid toilets treated with androstenol, suggesting that it could function as a male `spacing pheromone'.

Androstenol is unlikely to be simply a male pheromone, however. The reason for this is that it oxidizes to androstenone within 20 minutes and that most women rate androstenone as highly unattractive (despite Kirk-Smith's research at the dentist). The Austrian ethologist Karl Grammer discovered that this evaluation changes to a more neutral one at mid-cycle in women who take no hormonal contraceptives (Grammer, 1991; 1993a and b; 1995). He interprets this finding in the context of the research of Bellis and Baker (1991), who found that extra-pair-copulations (e.p.c.'s) in humans peak at mid-cycle.

If we realize that one of the most striking differences between human and other apes is that females of our species do not display their estrus and have almost no way of knowing when they ovulate (a subject which will be addressed further in chapters 5 and 8), these findings become of enormous importance. While hidden estrus is thought to enable women in our species to entice men into forming enduring pair bonds -giving them the impression of paternal certainty -, odor-induced mood-changes could help them to add the luxury of choosing superior genes to the certainty of male investment. The decrease in emotional repugnance with respect to adrostenone in ovulating women could thus function as a way to counter-balance the non-adaptive effects of hidden estrus and pair-bonding with respect to the conquest of `good genes'. This could also explain why such processes work largely subconsciously.

From the perspective of the male the female resistance to androstenone could be adaptive as well. If only ovulating women are not repelled by a strong male odor, it might be adaptive to emit a lot of androstenone and observe who is interested, despite that. `Stinking' could work as an ideal means of chasing off non-fertile, uninterested women.

Strong male odor seems to function within the pair-bonding process as well. There is evidence that female fertility is higher in the presence of a man. The menstrual cycle becomes more regular and the luteal stage, the stage in which the uterus is prepared and thickened to support a pregnancy, becomes longer (Cutler, 1991). The researcher Cutler and her associates have even requested and obtained a patent on the `essence of male' to regularize the female cycle (US patent No. 5,155,045 issued Oct. 13, 1992). Miller (1996) has speculated that the increased fertility of females as a result of male odors could explain a whole range of phenomena, including the human desire to cuddle and the male tendency to sleep after intercourse.

Finally it should be remarked that women also emit odors that influence male behavior. Some of these seem to have the effect of equalizing male ratings of female attractiveness (Grammer, 1996). Others, including estratetranol, seem to `tame the savage beast' and seem to make men less aggressive and more responsible (Miller, 1996). Miller (1996) speculates that the pair-bonding process has the character of a mutual chemical addiction in which men want to be exposed to estratetranol and women to androstradienone or related male pheromones. Of course, it is to be expected that both partners are addicted to the particular, unique mixture of smells and pheromones that only their partners can produce. Such addictions to particular odors sometimes also play a role in religious ceremonies and the relationship between cats and people. (It should be noted that the difference between love and fetishism, of course, is that in the case of love tactile and olfactory stimuli only form *part* of the whole `meaningful pattern' on the basis of which the object is adored.)

e. Conclusions

What can be concluded from all this with respect to the `referential' character of the senses? First, I have to conclude that traditional philosophy has concentrated somewhat one-sidedly on vision and its role in cognition. The role of smell has often been underestimated and this is a pity, because smell shows us a much more direct link from sensory input to behavior. Whereas vision, together with hearing, play a big role in `orientating' us, the sense of smell also offers us direct incentives for particular behaviors. Whereas vision and hearing enable us to construct an internal map of our environment which seems to give us an almost infinite freedom, the sense of smell gives us a minimum of `objective' information and a maximum of `subjective' guidance.

Of course, I am exaggerating here somewhat. There are also visual and auditive clues which are directly linked to very specific behavioral outputs, as will be seen in chapter 5. The purport of what I am saying is, however, that vision offers us a much larger `space of behavioral options' than smell and in function of these options it gives a much more extensive conscious representation of our external environment. If vision alone is studied, there is a strong tendency to stress the relation between sensory input and internal representations of the environment, while a study of olfaction suggests a more direct link to behavioral output (figure 8).

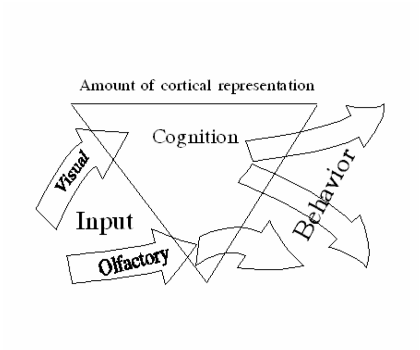

Fig. 2-8. Smell seems to be much more directly linked to behavioral output than vision.

Strange as it may seem, naturalism seems to fall in at this point with a doctrine of the hermeneutical philosopher Heidegger. Heidegger criticizes western ontology for being one-sidedly focused on `Vorhandenheit' or the `objectivity' resulting from having an object in one's hands in front of one's eyes (enabling one to study it closely). Heidegger contrasts this with `Zuhandenheit', the knowledge one has about the tools one uses. One could, however, also explain our obsession with `Vorhandenheit' as a result of the fact that we are stereoscopic primates with hands and that we have a strong tendency to grasp everything with our hands in order to control it. This preoccupation with vision and tangibility has certainly resulted in a one-sided ontology. It remains to be seen, however, what the best cure is for this one-sidedness: Heidegger's crypto-transcendentalism or a naturalistic justification and critique of our evolved frame-works of experience.

A second preliminary conclusion that can be made on the basis of this analysis is that constructivism does not necessarily entail relativism. Yes, contours of objects are already sharpened on the retina and the LGN certainly is not only informed by the eyes, but biased as well by cortical expectations. Does this mean, however, that *everything* we observe is *only* construction? Could this not simply mean that we, as every intelligent species, make an *interactive `image'* of our surroundings in which those aspects of this environment are singled out, stressed and `colored' that deserve our special attention, given their relevance within the survival plan of our species? Of course, this image is a construction of our brains, but characteristics of the environment may be `projected' or `translated' in it in a useful - informative - way. On the one hand the image is a creation - on the basis of particular sensors and from a particular position and perspective -, on the other hand it must contain relevant information as it is designed to guide the organism through its environment.

Both current views about the way in which a linear succession of electromagnetic waves with different lengths is `translated' into a color circle and Amoore's stereochemical theory of odor perception (according to which molecules of specific forms fit into particular receptors) show that there is a lot of arbitrariness in the way in which physical properties of the environment are used for orientation. Could it be otherwise? Given the fact that in evolution the first thing that matters is behavior that is adequate to particular situations, it is to be expected that all kinds of clues are used to bring this behavior in agreement with the circumstances. The clues that are used are `chosen' on purely pragmatic grounds by variation and selection in particular circumstances. There are a lot of circumstances which in our evolutionary past simply did not occur. We do not perceive carbon monoxide, apparently because it was not a serious threat to our ancestors. We do not possess a biological equivalent of a Geiger counter, apparently because radio-activity was not a serious threat to our ancestors. In our daily observations we do not even take into account the difference between the velocity of light and sound, apparently because most of the relevant objects that our ancestors encountered stayed within 300 meters and did not approach faster than 300 meters a second.

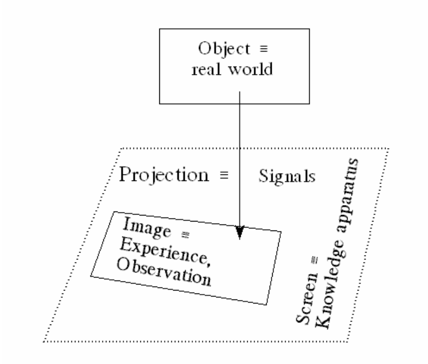

Fig. 2-9. Vollmer's analogy between projection and knowledge, `Projective epistemology' (after Vollmer, 1983).

This last example also shows that the mechanisms developed as a result of variation and selection are not perfect. Perhaps it would have been useful for our ancestors to have been able to calculate the distance of the lightning on the basis of the relative slowness of sound. In the neighborhood of Hiroshima and Chernobyl it would certainly have been useful to possess a biological Geiger counter. Not everything that is useful is produced by evolution, however. Only if the process of variation and selection happens to stumble across particular improvements can they be implemented. Evolution does not look forward, it is a `blind watchmaker' (Dawkins, 1986).

A final remark can be made on the basis of Harth's model about the function of the LGN. If the LGN functions as a kind of `sketchbook' which draws its information both from the retina and cortex (and even from the brainstem) a simple `projective realism' as proposed by Vollmer (1983: 123; see figure 9) is perhaps too simplistic. Vision is at least a feedback loop in which background knowledge and expectations determine what we see at least as much as sensory input from the retina (figure 10). Not only within the organism do we find a feedback loop, however: another feedback loop is at work between organism and environment. An observing organism behaves on the basis of its observations and learns not only from its environment directly, but also from the way in which this environment is affected by its own behavior. As a *moving perspective* it must learn a lot from the temporal sequence of its observations in a stereometric world in which all kinds of objects continually

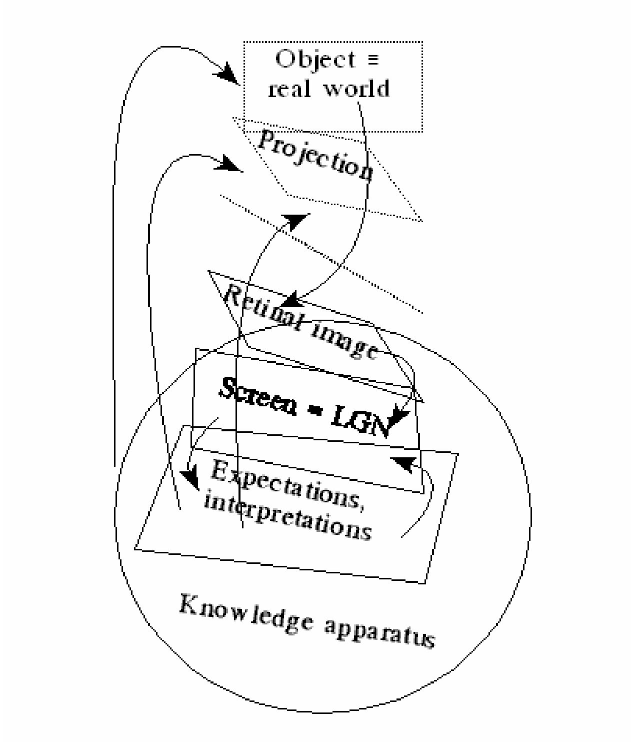

Fig. 2-10. Knowledge (in this case visual knowledge) is characterized by feedback loops on many levels.

recede or come nearer depending on its own direction. At the very least an *interactive ecological* realism is needed to account for that phenomenon.

2.THE STEREOMETRIC FRAME-WORK OF OBSERVATION

The way in which we reconstruct space and time and in which we `map' and `rewrite' our environment is determined by our evolutionary past.

Kant discovered that there is an element of `synthetic knowledge *a priori*' in Euclidean geometry and in the Newtonian physics that was based on it. Euclidean geometry is not derived from experience. Because Kant and his contemporaries thought that this geometry described real space (which was apparently confirmed by Newton's successful use of it), a problem arose that eighteenth century empiricism could not solve: how is a description of space possible, without actually *measuring* space? How is mathematical and even physical knowledge *a priori* possible? Kant's solution was, as always, extremely radical: the real world, *das Ding an sich*, is unknowable. Space and time as we experience it and the physicist describes it are not given in our experience, but they constitute a frame-work *in which* we experience: they are *Anschauungsformen* or *forms of possible experience.* As long as we are humans, we are caught in the human frame-work of experience and, with that, we are captured in geometrical space.

Non-Euclidean geometries and relativistic physics have accustomed us to the idea that there are other geometries and that in fact non-Euclidean geometries are sometimes necessary to describe the real world. That means that there are realms of experience in which we can actually discover that the concepts of Euclidean geometry do not work. According to Kant this should not be possible, because those concepts are *a priori*, before and beyond experience.

Does this mean that Kant was wrong? One can also be somewhat milder. First, Kant was right in pointing to the fact that geometry (as we now know, that also includes non-Euclidean geometries) is not based on experience. It is a creative construction of the human mind that can be used in physical hypotheses, but these hypotheses need not be correct. The application of a particular geometry to a particular theory in physics is a hypothesis itself. Second, Kant was right in pointing out that the ordinary world of our experiences and the world as we can imagine it *is* (almost perfectly) a Euclidean world in which the shortest connection between two points is a straight line. The way in which space `curves' as a result of gravitational fields is really difficult to imagine and one can only actually measure it on astronomic scales. Phenomena like `gravitation lenses' in which, for example, a quasar behind a galaxy is seen as through a lens which distorts the original image, have accustomed us to the idea that space really curves, but it still eludes our imagination. Who can really imagine a finite universe without borders? If we use our imagination the universe is either infinite or it has borders (an argument going back to Lucretius).

Evolutionary epistemology may help us to explain our limited imagination. It interpretes our ontogenetic `*a priori*' as phylogenetic `*a posteriori*'. Of course Kantians will protest, because they correctly see this as contrary to the spirit of Kant. For Kant (and other transcendentalists, like Husserl) research into the *a priori* structures of human cognition has to stay *a priori* itself. The world as we experience it has already been structured by our *a priori* structures and we cannot, therefore, find the sources of those structures in it. Above all, according to Kant, the *a priori* has a universal and necessary character: we simply cannot find anything in the world of experience that does not obey its `rules', because this world is already structured according to those rules.

This approach has proved to lead to dogmatism, however, as in the presupposition that Euclidean space is the space of all possible experience. In addition, it is dogmatic itself: if one can discover that one's mind is influenced by prejudices, delusions, alcohol, sophisms and logical errors, one can also discover that one's *a priori* expectations about the world are wrong. In fact, physicists have successively tried to demolish Kantian `forms of experience' like Euclidean space, and Kantian categories like causality and one-ness.

Perhaps Kant's position is so confusing because it is slightly ambiguous and gradually changed over the years. In the first edition of the *Kritik der reinen Vernunft* the *a priori* referred simply to the forms of experience and the categories - everything not given in experience itself, whether it consisted of innate ideas or logical presuppositions of knowledge. In the second edition he tried to radicalize the importance of synthetic knowledge *a priori*, its necessary and universal character, and he tried to separate the *logical presuppositions of empirical knowledge* from all contingent knowledge, including innate ideas. Many writers about Kant try to read the second `logico-transcendental' Kant back into the first `anthropo-transcendental' Kant (Engels, 1987; Prauss, 1971). With respect to evolutionary epistemology Vollmer correctly asserts:

> Wenn sie `a priori' als `angeboren' deutet, so liegt darin nich eine mißglückte (von ihm sogar ausdrücklich abgelehnte) Interpretation von Kant, sondern eine *Problemlösung*, die sich auf eine Teilbedeutung des Begriffs `a priori'(`unabhängig von aller individuellen Erfahrung') stützt und beschränkt. Diese Lösung wurde zwar von Kant selbst vorbereitet, indem er doch den `Grund' für die Ausbildung von Kategorien für angeboren erklärt; sie steht zu ihm aber auch in ausdrücklicher Konkurrenz, da sie die Bedeutungskomponenten `notwendig' und `allgemeingültig' mit guten Gründen verwirft und dadurch den eigentliche Kantische Begriff des Apriori `zerstört' (Lorenz) (Vollmer, 1988: 304)

Research into the `logico-transcendental' preconceptions of knowledge leads to a completely arbitrary list of these, as proved by the completely different analyses of, for example, Kant, Husserl and Heidegger. In addition, it is based on the illusion of the transparency of reason for itself. There seems more reason to believe that we can only understand reason after we have understood much simpler natural phenomena.

Therefore, we should concentrate on what we know about the `anthropo-transcendental' aspects of the *a priori*. Instead of repeating the hypothesis of a purely logical *a priori* without an origin, we should try to discover the innate biases which govern our experience - including our `instinctive preference for an Euclidean geometry' - and the limited contexts in which those biases apparently helped our ancestors.

Are there any indications that we are in possession of a stereometric *a priori*, an innate frame-work in which sensory information is `interpreted' in a spatial and temporal way? To me it seems that the evidence is overwhelming. First, spatial imagination is closely linked to vision. As has already been shown, the visual cortex does not simply passively record the stimuli it receives from the LGN and retina, but it actively interprets its input, while sending its interpretations back to the LGN. If we can show that the visual cortex is also actively `adding' stereometric elements, we have discovered at least part of the physical basis of Kant's *Anschauungsformen.*

Second, as a result of studies of brain injured people it has been known for some time that, while the ability to speak `resides' in the left hand part of the brain, the proper execution of spatial tasks requires an uninjured right hand part of the brain. If we can show somehow that actual brains occasionally specialize in performing some spatial tasks better than others depending on the strategic problems with which their possessors have to cope, we may infer that `space' as far as the brain is concerned is not an abstract monolithic entity, but an adaptive stereometric frame-work which the brain uses to map the environments in which specific tasks have to be accomplished.

a. Innate forms of space perception

Let us first review the stereometric activities of the visual cortex. In frogs much of the `interpretation' of visual data takes place in the retina. It is there that researchers found the `bug detectors' mentioned earlier and also fibers that respond exclusively to light, dark or moving edges (Thompson, 1975). The studies of Hubel and Wiesel on cats (luckily, they seem to have conducted them on anesthetized cats) show that in these mammals much of the more complicated interpretation tasks have moved to the visual cortex. It is there that Hubel and Wiesel found vertical columns of cells which respond to different stimulus orientations. Individual cells within those columns are sometimes completely specialized in detecting one characteristic of an object, for example a downward moving horizontal bar or a right angle. (The existence of such cells also throws a lot of light on cat behavior, as it is striking that cats are always interested in chinks and particularly in fast moving objects disappearing into them, as can be tested at home, early in the morning, by withdrawing your toes quickly under the blanket while your cat is watching you.)

Experiments on monkeys show that the neuronal activity across the surface of the visual cortex is a projection of the neuronal activity across the retina. If one marks glucose using a radioactive form of it and then fixates the monkey's eyes on a black and white pattern one can actually make a photograph of this pattern as it reappears on the visual cortex of the monkey using an X-ray film. (One can only hope that the researchers in these kinds of experiments have cared for the animal's well-being. It seems that one can do all this while the animal is anesthetized.) All this points to an `interpretative rebuilding' of the retinal image in the visual cortex in which all kinds of instinctively interesting features of the environment, like contours of objects, clues for the possible location of prey or predators, etc. are spotlighted. Whether Harth is right and this interpretation is projected back to the LGN where it is the object of our visual attention, is not clear at the moment, but everything points to a fusion of both a projection of patterns from the outside world and an interpretative enhancement of certain detected features in those patterns in a complicated feedback loop.

Up to now we have learned nothing about the internal construction or *re*construction of space. If we want to understand how animals and humans orient themselves, tracing the projection of one stimulus through the brain is not enough. The minimum amount of stimuli required for the most primitive form of geometric orientation is two, as in Euclid's line which forms the connection between two points. This minimum is embodied in the tongues of snakes which have two tips. The comparison of the measurement of certain chemical substances from those two tips are enough to give an indication of the direction in which its prey has to be searched (Schwenk, 1994). Although spiders often have eight eyes and insects often have three extra eyes apart from their compound eyes, this explains perhaps why many animals have both two ears and two eyes: it enables them to compare two stimuli which have emanated from the same object and deduce its position on the basis of this comparison.

With respect to auditory localization this process has been investigated in cats (Rosenzweig, 1961). It appears that auditory input from both ears is increasingly merged in successively higher levels of the auditory system. The auditory cortex on both sides of the brain receives input from both ears, but the left side receives more stimuli from the right ear and *vice versa*. Although it takes 10 milliseconds for a neural message to travel from the ear to the cerebral cortex and the differences in time at which sounds arrive at the ears are maximally about half a millisecond, it appears that those tiny differences do indeed serve to locate the sources of sound. Time differences of 0.0002 second between two sounds arriving at the two ears independently lead to reinforcement of the first stimulus in the brain of the cat, apparently enabling it to notice at which ear it first arrived.

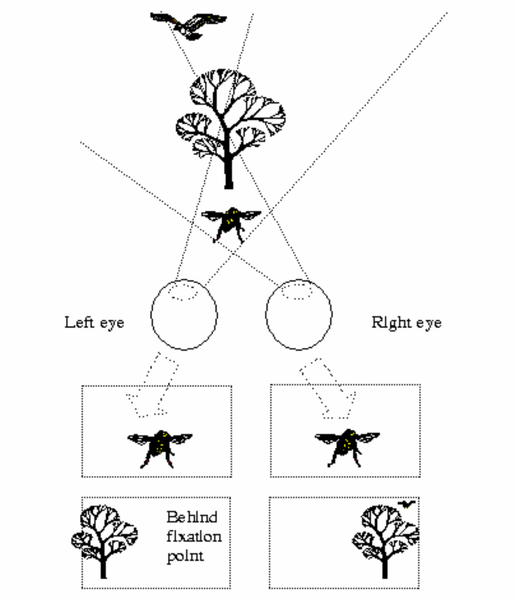

Fig. 2-11. If we focus on an object nearby, both eyes give completely different views of everything behind this level, producing a sensation of depth.

Of course, as a result of the speed of light, localization on the basis of visual clues cannot result from tiny differences in the arrival time of the stimuli at the retina. One can imagine a lot of clues by which visual stimuli betray their spatial origin, like perspective and movement relative to the observing subject, but it is striking that a couple of predators (owls, birds of prey, cats, primates) have developed binocular vision independently, giving the impression that the ability to see one object with two eyes at the same time is a reliable method for assessing its distance. (As there exists a trade-off between binocular and panoramic vision and as the latter organization helps one to scan one's environment for possible sources of danger, it is to be expected that prey animals are served more by panoramic vision.) The moment an object or situation is seen by both eyes at the same time, the input of both eyes can be compared in the visual cortex. Specialized `fixation cells' fire at the moment that the input from both eyes is the same, `near cells' and `far cells' fire if the input from both fixated eyes is different (Churchland & Sejnowski, 1992; Churchland, 1995). Of course, fixation is a more or less voluntary process in which the two lines of sight cross each other at a particular distance, the focus of our attention. On the basis of the angle between the two lines of sight (the binocular parallax) at the fixation point which results in two more or less identical images and as a result of the differences between the retinal and cortical images of the objects before and behind it (the binocular disparity) the brain can reconstruct (`translate') a three-dimensional world out of two two-dimensional images (figs. 11, 12 and 13). The astonishing fact, however, is that we *experience* our world as a completely three-dimensional (or even four-dimensional) world. Despite the fact that there are a few illusions in which the brain does not know how to decide what is `near' and what `far' (as the one created by the Necker cube, fig. 2-14), the trick is done almost automatically and we take the adequacy of our visual information processing system for granted, forgetting that it took half a billion years (500,000,000 years) to create and refine it.

Why do we have such a relatively sophisticated system of spatial reconstruction? Because we are apes which have descended from the trees. Related species, e.g. the gibbons and orang-utans spend most of their time in trees and while chimpanzees and gorillas have partly descended from the trees, our more related ancestor *Australopithecus* was clearly still adapted to living in trees. Only two and a half million years ago did we descend from the trees for good and for all. But at that point we became increasingly dependent on meat and could use our stereoscopy quite well (see chapter 7). In all stages a three-dimensional record of the world was no luxury: individuals with somewhat better depth vision were somewhat less likely to go extinct and to spread their geometrical talents into the population. (In addition, Churchland shows in his 1995 that stereoscopy is the best way to break camouflage).

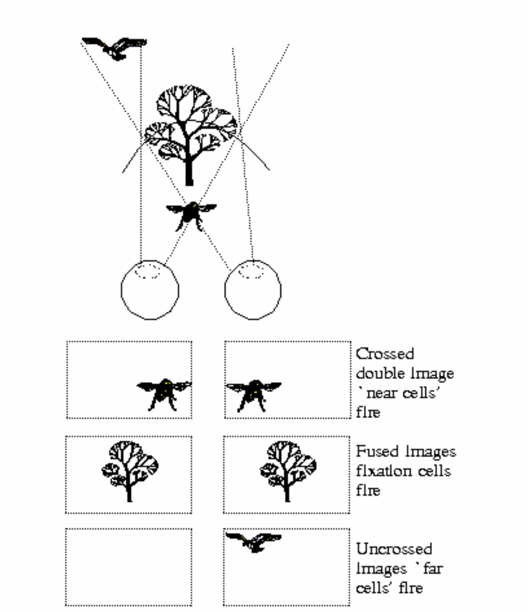

Fig. 2-12. The brain constructs a three-dimensional world out of two two-dimensional images by identifying objects before and behind the fixation point on the basis of the different ways they are perceived by both eyes.

What does this teach us about Kant's *Anschauungsformen*? First, it seems that Kant was relativizing space and time too much. For Kant space and time were purely frameworks of our perception. From an evolutionary perspective it is implausible that we would place our experiences in an stereometric hallucination if this did not increase our hold on the world. The idea that space and time are real and that we simply *reconstruct* it is much more elegant, has much more explanatory power and creates less problems. We are the product of a long line of ancestors who did relatively well, compared to some of their less successful conspecifics who fell from the trees and broke arms or legs.

Second, Kant was right in seeing that spatial knowledge requires an active *construction* and *interpretation* of incoming sense-data. This active construction is, however, directly guided by the interaction of the subject, who itself is the center of the space that it reconstructs. Kant's epistemology seems too much based on the idea of a more or less contemplative detached self, standing opposite to the world that it has to understand (Heidegger's *Vorhandenheit*).

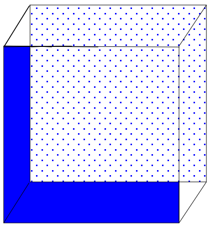

Fig. 2-14. Necker cube.

All in all, it seems plausible to assume that our ability to reconstruct three-dimensional space is to some extent innate. Such innateness should not be confused with rigid preprogramming, however, which is implausible given the interactive way in which both embryos and neural networks develop. Rather, stereoscopy plus the presence of certain recurrent connections in areas that are predisposed to process spatial information force the brain to choose one ontogenetic direction rather than another. However, to assess the degree to which such developmental processes can be influenced by genes, more information is needed.

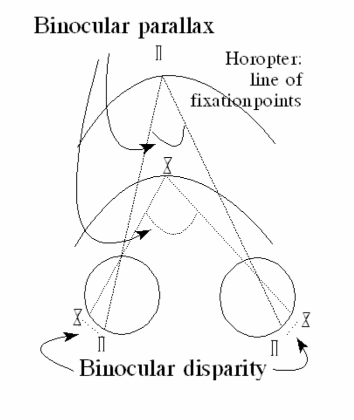

Fig. 2-13. The configuration of two objects is projected differently into each eye, on the basis of which the brain can compute their three-dimensional position.

b. The adaptive nature of specialized spatial skills

I also promised to show that there is a variation within the population with respect to the ability to perform particular spatial tasks. This is important, because it shows that the actual *a priori* (what *precedes* individual experience) does not have a universal character, but is adapted to particular environmental challenges. As a result of different ecological problems with which they have to cope, individuals - especially those belonging to different species, but also those within the species - have different transcendental frame-works to order their experience. With respect to space, it can even be said that *different individuals live in completely different `spaces'.* (Perhaps von Uexkülls concept of an `Umwelt' rings a bell here.) There are dramatic differences between the `spaces' (`Umwelten') in which dragon-flies, honey bees, swallows, whales, naked mole rats, bats and humans live. These differences emerge as a result of different habitats and feeding strategies and also as a result of different social structures.

It is interesting, too, that even within the human species different individuals live in essentially different spaces. A striking example is offered by the world in which agoraphobics live. It has recently been postulated that Darwin, after his travel around the world in the `Beagle', had to retreat to a remote country-house, as a result of agoraphobia. Many of the symptoms about which he speaks in his letters and autobiography seem to fit this diagnosis. But what is agoraphobia? It is a completely irrational phenomenon which forces an individual to become something similar to a hermit. If the person in question leaves his `safe' home and wanders off too far, he is `punished' by feeling tremendous anxiety, dizziness, nausea and a tendency to flee back home.

Of course, agoraphobia is a disease, but diseases are sometimes only extremes within the normal variation. Humans are a species with a home base, a small territory of their own within a much larger group territory which also represents their feeding area. If we are hurt somehow our instincts tells us to retreat to the homebase. Agoraphobia could be a sickly, enlarged variant of this impulse. Of course, this is only a hypothesis, but it could be worked out and lead to falsifiable predictions.

At this moment, the most important point is, however, that agoraphobia has something to do with the internal representation of space within the agoraphobe. Wide spaces are experienced as threatening. The world is represented as a large threatening space around a small, safe home base. (Many cats are agoraphobics, too, at least while they are young. A cat that is gradually discovering its new home will always look for safe places in each room to fly to, if necessary.)

The case for agoraphobia as a disturbance of an adaptive system of space representation is, however, not as convincing as the next example. Within a species, the two sexes almost always represent two different behavioral strategies (see chapter 4). As a result, it is not surprising to find that there are sexual differences in spatial abilities, in humans as well as in other species. There are several reasons to assume that these differences in humans are not purely culturally acquired. First, they are also shown in other species. Second, and more important, they are clearly influenced by hormones, which has been demonstrated both by experiments on rats and by a comparison of individuals with different hormonal abnormalities (Gaulin & Hoffman, 1988; Geary, 1996).

In 1986 Gaulin and Hofman hypothesized that spatial abilities in males would have been selected for in polygynous species, because, in such species, males would have to maintain larger home ranges than females to be able to spot or attract more than one of them. (Cat owners will remember that normally, tom-cats have larger home ranges than queens). To test this prediction they compared two related American rodent species with slightly different mating systems: meadow voles, which are polygynous, and pine voles, which are monogamous. As predicted, male meadow voles showed both larger home ranges and better spatial abilities than females, whereas pine voles showed no such differences between the sexes (Gaulin & Fitzgerald, 1986). In a later study they showed that male meadow voles have proportionally larger hippocampi than females, which had been anticipated based on the role of the hippocampus in mediating spatial functions (Silverman & Eals, 1992).

On the basis of these types of considerations Gaulin and Hofman theoretized that, in humans, males are also to be expected to have most talents for spatial orientation. It was not difficult to find psychological literature confirming this idea. With particular respect to mental rotation tasks, males outperform females dramatically in our species. Such tasks typically depict a three-dimensional object (e.g. a construction of blocks) and require the subject to imagine what the stimulus would look like from another perspective. A talent for performing such tasks is very useful in reading maps and as a result perhaps also in orientation within a relatively large home range. It is not difficult to show that man is a slightly polygynous species in which males need larger home ranges than females. Male superiority in spatial ability seemed to be explained before it was necessary to be demonstrated.

Male superiority? A Canadian Ph.D. student did not feel at ease with this concept and gave the matter more thought. Together with her supervisor, she designed a series of experiments in which some unconventional spatial abilities were measured (Silverman & Eals, 1992). In one experiment, subjects were confronted with a picture with a collection of drawings of familiar objects (an umbrella, a bear, binoculars, a chair, etc.). After a minute, they were shown a similar picture with a series of objects added. They were asked to put a cross through all of the items that were not in the original array. This was meant as a test of the subjects' memory for objects, independent of location *(object memory).*

After this test, they were shown a picture with the same objects as the original `stimulus array', but some of them were moved to a different location on the paper. The test subjects were then asked to circle the objects that still were in the same place and to put a cross through those that had been moved. This was meant as a test of the subjects' memory for the location of objects *(location memory).*

The result were striking. Females scored significantly higher on both tasks; they more accurately recalled which items were in the array and where they were located.

In another experiment subjects were left alone in a graduate student office, thinking they had to wait for the beginning of the experiment. After two minutes they were escorted back to the laboratory and asked to recall as many as possible of the objects that they had noticed in the graduate student office. In this experiment females remembered up to 70%

more objects than males did.

Another experiment was designed to separate incidental and directed learning. This study showed that females outperformed males both in object and location memory, independent of the way in which they learned. Silverman and Eals finally investigated the ontogeny of the female lead in object and location memory by studying different age classes. The data suggested that female superiority in location memory begins with puberty.

While Gaulin and Hoffman (1988) proposed that the differences between the sexes result exclusively from the tendency of males to have larger ranges in order to increase their access to potential mates, the studies of Silverman and Eals point to a divergent selection pressure for two different sex-related food strategies during human evolution, gathering and hunting. The male advantage in mental rotation could have evolved as a result of the need for males to hunt in unfamiliar territory, to encircle prey animals, to throw accurately and to find the way back home. The female advantage in object and location memory could have evolved as a result of a long history of foraging, in which it was necessary to find the same plants in different seasons and even to remember the fruits that were not ripe enough last week. Peripheral perception and incidental memory would have been particularly adaptive in this context, because it enabled ancestral females to remember all kinds of plants and their locations, while walking about or carrying out other tasks. Whereas hunting is often served by the ability to concentrate on one target, the effectiveness of foraging can be increased by remembering more than one possible food plant at the same time.

Instead of viewing male spatial abilities as just a male advantage, the studies of Silverman and Eals show that they are male specializations and that females have their own specializations. Instead of viewing the *a priori* as a monolithic, universal characteristics of our species, it turns out that the *a priori* as that part of knowledge which is not derived from experience is not universal, but is subject to individual variation and is different for different sex-age classes. Whereas Kant and Husserl view the *a priori* as an indication that the mind is an independent reality which is prior to the material world that it perceives and constitutes, this indicates that the mind is an adapted entity that helps to orient a material organism in a world that is already structured, independent of whoever perceives or reconstructs it.

3.THE VALUE-LADENNESS OF EXPERIENCE

Our knowledge of the world is colored as a result of subjective experiences and values.

We have seen that the senses do not simply register physical characteristics of the world in an objective fashion. Essentially the same physical characteristics can `mean' different things to different organisms. For example, what an arctic fox and a fennec, a fox living in the Sahara, perceive as `hot' and `cold' is entirely different. Both the air molecules above Greenland and those above the Sahara have a certain amount of kinetic energy which is measured as `temperature', but different fox species have evolved to attach completely different values to the same temperatures. The experience of temperature has, therefore, both an objective and subjective dimension. The same can be said about other senses, although the senses are slightly different in the amount of `objective content' they pass on.

Species-specific values are not only attached to incoming information at the level of sensory input, however. From an evolutionary point of view it is highly unlikely that the brain can afford itself the luxury of simply reconstructing states of affairs in the world, without directly noticing possible sources of danger. Certain environments and situations have to be `recognized' as dangerous (dark corners in dark woods), conspecifics and other species of certain sizes have to be avoided. If everything in this respect had to be learned by our ancestors from their parents, the risks during their childhood would be much too high. It is much more likely that learning involves a refinement of certain innate values than a start from scratch.

a.Innate reactions to light and dark

Are there any indications that we have such innate values that influence our behavior? A good first example might be our largely unconscious reactions to dark and light. This is a good example to start with, because something is actually already known of its neurochemical basis. Melatonin is known to be a chemical that both induces sleep and is produced during darkness. It is successfully used to relieve the effects of jet-lag. It seems reasonable to assume that it forms part of the neurochemical feedback system that drives our day-night rhythm, the `circadian' rhythm (derived from *circa diem*, about a day). (This is only one example of a biological rhythm. Coastal organisms often undergo circalunar cycles, which correspond to the position of the moon. Many bird species undergo circannual cycles which control features such as molting, breeding and migrating.) That means that this system is not entirely driven by experience and culture, but by certain innate factors which can be refined by learning processes.

A further clue can perhaps be derived from the effects of light-therapy on patients suffering from Seasonal Affective Disorders (S.A.D.; `winter blues'). In 1992, at the Clarke Institute of Psychiatry in Toronto, a special baseball cap was designed with two small green lights on its brim which shine directly into the wearer's eyes. It has been found that wearing the cap for 30 minutes to an hour a day helps about 60 to 70 per cent of patients within two weeks. This cannot be explained with reference to the placebo effect, because the success rate is double the usual effect with a placebo and because the effectiveness over time does not drop, as with placebos (Bochove, 1992). All this indicates that, somehow, the amount of sunshine is registered and `evaluated' in our minds. Such evaluation must be species-specific and our evaluations can be explained from the fact that we have descended from diurnal tropical primates. Cats, owls and bats clearly react differently to daylight and animals, like dogs, that have descended from nordic or arctic species, would not be helped much if suffering from winter blues.

b.Innate esthetic preferences

From an evolutionary perspective we would expect that we have certain innate species-specific preferences for particular landscapes and scenic values, too. Investigations in hospitals have shown, for example, that patients in hospital rooms with windows will recover faster than patients in hospital rooms without windows. Also, patients whose windows looked out upon a small grove of deciduous trees recovered faster than a matched control group of patients whose windows looked out on a building (Ulrich, 1984). The presence of flowers in a hospital room seems to have a very positive effect on the patients, too, and has led to the establishment in the U.S.A. of a National Council for Therapy and Rehabilitation through Horticulture (Orians & Heerwagen, 1992).

Psychologists have found a number of other, slightly surprising, preferences with respect to landscapes. People seem to prefer environments that have water, large trees, a focal point, changes in elevation, semi-open space, some ground cover, distant views to the horizon, and moderate degrees of complexity (Ulrich, 1986). People like to have surveyable landscapes, which still display enough `mystery' to invite further exploration (Kaplan, 1992). In an American study in which subjects rated five natural environments shown in slide format, young children (8-year-old) in particular were found to prefer savanna-like environments which they had never seen before. From age 15 on, savanna, deciduous forest and coniferous forest were liked equally well, and all three environments were preferred over rain forest and desert (Balling & Falk, 1982). The authors postulate a developmental pattern, in which innately programmed responses are modified by experience in particular settings (eastern U.S. forests). They propose that our preferences have evolved in savanna-like environments, but can be adjusted to some extent. Humans are supposed to originate in the tropical savanna, which is also relatively rich in resources. A limitation of this study was that the material did not include water or animals, because these were supposed to confuse the results. Proponents of the `aquatic ape theory' (who suppose that we evolved at least in the neighborhood of water, chapter 7) would protest, of course, because it is for them easy to show that humans almost always prefer landscapes with at least some water.

The human preference for landscapes with at least a couple of trees has been quite well documented. Orians and Heerwagen (1992) report their cross-cultural study of esthetic responses to trees with subjects from the U.S.A., Argentina, and Australia. They used black and white photographs of *Acacia*-trees from different savanna areas in Kenya. The trees rated as most attractive by all three groups proved to be those in which canopies were moderately dense and trunks bifurcate near the ground, a variety of *Acacia tortilis* which is characteristic of high-quality savanna. In wetter savannas, the Acacias are much taller and in dryer savannas they are denser and look like shrubs.

From this perspective, the popularity of Acacias in parks is striking (the Acacias I can view from my window are characteristic of a Dutch, relatively wet and poor crypto-savanna). One can see parks as places in which humans create an environment which pleases them maximally. If there are innate preferences for certain landscapes, they should express themselves to some degree in park designs. Many parks contain elements which remind us of a relatively rich savanna, including ponds, flowers, animals and isolated collections of trees (everyone raised in a Christian context will be reminded of the `tree of knowledge' standing central in Paradise).

Perhaps even closer to deep human esthetic wishes are some landscape paintings. Dutch landscape paintings of the seventeenth and eighteenth century certainly show that people like wide horizons, animals and trees. The problem with art is, however, that it is a medium with which humans often try to distinguish themselves from others. As a result, competition within an élite of artists and art-lovers can lead to something which Ortega y Gasset called the dehumanization of art. The need for representations which please the spectator is counter-balanced by the need to impress and even shock the public by being realistic or by expressing all kinds of mixed feelings, or by returning to supposedly `elementary' forms. It is sometimes revealing what kind of landscapes painters use to give a sense of alienation or to express despair. To find traces of original human preferences one should not rely on modern art history, however, but look to the paintings and portraits that humans use to embellish their houses or to gardening magazines. Or one should do research like that of Ulrich (1986) and try to find out how people react to slides with different scenes: he found that people in stressful situations show lower distress responses after viewing slides of natural scenes as compared to scenes of buildings.

c.The emotions: a frame-work for flexible decisions

Of course, esthetic responses to landscapes are only one example of a very broad kaleidoscope of values. From an evolutionary perspective there is no reason to assume that the human value structure is simple. Again, as in § 1.5d above and as I will be doing in the next chapter, I have to point to the work of Pugh (1978). As a designer of `artificial decision systems' Pugh found that the accuracy of decisions was served both by a relatively elaborate system of values and a ditto map of the relevant environment. Pugh proposes that the emotions form our system of innate values and he distinguishes primary values, which are innate, and secondary values, which are adaptations to particular environments. As I will elaborate in chapter 3, Pugh's theories in `The biological origin of human values' can be used to develop a theory of consciousness. The idea is that the contents of consciousness are not solely formed by `objective' information, but by *subjectively evaluated information* which enables organisms to weigh heterogeneous sorts of information and come to creative decisions. In contrast to stimulus-response and conditioned-response models, in this model sensations do not function only as rewards or punishments, but enable the weighing of many aspects of complex situations or even the anticipation of situations which might arise.

How would such a system of values work? An example is offered by birds. It has been found that woodland birds use patterns of tree density and vertical arrangement of branches as settling clues (Cody, 1985). The birds do not first investigate whether a particular grove contains enough insects or berries, but instinctively choose particular `nice' groves. On the other hand this instinctive evaluation is not so rigid that it cannot be weighed against other parameters. There can be a much `nicer looking' grove in the distance, the bird may be tired, it can become darker, conspecifics may be heard from the grove. The bird has to evaluate a whole situation and consciousness could be interpreted as an active integration of whole fields of subjectively evaluated information in order to reach a decision in which all factors are weighed.

Of course, the same goes for the evaluation of landscapes by humans. In contrast to the closely related chimpanzees and gorillas, humans live in a variety of habitats and have done for at least a million years. There are certain landscape elements we like to see, for example, wide vistas, water, animals and trees, but these preferences can be overruled by other considerations. Perhaps our innate tendencies express themselves most naturally in children and we gradually learn to bend them in the direction of a particular culture and particular preferences in later years, as Balling and Falk propose. That would mean that we are very flexible indeed, but does not mean a lack of something that has to be flexed into a particular direction in the first place.

The idea that our knowledge of the world is colored by subjective experiences and values will not come as a surprise to many people. However strange it may appear, in the tradition of epistemology not much attention was paid to it. Values are often seen as something that belong to ethics and this suggests a clear division of labor, which may avert a lot of problems. Such divisions of labor are sometimes very contraproductive, however, and are too often dictated by a timorous defence of existing academic territories. *If knowledge was completely separated from evaluations it would have been difficult to imagine how it could lead to decisions.* From an evolutionary perspective it is unlikely that an organism would evolve an elaborate cognitive apparatus that leaves it a complete freedom of choice with respect to what it does with the resulting knowledge. It is much more likely that new information is immediately interpreted within an valuative frame-work which allows the individual to assess its relevance with respect to upcoming decisions. Such a valuative frame-work could take the form of a `phenomenological cage' in which an organism is forced to evaluate certain phenomena as painful and negative and others as desirable and positive.

4.INNATE COGNITIVE EXPECTATIONS

We are equipped with a series of innate `expectations' which enable us to build, on the basis of relatively little information, a picture of the world which has a good chance of fitting some aspects of the real world.

Plato says in Phaedo that our `necessary ideas' arise from the preexistence of the soul, are not derivable from experience. - read monkeys for preexistence.

Darwin, 1838, M Notebook

The world in which we live is to some extent regular and predictable. If this was not the case, we would not be able to live in it. It would not make much sense having lungs in a world without oxygen: apparently our body `expects' at least some oxygen to be there. It would not make much sense having bones in a world without gravity: their strength is adapted to both our body mass and the size of our planet. Many characteristics of our bodies are designed for a particular world with particular constants and regularities - most characteristics simply *presuppose* a world with such constants and regularities. How could life have evolved if our planet did not rotate with such regularity around its own axis and around the sun? How could life have evolved if the properties of carbon and water at particular temperatures were not constant, but changed in a completely unpredictable fashion? At least since the Sumerians, the predictability and regularity of nature has been compared to the rules and laws without which no society could exist - which define, for example, the meaning of traffic lights and enable us to predict when post offices are open: hence the word `natural *laws*'. The metaphor is inadequate, however, since natural laws cannot be offended against and since they are not the product of minds.

Of course, there is the Kantian position that we are the creators of the order and regularity that we experience ourselves (see citation in § 1.4; KrV, A 125). Just like any `creationism' this model begs the question. If we, or God, create order and regularity, these are apparently products of minds. But minds themselves are already so complicated and organized that it is much more reasonable to believe that they *presuppose* order and regularity rather than *create* it from scratch. The `mind-first' movement - to which, we should not forget, Kant belonged - has very little evidence to build its case on. It is much more plausible that the regularities of this world are simply effects of the inherent properties of matter and that matter came first, cells and bodies next, and mind - only as a result of a snowball of coincidences - last.

In that case, one would expect not only bodies, but minds as well to be adapted to the particular regularities that they encounter in the world they come across. If brains evolved to reckon with particular possibilities in the environment, it would be a waste of time to force them to learn *all* regularities and constants from scratch each generation. The speed at which an organism learns to orient itself in its environment can be heightened enormously by not burdening it with unnecessary information about situations that it probably never will encounter and by preprogramming it with a series of plausible assumptions. Most birds need not to reckon with the relativistic effects that could occur when they would be flying almost with the speed of light, but they must somehow learn to cope with different speeds of the wind, with up- and downcurrents, with rains and blizzards, etc.. Most animals are equipped with a more or less task-specific learning programme rather than with a generalized learning attitude, as this is propelled by curiosity in a handful of species, including rats, cats, crows and humans.

A nice example of such a task-specific learning programme is offered by the nest-orientation of the bee-killer wasp *Philanthus,* a beautiful species which can be easily observed in the eastern parts of the Netherlands. As a result, it was also found by Nico Tinbergen at Hulshorst and it did even contribute to the creation of ethology (Tinbergen, 1958). Tinbergen and his students discovered that one can fool bee-killers by first accustoming them to a circle of fir-cones around their nests and then replacing this circle: the wasp would start looking for its nest in the middle of the cones. Subsequent experiments led them to conclude that the wasp is orienting itself purely on the basis of visual clues, preferably a pattern of relatively big objects protruding from the sand. The moment the bee-killer starts hunting, however, odor starts to play a crucial role, because it allows the wasp to control the identity of its prey, honey-bees. All this shows that the ability of the wasp to learn something (the place of its nest) is completely embedded in a more or less rigid, innate behavioral routine in which only some behavioral sequences have to be `filled in' or refined by learning processes. The mind of the wasp is, so to say, not a blank slate, but a form on which very specific questions are posed or on which one can sometimes only answer `yes' or `no'. The only reason that the behavior of the wasp is not completely preprogrammed is that its genes cannot `know' exactly in what kind of environment it is going to live. Learning should therefore be viewed, in the case of the bee-killer, as *a task-specific information-gathering activity, directed at very specific variables of the environment*. It is essentially based on a whole list of innate expectations: the wasp `expects' honey-bees to fly around with a particular scent, it `expects' a soil in which it can dig its elaborate tunnels, it `expects' at least some protruding objects around to be on the soil in particular patterns to enable it to locate its nest.

Of course, most philosophers, at least those belonging to the class of mammals and the family of primates, will immediately raise the chauvinistic possibility that those beings show a much more flexible and `open' learning ability. This is certainly true, but it also remains true that even curious beings with the possibility of gathering all kinds of information purely because it could sometime become useful - the elite of curiosers mentioned above -, need not be prepared for non-existent worlds. Even those beings are well served if they can concentrate only on the variables that really matter in the world in which they will have to survive. Even those beings are served well if their safety and reproductive success does not depend exclusively on skills that have to be acquired and knowledge that has to be obtained from scratch. Their `cognitive survival kit' is therefore expected to contain a lot of semi-automatic subroutines and `ontological expectations', just like those of insects and other invertebrates. Sometimes such `ontological expectations' are simply embodied in the very structure of their neural networks; sometimes special `recurrent connections' have been `installed' by means of variation and selection to ensure that the organism does not lose too much time and does not run unnecessary risks by having to learn the relevant properties of the mesocosmos which remain constant over generations.

Such properties, however, do not necessarily also pertain to the micro- or macrocosmos. The process of variation and selection is based on a limited, albeit enormous, sample of possible environments. *It has to be compared with induction (generalization), not with deduction.* As its effects are strongest in small, isolated populations its samples are essentially non-random and completely biased, otherwise speciation would not even be possible. That means that an evolutionary `justification and critique' of our innate cognitive expectations differs essentially from Kant's by being, on the one hand, much more aware of the essentially limited anthropomorfic nature of those expectations, and, on the other hand, by being aware of the possibilities of *transcending* those limits to some extent by understanding their origin from a limited sample of environments. Let us see whether we can make sense of some of the expectations on which our `instinctive ontology' is based.

a. We expect a `logical order' in nature

An old discussion in philosophy concerns the status of the so-called `laws of logic', such as the `principle of identity', `the principle of non-contradiction', `the principle of the excluded middle' and `the principle of sufficient reason'. The rationalists, like Leibniz, thought these `logical laws' were the most general natural laws. Empiricists, like Mill, thought they were simply *psychological laws*, `Denkgesetze', which simply expressed the way in which our minds work. Does the idea that we have certain innate, global expectations about the world enable us to transcend and integrate both positions?

Certainly our minds need not expect a world in which a tree may turn into a witch at any moment. The principle of identity is, therefore, a very sound starting-point for an organism which is not so much concerned about winning philosophical debates as it is about surviving in a dangerous environment. Whether it is always true, even on a microcosmical level, that things are always identical to themselves, one cannot, of course, decide on the basis of our natural tendency to expect so. The principle of identity is a principle which has proved its validity, which may be necessary to think (= create an internal model of) the world in which we evolved and which may even be necessary to think at all, but which proves nothing about the `logical' behavior of the ultimate constituents of the world.

To be able to think the world it is apparently necessary in most cases to fix the identities of objects and to expect that those identities will not change without a cause, but this thinking habit may also prove to be inadequate in some cases. While in the *meso*cosmos an individual, animal or human, which neglects the law of identity is simply unable to discipline its thoughts into representing possible objects and states of affairs in the world as we know it - it is simply dreaming or hallucinating - it could be necessary to understand the *micro*cosmos by seeing one and the same object as a particle one moment and a wave the next.

So, what is the status of those `laws of logic'? Apparently, they are *normative principles derived from our natural expectations*, expectations which were and are adaptive, but which may sometimes hamper scientific thought if taken too absolutely. First, *the principle of identity* assures us that sheep will not suddenly change into wolves. What mattered to our ancestors was establishing the identities of the objects they encountered. In science, however, we may discover that the world is not simply a collection of objects with fixed identities. What we sometimes identify as waves, must sometimes be identified as particles. The principle of identity is a *guiding principle* that teaches us how to order and think the world in so far as it can be understood and imagined by the human mind at all. Its presupposition is that the world is to some extent ordered and, obviously, we need this presupposition to be able to think about the world and talk about it.

Second, the principle of non-contradiction and excluded middle reflect our expectation that wolves are dangerous or not, fruits poisonous or not, partners trustworthy or not and that this sentence is true or not. We continually have to decide where to go, what to eat and with whom to share and cooperate and what to accept as true. Of course, our predicates and their negations do not fit the real world enough to be always exactly mutually exclusive. Even if the world were fundamentally ambiguous, we would still need an unambiguous language to think and speak. Probably, thinking and speaking are possible and successful only, because labelling and predication is an effective way of creating an order that at least reflects some aspects of its real structure or that at least reflects some constants in our interactions with it. At the level of the microcosmos many of our predicates start to appear inadequate, however, and that gives us a clue about their real nature. The principle of non-contradiction is neither purely ontological, nor purely logical. It tells us something about the conditions which have to be fulfilled by meaningful thoughts and utterances, thoughts and utterances that refer to the world.

Finally, the principle of sufficient reason reflects the conditions under which we are able to understand something. We are only able to understand a process by dissecting it into a series of causes and effects. Understanding thus sometimes comes close to being able to manipulate it. I have noted many synonyms of `understanding' which refer to hands (grasping, begreifen, begrijpen, comprendre). Noticing a cause enables you to produce the effect yourself at the moment that you wish.

The idea that these most fundamental `laws of logic' are extensions of innate expectations means nothing less than that we are born with a particular ontology. Normally, a child does not have to worry that its mother could turn into a witch at any moment or that her nice odor could stop signalling her protective presence. Actually, the child seems to be born with a lot of more specific expectations about both its mother and the natural world (Karmiloff-Smith, 1994), many of which seem to be justified by the structure of the world, some of which may lead to disillusionment in the long run. As I hope to show, without such expectations life would simply be impossible.

b. We expect objects and other stable elements in our environment

One of our innate expectations is the expectation that our environment is not in constant flux, indefatigable changing like Heraclitus' river which cannot be stepped into twice. We expect stable elements in our environment, things that one can grasp and that remain the same over time. D.T. Campbell has dubbed this the expectation of `entativity' (Cziko, 1995). As will be seen, without the expectation of `entativity' learning and language acquisition in particular would be impossible. Like Gorgias, the Heraclitean teacher of Plato, we would have to stay silent if we could not trust things to stay the same and we would not understand to what ontological categories our language teachers would be referring. Even more generally, we would be unable to learn anything if we could not connect a series of experiences with a particular object. Of course, even our bodies, especially our hands, are incarnations of the expectation of entativity. The success of the human hand proves that our expectation of a world in which at least some objects can be caught or grasped is at least partially true.

c. We expect regularity and repetition

The very structure and success of neural networks is based on the many regularities in nature. Conditioned reflexes, habituation and other elementary principles which underlie animal behavior would not be possible without them. Many animals are able to make unconscious calculations of probabilities and to apply an unconscious differential calculus, which is however based on completely different principles than the ones we learn in high school.

Animals in real-life situations cannot afford themselves the luxury of calculating probabilities by thinking over all kinds of logical possibilities. They also cannot afford themselves the luxury of first experiencing all the possible situations they could come across. Their `calculations' are, therefore, often based on a mixture of innate values representing particular dangers (the fear of the dark, fear of heights, instinctive fear of certain predators and parasites, etc.) and possibilities (attractivity of certain landscapes or certain conspecifics), which are reinforced and corrected by experience.

Psychologists studying inferential processes have been surprised to find that most people in everyday life are unable to apply the normative principles and inferential tools characteristic of formal scientific inquiry. People often tend towards a skimmed `availability heuristic' (Tversky & Kahneman, 1973; Nisbett & Ross, 1980): that is, they make inferences on the basis of an initial sampling which is far too small. This is the same bias to which is referred in Samuel Johnson's dictum that the opinions that most men have about women tell us much more about the particular women in their lives (their friends and wives) and their relationship with these women than about women in general. People also tend to apply a distorted `representativeness heuristic' (Tversky & Kahneman, 1974; Nisbett & Ross, 1980): they expect objects that they encounter to be representative of the features presumed to be characteristic of a category or of the generating process that produced it. This heuristic accounts, for example, for the `gamblers' fallacy' which makes people expect `black' after a long run of `red' on a roulette wheel, despite the fact that the chances of black and red remain equal all the time.

From the perspective of evolutionary psychology such biases are not completely surprising. An *Australopithecus* does not need to report to some scientific forum how many leopards and sabertooths a particular part of the forest contains. It may be very helpful to him if he is very cautious in all places in which he ever found evidence of any of these predators and in all places which bear particular resemblance to them. Every clue may be useful and in a band of *Australopithecines* it would make sense if particular individuals were obsessive about their personal experiences, although these were not based on a random sample.

Also, it would not make much sense to be scientifically accurate with respect to the danger posed by various animals and situations. Even if leopards and sabertooths only pose a real danger if they are really hungry, it would make much sense to avoid the risk and to simplify one's view about predators.

All this demonstrates that natural selection is essentially an *`inductive'* process, essentially producing networks which are trained by way of induction. Deductive certainty is neither attainable, nor necessary. Our natural talent for induction is simply the only way of filtering out all kinds of regularities and patterns in nature that may be relevant to our survival. It seems to be based simply on the nature of neural networks in general which work by `generalizing' particular input patterns into partitions of synaptic weights[1].

Does this mean that induction is also justified as a *scientific* way of collecting

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[1] Another, closely related, kind of inference to which the evolutionary process bears resemblence, is Peirce's *abduction* or `inference to the most likely cause/to the best explanation'. Abductive reasoning is characterized by postulating certain causal relationships where induction is characterized by postulating generalizations. Because abduction is as much opposed to deduction as induction, I will concentrate on induction here.

knowledge? Not automatically. Many kinds of knowledge can only be attained by induction, but this does not make induction unconditionally reliable. The way in which a child acquires language is also based on induction, but that does not mean that languages are not full of exceptions. In particular phases in which a child acquires language it makes characteristic and to some extent predictable mistakes based on premature conclusions with respect to regularities. Likewise, the world is full of regularities which make natural selection and induction such good strategies, but this does not mean that there are not a lot of patterns in nature which are irregular or purely coincidental.

Therefore, the tendency to make inductive inferences has *always* to be counter-balanced by a readiness to notice and correct precipitated generalizations. In science the need to draw fast conclusions is not as urgent as in everyday life, and the need for reliability is inversely proportional. No wonder that scientists have every reason to be more cautious than lay people, despite the fact that induction is as indispensable to them as it is to everyone. As there is no way of establishing the optimal mixture of inductive enthusiasm and critical prudence, one would expect scientists to disagree about all kinds of inferences and this is exactly what one finds in almost all disciplines.

d. We expect patterns and specific forms

We have seen that connectionism can clarify the way in which neural networks can be trained to connect specific input patterns with specific output patterns. Neural networks can be partly trained as a result of variation and selection over many generations, and partly during one lifetime. Because genes can never completely predict the environment in which the organisms they are building will find themselves, it is to be expected that both will play a role. Recurrent connections could bias the learning process in such a way that it is prone to absorb one kind of information rather than another. Dependent on the precision with which such recurrent connections control the training process the behavior that subsequently arises may appear more or less `innate'.

In some cases recurrent connections have the effect of strictly predetermining the reaction to certain input patterns, making them completely `innate'. In other cases the input pattern seems not to be completely predetermined and individual or social learning may direct a particular behavior to a more specific input pattern. An ethologically oriented learning theorist, Milton Suboski, has christened the type of learning involved `releaser-induced recognition learning' (Suboski, 1990, 1994) and has even tried to prove that this type of learning can explain many behavioral phenomena that cannot be explained by classical learning theories (instrumental and Pavlovian conditioning). This means that *instead of a dichotomy of `innate' and `learned' we have a gradual transition from relatively rigid stimulus-response systems to systems in which the gap between input and output is widened as a result of specialized learning mechanisms.* Such learning mechanisms should be seen as specific ways in which particular input- and output-variables can be adapted to specific circumstances. Instead of placing learning in opposition to heredity it should be seen as an inherited way of shaping a flexible part of the innate behavioral programme of an individual to unpredictable aspects of its environment. Let us explore a series of domains in which different degrees of behavioral and cognitive flexibility are adaptive.

1. Recognition of predators and brood-parasites.

Little flexibility is to be expected with respect to the recognition of predators and brood-parasites who have posed a threat to a particular species over millennia. On the one hand there has been a strong selection pressure that could shape a recognition system for an archetypical predator or brood-parasite, on the other hand flexibility with respect to such threats could be dangerous. As a result of that one can easily find several examples of `innate recognition' with respect to predators and brood parasites. Sheep seem to have an innate fear for wolves, many bird species seem to be suspicious of cuckoos and their eggs, and spider-hunting wasps become nervous in the vicinity of the cuckoo-wasp *Cerophales*.

As a result of the ability of many species to detect brood parasites a kind of evolutionary arms race will often arise in which both the instinctive detection mechanism of the prey species and the innocent appearance of the brood parasite are gradually refined. This may result in spectacular forms of mimicry as, for example, in the hover fly *Volucella bombylans* (not uncommon in the Netherlands) which comes in different varieties that all resemble specific species of humble-bees. This mimicry enables it to pass the guards of the bumble-bee colonies and to lay its eggs in their nests. (Similar mimicry can be found in a dozen species of ant-imitating beetles, wasps and beetles.)

Another example is offered by the cuckoo: different `races' or `gentes' of it have evolved the ability to lay eggs similar to those of their respective hosts. Most European birds with nests that are attainable for the cuckoo and that eat insects have already won their arms-race with it and will often recognize and remove the cuckoo's egg or an egg painted by an experimental ornithologist. Gentes of cuckoos that specialize in these species (e.g. the great reed warbler) have to lay very sophisticated imitations eggs to get them accepted. The cuckoo is continually forced to start parasitizing fresh `naive' species or to improve the similarity of its eggs to that of its host. At present cuckoos mostly parasitize meadow pipits, reed warblers, pied wagtails and dunnocks. Because Northern Europe was mostly covered with wood before Caesar's attempts to spread civilization and because dunnocks are not particularly common in woods, dunnocks seem to be the only species of host that did not evolve a discrimination of cuckoos' eggs. Dunnocks are still surprisingly naive with respect to cuckoos and will uncritically accept almost any egg which replaces one of their own (Davies & Brooke, 1991)[2].

Recognition systems often have to be refined and supplemented by learning, as well. Again it was Tinbergen who designed a nice experiment which allowed him to study the range of a particular recognition system. In his *Bird Life* (1958a) he notes that many birds are particularly sensitive to the prototypical silhouette of birds of prey with a short head in front of the wings and a long tail behind. Tinbergen and one of his colleagues fastened a long wire between two trees above a lawn on which ducks, geese and chickens were kept. They tested their reactions on models with a variety of patterns, but the birds only started to alarm if the `head' was short and the `tail' long. When `head' and `tail' were reversed the model did not evoke a reaction: it would then resemble a duck with a long head and a short tail. This innate reaction sometimes proves to be imperfect, however, and in those cases it has to be corrected. Tinbergen noted, for example, that many birds initially start to alarm in the beginning of May if the swifts return, as a result of their resemblance to hobbies. Within a couple of days the birds have learned that swifts pose no threat and they stop alarming in reaction to them.

In many cases the recognition system is flexible enough to enable the organism to identify its own predators, either by individual or social learning. Lorenz discovered quite accidentally that jackdaws will learn to see as an enemy everybody that they see with a black object, similar to a black jackdaw, in its claws, hands or in its bill. One evening

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[2] On a trip to the U.S., I observed a young Brown-headed Cowbird being fed by a Chipping Sparrow. It would be interesting to know whether this brood parasite also has evolved into different `gentes'.

Lorenz returned, after bathing in the Donau, to his colony of tame jackdaws, and took his black swim suit out of his pocket. He was immediately attacked by a whole bunch of angry jackdaws and painful pecks hailed down on the hands which held his swim suit. Lorenz subsequently discovered that any black object, even a piece of black paper, will evoke the same reaction and that anything or anyone, even a jackdaw itself, who has been seen a couple of times with such a black object is attributed as an enemy for good and for all to all other jackdaws, who are informed via very infectious alarm calls (Lorenz, 1969: 45).

The social transmission of particular predator prototypes has been discovered in a wide range of species, including fish (Suboski, 1994), birds and primates. Such social learning need not be in opposition to innate prototype recognition, however. At the very least it presupposes an innate sensitivity to particular alarm signals, but it often also presupposes an innate recognition system which enables the warning individuals to expose specific predators in the first place (e.g. by observing them with a black `conspecific' in their possession).

Probably the best way to ensure that an organism learns to identify the many possible sources of danger in its environment is to equip it with a series of innate prototypes and to enable it to refine these by individual and social learning. Cheney and Seyfarth (1990) show how juvenile vervet monkeys gradually acquire knowledge of their environment on the basis of instinctive fears, coupled to social learning. Infants initially give `eagle alarm calls' in reaction to birds and other flying objects. The adults that are near to them only give a second alarm call if the flying object really poses a threat. As a result of this training the juveniles gradually refine their recognition system and learn to distinguish a whole range of flying objects, birds and birds of prey of which only two species are confirmed predators of vervets, martial and crowned eagles.

All this means that even an innate prototype recognition system can be adjusted to some extent by experience and learning. It is to be expected, however, that this flexibility declines to the extent that particular predators were a constant threat to one's ancestors. It would be interesting to know to what extent humans display relatively rigidly predetermined sensitivities to particular prototypical predators which have posed a continued danger to their ancestors.

According to E.O. Wilson (1996) the fear of snakes might be a good example. First, we share this innate fear with many primates, including guenons, vervet monkies, rhesus macaques and the living species that is most related to us, the chimpanzee. Even chimpanzees raised in laboratories that have never before seen snakes are very fearful about them. The only primates that are not fearful of snakes are the lemurs from Madagascar, where poisonous snakes do not occur (Lumsden & Wilson, 1981: 83). Second, in humans the fear of snakes follows the same developmental sequence as in chimpanzees. At an early age snakes have little or no impact, but later on children grow increasingly wary. As a result of reinforcement by experience and/or training it can then be suppressed or grow into a pathological state or anything between those two extremes. It is highly unlikely, however, that one will ever be completely indifferent to snakes. Even in those few countries where there are no snakes at all, like Ireland, the fear of snakes is preserved in a cultural way and serpents are used as symbols in art and literature. Experiments with rhesus macaques make it likely that the key stimuli which determine the reactions of the macaques to snakes relate to the snakes' sinuous limbless bodies, their ability to remain hidden and the undulation with which they move through the vegetation.

2. Recognition of food types.

Food choice is a domain in which one may expect `innate' pre-specified pattern recognition to be much more flexible. Changes in the environment may sometimes force animals to change their diet. Of course, the relatively flexible species are best at adapting to new environments, as proved by house sparrows, starlings, rats, jackdaws, black-headed gulls and humans. It is in those species that we expect predetermined food recognition to be more based on direct nutrient-evaluation rather than on completely genetically-prespecified food prototypes.

Of course, even in species in which food choice is genetically preprogrammed, learning is still necessary. As is to be expected in species with an elaborate nervous system, innate releasers guide a learning process, rather than directly determine behavior. A chicken that has just hatched will start pecking at dark spots and will start imitating the pecking behavior of its mother (Suboski, 1994). The specific items that it will peck at are therefore partially innate (the innate `releasers' are spots, especially pecked at by conspecifics), partially acquired by learning: only some spots prove to be edible. It is this combination of an innate `releaser' and subsequent learning that led Suboski to his description of `releaser induced recognition learning'.

The phenomenon of warning-colors and mimicry allows us to study the ways in which birds recognize distasteful, poisonous or dangerous insects. Wasps, for example, have a clear yellow-black pattern which is apparently very easily associated with their venomous stings - most probably as a result of some kind of evolutionary programmed prototype. A great number of completely harmless insects has evolved that profits from this fear of yellow-black patterns by imitating it. Only in the Netherlands you can find a whole series of hover flies (*Syrphus, Xantogramma, Heliophilus* and especially *Chrysotoxum*), thick-headed flies (*Conops)*, beetles (different species of Longhorn beetles, like *Clytus* and *Plagionotus*) and even butterflies (the Hornet clearwing, *Sesia apiformis)* that at least superficially resemble wasps. As a result of a kind of arms-race between insect-eating birds and wasp-imitators, some of these imitations are not that superficial anymore, however. A *Chrysotoxum* hover fly flying restlessly through the shrubs looks very much like a wasp. (Similar arms-races as a result of mimicry can also be found in bee-imitating flies, beetles and butterflies.)

As has already been indicated, humans belong rather to the group of animals that directly assesses the value of particular food-items than those that rely on genetically-predetermined food-prototypes. Obviously, our taste receptors predetermine to some extent our food choice. Our taste receptors are not autonomous, however, and their `evaluation' of food items varies as a result of proprioception. At the same time it is striking to what extent some of our meals reflect the quests and obsessions of our evolutionary past. If it is true that *Australopithecus* at some point in its history relied on roots and that early *Homo* increasingly turned to meat, the typically north European and American diner with its trinity of roots (potatoes), meat and vegetables simply reflects three stages of our evolutionary past.

3. Imprinting and the individual recognition of conspecifics.

Whereas one would expect recognition of the own species to be innate, because mating with non-conspecifics implies a waste of energy, one would expect the recognition of specific conspecifics (for example, parents and offspring) to be essentially a learning process, because the specific characteristics of those conspecifics cannot be genetically preprogrammed. A famous example is offered by the phenomenon of imprinting, which was discovered and demonstrated by Konrad Lorenz. Lorenz is famous for imprinting his own image into the minds of young goslings of the greylag goose (*Anser anser*). By being the first individual around at the moment that the geese he became the archetypical `Mother Goose' and the young goslings followed him everywhere.

The way in which the imprinting process works is often adapted to the specific circumstances of the species and again it should be noted that learning does not imply infinite flexibility. Mallard ducklings (*Anas platyrhynchos*) will only imprint on objects that make the appropriate duck-like noises and prefer yellow-green objects, while domestic chicks more readily follow blue or orange objects, and will even approach a flashing light. The dangers posed by a too-flexible system of imprinting can be manifold. Young corvids and parakeets that are imprinted onto humans - it is here that I remember one of my own pets, a jackdaw called Karel - will often direct their sexual behavior to humans, too. Sometimes they will try to mate with humans or try to drive their real partners away, sometimes they will court them by building nests for them. Lorenz tells us of a tame house sparrow that built a nest in the pocket of its beloved (Lorenz, 1969).

In many cases, wrong imprinting will lead to disasters at a much earlier age, however. A good example is offered by a domestic chick, Egbert, who hatched in a frying pan in the middle of the Syrian desert during British army tank maneuvers at the end of the second world war (Johnson & Morton, 1991). Egbert stole the heart of the soldiers and proved to be imprinted onto army boots, which he followed religiously. Egbert traveled several hundred miles in the tank and spent some happy days in the camp following army boots, but was finally - and tragically - crushed by the boots of the corporal during parade. Happily such tragedies do not happen often enough to have formed a selection pressure that designed chicks in such a way that they are instinctively wary of army boots.

Figure 2-15.

Do humans display an equivalent of imprinting? A currently much-discussed example of an innate sensitivity to particular patterns is face recognition (Johnson & Morton, 1991). This can be studied by presenting babies of different ages with face-like models in which eyes, eyebrows and mouth have sometimes been re-ordered (fig. 2-14a & b), and in which they have sometimes been replaced by black squares. At different ages children will react differently to these kind of stimuli. For example, newborns prefer face-like models over blank and `scrambled' models, but models in which the eyes and mouth are replaced by black squares still elicit a lot of curiosity at this age. Two month-old babies prefer realistic faces to those in which eyes and mouth are replaced by black squares. Strangely enough, one month-olds do not seem to prefer `scrambled' faces over normal ones and this could indicate that more than one mechanism is involved.

Johnson and Morton draw parallels between the way chickens learn to recognize and follow their mothers and the way human children learn to recognize the faces of their parents. They postulate that in both species two separate mechanisms seem to be involved in the development of recognition of conspecifics: a device that directs their attention towards clusters of features possessed by conspecifics and a learning system engaged by objects to which the young individual attends. In humans the first device takes the form of a predisposition to pay attention to the characteristics of human faces which primarily seems to be mediated by subcortical structures. The second mechanism is concerned with imprinting and is supposed to work only if the cortex is already mature enough. It only starts working gradually during the months after birth.

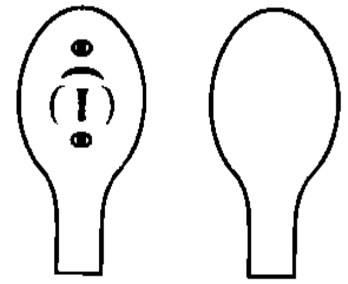

Fig. 2-16. Examples of stimuli presented to new-borns in various studies summarized in Johnson & Morton, 1991.

There are, of course, other candidates for innate `platonic, pure forms'. One that is closely related to face recognition concerns the criteria by which faces are judged. It seems that one can actually compose an `ideal face' for each sex and these ideal faces are not purely products of culture (instead, they betray fertility and fitness; Etcoff, 1999). One could also mention the Euclidean idea of a straight line as the shortest connection between two points. As has already been shown, there are specialized cells in the visual cortex firing exclusively in reaction to lines with particular characteristics and these cells could be the innate basis for our preference for Euclidean geometry.

4. Abstraction, generalization and taxophily

Given the almost universal necessity to recognize conspecifics, predators, brood-parasites, dangerous situations and poisonous food, it is not surprising that complex pattern-recognition evolved in a series of species. It is easy to see that a general tendency to abstract and induce on the basis of limited experience could be adaptive as well. Of course, any tendency to abstract and generalize may also lead to error. A group of ducks flying from a bird-watcher with a telescope, may be wrong in thinking telescopes and shot-guns to be the same thing, but will probably fare well with its simplicity. This adaptive value of abstraction and generalization could well underlay the almost universal human tendency to think in stereotypes and to entertain all kinds of prejudices.

In the past much stress has been laid on inferential reasoning as the source of scientific knowledge. It was Lorenz who pointed in his essay *Gestaltwahrnehmung als Quelle Wissenschaftlicher Erkenntnis* ([1959] 1983) to the role of pattern recognition. Recently, Roger Masters has identified three modes of knowing which have traditionally been viewed as mutually exclusive - intuition, verification and pattern matching, which are based on the limbic system, left and right hemisphere respectively - and claimed that pattern-matching is the most fundamental and general of them. "Pattern matching and holistic assessment of form characterizes the functions of the right hemisphere and, more broadly, the global integration of the brain's parallel processing of multiple cues in the environment" (Masters, 1993: 64). Indeed, given the results of both modern neuroscience and the philosophy of science, it is no longer possible to deny the fundamental role of pattern matching in knowledge (Churchland, 1989). The idea of an absolute foundation of all knowledge in a deductive system based on propositions should perhaps be seen as an exaggeration of the role of the left hemisphere in cognition. Apparently, our talents for science did not start with the origin of language and with its possibility of revealing, explicating and improving trains of thought.

Indeed, part of our enormous taxophily, our tendency to classify and identify all kinds of species, can be explained by our descent from tropical apes which have to know enormous numbers of plants and animals. We should not forget that even chimpanzees have to know a lot about plants and have to know exactly when certain fruit-trees will be ripe. Also the medical use of plants, both in the zoo (the Apenheul at Apeldoorn, the Netherlands) and in the wild has been documented. Probably the platonic doctrine of eternal ideas had not existed if it wouldn't have been necessary to recognize so many species - this, however, shows that Plato was not completely wrong. As Darwin saw, our pre-existential vision of those ideas took place when we were still only monkeys and apes.

e. We expect causal connections between successive events in nature

Hume and Nietzsche knew that we interpret continually linked events as necessarily connected. Hume still believed that this `instinct' corresponds to the real structure of nature, although he was unable to give a foundation for this belief (Hume [1848] 1970[3]). Nietzsche believed that our `Ursachen-Trieb' implies a perspectivistic misrepresentation which allows us to control nature - although he remains at the same time a very strict determinist in his justification of his belief in an eternal return (Ewige Wiederkehr, e.g. Nietzsche [1940] 1977). Both authors were unable to be consistent skeptics on the basis of their psychologistic analysis of causal knowledge and preferred, in the final analysis, the `doctrine of necessity' (Hume's formulation) over epistemological consistency. Thus the belief in universal causality poses a dilemma for critical epistemologists: on the one hand one always observes only a succession of events, never their causal connection - on the other hand, not even a madman can do without a belief in causality.

Nietzsche's attempt to be skeptical about causality is very instructive with respect to the consequences of such skepticism. In the end, such a skepticism would lead us to distrust even our own causal influence on the world. The world would become a succession of disconnected phantoms and understanding would become impossible. However, our ability to design tools for particular interferences in natural processes shows that our causal insight *works* very well. Would it not be unreasonable to prefer a theory which is unable to explain our enormous success in influencing and controlling natural processes over a theory that not only explains this success, but the connection between the rest of our experiences as well?

As shown in chapter 1, it is not only humans who are tool users. Tool use is widespread among the animal kingdom. Sand wasps close their nest holes with pebbles, woodpeckers use a crack in the bark of a tree as a vice-bench for fir cones and chimpanzees will carefully choose the right blade of grass to `fish' for ants. Some species, including the green-backed heron, even adapt their tools to their specific tasks. Of course, not all kinds of tool use prove real causal insight. The psychologist Visalberghi has explored the relationship between tool use and causal insight in capuchin monkeys (Visalberghi &

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[3] Here, ..., is a kind of pre-established harmony between the course of nature and the succession of our ideas ...

As nature has taught us the use of our limbs, without giving us the knowledge of the muscles and nerves, by which they are actuated; so has she implanted in us an instinct, which carries forward the thought in a corresponding course to that which she has established among external objects; though we are ignorant of those powers and forces, on which this regular course and succession of objects totally depends. Hume [1748] 1970, V, 345-346.

Limongelli, 1994). She shows that the inventive ways in which the capuchin monkeys use tools for solving problems in the laboratory are not a result of insight, but simply of trial and error. Tool use by chimpanzees seems to be much more based on insight (Byrne, 1995). In some cases, chimpanzees will design tools for specific tasks and in many cases they will adapt their tools for particular tasks before they start working with them. Tool use by elephants and dolphins also seems to be the result of real causal insight. At least, dolphins know how to use their conspecifics as `social tools' which may assist in the attainment of specific goals, e.g. the abduction of females (Conner *et al.*, 1992).

What distinguishes `real causal insight' from the simple use of causal laws? Perhaps Premack's distinction between natural and arbitrary causes is important here (Premack, 1996). According to Premack, most animals can learn about `arbitrary causal relationships' simply as a result of learning by classical or instrumental conditioning. `Causal reasoning' is to some extent independent of direct observation and is based on the understanding that some events are necessary conditions for other events. The belief that such events simply require a causal explanation belongs to the *very essence* of causal reasoning.

> Reasoning depends on a disposition to seek the causal origins of `unexplained' events. An individual who encounters a conspecific in a deflected state, highly positive or highly negative - will reason - or has the possibility of reasoning, only in so far as he is disposed to ask why is he deflected? What caused him to be in this state? Above all else, reasoning depends on recognizing the `unexplained' event, and being disposed to seek its causal origin. (Premack, 1996: 295-6).

According to Premack, among non-human species only chimpanzees display the ability to reason. Certainly, Frans de Waal had already noted in his *Chimpanzee Politics* (1981: 183, 187-190) that chimpanzees are able to think through a whole series of future consequences of their actions. Premack proposes that the ability to reason "may require a mind that can make copies of its own circuits". "Copies of circuits are not tied, as are the original circuits, to a fixed set of responses, and they may therefore allow for greater novelty and flexibility" (id.: 297). This flexibility can then be used, among other things, for postulating causes or speculating about consequences.

If this were true, causal understanding would require some form of self-awareness or at least a `distance to one-self'. On a simpler level, however, some causal understanding could already be based on an improved model or internal simulation of the external world. Many animals need to predict the behavior of objects and animals and the simple hypothesis that events have causes could help a lot in making the world predictable. A vervet monkey that hears a `snake alarm call' will start looking around on the ground to look for a snake: this is already `looking for a cause' (Cheney & Seyfarth, 1990). Closer to home one can test the intelligence of a cat by imitating a bird or mouse: often the cat will look surprised and sometimes it will even look around as if looking for a possible source of the noise. A cat that recognizes someone's voice on the answering machine will also look surprised and start look around as if looking for the person in question.

Thus, it seems to me that the distinction between `arbitrary' and `natural' causality (or, between an accidental and a necessary succession of events) can be made by animals without clear signs of self-awareness. More than self-awareness, a property like *imagination* is required, because such an internal simulation of an external series of events could enable the animal to `fill in' parts of the series that are invisible, like a supposed `cause' or future consequences. Clearly, a squirrel which is jumping from branch to branch at enormous speed already needs such an internal simulation of what is likely to happen if it jumps to a particular branch: simply, to predict whether that branch is strong enough or not (at least some awareness of the self is presupposed in this prediction, too). A pride of lionesses that is trapping a prey animal should be able to predict to some extent what will happen at the moment the prey discovers one of them.

All in all, the `hypothesis of universal necessity' might well form a part of the neural networks of a large number of animal species. Its indispensability is probably increasing as animals become more like agents which actively change the world around them. Of course, tool use is the summit of the tendency to change the world in a specific, goal-directed way and therefore it is no accident that causal thinking is a human universal. To some extent understanding can even be said to be identical to the knowledge of the specific *causes* of a process, `underlying' it - the knowledge that one needs to manipulate the process.

As several proponents of evolutionary epistemology have independently remarked, the fact that our causal interpretations of the world are adaptive does not mean that they are necessarily adequate. Some evolutionary epistemologists - e.g. Riedl and Vollmer - even consider the indeterministic interpretation of quantum mechanics to be right and use evolutionary epistemology as an explanation of our stubborn determinism. Lorenz has tried to give an independent `justification' of our belief in causality by pointing to the law of the preservation of energy.

However, the fact that evolutionary epistemology is unable to prove the adequacy of causal thinking does not prove its inadequacy either. Certainly, the way in which we sometimes have to chip an ongoing process into pieces may be an artificial by-product of our causal thinking, which is too narrowly focused on linear causal chains. This linear causal thinking seems to be particularly inappropriate in the analysis of complex wholes. The fact that we have difficulty understanding quantum mechanics does not in the first place result from a dogmatic determinism, but does result from a dogmatic belief in `Einstein separability', the belief that objects that have been separated can only have causal influence on each other with a speed slower than or identical to the speed of light (d'Espagnat, 1979). It is clear that in the realm of quantum effects our innate expectations somehow delude us and stand in the way of a true understanding. If this lack of understanding were to correlate with Planck's constant it would, however, be very small indeed. Perhaps the size of our lack of understanding is more appropriately measured by adding up all those instances in which we claim to understand a process while we are taking the fact of its obedience to universal causal principles for granted.

f. We look for useful objects and purpose

As the experiments by Köhler and many observations in the wild (especially in West Africa) have shown, chimpanzees both display insight in causal chains and the ability to devise technical solutions to problems. The advantage of technology exceeds the advantages of learning on which it is based: whereas learning enables an animal to adapt its instincts and behavior to particular circumstances, technology enables it to adapt even its organs to those circumstances and may even enable it to adjust its environment to its instincts and desires. The discovery of technology thus represents a major step in the liberation of the animal from the dictates of its immediate surroundings and the limits of its natural bodily equipment. No wonder that humans fancy themselves as beings which transcend nature. Technology did not arise at one go, however, nor does it allow us to change some of our most fundamental motives.

As we have seen, animals including woodpecker finches, green-backed herons and sea otters use various devices as substitutes for organs they lack for the attainment of their food sources. Elephants, dolphins, chimpanzees and orang-utangs seem to be very creative in finding the right tools for particular jobs. This not only presupposes some causal insight, but it seems to presuppose some imagination as well. A chimpanzee which is looking for a stone and an anvil for hammering some nuts that it has just found has to create an imaginary *searching image*, based on a virtual performance of its task. It has to know exactly what it is looking for. Of course, this searching image may be partly based on trial and error. By imagining how a particular tool might be used in function of a particular *goal*, this learning by trial and error can be speeded up many times, however, and this seems to explain the ease with which some of these animals devise new tools.

Certainly, our ancestors at some time needed this imagination and thinking in terms of purposes to devise their tools. *Paranthropus* (the robust Australopithecines) may have needed wooden tools to dig for roots and the earliest members of the genus *Homo* - *Homo habilis* or *Homo ergaster* - probably needed their stone tools for butchering carcasses and to open bones to eat the marrow inside. At some later stage tools were increasingly used as weapons and the endless arms races started, which seem to have characterized the latest stages of human evolution. All this presupposes not only handy hands, preferably with opposed thumbs, but certain cognitive abilities as well: an ability to look forward and to plan, to postpone the immediate satisfaction of desires, and an ability to make internal simulations of the functioning of particular designs.

To some extent one would not expect a tool-making animal to be a cognitive `generalist'. Even an ecologically flexible toolmaker like man has to be specialized in thinking in terms of efficiency and means-ends relationships. Perhaps this innate tendency to look for useful objects is the reason that some philosophers would like to impute purposefulness to the whole evolutionary process or even `design' to the whole universe. There is no reason to expect more `purpose' in living things, however, than that which arises as a result of the continual extinction of DNA which does not subscribe to DNA's universal `purpose', `more DNA' (Wilson, 1975) and as a result of the ongoing snowball of purposeful DNA. In the same way it is simply a superfluous hypothesis to postulate `design' apart from that which results from the inherent properties of matter and the creative and polishing work of natural selection.

g. We look for `meaning'

We have already seen that the information that an animal receives about its body and its surroundings is `colored' by certain innate values. The more information an animal has to process, the more values it needs to weigh this information in order to come to adaptive choices. These values are part of an innate system of evaluation that reacts to all kinds of proprioceptive signals and that changes in reaction to internal physiological and psychological conditions, the whole system ultimately designed by natural selection.

The human cognitive apparatus, too, selects information on the basis of innate values and assigns values, in the form of emotions, to almost all information that it receives. Many philosophers and anthropologists have concluded from the fact that we are a very flexible species that we are able to acquire almost any habit and that we are able to learn to appreciate almost any kind of food or environment. Flexibility is not the same as looseness, however, just as freedom does not mean arbitrariness. Our innate (`primary') system of values guarantees that all lifestyles with which we experiment are judged on their appropriateness with respect to a series of innate needs and expectations. To the extent that we lose contact with these deep-felt needs and expectations we will feel alienated and unfulfilled. As a result we will end up with a kind of `second nature' that fits to some extent both our primary nature and the environment in which we have to live - or that at least represents the best attainable compromise.

The fact that humans live in a culture means, among other things, that we do not have to start from scratch with this process each generation, but that we inherit by way of social learning a lot of habits and practices - indeed a whole system of `secondary' or acquired values - that have proved to be useful in a particular environment. Often this kind of cultural wisdom is given authority by means of a particular world view which presents itself as a revelation of life's ultimate meaning. Indeed, such world views enable most individuals to find a personal way of living which is particularly suited to that environment and it is no wonder, therefore, that these individuals tend to equate their culturally inherited world view - and their specific culturally acquired or `secondary' (Pugh, 1978) values - with the `meaning of life'.

Ultimately, however, it is not to be expected that there can ever be a complete correspondence between any primary and secondary system of values. The simple reason is that environments tend to change and interests tend to be incompatible. Secondary or culturally acquired values only reflect strategies that were successful in the past and may also reflect only the interests of a limited group of people. Therefore, no individual can rely on culturally acquired knowledge about the `meaning of life' and to some extent each individual has to discover its own favorite `life style' for itself via a trial and error process guided by innate evaluations like alienation, boredom and fulfillment. The experience of fulfillment and `meaning' should therefore be ultimately interpreted as a biological signal that tells us that we are `on the right track' and that our current lifestyle is in accordance with some deep felt, biological needs (Slurink, 1994).

Ultimately, of course, even our primary system of values and conative expectations is a fallible guide. It is a product of variation and selection in a particular set of environments. If the primary systems of value were to be adaptive all the time, this would be more an argument for Providence than for evolution. The same can be said about our evolved cognitive expectations generally. If these expectations had been true all the time, they would not have been products of natural selection. They may tell us something about the environment in which our ancestors evolved - what Bowlby calls the `environment of evolutionary adaptedness' (Bowlby, 1969) - but they do not necessarily tell us something about the universe in general.

5.THE SOCIAL CONSTRUCTION OF REALITY

We are social animals and the acquisition of knowledge is a social enterprise.

Thus far I have only discussed what Bacon called the `idols of the tribe', arising from the nature of human understanding - the list of idols or false images which Bacon composed also includes `idols of the cave' - personal idiosyncrasies -, `idols of the market-place', resulting from the deception of words, and `idols of the theatre', resulting from the power of received philosophical systems (Hesse, 1964). In contrast to Bacon I hope to have shown that the `idols of the tribe' are not merely handicaps which impede the growth of knowledge, but that they constitute above all an indispensable frame-work of working hypotheses which enables us to start collecting knowledge in the first place.

Does this same ambivalence hold for the `idols of the market-place' and for the `idols of the theatre'? A large group of modern philosophers takes a much more radical view. Laughing at Bacon's (and the logical positivists') inductivism and about rationalistic attempts to justify knowledge with reference to the sound methodologies of reason, these thinkers have embraced the discoveries of a series of sociologists of knowledge with respect to the `social construction of reality' (Berger & Luckman, 1966) - and they often take them to the very heart of their philosophies (e.g. Bloor, 1976). If some of these `social constructivists' are right, scientific theories are purely products of social negotiation and the acceptance of particular theories reflects the social dominance of their supporters rather than a set of inherent qualities which guarantee at least some progress in the direction of truth. With respect to naturalism and Darwinism such thinkers will sometimes claim that these can better be viewed as theoretical by-products of the currently dominant ideology of neo-liberalism and neo-capitalism than that they reflect break-throughs in our self-understanding and our understanding of the nature of life and the world.

Does the `social construction of reality' mean that we are locked up in socially created phantasmagoria and that we can never transcend the equation of social agreement and truth? Perhaps, but if this were true it would be a paradox at the same time: the truth of radical social constructivism would be itself `merely' socially determined. Can evolutionary epistemology help the social constructivist to step out this circle?

First, let me stress that evolutionary epistemology simply has to fall in with social constructivism on many points. We are social primates that have become completely dependent on social learning and the social transmission of information (King, 1994). Although some animals are individual learners and to some extent survey their habitats as individuals, unable to transmit their acquired maps of their environment and other knowledge to conspecifics, science as we know it is fundamentally based on language and on the social transmission of ideas based upon it. If each individual had to start from scratch, its knowledge of its environment would come no further than those mythological children raised by wolves - and even those children were helped by rather intelligent, cooperative group hunters with an extensive knowledge of their environment.

At the same time, it is clearly true that many ideas owe their success largely to social factors. To be successful or popular an idea has to be, for example, easy to understand, applicable to many situations (especially enlightening with respect to the current socioeconomic and political situation), status-enhancing (e.g. as a result of the high status of its originator), not too deviating, stimulating (or at least somehow reassuring), in agreement with the perceived interests and aspirations of the generation of its supporters (compare the advantages of political correctness) and sufficiently vague to allow for hermeneutical and ideological maneuvering within a wide range of personal and political situations. In many cases people have good strategic reasons to be in favor of a particular idea. Scientists do not form an exception to this rule - on the contrary: they often have to choose between one or two, at best three, competing schools to be eligible for financial support.

All this cannot mean, however, that what we perceive as reality is entirely a social construct. If the truth of social constructivism itself were merely another social construct it would not deserve more serious consideration than other social constructs, like, for example, astrology, scientology or the belief that the aliens are already among us. To compete with other social constructs social constructivism has to give better explanations, better predictions and to show that it is compatible with more scientific theories than other theories of science. One of the social constructivists has even made this demand for `reflectivity' explicit (Bloor, 1976; Luyten, 1995). Social constructivism cannot, therefore, merely dogmatically state that theories are social constructs, it should also explain why such social constructs emerge and why they are needed in the first place. Like any theory of science it should attempt to defend its anthropological assumptions and it should show why its implicit anthropology is better than that of other models.

In Berger and Luckman's *The Social Construction of Reality* precisely this has been done. They try to give their social constructivism a foundation by explaining why man needs a socially constructed model of the world:

> Man, unlike the other higher mammals, ... has no species-specific environment... There is no man-world in the sense that one may speak of a dog-world or a horse-world. (Berger & Luckman, 1966: 45).

They even go so far as to claim that

> Social order is not biologically given or derived from any biological data in its empirical manifestations... it is an ongoing human production... Social order exists *only* as a product of human activity. (Op. cit.).

Thus their social constructivism seems to be based on an opposition between `social' and `human' on the one side and `biological' on the other side, as if animal societies do not exists and as if humans are not products of biological evolution. If this were the case, however, one would have to explain how such parabiological creatures could have evolved in the first place and why they would need a social order. Would they not be better off without a social order, making their hypotheses all for themselves without competition from other hypotheses? Why would a being with such `highly unspecialized and undirected drives' (op cit.) not live for itself and why would it bother, if it were really indifferent to social status, to get its theories accepted?

The problem with social constructivism is that it is not completely untrue, but not truly complete either. It has at least to be completed by something like the `social psychology of science' (Campbell, 1988; Shadisch & Fuller, 1994). What factors cause one theory to be accepted and another theory to be rejected? What motivates the proponents of a theory and what its opponents? Why would science, just like religion, need `central' and `peripheral cults' (Lewis, 1971) and why do major scientific revolutions (say, those instigated by Copernicus or Darwin) take at least three generations? Why do some scientists prefer revolutionary new paradigms while others tend to cling to traditional models, even if they show many anomalies (Sulloway, 1996)? Why would the scientific community be so hierarchical and why would it need so much *rites de passage*? Why would the success of scientific theories depend so much on the specific talents and charisma of its dominant proponents and their ability to found a `school' for themselves (Campbell, 1988). Why would there be a tendency to develop esoteric vocabularies, even if these obscure matters more than they enlighten them?

For someone familiar with modern ethology it is difficult to resist the temptation to notice all kinds of parallels between the territory fights of animals and those of scientists defending their specific specialism. Such parallels may be suggested by phylogenetic affinity - which reminds us of the group territories, coalitions and traditions of chimpanzees - but they may also be based on the convergent evolution of species that have to defend some kind of territory - be it a spiritual or virtual one - or that have to display their feathers - their expertise - at some kind of communal arena or lek to assert their rank. The moment one starts to speculate about the psycho-evolutionary and ecological constraints which have given rise to this strange segment of modern society, the `scientific community', it becomes harder and harder to remain a social constructivist, however. The deeper one starts to reflect on science and its origin, the more one has to dive into primate evolution and the evolution of `social information transfer' (King, 1994) and the more one is forced to take the *survival value* of information and its transmission seriously. Thus one is forced to give an answer to a question that the social constructivists simply seem to neglect - why would science arise in the first place?

With this question the inadequacy of a simple relativism becomes apparent, too. If one assumes that one's hypothesis about the causal determinants of science is better than others, one has to assume at the same time that scientific hypotheses not only owe their differential success to the psychological and social weapons of their proponents, but that they also display differential ontological adequacy. What we perceive as `truth' may be determined by elaborate intellectual negotiations, but these negotiations might at the same time function as a decision process in which complex and contradictory evidence is weighed in such a way that at least some progress is made. *The factors that determine the social acceptance and success of a particular theory need not be completely different from factors that may guarantee some degree of ontological adequacy.* To suggest that only the `social factors' matter to the success of a scientific theory, is to underestimate the creativity, curiosity and critical abilities of at least some of the individuals that constitute the scientific community. At the same time it implies that one ignores the irreplaceable value of knowledge and orientation to animals in general and humans in particular. The fact that some scientists *pretend* to have knowledge and that their charisma and rhetoric virtuosity may attract a snowball of supporters, means only that there is a lot of deception and snobbery going on in the knowledge market - as in almost every market.

To show the differences and the correspondences between the causes of the popularity of a theory and the factors that may increase its likelihood of being true, one can make a table in which the various factors are listed (see table 2-1). Of course, one may differ in opinion with respect to some of the factors listed, but at least this table shows that the ease with which social constructivists uncouple success and truth is not justified. The gap between the causes of success and the ontological adequacy of a theory explains the necessity of a good set of scientific norms, which have to be based on a knowledge of the strong and weak points of the human knowledge apparatus and the scientific decision process. It is not unreasonable that those norms are sometimes distilled from those characteristics of theories that both promote their social acceptance and their likelihood to be true (marked with an asterisk). This should not tempt us, however, to forget the tension between the acceptance and the potential adequacy of theories. Many theories are true *despite* their lack of popularity - a fact which, perhaps, social constructivism should try to explain.

Factors that may be responsible for	Social success and acceptance of a theory.	Ontological adequacy of a theory.	Is there a conflict?
Simplicity	Yes, people like theories that they can easily understand.	Yes, theories which are too complex often contain superfluous theoretical entities.	Not always
Coherence	No, people often do not notice incoherences.	Yes, if incoherent theories were ontologically adequate, science would be impossible.	Yes
Conceptual clarity	No, people prefer theories that are sufficiently vague to allow for hermeneutical and ideological maneuvering within a wide range of personal and political situations.	Yes, theories in which concepts are unclear may suggest that they offer more insight than they really do.	Yes
Verifiability	Yes, in the long run people will be impressed by the evidence.	Yes, whatever verification means, a theory without it is just a thought.	No*
Predictive power	Yes, in the long run people will be impressed by the utility of the theory.	Yes, despite the claims of the instrumentalists, the predictive power of a theory is seldomly a coincidence.	No*
Explanatory power	Yes, people are interested in theories that throw light on their current socioeconomic and political situation.	Yes, the more a theory explains, the more it becomes improbable that this is just a coincidence.	No*
Robustness or multiple derivability (Wimsatt, 1981)	Yes, people are generally better at assessing the robustness of a hypothesis, than they are in following complex deductive arguments.	Yes, if a theory is independently confirmed in different fields, it becomes improbable that this is just a coincidence.	No*
Intuitive plausibility	Yes, this is often one of the reasons that people disagree with scientific theories.	No, many scientific theories are contra-intuitive.	Yes
Stimulating power	Yes, people prefer theories that give them hope and that assert their values.	No, optimistic people are often bad realists.	Yes
Snob value	Yes, people like theories which make them look relatively intellectual and sophisticated (which enhance their status).	No, theories which look intellectually sophisticated are often simply based on an exaggeration of one aspect about which ordinary people are naive.	Yes
Conformistic appeal	Yes, as judging the evidence oneself is difficult, one can sometimes better rely on the choice of others or on supposed authorities.	No, the fact that millions believe something or that a famous scientist or philosopher believes it, does not make it true.	Yes
Conclusion	Although the social success and acceptance of theories is partly based on factors that have nothing to do with the likelihood of their ontological adequacy, there are also factors that both promote the success and acceptance of a theory and its likelihood of ontological adequacy (marked with an asterisk).		

Table 2.1 Theoretical virtues that may be responsible for the social success and/or ontological adequacy of theories.

One additional way of clarifying the thinking error of the radical social constructivists is by reflecting further on the parallel between theories and social displays. From the perspective of modern evolutionary psychology (part II of this book) one could compare the eagerness of young scientists and philosophers to present their new discoveries and theories as an attempt to win social recognition and status. One could even compare their articles, books and lectures to the bluff displays of chimpanzees by which these relatives of ours try to gain dominance (e.g. de Waal, 1981) or to the displays of feathers by male peacocks. Such a comparison is consistent with data that show that human males start to talk more about work and academic subjects in mixed groups (groups of both sexes), which brought Dunbar to the idea of talking about `vocal leks' (Dunbar, 1996). Often relatively successful scientists and philosophers are willing to admit in private that they owe part of their success to bluff and window-dressing, so this interpretation is not entirely in conflict with the phenomenological evidence.

Does this justify the conclusion, however, that the success of particular theories and their proponents is *merely* the result of bluff and window-dressing? As a result of the ethological analogy we can gain the critical distance required to answer such questions by watching and studying peacocks and chimpanzees more closely. Is their success *merely* determined by the attempt to impress rivals and females or are there more factors involved? In the case of peacocks and chimpanzees it is immediately obvious that *displays, in order to be successful, have to be difficult to imitate.* Only a healthy peacock can grow a train with many `eyes' and females consequently choose males with most `eyes' in their trains (Petrie, 1994). For a not-too-healthy male it is simply not possible to fake a train with a lot of `eyes'. In chimpanzees the situation is slightly more complex. Most bluff displays are hard to imitate, because they presuppose a lot of agility, daring, command and force. Some chimpanzees seem to be intelligent enough to know that it is the impression that they leave on others that counts (as will be seen in chapter 4, sociobiologist even suspect that self-consciousness arose as an ability to anticipate one's social impact). Jane Goodall tells us in one of her early books how the chimpanzee Mike used empty petrol cans in his bluff displays. By slamming them together and even by flinging them away, Mike succeeded in making so much noise that he won the respect of several important males and even conquered the dominant male at that time, Goliath (Van Lawick-Goodall, 1971: chapter 10). Even in such cases, however, such displays are hard to imitate. It would only be naive to assume that they reflect force, command and agility only - a lot of ingenuity, daring and `pure bluff' is also needed.

The analogy with the behavior of scientists and philosophers bears fruit now. Of course, such intellectuals defend their theoretical positions partly because they are building their careers on them. They will display their expertise at any place - their `vocal leks' may include coffee-tables, seminars, conferences and scientific journals - and they will do so especially when other intellectuals start to invade `their' intellectual territory. At the same time, however, their anxiety to find support for their `position' *forces* them to consider enormous collections of data. Their continual fights with other intellectuals *force* them to localize the strongest deductive links between those data. Their intellectual fighting power is, therefore, at least partly based on factors that also increase the likelihood of the truth of their theories. In most disciplines - philosophy and the humanities sometimes offer interesting exceptions - a recourse to pure rhetoric and a reference to authorities and dogmas will be seen through by their colleagues. As a result, it pays to look to the facts and arguments sincerely: the truth is simply the best weapon. Thus the individual curiosity that a scientist drives and his public need for support may reinforce each other, despite the all too real temptation of resorting to rhetoric, window-dressing and even fraud. In a situation in which all parties concerned are committed to the truth, collective scientific progress is possible, even if science is partly driven by the private interests of a multitude of scientists. In fact, scientific progress is largely propelled by arm-races between scientists, scientific teams and scientific communities which have to *prove* their superiority by being the first to unearth bones of dinosaurs or hominids, to reveal particular molecular structures, to synthesize new chemical compounds, to clone mice, to place astronauts on the moon and on Mars or to create new resistant crops. If such exploits are displays of ingenuity and power, at least part of their appeal lies in the fact that they are hard to imitate: in that respect they represent much more than `pure bluff' and window-dressing.

6. PRELINGUISTIC THOUGHT, LANGUAGE AND THE TENDENCY TO TRANSCEND EXPERIENCE

As a result of its constructive and `hypothetical' character, language enables us to transcend the horizon of our immediate experience and to train our imagination. As a result, we live in a world of fantasies and theories.

a.Is the systematism of natural language ontologically arbitrary?

Contrary to what was formerly often thought, the sounds of many animals not only express states of mind, but also refer to real structures of the world, for example to specific classes of predators (e.g. Cheney & Seyfarth, 1990; chapter 6). Many solitary animals without language have the same underlying capacity to discriminate different types of dangers and possibilities. Connectionism shows how prototypes might originate in neural networks which have been designed to connect particular input patterns to specific behavioral outputs, without the intervention of explicit language (Churchland, 1989, 1995). It is, therefore, reasonable to assume that language and thinking have evolved partly independently, language already presupposing some kind of `mentalese' (Fodor) and particularly evolving in extremely social animals which have to *share* information about the world.

Because many substantives seem to refer to specific classes of objects or `natural kinds', it is tempting to assume that the structure of language somehow reflects the structure of the real world. However, the idea that language evolved as a system of reference which had to map the world on a scale of one to one ignores the fact that a `translation into another medium' always results in transformations (chapter 6). The medium, in this case the mind, does not passively *reflect* but actively *reconstructs* the world *in function of particular behavioral goals.* On top of that, according to one recent theory, language did not primarily evolve to share knowledge about plants or animals or to transmit technological skills, but to enable individuals to entertain more contacts in larger groups (`vocal grooming'; Dunbar, 1993; 1996; Aiello & Dunbar, 1993). Linguistic expressions often constitute *social actions* and description is therefore only one of the functions of language. Apparently language served more than one function during its evolution and as a result of that one might expect that its constitutes a compromise between:

a. usefulness as an instrument to transmit (prototypical) information about danger, food and skills;
b. usefulness as an instrument to attract, bind, entertain and manipulate conspecifics;
c. manageability for the speaker;
d. decodability for the listener.

Consequently, it would be very unwise to extract an ontology from the way in which language (re-) structures the world. Grammar, even deep grammar, cannot be trusted as a guide to the real structure of the world, because it is largely based on a very rough and largely arbitrary schematization of the world in terms of `subjects' and `actions'. For example, *`it'* can *`rain'* (verb) and one can walk in *`the rain'* (noun). The partial arbitrariness of natural language can be shown by speculating about the possibility of languages without nouns, as Borges does in his story *Tlön, Uqbar, Orbis Tertius*: according to Borges there is in the language of Tlön

> no word corresponding to the word `moon', but there is a verb which in English would be `to moon' or `to moonate'. `The moon rose above the river' is *hlör u fang axaxaxas mlö*, or literally: `upward behind the onstreaming it mooned' (Borges, 1978).

Several philosophers, including Nietzsche and Wittgenstein, have pointed to the ontological seductions of natural language. Nietzsche saw clearly that the tendency to think in terms of `subjects' and their `actions' was both deluding metaphysicians and physicists. Wittgenstein went so far as defining philosophy as the struggle to overcome the bewitchment of language. This would imply however, that we are able to overcome this bewitchment and that our thinking is not necessarily completely dominated by the deceiving systematism and schematism of natural language.

b.The essentially constructive and hypothetical nature of words and language

Despite the fact that there are clearly forms of thinking that are independent of language - one needs only to look at one's own dreams and semi-automatic actions - it cannot be denied that language is a superior means of training one's thoughts and expanding one's cognitive horizon. As every field naturalist knows the simple activity of naming or determining species of plants or animals will enormously enhance one's discriminatory power and one's attention for both detail and global form. From the perspective of connectionism, detailed linguistic categories can be seen as a diversification of output patterns that force the system into extracting a maximum number of prototypes out of the series of input patterns. Language also enables the borrowing of prototypes from other semantic domains into regions in which it is not easy to form prototypes. Such metaphors need not be completely adequate to catch at least some distinctions which would otherwise get lost.

Trial and error must play both an important role in language evolution and in language acquisition. This is already clear in the `language' acquisition of vervet monkeys to which I referred already. Infants and juveniles start giving eagle alarm calls at different birds and other things in the air, leopard alarm calls to all kinds of terrestrial mammals and snake alarms to long, snakelike objects. In reaction to such alarm calls, adults nearby will look up or down and only give a second alarm call if the object in question really poses a danger. This seems to work as a reinforcer and infants and juveniles gradually learn to give the alarm calls only in the appropriate context (Cheney & Seyfarth, 1990).

Language acquisition in human children often shows the same trial-and-error-structure and perhaps this is why babbling and mother-baby and father-baby dialogues are important. Only a type of learning by trial and error can solve Quine's `Gavagai'-problem: the problem of a linguist visiting a country whose language he does not know and who hears everyone speaking about `gavagai' in the presence of rabbits. The problem is how such a linguist can ever be sure what `gavagai' means, `rabbit', `animal', `mammal', `head', `fur', `rabbit-like shape' or whatever (Quine, 1960). Of course, we are all such linguists and we have inferred the meanings of most words from specific contexts at an early age - we can only use them because we hope and trust that others share our interpretation. Donald T. Campbell has suggested that our initial guesses have a more than random chance of being successful as a result of an innate expectation of `entativity': we have an innate tendency to suppose that words are most likely to refer to easily perceivable, stable aspects of the environment (see § 2.5.b above). Perhaps it is because we share a whole set of innate expectations with our conspecifics that we are able to step into the hermeneutical spiral which makes language learning possible. At the same time, trial and error learning processes are certainly necessary to pin some meanings down and the fact that they take place is continually proved by children who overgeneralize.

All this means that many words are by their very existence a kind of `hypothesis'. The word `horse' implies that there are a series of characteristics which hold a collection of quadruped entities together which may all neigh, trot and graze if they are not dumb, lame or dead. As Plato saw, the word `circle' refers to a transcendental similarity between a lot of quite dissimilar entities. Perhaps as a result of our tendency to postulate entativity with respect to the meaning of words we also tend to reify abstract terms and properties of systems. In most cases, this is exactly the tendency that Nietzsche and Wittgenstein tried to overcome. For example, there need not be postulated a distinct faculty like `free will' floating above the rest of our psyche to account for our ability to make decisions on the basis of the weighing of different scenarios instead of the weighing of different inclinations only. There need not be postulated a *res cogitans* to account for our ability to think and there need not be postulated `an idea of the Good' to account for the fact that the goals of a multitude of humans are not necessarily in conflict all the time. Each time, the creation of a word seems to imply a hypothesis about a new kind of entity: more than anything else this shows that language has an essentially constructive character. (Yet, at the same time it should be noted that we should beware not to throw away the baby with the bathwater when we are trying to overcome our tendency towards reification. While properties of systems are not things, they are still relevant. See for example fig. 4-9 to see how `a common good' may emerge when individuals have overlapping goals.)

c. Our tendency to form hypotheses which transcend experience

As has already been seen in chapter 1, one can teach grey parrots, apes, dolphins and sea lions elementary languages, too. This could mean that our difference from such species is not one of kind, but one of degree, to cite Darwin. On the other hand, the fact that we are specialized in language production (as proved by the form of our larynx and by specialized brain centers like those of Wernicke and Broca) points to the fact that our intellectual abilities have been co-evolving with language for a long time. This is probably the reason that we have such an exceptional imagination, compared to other species. Because of its constructive and hypothetical character, language is often able to lift us beyond our immediate horizon. Both the theory that language evolved to enable us to entertain contacts with larger groups and the theory that it evolved to transmit information about food or danger `beyond the horizon' are compatible with the idea that language stretches our minds into the otherwise unknown: it is a vehicle for the imagination, a tool with which the messenger-god Hermes lifts us beyond our narrow and transitory perspective.

At least since the upper paleolithic transition - very roughly, the period in which the Cro-Magnons arrived and the Neanderthals declined - humans have become increasingly dependent on stones, shells and other goods which had to be transported from afar: the amount of planning, deliberation and cooperation involved is hard to imagine without language, because only language is a system of reference which goes beyond the immediately given. If this is true, language and the ability to expand our immediate horizon by devising scenarios of the `beyond' may be considered one of the characteristics that distinguish us as a species. A similar idea was expressed by the Spanish philosopher (who spent most of his life in exile) Ortega y Gasset:

> Man is a fantastical animal, he was born of fantasy, he is the son of the `mad woman of the house'. And universal history is the gigantic and thousand-year effort to go on putting order into that huge, disorderly, anti-animal fantasy. What we call reason is no more than fantasy put into shape. Is there anything more fantastic than the mathematical point, and the infinite line, and, in general, all mathematics and all physics? Is there a more fantastic fancy than what we call `justice' and the other thing that we call `happiness'? (Ortega y Gasset, 1975: 248).

Contrary to what Ortega y Gasset thinks, this idea is completely compatible with Darwinism, however. Imagination and fantasy need not be seen as sickly, non-adaptive `anti-animal' capacities. Since the upper paleolithic transition our species may have been successful in competing with other species, *Homo neanderthalensis* for example, exactly as a result of its innovative fantasy, which enabled our ancestors to become ecologically flexible. Since that period our species started to penetrate new habitats and to exploit new food sources. Often technology played an important role in opening such habitats: harpoons were devised, for example, to catch fish; animals were domesticated (the start of zoo-technology); finally the plough was invented. It seems that man has a natural tendency to transcend the given, including the tradition, by means of the imagination and technology (which is the fruit of this imagination). Even religion could thus be explained: the moment people lose control over their destiny, their imagination is stimulated to do anything that *could* work, even if this implies begging virtual dominant individuals for help. This way they can keep hoping and stay ready to intervene immediately the situation changes for the better.

Therefore, paradoxically, the same excessive imagination gave rise to both religion and science. The advantage of this imagination is that one does not need to discover everything by means of trial and error: one can often rely on an internal simulation of what is likely to happen. As a result one no longer needs to make *every* stupid mistake to be able to learn. One can start with internal reconstructions of aspects of the world, models which one can test in artificially created circumstances in which most other aspects are kept constant. As a result of this ability to create, test, improve and integrate better and better models of the world, humans were able to transcend the limits of their natural world-experience.

That does not mean that we have finally left this limited natural experience of the world, however. Although we may know that the sun does not set, but that we gradually turn into the shade of our rotating planet, we still may be unable to realize this continually. Most of the time we simply live in a world which is largely the product of our innate expectations and our innate categories. In most cases our fantasy is largely recruited to devise scenarios which are highly relevant to our own interests. That means that our cognitive faculty stays a vital `organ', which is continually *evaluating and driven by values.* If we are depressed it produces gloomy scenarios for the future of our genes and about the world in which they have to survive; in a more elated mood it explores opportunities to improve the world in general and our lives in particular. Only a small fraction of the population worries about models about the world beyond a small horizon. The thought that the sun will burn away or that the universe contains enough dark matter to make it collapse does not alarm us most of the time - in contrast to the possibility that we will lose a member of the family: only something like that can really make our universe collapse.

7.THE ART OF GAMBLING

Our knowledge-capacity, itself a product of variation and selection, enables us to expand our knowledge by trial and error, but not to transcend the inherent uncertainty which results from this procedure.

All living organisms with internal representations of the world are indeed monads, locked up in the world of their experience. In contrast to what Leibniz thought about monads, however, it is not God, but natural selection which has seen to it that our experiential worlds `fit' to some extent the real world. As `fantastic animals' we are, on top of that, monads locked up in our own fantasy worlds. Selection through falsification and/or selection as a result of differential theoretical and empirical progress guarantees to some extent the `fitting' between some of our disciplined fantasies and the world. Life is a product of chance, lucky circumstances and the preservation of successful formulas - and so is knowledge.

That means at the same time that all knowledge remains uncertain. The uncertainty with characterizes theoretical models is a late descendant of the same uncertainty with which life started. Once, about four billion years ago, self-replicating molecules arose as a result of the endless chemical reactions in the primeval atmosphere. Because successful replicators inherited their successful properties such properties could accumulate in their descendants and could `inherit the earth' (to use a biblical phrase). If it is true that Einstein, with respect to the uncertainty principle, said that God does not play dice, he was certainly not right with respect to the creation of life, because God or nature (which for Einstein, a follower of Spinoza, were the same) must have actually liked playing dice to find the successful formulas to start with. Playing dice is also a good metaphor to render the way in which life is able to adapt to changing geological and climatological circumstances. In fact, sexual reproduction can be explained as a system of increasing the variability of offspring, which increases the chances of variants which are successful in future circumstances.

The miracle of knowledge - the, to some extent, `adequate' internal representation of the world - is also best explained with reference to the art of playing dice. In contrast to the normal play of dice in which no progress is possible, however, an accumulation of lucky chance is possible in knowledge as it is in life generally. With respect to knowledge this means that *progress never implies the erasure of uncertainty but rather the accumulation and convergence of plausibilities.* As is shown by the phenomenon of the `Gestalt-switch', even our sophisticated perception still bears the traces of the necessity to gamble. As Grégory claimed, an observed object is a hypothesis which is proposed and verified on the basis of sensory data. The more observations we combine by means of categories, laws and models, the less brain power we have left to compare the resulting image with the image we would have produced if we had used different categories, laws and models. (We need theories, because our brains are too limited to contain all possible facts: theories are a means of regaining an overview by abstracting from details. The word derives from the greek θεωρία = looking on, witnessing a spectacle).

Exactly for that reason a naturalistic, instead of a transcendental, justification of our innate forms of knowledge can never be more than cautious and pragmatic: induction, abstraction, the postulate of universal causality and the law of the preservation of energy remain hazardous - in the last resort a series of successful and well-tried guesses. Despite the fact that we can criticize our own knowledge apparatus, can study its adaptedness and compare it to other biological and artificial systems, despite the fact that we can abstract to some extent from our own subjectivity by registering the same information using non-biological measuring-instruments, we still remain in the last resort `frozen into a particular interpretation'. There are no decisive criteria to establish the adaptedness and adequacy of our knowledge forms, because we cannot step outside our cognitive relation to the world and compare it with all other possible cognitive relationships. At the same time, we can flatter ourselves with the idea that we have inherited some very successful knowledge forms and categories which are the result of several billion years of cognitive evolution. Although, strictly speaking, theories that *work* are not necessarily *true* as well, it is hard to imagine that the success of such inherited knowledge forms over billions of years of evolution is purely accidental. To some extent, perhaps, to live is to err, but the discovery of that fact would be impossible if we were not, at least sometimes, able to discover the truth. Evolutionary epistemology offers a frame-work for understanding the conditions under which we are likely to err and under which we are likely to conquer our errors.

However, it is wise to remember that all knowledge of the world derives from a snowball of unsupported, but successful guesses. It would be paradoxical if evolutionary epistemology were to claim to produce an absolute foundation of our knowledge. It can only claim that our technique of making informed guesses has enabled us to survive and that the scientific procedure of devising, testing and improving hypotheses may continue to improve our grip on the world (but not necessarily our grip on ourselves). At the same time it predicts that we, as parts of nature, will probably never be able to understand everything. Max Planck compares the uncertainty in the prediction of the behavior of elementary particles, which as a result of measurements is influenced in an immeasurable way, with the uncertainty in the prediction of our own behavior, which is influenced in an unpredictable way by this prediction, and sees both as results of the fact that we are *parts of nature*, unable to look at it `from outside' (Planck, 1947: 265). Evolutionary epistemology makes us suspect that we are probably `blind' to particular types of information and to particular laws or properties of nature and that our natural expectations probably prevent us from seeing particular connections. It could be possible that the discovery of the true structure of the universe, if something like that exists, requires a `Gestalt-switch' which is beyond the capacities of any evolved intelligence, at least beyond the capacities of the coarse hominoid apes of this planet. Let us not forget that a lack of cognitive resources also represents a certain survival value. When Odysseus leaves Calypso and returns home on a wobbly raft, the goddess warns him "that he, if he could only vaguely suspect what sorrows destiny disposed him to suffer before he were to arrive home, would certainly remain with her" (Odyssey, V, 206-210).

3

* Captured in our Cockpits: Why Consciousness Evolved \\\

3.1 INTRODUCTION AND OVERVIEW

The most central topic in epistemology, in the philosophy of mind and in the area of `animal philosophy' is the problem of consciousness. In recent years several attempts have been made to `explain' consciousness and although many of the resulting models explain important aspects of consciousness, other fundamental aspects of consciousness are still neglected. Sometimes this is a consequence of presuppositions which cannot be critically assessed within the discipline from which the model stems. In this chapter I will claim that the different approaches can best be integrated within an evolutionary framework. Although many philosophers, neurobiologists and cognitive scientists think of themselves as evolutionists, they are not always aware of the consequences of Darwinism. Because they are relatively unfamiliar with the way in which evolution works, they are often too optimistic about the chances that particular kinds of minds can arise as a result of natural selection processes. It seems to me that it is this `semi-evolutionism' (or demi-Darwinism) that leads to pitfalls such as:

a. treating consciousness one-sidedly as a cognitive phenomenon (it could well be primarily a motivational phenomenon),
b. focussing one-sidedly on the neurophysiological level (forgetting that adaptations are likely to be emergent properties),
c.treating learning as the expression of the plasticity of the mind only (and forgetting that learning abilities are usually designed to acquire very specific skills and types of knowledge).

All these misunderstandings derive from an inability to see consciousness as an *adaptive phenomenon.* Consciousness is a good candidate for an `adaptation', because complex properties of organisms that require very specific combinations of genes are more likely to be products of variation and selection than of pure chance. Of course, consciousness could be an accidental by-product of another adaptive trait. This is unlikely, however, because the *subjective qualitative contents* of our experiences (e.g. pleasure or pain) are an integral part of our behavior. Negative experiences are linked to injury and malfunctioning and stimulate withdrawal, caution and care for oneself, whereas positive experiences are linked to health, growth and reproduction and stimulate activity, territorial expansion and reproduction (an argument going back to William James and Roy Wood Sellars). Some organs, like the heart and the intestines, seem to work independent of conscious control (being coordinated by the autonomous nervous system), whilst other organs seem to require conscious control at least during the obtaining of different skills (Baars, 1997). On the other hand, several defects have been discovered, like blindsight and the amnesic syndrome, in which conscious control of - and conscious access to - specific functions is lost without erasing those functions completely. However, nowadays such defects are no longer used to nourish the `epiphenomenalist suspicion' (Flanagan, 1992), because it is exactly the study of these defects that has enabled neuroscientists to compare cognitive processes which are consciously controlled with those which are not (Weiskrantz, 1997). As a result, students of brain and behavior are increasingly starting to consider the study of the evolutionary `Why?' of consciousness as a legitimate enterprise.

In this chapter I will defend the thesis that questions relating to the presence and nature of consciousness in animals and man can only be answered by interpreting consciousness as an adaptive phenomenon fully integrated into the behavioral repertoire with which a species has to cope within a particular environment. That implies that all theories which try to explain the neurophysiological `How?' question about consciousness should be integrated with the evolutionary `Why?' question, which should be asked from an all-encompassing evolutionary and ethological frame-work. I will try to show that in some current theories about consciousness the degree to which the brain is genetically prewired is still underestimated and I will propose that the phenomenon of radical subjectivity is best explained by cross-fertilizing evolutionary psychology with the theory of value-driven decision systems. Evolutionary psychology, building on selfish-gene theory, explains why consciousness is thoroughly perspectivistic and related to the interests of the individual or even of its genes. Value-driven decision-system theory, as developed by G.E. Pugh, explains the necessity of a decision system in which different behavioral options can be compared and `weighed'. I will try to show that consciousness constitutes a cognitive and motivational straitjacket which `subjectively forces' animals to act in an adaptive, and (inclusive) fitness maximizing, manner. `Innate structures of experience' are needed to supply values that enable animals to weigh different behavioral options: They supply heuristic approximations of the survival values of different experimental behavioral strategies (which may be explored during play). With a variation on a recent concept of Melzack, they may constitute a `genetically prewired neuromatrix for adaptive decisions'. The resulting evolutionary epistemology is somewhat more critical than German-Austrian evolutionary epistemology as it stresses the way in which information is subjectively transformed to narrow down the list of behavioral priorities for the organism. The model thus suggests a realistic and adaptive interpretation of qualia and stimulates the search for their behavioral correlates in animals other than man. At the end of the chapter, I will do an attempt to evaluate the evidence for animal awareness from this perspective.

What is consciousness?

Probably most readers would agree that consciousness can be viewed as a property of a living and working brain which enables the organism equipped with this brain to `live a life on its own', to experience its situation from its own perspective. Consciousness creates an unbridgeable gap between an individual that follows its own idiosyncratic course through its surroundings and all other organisms that can only guess at what the individual in question is intending. It thus constitutes a gap between inside and outside, between a domain of private and privileged access and a domain to which others may also have access.

Much philosophical confusion has arisen as a result of a tendency to reify both domains as different `substances', mind and body. On the one hand, a simplistic identification of those `substances' will not suffice, because much more activity goes on in our bodies and brains than we are consciously aware of. The phenomenon of death shows that consciousness is much more a property of specific bodies and brains than that it can be identified with those bodies/brains. On the other hand, most philosophers don't want to go back to an attempt to view the mind as a kind of transbiological phenomenon that `hovers' above the brain and makes contact with it via, for example, the pineal gland (as Descartes thought). I defend the view that consciousness is *an adaptive function, embodied in a* *particular brain organization, that enables certain organisms to interact effectively with their environments in such a way that they are able to `calculate' and pursue their own unique interests within that environment from their own unique perspective.* Consciousness is in this view completely linked to making very complex adaptive choices. The problem is, of course, that we all know that many, many conscious choices are not adaptive. The argument that "nature is not perfect" and that man is probably not optimally adapted to its current environment sounds as a bad excuse, similar to the `justification of God' or theodicee within the theistic world-view , but may nevertheless offer the a better solution than throwing out the baby (of adaptation) with the bathwater (of perfectness).

Before I start defending the evolutionary approach, however, let us try to agree on a number of `phenomenological' issues that have to be dealt with within a complete theory of consciousness. Most readers will probably agree that an adequate theory of consciousness has to explain some of the following properties on which philosophers have dwelled for centuries:

- Consciousness is characterized by *qualia*, the Latin word that was originally selected by Cicero to translate Plato's `poiotês', `of-what-kind-ness' (Barlow, cited in Baars, 1997: 82). Originally the word referred to characteristics of objects, but it is used currently to refer to our unique subjective experiences of such characteristics. There is a difference between the different wavelengths of visible light and the way an organism *experiences* them. Additionally, one cannot describe one's pleasures and pains simply by `measuring' their values on some quantative scale. The problem is that qualia are only perceptible from a first-person perspective and that one cannot compare first-person perspectives objectively: Long conversations with much empathic projection are the only means of obtaining glimpses of the internal states of other persons.
- Consciousness is often linked to *intentionality*. Intentionality derives from the Latin word *intendere* which seem to have arisen in the context of fighting with bow and arrow and means: stretching, aiming at, threatening with, etc.. One could translate it as `aboutness', claiming that we are always conscious `about' something (Brentano's thesis). Often objects or relations surrounding an organism are somehow `represented' in its mind. This `representation' should not be seen as a mind-copy of the object, but should be seen as the organism's *cognitive gateway* to that object, the `sign' or `access-code' which enables the organism to deal with the object and to learn more about it.
- Consciousness seems, to some extent, linked to *`control'* and *volition*. In the cognitive realm that means that it may result in the control of attention; for the organism as a whole this means that consciousness seems to be linked to volition and action. Traditionally the so-called freedom of the will was often opposed to determinism, but within a naturalistic frame-work it should only be opposed to a narrow physical, chemical or genetic determinism and the will can be called free if it is determined by a weighing of the desirability of different scenarios (`soft determinism'). A transcendental free will, which does not somehow reside in the unique properties of some brains, cannot be the object of scientific thinking.
- As shown by many writers, including Augustine, James, Joyce and Proust, consciousness has the character of a *stream*. In fact a lot of small brooks lead into it and it shifts its course continually, which makes its behavior hard to predict. It certainly does not have the character of a series of logical deductions from

observations and it often enables us to be occupied with different problems at the same time, shifting our attention from one to the other continually. (If we are unable to retrieve a name, for example, it often ascends later unexpectedly, as if a search-program had been working backstage all the time).

- Consciousness, at least in human beings, seems to result in *self-consciousness*, an awareness of an own unique self which is different, and to some extent isolated, from the rest of the world. This self offers both the context of the series of decisions which emanate from it as it is, to some extent, changed and constructed by them.

3.2 CONNECTIONISM, CORTICOTHALAMIC LOOPS AND FORTY-HERTZ OSCILLATIONS

Consciousness is currently more intensively studied than ever before. Over the last ten years a series of new discoveries have been made which will probably have to be integrated in any mature theory about consciousness. As always, such discoveries will sometimes lead to enthusiastic and exaggerated theoretical claims. Before introducing the perspective taken in this chapter (3.3), I will briefly discuss some current perspectives on consciousness. I will look whether these theories, developed by people who mostly think of themselves as darwinians, really do take the lessons of the `second darwinian revolution' (Cziko, 1995) to their heart. In part 3.4 I will show, then, how the valuable elements of these perspectives can be integrated into the theoretical framework defended here.

(Negative) feedback control theory. Already William James noted that organisms differ from other natural systems in that they produce consistent ends by variable means. In the twentieth century Norbert Wiener showed that certain neuromuscular `reflex arcs' are based on the principle of negative feedback. Gradually it was realized that his cybernetics could explain how organisms are able to maintain certain goal states independent of fluctuations in the environment. In that, they were like thermostats, but thermostats that continually have to work to stay balanced.

In recent years William Powers and the `Control Systems Group' have proposed that negative feedback theory in the end can explain most design features of the brain. The psyche is essentially seen as device that enables organisms to stay directed to their goals, independent from external influences. `A control system, properly organized for its environment, will produce whatever output is required in order to achieve a constant sensed result, even in the presence of unpredictable disturbances' (Powers, 1989: 77).

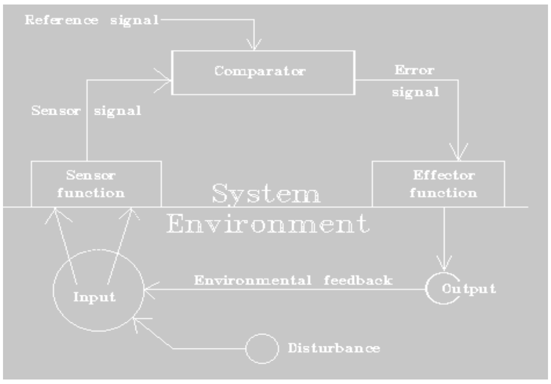

Figure 3-1. Control-system unit according to Powers. The system corrects differences between sensor signal and reference signal by producing an output which influences the input.

In the model of Powers (see figure 3-1) a disturbance of the environment affects an organism via a sensor signal which in a `comparator' is compared to a `reference signal' and leads via an `error signal' to behavior that restores or changes the environment in the direction that is desired. If there is a place for consciousness and qualia in this model they should probably be placed somewhere between the reference and the error signal. Apparently consciousness should be viewed as the way in which nature enables us stay in a `dynamic equilibrium' and to be faithful to ourselves in a changing environment. As the writers of the Control Group's `Introduction to Psychology put it:

> 'The `stream of consciousness' seems to be the play of perceptions in systems which are making adjustments, or, in other words, the focus of attention follows the largest-magnitude error signals anywhere in one's systems' (Robertson & Powers, 1990: 210).

Thus, control theory interprets the brain as a complex `homeostatic' device which has to keep the organism in control of its environment. According to the Control Group `the overall purpose for which an organism controls its environment is to maintain and optimize its existence' (idem: 86).

Is this theory sophisticated enough to explain the nature and evolutionary necessity of consciousness? It is certainly an improvement compared to the behavioristic stimulus-response models, but seems still much to simplistic to explain consciousness. Organisms do much more than maintaining and optimizing their existence by reacting to environmental disturbances. At least those that have to move and possess brains are actively pursuing a whole list of goals, including different types of food, safety, sleeping sites, sexual partners, the well-being of their brood, etc.. In order to be able to reach those goals, many intelligent organisms have to make choices, to look forward and to plan. This is much more than just `correcting error signals'. Despite its name the `Control View' seems only to be about `correction': real control also includes the ability to remain faithful to a set of goals in a completely unexpected situation. Real control implies the cognitive assessment of such a new situation and the ability to react appropriately, despite the complexity of the situation. The Control View is much too general to be particularly enlightening with respect to this ability and, therefore, to consciousness.

Churchland and Connectionism. The study of the properties of neural networks is as old as cybernetics. In 1959 Rosenblatt proposed the idea of a *perceptron*, consisting of a series of input units linked to output units via adjustable connections (Harth, 1993: 55). During a series of instructional steps the strengths of the connecting signals could be adjusted so that the perceptron could be `trained' to link complex input patterns with specific outputs. As a result of the success of serial computers, the concept of neural networks was overtaken for some decades by the idea of software `computer programs' that can be run on any hardware digital computer.

However, during the eighties the concept of neural networks won new interest as a result of the discovery of new ways to improve the performances of the old `perceptron'. A layer of `hidden units' was inserted between the input and the output layers and new rules were introduced to make it possible for each unit to adjust its `synaptic weight' effectively to that of the adjacent units, if an undesired output was produced. As a result the new networks could be `trained' to make certain distinctions simply by instructing them to adjust their synaptic weights according to specially designed rules if they were giving the wrong output.

As we saw in chapter 2, the new networks proved very successful in `learning' to `recognize' complex input patterns and to link them to particular distinctions and even decisions (Churchland, 1989; see figure 2.1 to 2.3). This was the more surprising as the only way in which the `information' was stored was a distribution of `synaptic weights' in a neural network. The particular distribution of `synaptic weights' that enables the recognition, or `activation', of particular patterns is called a prototypical `vector'. Parallel distributed processing showed very clearly how real neural networks could *learn* to make certain distinctions by trial, error and effective adjustment rules. (In nature, of course, these adjustment rules themselves have to have their origin as a result of natural variation and selection.) As such they show how conceptualization is possible within a material device.

Initially, Patricia and Paul Churchland, who have become the major philosophical defenders of connectionism, did not give an explanation of consciousness. They even tended to evade the problem and suggested that a first-person account is not characterized by specific unique contents, like qualia, but only by a specific and very inadequate conceptualization of the things that go on in a neural network: `folk psychology' (a concept showing the influence of Wilfrid Sellars who was one of the first to state clearly that even the way in which we observe ourselves is theory-laden; Sellars, 1963). In the end Paul Churchland hoped that we could learn to use a more appropriate language to reveal the idiosyncratic caprices of our neural networks to each other.

> Given a deep and practiced familiarity with the developing idioms of cognitive neurobiology, we might learn to discriminate by introspection the coding vectors in our internal axonal pathways, the activation patterns across salient neural populations, and myriad other things besides (1989: 75).

From this sentence it is clear that Churchland does not see qualia as constituting an independent ontological level, as phenomena that are somehow part of the way in which our mind works. As a typical epiphenomenalist he tends to `quine qualia' (to quine means `to deny resolutely the existence of seemingly undeniable phenomena', Dennett, 1990; Flanagan, 1992). Qualia are perceived as merely inadequate descriptions of the complex neurocomputational processes that go on in our minds and `nothing more'. Churchland hopes that these inadequate descriptions can be replaced by descriptions in a more scientific terminology, just as water `really' is H_2O and red is `really' electromagnetic radiation with a wavelength of somewhat less than 10^{-6} metres. At least until his 1989 work it seemed to be his hope that an adequate scientific terminology could completely replace the first-person perspective: We would be able to refer to our emotional states not in terms of such crude categories as `love', `pain', `hunger' and `hope', but in terms of specific neural fibers giving signals from one group of neurons to another group. This we could call the `Quine qualia' or QQ-thesis. As will be seen later in this paper, the hope that this thesis may be right results from both a misunderstanding about qualia and about introspection.

In a later work (1995), Churchland has placed his bets on `recurrent networks' in which `recurrent (descending) pathways' are projected back from the output level to intermediate levels. Such recurrent network display properties which one does not find in simple `feedforward networks'. For example, the `recurrent pathways' can bias the network in such a way that particular prototypes are activated instead of others. Recurrent networks are not continually dependent on new input: They can generate complex sequences of activation `vectors' all by themselves. Recurrent networks are also not only able to pattern recognition, as feedforward networks do, but they are also able to recognize and represent prototypical processes which are extended in time. They thus enable one to recognize causal sequences and even to predict the future to some extent. Thus, the dimension of time is added to the neural network as a result of descending pathways, which add information about the network's past activities to its current activities.

Following suggestions made by Francis Crick (1995; Crick & Koch, 1992) and others, Churchland proposes in his 1995-book that the phenomenon of consciousness should be explained as the result of the ascending and descending axonal pathways that connect the cerebral cortex with the intralaminar nucleus of the thalamus - in short, as a `network property' of a large-scale *recurrent* neural network. The difference between sleeping, dreaming and waking can be explained as a result of the ways in which the intralaminar nuclei (clumps of nerve cells inside the two thalami, a loss of which produces an irreversible coma) can stop initiating 40 Hertz oscillations (see below) and can shut down the recurrent pathways back to the cortex. The phenomenon of attention can be explained as the shifting pre-activations of particular neuronal layers in the cortex in such a way that particular prototypes have a bigger chance of becoming part of the global oscillations (if you are looking for your cat, all kinds of cat-features and cat-related associations are pre-activated).

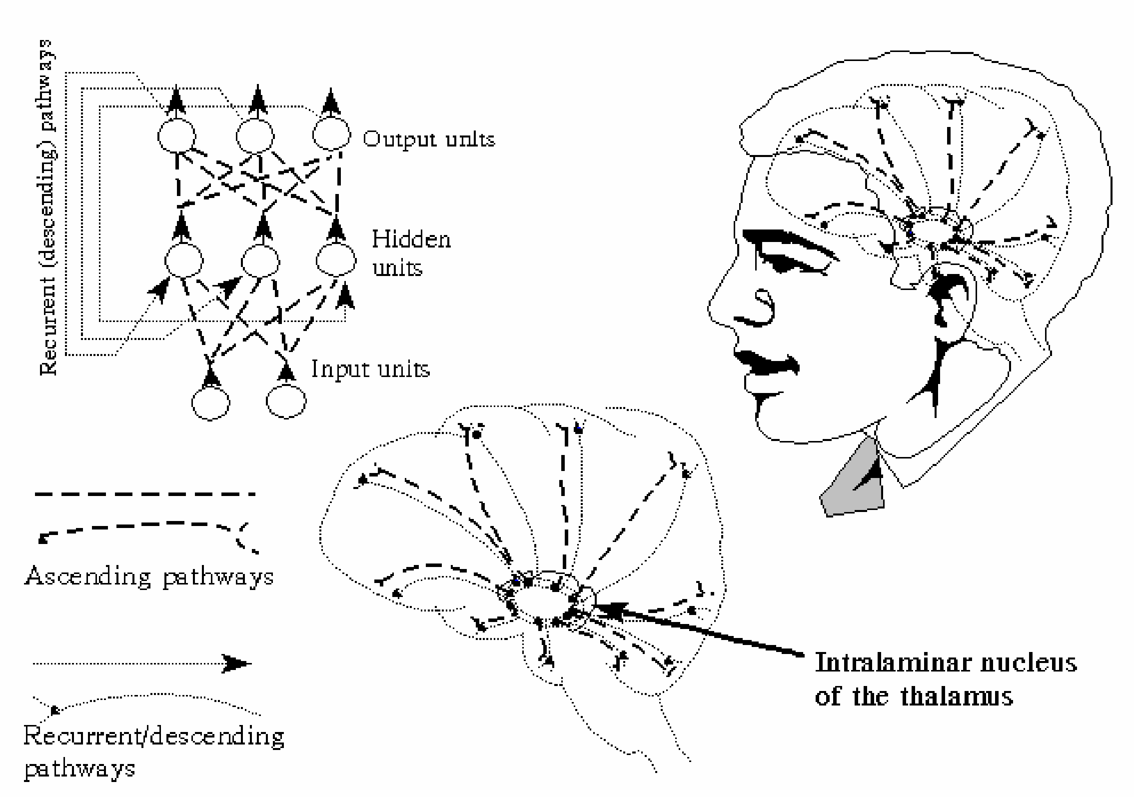

Figure 3-2. Because it communicates back and forth with the cerebral cortex, the intralaminar nucleus is supposed to `carry out' the function of consciousness (Adapted from Churchland and Llanás).

It remains to be seen, however, whether even this attempt at `reducing' consciousness (Churchland keeps flirting with eliminative materialism) is not somewhat too simplistic. Connectionism seems to be able to explain abstraction, pattern recognition and even cognitive biases, but is by itself unable to explain why organisms have internal goals, subjective experiences, intentionality and self-consciousness. Given the fact that Churchland has committed himself to the defense of the almost infinite *plasticity* of the human mind, I do not see how he can bridge the gap between the collection of very general cognitive mechanisms that he is able to explain and the behavior of real organisms that have to pursue very specific goals in an often unfriendly environment. If Churchland continues to defend the plasticity of the human mind - and does not tone down on this point - he will also never come to understand why particular qualia are coupled to particular situations. If our evolutionary history had not `programmed' us otherwise, the act of eating could go hand in hand with nausea, sex could be horrible and drowning could feel absolutely fabulous, etc. The `meaning' of particular qualia, the specific connection between a phenomenological quality and the series of objective situations which it evokes, can only be understood in the light of their evolution.

Edelman, Crick, creative loops and the forty-Hertz hypothesis. Churchland is not the only one to have come up with recurrent networks. Many different authors have proposed the idea that the essence of consciousness lies in some kind of loop. Harth has proposed that positive feedback loops (reinforcement) in the form of `creative loops' play an important role in some kind of cognitive `bootstrapping' which eventually leads to consciousness. The idea is that `particular fluctuations are amplified selectively so that features not initially present at the input may be *generated* in a *bootstrap* fashion' (Harth, 1995: 71; see also figure 2.5, 2.6, 2.10 which were all derived from or inspired by Harth). The resulting images may then be compared with the input again and so forth. `Consciousness, which arises in this self-referent process, not only unifies the immediate sensory messages but also becomes the joiner of everything around us, past, present, and future' (Harth, 1995: 144).

Loops in the form of `reentry' also play a significant role in the `theory of neural group selection' of Gerald Edelman (1992). Even on the level of what he calls `primary consciousness' (as distinguished from `higher-order consciousness') a `reentrant' loop is crucial. Edelman thinks that primary consciousness is already based on a residue of past interactions with the environment in which value-laden categories have arisen. Primary consciousness arises at the moment that these value-laden categories activate (re-enter) current information processing of new sensory input. Therefore Edelman speaks of primary consciousness as a `remembered present' based on a circuit that `allows for continual reentrant signaling between the value-category memory and the ongoing global mappings that are concerned with perceptual categorization in real time' (Edelman, 1992: 119). Physically he locates the `value-category memory' in the frontal, temporal and parietal cortex which interacts with deeper parts of the brain like the brain stem and hypothalamus via the hippocampus, amygdala and septum. The input of `world signals' is processed in the primary and secondary cortex.

According to Edelman, the circuit in which primary consciousness emerges also creates the possibility of `higher-order consciousness' in animals with language or language-like abilities. Between the primary and secondary cortex in which sensory input is processed and the value-category memory, Broca's and Wernicke's areas are placed. These allow for a new kind of conceptual memory which can probably compress more data in a much more efficient way. This leads `via semantic bootstrapping' to a `conceptual explosion', as a result of which `the self, the past, and the future can be connected to primary consciousness'. The animal becomes aware of the fact that it is conscious: Consciousness of consciousness becomes possible.

Many different authors have observed that consciousness somehow seems to solve a `binding problem'. As Churchland repeatedly stresses, the brain is a massive *parallel* `computer' and somehow all lines of independent information processing have to be bound together to be coordinated. Both Rodolfo Llinás and Francis Crick (together with Koch) have developed the theory (already mentioned above), inspired by research and suggestions of many other neuroscientists, that consciousness emerges from the correlated firing of a large number of neurons at an oscillation of 40 cycles a second (40 Hertz) that has been found to be characteristic of the whole cortex and of the intralaminar nucleus during waking hours (Baars, 1997; Crick & Koch, 1992; Churchland, 1995). According to Crick (1995) spikes arriving simultaneously at a neuron will produce a larger effect than the same number of spikes arriving at different times. Consciousness thus plays the role of integrating information by forcing independent thoughts to `dance the same tango'. Crick points to the thalamus as the brain's `organ of attention' which directs its `spotlight' to neural areas where a lot of information has to be integrated by imposing its 40 Hertz `beat' upon them.

All this is certainly very interesting and might well be true. At the same time it does not yet explain why we need a private domain in which we are emotionally and cognitively isolated from the rest of the world. It remains to be seen whether neuropsychology can answer that question.

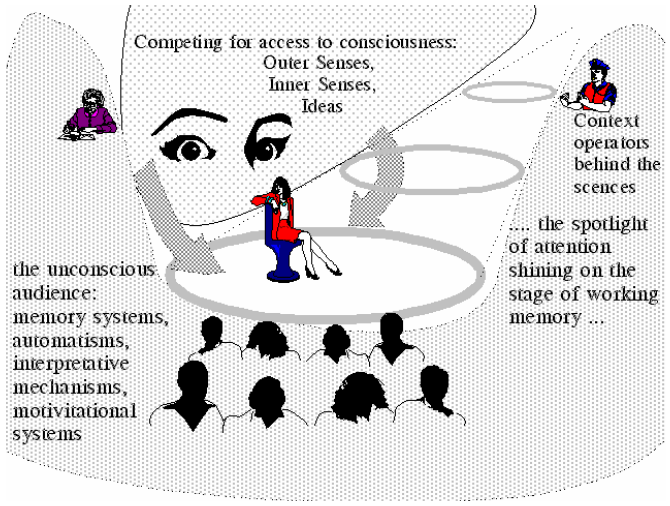

Figure 3-3. Baars' theater metaphor for conscious experience. Different inputs *converge* into conscious experience, yet *diverge* again to all kinds of intelligent unconscious mechanisms.

Baars and his global workspace theory. The forty-Hertz hypothesis is based on a notion of consciousness as an *integration* of information that would otherwise be independent. The idea that it is the function of consciousness to coordinate the information processing that goes on in many different parts of the brain is far from new. Ten years ago Bernard Baars had already developed his `Global Workspace theory' in which consciousness is compared to a theater in which a lot happens behind the scenes, but in which everything is focused on what happens `on-stage'. Automatic processes and routines happen everywhere in the brain, but the moment new habits have to be learned and behavior has to be changed all relevant information has to be recruited from all of these dispersed brain regions. Consciousness should be seen as a field of heightened neuronal activity which enables problems to be solved which can only be solved by linking brain regions which lie far apart. In the words of Baars:

> It seems that the single most prominent function of consciousness is to increase access between otherwise separate sources of information (Baars, 1997: 162).

Baars himself thinks his `theater model' emerges naturally from all recent developments of neuroscience, including the discovery of the forty Hertz oscillations in the cortex and extralaminar nuclei. The theater metaphor, although very enlightening in some respects, also has some disadvantages, however. As Baars would probably be the first to admit, what happens `on-stage' will often result in action: A parliament metaphor would be better in that respect (a parliament being a theater in which the actors at least think they have some power). Only in this respect is Baars' theory still somewhat too much based on the presupposition of a purely *cognitive* function of consciousness.

Interim conclusion. Various different theories about consciousness and the brain will probably prove to be mutually compatible as they are all portraits of the brain from different perspectives, on different scales and with a different degree of resolution. Connectionism explains how neural networks can store `concepts' and can even `learn' by continually readjusting their synaptic weights. Recurrent networks are probably the best technological parallel to simple systems of neurons. Loop theories refer more specifically to the possible physical properties of the brain that allow it to display consciousness: Consciousness is identified with the reverberation of an electronical tornado between thalamus and cortex. The forty Hertz hypothesis gives at least the beginning of a solution to the `binding problem' and is compatible with the Global Workspace theory which stresses the role of consciousness in integrating a great deal of information from different parts of the brain.

Some of the above mentioned properties of consciousness are explained by all these models. For example, the theory about recurrent networks can explain why the activities of the brain are to some extent independent of the environment. Connectionism can explain why concepts in our minds are not `defined' clearly and do not correspond exactly with an aggregate of `meaning atoms' within clear cut boundaries. Loop theories can explain why consciousness is more a `field' or `stream' than a calculator or a serial computer which essentially thinks in the way in which only a hyperintelligent mathematician or rationalistic philosopher can talk, occasionally.

Yet, something is still missing. To my mind, at least, all of these theories still do not explain the most essential property of consciousness: the radical *private* nature of consciousness and the way it creates a gap between `inside' and `outside' the organism's unique `point of view'. Workspace theory is, in principle, compatible with a more radical Darwinian approach, but a much more sophisticated theory about sensation is needed to account for its radical, unavoidable, qualitative and private nature.

3.3 CONSCIOUSNESS AS AN ADAPTIVE PHENOMENON

Sometimes it helps to step back a little to get a wider perspective (or to replace your close-up lens with a wide-angle). It is by no means self-evident that consciousness is better understood by observing it as closely as possible, be it from the inside, as phenomenologists have done, or from the outside, as physiologists do. One way of stepping back from both perspectives is to see things within an evolutionary frame-work. Perhaps consciousness should be viewed as a biological phenomenon that we can understand better *after* we have understood more about evolution in general.

Selfish gene theory and evolutionary psychology. In my view, it is especially the `selfish gene'- approach that is enlightening in this context. Because I will give a historical analysis of the sociobiological `bottom-up' perspective in chapter 4, I can be short about it here. At this point, I only want to stress that the view of the individual organism as `DNA's way of making more DNA' (Wilson, [1975] 1980) or as the `survival machine' that is designed to help replicate the `selfish genes' that have built it (Dawkins, 1976) are to be understood as short and lively ways of stressing the `bottom-up' architecture of nature in which higher and more emergent entities like societies should be understood at their proper level. It is not always the smaller building block that makes the bigger entity of which it forms a part understandable, however. Rather, we should try to locate those building blocks that have been chiseled out by nature itself, in the form of natural selection or differential reproduction. Only if we understand the levels at which selection in nature really works can we understand the elements of `design' inherent in the features of living objects. Although selection may have worked on many levels, it is especially the individual as a fortress of an alliance of `selfish genes', which often forms an integrated building block of self-interest in nature. It seems to me that this view throws light on the phenomenon of consciousness. Why?

First, it explains why the knowledge-apparatus has evolved to serve individual organisms in the first place and why the information in consciousness is stored in a thoroughly perspectivistic way. As the cybernetic resources of information processing systems are always limited, only relevant information can be processed. Information is relevant insofar as it leads to survival (of genes and their temporary `survival machine' or `vehicle') and for this reason information concerning the direct environment is valued above anything else. This information does not need to be `objective', but *should* be perspectivistic, because it should also entail information about the current position of the organism (a lion is conceived quite differently by its fleas or by a candidate-prey, like a wildebeest).

Secondly, for this reason the way in which this information `touches' the organism should be `value laden' and relate directly to its interests: Only in this way can the organism perceive something as `threatening', `dangerous', `attractive', etc. *So, perspectivistic, value-laden information processing is to be expected according to a `bottom-up' selfish gene approach to organisms. Even in a hypersocial environment it is important that an individual keeps an eye on its own interests and, therefore, gathers information from its own perspective.* Of course, even in this situation most of the information relevant to an organism concerns its own body, its position and the availability of dangers, food and potential partners in its direct environment.

Thirdly, talking about `survival machines' may help us to remember why minds are not in the first place `information processing tissues', but biological `decision centers' and why the information used by these `decision centers' need not be represented completely to the central parts of it. It is to be expected that a survey is somehow made of the information most relevant to the decisions that have to be made: The different options have to be clear, but it does not need to be clear how a process of data-compression led to these options. It is to be expected, therefore, that an individual survival machine somehow, somewhere, keeps an `overview' of the most crucial information relevant to the most necessary and inevitable decisions. Consciousness could serve this function. It integrates information relevant for behavioral options. So conceived, *consciousness can be viewed as a way in which a survival machine is given an overview of information that is immediately relevant for its behavioral options* (one notes here the affinity with Global Workspace theory; I will come with my own metaphor later).

Finally, the selfish gene approach may also help to explain why consciousness, at least in many mammals, is a private phenomenon, even though these species display a relatively sophisticated level of mind-reading. Why would the information that is used to steer the organism be available primarily to the organism itself? This way of organizing things would be very awkward if individual organisms behaved for the good of the species or even for the good of the group. If it is the good of the group that matters, then not every individual needs to collect all necessary information for itself: Ant colonies, with a high degree of kinship, can also react collectively to new situations and even `learn' collectively (Gordon, 1995).

Even if it was necessary to integrate all information in each individual, individuals could be like open books to each other and inform one another continually about all new mutually relevant information. Clearly, this does not happen in many mammalian societies, including humankind. Our societies are not `superorganic', `top-down' superorganisms in which individuals almost always form cooperating `cells', but a kind of `bottom-up' emergent group-contract to which everyone agrees as long it is in his/her interest. The possibility of parasitism looms everywhere and all financial and informational systems have to be secured against fraud by elaborate procedures. Any personal information can be misused at any time and this is probably the reason why we keep many things secret, even from ourselves.

Thus the selfish gene approach may explain why the information in consciousness is always perspectivistic, up-to-date and related to the interests of the conscious individual and his/her genes, the `first-person' of consciousness. However, we do not know yet why - often - `survival machines' are not robotic automata and - often - seem to have been designed to *experience* the information that they have to process.

Value-driven decision system-theory. Information in itself is neutral. Something is simply true or not true and by means of logic one can deduce other truths from it. A survival machine obviously does not need information for the sake of information and, as we have seen, it should therefore restrict itself to relevant information. How, then, should it select relevant information? Obviously one way is by not having unnecessary sense-organs. But probably even the most necessary sense-organs create a lot of noise. Above that, information that comes in from different senses somehow has to be matched together in a picture of the world on the basis of which the organism can `compute' its priorities, the `vector' of its will and/or its intended course through the outside world.

How should it compute such decisions? Selfish gene theory suggests that the central decision system within an organism will behave like a parliament of representatives, but that does not exclude *one* resulting teleonomic `vector'. In most cases this vector is directed to a maximum of offspring that can be raised successfully given the current circumstances (in albatrosses and chimpanzees this does not lead to a high number of offspring). However, the organism has to achieve this goal in a completely unpredictable environment. Of course, it is possible to instruct its DNA with an amount of potential strategies and with a series of routines that enables it to discover its environment and then to choose the most adequate behavioral strategy. Obviously, an enormous brain would be needed if it had to be programmed with all possible alternative strategies. The chances would also be high that the strategy triggered by a specific set of stimuli will be slightly inadequate in a new environment; the consequences of such small inadequacies could be disastrous.

Control or feedback theory gives one possible solution to this problem of an unpredictable environment. One specific control variable is specified that has to be kept constant at some specified control level. Compensating actions can be specified too, even in complicated decision tables, so that the organism knows what to do when the variables move outside the specified control range (e.g. body temperature can be corrected by increasing metabolism). A whole hierarchy of control systems can together create a sophisticated control system in which several partly independent feedback loops are intertwined (Powers, 1989).

Within this approach the problem of the unpredictable environment is not completely solved, however. In many planning processes the series of decisions that have to be made sequentially is so complex that it cannot be derived simply from a series of control variables and a related decision table. Sometimes even the control variables can no longer be kept constant, and have to be adjusted. The only adequate decision table for such a system would consist of an almost infinite branching tree of decision tables in which the possible alternative consequences of certain decisions in certain environments would have to be anticipated and in which an adequate way of keeping the relevant control variable within an acceptable range would have to be specified in advance. If these decision tables had to be `installed' in actual organisms, they would need enormous brains.

George Edgin Pugh describes in his *The Biological Origin of Human Values* (1978) how he was working for the U.S. Defense Department in the late 1950s and the early 1960s to develop a computer system for the automatic development of bomber flight plans. It proved impossible to instruct the program simply with the series of rules of thumb that the military experts had provided, because they proved to be contradictory and inconsistent for numerous situations. This had not been a real problem for the military commanders in the past, because they could always fall back on their common sense if the rules proved to be in conflict or inapplicable. If the inconsistencies were removed enormous lists of exceptions and new rules emerged and the resulting decision process became even more complex without increasing effectiveness.

The only way in which it proved to be possible to enable a computer program to devise optimal bomber fighter flight routes and schedules was to enable the program to list a large number of alternatives and to score them by means of heuristic values assigned to both the aircraft and crew and the targets destroyed (multiplied both by the probability of recovery and destruction, respectively). The introduction of these heuristic values made it no longer necessary to think through every contingency in detail and the system could even devise new alternatives, the possibility of which the planners had not foreseen. Because the program would always note the possibility of disastrous consequences if the values were scaled appropriately it was possible to let it explore large numbers of alternatives and to find optimal solutions which would not otherwise have occurred to a human being. (Such a program can probably also be produced within a connectionistic architecture. One can `train' such a network by feeding it with a large number of prototypical input-output relationships; perhaps values arise the moment output is given in broad classes of behavior).

The importance of Pugh's work lies in his use of the concept of such so-called *value-driven decision systems* to throw light on biological intelligence. He notes that there is an obvious parallel between the problems of too-simplistic artificial and organic `decision systems'. Light-seeking moths that fly into flames, light-seeking flies and wasps that keep bumping against windows and hedge-hogs that roll up in front of cars all show the limits of a too-limited collection of preprogrammed action patterns. Like a human designer, evolution or the virtual `evolutionary designer' (a concept used by Pugh to make it easier to speak about evolution's `design problems') is almost certainly unable to foresee all the situations in which its designs will be put to the test. The only way in which flexibility can be built into a system is by giving up the idea of complete preprogramming and by introducing representations of the world into the system combined either with a notion of ultimate goals or with heuristic values.

However, building a notion of ultimate goals into a decision system will almost certainly lead to overcharging its cybernetic resources. An obvious parallel is offered by the game of chess. Ultimately, the only real objective in a game of chess is to win i.e. to achieve a checkmate. Yet, experienced chess-players and chess computers will assign values to specific pieces, like the queen, and to certain favorable or dangerous configurations. These values are a `surrogate' for the real goals. The perfect player would not need them: Such a player would `simply' compute every possible consequence of every individual move up to the last move of the game each time that it is his/her turn. Such a perfect player would need almost infinite cybernetic resources, however, because the amount of possible reactions on the part of the opponent multiplied by the amount of possible next moves multiplied by the amount of next reactions of the opponent multiplied by the amount of the amount of possibilities thereupon, etcetera, will be enormous.

Obviously the game of gene survival in a complex environment has still more possible moves and at least some players have more turns than in the game of chess. The ultimate goal can be described as the maximization of gene replication (Pugh himself still thinks in `survival of the species' terminology: *op. cit.* 73), but biological decision systems would need very large brains and these would be very slow if they had to calculate the consequences of each possible move in function of this goal each time they had to make a decision. In addition, it is not clear how a process of natural selection which has to lead to at least some adapted individuals in each generation, could result in the evolution of such decision systems. Such systems would obviously be outcompeted by systems that were less wise, but smaller and faster. In fact, in present-day warm-blooded animals the process of natural selection seems to have led mostly to relatively small, compact and very efficient decision systems in which the ultimate goals of gene survival are represented by a series of heuristic values assigned to such different topics as food, sex, predators, safety, comfort, good company, pleasurable and repulsive smells, hygiene, etc.. If evolution ever had a choice between the representation of ultimate goals and the adjudication of `surrogate' values, it is clear that it has made its choice for the latter.

How, then, are these `surrogate' values represented? In the case of the `human decision system', Pugh makes a distinction between primary or innate and secondary or derived values. The latter are the values of everyday conversation, the values that many people think to be `culturally determined', because they are slightly different in different cultures and in different times. According to Pugh the *primary values correspond to the elementary valuative sensations of human consciousness*, like discomfort/comfort, pain/pleasure, bad/good taste, bad/good smell, sorrow/joy, shame/pride, fear, anger, hunger, thirst, itch. They are to a large extent innate and they represent decision criteria built into our brains as a result of random mutations and the survival of the fittest. Pugh thinks of them as built-in valuative sensations that are `a result of physical linkages in the neurons of the brain, which are inherited in exactly the same way as other physical characteristics'.

Pugh's belief in the innateness of a collection of fundamental human values is not a result of dogmatism. His experience as a programmer using value-driven decision systems has taught him that a system begins to behave much more adequately if the number of preprogrammed heuristic values increases (Pugh, 1978: 66). His most important example in this respect is the development of an automatic `student assignment system' which had to achieve a maximum of racial balance in public schools with a minimum of busing for individual students. (From his references we may conclude that he worked for two years, 1971 and 1972, on this problem or its reconstruction.) The development of a value structure that could produce an optimum solution started with a simple concept of a value structure: A positive score was given according to the level of desegregation achieved and penalties were given for every child that had to ride more than thirty minutes. This simple value structure had to be refined, however, in six steps, before a more intuitively attractive distribution of students arose: small extra penalties had to be given for each student that had to use a bus, for each minute at the bus, a nonlinear travel penalty had to be introduced, travel penalties had to be increased and an extra penalty had to be introduced to discourage different school assignments for the same neighborhood area. Pugh concluded that the introduction of extra values, sometimes negative ones, is essential for the fine-tuning of a sophisticated decision-process in a complicated real-life situation. The parallel to the evolution of biological decision systems is obvious: Multicomponent value structures simply have to be expected given enough time and ecological variation for experimentation. This applies especially to species with a relatively small number of offspring living in relatively complicated ecological and social situations, because the value of each individual `vehicle' is relatively high in this case and it may well be worth the trouble to equip it with a talent for sensible decisions[1].

One obvious advantage of an innate value system is that the organism that is equipped with it does not have to learn as much, or at least knows *what* it has to learn (it knows the value of particular information). However, there is another fundamental reason why the value structure has to be innate and irrational, and not subject to change on the basis of rational thought. The survival machine has to serve evolutionary objectives that it does not need to understand. If it were allowed to adjust its own primary values it might start to drop all kinds of penalties for which it does not understand the reason. It could even assign positive values to poisonous food, dangerous situations, and non-adaptive behavior. Narcissism, escapism and suicide could result. It is clear that the ability to change the own primary value structure is in contradiction with the very idea of a value-driven decision system which has to serve the objectives of a designer beyond the system itself.

That does not mean that in both artificial and biological decision systems there is no room for the adjustment of particular *secondary* decision criteria which might enable the system to learn from experience (Pugh, 1978: 32). In the case of humans these might be inherited culturally. However, such secondary values always have to be evaluated against the primary values. Perhaps the cultural success of particular secondary value systems in our species depends largely on their effectiveness in adapting characteristics of the primary value structure to a particular ecological and social niche and the life style required by the economic possibilities that it offers.

All this means that our minds are less plastic than philosophers such as the Churchlands suspect and that the information that ends up on our desk, the desk beneath our skull, is already censored and colored. On the one hand the primary values seem to be

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[1] Mammals are a group whose number of offspring is naturally limited as a result of their system of internal hatching and intensive parental care (they are relatively `K selected'; see chapter 6). Additionally, the size of their brains is not limited by their respiratory system, by an exoskeleton or by the necessity to fly.

innate, on the other hand they seem to be conscious. That means that consciousness is not as related to plasticity as is sometimes thought and that, to the contrary, *consciousness is an inborn mechanism of weighing the survival value of incoming information.* Consciousness enables us to be `plastic' only by having a particular structure. *Consciousness represents an innate framework in which complex, flexible and adaptable biological decision systems are `allowed' or `forced' to adaptive self-government.* The flow of experience is the flow of information that befalls a particular survival machine and that is `weighed' according to inborn values which represent the interests and perspective of its genes. Consciousness is the way in which information is thus `subjectivized' to make autonomy possible, within limits that guarantee that the organism remains dedicated to its genetic mission.

Pugh's model thus revolutionizes our way of understanding consciousness. According to Pugh `the cognitive decision process is intimately linked with our sense of awareness or consciousness' (Pugh, 1978: 154). Consciousness can be termed the way in which we are *forced* to *use* information to make decisions. Consciousness is the product of the `experiential values' which are programmed into the individual organism as a result of a long evolutionary history and which are orchestrated together in such a way that it is able to make decisions which are in its own interest or in that of its genes.

3.4 CAPTURED WITHIN OUR COCKPITS, NAILED ONTO OUR DASHBOARDS: THE RELATION BETWEEN BODY AND SELF

Despite the fact that they give, by definition, incomplete knowledge, metaphors can be very instructive. They often show analogies across different realms of knowledge and enable one to give names to phenomena about which it would be otherwise very hard to talk. Of course, it is important to be aware of the limits of the metaphors one uses: One should leave one's ship the moment it grounds.

With respect to consciousness, we now have an interesting set of metaphors. If we combine Dawkins' metaphor of the survival machine and Pugh's analyses of value-driven decision systems a whole set of interesting new metaphors about the mind emerges (Slurink, 1986). The organism can be seen as an organic missile, a smart bomb, that did not fire itself, but has been globally instructed with a set of selected values with which it takes its `own' course in a new environment. It does not know that the way in which it takes this `own' course is in fact, via these values, based on a long history of success and failure. Somewhere in the center of the missile, say in its cockpit, a decision center emerges from which `it' views the world and plans its course. Inside this cockpit a simplified map of the world helps `it' to orient itself, a series of bulbs, switches and monitors shows `it' the dangers, hopes and possibilities.

Where, then, is the person *behind* this organic dashboard of bulbs, monitors and switches? Who is it and can it leave its cockpit? No, if this were the case many survival machines would probably be deserted in the midst of the struggle for life and they would never accomplish their genetic mission. Even heart-attacks and suicides cannot be interpreted as desertion, but should be seen as accidents or the turning of a switch that exists only for emergencies. There is no metaphor for the relation of an organic dashboard and its pilot, because our artificial robots are still too primitive. The pilot or driver inside an organic robot, the `I' behind its dashboard, is in fact *this dashboard itself which is curved and monitors its own monitor.* In vain are we looking for an independent homunculus inside the cockpit: The only unique `homunculus' inside is *a particular point of view, the source of a unique stream of experiences, another version of the world-movie as it can only be seen* *from somewhere `within'.* Physically this is probably an emergent property of the `recurrent networks' and `loops' between thalamus and cortex as noted by the connectionists and loop theorists.

What about self-consciousness? Should this not be seen as an extra dimension resulting from some sort of extra ability? Yes; as a result of our evolutionary history as highly social animals in very complicated societies we, as humans, develop a self-image during our lifetime. This self-image enables us to guess how our conspecifics judge us and is therefore often strongly linked to evaluations of merit and rank. However, even this self-image should be seen as another lifelike phantom projected on the `monitor' at the inside of the organic cockpit which is the locus of our subjectivity. Maybe we should speak about a special extra monitor on which social relations are mapped and which gradually starts to represent its own host as a unique separate individual, an `I' in a world of `you's'. Anyway, we do not see ourselves from the point of view of an extraterrestrial, `objective' ethologist most of the time; we simply play a role in most of the movies on our own monitors. (Of course, this opens up the possibility of an infinite regression of reflective loops, but our neurocomputational systems do not break down as a result of such loops, they simply get bored and start to pay attention to other monitors).

Does this view of consciousness help us to resolve the classical philosophical topics relating to that subject? A philosophical question deserves a philosophical answer: yes and no. Yes:

(a) - It helps us to resolve the mind-body problem: The *cause* of the classical dualism is simply the reification of two points of view relating to the same body: the unique private view from `within' (the perspective from which a survival machine calculates its interests, the internal `dashboard' of subjectivity) and the much more public view from the outside. (Exit both simplistic dualism ànd monism.)

(b) - It helps us to explain why there is a gap between the world of experiences - *die Erscheinung* - and the unknowable world `itself' - *das Ding an sich*: Information relating to our world has to be `subjectivized', because only in this way does it help us to make adaptive decisions. (Exit naive realism and idealism.)

(c) - It helps us to explain why there is an unparalleled type of causality, agential causality (R.W. Sellars, 1973), which seems to be directed `downward' (`downward causation'; Campbell, 1974). This `top-down' type of causality is to be expected where a number of different input channels have to be integrated in some central *locus* of weighing, scenario-building and deciding. Of course, this `top-down' causality is intimately linked with a whole battery of `bottom-up' channels via which the input from the external world is gradually selected, interpreted and valued. Finally all this information arrives at the central `dashboard' to be weighed together with other generalized information to allow balanced decisions. Thus, bottom-up and top-down causality *together* enable the organism to cope with its environment and to remain faithful to its genetic mission at the same time. (Epiphenomenalism and the QQ-thesis are therefore implausible; exit both hard determinism and the indeterministic theory of free will.)

(d) - It shows us the origin and nature of values, which might ultimately be called `subjective', but which we share with our own conspecifics and which we also share, to some extent, with a series of other species and to which we therefore can refer as though they belong to an `objective' world. They do not have their origin in a platonic sphere beyond actual organisms, nor do they have their origin in some rational contract between them. Nor do more `sophisticated' values, like curiosity or a sense of beauty, necessarily reduce to more `primitive' values, like pleasure and pain. The fact that values vary throughout different cultures and times (a subject to which we return in chapter 6) does not exclude the possibility of the existence of an innate human value structure which is, roughly speaking, universal to members of anatomically modern humans. Ethical relativism and voluntarism have to take into consideration both the effects of these semi-universal values, which derive from the innate `structures of experience', and the way in which they lead to a public `morality' as a result of particular ecological pressures and social `system requirements'. (Exit both moral objectivism and a too-simplistic relativism.)

(e) - It may help us to assess the question of animal awareness more realistically. Pugh's `value-driven decision system' view suggests a gradualism with respect to the level of consciousness displayed by various animals and by humans of different ages and talents. Just as there exist screw-drivers of all types and sizes, there probably exist different classes of intelligence which may fit into different structures of the world. As is to be expected with respect to a great variety of different vehicles with different purposes moving around in different terrains, each vehicle has its own type of dashboard which affords it an incomparable window on the world. (Exit anthropocentrism; more on this question in 3.6 and 3.7.)

However, we should also pay attention to the `no' answer. No:

(a) - Of course, we can only answer such classical philosophical questions *by changing them slightly*, by consciously neglecting and transcending their implicit ontologies. Therefore the traditional philosopher can always retort that the naturalistic answer does not match his question.

(b) - At this point the answer to the `why'-question relating to consciousness is only schematic and largely intuitive. Perhaps it is true that consciousness evolved *to force organic vehicles into making semi-autonomous adaptive decisions*, but then, still, we do not know why pain, pleasure and related sensitivities were the only evolutionary option for such a compulsion and how neural networks have to be wired to get such results.

(c) - Finally, it is quite possible that our natural categories are simply inadequate to understand complex emergent properties. Our intelligence, which seems partly to have co-evolved with our technological skills, is often better at analytical reduction (bottom-up analysis) than in understanding a system as a whole and the way in which particular properties emerge as a result of its specific composition.

A typical expression of the tendency to prefer analytical reduction to synthetic reconstruction is Churchland's claim that we can and should learn to describe our qualitative experiences in terms of neurophysiology. Our experiences are constituted both by the unique objective situations in which we find ourselves and by our unique subjective evaluations of them. Of course, they are embodied in a transient state of our neural network as it interacts with the world via a battery of sense organs. It is uncertain, however, whether it would be possible to describe them sufficiently by just isolating the neural network from the rest of the world and noting the configuration of its synaptic weights at one particular moment. The essence of those experiences probably lies in the dynamic brain-world interaction of which they form a part and *in the way this interaction is represented `from within' our `phenomenological cockpit'*. Introspection can never give us our qualitative experiences as they `really are' in neurophysiological terms, but only as they `really are' on our `internal monitor', as it is designed by evolution to control our cognitive and evaluative interactions with the world. Qualia are not simply neurophysiological states, but the way in which we experience and evaluate a particular situation `from within' an ongoing series of those states. There is no need to `translate' them in neurophysiological terms, because we can already feel what they really are. One cannot describe a movie in terms of the workings of a television, although the television certainly is a factor in what a movie looks like; and, of course, we are not only watching a movie, but playing a role in one as well.

Consciousness as the autoconnected dashboard of the mind. In all, there are good reasons to interpret consciousness as an emergent property, the product of variation and selection of `holistic' properties of *whole* organisms, embodiments of a history of successful behavior in a series of past environments. Its function or evolutionary *raison d'être* is probably that it enables organisms to cope with unique, unprecedented situations; as a result conscious states are probably as various as the brains of actual organisms and the situations in which they find themselves. I have proposed, in the spirit of George E. Pugh, that consciousness represents the way in which information is `weighed' in function of its survival value and have used the metaphor of a dashboard to show how it is linked to decision making and how it gives direction to the interaction of a particular survival machine and its environment *via* a simplified representation within a rigid, innate frame-work. This metaphor shows at the same time that consciousness is not a kind of accidental intrapsychological transparency, but that it is *designed* in a functional way to make adaptive decisions to new and unique situations possible.

Some characteristics of consciousness can thus be explained:

- *Qualia* and qualitative distinctions arise, because sophisticated decisions in complex environments require a differentiated set of sometimes opposed values (as artificial decision systems show). The emotions seem to be orchestrated such that information *has to* reverberate inside the organism into adaptive decisions. Subjectivity thus constitutes a kind of sensitive interface between the genetic interests of a particular survival machine and its environment such that this survival machine is *forced* to take particular types of information seriously. From Pugh we learned that a value-driven decision system that has to be programmed to perform certain tasks may not be allowed to change its own `primary' values.
- *Intentionality* is an effect of the preprogrammed goal-directedness of an organic decision system as it guides the interaction with the environment from `within', from behind its `dashboard'. It constitutes the form in which the representations on the various monitors and dials *refer* to the real world outside and to the virtual targets and goals of the organic vehicle. The properties of the environment that are used for orientation have to be selected and valued to create a schematized mapping inside the neural network that enables it to build scenarios and to choose between them. Because the organism often needs specific information its sensors need the ability to focus on the outside world which is only possible via a feedback loop in which the representations `on the inside' guide the systems of information-gathering in the outside world. This is only possible, of course, if these representations link up somehow with the real world. The mysterious `aboutness' over which philosophers have pondered for several millennia, is a characteristic of this process of focussing, in which internal representations are gradually improved by manipulating the external sensors and feelers.

- *Control* in unprecedented circumstances is the primary function of consciousness. Control implies a cognitive assessment of a completely new situation in which one often has to take unprecedented steps to remain faithful to one's goals. As Pugh has shown a complex set of heuristic values can be an ideal device for estimating the consequences of various possible decisions in such a situation. This only confirms the idea that control and `freedom of the will' is not opposed to causal determination, but to the dogmatic activation of rigidly preprogrammed action patterns and to the inability to devise entirely novel solutions, plans and decisions. (Freedom is therefore a relative notion, entirely linked to one's elbow-room before one's drives).
- Consciousness has the character of a *stream*, because an organism in its environment has to deal with a lot of independent problems, some more urgent than others, and at the same time still needs all its cybernetic resources in order to devise an optimal solution to the most important problems. Apparently this `concentration' of effort is needed to pre-activate all relevant prototype vectors and knowledge and to ensure that all relevant values are weighed in one shot (perhaps a shot in which a whole web of neurons begins oscillating in a 40 Hertz rhythm). Although all organisms have many problems, creative solutions require an answer which arises from the organism as a whole. Less urgent decisions can be postponed or delegated to subconscious processing. Often consciousness is only needed to initiate search procedures, so the stream-character of consciousness is not in opposition to a certain level of multi-tasking. In nature, an organism has to be continually watchful of any new dangers and possibilities that it may encounter. A whole battery of sensory canals has to be kept open all the time and urgent information from the external world should be able to overrule all current conscious activities. In that respect consciousness is similar to the changing field of attention of the pilot behind a dashboard, who will sometimes turn to his attention to one monitor, then to another, then to a flickering bulb, etc. The autoconnected dashboard is a place where different problems are continually fighting for attention and for the cybernetic resources that go with a centralized decision procedure.
- *Self-consciousness* could be a more relative notion than is often thought, because the `self' which is represented on the internal monitor can be viewed from several viewpoints. A cat which is continually cleaning itself needs a representation of its own body contours and fur; a cat that has to decide whether to fight with the neighbor's cat has to make an estimation of its own strength and condition. A macaque that approaches a water hole, at which some group members are already quenching their thirst, needs to make a complex calculation in which its own sex, age and rank are compared to that of the other animals that are present. Humphrey, Trivers and Alexander, amongst others, have speculated that a sophisticated self-consciousness is the result of adaptations that enabled our ancestors to cope with extremely complex social environments. It should probably be seen as the result of genetic instructions which guide the growth of the brain in such a way that cybernetic resources can be spent on the representation of complex social networks. At some point (perhaps in the Pongidae and Hominidae only), not only is there a representation of the self and of others, but at the same time a representation of the self *as viewed by others.* This social self-image can then be manipulated continually not only by others, but also by the self (thus the effectiveness of `positive thinking', self-hypnosis and some forms of psychotherapy).

3.5 THE ADEQUACY OF THE DASHBOARD METAPHOR: SOME LINKS TO THE EVIDENCE

Recent new discoveries have strengthened the idea of an innate dashboard on which information from different canals and brain-regions is centralized to allow for optimal decision-making. In a discussion on phantom limbs, Ronald Melzack reports that even people born without a limb often perceive one from time to time. He tells us about an eight-year-old boy, born with paralyzed legs and a right arm that ends at the elbow, who sometimes feels phantom fingers. Another example is a 32-year-old engineer, born without a leg below the knee, who often experiences a whole leg, including a foot. Sometimes the experience will disappear only to return, to his relief. Melzack proposes that the brain contains a neuromatrix, or network of neurons, that, in addition to responding to sensory stimulation, continuously generates a characteristic pattern of impulses indicating that the body is intact and unequivocally one's own, the `neurosignature'. If the neuromatrix operates in the absence of sensory inputs from the periphery of the body, it may create the impression of having a limb even after that limb has been removed. (Incidentally, temporary states of this neuromatrix could also explain the sensation of rising outside of the body and returning into it, P.S.).

Because phantom limbs are sometimes experienced by people who never had the original limbs or who lost them at an early age, Melzack proposes that the neuromatrix is largely genetically prewired, although it can also be sculpted by experience. He believes that the brain produces a natural `body image' which does not stop working the moment that external input stops (Melzack, 1992). Of course, the brain produces more than a body image alone. It also contains a natural `world image' which is normally constructed and corrected on the basis of sensory input. If input from the senses stops coming, however, the brain may simply create an image itself. This seems to be what happens when we dream, but this could also explain the phenomenon of *phantom seeing and hearing* about which Melzack also has something to tell us. Phantom seeing and hearing often occurs in partially blind or deaf people. A lack of input from eyes and ears causes the brain to generate very vivid images and sounds itself. One woman who is partially blind continues to see a phantom building, which will come and go unexpectedly. Another woman who was a musician before losing her hearing hears piano concertos and sonatas which she cannot turn off and which sound so real that she first thought them to come from a neighbor's radio.

Both the body image and the world image can be seen as projections on `internal screens' which have been erected by evolution to give us concise information on the basis of which we can make decisions. Several authors have proposed similar metaphors to account for consciousness and sometimes they even try to locate the transition to consciousness. With respect to vision, we have seen already in chapter 2 that Erich Harth points to the LGN as an `internal sketchpad' (Harth, 1995: 70). With respect to emotions and to qualia, Pugh tries to explain why they are qualitative rather than quantitative by pointing to the relative distinguishability of qualitative signals. According to him, the use of distinguishable different values makes it easier to associate specific value components with specific causal factors (Pugh, 1978: 110). Implicitly he is comparing the framework of our consciousness here with a kind of dashboard on which the different monitors, bulbs and measuring-instruments have to be conveniently arranged and clearly indicated to make decisions possible.

The dashboard metaphor is also compatible with the distinction between conscious and unconscious. There is a lot of activity in the organism that has to go on unconsciously and in which we have no say. If we could stop our own heart-beat, many would stop it if they found themselves in pitiful circumstances. If we could reprogram ourselves so that we would be happy under any circumstances in which we may find ourselves (with or without a particular partner, with or without a job, in absolute poverty, after a tragic loss, etc.), we would probably reprogram ourselves in such a way that we would not be able to feel pain and sadness anymore and that we would feel joy, satisfaction and ecstasy even in the midst of disaster - as a result of which we would probably become extinct within one generation. Therefore, most of the machinery behind our internal monitors and bulbs is completely sealed away from us and we can only fumble around with some of our wheels and switches. In that respect we are in a deep sense captured within our cockpits and nailed onto our dashboards. Yes, we are free, we make choices continually, but at the same time: no, our freedom is limited to the options as they are given emotional values by our partly innate value-system and as they are presented to us on our `internal monitors'. The degree to which we are free is largely dictated by the adjustability of our monitors and the options on our switchboard. We cannot change the way in which we are conscious about the world.

Finally, psychopathology brings out the strength of the dashboard metaphor. Patients with different psychological abnormalities can be viewed as persons without specific monitors or with monitors that give a distorted view of reality or that represent aspects of the world to which a normal person does not pay much attention. Autism is currently understood as an impairment of a specialized, largely innate module, situated in the left medial prefrontal cortex, which enables us to reconstruct mental states of other persons (e.g. Frith, 1993). Depression can be viewed as a state in which an overactive amygdala prompts the left prefrontal cortex to devise dark scenarios and gloomy or one-sided views about other people (Posner & Raichle, 1994). The dashboard metaphor shows very clearly that people suffering from such illnesses live in their own idiosyncratic worlds, resulting from lack of particular monitors, or from their oversized format, while at the same time stressing that the properties of such worlds can be studied and explained scientifically.

3.6 CONSCIOUSNESS AND ITS ANATOMICAL AND BEHAVIORAL CORRELATES

In spite of the fact that consciousness is a private property, it does not necessarily have to remain completely mysterious. I have suggested that it was designed to force animals to take into account multiple factors in flexible decisions. Qualia are necessary to reward and punish behavioral experiments in such a way that an organism can gradually acquire a series of behavioral patterns which are adequate both to its needs and to its environment. Play behavior may be a sign that this type of learning is present in a species. Intentionality is necessary as long as an organism has to be guided by temporary plans and goals, which have to be adjusted each time depending on its situation and its needs. Intentionality may be interpreted as a characteristic of an active mind, which does not simply react to stimuli, but that fulfills its mission via a series of temporary plans which are the product of its imagination. The ability to conceive such plans and to `write' such scenarios may manifest itself in idiosyncratic behavior, but it could also manifest itself in the ability to dream, dreaming being conceived here as the activity of a mind which is continually scanning possible scenarios in a situation in which the information from its sense-organs is not passed on.

Consciousness, therefore, according to this model, is linked to choice and values. As our `innate structures of experience' are the product of variation and selection of a long series of past choices they can be considered as sediments of past experiences and past lives. Ancestral animals which tended to make adequate choices as a result of adequate sentiments simply contributed more to the design of the psyches of their modern descendants. Evolutionary `monadology' can be seen therefore, paradoxically, as a doctrine about selective `metempsychosis'!

One of the problems of the theory of metempsychosis was, however, that it remained unknown whether animals could reincarnate into humans or not. In later antiquity an increasing number of philosophers started to claim that only rational creatures could reincarnate into each other. Yet, consciousness could be something more fundamental than rationality, which can be claimed to depend at last partially on language. Perhaps all animals exhibit some degree of consciousness. At least the word animal derives from *anima* or soul. Do bumblebees, cuttle-fish, eels, salamanders, seven-months-old embryos, penguins, elephants and dolphins *experience* their lives to some extent consciously?

The problem of animal awareness is one of the hardest tests for each model of consciousness. The problem with animals is that they do not speak, or, at least, are unable to relate to us their inner experiences. Thus, if we want to answer the question of whether they are conscious and what kind of consciousness they do possess we have to look for the anatomical and behavioral correlates of specific types of consciousness. Can the above model help us find these?

Qualia. In the spirit of Pugh qualia constitute the heuristic values in the organic decision system. Why do they have to be *experienced*? Perhaps the simple reason is that they would otherwise be neglected. *The intensity of experience therefore has to correlate to the urgency of the decisions that have to be made (in terms of selfish-gene interests) insofar as this urgency can be somehow assessed by the organism in question.*

What animals *do* experience them and to what degree? *As qualitative experiences seem to be designed to enable the organism to `measure' the adaptive value of a large number of behavioral alternatives, they are probably experienced by animals to the extent in which they display flexibility and creativity in their natural environment.* Of course, it is not easy to assess the degree of this flexibility and creativity in the laboratory. Because the `primary' values have to be innate, it is to be expected that individuals that are unable to display their `creative potential' as a result of special circumstances are not falling short of the `experiential level' of their species. As the `primary' values are a product of evolution, we have to expect that they are at least as completely differently orchestrated in different species as they are already differently orchestrated in different individuals of our own species. Species that, even in their natural environment, do display a lot of rigid preprogrammed action patterns, which cannot be corrected by taking into account environmental novelties (a wasp that does not think about turning away if hitting a glass panel), probably do not use subjective experiences in the `decisions' that constitute those fixed action patterns. Species which have evolved to be more flexible, however, need not to have lost all of their more rigidly preprogrammed action patterns. Instead, we would expect a kind of hierarchy of psychological mechanisms: a., in which some reflexes guarantee a minimum security level, b., in which a series of preprogrammed stereotypical action patterns constitute the behavioral repertory which is typical for the species (which however in many cases has to be refined by training) and c., in which, in only some specific domains, more flexibility can be built in by learning which results in completely new patterns of behavior.

These learning processes probably enclose conscious experiences with which the trials are rewarded and the errors punished. Of course, between the level of fixed action patterns and learning processes there is also a level of acquired habits which result from past learning processes and which allows for their semi-automatic execution. *Apparently the procedure of conscious `weighing' integrated information and behavioral scenarios is followed only if fixed action patterns and habits are inadequate for the correct performance of the survival tasks of the organism*. Often the results of such conscious learning processes are `stored' as semi-automatic action patterns or habits.

Thus, we would expect conscious experience especially in animals which display a lot of creativity in their natural environment and which are able to change their action patterns at the moment that these become unadaptive. Let us not forget, however, that even humans display a lot of unadaptive behavior, especially if this is reinforced by traditions which have been formed in other ecological circumstances. The hall-mark of consciousness, however, seems to be constituted by learning processes on the basis of the creative testing of new behavioral possibilities. *It is probable that species which display play-behavior, at least in their juvenile phase, are conscious.* Such behavior is demonstrated by many birds and mammals.

There are several reasons to expect consciousness especially in animals with parental care. One of them is purely economical: in these species individuals are more `valuable' (they are more `K selected') and any extra education would be a useful supplement to their expensive upbringing, increasing the likelihood of their success. Another reason is simply practical: in these species parents and offspring meet and therefore, at least the possibility exists of transmitting valuable non-hereditary information from one generation to another. As long as the parents are able to create an environment of relative safety, the juveniles of such species can practice a number of skills under the supervision of their parents. For example, in many species of birds and mammals hunting skills improve only gradually while parents gradually reduce their level of feeding and protection over an extended period (consider Trivers' `parent-offspring conflict', Trivers, 1985, chapter 4.3). In these species a lot of behavioral experimentation can take place during this period of extended dependence. It is probably in these species in which we should expect to see the crucial role of play behavior in the gradual genesis of the adult behavioral repertory and in which we, therefore, should expect to see the crucial role of consciousness, too.

Intentionality. Apparently intentionality concerns the way in which objects or relations surrounding an organism are `represented' in its mind and in which it can manipulate both these objects or relations and itself to improve these representations. One can speculate whether this kind of `intentionality' presupposes consciousness. Many modern cameras are equipped with an auto-focus system which via a feedback loop guarantees that the object is projected sharply on the film. Of course, this kind of focussing can work entirely without consciousness.

Probably something else is meant by Brentano c.s.. Intentionality seems to refer to an orientation to goals: not to goals which are somehow fixed, but goals that can be fixed entirely anew at any moment. Intentionality seems to be an `open' goal-directedness. This is entirely compatible with the element of scenario-building in the value-driven decision system. Intentionality seems to be specifically attributable to organisms that are continually changing their internal goals and `weighing' the value of the goals they are imagining and striving for.

How could we know which animals are such natural `scenario-builders'? One possibility is that we can simply observe the animal in question and see how it seems to change its goals in the middle of its activities. This procedure can be hazardous, however, because this change of behavior could also result from a clash of two fixed action patterns. Another possibility is that *dreaming* can be interpreted as the activity in which free course is given to the mind without feedback from the environment. Animals that dream are animals with a mind that is continually throwing up and going through possible scenarios as a result of which they can better anticipate changes in their environment. Whether an animal is dreaming or not can often be observed as a result of grunts and rapid eye movements while it is asleep (REM sleep). According to Winson (1990) placentals and marsupials do exhibit REM sleep, whereas more `primitive' mammals, including the echidna, do not.

Volition. Many animals do experience conflicting impulses, for example when a male is unable to decide whether to fight or court a female. Often such animals will display so-called displacement activities which to an outside observer seem totally irrelevant. They will start scratching themselves, or start pecking into the ground, etc. (Humans are believed to show displacement activities, too, for example in the form of sucking on pens and spectacles, head scratching, beard stroking, McFarland, 1987.) In many species of birds such displacement activities have evolved into ritualized behavior.

Conscious control over one's own behavior perhaps presupposes a behavioral flexibility which enables one to solve conflicting impulses in a more creative fashion. This can only evolve the moment an animal is able to postpone the execution of some of its drives or the moment it is able to transform or integrate its drives. True control is only achieved if the animal is able to give priority to some goals over others or if it is able to devise new goals and plans in order to integrate some mutually almost incompatible drives. It presupposes the ability to devise internal models of the possible results of one's own different possible strategies. It is known that chimpanzees, at least, are able to suppress short-term desires in favor of the achievement of their goals. Frans de Waal tell us, for example, how one chimpanzee pretended not to know where some bananas were buried only to unearth them the moment no other colony members were watching (de Waal, 1981).

Such conscious control over one's actions probably transforms instinctive drives into a system of values which can be used to weigh alternative action-plans. Even human beings, however, do not always think before they act. `Free will' is only a relative notion: the stronger the ability to predict the consequences of one's own actions and to adjust and change one's plans creatively, the freer one is. It seems to me that most of us are not always as free as we would like to be.

Consciousness should not be thought to be linked to a free will, however, but to the experience of qualia. An animal that experiences qualia is able to learn from its experiences, but it may also have to endure experiences from which nothing more can be learned than that the world is not always pleasant and just.

Self-consciousness. In one form or another consciousness can always be viewed as self-consciousness, because it is always one particular point of view that is experienced and many animals need to know the effects of movements of their own bodies. A squirrel has to guess its own weight, a zebra has to know when her young is standing in her own shadow, etc. Additionally, all social animals which live in a hierarchy that is not fixed, but results from competition, seem to need some kind of image of their own social status. Individuals of such species which are consistently defeated in encounters with their opponents often become psychologically `down', display timidity in encounters with new opponents and will, as a result, remain in their position of low rank. This effect can even be observed in bumblebees and crickets (Wilson, 1980: 123), although, of course, it is unclear what kind of self-image is implied. Of course, one possible test that an individual is aware of its own status would be the purposeful use of signals and ornamentation to advertise one's status. Recently, it has been discovered that the reddish taint of the breast-feathers of the Lammergeier is not only placed there by themselves, but is also a clear signal of its status.

At the moment many authors seem to agree that self-consciousness, as it is expressed in apes and humans, is probably a result of social evolution. The idea is that a self-image enables us to guess how we are judged by conspecifics and, therefore, also enables us to manipulate them better. A good argument for this position is that our self-image always seems to reflect social value-judgments and that the way in which we relate to ourselves, even in diaries and prayers, is tightly linked to judgments concerning `merit' and `self-esteem'. A closely related argument is afforded by the theory of reciprocal altruism: it is predicted that it is adaptive to deceive oneself and others about one's investments in the reciprocal relationship. To be able to do this one needs on the one hand a flattering self-image - on the other hand one needs to `know', unconsciously, one's real purposes (Trivers, 1985; 1991; `knowing unconsciously', of course, is an interesting paradox). The ability to recognize oneself in mirrors, which can be learned by chimpanzees, orangutans, and dolphins, but not by most gorillas and not by any monkey (Parker *et al.*, 1994), could be a side-effect, perhaps also related to a talent for object manipulation and rotation.

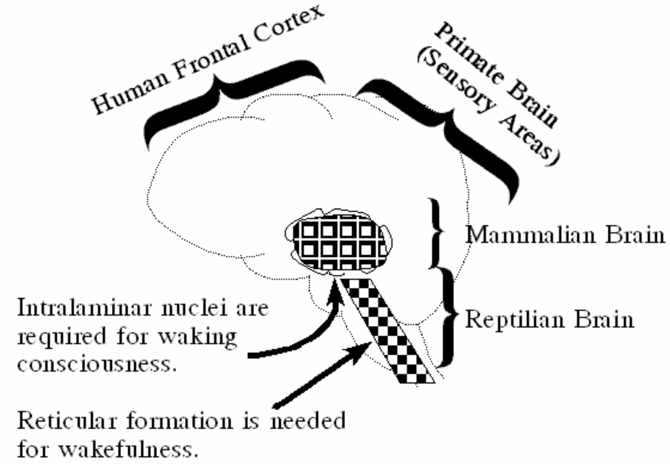


Figure 3-4. To the extent that animals share particular parts of our brains known to have specific functions, it is reasonable to believe that they share the corresponding experiences. Redrawn after Baars, 1997: 32.

Anatomical evidence. Often anatomical evidence offers a invaluable amplification of the behavioral evidence (the argumentation used is a kind of triangulation). For example, both corvids and parrots are known to be groups of birds displaying an extreme level of playfulness and intelligence. (I recently watched a crow trying to open an acorn by dropping it repeatedly on the road). At the same time, it is known that both groups of birds have a relative big *hyperstriatum*, which is the part of the forebrain responsible for general intelligence in birds (Savage, 1995). Above that, corvids are at the top among birds with respect to brain size, having a brain-to-body ratio equalling that of dolphins.

If we use this kind of anatomical evidence and study the evolution of the brain in our own lineage, there is are good reasons to believe that we share the division between waking and sleeping with reptiles, that we share the behavioral flexibility which comes with an elaborate system of values and emotions with all mammals and that we share our detailed visual world with all primates (Baars, 1997; fig. 3-3).

Conclusion. In what kind of animals may we expect consciousness and the ability to suffer? It seems that the ability to use symbols and language and to recognize one-self in mirrors are neither necessary nor sufficient for the ability to suffer. The ability to suffer seems directly implicated by the ability to experience qualia. (Qualia seem to be linked to the type of behavioral flexibility we see at least in birds and mammals.) More sophisticated psychological abilities could enhance it, but they could also give some relief.

II

** Ape, biology, culture **

Many discussions on evolution get stuck at the moment that the human ability to absorb and create culture is raised. Almost always this ability is mentioned as a sign that humans are unique and often it is implicated that culture simply defies an evolutionary explanation. In a kind of relativistic rhetoric, which is sadly enough characteristic for our age, it is then claimed that only some aspects of human behavior and culture can be explained with reference to evolution or `biology'; other aspects are claimed to be `purely cultural' in origin, whatever that may mean.

In this part I will try to correct the wrong assumptions underlying this double misunderstanding. In essence they arise as a consequence of the remnants of an old dualistic way of thinking in which man is citizen of two worlds, a natural world and a world of symbols and meanings. The human ability to speak language is then often thought to enable him to leave the first world and to enter the second one. Yet, it is forgotten that the natural world is full of signs and symbols, for example in the area of courtship and even in the predator-prey relationship, and that there is no reason to believe that a capacity to handle large amounts of signs and symbols in a very quick fashion is purely a luxury from a biological viewpoint, something without adaptive meaning whatsoever.

To free ourselves from the old, dualistic way of thinking it is necessary both to change our opinions on nature and animals and our opinions on humans and culture. Hopefully, I have already shown in the first part of this book that knowledge and consciousness did not start with humans and that animals are often more complex than we think. In this second part I introduce an alternative model of culture. Culture is not `reduced' to something at a `lower' level. At the same time the ability to absorb and create culture does not arise out of the void and culture is simply the human way of doing what everyone else does in slightly different ways: surviving, eating, hiding, protecting oneself, mating, competing, selecting. Instead of enabling us to transcend the `struggle for life', culture is our specific way of fighting. Our unique human capacity for symbols and language is simply our unique weaponry. Above that, the complexity of culture does not arise out of nothing, but is solidly grounded in the complex value system already present in our ancestors. Symbols and language enable us to create an infinite number of variations on a limited series of old themes.

Chapter 4 is a historical reconstruction and `justification' of sociobiology and evolutionary psychology which may function as an introduction to some, as a mnemonic to others. Sociobiology is understood as a revolution in ethology, necessitated by ethology's growth beyond its borders and especially by its need to be properly rooted in evolutionary biology. Sociobiologists demanded that phenomena should be explained at the proper level: characteristics of groups for example should not be explained with resort to group selection when it is possible to explain them as a result of individual selection or even `gene selection'. The explanation of social behavior could no longer be* *based purely with reference to the `survival of the species', but was preferably based on cost-benefits analyses of alternative strategies from the perspectives of all parties concerned. Their interests can ultimately be only understood with the aid of evolutionary genetics, which predicts that interests can diverge even within groups and families of one and the same species.

In the second part of chapter 4, some common charges against, and misunderstandings about, sociobiology and evolutionary psychology are discussed. Against the charge of `genetic determinism' it is argued that a difference should be made between genetic determinism and evolutionary explanation. Against the charge of `adaptationism' it is argued that adaptationism is flexible enough to encompass effects of maladaptation, chance and complexity. Against the charge that sociobiology resorts too much to AD HOC *theories it is argued that sociobiology is in essence precisely a reaction against* AD HOC *theories which result when nobody cares about the compatibility and integratibility with adjacent disciplines.*

Thus sociobiology is simply understood as the result of an integration of ethology with evolutionary genetics and an `energy-budget' view of life, in which behavior is explained with reference to its costs and benefits. Evolutionary psychology, a term which was already used by William James, is its extension in the domain of psychology and explicitly addresses questions with respect to the adaptedness of specific psychological mechanisms, thrown up by evolution to solve particular behavioral problems. (One of the favorite dogma's of evolutionary psychology - and perhaps one that is used much too easily - is that many psychological mechanisms that were adaptive in the long hunter-gatherer stage of human evolution are not so in our current, industrialized circumstances.)

In chapter 5 it is argued that both sociobiology and evolutionary psychology form the proper basis for the analysis of culture. Culture cannot be considered to be an autonomous realm, floating above the interests of its biological bearers. An evolutionary analysis of culture cannot, therefore, concentrate on the differential reproduction of `memes' as if cultural evolution is a more or less autonomous, elevated process which uses humankind as its humble substratum. Instead, `memes', `culture-genes' or `ideas' should be considered to be pieces of information with which individuals try to assist, influence or manipulate each other. `Memes' are almost continually manipulated in such a way that they can be used in a kind of biological warfare as `mind viruses' not with an eye to their own survival interests, but serving the survival interests of their creators and manipulators, often infecting other individuals and bringing them to behavior that is not in their own interests. Within this view of culture, deception is one of its essential components.

Although a clear correlation between intelligence and reproductive success is perhaps hard to give, it is clear that an ability to absorb and create ideas has fitness consequences. One of the reasons that things are not simple may be that culture is a complex environment of its own in which different individuals may follow different strategies which may coexist in a complex equilibrium.

Chapter 6 is an attempt to do justice to the complex ways in which cultures are used by individuals to adapt themselves to particular ecologies. Apparently, cultural traditions are used and changed to adapt individuals and their societies to particular ecologies, just like instincts adapt an animals to their niches. This would explain the parallels between, for example, the mating patterns of animals and the marriage systems *in different human societies, although mating patterns are produced by a process of relatively slow, organic evolution, whereas marriage systems are products of cultural evolution, which is a very fast process of coping with changing ecological and economic circumstances. I think, however, that one can claim that culture `replaces' instincts. First, in opposition to what perhaps is suggested by the word itself, `instincts' are flexible already. Second, humans are not totally without `instincts' and cultural evolution is thus not an independent para-evolutionary process. Humans are very flexible, but not infinitely so and I will try to show that human behavior is based on conditional strategies which are activated by particular ecological and economic circumstances. Probably human behavior is more affected by cognitive and cultural processes than the behavior of any other animal, but that does not mean that humans are able to change their innate values, goals and conditional strategies at will. On the basis of a series of innate values and goals, and as a result of their unique capacity to look forward and plan, humans are continually making and evaluating scenario's in which they can virtually test alternative behavioral strategies. On the basis of such internal scenario-weighing they are continually creating and correcting their life programmes to suit particular ecologies and economies. In the end, however, it is their emotions, that is their innate value systems (see chapter III), that guide them through life, and emotions can best be seen as the subjective manifestations of conditional strategies. Chapter 6 gives some examples of the way in which conditional strategies give rise to particular cultures as a result of particular circumstances.*

The upshot of part II is that culture is not opposed to `biology' and that culture enables humans to adapt themselves to different environments. Culture does not make life easy, however, because it seldomly suits perfectly to each individual's own innate teleonomic value system and thus forces individuals to find compromises or new solutions. Culture as the sediment of a large number of individual decisions, solidified as a result of imitation and teaching into massive traditions, can weigh heavily on a young individual of a new generation that still has to find its own place and to fight for its unique codes. Perhaps freedom is the ability to create your own course of life despite the plurality of advises with which one is bombarded almost continually. In that case one could also claim that freedom is not opposed to `biology' either, but that it represents the talent of remaining true to oneself (to one's fundamental character) in the midst of the dynamics of cultural change.

4

** A revolution through integration: the origins of sociobiology and evolutionary psychology \

> Great is the power of steady misrepresentation.
>
> Darwin, 1872

4.1 INTRODUCTION

In recent years, sociobiology and evolutionary psychology have gradually gained acceptance, partly as a result of a wave of popular and more scientific accounts (e.g. Wright, 1994; Ridley, 1996; Roele, 1996; Thiessen, 1996; Low, 2000, etc.). Sometimes, however, one still hears the classic objections expressed by the old critics of sociobiology, which was supposed to be a `genetic' or `biological' `determinism' (Gould, 1977; Harris, 1979; Kitcher, 1987; Rose & Rose, 2000) and to be a form of panadaptationism or `adaptationism' (i.e., using adaptation as an all-explanatory principle, Gould & Lewontin, 1979). Partly as a result of the power of these critics the term `sociobiology' became a curse during the eighties and nineties and many researchers have rejected the term (e.g. Alexander, 1987: 6) and resorted to new or other names, like behavioral ecology, socio-ecology, evolutionary anthropology and evolutionary psychology - often by giving a new twist to the original ideas. All these tendencies culminated in 1996 when the successful journal *Ethology and Sociobiology* was renamed *Evolution and Human Behavior.*

Intellectual honesty demands, however, that justice is done to the history of a discipline. In this chapter I will delve into the roots of sociobiology. I set out to demonstrate that despite a number of misleading statements from the first generation of sociobiologists themselves, neither blind genetic determinism nor extreme adaptationism have ever formed the central core of sociobiology. Sociobiology was simply an attempt towards interdisciplinary integration (Barkow, 1989: 3, speaks of `vertically integrated explanation'; Wilson, 1998, uses Whewell's `consilience'), emanating from the knowledge that it is important to keep the presuppositions of adjacent disciplines compatible and to explain phenomena at an adequate level.

According to my analysis, sociobiology and all sister and daughter disciplines (behavioral ecology, socio-ecology, evolutionary psychology, etc.) should be viewed as long-term effects of the emancipation of ethology. At a certain point ethology began to ripen, and it was increasingly confronted by its limitations. The result was that in choosing between alternative hypotheses within ethology it was no longer possible to decide on the basis of ethology alone: it became necessary to give it a `foundation' into the discipline that studied the `underlying' level - evolutionary biology. Eventually a bold attempt towards an evolutionary foundation forced ethology into a process of transformation and deepening, which in turn led to the creation of sociobiology.

On the basis of this analysis the relationship between sociobiology and the human sciences is placed in another perspective. It is no longer the issue whether sociobiology (or behavioral ecology, evolutionary psychology, etc.) attempts to `reduce' independent sciences to biology. Rather, independent sciences which started to ripen and to come to their most fundamental assumptions were confronted with their borders and limitations. To be able to decide between several possible sets of assumptions a mature scientific discipline needs to consult with its adjacent disciplines to keep its assumptions compatible with the theoretical result of those other disciplines with whom it has become interwoven in the web of successful scientific theories which form our best current interpretation of the world.

Figure 4-1 gives an idea of the kind of integration that I have in mind. It is an ontological (or even metaphysical) interpretation of a historical process. Initially, evolutionary science, the social sciences and ethology tried to establish themselves as independent disciplines. Over time, it proved impossible for these disciplines to justify their own fundamentals purely on the basis of their own expertise. At some point all disciplines concerned with realms of related phenomena on specific `levels' of reality had to cross the borders of their own `level' to justify some of their principles. Sociobiology and evolutionary psychology represented historical points at which disciplines in adjacent realms had to be united, integrated or brought into balance with each other: sociobiology represents largely an integration of ethology with evolutionary science, evolutionary psychology was an attempt to integrate the social sciences within the new synthesis.

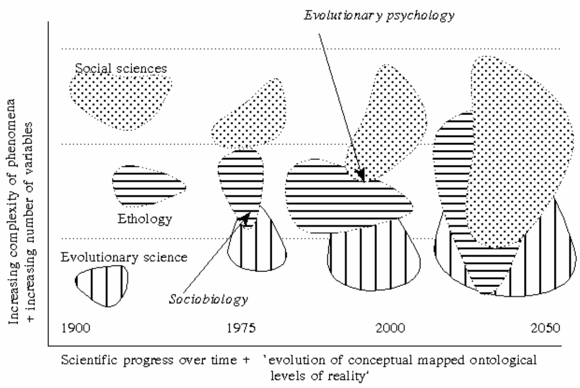


Figure 4-1. An ontological interpretation of the evolution of conceptual maps at three `levels of reality': evolutionary science, ethology, and the social sciences.

4.2 A REVOLUTION THROUGH INTEGRATION

The creation of sociobiology is an excellent example of a scientific revolution which does not simply result from new technologies or measurement methods, but from conceptual integration of a number of previously independent disciplines. It is probably characteristic that the first monumental public program of sociobiology, E.O. Wilson's *Sociobiology: the new synthesis* (1975), had a great deal in common with a summary work. In the terminology of the last chapter, one of the biggest virtues of sociobiology is robustness or multiple derivability.

In his *Sociobiology* Wilson synthesized a great quantity of information from ethology, evolutionary biology, development biology, genetics and ecology in order to trace the evolutionary conditions of the various forms of social behavior (aggression, territorial behavior, dominance systems, caste systems, mating patterns and parental investment). He defined sociobiology as "the systematic study of the biological basis of all forms of social behavior" (Wilson, 1975: 4), apparently without realizing that `biological bases' are (erroneously) associated by many psychologists, sociologists and jurists with `unchangeable determining factors' (Alexander, 1987: 6-12). To avoid confusion it would have perhaps been better if he had have spoken of the *evolutionary* backgrounds of all forms of social behavior (including cultural transmission). In fact, the central claim of *Sociobiology* is not so much that behavior is completely genetically preprogrammed, but that the (sometimes more, sometimes less flexible) aptitude for social behavior and the different varieties of social behavior have to be explained within an adequate evolutionary frame-work, a frame-work in which the costs and benefits of different types of behavior are critically assessed.

The central message of Wilson's book is the realization that it is not self-evident that animals (and people) live together in groups: group-members are often a nuisance to each other. Yet, in many animal species we see many types of social forms and habits, which are not only explained by examining their evolutionary origins (phylogenetic inertia), but also by current ecological circumstances. The central antitheses in sociobiology are then not those between `nature' and `nurture', but those between the *ultimate* causes (selection factors in the direction of specific adaptations) and *proximate* causes of behavior (the actual realization of adaptations in specific hormonal and neural organizations), or to put it simply: between the *functions*/the *evolutionary `why?'* and the *causes*/the *physiological/psychological `how?'* The fact that extreme flexibility in social behavior is prevalent in a number of animal species, including man, calls for an evolutionary explanation in itself. It is, therefore, surprising to see how such a fierce critic of sociobiology as Marvin Harris (Harris, 1979: 140) refers in most of his criticism to this flexibility as if sociobiologists do not acknowledge it, while Wilson not only acknowledges it, but also tries to explain it (Wilson, 1975: 547).

2.1 *Ethology as the mother-discipline*

It seems to me that Wilson's *Sociobiology* is an important milestone, which however should be seen as the culmination of a revolution which was gradually taking place at that time in ethology, the discipline for which von Frisch, Lorenz and Tinbergen got their Nobel Prize in 1973. In its first phase ethology, as the study of instinct (Tinbergen, 1951), was not always aware of the importance of the evolutionary basis of behavior or of the exact consequences of evolution. Some `classic' observers of animal behavior, such as Fabre, had never even been evolutionists. They continued to remain completely oriented towards the description and classification of animal behavior. The twentieth century founders of ethology were, however, evolutionists, but were initially limited to somewhat generalized and sometimes even wrong hypotheses concerning the function, survival potential or adaptiveness of behavior.

In the important summary work of 1951 *The Study of Instinct*, with which among other things Tinbergen attempted to make European ethology more accessible to the Americans, he admits that at that time the study of the evolution of behavior lagged still very much behind the knowledge possessed with respect to morphological evolution (1951: 185). He attributes this lagging behind to the relative intangibility and fossilizability of species-related behavioral repertoires and to the difficulty of establishing their genetic basis.

A factor that Tinbergen does not name is the absence of competitive explanatory models, however improbable these may appear or be. These can move researchers into better underpinning the foundations of their specialist field, helping to expose and highlight any eventual imperfections.

An all-too-easy truism, which led many pioneer ethologists, such as Lorenz, astray, was the truism that certain forms of behavior did not so much serve the continued existence of the individual, but served that of the *group* or the *species* (Lorenz, for example, speaks of the *Arterhaltende Funktion* and *Arterhaltungswert* of behavior). This idea was often not presented as a hypothesis, but as an obvious consequence of Darwinism. It was probably so popular because it created the possibility of grinding the sharp edges of Darwinism, and presented natural selection as a Providence concerned with the survival of species, which arranges everything in nature to everyone's best advantage.

In his famous work on aggression, *Das sogenannte Böse*, Lorenz states that individuals of the same species seldomly damage one another, because two fighting individuals of one species are in the end both oriented towards the `conservation of the species'. If conflicts get nevertheless out of hand, such as amongst man, this is caused by a *`Fehlfunktion'*. The hypothesis that both the provocation of a conflict and the avoidance of an escalation could sometimes be an advantage to the *individual* (or even his genes) remains undiscussed by Lorenz (Lorenz, 1966).

2.2 *An evolutionary mechanism: group selection*

The very attempt to *systematically* underpin and prove the theory that a great deal of behavior is aimed at the survival of the group (instead of the survival of the individual) started an extremely fruitful discussion, which in turn laid the foundations of sociobiology. It was V.C. Wynne-Edwards with his *Animal dispersion in relation to social behaviour* (1962), who forced a discussion about the precise benefits and costs from investments in group activities. (Before the work of Wynne-Edwards a modest model of group selection had already been proposed by Sewall Wright, who was criticized by Simpson, but it was only Wynne-Edwards who started to use group selection as an explanation of almost anything.)

Wynne-Edwards based his discussion on a number of studies that indicated that the distribution density of many animals was related to the distribution density of their food sources: in fact, the number of sea birds in each part of the Atlantic Ocean related quite accurately (correlation +0.85) to the plankton density in that area. Wynne-Edwards subsequently demonstrates the consequence of the inability of man to determine whale and fish catch quotas: as a result of overfishing the catch will eventually reduce. Consequently, Wynne-Edwards asks how it is possible that the behavior of man is responsible for disturbing the balance of nature. What mechanism prevents other predators from exhausting their food supplies? In his opinion, "something must restrain them, while in the midst of plenty, from over-exploiting their prey" (Wynne-Edwards, 1962: 7).

The mechanism that he put forward is *group selection*: groups successful in adjusting their population density to the level of food available in the area have been able to build up and maintain their restrictive characteristics over the millennia, whilst groups with a tendency towards short-term planning would have become extinct over the millennia as a result of food shortages.

Wynne-Edwards now thought, as a real sociobiologist, he had found a key to understanding a wide spectrum of astonishing forms of social behavior: from territorial behavior and the struggle for dominance, to the formation of large schools and swarms. According to him, territorial behavior is easily explained because it guarantees an efficient distribution of individuals over the available area, in addition to accurately attuning the population density to the availability of food. The moment no territory remains for new individuals, the optimum population density has been reached. Dominance hierarchies have the same effect: these prevent lesser individuals from reproducing themselves and guarantee that the most healthy and powerful individuals maintain the group. Wynne-Edwards is at his most original in his explanation of the large shoals or swarms prevalent among many animals: these so-called `epideictic' displays apparently function as a sort of unconscious population count, that as a result of negative feedback has subsequent repercussions on the size of the population.

2.3 *Wynne-Edward's presuppositions*

Wynne-Edwards' model made explicit a mode of thought that was common amongst biologists and ecologists at that time, and thought it through to its ultimate consequences. By drawing radical, and often completely contra-intuitive conclusions from more or less silently accepted premisses, Wynne-Edwards exposed a great deal of the presuppositions in this viewpoint while defending them. In doing so he made himself extremely vulnerable. That earns him considerable scientific merit.

One of the presuppositions that he very clearly puts forward and defends is the idea that groups are more or less bound to one location, forming closed units as a result, between which very few genes are exchanged. In Wynne-Edward's words, such local populations are of "common descent, self-perpetuating and potentially immortal" (1962: 144). Only in this manner can they form a genetic reservoir, in which characteristics attributed only to groups and not to individuals are disseminated. Wynne-Edwards very explicitly postulates that "what is actually passed from parent to offspring is the mechanism for responding correctly in the interest of the group in a wide range of circumstances" (1962:144).

The presupposition that he makes explicit here, is that certain group characteristics evolved because groups without them became extinct. "What is at stake is whether the group itself can survive or will become extinct" (1962: 144). Selection at the level of entire groups, that will or will not survive as a result of their capacity to limit births, must be stronger than selection at the level of individuals. A very long time ago groups with selfish and non-moderating members must have caused their own demise as a result of exhausting their environment (1963). In that respect Wynne-Edwards' work also contained a very clear message and warning for man, who has apparently already lost the capacity for natural birth control: this species must beware of the "axe of group selection" (1963).

In fact, by making his presupposition so explicit Wynne-Edwards made it very easy for his critics. The entire construction of his theory would collapse like a house of cards at the moment that it could be demonstrated that his presuppositions were incorrect and that all his examples of social and `altruistic' behavior could be explained as advantageous on the individual level.

2.4 *Wynne-Edwards' Critics: Lack and individual selection*

David Lack, whose book *The natural regulation of animal numbers* (1954) Wynne-Edwards acknowledges as a particular inspiration (1962: 2), reacted immediately by means of the latter strategy. He discussed the invasions of Crossbills, Nutcrackers and Waxbills from the Taiga to our regions, that Wynne-Edwards actually viewed as a sort of collective altruistic suicide in the interest of maintaining the species (he literally writes about an `*automatic social guillotine'*, 1962: 471). Lack reminds Wynne-Edwards that he had already excluded the suicide explanation in his 1954 book on the basis of two arguments: in the first place such a clear suicidal tendency would have been quickly wiped out by natural selection, and in the second place there are not many, but enough indications that emigrants - mostly juveniles that in competition with older individuals suffer defeat - in many cases fly back to the country of origin at the moment that the situation there is more favorable (Lack 1954: 232; 1966: 304).

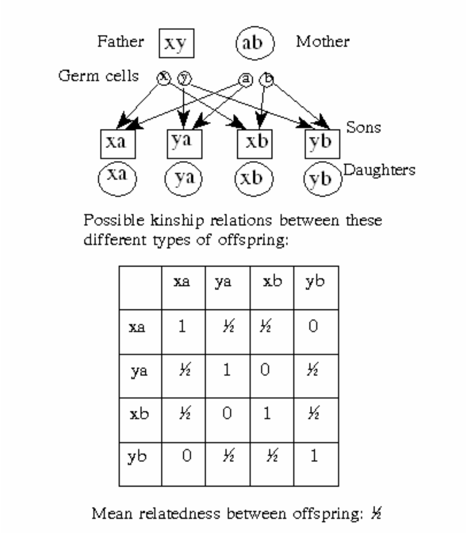
Lack also demonstrated that most cases of reproductive self-limitation, such as a limited number of eggs per nest for example, can best be explained by selection at an individual level (equated by Lack to natural selection). In the Sparrow, Swallow and mostly also in the Great Tit, the number of eggs per nest correlates to the maximum number of offspring for which the parents could find food for the duration of a specific season (Lack, 1954: 22 e.v., 1966). The effect of laying more eggs is, therefore, counter-productive, and eventually leads to less offspring. Of course if this were not so, the genotype of the most fertile - the most egg producing individuals - would spread fastest through the population. As Lack noted in 1954: "natural selection operates on the survival rate of the offspring of each individual or genotype" (1954: 22).

2.5 *Williams and the selection of genes*

Lack was not the only `orthodox' Darwinist, who was forced by Wynne-Edwards to come with clear arguments for his point of view. In reaction to Wynne-Edwards a great number of authors felt it essential to indicate how group characteristics could be the result of the adaptedness of individuals to group life (Wiens, 1966). In his book *Adaptation and natural selection* (1966) G.C. Williams tried to create some clarity about the levels of selection, whereby he makes a distinction between `genic selection' or the natural selection of alternative alleles, resulting in organic adaptation, and `group selection', resulting in `biotic' adaptation. There is a clear difference between a population of adapted insects and an adapted population of insects (Williams, 1966: 108).

His argument against group selection does not mean that this form of selection is not possible, but only that it is a rather superfluous and implausible explanation for most adaptations that we see in nature. He shows that many explanations that refer to `group selection' and even to the `good of the species' confound *effects* and *functions.* For example, the `survival of the species' may be an effect of reproduction, but not its function. Individuals simply reproduce because they have inherited genes that caused their ancestors to do the same. Sex may confer evolutionary plasticity to a species, but only individual reproductive advantage can explain why asexual and sexual modes of reproduction are chosen in particular circumstances. The population as a whole may benefit from the tendency of birds to adjust their clutch size to the availability of food in a given year, but this property could only evolve because this tendency benefits individual reproductive success. In all, one should be very careful in identifying adaptations, because a property of an organism can only be called an adaptation if it really evolved as a result of the benefits it conferred on its possessors in the past. To call something an adaptation is to make a historical and causal claim.

According to Williams, very few traits can have evolved because they conferred benefits to groups or species. Group selection presupposes a series of circumstances which seldom occur in nature. Groups would have to possess a unique genetic code as a whole, that would have to force them into extinction or help them to survive as a whole. Groups would have to be relatively small and isolated, because otherwise selection on the level of individuals within groups would become more important. However, in contrast to individuals, groups seldom become extinct as a group, and that means that they are rarely `adapted' as a group. Williams can only find one example in the literature in which group selection is really the most likely explanation (Williams, 1966: 117).



Possible kinship relations between these different types of offspring:

	xa	ya	xb	yb
xa	1	½	½	0
ya	½	1	0	½
xb	½	0	1	½
yb	0	½	½	1

Mean relatedness between offspring: ½

Figure 4-2. In diploid organisms the mean relatedness between offspring is ½.

Actually the only unit that according to Williams is stable enough to change significantly over many generations as a result of selection is the gene, defined as a chromosomal fragment that is not split by continuous recombination or meiosis, which is, therefore, `potentially indestructible'. Even individuals are not completely suitable as units of selection as long as they are unable to replicate themselves as individuals and can, as a result of meiosis, never contribute to much more than about half of the characteristics of the offspring (of course, mothers somewhat more than fathers, because they also contribute the first cell and its extrachromosomal DNA). The phenotypical physical appearance of Socrates plus the genotype lying at its foundation died out in the fourth century before Christ, but it is quite possible that some of Socrates genes still exist amongst us (Williams, 1966: 24).

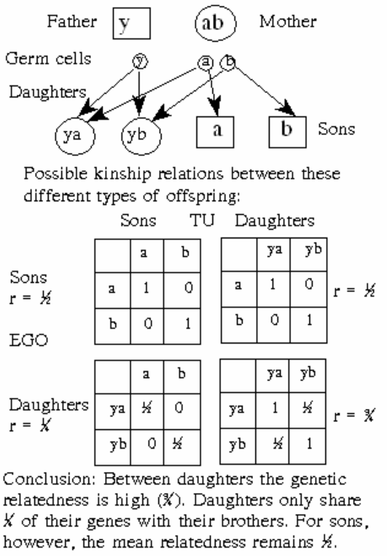
With that, Williams' reaction to Wynne-Edwards and other group selectionists appears to have brought him to the other extreme. His argument is not only that selection at the level of the individual is stronger than selection at the level of groups: he immediately seeks the most fundamental level of selection and thus arrives at his `*one-locus model of natural selection*'. In doing so he does not deny that it is eventually individuals in which genes are tested (1966: 65), but he argues that it is the genes that connect generations, and that it is the genes, therefore, that are subject to variation and selection over many generations.

2.6 *The altruism question as a test: Hamilton and `inclusive fitness'*

A crucial test for the tenability of such a perspective was, of course, the possibility this model offered to explain behavior that in Wynne-Edwards' opinion could only be explained by alluding to group selection. From the very beginnings of sociobiology it has always been the explanation of altruism in particular that has remained the focus of attention. In ethology the term `altruism' is used to indicate behavior in which one individual sacrifices energy and reproduction opportunities for the benefit of the energy and reproduction opportunities of another individual (the extent to which altruism is accompanied in some animals with intentionality and awareness is, therefore, left open in this definition). The behavior of worker ants is described as being `altruistic', because they themselves do not reproduce, but invest all their energy in the reproduction of the queen of the colony. Another example that is often referred to (e.g. Maynard Smith, 1965) is the alarming of tits in groups of tits. The alarm call does indeed have acoustic qualities that make it difficult for a sparrow hawk to locate it, but it nevertheless remains a risk to the alarming individual and an advantage to the individual that is being warned. It therefore poses a problem for everyone rejecting group selection and its resultant unconditional group loyalty.

In order to explain altruistic tendencies without resort to Wynne-Edwardsian group selection both Williams and J. Maynard Smith subscribed to the work of the geneticist Hamilton, who must surely rate as one of `fathers' of sociobiology (and whose recent death therefore means another blow to that discipline). Hamilton (1963, 1964) showed that altruism can evolve if the altruistic investment correlates to the extent of the genetic relatedness between the altruist and the benefiting individual. To demonstrate that altruistic behavior could evolve under this condition, he had to assume that a mutant with a slightly greater altruistic tendency would have more success under certain circumstances than his conspecifics that mutations - thus enabling the successful `altruistic mutant' to spread its altruism.

In other words, Hamilton postulated a genetic basis for altruistic behavior - `a gene for altruism' - which in fact is not at all that unusual when considering ants. A `gene for altruistic behavior' could emerge and prevail if the resultant altruism benefited other carriers of that same gene. The sacrifice of the altruistic gene in one individual could be compensated for by its survival in other individuals favored by the altruism. Altruism would therefore be specifically expected between gene-sharing individuals or kin. As Dawkins was to express it later: kin act as `survival machines' for the same genes, and altruism between kin could be the strategy of a `selfish' gene that is able to survive yet another generation as a result of mutual help among the survival machines that it has constructed (Dawkins, 1976).



Possible kinship relations between these different types of offspring:

	a	b
a	1	0
b	0	1

	ya	yb
a	1	0
b	0	1

	a	b
ya	½	0
yb	0	½

	ya	yb
ya	1	½
yb	½	1

Conclusion: Between daughters the genetic relatedness is high (¾). Daughters only share ¼ of their genes with their brothers. For sons, however, the mean relatedness remains ½.

Figure 4-3. Relatedness in a haplodiploid species

Hamilton, for example, explained the independent evolution of infertile worker classes in several groups of hymenoptera as the result of the extra portion of kinship between sisters in this group, being a consequence of the fact that hymenopteric fathers are haploid and only produce identical sex cells (1964; see figure 3.1 and 3.2). (Hymenoptera can, like Water-Fleas, choose the sex of their offspring. Unfertilized eggs become males, which therefore have only one set of chromosomes.) As the process of natural selection therefore not only leads to the maximization of the fitness of individuals, but also to the maximization of the fitness of their kin, Hamilton introduced the concept of *inclusive fitness* to describe the effect of natural selection. (According to the *Oxford Companion to Animal Behaviour* (1987), *fitness* refers to "the ability of genetic material to perpetuate itself in the course of evolution"; *inclusive fitness* "is a measure based upon the number of the animal's genes that are present in subsequent generations, rather than the number of offspring").

2.7 *Maynard-Smith: the difference between kin and group selection*

Maynard-Smith (1964) introduced the concept of `kin selection' in order to clarify the difference between the Hamilton model and that of Wynne-Edwards. At a later stage he sharpened the distinction between group selection and kin selection even further by very explicitly insisting on the extinction of isolated populations in group selection (1976).

Contrary to group selection, kin selection can explain the existence of altruism in non-isolated populations of mutually competing individuals. In contrast, group selection requires that only a limited number of individuals are exchanged between groups: the altruism resulting from group selection could otherwise be misused by egoistic mutants, that would be able to plunder the environmental resources of their group and would leave for another group at the moment that their behavior caused an escalating shortage of food. Group selection requires that such mutants become extinct with the group which they have harmed, as a result of which this egoism does not pay.

So, while Wynne-Edwards was convinced that the competition and selection within groups would be suppressed and `overridden' by competition and selection between groups, the `fathers of sociobiology' (Lack, Williams, Hamilton, Maynard-Smith, Wilson, Dawkins) were placing the emphasis on selection within the group as the explanation of social behavior. For the very reason that the group selection model can be used more or less to explain everything as an adaptation aimed at group welfare, it is a methodically sound starting point to keep explanatory models as straightforward as possible and assume selection at the lowest possible level. If group characteristics can be explained as the result of the sum of many individual interactions, it is no longer necessary to present the group as a whole as a separate metaphysical entity. It is as a result of this critical approach that one would be able to distinguish those cases in which selection is really effective at the level of entire groups. If it can be demonstrated that a specific animal living in small isolated populations is sometimes entirely wiped out as the result of the emergence of egoistical mutants, and eventually becomes completely extinct *including the egoists*, then the suggestion that in this case there could probably be a question of group selection might possibly be proven. (Ewald, 1991, reasoned, for example, that group selection could well be the mechanism behind the relative good-naturedness of some parasites, that in their harmful form would not only destroy their host but also their own living environment: in the past only those parasites survived that remained beneficial to their host at least until they were able to move to a new one.)

2.8 *A new aspect of aggression: the evolutionary stable strategy*

The totally different methods with which Maynard-Smith (1976) and Lorenz (1966) approach the phenomenon of aggression are typical of the new approach. As said earlier, Lorenz believed that the ritual confinement of aggression could be explained as an adaptation serving the preservation of the species. Maynard-Smith drew up a mathematical model that takes the advantages and disadvantages of different behavioral strategies into account *from the point of view of the individual*, and illustrates how (hypothetical) populations, in which every individual has a specific strategy, are sensitive to an invasion of an alternative strategy, `misusing' the original strategy. The idea is that the selection process continuously removes those strategies that are sensitive to the invasion of alternatives. The result is the evolution of an *evolutionary stable strategy*, a behavioral pattern that is optimally adjusted to the unpredictability of the behavior of conspecifics.

With the aid of examples Maynard-Smith suggests that a strategy of unconditional aggression is very soon replaced by a strategy whereby an attempt is made to estimate the strength of the opponent, because individuals cannot blindly assume that they will always be the strongest in any potential conflict. From this theoretical model the ritual `sublimation' of aggression that we see in many animals can be understood to be an attempt by the individual parties to estimate their mutual power without having to be exposed to any particularly great risk. It is not necessary to explain it as an altruistic act on behalf of an individual to maintain the species, but simply as the optimum strategy for the individual, considering the unpredictability of the behavior and strength of the opponent.

The concept of the evolutionary stable strategy can also throw light on the emergence of altruism in nature. A widespread misunderstanding of Hamilton's theory postulates for example that altruism in nature appears to the extent to which there are similarities between the genotypes of the parties involved. Hamilton's kinship theory does not, however, predict altruism on the basis of any global similarity between two genotypes. It only shows that a new *emerging* altruism-promoting mutation can more easily arise to the extent that it is shared by related individuals, who are likely to benefit from each others altruism: thus, between kin, the cost of altruism is balanced by the resulting benefits and it becomes an `evolutionary stable strategy'.

The question that the theory answers is thus: how is it possible for an alternative strategy, i.e. altruism, to *break through* within a population of egoists? An individual that only depended on the similarities between genotypes would enslave itself in the service of its conspecifics, and also in the service of related species, with the result that it would have no resources left to spread the gene responsible for this behavior. Altruism does not arise automatically the moment individuals coincidentally share a number of genes, as a gene promoting such altruism would eradicate itself.

To understand the origin of altruism we have to examine the circumstances under which a `gene for altruism' would be able to *emerge* in the population, in other words, the circumstances under which the disadvantage that such a gene would cause its possessor is compensated for by the advantage gained by another possessor of *exactly the same* gene. Under nearly all circumstances such a gene would again be selected out immediately, because it would prevent the owners from reproducing and therefore spreading further. Only if the gene emerges simultaneously in closely related individuals and it results in altruism that is oriented towards possessors of the same gene, can the gene spread this altruism as a result, i.e. it is evolutionary stable.

What actually counts, therefore, is not so much the global similarity between genotypes, but the chance that another specific individual shares a gene for altruism (Trivers, 1985: 126). Undirected help to congeners is therefore evolutionary unstable, as opposed to kin-specific help. Only nepotistic genes that promote copies of themselves in other individuals are therefore able to multiply through these individuals and will spread through the population like a stain of oil. In this universe, only altruism-promoting genes that guarantee their own propagation by being `selfish' (helping their own kind), will flourish.

2.9 *Levels of organization and explanation and the evolutionary stable individual*

In this analysis we see the characteristic `bottom-up' approach of sociobiology: considering that behavior must always first have a genetic basis somewhere, and that behavior that propagates its own genetic basis will increase in the population, we can view individuals as survival machines of their own `selfish' genes (Dawkins, 1976). This does not mean, however, that we can explain everything at the level of individual genes: this is because genes have to be `tested' in, and are dependent on, the individuals that build them up, thus forcing them to `cooperate' and preventing them from `parasitically existing' on the other genes with which they continuously move from body to body. In the process of selection the individual therefore represents an extremely stable organizational level, a `holistic' top-down element that may never be omitted from evolutionary explanations (Maynard-Smith, 1990). Genes are selected to build up individuals together that will try to preserve themselves as long as they are able to spread these genes further. (Again and again, it is the holistic properties of the individual that are tested by natural selection each generation, however much these properties are caused by a collection of specific genes.) Only to the extent that individuals have lost their residual reproductive capacity and have become a burden toward kin will they sometimes develop self-destructive tendencies (De Catanzaro, 1991). The cooperation of individuals within a group, however, is less harmonious than that of genes within an individual, because parasitic individuals can move from group to group. As a result sociobiological models force the acceptance of a hierarchy of selection and explanation levels that form a correctable midpoint between the purely speculative extremes of reductionism and holism (Trivers, 1985: 135; Maynard Smith, 1990; see also Slurink, 1996, on holism and reductionism).

4.3 CONFLICTS OF INTEREST WITHIN GROUPS, WITHIN SPECIES: TRIVERS' FOUR FUNDAMENTAL THEORIES

Sociobiology began as an attempt to underpin claims with respect to the function of different forms of social behavior by means of more accurate cost/benefit analyses and a more accurate insight into the underlying evolutionary genetic level. An integration of ethology, ecology and evolutionary genetics was necessary, simply because without the latter the first two disciplines would be left dangling in the air.

Strictly speaking, the sociobiological revolution was a return to the original Darwinism, which arose as a reaction to the negative consequences of the emancipation of various biological subdisciplines, such as ecology and ethology. Sociobiology did not do away with these disciplines, but merely showed that it was not possible within these disciplines to make a choice from all the possible theories that could be raised by them.

It was G.C. Williams (1966) who pointed out that all the aspects of group life that Wynne-Edwards interpreted as consequences of group selection can also be interpreted as statistical consequences of individual adaptations. In his discussion of shoal formation in fish he remarks that the striking compactness and mutual coordination of shoals of fish do not intuitively lead us to the individual, but to considering the total shoal as being the primary body to be explained. Nonetheless, he asserts that shoal formation can only be understood by ignoring this intuitive reaction completely, and thinking in terms of the individual interests of each fish separately: shoals exist mainly in an environment where there is no shelter from predators, and the fish in shoals use their companions as a type of living shield. Because each individual continues to avoid the periphery separately, shoals often result that are so compact that predators are able to take advantage of them (he reports an observation of an enormous shark taking bites out of a dense shoal of herring as though it was an apple). Indeed, the nonconformist strategy of the *Einzelgänger* is relatively dangerous, otherwise shoals would cease to exist.

In his *Geometry of the selfish herd* (1971) Hamilton elaborates on this theme, but he also considers another factor that can make life in groups attractive: the increased chance of reproduction. He attempts to explain the curious dancing movements made by a swarm of mosquitoes by assuming that within these swarms there are actually advantages to being located on the outside: swarms of mosquitoes consist of males that act together to attract females, and quite possibly the males on the outside have the greatest chance of being first to welcome newly-arriving females. The irregular dancing movements of swarms of males could then be explained by the tendency of each male to continuously seek compromises with respect to his position in relation to the wind direction, chances of being captured by a predator and chances of finding a mate.

The increasing emphasis on the explanation of group characteristics on the basis of individual interests can also be seen within the development of the study of the ecological determinants of various forms of society, i.e. socio-ecology. In the first instance socio-ecologists only looked for correlations between types of food and forms of society. That led to the discovery that the differences observed in the social structures of the Red Colobus and the Black and White Colobus were basically a result of a difference in the use of food. Gradually socio-ecology began attaching increasingly more importance to the role of several other variables, such as the internal dynamics of interests resulting from the presence of two sexes, or the external pressures exerted by predators (Van Schaik & Van Hooff, 1983). Due to the criticism of group selection models it became inevitable to explain social phenomena at the appropriate level and to chart out all causal factors involved.

At that time the ultimate causes of social behavior had been problematicized to such an extent that it became obvious that an attempt could be made to systematize them in some way, and that is evidently one of the challenges that inspired Wilson to his *Sociobiology*. He provided us with a list of factors lying behind social evolution, which not only included defense against predators, but also the increase in competitive capacity (against other groups), the increase in foraging efficiency, the capacity to colonize new habitats, the increase in reproductive efficiency, the increased chance of survival at birth and the possibility of adapting the environment to the requirements of the collective needs of the group. The fact that animals often live together was no longer a matter of course for sociobiology, and that alone probably explains the anxiety felt by many social scientists and philosophers. Sociobiology put an end to social structures being taken for granted, and enabled a new analysis to be made of conflicts and antisocial tendencies within groups.

1. *Trivers' analyses of conflicts of interest: parents and children*

It was Robert Trivers in particular (1971, 1972, 1974, 1985; Trivers & Willard, 1973) who, by means of a number of concrete analyses of conflicts of interest, cleared the way for a deeper understanding of conflicts within societies. For example, in his article *Parent-offspring conflict* (1974; see also Trivers, 1985: 145) he developed a theoretic model to explain the `weaning conflict' and other complications in the parent-child relationship. It was shown that the optimum cost/benefit ratio of parental investment from the perspective of the parents develops differently from the perspective of the offspring. From the perspective of the parents all successive offspring are in a certain sense survival machines of equal merit for their own genes (all their children bear at least half of their nuclear DNA); from the perspective of offspring other progenies are only equal to the extent in which there is a chance that they share genes. Considering that offspring are the products of sex cells that have undergone a reduction division, the chance that a specific gene is shared by a brother or sister is on average 0.50: for each individual gene there is a 50% chance that the brother or sister has obtained the parallel allele from the other parent (fig. 4-2).

The process of natural selection in parents and offspring will now produce differing optimum strategies. *Parents* will be selected to invest until the costs become greater than the benefits, in other words: until further investment in a specific child no longer balances up against the option of investing energy in a possible new child. *Offspring*, however, will be selected to stretch the parental investment until the costs (for the parent) are twice as great as the benefit if there is still any chance of brothers and sisters, and until the costs are four times greater than the benefits if there is principally any chance of half-brothers or half-sisters. In other words: offspring will be selected to consider themselves as being worth twice the trouble of being favored over brothers and sisters, and four times more than half-brothers or half-sisters.

Many predictions follow from this model, including the prediction that in species where the fathers come and go, the offspring remain demanding help from the mother for longer (after all, any new offspring are only half-brothers or half-sisters), and the prediction that older parents are likely to invest more in their children. In the meantime a number of these predictions have been proven by extensive empirical studies. It appears that older hinds produce better calves, despite their age, and Californian seagulls appear to invest more time in their offspring as they become older. In baboons, older mothers start rejecting their offspring later than younger mothers and reduced rejection rate is associated with longer time until the mother reproduces again (Trivers, 1985). On reading Jane Goodall's story about the exceptional relationship between the old, powerful, female chimpanzee Flo and her cherished offspring Flint, one is reminded of Triver's theory, but then incidental cases can hardly apply as evidence (Goodall, 1971; 1986). Neither can the fact that amongst humans, both in our own and other cultures, young mothers will sooner kill their children be considered as evidence, but it does fit exceptionally well into the theory (Daly & Wilson, 1988: 76).

In many other species however, such as grey flycatchers, both parental investment and the child's call for help has been measured exactly. During the first nine days of their life young, grey flycatchers are apparently fed without ever having to cry or call for food. From the tenth to sixteenth day after leaving the nest the young have to chase their parents to an ever-increasing extent in order to obtain food, and despite all their efforts are fed less often and with ever-decreasing portions. The result is that they have to learn to catch flies and other insects themselves. Fourteen days after leaving the nest young flycatchers obtain more food from their own catches than from their parents.

The same patterns can be observed in many different species of animals: nearly everyone in Europe has probably seen the great crested grebe feeding its young. Especially later in the season one can often see how older young beg for fish continuously with an enormous degree of spectacle, but despite all their efforts are nevertheless chased away.

What happens if parents and offspring do not share genes can be seen the cuckoo: in this case the offspring has no interest whatsoever in the survival of its `brothers' and `sisters' and in the residual reproductive capacity of its parents. When the cuckoo comes out its egg, its first act is to throw its `siblings' overboard. Then it starts exploiting its stepparents by growing at least twice their size. Anybody who has ever seen a deceived wren, robin or hedge sparrow sitting on the back of `its' cuckoo offspring to feed it knows the extent of the cuckoo's parasitism on its hosts. It is no wonder that an evolutionary arms race is going on between the cuckoo and its parasites, which have evolved the capacity to recognize the eggs of the cuckoo, even if these have evolved a resemblance with the eggs of the host (Davies & Brooke, 1991).

Two further significant aspects of the parent-offspring conflict theory still remain to be discussed, in particular because they are also especially important to human psychology (Trivers, 1985: 155; Badcock, 1986; 1990). The first one concerns the consequences of the vulnerable, dependent position of the offspring in comparison with its parents. Because it possesses relatively little physical strength, it is to be expected that it will employ psychological tactics in order to prolong parental investment: one of them could be something like the Freudian *regression*, an attempt at looking younger and more dependent than is really the case (Badcock, 1990). It is safe to assume that offspring possess a far greater degree of psychological skills for manipulating parents at a very early stage than they are credited with, and that in some cases parents develop counter strategies: for example, it appears that *unlike* their male counterparts, female budgerigars are immune to the begging of their offspring. Additionally, it is to be expected that offspring of intelligent learning species, such as humans, will develop both an internal representation of the interests of their parents and that of themselves. It was Trivers himself who pointed to the parallels with the Freudian system of super-ego, id and the arbitrating ego that lies between them (Trivers, 1985: 163).

A second additional aspect concerns the conflict between parents and offspring regarding the relationships between their offspring. Assessed from the *parent's point of view* the offspring have to be mutually altruistic if the benefits of that altruism (for the offspring being helped) are greater than the costs (for the helping offspring), because from their perspective offspring are survival machines of equal merit for parental genes. From the *offspring's point of view* altruism with respect to its brothers and sisters is only rewarded if the benefits are twice as great as the costs, because they only share approximately half of their own genes with them (in diploid species!). In relation to half-brothers and half-sisters the benefits have to be four times greater than the cost. A consequence is that disagreement is to be expected regarding the behavior of the offspring. Because the offspring is far more dependent on the parent in an early phase than in a later phase, it will adapt to parental wishes in the earlier phase: bringing to mind Kohlberg's good-boy/nice-girl stage. However, around the time that offspring become sexually mature they will begin reorganizing their own personality in such a manner that it more accurately represents their own interests. If they are still living at home at this stage this can imply the explosion of a bio-psychological time-bomb.

2. *Trivers' analyses of conflicting interests: sex differences*

Another Trivers' model (Trivers, 1972; 1985: 203) explains a number of the most significant sexual differences in various parental strategies. Contrary to some socialization theories, this model does not only refer to sexual differences in humans. On the contrary, like all sociobiological theories it tries to apply an understanding of the behavior among all living beings in general to throw light on the behavior of humans.

Trivers ties into the famous study made by Bateman in 1948 regarding the differences in the reproductive success between the sexes of the well-known fruit fly, *Drosophila*. The study revealed that there was a great relative difference in reproductive success among the males in particular. A small number of males appeared to achieve unbelievably high scores, while among females the number of matings following the first mating did not appear to affect the eventual number of offspring. Bateman explained the variation as being due to the different investment of both sexes in their sex cells (anisogamy). The production of an individual sex cell costs a male very little energy, so that it is not the production of sex cells that limits his total reproductive success, but the preparedness of the female to mate. For the female, however, the situation is different, because she lays the eggs, and her eventual reproductive success is therefore not limited by her ability to have the eggs fertilized, but by her capacity to produce them.

Trivers subsequently noted that in all species in which the males refrain from making a large initial investment, the reproductive success of the males shows a far greater degree of variation than in the females (he quotes field studies about dragonflies, baboons, frogs, prairie dogs, geese, lizards, walruses and dung flies). At the same time, however, he remarks that in monogamous species the reproductive success of males would vary just as little as in females if there were no possibility for adultery and no variation in the mortality of females. He consequently attempts to arrive at a more general wording in which parental investment is coupled to sexual selection. Thereby he defines parental investment as *every investment made by the parent in an individual offspring which results in the chances of that offspring to survive (and therefore reproduce) being increased at the cost of the capacity of the parents to invest in other offspring.* He then arrives at the rule that the sex providing the greatest parental investment is a limiting factor for the opposite sex and that this latter sex will mutually compete for access to the more investing sex.

With this formulation he simultaneously corrects the impression, which might possibly be raised by the Bateman study, that it is always the males that fight over females. What is actually explained is that the sex making the greatest initial investment usually specializes in a qualitatively high-value further investment, while the sex with the smallest initial investment usually has to compete mutually to gain access to the most investing sex.

Because egg cells are larger than seed cells this *usually* concerns females and males respectively, but that is not always the case. In a number of species the initial investment made by the male is also considerably high. In mormon grasshoppers, for example, the male adds a spermatophore to his seed that is extremely rich in nutrients, male sea horses have a pouch in which to keep eggs, in at least one species of frog it is the male that transports the eggs, and among grey fringillines, emus and lily-trotters it is the males that brood and hatch out the eggs. *In all these species the females fight for the males instead of the opposite way around.*

A beautiful scene from David Attenborough's *Trials of Life* clearly shows, for example, how a female lily-trotter marches across the water-lily leaves toward an industriously brooding and much smaller male lily-trotter. Once she has looked about to establish that there is no `lady' around to protect this `gentleman' she resolutely runs up to the brooding male, drives him off the nest and tramples the clutch of eggs. A little later we see her mating with the male, undoubtedly to leave him shortly afterwards sitting on a new clutch.

The reproach that Trivers' theory is sexist (e.g. Roeleveld & Kemps, 1986) is therefore somewhat paradoxical, because it is Trivers himself who has focused so much attention on these cases, and as such can justifiably claim to have put a definite end to stereotypes (Trivers, 1976). On further study, this reproach, as formulated by Roeleveld and Kemps, appears to rest on an incorrect interpretation. Roeleveld and Kemps interpret the theory of parental investment by assuming that this means that the *total* reproductive investment in females is greater than that of males. They triumphantly state that males make at least as much effort, because they deliver their sex cells in great quantities and in addition to that they fight over females! In fact this was exactly what the theory of parental investment was trying to explain. What the theory of parental investment is concerned about is not the total reproductive effort, because from the sociobiological perspective it is actually expected that *all* male efforts - exactly like the female efforts - are eventually oriented toward the spreading of their genes. It concerns the differing *manner* in which males and females make the effort, and in particular their different investment in *each* *individual offspring* (which Roeleveld and Kemps could have known if they had read Trivers' definition of parental investment).

Of course, Trivers' theory of parental investment would have undoubtedly been the product of a male *bias* if he had blindly assumed that it was always the females that invested more per individual offspring. However, he actually avoids all bias by defining parental investment in such a way that high initial male investment, such as the result of male egg hatching for example, is also included, and by not postulating that males always fight over females, but that the less investing sex always fights over the more investing sex. That female mammals have to make a high initial investment as a result of pregnancy, and therefore have a tendency toward polygamous systems where often one male is temporarily involved in defending a complete harem of females, is of course another matter all together. Only a small minority of mammals are monogamous, amongst which, however, 37 species of monkeys. Amongst birds those ratios are, however, completely different, as the males are able to help in hatching the eggs.

Perhaps Trivers' explanation of sex differences on the basis of opposing and divergent investment strategies has been his most influential theory. Sociobiologists and evolutionary psychologist have been concentrating on the study of sex differences almost continually. In recent years there have been a lot of studies on sex differences in mate choice and sexual selection. One of the big questions is whether sexual selection can be seen as an alternative to natural selection, as Darwin saw it already (Darwin, 1871; Zahavi & Zahavi, 1996; Miller, 2000). In principle, individuals could choose partners with characteristics that are disadvantageous if it comes to simple, straightforward survival. The peacock is an obvious example. His beautiful tail cannot be said to be practical apart from its function in attracting mates. It is a handicap rather than handy, but it has evolved simply because peahens prefer males with a lot of `eyes' in their tails. Why would they prefer such males? It could be simply an evolutionary luxury, evolving by runaway sexual selection: if most females like males with large tails, males with large tails leave more descendants and mean tail length will increase rapidly. Having sons with short tails would become unwise rather soon and that would reinforce the tendency to choose males with long tails (the `sexy son hypothesis'). It is also possible that tail-length reflects general health and strength. If only healthy males are able to grow long tails, long tails would be ideal `fitness indicators' (Miller, 2000). Despite being a `handicap' (Zahavi & Zahavi, 1996), the tail of a particular peacock would in that case advertise good genes. The beautiful song of a Song Thrush with its many repetitions could be translated into "ex Hey dear eee, e I am here eee, To what I tell eee, e Listen well eee, e In this contest eee, e My e genes proof best eee".

Of course, it is unlikely that sexual selection runs completely opposite to natural selection. Yet, at the moment that in a particular species one sex almost invests nothing in its offspring, it can concentrate fully on transferring genes to the next generation via the bottleneck of pleasing, courting and mating. For the non-investing sex in such species pure simple surviving becomes of secondary importance. Only one thing counts: being chosen, whatever that may imply. It is also not unlikely that in some species some individuals (Don Juan-types) specialize in being chosen as good-genes suppliers, while other individuals (respectable house-fathers) advertise via a mix of good genes and other services. Trivers himself has dedicated one whole chapter of his most important work *Social Evolution* (1985) purely to show that the differential mortality by sex in humans is no accident, but that it reflects differences in priorities which have been shaped by natural and sexual selection.

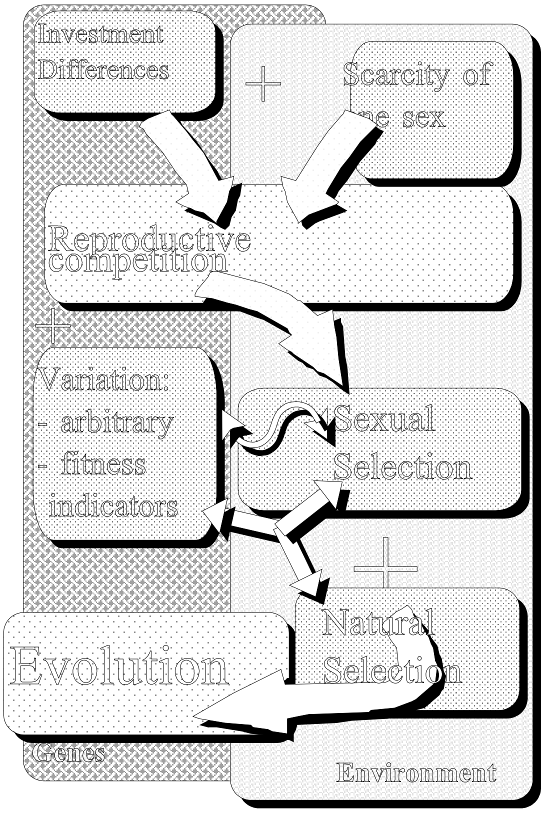


Figure 4-4. A variation on figure 0-1: sexual selection as an extra creative loop in evolution.

3. *Trivers' analyses of conflicts of interest: preferring children of one sex over another*
A third, much less obvious, Triversian theory was coauthored with the mathematician Willard (Trivers & Willard, 1973) and concerns small deviations in the proportion of males to females, the so-called sex-ratio, in different species. It carries the way of thinking expressed in the first two theories one small step further, but this small step is great indeed if one looks at its consequences.

According to the mathematician and geneticist Fisher sex-ratio's will tend to be 50/50 (ratio of males to females) at birth, because a relative overproduction of babies of one sex will always be counterbalanced by an increase in the reproductive value of babies of the other sex. Parents who in that situation produce babies of the opposite sex can be certain that their children will be able to choose the best available mates and will produce a maximum number of grandchildren. In the long run the optimal strategy is to produce babies in a 50/50 ratio.

According to Trivers and Willard there is, however, one factor which could result in small deviations from this ratio: the relative high variation of male reproductive success. If male reproductive success varies with health and strength, it makes sense to produce and favor sons which are healthy and strong. This is probably only possible if the mother itself is in good condition. If the mother is in poor condition, daughters could be a better investment, because their chances of failing to reproduce are smaller.

Trivers and Willard cite an interesting series of examples to sustain their claims. For example, it seems that there are two species of seals of which females pupping early in season produce sex ratios larger than 120/100, while females pupping late produce a complementary ratio (less than 80/100). It seems that sex ratio at birth in dogs, deer and humans drops after an increasing number of pregnancies and an increasing litter size (personally, I have had two elder brothers and two younger sisters, but, of course, it is dangerous to take one's own family as an example). Because in mammals it are the males who determine sex of offspring, it is assumed that female `control' over sex ratios involves early differential male mortality. It is known for a long time that more male embryos result in miscarriages than female embryos.

Trivers and Willard suspect that the model can be applied to humans as they are differentiated according to their position on the socioeconomic scale. They point to the tendency of females to marry upward the socioeconomic ladder (hypergamy) and to a correlation between socioeconomic status and sex ratio at birth. They also predict that parents in better condition or in higher social classes will show a bias toward male offspring.

Gradually, some evidence has been collected the last ten years to show that the `Trivers-Willard effect' is no fiction indeed (for overviews, see Voland, 1993, and Mealy, 2000). First, it has been found that increased resource access and increased dominance correlate with an increased production of sons. One of the postulated mechanisms relates to the testosterone-level of the mother (Grant, 1998). Second, a series of good examples are found in which the predicted postnatal patterns of favoritism for one sex over the other fit the Trivers-Willard model. Voland (1984, 1993), for example, found a clear relationship between sex ratio and social status by researching historical records of a farmer community in Sleswig-Holstein. Bereczkei & Dunbar (1997) researched a group of Hungarian gypsies and found a series of female-biased reproductive strategies, exactly as one would expect this in a community of a discriminated minority. Lee Cronk (1989, 1999) discovered a postnatal favoritism for daughters among the Mukogodo, a Kenyan tribe that only recently left its caves and its atavistic hunting habits and has considerable difficulty competing for cattle with the neighboring Massai and Sambura. Daughters in this community have much more changes of finding a good partner outside their community than sons. Strangely enough the Mukogodo say that they prefer sons over daughter just like the surrounding tribes, but their actions speak louder than words.

In many other societies a clear favoritism for sons is found. In the upper classes of India this is particularly visible. It would be interesting to research the behavior of current chinese families, now that there are emerging larger differences in income and now that there is still an official one-child policy. From the theory of Trivers and Willard one would predict, that there would emerge a favoritism for daughters among the poor. The daughters that are `exported' and are given at western adoption parents would then descend from the relatively rich. Undoubtedly, the Trivers and Willard effect will keep sociobiologists busy for a long time to come.

4. *Trivers' analyses of conflicts of interest: living together with non-relatives*

A final major contribution made by Trivers to sociobiology was a model with which the origin of cooperation between non-related individuals could be explained (Trivers, 1971, 1985, but also G.C. Williams, 1966: chapter 4). According to Trivers, cooperation between non-related individuals is possible if they at least live for long enough, can recognize one another personally and are able to observe one another for long enough. Under these conditions *reciprocal altruism* is possible, i.e. cooperation on the basis of an exchange of investments. Trivers saw that complications arise in reciprocal altruistic relationships that do not occur in relationships that are the product of kinship: for example the problem of taking undue advantage by means of raising false expectations, of distrust in general, and the effect of `social monitoring' by third parties, who follow the interactions between two individuals and record which one cheats the other most.

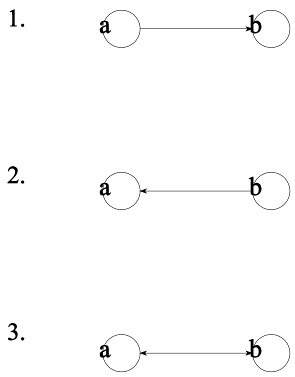


Figure 4-5. Reciprocal altruism. If b rewards investments of a with equal investments, a cooperation can emerge from which both parties gain profit.

In the meantime studies have been made into reciprocal altruistic relationships in a large number of species, including vampire bats, baboons and chimpanzees. The tense relationships between two territory holding neighbors amongst birds are also extremely suitable for analysis using the model. Neighbors recognize each other's call and leave one another in peace, provided the unwritten territorial borders are respected. A number of sea mammals, including whales, dolphins and walruses, are also talented reciprocal altruists. Just as among chimpanzees and vampire bats, a situation of mutual dependency exists in these species, because a wounded animal can easily drown. Whales and dolphins demonstrate a stubborn tendency to lift their wounded to the surface, an action which they have even been observed to do with drowning humans.

Trivers himself gave cause for extensive speculation with respect to the consequences of reciprocal altruism for the human psyche (Trivers, 1971, 1985; Badcock, 1986, 1990). In his 1971 article he expressed his suspicion that the growth of the human brain could well be a product of the complicatedness of reciprocal altruistic relationships in humans. Among other things these make the demand that the individual should pretend rather than be altruistic. Considering that it is easier to lie about something to others if you believe it yourself, this could lead to the evolution of an unconscious representation of one's own interests (the id).

In contrast to this unconscious representation of one's own interest, group interests can also be internalized into a `super-ego', which we have already encountered in the context of the parent-offspring conflict. Reciprocal altruistic relationships in somewhat larger groups can, as a result of a process of collective mutual monitoring, generalize into a moralistic pressure to invest in the welfare of the group. Dominant individuals, who are best served by an atmosphere of decency and dedication, can start playing the role of the representatives of the `collective interest' and can start rewarding altruistic investments made in the group's welfare and punishing egoistic actions. Alexander (1979, 1987) called this kind of reciprocal altruism, in which it becomes important to be known as a reliable cooperator (to have a high `moral status'), *indirect reciprocal altruism* and considers it to be the most important drive behind the creation of group moralism amongst people (cf. also Slurink, 1989, 1994).

This speculation connects well to that with respect of the parent-offspring relationship, because in human society it is usually the parents that attempt to introduce the group's standards to the child. The super-ego is therefore first identified with the parents, and later with different standards of ethics, e.g. those referring to `the welfare of the group' or even to the ideal of universal welfare. However, the ego continues to zigzag between the super-ego and the id in such a manner that on the one hand the interests of the id are looked after, while on the other hand the moral status of the individual remains undamaged. Sociobiology proofs, therefore, not to be incompatible with aspects of psychoanalysis and may even claim to have rediscovered, within a completely new evolutionary frame-work, some of the psychoanalytical doctrines of the topography and dynamics of the subconscious (Badcock, 1986; 1990).

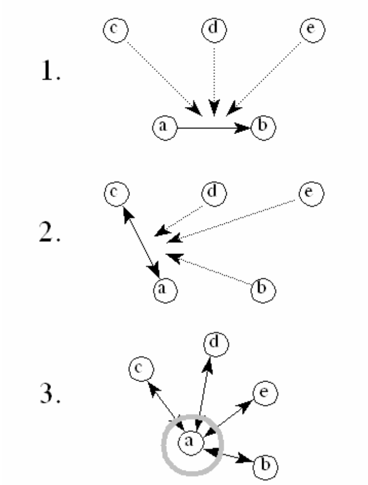


Figure 4-6. Indirect reciprocal altruism: 1. c, d and e observe the way a treats b; 2. c concludes that a is a good cooperator; 3. a is judged a good cooperation by all, because of his conduct with respect to b and c.

4.4 IF FOR BIRDS AND BEASTS, WHY NOT HUMANS?: THE CRITICS.

Trivers' four above mentioned analyses all refer to areas of intraspecific conflict which are central to human consciousness and suffering (Trivers, 1976), but offer completely new, contra-intuitive, trans-phenomenological interpretations of them. As a result, we probably will never see the relationship between parents and children, brothers and sisters, men and women, friends and enemies in the same way as before. In that respect, sociobiology represent a fundamental *Gestalt-switch* which often makes it hard to understand for people that are still too much immersed in analyses at the proximate level.

Often such people tend to understand evolutionary analyses, in which simply *nothing* is self-evident, as analyses in terms of particular proximate mechanisms, especially in terms of a rigid, genetic predetermination of behavior. In fact, if behavior is rigidly preprogrammed, as it probably is in insects, this is because it is selected to be so during evolution. Human behavior, which is selected to be adaptable to a variety of habitats and a spectrum of sex-age classes, social roles and cultures, can be expected to be highly flexible.

Currently, human sociobiology is often referred to as evolutionary psychology to avoid the incorrect association between `biology' and `unchangeable and genetically determined' (Cosmides & Tooby, 1987). Ironically, no one seems to remember that this term was first used by William James (1890: e.g. 146). Nowadays it is used, however, to underline the importance of investigating not only the adaptedness of behavior, but also the specific mechanisms through which this adaptedness is achieved by natural selection. Only that way can we appreciate the limits to adaptation, which is not the result of a conscious act of design, but simply of a blind process of variation and selection. Evolutionary psychologists often stress that the human psyche has evolved during the Pleistocene while humans were hunter-gatherers; many psychological adaptations seem only to make sense within this context (Barkow, Cosmides & Tooby, eds., 1992). Thus, one should not expect all modern human behavior to be perfectly adaptive. Also, because the human mind consists of a series of independent modules (Tooby & Cosmides like to compare it to a swiss-army knife; Horgan, 1995), one should not expect that it is an all-purpose problem-solver which can be applied to any problem with the same ease and speed.

However, even in this new shape sociobiology is sometimes still experienced as dangerous and offending (Rose & Rose, 2000). People are well able to accept that the earth has been dominated by Dinosaurs for more than two-hundred million years, that the earth will be swallowed by the sun in about five billion years or that the universe will collapse in a Big Crunch or will expand forever. With respect to these topics they rely blindly on experts who will claim now this way, now that. When it comes to a deeper understanding of their relationship with their parents and children, with their lovers and partners, with their friends and foes, however, many think they are experts and that their experiences are unique and cannot be understood with reference to general laws that apply to other species as well.

It is this obsession with our own human uniqueness and dignity (plus the hope that the factors determining our destiny are controllable) which have made analyses which refer to proximate factors, often very specific for the human species, far more popular within the human sciences than analyses which refer to ultimate, evolutionary factors. Yet, it cannot be denied that inventories of the ultimate level are still often speculative and that there can be made many mistakes when we try to map this unknown territory. Exactly those points that are placed central by a recent generation of evolutionary psychologists, the swiss-army knife metaphor of the human mind (the hypothesis of functional modularity) and the myth of the stone-age mind (the hypothesis of delayed adaptation) could belong partly to the category of `informed speculation'. Of course, such speculative assumptions that could turn out to be mistakes are often placed central by critics in their search for weaknesses and in their attempt to make the whole enterprise seem ill-founded and ridiculous.

It seems a good idea to give some attention to the criticisms that are still often raised. Let us concentrate on the issues that are raised in discussions on sociobiology and evolutionary psychology:

- 1. the accusation of strong genetic determinism,
- 2. the accusation of adaptationism (`ultra-Darwinism')
- 3. the reproach of *ad hoc* speculation,
- 4. the idea that adaptationist theories are dispensable and unnecessary,
- 5. the idea that sociobiologists underestimate forms of group selection,
- 6. recent criticisms of evolutionary psychology.
- 7. the reproach that sociobiologists are falling prey to the *naturalistic fallacy.*

ad 1.*Human sociobiology: genetic determinism?*

At least in the articles written by Trivers very little can be found which justifies the criticism that human sociobiology is characterized by an extreme genetic determinism and adaptationism. The underlying train of thought is of a completely different nature. It does not state that: "animal behavior is innate; man is an animal; therefore, human behavior is innate as well", but "living in groups has serious disadvantages and animal societies are always characterized by conflicts of interest between generations, sexes and non-related individuals; people also live in groups; let us examine how people deal with their conflicts of interest". The possibility that man has an exceptional way of living together is left completely open. There is no question of man being dealt with as being "just like any other animal" in the global and pejorative sense, in which, unfortunately, people often speak about animals.

The only implicit claim is that man should be viewed as a product of evolution, and that, accordingly, all unique human characteristics, such as human intelligence and morality, require an explanation in terms of selection, whereby, however, group selection should not be too easily invoked as a sort of *deus ex machina*. From the point of view of sociobiology, the social sciences form typical examples of emancipated and liberated disciplines that are in need of having their presuppositions calibrated against the underlying level. The division of the reality into sub-sectors does not justify scientists to neglect their `antidisciplines' (Wilson, 1990).

A crucial distinction that should be made in this context is that made between `reduction by dissection' and `evolutionary reductionism' (Alexander, 1987). Reductionism by dissection refers to the proximate organization of an organism and examines *how* it is composed: the male sex hormone, for example, appears to effect a small increase (5%) in the total combustion. Evolutionary reductionism however poses the *why*-question, and reveals why men that burned more in the past had greater reproductive success, so that now men on average burn a little more than women. The danger of `reductionism by dissection' is that it often does not recognize the complexity of an organism, because it only isolates one essential causal factor.

Evolutionary reductionism does not, on the other hand, make any pronouncement regarding the complexity and flexibility of a specific organization, because it often just examines the *effects*, leaving the ways in which these are achieved aside. Evolutionary reductionism expects a specific capacity for fitness maximizing choices from both the neural nodes of a flatworm and the human brain, explicitly leaving open the possibility that the human brain has to perform far more computation to achieve the same objectives. Contrary to `reductionism by dissection', the evolutionary reductionist concentrates on the characteristics of the *whole* organism as it is functioning in its environment, because in the past it is these characteristics which have been tested by natural selection. The evolutionary reductionist has good reasons to assume that organisms are purposeful entities, that distribute their own building plan. His reduction, therefore, *refers to this purposefulness*, towards this tendency towards *inclusive fitness* maximization or selfish gene propagation. This tendency itself is a holistic property of the organism such as it is functioning within its environment and such as it has been bred and tested, again and again, by natural selection in the environment in which its ancestors were bred (the E.E.A. or environment of evolutionary adaptedness, Bowlby, 1969; Tooby & Cosmides, 1990). Thus, evolutionary reductionism presupposes a version of holism, in which only the organism as a whole is `visible' to natural selection. Defects and new properties are only `known' to natural selection via their fitness consequences, that is via the differences in reproduction success that they bring about.

In the past the claims made by sociobiology were often incorrectly interpreted as being reductionist in the dissectional sense. It was, in fact, Wilson himself (1975) who unfortunately gave reason to this. In his closing chapter he wrote somewhat confusedly about the effects of biology on sociology:

> The transition from purely phenomenological to fundamental theory in sociology must await a full, neuronal explanation of the human brain. Only when the machinery can be torn down on paper at the level of the cell and put together

> again will the properties of emotion and ethical judgement come clear... Having cannibalized psychology, the neurobiology will yield an enduring set of first principles for sociology (Wilson, 1975: 575).

This passage, as I have quoted it with the omission of several nuances, can easily be read as an attempt to reduce sociology to neurobiology. In all probability, these types of passages have misled the critics. Unfortunately the resultant effect was that the actual meaning of sociobiology disappeared from sight. The need to assess behavior within a specific evolutionary context became confused with taking up a specific position in the nature-nurture discussion. The importance of selection at the level of individuals or genes (contrary to at the level of groups) was confused with genetic determinism (Dawkins, 1982).

In fact, sociobiology leaves open the possibility that the behavior of man is to a great extent the product of learning processes, cultural habit-forming and intelligent planning (Wilson, 1978; Alexander, 1979, 1987). It is just these types of mechanisms that evidently make man capable of surviving under a multitude of ecological and social circumstances. On the basis of evolutionary theory we should not expect a `gene-free culture' (Harris, 1979), but a culture that enables people to survive in a multitude of ecological circumstances. Within the context of sociobiology it is even possible to speculate about human freedom and its function. Human freedom is interpreted then as the capacity to make optimum inclusive fitness maximizing choices within a wide variety of cultural contexts (Slurink, 1989). It is not opposed to physical determinism, but it is opposed to a psychological determinism in which drives directly express themselves in behavior, without mediation of learning, experimentation, culture, and creativity. For a species which has to survive in a variety of ecological circumstances such a capacity is highly adaptive.

Indeed, it has been this very hypothesis that has been tested successfully many times in recent decennia. For example, social success is defined differently in a diversity of cultures: it can be defined by power, wealth, ferocity, and so on. However, it is striking that there is often a correlation between social and reproductive success: in cultures where wealth is valued most (as in the Yomut Turkmen, Irons, 1979), the rich have often most children, in cultures (such as the Yanomamö) in which ferocity is valued most, ferocious men have the most children (Chagnon, 1988), and in societies with a despotic character it is the powerful who appear to monopolize the women (Betzig, 1991). Apparently the universal tendency to increase one's reproductive success is somehow determined genetically, via a series of psychological mechanisms, while the standards of social success can be adapted to the circumstances to some extent (obviously ferocity and the ability to become wealthy or powerful are not completely different phenotypical traits).

The same complicated relationship between genes and culture can be seen in numerous aspects of human behavior. For example, the various cultural forms of marriage that we see in different societies are apparently not innate, but neither are they merely expressions of an unbridled creativity in search of a change. Just like dunnocks, people are monogamous, polygamous or polyandrous dependent on ecological circumstances: amongst ourselves, too, it appears that only `rich' territory owners are capable of attracting and maintaining multiple females (Flinn & Low, 1986). That means at the same time, however, that in both dunnocks and man the genetic potential includes a polygamous option that emerges under particular circumstances. The underlying cause is undoubtedly the anisogamy (the difference in size of male and female gametes) shared by dunnocks and man: the large size and small amount of the female gametes implies a relatively large original investment, which forces females to be much more careful with the resultant offspring. The moment that paternal certainty drops, or that there are more females who prefer one superior territory, males of both species can permit themselves the luxury of adopting a relatively non-obligatory attitude with respect to their offspring, which forces females to accept a relatively large part of the parental responsibility.

Yet, there are a number of differences between dunnocks and man that we will have to sketch out in order to remain ahead of the critics. One of the differences with dunnocks, for example, is the phenomenon of `socially imposed monogamy' (as opposed to `ecologically imposed monogamy', Alexander, 1979, 1987) in large societies: this form of monogamy, that is quite exceptional in historical terms, but which has gradually spread over the entire world (Betzig, 1991; Low, 2000), appears to be a product of the incapacity of the elite to monopolize power in `modern' societies, and is in all probability partially due to a common dependency on technology. In large societies the social pressure of the masses on the dominant group has increased to such an extent that it has had to abandon the sexual privileges that are coupled to dominance in many societies.

Using data from Murdock's ethnographic atlas, Frans Roes has demonstrated that monogamy and the belief in moralizing deities - products of a collective moralistic aggression - is directly related to the size of societies (Roes, 1992; chapter 6). Language and morals do not so much create a new, independent, `super organic' (in the terms of Durkheim) dimension, as new balance-of-power relationships with far-reaching consequences. A sociobiology of man that does not take this into account can be compared with a sociobiology of the hawk that fails to take into account its hooked beak.

The human capability for creating culture should, therefore, not be merely viewed as a luxurious creativity, but as a gene-based capacity for making fitness-maximizing choices under a diversity of ecological and social circumstances. Standards and values are not created from thin air, but are adjustments to circumstances. Many of our Western standards and values can, for example, be understood as the effects of relatively low infant mortality. Infant mortality is of immediate significance for determining the most optimal reproduction strategy: one aimed more at quantity or one aimed more at increasing the chances of relatively few children (Reynolds & Tanner, 1983). Many Islamic countries have been faced for centuries with a relatively high occurrence of hunger, war and infant mortality in comparison to Christian countries: these differences are expressed in various regulations with respect to sex, marriage, celibacy, abortion, etc.

Because religious decrees often have a reproductive-strategic content, individuals can determine their own reproductive strategy in their choice for specific cults. As such, religious doctrines give a large amount of elbow-room for strategic adjustment. Christianity attaches much value to the individual and as a result it is favored in countries with a relatively low infant morality. The whole pattern of values characteristic of our modern welfare state, especially the increase in the emphasis on the individual and his self-realization (relative, even, to traditional Christianity), can be seen as the effect of scarcity combined with an exceptionally low infant mortality.

Viewed in this way the claim that sociobiology is `genetically deterministic' appears somewhat unfounded. Sociobiology does not claim that people are genetically programmed to behave in specific ways, but more that they are capable of devising inclusive fitness-maximizing ways to cope with a wide variety of circumstances (Alexander, 1987). As people have been continually tested in this respect throughout their evolutionary history, their psyches have become orchestrated with a collection of drives and values that ensures that they do not forget important points on their teleonomic agenda. Of course, some of these drives may themselves become non-adaptive in a changing ecology, and it is only to be expected that individuals continue to be born that display non-adaptive combinations of psychological characteristics. Without variation, evolution would not occur.

ad 2. *Human Sociobiology: adaptationism?*

This now brings us to the problem of adaptationism: sociobiologists and evolutionary psychologists have often been reproached for being somewhat too frivolous with explanations in terms of adaptation. Linguistic categories in particular are suspected of having mislead them in their search for adaptations. Furthermore, they also apparently fail to give sufficient consideration to evolutionary neutral characteristics, or to characteristics that are non-adaptive consequences of other evolutionary acquisitions. Just as Pangloss in Voltaire's *Candide* they see perfection in everything, while paying too little attention to the banal role of chance (Gould & Lewontin, 1979; Gould, 2000).

Again, the critics are right with their warnings, but unfair in their diagnosis. Sociobiologists and evolutionary psychologists are no Panglossians. It was C.G. Williams himself, one of the originators of sociobiology, who warned against the use of `adaptation' as an all-explanatory magic word in his book *Adaptation and Natural Selection*. Williams states that a *fundamental rule* that must be accepted is that "adaptation is a special and onerous concept that should be used only where it is really necessary" (4). It is true that Wilson speculates in the final chapter of his *Sociobiology* about the human `biogram' (ethogram), but he does not claim to know already to what extent all its independent properties are adaptive or are still adaptive:

> One of the key questions, never far from the thinking of anthropologists and biologists who pursue real theory, is to what extent the biogram represents an adaptation to modern cultural life and to what extent it is a phylogenetic vestige. Our civilizations were jerry-built around the biogram. How have they been influenced by it? Conversely, how much flexibility is there in the biogram, and in which parameters particularly? (Wilson, 1975: 548)

Of course, Wilson and other sociobiologists are firmly rooted in the `adaptationalistic program': i.e. the theoretical commitment to start interpreting the characteristics of people and animals as adaptations. As indicated previously, there are good reasons for doing that: important characteristics do not develop without a cause. A peacock's tail, the hooked beak of a hawk and the heavy brain of man must all have an ultimate cause. Coincidence is an insufficient explanation for the complicated combinations of genes that generate such organs. Put an ape behind a typewriter and the chances of obtaining the works of Shakespeare are extremely small.

This does not, however, mean that speculation with respect to the ultimate causes of specific human behaviors or characteristics is not without risk as long as nothing is known about the proximate mechanisms responsible, and the conditions under which they become operative. Indeed, because man is currently living in a rapidly changing environment, one which is greatly different from the environment in which he evolved, it is safe to assume that at least important parts of his behavior are *not* `adapted'. Proximate mechanisms, that were previously purely functional, can now be extremely harmful. A thorough knowledge of the conditions under which man evolved (the `environment of evolutionary adaptedness' (Tooby & Cosmides, 1990), therefore represents a long-cherished dream for sociobiologists. Evolutionary psychology even has placed the `environment of evolutionary adaptedness' central (Tooby & Cosmides, 1990).

But man's changed environment is not the only cause of the unadapted nature of much human behavior. Another cause lies in the ways in which evolutionary adaptations are brought about. Adaptation is not planned improvement, but a process in which the most successful variants are reproduced, simply because they are most successful in reproducing themselves. Such variants often owe their success to developmental changes that usually turn out favorably, but often have a damaging effect too. A specific psychological tendency - striving for status for example - can in general be fitness-increasing, but in a number of conspicuous cases it can in fact have a completely opposite effect. If these cases draw a relatively high level of attention, the impression may be created that man is a victim of supra-evolutionary impulses, while in fact he is only a victim of the discrepancy between adaptation and perfection.

Alcock (1989) proposed a methodology that would allow us to implement the adaptionalistic program for man. Instead of preparing hypotheses for all the different human properties, in his view only three possibilities have to be analyzed each time:

- The property is functional; possessing it leads to increased reproductive success.
- The property was previously functional; it led to reproductive success during some part of human evolution.
- The property is an adverse by-product of an apparently functional characteristic.

By considering these three possibilities each time one is tempted to assume an adaptation, he thinks that we can avoid remaining at the level of *ad hoc* hypotheses. Each possibility leads to a specific prediction for each special human property under consideration, and could in principle lead to testable hypotheses. In this manner three alternative hypotheses can be weighed up against one another for an entire series of themes - from suicide, celibacy and belligerency to incest and homosexuality.

ad 3. *Are sociobiological theories ad hoc?*

With that, we arrive at a criticism which we sometimes hear: that sociobiologists do only create an endless series of *ad hoc* hypotheses. In my opinion this reproach is inspired by a number of less successful attempts to make certain phenomena fit within the evolutionary framework. The fact that such attempts have been made is in my view perfectly legitimate. It would be equally as wrong to consider the fact that here on earth two objects, such as a feather and a stone, which do not usually fall to the ground with equal speed, to be an immediate refutation of the laws of gravity. Of course it is all too easy to collect several examples of simplistic *ad hoc* reasoning from the extensive amount of sociobiological literature available. Of course, sociobiologists did initially attempt to place all kinds of surprising phenomena into Alcock's first category.

However, such *ad hoc* maneuvers are unavoidable in virtually every science that is occupied with phenomena of which the complexity exceeds that of a simple physical system to a number of powers. The number of *ad hoc* maneuvers that have been used to defend the theories of Freud and Lévi-Strauss are also virtually infinite. Nevertheless, the question remains as to whether it is fair to place the emphasis on a number of all too evident *ad hoc* maneuvers by sociobiologists, especially considering that sociobiology started by putting an *end* to the *ad hoc* character of ethological theories by underpinning them with reference to genetics and evolutionary theory. In the social sciences too, sociobiologists seem to face considerably more difficulty than their colleagues because they have to keep their theories compatible both with evolutionary biology and with the facts.

Of course it is possible, for example, to view Trivers' theory of reciprocal altruism as an *ad hoc* theory that has to be mobilized because kinship alone cannot sufficiently explain all forms of altruism (Gray, 1985). However, this accusation misses the fact that the underlying reasoning behind kinship theory is not that kin necessarily help each other in nature (in fact that is quite often not the case), but that a genetic disposition toward altruistic investments can only arise if the benefits of such an investment exceed the costs involved, both viewed in terms of the number of offspring. In the majority of animals this results in relatives helping one another. In longer living animals this same principle can also lead to altruistic investment in non-relatives if the interaction between both parties has a somewhat long-term character as a result of which their is a fair chance that altruistic deeds can be repaid. Of course, this requires a lot more intelligence for the processing of complex social interactions and for the calculation of the balance of reciprocal investments. When a researcher decides to explain the behavior he has observed by appealing to reciprocal altruism, certain predictions follow with which he can test his theory: it should be possible to exclude kinship as an explanation, specific partners should cooperate, help should be rewarded at some later stage, negligence should be punished, etc.. As Wilkinson's research relating to vampire bats shows, the conclusion that some forms of altruism arise as a result of reciprocity no longer can be considered to be an *ad hoc* hypothesis (Wilkinson, 1990).

An example of apparently *ad hoc* reasoning can also be found in the explanation of the hypersocial structure of termites by incest cycles (Trivers, 1985: 180). The fact that termites are eusocial and not haplodiploid led to a further study of their genetic system, whereby it appeared that the mutual kinship between (both male and female) members of the non-reproductive caste is extremely great as a result of another factor. It was discovered that the winged colony founders were not the direct product of other winged colony founders, but that eggs were produced by `secondary' queens in the colonies, that were fertilized by `secondary' kings from their own colony. The result of these incestuous activities is that the resultant winged kings and queens, who are intended to leave the colony, have identical sets of genes for all their characteristics (are homozygous). When two such non-related individuals are crossed, the kinship between the offspring is extremely great, because it continuously combines the genes of both parents (see figure 4-7). While sisters in haplodiploid insects share the genes of their father, termites therefore often share the genes of both fathers and mothers!

An objection that might be raised to this theory could well be that in this case sociobiologists are attempting to sweep a problem for their theory, namely that the hypersocial termites are *not* haplodiploid, under the carpet. It could also be remarked that sociobiologists first attempted to explain the universal incest taboo in human societies by referring to the risks attached to incest, while they now suddenly need incest again in order to complete their story. However, both objections fail to take the complexity of the biological world into account, in which no law can ever be blindly applied without first examining the exceptional circumstances to which it is being applied.

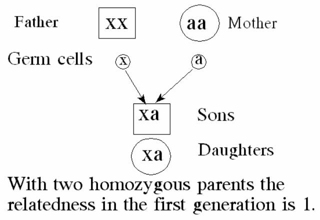


Figure 4-7. Relationships between offspring of homozygous individuals.

The hypersocial structure of termites does indeed appear to correspond to that of hymenoptera, but there are also dramatic differences. With termites we find an infertile worker-caste of both sexes, with both a king and queen at the top; in social hymenoptera the male sex is totally marginalized and the workers and soldiers, in addition to the actual founders of the colony, are female only. Males are usually only produced for a short period, in order to be disposed of again as quickly as possible. That termites are diploid, and therefore more strongly related to their sisters, can therefore be interpreted as an important confirmation of the theory. The fact that termites nevertheless have a hypersocial structure screams for an explanation, which does not necessarily have to be *ad hoc*. In fact it would be *ad hoc* if the sociobiological thesis held that the haplodiploid reproductive system was the only cause for hypersocial behavior. The thesis, however, is that individuals maximize their inclusive fitness and it can therefore be expected that reproductive systems which generate an extremely high degree of kinship between family members can evolve extreme forms of social behavior.

While at first sight it might appear that the `incest theory' is an ingenious attempt to neutralize an anomaly, new predictions do in fact follow. For example, you could reasonably expect to find other species in which cycles of inbreeding lead to the evolution of infertile worker-castes. It has since appeared that the East African naked mole-rat is exactly such a species (Sherman *et al.*, 1992).

The objection that incest is avoided in much larger mammals can also be refuted in a similar way. The fact that naked mole-rats are extremely incestuous does not necessarily imply that no incest avoidance mechanisms have evolved in larger mammals. In fact, no-one doubts that incest must have significant disadvantages, even for termites and naked mole-rats. However, natural selection is not an anticipatory organizer searching for the best of all possible worlds, but is more an untidy architect who, if necessary, would save a cathedral from collapsing by filling it with concrete. The disadvantages of incest amongst termites, and also amongst naked mole-rats, in all probability finds compensation in a substantial overproduction of individuals. If a number are born with defects they can be raised by their brothers and sisters and still become soldiers. In large mammals the costs of an individual are directly proportional to the duration of pregnancy (man probably forms an exception if it is true that birth occurs too soon in relation to body weight). Individuals then become so expensive that the negative effects of incest weigh far more heavily. That could well be a cause of the exogamous social systems found among many species of birds and mammals, in which incest is avoided by the migration of males or females, or even by psychological incest-barriers (the so-called Westermarck-effect), that provides a possible explanation for the universality of the incest taboo in human cultures (Van den Berghe, 1983).

Now that we are on the subject of incest and *ad hoc* explanations: the avoidance of incest in man can also be viewed as a problem for the sociobiological theory with respect to incest taboos. The recently proposed attempt to couple incest between a father and child to the uncertainty of fatherhood (Welman, 1990) could be interpreted as an *ad hoc* manoeuver, once again intended to set the entire story straight. However, this explanation of father-child incest is not totally unfounded, but is supported by data, and therefore either falls apart or is reinforced by the quality of that data. If that data should appear to be valid, and fathers do indeed tend toward incest if they doubt their fatherhood, it would mean that there are indeed conditional psychological barriers (which can more or less be considered to have been clearly demonstrated for the brother-sister relationship (e.g. Van den Berghe, 1983).

Hopefully, I have shown here that sociobiological theories often *appear* to be more *ad hoc* than they *are*, and that they in fact form a dramatic example of an attempt, once and for all, *not* to base social sciences on *ad hoc* points of departure. The idea that man can attribute the greatest part of his behavior simply and purely to `culture' (often used as a vague notion that gives the impression of some kind of independent supernatural dimension), is an example of such an *ad hoc* point of departure, which is incompatible with the rest of the current scientific world view.

Of course nobody denies that man is a cultural being, and that each individual pattern of man's behavior bears the stamp of his local culture. For that matter (as we have seen in chapter 1.5e), the extent to which animals display culture, in the sense of non-genetically inherited behavior, is often underestimated. Nonetheless, the theory of evolution forces us to confront the questions as to how the extreme cultural dependency of man was created (part III), what purpose the culture of early man actually served, and to what extent our genes continue to ensure that we exactly pick those elements from our surrounding culture that we can best use to realize particular biological goals. Evolutionary theory leads us to believe that culture in itself is never an objective, but just a means as other means in the `struggle of life'. In addition, the comparative biology of societies has taught us that even the total spectrum of human cultures demonstrates only relatively small variations on the recurrent basic patterns of human nature, and that a large number of human characteristics that we tend to interpret as being self-evident, are in fact typical human characteristics and bear the traces of our evolutionary history which is unique, just like the evolutionary history of all other species.

ad 4. *Are sociobiological theories dispensable?*

Now that sociobiology and evolutionary psychology are gradually becoming accepted in academic circles, one can sometimes hear a completely new way of debunking them. The new argument goes like this "Yes, an evolutionary approach can be very fruitful in the analysis of some of the biological bases of human behavior. But we sociologists/ anthropologists/ philosophers are studying phenomena on a different level. Such theories are simply not relevant for our subject matter."

This is, of course, a relatively clever argument. While the three former critical approaches still presupposed some expertise in the subjects criticized, one can rely on this argument without any acquaintance with it. Above that, the argument contains always a grain of truth. It is always possible to outline one's `subject' (this fetish which lies at the heart of academic territorial behavior) in such a way that even the study of human nature is not relevant to it. Often the argument is accompanied by the tempting challenge to show the relevance of evolutionary analysis to some tiny subject studied by the scientist in question. If the sociobiologist is stupid enough to try an evolutionary analysis (personally, I always bite), it is easy to show his ignorance with respect to this tiny subject. If his argument does not ignore the facts, however, one can always accuse the sociobiologist of creating *ad hoc* theories.

Where does the mutual irritation emerging from such debates come from? First, of course, there is the discrepancy between those interested in the `big picture' and those interested in particular empirical details. Second, there is, however, the question of authority and legitimacy, in short the issue of academic territory ownership. In the eyes of many scientists, authorities are those who have studied a particular empirical domain exclusively for many years. Apparently, evolutionary theorists are often experienced as intruders, jumping to conclusions much too fast on the basis of an inadequate knowledge of a particular subject. It is exactly their enthusiasm for new perspectives and covering paradigms which becomes fatal to them.

In defense of the evolutionary approach it should be remembered, however, that there does not exist a correlation between the endurance of a paradigm and its truth value. Of course, a longduring acquaintance with a subject often guarantees deep knowledge. Yet, it can at the same time imply blind spots and even a narrowing of vision. Sometimes, the insights of relative outsiders can be refreshing and can even be necessary to break through the taboos of a discipline.

Of course, there is nothing wrong with the empirical approaches used within the human sciences. Yet, the human sciences can reach a point in which they themselves are no longer able to decide between two possible sets of presuppositions. I have argued that ethology was revolutionized at some point simply because it ripened to such an extent that it needed a more detailed evolutionary foundation which allowed a better analysis of the costs and benefits of particular types of behavior. It seems to me that this situation is repeating itself in the human sciences. Often, human scientists are no longer able to decide between two sets of hypotheses on the basis of their own discipline only. At such a moment a recursion to a wider, covering paradigm is necessary. The presuppositions of social scientists need to be kept compatible with developments in biological thinking. Sociobiology, as the study of the biological laws governing all social behavior, was concerned with a series of areas in which the presuppositions of the social sciences had to be deduced from evolutionary principles. Of course, each discipline has to protect its own goals and its own reliable methods and data. In the end, however, all disciplines have to be kept compatible, because it is inconceivable that what is true within one discipline is untrue within another discipline.

ad 5.*New versions of group selection: multilevel selection*

It has to admitted, though, that even within biology the way in which sociobiologists have accentuated selection at the relatively low level of the individual is still debated. Recently, the biologist David Sloan Wilson and the philosopher Elliott Sober have written a volume on altruism in which they try to get the best of both worlds by defending `multilevel selection'. They claim that *altruism can evolve to the extent that altruists and nonaltruists become concentrated in different groups* (Sober & Wilson, 1998: 26). If temporary subgroups with a relatively high number of altruists grow faster, altruism may spread in the global

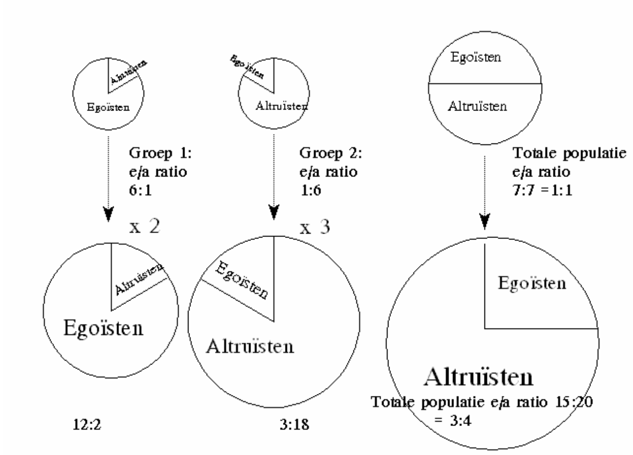


Figure 4-8. If groups with relatively high numbers of altruists grow relatively fast, the number of altruists in the general population grows steadily. Changed after Sober & Wilson, 1998.

population, even though in direct conflicts between altruist and egoists the altruists turn out to be the losers.

Figure 4-8, slightly changed after Sober & Wilson (figure 1.1), clarifies their point. It is a thought experiment in which we start with an original population of seven altruists and seven selfish individuals. They are divided in two groups, one (1) in which the self-seekers predominate with 6:1 and one (2) in which the altruists predominate with 1:6 (`the self-seeker/altruist ratio or s/a ratio). Then, we assume that group 2, with the relatively high number of altruists, has more reproductive success and triples (becomes 3:18), while group 1, with more self-seekers, only doubles in size (becomes 12:2). The result shows that the balance between self-seekers and altruists is now disturbed in favor of the altruists which have gradually become three-fourth of the general population (group 1+2: 15:20). The point is that altruists can grow in numbers, because they may profit from their own behavior via the well-being of a subgroup which prospers as a result of their behavior.

All this could work in principle, but it is still based on a presupposition, namely that the proportion of self-seekers and altruists remains constant in a population. In the above mentioned example, in subgroup 2 the small number of self-seekers could grow disproportionally, because these self-seekers could profit from the services afforded by their altruistic group-members. Even in group 1 the number of altruists could decline, because they would probably put all their energy in helping their more selfish group members. As a result, the relative number of self-seekers would probably not decline as predicted by Wilson & Sober, but remain constant.

Of course, there is something intuitively plausible in the idea of the relative adaptiveness of altruistic behavior in small subgroups that subsequently dissolve in larger wholes. It seems to me, however, that this phenomenon can be explained with reference to kin selection and reciprocal altruism, perhaps supplemented by sexual selection and the handicap principle (if altruistic partners are sexually more attractive or if altruism is a handicap which demonstrates one's force and vitality, this could explain a moderate level or altruism; Zahavi & Zahavi, 1996; Slurink, 2000).

Of course, one should also beware of simply dividing populations in self-seekers and altruists, as if altruism is a matter of genes only. It is much more plausible that individuals behave altruistically if they can afford it, for example if they do not yet have their own offspring to care for, if it costs them relatively little or if they can see that it contributes to the well-being of their relatively small subgroup. In fact, if altruism was a phenomenon that was displayed continually by at least some individuals, I would probably be more interested in theories like Sober and Wilson's one. It seems to me, however, that what we witness in our societies is that individuals turn into self-seekers at the moment they become part of bigger subgroups. Part of the reason that many people feel some nostalgia towards the past is that individuals in the much smaller communities of the past were often forced to exhibit more social awareness - a phenomenon which can be explained very well by the theory of direct and indirect reciprocal altruism.

ad 6. *Criticisms of evolutionary psychology*

Evolutionary psychology is gradually gaining influence. Yet, some of the old critics keep repeating the same criticisms and accusations, for example in the volume *Alas, poor Darwin* (Rose & Rose, 2000). In the mean time sociobiology and evolutionary psychology have evolved, and have tried continually to clarify their real theoretical motives. For some critics, however, the best is not good enough. It is somewhat comical to see the complex somersaults that such critics are prepared to make to keep finding weaknesses in their opponents.

I give one example from the first two pages of *Alas, poor Darwin*. During the eighties E.O. Wilson was often ridiculed for his claim that the evolution of the human species was still going on. As a consequence evolutionary psychologists started to stress the fact that the culture in which we live today is so young that it probably has had a relatively small impact on the human genome. The largest part of our history as a species we did not have cars, refrigerators, computers and faxes. Hence, evolutionary psychologists stressed the fact that we are adapted to the life of hunters and gatherers. This could be called the `myth of the stone-age mind' or the `hypothesis of delayed adaptation', because it presupposes that the genetic evolution during recent history has been relatively minor.

Now that the critics have understood that they can no longer accuse evolutionary psychologists of claiming that humans are even adapting to their modern cultural environments they start claiming that it is absurd to think that human nature is still frozen in its ice-age form:

> Thus, for evolutionary psychology, what its protagonists describe as the `architecture of the human mind' which evolved during the Pleistocene is fixed, and insufficient time has elapsed for any significant subsequent change. In this architecture there have been no major repairs, no extensions, no refurbishments, indeed nothing to suggest that micro or macro contextual changes since prehistory have been accompanied by evolutionary adaptation. The extreme nature of this claim, granted the huge changes produced by artificial selection by humans among domesticated animals - cattle, dogs and even Darwin's own favourites, pigeons - in only a few generations is worth pondering. Indeed, unaided natural selection amongst the finches in Darwin's own islands, the Galapagos, studied over several decades by the Grants is enough to produce significant changes in the birds' beaks and feeding habits in response to climate change. If for birds and beasts, why not humans?' (Rose & Rose, 2000: 1-2).

It is surprising to see how the critics have absorbed one of the insights of the early sociobiologists - that evolution never stops - to use it against modern Darwinians. Of course, the criticism is unfair, because evolutionary psychologists are the last to deny that evolution is still going on. The only thing they have claimed is that currently our environment is changing at such a speed that one cannot expect the human genome to be adapted to it. Even our domesticated animals have still largely retained their original behavioral programmes, despite their changed physical appearance. A dog is still a group hunter and groups of escaped dogs sometimes start harassing deer. Cats are solitary hunters and they will exercise their skills on mice, but if mice are not available they will use a ball of wool, or any other object that rolls or moves in response to pushing and pulling. Of course, smaller and larger evolutionary changes are continually taking place, especially in small, isolated populations. Evolutionary psychologists are the last to deny this.

This is only one example of the complex mix of misunderstanding, mispresentation and false accusations that one still sometimes meets, even after an almost continual stream of books in which sociobiology and evolutionary psychology are explained. Sociobiologists and evolutionary psychologists have been particularly frustrated by one critic, who has a lot of power and continues to repeat his misrepresentations as if his criticisms have never been answered and without referring to the literature. This is Stephen Jay Gould, who also contributed to the recent volume (Rose & Rose, 2000), and who has misused his column in *Natural History*, to fulminate against the `ultra-Darwinists' that dare to assume that human behavior is adaptive or results from mechanisms that once were adaptive to some extent. One is sometimes even reminded to the ways in which the `fathers of the church' once commented on the gnostic schools. If one would try to reconstruct the views of sociobiologists and evolutionary psychologists on the basis of Gould's essays alone (and like the books of the fathers of the church the copies of his books outnumber those of his victims), one would indeed find that one knows almost nothing about them (in the same way as we did not know much about the gnostics before the finding of the Nag Hamidi scriptures). For example, from Gould's essay on the views of Dawkins (Gould, 1984) one could conclude that Dawkins is blind for the organism as a whole, which is far from the truth (Dawkins, 1982). Apart from misrepresenting sociobiologists, Gould has also been very cunning in using his reputation as a Harvard scholar in bluffing authority in evolutionary matters. If we analyze Gould's essays (as John Alcock did) we find in fact that their force lies in fact in a series of very simple rhetoric tricks (Alcock, 1998; table 4-1).

Step 1. Advertize the scholarly credentials of the author.
Step 2. Characterize persons with opposing views as bumpkins.
Step 3. Demolish a strawman afflicted with `genetic determinism'.
Step 4. Make a small (and insincere) concession to opposing views.
Step 5. Proclaim allegiance to all that is politically correct and morally desirable.
Step 6. Assert that behavior *X* is immune to adaptationist analysis.

Table 4-1. Gould's recipe for writing an essay on sociobiology, according to John Alcock, 1998.

ad 7. *The naturalistic fallacy*

Let us get back to serious problems, however. Sociobiologists and evolutionary psychologists have often been accused of being fatalistic, supportive of the *status quo*, and of committing the *naturalistic fallacy*. By revealing the fundamentally different nature of the sexes or of the hierarchical nature of human societies they are supposed to be against equality or reform. By pointing to the selfish or even genocentric nature of human motives sociobiologists would run the risk of promoting selfishness.

Of course, fatalism is a danger. Yet, it was Socrates himself who placed the dictum `Know thyself' at the heart of ethics. If our moral attitudes would melt like snow under the sun of scientific truth, they would not be worth much. Indeed, it has been sociobiology which has discovered that genuine altruistic motives are compatible with the scientific world-view. It has been modern genetics which has shown (in contrast to the philosophical views of Aristotle c.s.) that men and women contribute about the same to their progeny (in fact, women contribute more, namely their mitochondrial DNA). It has been modern sociobiology which has stressed that male and female strategies have evolved in a kind of arms race and that it thus would be very unlikely that one of them is a `winner' or a `loser' (Trivers, 1976).

Thus, instead of undermining altruistic or moral attitudes, scientific models can reinforce them by lifting prejudices. Of course, a scientific analysis of morality does not give a foundation to it and even shows that there is no such a thing as an absolute non-perspectivistic `good' and `evil'. Values arise in the context of the interests that animals and humans have in their own survival, well-being and reproduction (Pugh, 1978; see chapter 3). For a darwinist, it is unlikely that the values of different organisms are in harmony and that there thus exists a `good' that is good for everyone (apart from the sun). Of course, every organism wants to survive and to reproduce, but predator and prey, if they could speak, would probably have different concepts about who has the right to survive and would probably have different moral codes as well (Slurink, 1994).

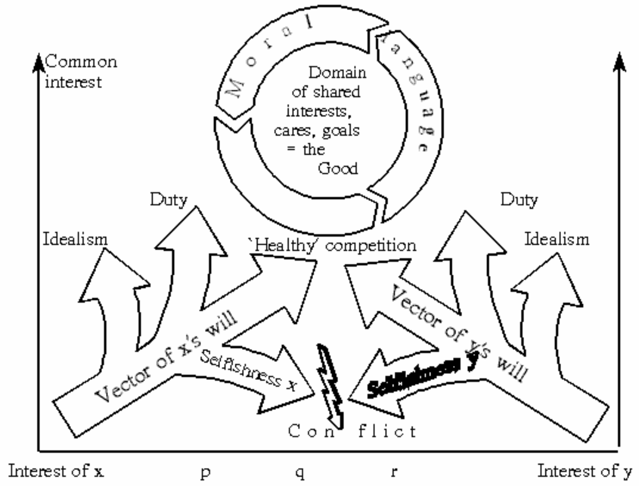


Figure 4-9. The common good emerges when individuals together can increase their utility space, even though they remain competitors in taking their share (Slurink, 2000).

All this shows that a naturalistic approach to ethics is not compatible with the kind of absolutist morality which one would need to commit the `naturalistic fallacy'. In fact, from the perspective of evolutionary theory, morality can be seen as an emergent property of a social system based on direct and indirect reciprocal altruism (Alexander, 1987). Because all parties in such a system have their own `good', but are mutually dependent at the same time (for example, because they can together, and only together, exploit particular natural resources), they have to determine their common interests and their `common good' by negotiating (fig. 4-9). Even if they agree on some `common good', this is not an absolute good to which *all* could agree. The history of morality shows that there are always some parties excluded, be it slaves, women or animals. Indeed, I cannot imagine a morality to which everyone would agree, because this would mean that there would not be a struggle for live: there would be no cheaters, no parasites, no criminals, etc. In such a world we simply do not live.

Yet, happily enough we do live in a world in which most people agree on a series of common goals. If we accept a series of such goals, we are perfectly able to talk about good and evil in an almost empirical fashion. We are not hindered at all by a naturalistic fallacy if we decide that it is "good not to beat your wife and children", because we agree silently that it is important that our wifes and children are happy and will be happy in the future. Considered this way, the sciences have an enormous influence on our knowledge of good and evil. If we agree that animal suffering is bad, knowledge about the stress caused by different ways of keeping animals is immediately relevant. Instead of committing a naturalistic fallacy we can even make a naturalistic deduction of a moral imperative, of course not based on absolute values, but on an agreement about moral goals.

It is shocking how easily philosophers interested in ethics are sometimes dismissing the importance of scientific knowledge with sneers about the naturalistic fallacy. It seems that such philosophers do not realize that knowledge is the only weapon against prejudices and unrealistic expectations. Wisdom is not based on a mystical contact with supernatural values nor on transcendental imperatives which can be only witnessed in a state of ratiocinative trance, but simply on a throughout and compassionate knowledge of human nature and of animal nature generally (for a more extensive discussion of the theme of sociobiology and ethics see Slurink, 1979; 1994 and 2000).

5. MULTIDIMENSIONAL THEORY EVALUATION AND THE POSITION OF THE SOCIAL SCIENCES

Finally a word about the legitimacy of theories. Specialists in the social sciences are sometimes still devoted to the creeds of positivism, sometimes they are flirting with social constructivism, depending on the philosophy of science that they use. As I have argued in part I, evolutionary theory gives an extra argument for realism, not by way of an `absolute foundation', but simply because only evolutionary theory can explain why truth matters to some organisms at least sometimes. For want of one absolutely reliable way of establishing the truth of theories, I have given a sketchy analysis of some of the values that people in fact use to decide between various theories (chapter 2.5) and of the types of arguments one can use to decide whether these values do only refer to social success or do in fact point also to ontological adequacy. In accordance with this approach, I propose to use several criteria at the same time to decide between theories. Of course, in practice this will increase the amount of subjectivity involved, but perhaps some subjectivity is good for a fruitful pluralism in situations in which no certainty is given.

Whereas traditional philosophy of science stressed the importance of the values such as coherence, verifiability (or falsifiability) and predictive power, within an evolutionary approach explanatory power and robustness or multiple derivability (Wimsatt, 1981) become crucially important. This is because evolutionary theories often cross the borders of several disciplines and refer to several ontological levels at the same time. Whereas it is not always possible to decide their relevance with respect to each discipline apart, data from several disciplines together can form pieces of the puzzle that is emerging from an interdisciplinary approach.

As claimed before, evolutionary explanations and `evolutionary reductions' do not imply a `reduction by dissection' (Alexander, 1987). Rather they restore Aristotle's idea of multiple explanatory dimensions, placing them within the context of a world in which goals emerge as a result of variation and selection. Of course, it would not be wise to try to find modern equivalents of the four categories of causes proposed by Aristotle. Yet, a complete evolutionary explanation of a behavior would entail at least a hypothesis about an existing atavistic variation on a particular trait, a postulated atavistic selection pressure, a genetic basis, a protein-mechanism, a tissue-mechanism and models about the ways in which these mechanisms do their job in different environmental and social contexts and about the differences in reproductive success that they currently produce.

Of course, with respect to most phenomena to be explained we are still far away from such complete explanations. In the next chapters, I will try to do my best, however, to explore the phenomenon of human culture from an interdisciplinary evolutionary perspective in the hope of finding a theory which is strengthened by data from several sciences and fits ordinary experience as well.

5

** Culture, the Human Arena \\

Conflict is the father of everything.

Herakleitos

Omnis cultura ex natura.

David Bidney

5.1INTRODUCTION

Anthropologists, social scientists and philosophers who are not familiar with animals or with the scientific study of their behavior, ethology, sometimes tend to make generalizations about animals in which everything between cockroaches and apes is lumped together as if the differences between cockroaches and apes are not much greater than those between apes and men. It is no wonder, then, that some of such thinkers are inclined to consider human culture as completely `beyond biology', a new form of life, the origin of which lies in a cloud of mysteries or at least far in the past. In fact, this way of thinking is probably partly reinforced by the emancipation of the various human sciences which all have to demonstrate that they are studying independent `realms' of reality, but which, as a result, sometimes forget to study the sciences of adjacent `realms'. The history of sociology and anthropology is far too rich, however, too allow for generalizations and there have always been researchers who were not obsessed with the delineation of their specialism and who were, as a result, often much more relaxed in their statements about the independence of their ontological `territory' (e.g. Ritzer, 1988; Moore, 1997).

Perhaps the sociobiology-debate of the seventies and eighties has had the unhappy effect of a polarization which makes it not always easy to approach the phenomenon of human culture in a balanced way. As we have seen, sociobiology has been fiercely criticized since its diverse manifesto's in the seventies proclaimed that it would have serious consequences for the social sciences. Although the criticism that sociobiology is inherently genetic deterministic, adaptationistic and characterized by *ad hoc* hypotheses was not justified, one weak point remained: the lack of sufficient convincing examples of links between genes, brains and behavior that show that the many peculiarities of human nature can be explained as evolutionary adaptations. As long as everything between genes and behavior remained a black box, sociobiology had to remain just a handbag of general biological principles for most people working in philosophy, psychology and the social sciences.

Happily a lot has changed since the seventies. A new generation of sociobiologists has arisen within the bulwark itself of the human sciences (e.g. Crawford, Smith & Krebs, 1987; Betzig, Borgerhoff-Mulder & Turke, 1988; Maxwell, 1991; Betzig, 1997). They have started fresh research in which an evolutionary perspective is brought to bear on the traditional research questions of their disciplines. Often this research is no longer labeled sociobiology, partly because this term has become too much of a burden, partly because it would be much too general to refer to the specific research that is being done. In spite of that, much of this research, be it under the name of behavioral ecology, social biology, biopolitics, evolutionary psychology, etc., is characterized by the same interest in the evolutionary foundations of human behavior displayed by classical sociobiology.

Sometimes the new names betray a revolutionary new orientation, however. This is especially the case with evolutionary psychology, which arose out of the realization that the `black box' approach to the link between genes and behavior was disastrous (e.g. Symons, 1987; Cosmides & Tooby, 1987). The only way in which genes can affect behavior is, of course, via specific physiological and psychological mechanisms. The fact that these mechanisms have to be viewed, from an evolutionary perspective, as products of selection, does not imply that they are without peculiarities or without non-adaptive side effects. Because humans have invaded a variety of biotopes and have changed their own environment dramatically, it is not to be expected that their psychologies are completely adapted to their current environments. Evolutionary psychology tries to map and to dissect the conglomerate of psychological mechanisms which constitute the human mind. (Of course, the term evolutionary psychology was already invented by William James and I will use it in a general sense, not referring specifically to some beliefs which may be exaggerated by some evolutionary psychologists, e.g. the hypothesis of delayed adaptation (the belief that we are still essentially adapted to the hunter-gatherer way of life of our stone age ancestors) or the hypothesis of functional modularity (the belief that our minds consists of a plurality of independently evolved domain specific modules, like a swiss army knife, Tooby and Cosmides, 1994; Horgan, 1995; Mithen, 1998)).

In this chapter I will try to select an adequate model of the relationships between genes, mind and culture. Time and again, a series of questions re-emerge in discussions about the evolution of human behavior, which refer to the much-vaunted human capacity to create culture: should culture be considered as a phenomenon that enables humans to *`transcend'* their `biology' or should it be considered an extension of an evolved human nature? Is human culture the expression of an almost unlimited human psychological flexibility or should it be understood as the result of a series of very specialized psychological faculties that have been shaped by variation and selection during the specifically human evolutionary trajectory? Is culture the product of human nature or is man, as claimed by Geertz (1973), the product of culture?

I will try to show that evolutionary psychology (with or without functional modularity and delayed adaptation) may well be the crucial innovation enabling us to integrate the concept of culture within an evolutionary frame-work. Whereas most social scientists are justified in considering man to be a species that is uniquely dependent on culture, especially on a `symbolic culture', they are mistaken to the extent to which they interpret culture as a `superorganic' level `imposed' on an almost infinitely malleable human nature. Certainly culture enables people around the world to display a wide variety of customs, rules and behaviors, but these all remain variations on a limited series of basic themes, most of which we share in one way or another with other animals. Some of these themes arise out of the same devotion to food, safety and reproduction that is displayed by most nonhuman animals, but even a series of apparently uniquely human themes can be shown to be elaborations of behavioral tendencies which we share with other species. Even our capacity to acquire language and other symbolic systems is firmly rooted in our evolutionary past, although it forces us into unique technological arm-races and into uniquely accelerated cultural and social changes.

The most important point, however, is that culture does not create humans, or at least does not create them *ex nihilo*, but is needed, used and created by them to realize their needs and drives. Although culture as the cumulative product of a history of individual learning processes can be opposed to the interests of the individual, it remains the individual that actively molds culture to suit its personal teleonomic needs, drives and values. Culture, then, is not merely *imposed upon* individuals, but is *used by* them and is transformed as a result of the continual competition between societies and individuals within societies.

Cultural evolution can then be modelled to some extent as an independent process at an independent level `above' the genetic evolution, but such a model has only limited explanatory power, as long as it does not include the evolved psychological mechanisms which force humans to adopt particular cultural systems rather than others. In the end, many apparently purely `cultural' phenomena can only be understood if we understand culture as the cumulative product of the universal reproductive arms-races between individuals of our species. Of course, this needs not to be immediately apparent, because this competition is mediated by a plurality of psychological mechanisms.

Despite all this, it remains true that culture creates its own laws and does often lead to apparently maladaptive behavior. The crucial question of this chapter is therefore: *to what extent is there a conflict between the phenomenon of culture in the human species and the universal organic tendency towards inclusive fitness maximization*? I will try to show that human culture is a manifestation of the same `struggle for life' and the same reproductive competition that underlies all life. My claim will be that the level of `meanings' which is often taken as characteristic of human culture is more directly linked to the level of needs and musts than is usually thought. What we take as the `independent' level of human culture is the outcome of the conflicting strategies of many individual humans which all use and transform the collective `culture pool' to their own ends. As a result, culture reflects the continuing conflict between cooperation and competition within the human species.

At the same time, cultural `meanings' have often functions at different levels and often contain `biological' signals. Yet, it is not always easy to understand the adaptive function of `biological' signals, even in nature. As Darwin and Zahavi have both observed, biological signals sometimes may overrule the laws of simple straightforward utilitarian selection. The fact that this does not make an evolutionary analysis easy and intuitive does not imply that it is not the kind of analysis needed.

First, I will present six alternative models of the genes-mind-culture relationship (Lumsden & Wilson, 1983; Flinn, 1997). These are used as a first generation of theories, which are objects of selection, retention and manipulation. After a first inventory their advantages and disadvantages, I will start my work as a selector, the substitute of natural selection at the level of theories. The first model is the `ideational' concept of culture, which is defended by many anthropologists, for example Clifford Geertz. Often it is this `symbols-and-meanings' view of culture of which sociobiologists and evolutionary psychologists are accused to be ignorant. I will try to show that it presupposes, at least in the writings of some anthropologists, a certain concept of `biology' and of `animals' which is not warranted by the evidence. I will claim that Geertz' model presupposes a kind of `top-down determinism' or cultural determinism which leaves many aspects of culture unexplained and which leaves, on the whole, culture hanging `in the air'.

The second model that I will discuss also stems from the traditional human sciences. It is the view that a given culture is purely the product of the environmental conditions in which it arises. Exemplary for this vision is the `cultural materialism' of Marvin Harris, which is really a kind of environmental determinism. While this approaches has yielded a very rich spectrum of explanations for a variety of cultural phenomena, it is severely limited by its neglect of the evolved complexity of human nature. I will illustrate this with citations from Harris' writings and argue that there are reasons to believe that Harris' view of human nature is too limited.

I then turn to the evolutionary models. Surprisingly enough they sometimes seem to make the same mistakes as the traditional science models in neglecting human nature. I will show that models 3 and 4, the `ideational selection' model and the `dual inheritance' model of culture are incomplete to the extent that they do not explain *why* particular ideas, habits and rituals are more successful in a given environment than others. A purely `symbols-and-meanings' view of culture is always incomplete and should be replaced by a `musts-and-meanings' view in which symbols and meanings are no longer understood as parabiological phenomena and in which complex psychologies mediate between genes and culture.

After these eliminations two evolutionary models are left which both somehow try to cope with the constancy underneath the variety of human cultures. The first model (model 5) is in my opinion largely a chimera, a caricature needed by traditional social scientists like Geertz and Harris to be able to contrast their views with a view which is obviously mistaken. Yet, it shows that the relationship between genes and human nature at this time in history, now that the humane genome project is underway, is still unclear and still needs a lot of clarification. It is useful, therefore, to review some current knowledge with respect to the nature-nurture dichotomy in the hope of finding the right level at which we can expect adaptations. Only after this, can we expect to find a reasonable answer to questions with respect to the existence of a human nature and the adaptive nature of culture. To what extent is man a cultural being by nature? Why do people have culture? What drives artists, scientists, political leaders? Is culture adaptive as a whole, or does it reflect many individual adaptations?

In my opinion evolutionary psychology (model 6) is closest to answering such questions. Because it stresses an independent level of psychological phenomena between genes and memes it is able to deal with those behaviors that are not adaptive or are no longer adaptive in our present environment. Yet, evolutionary psychology has certainly its blind spots and unnecessary dogmas and therefore I will try to pursue my own analysis in determining what `drives' human culture.

One of the vague ideas that an evolutionary analysis has to handle is the myth that culture is a good that benefits all equally, something which brings harmony where brute nature only has to offer conflict. I will claim that the evolutionary approach implies that culture is used by each one individually for his or her own benefit and is driven by competition. As a result of different processes of competition and selection within groups, cultures are a battleground in which different characters and sex-age classes pursue different strategies. I will even consider the hypothesis that the different human characters reflect an underlying polymorphism. `Human nature' therefore should not be understood as a monolithic, homogeneous entity, but something which is evolving constantly. Beneath the variety of cultures there is a variety of continually evolving human strategies trying to cope with a variety of ever changing environments. As a result of an ever accelerating cultural and technological evolution the conflicts inherent in a particular ape society are transformed, but never transcended.

5.2 SIX ALTERNATIVE MODELS OF THE GENES-MIND-CULTURE RELATIONSHIP

Let me first give a very short impression of the six models of culture that I will discuss. It is challenging to depict them in the form of a kind of diagram as in figure 5-1, because in this way we are better able to discuss and compare them. Our first two models stem from the traditional social sciences. They have a lot in common, but depart from each other in one important respect.

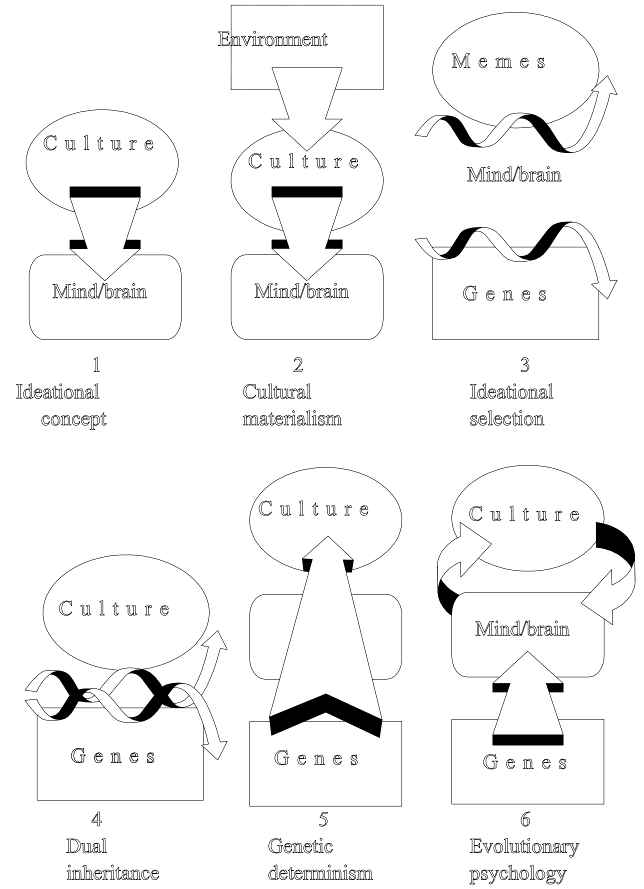


Fig. 5-1. Six alternative models of the genes-mind-culture connection.

First, let us take the ideas of Clifford Geertz (1973) as exemplary for the `ideational' concept of culture (Durham, 1991). Because this influential anthropologist does not mention genes and does not agree with any `levels-approach', and because he believes that the human mind is very malleable, his position can be schematized simply by drawing an arrow between the level of culture and the level of mind (fig. 5-1: 1). According to Geertz, cultural ideas are `programs' which turn a multi-purpose neural tissue into a specific encultured being, be it a Bushman or an Inuit: we could call this top-down determinism, cultural determinism or culturalism. As I will show below, this position is unsatisfactory, because it does not answer the question where ideas come from. If particular cultures were solely shaped by ideas, a Bushman could be clothed in the hides of bears and an Inuit could go almost naked, as Bushmen do. Clearly, at least to some degree, culture is determined by environmental conditions.

It is here that the other model from traditional social science comes into play. It stresses that cultures do not arise apart from their ecological context or are even a product of this context. A good example is formed by the writings of the anthropologist Marvin Harris. Marvin Harris is well-known for his brilliant explanations of all kinds of cultural phenomena - from India's sacred cows to the cruel rituals of the Inca's (Harris, 1974; 1977). In his *Cultural Materialism* (1980) he explains why these explanations are always so elegant: it is a challenge "to explain much by little". According to Harris one should be very parsimonious about postulating human bio-psychological drives and predispositions. Apart from our need to eat and to love, we are sponges that can absorb almost any kind of culture. "As a species we have been selected for our ability to acquire elaborate repertories of socially learned responses, rather than for species-specific drives and instincts" (1980: 62). As a consequence it is possible to relate all kinds of complex cultural phenomena to a very small collection of human needs. The complexity of a culture is not the product of human nature, but of the complexity of the environment (fig. 5-1: 2). We could call this position environmental determinism.

Next, we turn to the evolutionary models. Especially model 3 has been very influential recently and we have encountered it already as a version of evolutionary epistemology. It is the idea that culture is inherited in a way that resembles genetic inheritance. Culture is seen as a network of `memes' (Dawkins, 1976), `culture-genes'

(Lumsden & Wilson, 1983) or whatever, which have differential reproductive success just like ordinary genes. As a result, two processes of evolution are postulated, one of which results from the variation, selection and reproduction of genes, and the other from the variation, selection and reproduction of memes. This model, sometimes called `memology' is very appealing, because it allows us to talk about the rise and fall of ideas, cultural habits etc. in a new, epidemiological way. Ideational phenomena, the objects of cultural transmission, ideas, habits, etc., often behave as if they are `mind-viruses' which infect a particular population and spread in it as a stain of oil. It could also be called `ideational selection theory', because it stresses the unique character of ideational phenomena, while applying the idea of evolution by variation and selection to them.

Memology or ideational selection theory has also disadvantages, however. It is a return to a rather simplistic nature-nurture dualism, which could explain its appeal, but does not prove its worth. It is unclear about the role of human nature in favoring particular memes above others and has limited explanatory power in this respect. Finally, it does not explain why inclusive fitness maximizing organisms would allow mind-viruses to parasitize their neural tissues without doing anything in return.

Theory	Human nature and its ability to learn	What determines cultural contents?	Function of culture
1. Geertz & `culturalism'	No human nature or blank slate; mind is ready to receive any `program'	Unclear; culture programs the mind, but what determines culture itself is unclear	Provide meaning (Geertz)
2. Cultural materialism (Harris)	A few biopsychological predispositions plus an ability to acquire elaborate repertories of socially learned reponses	The environment and a small connection of human needs (eating, convenience, sex, love and affection)	Find a balance between production and reproduction (Harris, 1980)
3. Ideational selection	Unclear: blank slate or evolved	Differential reproductive success of memes/mind viruses	Unclear
4. Dual inheritance	Simple learning biases: imitation, conformity	Learning biases and transmission processes determine culture content	Unclear
5. Genetic determinism	Unclear	Genes via human nature	} Individual inclusive fitness maximization }
6. Evolutionary psychology	Multiple learning aptitudes; an ability to adopt culture content with adaptive value	Individuals adopt those elements from a culture that they can use in a particular environment	

Table 5-1 Six theories of culture. Expanded and changed after Flinn (1997).

Model 4, Durham's `dual inheritance model (Durham, 1979, 1991) is more hybrid and less dualistic and can be seen as an admission that the evolution of genes and memes is not independent. This model recognizes the role of simple learning biases in channelling cultural evolution. A set of `primary values' (compare Pugh, 1978) enables humans to select those `secondary' cultural values that prevent them from creating completely non-adaptive cultures. Imitation and conformity ensure a, to some extent, independent evolution of culture. Yet, it is assumed that evolution has not been able to refine the human learning mechanisms enough to enable humans to select those cultural forms which are adaptive in a given situation. As a result, many cultural traits may be transmitted without being judged on their adaptive value for the individual that is copying them. Of course, it remains to be seen whether a relatively small collection of learning biases is able to explain all cultural diversity and to what extent the dual inheritance model is able to explain why humans have cultures, how they use them and to what extent human nature limits the universe of possible cultural expressions. Only if sociobiologists and evolutionary psychologists would fail finding specialized learning modules and would fail to give adaptive explanations for phenomena like suicide, celibacy, and homosexuality, dual inheritance as defended by Durham would be supported. Otherwise, in figure 5-1(4) at least the mind/brain would have to be reintroduced between genes and culture.

Although they have different views about the influence of the environment on a culture, it is clear that many social scientists like Geertz and Harris agree on one important point: human nature can be almost completely disregarded. It is a very general learning device with two or three extra biological drives, but apart from these it is very malleable. It is clear that both model 3 and 4, although they pretend to be `evolutionary models', share an important assumption with models 1 and 2: human nature is thought to consist of a relatively simple collection of bio-psychological mechanisms plus a relatively general learning device.

It has been especially Marvin Harris who has made much fuss about another model of culture which does not share this presupposition: sociobiology. In his view, which has been very influential indeed, sociobiology is almost identical with a genetic determinism which neglects complex organism-environment interactions (fig. 5-1: 5). This would imply that sociobiology is simply a `reverse model' of the top-down cultural determinism of Geertz and co. This position is purely a straw-man, a position attributed to many, but entertained by nobody, at least to the best of my knowledge. It assumes that the intermediate level of psychological mechanisms is a perfect instrument for inclusive fitness maximization. It is a black box which somehow translates genetic interests directly into actions and can therefore be omitted with impunity from the analysis. It is not sure whether this is biologically possible, because it probably would require an enormous brain and almost infinite computational resources. Of course, to what extent the human mind is actually an optimal inclusive fitness maximization instrument can only be decided empirically. Whether Harris likes it or not (or is interested in it or not), different `sociobiologists' and evolutionary inclined theoreticians work with a variety of provisional hypotheses with respect to this question (Lumsden & Wilson, 1983; Barkow, 1989; Durham, 1979; 1991; Richerson & Boyd, 1992; Flinn, 1997; Janicki & Krebs, 1998).

A model which is much closer to the intentions of the original sociobiologists is model 6, a simplified version of evolutionary psychology (fig. 5-1: 6). In this model the intermediate level of proximate psychological mechanisms has been given more autonomy. According to the evolutionary psychologists, this level, the level of our innate drives and motives, is imperfect in representing genetic interests, because it is simply the result of blind trial-and-error-engineering, because it reflects all kinds of design-compromises and because it is adapted to a mixture of past environments. This model is a simplification of evolutionary psychology, because probably most evolutionary psychologists would also draw an arrow downwards from culture to genes, not to imply a kind of Lamarckian heritability of acquired characteristics, but to imply what Lumsden and Wilson (1983) called `gene-culture coevolution'.

Table 5-1 summarizes the successive models, adapting and expanding on a figure from Flinn (1997). The second column in this figure is probably the most important: all these different views of culture boil down to different presuppositions with respect to human nature. Does human nature exist or is it entirely a product of culture? If it exists, to what extent is it flexible? Does human nature consist, simply, of a series of simple learning biases and can it adopt almost any culture content? Or is it characterized by a series of highly specialized modules which together constrain the universe of possible human cultures? To some extent, these questions can be answered empirically, that is, by referring to the success and failure of various models to predict data obtained in all kinds of tests and experiments. Of course, this is important, because only hard data are able to force us into choosing between alternative models. Let me try to review the merits of the successive models, then, on the basis of their compatibility with the empirical evidence.

5.3 GEERTZ AND THE `IDEATIONAL' CONCEPT OF CULTURE (MODEL 1)

First, I investigate the view that there does not exist something like human nature: humans are unique in that they can be made into almost anything as a result of education. This view was eloquently defended by the anthropologist Clifford Geert in one of the best-known discussions of culture in anthropology `The Impact of the Concept of Culture on the Concept of Man' (1973). Geertz starts by noting that during the Enlightment many thinkers believed in a kind of universal human nature, underlying cultural differences as large as those between eighteenth century France and classical Greece. In his opinion this notion of an `underlying' universal human nature is an illusion, because men unmodified by the customs of particular places do not exist, have never existed and could not in the very nature of the case exist. Very consistently, he attacks what he calls the `stratigraphic' conception of the relations between biological, psychological, social, and cultural factors in human life, the `levels approach'. He calls it a `halfway house between the eighteenth and twentieth centuries' and claims that the parallelism between biological requirements and cultural practices is `a mere correlation, and that intuitive, of separate findings' (1973: 42). He is only one step away from the relativistic idea that everything we can ever claim about our biological nature is just another cultural construct.

Fortunately, Geertz does not become a relativist, however. What he defends is a `control mechanism' view of human nature, according to which:

> ... culture is best seen not as complexes of concrete behavior patterns - customs, usages, traditions, habit clusters - as has, by and large, been the case up to now, but as a set of control mechanisms - plans, recipes, rules, instructions (what computer engineers call `programs') - for the governing of behavior... man is precisely the animal most desperately dependent upon such extragenetic, outside-the-skin control mechanisms, such cultural programs, for ordering its behavior (44).

He even claims that the behavior of man, undirected by such cultural programs would be `virtually ungovernable, a mere chaos of pointless acts and exploding emotions, his experience virtually shapeless'.

In this context he launches a well-justified attack on thinkers who assume that culture is just an external add-on to an otherwise wild animal. Geertz explicitly argues on the basis of what was then (in 1973) known about human evolution that there is not such a thing as a mental Rubicon that was crossed at some date, after which cultural evolution took over biological evolution. In that respect he is, paradoxically, a forerunner of Lumsden and Wilson's idea of gene-culture coevolution (Lumsden & Wilson, 1981; 1983).

It is a pity, however, that he dogmatically thinks that this process of biocultural evolution is a process in which humans have become ever more plastic. It is here that his program-metaphor probably works misleading. If one compares specific cultures with computer software on traditional serial computers, one has to assume that the hardware is a very general unspecialized multi-purpose machine. Culture is then compared to software which can change such a general unspecialized multi-purpose machine in a very specific machine, be it a calculator, an editor, a drawing-tool, a data-base. According to Geertz, only a very general collection of talents, like the capacity to speak, is innate; all else is the product of specific cultures, about which one can make no general statements.

It is this, alas, what he means with the statement: "without men, no culture, certainly; but equally, and more significantly, without culture, no men" (1973: 49). He simply could have referred to gene-culture coevolution with this claim, but he clearly intends to make a much more radical statement, which, however, presupposes a *tabula rasa* view of human nature. To show what he has in mind, let us compare his sentence with the following: "without Finches, no songs, certainly; but equally, and more significantly, without songs, no Finches". It has been known since a long time that the song of the Chaffinch knows local dialects. Recently, it has been found out that these dialects are transmitted culturally and are an ideal tool of studying cultural evolution (Slater, 1994). It is clear that this sentence about Finches is as true as Geertz' claim about humans, even though Geertz thinks he has pointed to something uniquely human. Apparently, the much more radical intention of his claim is hidden in an apparent self-evident truth (compare "without birds no nests (feathers), certainly; but, equally, without nests (feathers), no birds"), as a result of which it is difficult to contradict him or to catch him erring. What he has in mind, however, would be comparable to the statement that Finches *as a result of their song* could turn into Penguins, Ostriches or even back into Dinosaurs.

The fact is that humans are not the only organisms which are completely dependent on some kind of extrasomatic medium which can be adjusted to local circumstances or which is subject to the whims of local traditions. Of course, there is no creature on earth of which the behavior is affected by culture in so many domains and which has to learn so much before being able to reproduce itself. There is no other creature with such a complex society in which everyone has to be able to play so many different roles. There is probably no creature that has to adapt its life-program so often within one life-time as a result of changing ecological, social and economic situations.

That does not mean, however, that humans are free to create their *drives* and *desires* and that human culture transcends their teleonomic needs. It does not mean that man is a *tabula rasa* and that he can reincarnate at will as the creature he wishes to be (compare the ideas of Plato and Pico della Mirandola). It simply means that man is a blank form, a questionnaire, in which many questions have to be answered and which allows for a lot of options at each particular question and which has to be filled in many times during one life. The questions, themselves, however, could well be universal and could well refer to a series of fundamental needs, which might be shared with many non-human animals (one only has to think of the need for warmth, shelter, safety, company, dominance and sex).

Geertz' view of culture as a kind of `program' which can be `run' on an infinitely malleable neural tissue, which cannot even be called `human nature', presupposes a kind of top-down determinism in which ideas have an enormous `causal power'. Ideas somehow have the capacity to form even the essence of what we are. Apparently, the only reason that one culture differs from another is that it is determined by a different set of ideas. One wonders where all these different kinds of ideas come from and to what extent they can be mixed and recombined. Would it be possible to create a culture in which food, sex, safety and status are completely irrelevant and in which other factors determine our behavior? Would it be possible to create a culture in which, for example, ten sexes are acknowledged and in which children are deemed wiser than elderly people?

In all, Geertz' `ideational' concept of culture is a half-truth at best. No one can disagree if the `ideational' concept of culture (Keesing, 1974; Durham, 1991) simply states that culture is a body of ideas, values, beliefs (all `ideational' phenomena) that are transmitted socially by means of symbols, and that gives rise to traditions and particular histories of particular cultures. Almost everyone will admit that human behavior is uniquely dependent on ideas and that those ideas are shaped by a unique process of `ideational evolution' in which ideas and symbols are formed, selected, transformed, combined and accumulated.

We are losing contact with reality, however, if this idea is presented as implying that individuals do not have needs that force them to acquire and develop specific skills and specific forms of knowledge and culture rather than others. The problems begin when we focus exclusively on the content of particular beliefs or on the differences in cultural styles between periods or peoples and when we forget to ask why individuals adopt particular beliefs or cultural styles rather than others. The ideational concept of culture may seduce us to concentrate exclusively on ideas as if people do not have good reasons to entertain particular ideas.

Of course, the ideational concept of culture is not defended by Geertz only. It has been defended in many versions and often it is based on (or closely related to) a series of presupposition and misunderstandings:

a. Usually *the gap between man and the other animals* is exaggerated, because only man is supposed to be able to use symbols. (However, even bonobos, dolphins and sea-lions understand some grammar, as was claimed in chapter 1.) Even if there were a very deep gap between man and the other animals, this would not necessarily mean that man's linguistic skills do raise him beyond the realm of biological necessities and urges.

b. Often *the nature of learning* is misunderstood. The ability to learn is not identical to the ability to acquire almost any information or skill. Often an ability to learn *specific* skills has evolved to enable an animal to improve its skills and to adapt it to particular circumstances. From an evolutionary point of view it is very implausible that an organism would evolve that would be able to learn *almost anything* as if the acquisition of particular skills would not matter more to survival and reproduction than the acquisition of other skills.

c. Often *cultural differences* are too easily taken as evidence for an infinitely malleable human psyche. The fact that humans who are `unmodified' by particular cultures do not exist does not imply that there are no cross-cultural constants in human nature. In fact, there do not even exist dandelions which are `unmodified' by the particular meadows in which they grow.

d. Often *evolution* is misunderstood as something which has happened `in the past' rather than as the process resulting from the differential reproductive success of particular genotypes. In fact, it is impossible to `stop' or `transcend' evolution, including human evolution, except by applying nuclear arms. If a characteristic of a species remains constant during millennia this is not as a result of the lack of differential reproductive success, but as a result of *stabilizing selection*. Stabilizing selection weeds out deviant forms, which arise as a result of mutations and recombination all the time, and cause a characteristic to remain constant over time (see fig. 5-3). If a species has characteristics which apparently enable it to

> `transcend' a series of narrow biological goals, these characteristics have to be maintained by selection in order not to fade away within a few generations, like the wings of the flea's ancestors or the hind-legs of those of whales. If a species has characteristics which are of no adaptive worth whatsoever they have either to be linked to adaptive characteristics or they will gradually vanish like the eyes of many cave-inhabiting fish and insects. Therefore, the talents that enable humans to participate in cultures and to create networks of meaning can not be completely adaptively `neutral': the `ideational' aspect of culture should at least have some biological basis.

In short, the ideational concept of culture is wrong to the extent that it assumes

a. that there is not such a thing as `human nature' as something which characterizes humans as a species among other species;
b. that the ability to learn and to adopt specific cultures implies an almost unlimited flexibility of the human mind;
c. that universal psychological characteristics would imply a constant, unaltered expression of those characteristics across a variety of ecological, economical and social conditions;
d. that biological evolution, including human evolution, can ever be `completed' or `finished', except by complete or final extinction.

A complete theory of culture, therefore, should not concentrate on ideas and other deposits of cultural behavior per se, but should try to map the way in which such phenomena are used and produced by a plurality of individuals in a given environment. Instead of exclusively studying culture in the library or at the museum, a theory of culture should also focus on the psychologies and circumstances that gave rise to particular trends, styles and works of art. A complete theory of culture should not only interpret `meanings', but try to link them to the underlying `musts' as well. These `musts' are certainly not inflexible, constant `givens' that express themselves identically across a variety of cultures. To the contrary, from an evolutionary perspective it is to be expected that they can be molded to some extent to fit the conditions posed by the environment.

5.4 HARRIS AND HIS CULTURAL MATERIALISM (MODEL 2)

Fortunately, most theorists within the social sciences do not place a culture completely apart from the human needs from which and the ecological context in which it arises. Often it is attempted to explain cultural phenomena in terms of environmental variables. A good example of an anthropologists who apparently succeeds in explaining a whole spectrum of cultural phenomena almost exclusively on the basis of environmental variables is Marvin Harris (e.g. 1974; 1977).

In his *Cultural Materialism* he gives an interesting theoretical foundation for this undertaking. It appears that he is partly inspired by the simplicity of models in the natural sciences. Powerful explanations should be simple: "our object is to explain much by little" (1980: 63). "The more parsimonious we are about granting the existence of bio-psychological constants, the more powerful and elegant will be the network of theories emanating from sociocultural strategies". Yet, he admits that "without postulating the existence of selective principles operating at the bio-psychological level, one cannot explain how infrastructure mediates between culture and nature." Thus he ends up with a minimum list of human bio-psychological drives without which even an `environmental' explanation would not work:

1. People need to eat and need proteins and other nutrients.
2. People like convenience and prefer to expend as little energy as possible on a given

task.

3. People `are highly sexed' and like sexual intercourse - more often heterosexual intercourse.
4. "People need love and affection in order to feel secure and happy".

This list is interesting for several reasons. Firstly, whereas it is meant to point to a very small collection of fundamental human drives, it hints at a human nature that is much more complex. People need to eat, but they do not only need proteins. People like sex, but preferably heterosexual sex. People need love, but they apparently need to feel secure and happy as well.

Secondly, as Harris admits, for each item on this lists one can immediately think of antithetical behaviors and thoughts. "For the first, there is obesity, voluntary starvation, vegetarianism, and self-inflicted dietary pathology. For the second, there is the intensive expenditure of energy in sports and artistic performance. For the third, there is abstinence, homosexuality, masturbation. And for the fourth, there is infanticide, domestic strife, and exploitation." According to Harris, this does not prove that his list is wrong, but only that people are inefficient in attaining their goals. He suggest that scarcity could explain why people sometimes deviate from their four original bio-psychological drives. Yet, scarcity is a perfectly natural phenomenon that is almost universal and it would be strange if people would start behaving completely differently under such a normal condition. Above that, scarcity does not explain sports and arts and Harris does not offer a satisfactory explanation for either one of these.

It seems to me, then, that a careful reading of Harris list indicates that human nature must be much more complex than he thinks. It is as if he is describing a floating ice-berg and denies that a big part of it lies invisible underneath the water. Why would Harris deny so obstinately that human nature contains more than those four bio-psychological principles?

Apparently, he is afraid that his explanations will loose much of their elegance if he needs to delve into the real complexities of human nature. Above that, he is afraid that cultural anthropology will loose much of its independence *vis-à-vis* biological anthropology and other biological disciplines.

> "You may wish to postulate that human beings also naturally seek to create music and art, to dichotomize, to rationalize, to believe in God, to be aggressive, to laugh, to play, to be bored, to be free, and so forth. By succumbing to the temptation to open this list to all nominations, you will rapidly succeed in reducing every recurrent cultural trait to the status of a biological given."

Yet, it is here that he reveals his lack of understanding with respect to biological approaches to human culture and psychology. Why would the attempt "to render a complete account of what it is to be human" (Harris' wording) end up in a denial of culture, cultural variety and complex interactions between human nature and culture? Why would it be necessary to claim that humans are on a bio-psychological level as simple as amoebas or flatworms to do justice to the relative causal autonomy of their culture? Why would a more complete rendering of `biological givens' do injustice to the many ways in which these givens result in all kinds of cultural traditions and institutions? Does one do justice to the richness of the phenomenon of human culture by denying the complexity of the underlying level?

It is clear that Harris is fighting with a self-created chimera. His enormous knowledge with respect to human cultures around the globe contrasts sharply with his very meager understanding of the complexity of animal life and the complexities of human biology and psychology. Even most birds and mammals have more than the four bio-psychological predispositions that he lists. While it may be a good thing to abstain from redundant explanatory principles in physics and cosmology, there is no reason to suspect that the behavior of a primate with a history of many millions years of evolution deposited in a genome of 46 chromosomes will be explainable from four bio-psychological principles. The explanation of complex phenomena in terms of a whole series of causal factors is not the same as the introduction of redundant explanatory *deii ex machinae.* It is simply not possible to explain the workings of a camera simply be referring to its lens or to its shutter although both are indispensable. In the same way, culture may be a complex whole created by a network of causal factors. Its explanation would then require the unravelling of all these causal factors.

If one tries to artificially reduce the number of causal factors involved in order to create `powerful and elegant' theories, one will sooner or later be confronted with the limitations of such theories. In many cases one will discover that the choices that one has made to get a `minimal set of human bio-psychological selective principles' were arbitrary. Critics will come up with alternative explanations on the basis of an alternative selection of principles. In the case of Marvin Harris this has happened, for example, when the anthropologist Napoleon Chagnon questioned the cultural materialist explanation of Yanomamö warfare, asking "why fight over bananas if you can fight over women?" (Gibbons, 1993).

The history of human sciences is filled with examples of bio-psychological minimalism leading to powerful and elegant theories. It is a pity that most of these theories are one-sided and are finally criticized on the basis of different, equally arbitrary, views of human nature. In the case of Freud, for example, this happened when Jung postulated a more complex human nature stacked with all kinds of exotic archetypes. The only way to `get it right' is to avoid both the Scilla of minimalism and the Charybdis of an obscurantistic holism. Both a comparison with our closest living relatives and a working knowledge of human psychology can be helpful here.

Perhaps it is good to refer to G.E. Pugh again in this context. In chapter 3 I have already explained why he thinks that `value-driven decision theory' predicts a much more elaborate view of human nature than the traditional social sciences are willing to admit. In his book *The biological origin of human values* (1978: 284) he comes with a list of fundamental human (social) motives that is based on his own `value-driven decision theory', and on his primatological and psychological knowledge. According to Pugh the variety of human instinctive motives is hidden somewhat, because many of these motives are linked to the same value sensations or emotions. That does not mean, however, that there is no natural differentiation in human motives.

> "For example, being liked will make us happy, participation in play or conversation will make us happy, working in a team can make us happy... Almost all of the `social motives' seem to be concentrated in just *two* of the nine emotional dimensions, specifically the emotions of *joy versus sorrow* and *pride versus shame*".

According to Pugh this does not prove anything about the number of natural motives. Pugh comes to an `illustrative list' of 11 basis motives, which all relate to separate innate human goals.

1. Desire for dominance
2. Desire for approval
3. Desire for social acceptance

4. Gregariousness
5. Enjoyment of conversation
   a. Talking
   b. Listening
6. Activity motive (desire to exercise one's body and exploit one's physical skills)
7. Enjoyment of humor in conversation and play
8. Social preferences
9. Team motive (desire to work with others for common goals)
10. Constructive motive (desire to make or build something)
11. Contribution motive (desire to contribute or do something meaningful for society)

Although Pugh admits that this list is speculative he is able to defend all motives included and in many cases his defence sounds convincing. His list can in principle be corrected continually on the basis of knowledge emanating from ethology, neurology, psychofarmacology and psychiatry. Hopefully, the human genome project and other projects will throw also some light on the links between genes and the human mind.

Without knowing whether Pugh is right in his postulate of 11 distinct innate motives (he also refers to McDougalls instinct theory), I think that his `value-driven decision theory' should be taken seriously. Decision systems having to cope with complicated environments such as the human primate are unlikely to be based only on four fundamental motives. At this point it is only important to note that it can in principle be dangerous to be *too* parsimonious if one not only tries to create powerful and elegant, but also realistic theories. We can conclude that model 2 has to be rejected as too simple, too.

5.5 WE ARE ALL DARWINIANS: MEMOLOGY (MODEL 3)

Traditional human sciences are not the only ones that have often yielded to the temptation of constructing `powerful and elegant' theories. The same reproach can also be made with respect to most evolutionary models of human culture. The human mind seems only able to understand something by simplifying.

One of the ironies of the reception of the sociobiological approach has been that many commentators thought that Richard Dawkins with his *Selfish Gene* (1976) was a representative of an extreme genetic determinism. In fact, in the last chapter of this book Dawkins revived an approach that to some extent turns Darwinism upside down and gives the level of culture and ideas, dubbed `memes' (unit of imitation, from Greek `mimeme', English `memory' and French `même'), an autonomy which reminds one of the ideational concept of culture. "I am an enthusiastic Darwinian, but I think Darwinism is too big a theory to be confined to the narrow context of the gene", Dawkins wrote. According to Dawkins `memes' evolve just like genes by variation, selection and differential transmission and their replication is called imitation. They started their evolution as replicators in a primeval soup, like genes, but this "new soup is the soup of human culture". The new replicator, the meme "is still in its infancy, still drifting clumsily about in its primeval soup, but already is it achieving evolutionary change at a rate which leaves the old gene panting far behind".

Meme theory, memology or ideational selection theory has been criticized by the philosopher Mary Midgley because culture is holistic and `thought is not granular' (Midgley, 2000). Meme theory suggests that there exists `atoms of culture' and that a unified theory of culture would be possible. Yet, the opposition between holism and reductionism is often artificial, because wholes emerge from parts and some researchers just love parts while for others the whole is holy. In principle there could be `atoms of culture', although I tend to agree with Ortega y Gasset (1955) and to find them in `customs'. In contrast to Midgley and her co-authors (Rose & Rose, 2000) I do not think memology is too darwinistic, but that it is not darwinistic enough. Indeed, memology is only darwinistic to the extent that it recognizes the power of variation and selection. It is *not* `taking Darwin seriously', to the extent that it neglects the conative beings that have their private interests in selecting, manipulating, adapting and transmitting particular memes or culture-genes rather than others.

In the wake of Dawkins many thinkers have thought of themselves as radical evolutionists or darwinists, because they applied natural selection to the level of ideas. A lot of philosophers, including Donald Campbell, Thomas Kuhn and Daniel Dennett (1995) are enthusiastic memologists. As has been shown by Chris Buskes (1998) it clarifies a lot in the philosophy of science, because it enables one to transcend the traditional rationalistic or empiristic models of science. The idea is that scientific theories are never completely falsified, but are simply replaced by more successful theories. Successful theories are not necessarily the product of better methods or minds, but are simply those informed guesses that survive in contrast to the competing guesses: they leave more `offspring' in the form of young, enthusiastic (literally) scientists prepared to spread them even further.

Ideational selection theory itself, however, is unable to explain why humans under certain conditions would prefer theories with qualities like verifiability, explanatory power and coherence above theories that are simply pleasing or stimulating. To answer such questions, ideational or hypothesis selection theory necessarily needs to be complemented by an evolutionary epistemology in the Lorenz-Vollmer tradition. Even that tradition would not be enough, however, to explain why most people are hardly interested in science. Ideational selectionist simply observe that "variation and selection happens", but do not explain the differential survival values of different memes in different environments (societies or segments of societies). Why would science remain an endeavor of an elite, while religious ideas are spread throughout society? Why would particular scientists favor a radical scientific innovation, whereas other scientists are inclined to resist it? To answer such questions ideational selection theory would have to be complemented by a sociological and psychological approach to theory-acceptance, which is informed by sociobiology and evolutionary psychology.

This incompleteness of ideational selection theory becomes a handicap at the moment that it tries to explain the evolution of culture in other areas. Let us look at clothing. Why would certain echelons of a society try to distinguish themselves using white collars, silken ties, perfectly ironed suits, expensive watches and suitcases? Ideational selection theory may suggest that the `idea' of a white collar survives because it is apparently replicated by many diligent and devote believers. The idea uses the believer to replicate itself. The believer wears his white collar with a beautiful silken tie, young people watch him in the streets and are impressed and will, after many years of strain and struggle, finally have money enough to buy the same kind of shirt and tie.

Those same believers and converts would transmit a completely different idea and buy a completely different suit, however, if that was in their interest. With other words: not only do ideas use believers, believers are driven by much more and ultimately they are used by genes as well. Motives and genes are far more robust entities than ideas, which are volatile and replaceable. Therefore, motives and genes are more appropriate and more encompassing explanatory principles. Whatever ideas people have, it is the genes that have the last word, a word that may have been transmitted already long before the advent of human culture.

Of course, people are prepared to die for ideas, apparently even for the idea of a white collar, but *the reason why they are prepared to do so* is that some ideas are in their (genes') interest. Studying ideas without studying the ways in which people use them for their own (extended) benefit is like studying birds solely on the basis of stuffed specimens. Only by studying the behavior of the whole bird, can we interpret the function of some of its feathers and only by studying businessman in action can we understand why they need expensive `classic' clothing to distinguish themselves instead of wearing, for example, simply extravagant clothing, which would be much cheaper. To me it seems that the correspondence between the bird's need for ornamental feathers and the same need for ornamental clothing in humans is much more important than the differences between *natural* feathers and *cultural* clothing. It might not be an accident, for example, that *white* collars are used: as the color which is the hardest to keep clean it constitutes a `handicap' which efficiently signals the luxury of letting other people do the dirty work (more on Zahavi's handicap theory below in section 5.12). (The general idea that the gap between biology and the social sciences is not as deep as that between biology and other natural sciences is defended by Anne Ruth Mackor, 1997). Of course, however, as humans we like to stress our uniqueness and therefore the enormous variability of human ornamentation, which is made possible by culture, which distinguishes tied businessmen from ordinary peacocks. We also cherish our apparent ability to `transcend' `low' biological motives, forgetting that many other biological creatures exhibit extremely altruistic behaviors and that we are at our best in demonstrating our beautiful ideals and motives exactly at the age that we are also showing off with other beautiful feathers.

The fact that memology and ideational selection theory are neglecting the level beneath culture was pointed out by several sociobiologists, but the most impressive argument I heard came from Lee Cronk while he was speaking for the AAAS*93 in Boston (the 1993 meeting of the American Association for the Advancement of Science; Cronk, 1993; see also Cronk, 1999). Cronk argued that people often use ideas to manipulate each other, and people manipulate others in the service of their own genes. The history of ideas is the product of a kind of biological warfare, in which people try to infect each other with their mind-viruses. For example, religious and ethical leaders may try to seduce people to invest in projects that are seemingly in the interests of all, but which are in the first place in their own selfish interests. The notion of a `disinterested' morality, of a `free will' that enables everyone to choose `differently', etc., etc., all are often used to manipulate people into doing things which they perhaps would not do if they would know more about the persons using those very notions or ideas. People are continually changing and `genetically manipulating' those mind-viruses in order to adapt them to the current conditions. To understand processes of cultural change one should first try to understand the way in which ideas function within a particular ecological, economical and social context; the differential reproduction success of different ideas is of secondary importance.

It seems to me that the popularity of memology can be explained as a result of the assumptions it shares with culture determinism. For those who in their hearts remain culture determinists, but who want to be Darwinians too, ideational selection theory offers the possibility to get the best of both worlds: a platonic world of ideas ànd Darwin's mechanism of natural selection. Yet, the presuppositions that it shares with culture determinism are its Achilles' heel, too. Ideational selection theory seems to presuppose the idea of humans as blank slates which can be used by ideas at will. It often exaggerates the gap between man and animals, misunderstands the nature of learning and concentrates on cultural differences without considering the underlying similarities. It does not have any predictive power. All in all, it seems to me often a kind of culture determinism with a darwinistic flavor.

It has to be admitted that some of the best Dutch philosophers of science seem to be memologists (Buskes, 1998; Callebout, 1993). To them I can only recommend my list of values on the basis of which theories are selected (ch. 2.5). Only if this list is combined with an adequate knowledge of the human beings, can we predict anything about the theories that people will adopt in the future (e.g. about the likelihood of a worldwide darwinistic or islamic revolution).

5.6 THE BEST OF BOTH WORLDS: DUAL INHERITANCE (MODEL 5)

An attempt to do justice to the complex interrelationships between genes and culture can be found in Durham's `dual inheritance model' of gene-culture coevolution (Durham, 1979; 1991). Durham offers some of the most complex and perhaps profound discussions about the evolution of culture and his model is certainly an improvement on simple ideational selection models. He criticizes those models for postulating "the gradual and cumulative organic evolution of an organ (the brain) that meanwhile often functions antagonistically to natural selection" (1979: 58). At the same time, he criticizes `sociobiological' explanations which he identifies, alas, too much with genetic ones (evolutionary psychology is apparently still unknown to him). His own proposal can be seen as an attempt to `save' an independent realm of ideational phenomena, while admitting that humans must have evolved means to ensure that their cultural systems do not completely drift apart from their biological interests. In this context, he relies on Pugh's (1978) distinction between primary or evolved values and secondary, cultural values. Despite the fact that they have originated to ensure a `fit' between primary values (biological interests) and culture, secondary values have started a life on their own and as a result, culture is to some extent an independent, autonomous level. Durham attaches much value to the idea that much cultural evolution is completely neutral or even in opposition to the `biological level'.

While Durham's model has an appearance of sophistication and shade, it still seems to share a lot of presuppositions with pure culturalism and pure culture selection theory. Durham often seems to neglect the forces that drive cultural evolution in the first place, for example the complex patterns of cooperation and competition between the creators and selectors of culture. As a result, he seems unable to look beyond the superficial impression that many expressions of culture are non-adaptive. The fact that culture on the whole is adaptive does not mean that each cultural act has to be adaptive or that all cultural phenomena benefit each individual of the species. If this were true, the human species would only count winners and no losers. No one would deny, however, that bird song and the peacock's tail have adaptive functions, although many individual birds meet with considerable personal misfortune as a result of their relative inability to sing the right song or as a result of the clumsiness of their tails.

It seems to me, then, that Durham's analyses (and with that model 4) still suffer from a lack of detail on the *sociopsychological* level, the level between genes and memes. It is on this level that the memes are chosen, tested and changed. If we want to understand the evolution of culture in flesh and blood we have to look for the ways in which people use ideas for their own interests and causes. Culture is not a completely independent level above the genetic or psychological level. Even in human societies a lot of competition is going on and many expressions of culture result from this competition and its resulting arms races, either those between individuals or those between groups at different levels. Many expressions of culture can be understood as ways of drawing attention, showing off one's identity or manifesting one's qualities or even one's superiority, both on the level of the individual and of its cultural identity group. To look at these expressions *as if* they have been created for the sake of a platonic realm of ideas is like considering flowers as a means to embellish a divine herbarium or like considering butterflies as emanating from God's entomological interests. In the course of this chapter we will hopefully arrive at a better model.

5.7 PURE GENETIC DETERMINISM: A RHETORICAL DEVICE? (MODEL 5)

Now that we can at least exclude two-third of the above mentioned models, one thing has become clear: Culture has to have at least some biological roots. It *has to*, simply, because clearly a neural and even social substratum is needed: mushrooms are unable to have cultures, because they do not have brains; butterflies do not have cultures, because they lack the necessary contact between individuals of different generations; ear-wigs do have this contact (they care for their young), but probably do not have enough time to learn. There are a lot of species which are currently thought to have at least some culture (chapter 1), but they all need to have at least some intergenerational contact and a minimum cognitive ability. Many species are simply living to short to make the cultural transmission of knowledge a strategy that is worthwhile. They are simply too specialized, too much build for a specific way of life in a specific environment to *need* culture.

Clearly, a phenomenon like human culture presupposes an enormous learning capacity and an enormous flexibility. This does not imply the kind of human nature envisioned by Geertz or Harris, however. A human nature that would be able to profit from its learning capacity and its flexibility would need guidance also, in order not to loose contact with its biological objectives. Humans that would go learning around completely undirected and that would blindly adapt to any circumstances, would probably forget to reproduce and go extinct. If we define culture as a body of information which is transmitted in a nongenetical way, there is no reason to suppose that the transmission of this information does not require elaborate genetic instructions for dealing with this kind of information and for using it in an adaptive way.

On the other hand, if we take this definition of culture seriously, at least one other model of culture can immediately be excluded: pure genetic determinism (model 5). If the contents of particular cultures were themselves directly genetically determined, rapid cultural changes would become a mystery. Not only the long learning period of humans would become somewhat superfluous, but it would become unclear what culture actually *is* and why it ever evolved. If we take genetic determinism as the hypothesis that our psychological mechanisms are perfect instruments for inclusive fitness maximization and that culture is simply the deposit of all the adaptive decisions of all individuals, it becomes unclear why we need such a long learning period and why human life is characterized by so much experimentation. As I already pointed out, this hypothesis is very implausible, because it probably would require more brain power and more computational power than we actually have and we would have needed more time to have evolved them (Lumsden & Wilson, 1984). Let us not forget that the common ancestor of chimps, bonobos and humans has probably lived only about five to ten million years ago. (This was perhaps the biggest discovery in anthropology in the 1980s. Before that, anthropologists could still believe that man was more closely related to *Ramapithecus* than to *Pan.* Now *Ramapitecus* is considered to be an ancestor of the Orang-Utan.)

Clearly, pure genetic determinism would imply a misunderstanding and a denial of the brain as an autonomous organ which allows the organism to interact with its environment. Pure genetic determinism does not even apply to dandelions, because even these grow in an interaction with their environment and in reaction to the available nutrients and the available light. In animals pure or absolute genetic determinism would require an almost infinite reservoir of detailed motor instructions coupled to a typology of all possible situations that an animal could meet. It would require infinite genetic instructions and an enormous brain. As I have claimed with Pugh in chapter 3 and 5.4, an elaborate innate value system is much more likely for the explanation of human behavior than a series of rigid step-by-step motor instructions. Only an elaborate value system is able to enable to make adaptive decisions and to work towards sensible goals in an enormous variety of circumstances. Although such a value system would be innate, it would allow and require at the same time an enormous degree of freedom. The individual is continually weighing the different emotional value outcomes of all its available behavioral options and its decisions are not predetermined, but the result of this complex weighing and planning processes.

Pure genetic determinism would also deny the trade-off between fertility and cognition in nature (see chapter 6.3). Animals can react to unpredictable environments either by having large numbers of offspring or by increasing their cognition-based flexibility. The quantity-based solution requires low investment per offspring and thus cheap constructions based on fixed action patterns. The quality-based solution requires high investment and a long learning period, but results in behavioral flexibility. Genetic determinism refers only to those organisms in which the arch between genes and behavior is relatively short. Humans clearly do not belong to this category. Genetic determinism does not do justice to their behavior, which shows that the gap between genes and behavior is filled with a lot of psychology and cognition.

As we shall see shortly, even behavioral geneticists are no proponents of genetic determinism. Twin studies show that about one-third of the variance in personality traits is not due directly to genes (Bouchard, 1994: 1700). Of course, it is not always clear how one should separate and calculate the percentages of genetic and environmental influences. I will come back on these issues in 5.9 and 5.10.

Given these considerations, it is not a miracle that probably no one has ever been a serious genetic determinist. It is largely a position created by writers such as S.J. Gould and M. Harris as a rhetorical device for ridiculing an evolutionary approach to human affairs. As noted before, the human mind often thinks in terms of opposites. As a result it often needs caricatures to defend its own arbitrary choices. The attempt to rise above such simple dichotomies is the real hall-mark of philosophy.

5.8 BETWEEN GENES AND MEMES: THE AUTONOMY OF THE PSYCHOLOGICAL (MODEL 6)

It is clear now that most of the models discussed are too simplistic. They are not necessarily wrong, but they do not explain enough either. They simply do not answer some questions which keep coming back to the mind of an evolutionist: Why would we create culture? Why is it not enough to chew on a bunch of carrots? Why would we still work even if we have enough food?

It seems to me that the lack of explanatory power of models 1 to 5 can be explained by their neglect of a third level between genes and memes - a level which is placed central in evolutionary psychology (model 6). I take the central idea of evolutionary psychology to be that the level of evolved mechanisms of behavior is to some extent autonomous. Never do genes directly determine behavior - in fact, it is not clear how they should manage to. In every case in which the influence of genes on behavior is studied more extensively, genes influence behavior via the characteristics of particular tissues, via particular hormones or via neurotransmitters. The physiological and psychological level has a life of its own - it constitutes the level at which behavior is created and decisions are made instantly, the `executive board'. As a result, we can often see animal behavior that is maladaptive: it is apparently caused by evolved physiological and psychological mechanisms, which are inadequate in a particular situation. Thus, even in animals without culture there are already two levels, the level of genes and the level at which behavior is directly caused.

If we add the level of culture, the picture becomes even more complicated. It seems that human individuals are neither automata driven by their genes, nor robots programmed by a particular cultures. Certainly the particular culture that surrounds us points us into a certain direction. It is constituted by collective norms and values as a result of which we feel stimulated or slowed down in certain directions (as birds in a flock are moved to some extent by the forces of the collective - but, of course, within this collective there are individuals with more power to push others in certain directions). At the same time we often feel resistance and sometimes we feel obliged to follow a completely different way. Thus, *the extent to which we allow a particular culture to be influential in our personal lives depends to some extent on idiosyncracies within our personalities*, like our amount of obedience, defiance, dominance and originality. Such personality characteristics may originate in our genetic make-up, but they may also depend on factors like our position in our families or in the power-pyramid of our society. In all cases, however, psychological characteristics are decisive factors with respect to the viability of particular cultural elements or memes. The psychological level is the level at which the practicability of a specific culture is finally tested. It is the level at which a specific culture is accepted, rejected or adjusted. It is also the level at which the struggle for power in societies is fought and memes are often just weapons in this struggle.

With respect to the conceptual nature-nurture schizophrenia which has infected many theoretical debates in the human sciences, this means that nature and nurture are not in opposition, but that nurture presupposes a certain nature, a genetic blueprint of the learning possibilities of the mind. Culture can perhaps be defined as the cumulative effect of collective knowledge, evaluations and aesthetical preferences as this often stretches beyond individual generations. To some extent it constitutes an independent level to which individuals can respond by selecting only those influences from it that they can use for their own purposes. At the same time, however, those cultural elements which are not used, and therefore replicated and modified, by at least some segments of the `underlying' societies will go extinct immediately. Cultures are products of humans and not *vice versa*, because humans are selected to use only those elements of cultures which happen to fit their evolved psychologies as they have developed in particular circumstances.

This precedence of humans over culture can be easily proved by a thinking experiment. *If* there happened to be two types of humans, one of which was completely determined by the surrounding culture and the other of which was able to select useful culture elements, certainly the latter individuals would have an advantage. Critical culture selectors and modifiers would mold a culture that perfectly suited their teleonomic needs and would therefore leave more genes to their descendants. It is the genes that have the last word, not the memes. The mind is a product of genes and it chooses those memes that it can use.

In most cultures, what we indeed see is that culture is `superimposed' on a hierarchical group structure, that we seem to have inherited from the apes. Often it is the dominant group that chooses the culture that suits their interests best; the subdominants find themselves in a situation in which their interests are not optimally represented. Of course, the dominant group is involved in arms races with other such groups. As a result even they are not free to choose the culture that they like most. On the whole, one can not say, however, that `culture makes man', but it is more appropriate to say that cultures reflect a series of reactions of human beings to their environments and to each other. Culture is a human `deposit' rather than the other way round, although this collective deposit often feels like a burden and a cage to the individual, especially the subdominant one.

As a result, models which tend to neglect the autonomy of the psychological level are necessarily incomplete. They either exaggerate the influence of culture (model 1 and 3) or the environment (model 2) and neglect the autonomous choices of the individual, or they do not sufficiently map the important area *between* genes and culture (model 4 and 5). At this moment, I prefer the evolutionary psychological model (model 6), because only this model does justice to genes, memes *and* mind. Yet, at the same time I have to admit, first, that picture 5.1 gives a very simplified version of evolutionary psychology, and, secondly, that evolutionary psychology, as I view it, is not represented by one author, but by an army of researchers who share some beliefs, but disagree on others. As a result, as I have indicated before, evolutionary psychology, a term created by William James, has become associated with a series of more specific hypotheses, like the `swiss army knife' and `stone age mind' hypotheses of the human mind (Cosmides & Tooby, 1997; Allman, 1994).

In my view, evolutionary psychology is simply a sophisticated version of sociobiology in which the human mind is taken seriously - as, by the way, E.O. Wilson was already trying to do in his books *On Human Nature* (1978) and *Genes, Mind, and Culture* (Lumsden & Wilson, 1981). Yet, sociobiology has been widely misunderstood as genetic determinism. The only way to come further, then, is to delve deeper into the relationship between genes, mind, and culture. Before we are ready to answer questions like the question why culture evolved and why it does not gradually disappear like the hind-legs of whales or the tails of our ancestors, we first have to look more closely at the influence of genes on behavior. In the next paragraphs we will inspect some current knowledge with respect to nature and nurture.

5.9 NATURE VERSUS NURTURE 1: BEHAVIORAL GENETICS

Let us first have a look at behavioral genetics. As a result of sophisticated new methods and models, behavioral genetics has gradually ripened into an important field, which deserves attention and respect from all scientists and philosophers interested in man. Behavioral geneticists try to disentangle the complex relationship between nature and nurture by studying similarities and differences of individuals that share genes and/or a family environment. Twins and adopted individuals provide the natural experiments that they need most, and behavioral geneticists have indeed succeeded in locating many. Literally thousands of twins have been studied by Loehlin, for example, and the so-called Minnesota Study of Twins Reared Apart (MISTRA; Thomas Bouchard and co-workers) has even succeeded in locating hundreds of monozygotic twins that have been separated at an early stage (Bouchard, 1994; Wright, 1998).

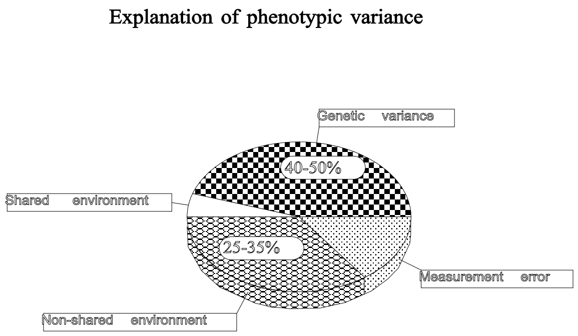


Fig. 5-2. Factors contributing to phenotypic variance according to recent estimates from behavioral genetics (e.g. Lalumière, Quinsey & Craig, 1996).

Behavioral geneticist have gradually learned to interpret their data very critically, fitting them into different models at the same time, and sorting out those that optimally explain the data. They have learned to take into account factors that tend to complicate the interpretation of the natural experiments that they work with: the inheritance of recessive and polygenic traits, the effects of assortive (not random) mating and the tendency of children to select their own environments (Plomin, 1990). Gradually, they have collected an enormous set of data, mainly with respect to the inheritance of mental abilities, personality traits and mental illnesses.

The picture that emerges from all these data is that genes, indeed, play an important role in the development of cognitive abilities, personality traits, and several mental illnesses. Monozygotic twins raised apart proved to be in many respects as similar as monozygotic twins raised together. The most spectacular and disturbing discovery was, however, that the so-called `shared environment', the environment that individuals share which are raised in the same family, accounts for only a small part of their similarities (7% according to the Minnesota study; 5% according to Locurto & Freeman, 1994). Children raised in the same family tend to diverge and are more deeply influenced by environmental factors *outside* than by those *inside* their own families, the so-called non-shared environment (Lalumière *et al.,* 1996). Those factors need not to be purely accidental: to the contrary, the picture that emerges is that of individuals actively looking for particular environments in which they can learn what they *want* to learn (Plomin, 1994). This picture is reinforced by the fact that the genetic component of a trait increases and never decreases with age (Wright, 1998: 88).

Of course, one of the problems for any attempt to determine the heritability of a trait is to come to sound system of the fundamental traits themselves. As many personality psychologists seem to agree on the existence of the `big five' personality traits, behavioral geneticists have measured the hereditary basis of these five relatively often. The Minnesota Study of Twins Reared Apart found that the `big five' personality traits have a heritability of about 41%. That means that at least 41% of the similarities of two individuals can be purely attributed to shared genes. That does not mean that 59% is purely environmental, however. As said, only about 7% is estimated to be a product of the shared environment. The remaining 52% is attributed half to the nonshared environment and half to error of measurement. As a particular nonshared environment will be to some extent the product of someone's genetic inclination to watch out for certain stimuli, it cannot be said to be purely `non-genetic'. In the terms of Dawkins (1982), the environment is partly one's own `extended phenotype'. As a result Bouchard can conclude from the MISTRA that "about two-thirds of the reliable variance in measured personality traits is due to genetic influence" (Bouchard, 1994: 1700).

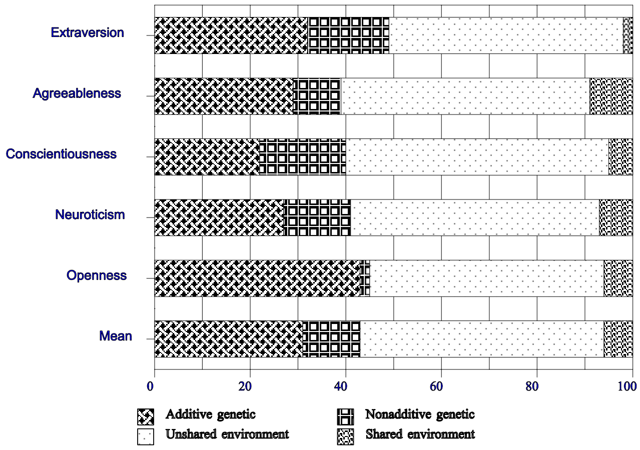


Fig. 5-3. Estimated sources of variation in personality. (Data from Rowe, 1994: 65; see also Bouchard, 1994: 1701.)

Figure 5-3 shows one of the three data sets on which Bouchard's claims are based. The figure shows at the same time that the total genetic influence is currently divided in `additive' and `nonadditive' genetic influences. As Mendel already knew, the effects of separate genes cannot be always simply added up: there are dominant and recessive genes and sometimes the effects of genes are suppressed by other genes. First-degree relatives often share `only' the purely `additive' genetic effects, while identical twins also share the effects which arise from specific combinations of genes (dominance, interlocus interactions)[1]. Thus, by comparing the correlations between close relatives and identical twins one can get an idea to what extent traits are polygenic in origin. Lykken *et al.* (1992) have coined the word `emergenesis' to refer to those traits that are thought to be `emergent properties of configurations of monomorphic genes'. Yet, figure 5-3 also shows that one should not exaggerate the extent to which traits derive from such `nonadditive' genetic effects.

Gradually more forms of cooperation between behavioral genetics and other disciplines, from molecular biology to psychology, are beginning to emerge. Geneticists are currently very busy to reveal the complex causal trajectories between genes and specific traits. In fact, some of the causal trajectories between genes, particular hormones and psychological traits are already known well enough to be manipulated by drugs. Of course, this new knowledge is gradually also having repercussions for divisions in personality psychology. For example, the biological psychiatrists Cloninger has proposed a new taxonomy of seven basic personality of which at least three are now known to be based on the working of specific neurotransmitters. To give an idea of the kind of cooperation that gradually arises, I will discuss some research on two of these traits and on the genetic basis of homosexuality, drawing on information from the book of Hamer and Copeland (1998).

Novelty seeking. The MISTRA showed that identical twins had a correlation of 0.54 for a trait called novelty seeking (closely related to extraversion) by the psychologist

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[1] Suppose alcoholism has a hereditary basis via allele `A'. If the effects of A are purely additive the severeness of the alcoholism simply increases with the frequency of `A'. Nonadditive effects include dominance (A suppresses its parallel a, which is called `recessive) and (for example) the influence of another (hypothetical) recessive allele `b' which suppresses A.

		Beers or glasses of wine/night		
Type of effects		AA	Aa	aa
Additive effects		**6**	4	2
Dominance effects		**6**	6	2
Effects of	+BB	6	4	2
other allele b	+Bb	6	4	2
	+bb	2	2	2

Cloninger, while fraternal twins scored 0.32. On the basis of these figures one estimated the heritability of this trait to be about 59 percent, which was the same for twins raised together. By accident, an Israeli team of geneticists found a gene of which the length was related to the score for novelty seeking in the questionnaires of Cloninger. An American team, led by the geneticist Dean Hamer was able to confirm the relationship. It was estimated that the gene concerned, which makes a receptor for dopamine called D4, accounts for about 10 percent of the trait of novelty seeking. It was already figured out that dopamine has a direct influence on the pleasure centers within the brain and is partly responsible for the way in which we feel. The apparent novelty-seeking gene influences certain parts of the brain such that novel experiences are rewarded by pleasure. It was found, for example, that gay men with the D4 dopamine receptor gene had experimented more with female partners, while half of the straight men with the D4 dopamine receptor gene had at least once experimented with a male partner. Note that a trait like `novelty seeking' may directly influence cultural evolution, as it is possible that it increases the turnover rate of particular memes.

Harm avoidance. Another trait about which a series of interesting discoveries have been made is called harm avoidance and includes anxiety, fear, inhibition, shyness, depression, tiredness and hostility. It proved identical to the trait neuroticism, which the MISTRA found to have a heritability of about 50% (earlier studies found it to be lower, 30%). For some years it has now been known that some antidepressants work by influencing the amount of the neurotransmitter serotonin. Now it has been found that one-third of the population has one or two copies of a relatively long and powerful version of a gene that produces the so-called serotonin transporter, while two-thirds have one or two copies of the shorter version of the gene. As a result, about two-thirds of the population is relatively liable to mild anxiety and depression. It also turns out that people with the shorter version also have sex more frequently, which could explain why the shorter version has not gone extinct so far. Apparently, people with a tendency towards anxiety and depression also are more obsessed with sex, which may make the trait evolutionary stable. (In § 5.19, I will come back on such issues and try to explain personality differences as a result of complementary behavioral strategies that remain in a stable equilibrium.)

Homosexuality. Perhaps most famous is the research on the genetic basis of homosexuality in men. In contrast to homosexuality in women, which seems to be culturally transmitted and is strongly influenced by the shared environment, male homosexuality has a heritability of 50% and its shared environment component of variance is 0%. As it is inherited via the maternal line, Dean Hamer and co-workers started to look on the X-chromosome. There they found a region called Xq28, in which a combination of five markers turned up in 33 of 40 homosexual male sib-pairs (Hamer *et al.,* 1993). The gene itself, however, has not yet been found. In another study they found that the female carriers of the gay version of Xq28 began puberty on average six months earlier than other women. If the gene indeed lengthens the reproductive life-span in woman, male homosexuality could actually be a nonadaptive side-effect of a characteristic favoring the female carriers of the gene! As Trivers has pointed out, "such a gene might only need to provide female carriers with a benefit one-half as great as the cost to males" (Masters, 1993).

__	x'	X
x'	x'x' (+ ½b)	x'x (+ ½b)
y	x'y (- 1b)	Xy

Table 5-2. A male homosexuality trait (x') can be evolutionary stable, even if it is disadvantageous to the males in which it is expressed (-1 benefit), if it is advantegeous to its female carriers (+ ½ benefit).

To see this, let us call the normal version of the X-chromosome x and the `gay version' x'. If a male carrier x'x, apparently a bisexual, mates with a female carrier x'y, they produce three types of gametes: x, x', y. These combine into a generation in which females are two times as often carriers of the gene x' as males (see table 5-2). Thus, if there is a benefit ½b to being a female carrier of the x' chromosome, this is enough to compensate for the cost of -1b to being a male carrier.

All this could imply a genetic basis for male homosexuality, even if this is not an adaptive trait. Yet, remember that behavioral geneticists only have found a heritability of about 40-50%. It seems likely that homosexuality is at least partially a conditional strategy. This would presuppose that it is to some extent adaptive, however, and works as a kind of adaptive alternative tactic or even as a kind of `genetic short cut'. (I will come back to this possibility in chapter 5.19).

In all, the provisional lesson that we can learn from behavioral genetics is that behavior, in humans, is neither exclusively the product of genes nor of the environment. This is exactly what we would expect if the relationships between genes and culture are somewhat more complex as in most models of culture that I discussed. This is also what we would expect from a Darwinian point of view. From a Darwinian point of view one would expect the evolution of conditional strategies, which are turned on or off dependent on the situation. For example, if being dominant has reproductive advantages, one would expect the evolution of a genetic proclivity to display dominant behavior. Yet, genes cannot guarantee that an individual will actually become dominant: they probably will move through dominant and subdominant individuals continually. It is to be expected, then, that individuals will be selected on their ability to adapt their strategy to their place in the group's hierarchy. In the long run, their genes may both contain optimal subdominant strategies and optimal dominant strategies plus the ability to switch between them according to the social situation.

The fact that many behavioral genetic studies focus on psychological characteristics does also support the idea that genes influence behavior via a series of psychological and evaluative mechanisms. In chapter 3 I have argued with Pugh that consciousness is not purely information about the world, but arises out of a natural system of values which enable organisms to weigh information in adaptive decisions. Apparently, some within-species variation in valuative and cognitive mechanisms exists, which may not even be purely stochastic, but may constitute a polymorphism reflecting a natural balance between opposite strategies (see 5.19).

5.10 NATURE VERSUS NURTURE 2: EARLY EXPERIENCE

What we learn from embryology is not that organisms are build according to a completely fixed building-scheme, but according to a series of steps. If one step is finished, the next is initiated. A nice example is the way in which male and female characteristics form. In mammals the Y chromosome contains very little information, but it contains the crucial information for the development of testes. In the early embryo, testes produce testosterone that influence the growth of the brain in such a way that a male brain is formed. The testosterone receptors in the male brain subsequently are orchestrated in such a way that typical male behavior evolves. The normal pattern of development of a male individual out of the `initial universal female embryo' can be easily disturbed, however, for example under the influence of female hormones. As a result, even in humans, boys can be born with a series of female behavioral characteristics (and *vice versa;* Moir & Jessel, 1991). In mice, the expression of male characteristics, including aggression, is influenced by the position of the embryo between its fetal siblings: if a male has been sandwiched between two sisters it will display an increased sexuality and a decreased level of aggression (vom Saal, F.S. *et al.*, 1983).

If the environment already plays such a big role *in* the uterus, it is unlikely that it will have no effect *ex utero*. At the moment that it is outside the uterus the new individual has much more opportunities to gather crucial information about the world in which it is born and to adopt a strategy accordingly. The process of natural selection tests the abilities of individuals to adapt their strategies and thus, conditional strategies are likely to evolve. It is therefore not completely unlikely that there is, indeed, a period in our childhood in which our personality is formed. This is an idea which is very popular in our culture, probably due largely to its compatibility with the idea of progress and fostered by completely opposite psychologists from Freud to Watson and Skinner.

Yet, if we take behavioral genetics seriously we should be very careful not to exaggerate those early influences (Rowe, 1994). Bouchard claims that the non-genetic influence of parents on the child can only account for about 7% of its characteristics; Rowe is even more skeptical. Only with reference to hard facts can we decide what childhood experiences do mold the personality of a ripening individual. Hard facts are hard to come by, however, because the literature is dominated by perspectives in which the extent to which the supposed pedagogical influence of parents on their children is not critically separated from possible genetic factors (Rowe, 1994; 2000; Harris, 1999). As a result, even within the Darwinian paradigm, the influence of childhood experience is easily exaggerated. Let me mention a few examples of recent hypotheses about the influence of early experience from a Darwinian perspective.

Attachment theory. Like Freud, John Bowlby, father of attachment theory, thought about himself as an evolutionist. Indeed, he had a decisive influence on evolutionary psychology by coining the word `environment of evolutionary adaptedness' (Bowlby, 1969). The notion that children can be either securely or insecurely attached as a result of the behavior of their mothers or caretakers and that these different attachment types determine their later social behavior has influenced many evolutionary psychologists. Belsky *et al.* (1991), Draper & Harpending (1982) and more recently Chisholm (1994, 1999) have tried to rephrase attachment theory in terms of conditional strategies: an insecure attachment is not viewed as a purely pathological phenomenon caused by accidental failures during raising, but as an adaptive response to a particular type of environment in which parents did not have either resources or time to be able to provide enough love and security to a child. Chisholm (1999: 200) even bases himself on behavioral genetic research showing that genetic love style have no genetic causes (I will come back to Chishom in chapter 6).

All this may be exaggerated, however, if behavioral geneticists are right. Their evidence is often very compelling. Especially the Texas Adoption Study described by Rowe (1994: 69) shows the limited nature of rearing influences. Generally speaking one can claim that children adopted at an early age show much more similarities to their biological parents and to their adoption parents. Attachment theory simply attributes too large consequences from influences that are relatively small. It is hardly worthwhile to take the three volumes of Bowlby's *Attachment and Loss* to your psychologist if it explains maximally 7% of your misery. The research of Jerome Kagan on the (normal) cognitive development of Guatemalan school-aged children who had endured an early parental treatment which would be judged as child neglect by American standards (Kagan, 1998) further undermine attachment theory's explanatory monopoly. As a result, theoreticians have started to look for other early influences on the developing personality.

Sibling rivalry. One factor contributing to someone's personality could be the family in which the individual finds itself. Behavioral geneticists were surprised to find that individuals raised in the same family are often more different than individuals raised apart. Brothers and sisters from the same household tend to diverge; if raised in different households, those same brothers and sisters could converge (Lalumière *et al.*, 1996). As a result, one finds the most surprising similarities if brothers and sisters are raised apart. (Often we notice, too, that we start looking and behaving like our parents when we grow older.)

Recently, Frank Sulloway has proposed that sibling rivalry is the chief source of the differences of individuals from the same household. On the basis of their specific talents on the one hand, and on the basis of their position in the family on the other hand, siblings develop their own niches within their families. Sulloway claims that the effects of sibling rivalry are even stronger than those of sex differences, although they are not genetically determined in the sense that one and the same genotype will develop differently purely as a result of its position in the family.

One of the most important differences in which siblings tend to diverge, according to Sulloway, is their level of conformism. First-borns are generally more conforming and closely identified with their parents. Later-borns are *Born to Rebel* as is already claimed in the title of Sulloway's treatise (1996). They have to find new territories and new niches to survive. As a result, cultural revolutions may find their origin in population explosions in which a lot of later-borns are produced. I will return to this topic in a later section (5.18).

Peer-group socialization. Another recent proposal with respect to the main influences on the developing child is also partly inspired by some results of behavioral genetics and by evolutionary considerations. Given the limited influence of parents on children and given the fact that siblings often diverge rather than converge, who else may have influence on the developing child? Judith Harris proposes in *The Nurture Assumption* (1998) that peers may be more influential than parents. One of her arguments is that the nuclear family could be a relatively recent discovery and that in many societies children are more or less raised by each other, at least not exclusively by their biological parents. Even in our own society children spend only part of their time with their parents.

One strong argument in favor of Harris' idea is that one cannot choose one's parents, but one can choose one's peers. The idea of Harris is therefore perfectly compatible with the idea that the developing individual *creates* its own environments and is actively looking for efficient ways of mastering particular skills. Children that would wait with learning, for example, about sexuality until their parents taught them about it, would be at a disadvantage in many situations. They are already replaced by children that are continually looking for learning situations and that are actively choosing friends from which they can still learn. (Children from which you cannot learn anything are boring...).

Early experience: a myth? Despite the number of theories, current behavioral genetic and biopsychological literature reflects a enormous uncertainty with respect to the factors that mold a personality. It seems to me that the evolutionary approach can sometimes help researchers by giving arguments in favor of an optimal mix between genes and learning. For example, from the gene's point of view it would be risky to give early childhood experiences a decisive influence on someone's personality. It would be unwise to burden limited and fallible parents with responsibilities having an decisive effect on a child's later success or failure. Above that, as David Rowe states `fixing the design of an organism to information that is 15 to 20 years outdated would seem to be a poor evolutionary choice, given that weather-driven famines last 1 or 2 years and that intergroup warfare can change the demographic structure of a tribal group in a single day' (Rowe, 2000: 354).

In all, it seems to me that the theory of early experience should not be used as an all-explaining theoretical framework. Even if we assume that psychotherapies based on this theory really work, and improvements are not just the result of the healing effects of time and attention, this does not prove that the theory is right. At this moment the only thing that we know certain is that genes have an enormous influence on human behavior via bio-psychological features and mechanisms. Even the extent to which early experiences contribute to the personality of an individual is genetically determined. The same goes for the extent to which an individual is formed as a result of his position between other siblings or as a result of the influences of friends.

5.11 THE MISSING LINK: CULTURAL AND REPRODUCTIVE SUCCESS

All this is not without implications for our models of culture. The idea that individuals are molded by culture has to be replaced by the idea that some of the ways in which individuals deal with culture have a genetic basis. Some of the personality traits that have been studied by behavioral geneticists (e.g. novelty seeking and other personality characteristics) have direct implications for the ways in which individuals react to memes. This strengthens the belief that culture is not simply superimposed on a biological substratum, but that it also emerges from this substratum. To some extent it can even be considered to be an `epiphenomenon' of the learning and culture-creating talents of interacting on a group level. Words like `substratum', `emergence', `epiphenomenon', however, have caused many philosophical debates, simply because they seduce us to make conceptual dichotomies where in reality only complex systems exist. In complex systems the whole is always more than its parts, but it can never exists apart from them.

Now that we have found that human culture is to some extent based on human nature we are perhaps ready to delve somewhat deeper. The evolutionary psychological approach is by no means identical to the idea that human behavior is genetically determined via certain evolved psychological mechanisms. It is a way of asking questions. Current psychological mechanisms have evolved in the past, they reflect past environments. It is here that we meet again Bowlby's concept of the `environment of evolutionary adaptedness' (Bowlby, 1969). Thus, evolutionary psychology does not simply ask what genes or psychological mechanisms are responsible for various types of human behavior, it is interested in the original function of those mechanisms. Why did they evolve? An evolutionary psychological approach to culture thus asks why we have psychological characteristics that cause us to absorb and create culture. Instead of only studying *proximate* causal explanations (referring to evolved mechanisms) we also have to study *ultimate* ones (referring to past selection forces that molded these mechanisms).

Of course, it would be premature to conclude that human cognitive adaptations do only reflect past environments: I called this the hypothesis of delayed adaptation. It is therefore not implausible that some of the selection forces that originally started human culture are still in place. Theoretically, they would have to emerge spontaneously from any sufficiently complete model of culture. Thus, let us look first, what we have now.

We have come to the conclusion that we need at least three levels in our theory of culture. Figure 5-4 is an attempt to do justice to some of the complex relationships between the three levels. The three most important causal relationships are given numbers:

1. Genes, of course, are responsible for the neural tissue that enables humans to create, select and modify culture in the first place. As a result of past selective forces, the mind is selected already to create a culture that solves problems which arise from the particularities of the environment and the society in which it finds itself. Genes determine for about 40 to 80% of a person's general intelligence, his language capacity, his level of altruism, conformism, aggressiveness, cooperativeness, ambition and a spectrum of other talents (Bouchard, 1994).

2. Individuals face a series of problems in their environment and society, which they solve in part by creating (2a) and selecting (2b) cultural elements that they can use. The culture that they produce collectively is the product of a large number of individual choices and creations. As a result, for each individual the surrounding culture is largely as unchangeable and monolithic as the environment. Yet, relatively dominant and powerful individuals have more possibilities to change their surrounding culture in their own interest. Thus, corresponding to a spectrum of human differences there is also a spectrum of different ways of relating to one's surrounding culture.

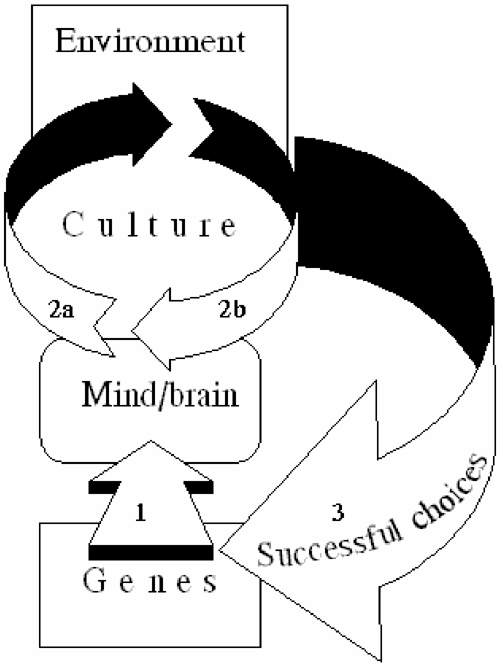


Fig. 5-4 A three-level theory of culture.

3. Individuals which successfully use the possibilities afforded by their culture (or, in some cases, which successfully resist the coercion enforced by their culture) are rewarded by relative reproductive success. As a result, their genes are spread throughout the population. These genes result in individuals with particular skills, attitudes and talents. In a complex environment such as culture it is to be expected that conditional alternative characteristics are adaptive. Thus, the expression of a particular attitude will often depend on circumstances. Human individuals may have the possibility of adapting their strategies to the environment and culture that befalls them.

The evidence for this model lies, of course, scattered throughout an enormous literature. Traditionally, culture was only studied as an almost independent phenomenon, sometimes in relationship to knowledge with respect to the mind. Ecological anthropology has tried to bring the environment in, but it was only since the rise of behavioral ecology that relationship 2 was studied systematically. Behavioral genetics has brought relationship 1 back on the agenda.

However, more than anything else, relationship 3 has always been a `missing link'. The importance of this relationship was stressed by sociobiologists, but they were accused of neglecting the subtilities of relationship 2. This is unfair. It is the essence of science to abstract. When predicting the course of a bullet, students in the area of ballistics probably do not include the humidity of the air or the gravity of the moon in their calculations.

During the rise of evolutionary psychology sociobiologists have learned to include factors in their models that result from the autonomy of the psychological level, including maladaptation. Currently, conditional strategies are postulated at a regular basis, even with the risk of unfounded speculation. Yet, the general or global teleonomic tendency of humans towards inclusive fitness maximization still can be studied abstracting from all kinds of individual and psychological aberrations.

On the whole, sociobiological studies during the last decennia have confirmed the idea that humans indeed maximize their inclusive fitness. More than a dozen studies have clearly shown that the pursuit of status and wealth in many societies is an approximation of inclusive fitness maximization (Voland, 1993; Low, 2000). The first of these, and the most famous, is the study of William Irons (1979) which showed that wealthier Yomut Turkmen (an ethnic minority of northern Iran) have more reproductive success. The wealthier half of the population's men were reproducing at a rate of 1.75 times that of their poorer counterparts; wealthier women at 1.12 times the rate of poorer women. Thus wealth in the Yomut proved directly linked to reproductive success, as table 5-3 shows for the male fertility data.

	Wealthier Half of Population			Poorer Half of Population		
Ages	**Person Years**	**Births**	**Age-Specific Birth Rate**	**Person Years**	**Births**	**Age-Specific Birth Rate**
15-19	1,889	83	.044	2,189	49	.022
20-24	1,468	293	.200	1,42	228	.124
25-29	1,125	345	.307	1,516	335	.221
30-34	909	297	.327	1,265	337	.266
35-39	723	257	.356	1,008	275	.273
40-44	546	178	.326	735	178	.242
45-49	417	105	.252	528	123	.233
50-54	277	58	.209	338	51	.151
55-59	169	38	.225	223	18	.081
60-64	100	17	.170	156	11	.071
65-69	35	5	.143	86	4	.047
70-74	17	2	.118	39	1	.026

Table 5-3. Summary of male fertility data from the Yomut Turkmen of Persia, collected by W. Irons in 1973-1974. Irons, 1979. (df = 12, $x^2 = 113.36$, $p<.001$.)

The same correlation between wealth and reproductive success has been found in a number of traditional societies, including the Hausa (Barkow, 1977), the Kipsigis (Borgerhoff Mulder, 1987), the Mukogodo (Cronk, 1991) and the Ifalukese (Turke & Betzig, 1985).

Of course, wealth is not the only proximate goals which humans are pursuing. In many primitive egalitarian societies and in some relative sophisticated modern societies (the medieval church, communistic Cuba) the possibility of accumulating properties was limited. The effect, however, is apparently not a relaxed reproductive competition. A number of studies suggest that in such societies we have to look for other symbols of status and social distinction. Among the Yanomamö of Venezuela, for example, one's prestige seems to be determined by one's ferocity. Napoleon Chagnon, who has stayed among the Yanomamö for 50 months, discovered a surprising difference in reproductive success between those Yanomamö who at least once had to undergo the purification ritual `unokaimou' after killing a person and those who did not. As shown by table 5-4, the so-called `unokais' (killers) had more wives and more children (Chagnon, 1988).

Similarly, among the Ache a correlation was found between a person's hunting reputation and his reproductive success (Kaplan & Hill, 1985). All in all, the idea that there exists a correlation between different measures of `cultural success' on the one hand and reproductive success on the other hand is at least a good provisional hypothesis with respect to traditional societies (Irons, 1993).

Yet, there are signs that the relationship between cultural and reproductive success breaks down in modern industrial societies. Vining (1986), for example, could not find a positive relationship between wealth and reproductive success in the U.S.. Pérusse (1993) could not find a positive relationship between cultural and reproductive success in Quebec, but he found an interesting positive relationship between cultural success and `number of potential conceptions' or matings instead. If we have to believe his study, both contraception and socially imposed monogamy are effective in counterbalancing the advantages of cultural success for the reproductive success of ambitious men. Women still show a tendency to choose cultural successful men over less successful ones, but these choices do not result in extra reproductive success any more. Of course, as Betzig (1993) points out, the number of children born from extramarital affairs of cultural successful men is difficult to measure.

	Unokais			Non-*unokais*		
Ages	***n***	**Number of offspring**	**Average number of offspring**	***n***	**Number of offspring**	**Average number of offspring**
20-24	5	5	1.00	78	14	0.18
25-30	14	22	1.57	58	50	0.86
31-40	43	122	2.83	61	123	2.02
>41	75	524	6.99	46	193	4.19
Total	137	673	4.91	243	380	1.59

Table 5-4. Reproductive success of *unokais* and Non-*unokais* of 1987. 88% Of the 137 *unokais* have reproduced compared to 49% of the 243 non-*unokais*. From Chagnon, 1988.

Yet, we should not forget that modern industrial societies are characterized also by an extreme low rate of child mortality. To some extent, we can afford ourselves the luxury of having very small numbers of children. Modern industrialized nations are also extreme in requiring a level of education which is unknown to any tribal society. Instead of investing in large *quantities* of offspring, we are to some extent forced to invest in a high-*quality* upbringing for our children (a *K*-strategy as opposed to an *r*-strategy, see chapter 6.3). It is unclear whether this constitutes a strategy which makes sense from an evolutionary perspective or a consequence of innate tendencies which were adaptive in the past, but maladaptive nowadays.

The fact that women in industrial societies still seem to prefer men which are somehow cultural successful shows that both industrialization and the pill did not completely change the human psyche. Social prestige is enhanced by cultural success and cultural success does have at least some advantages, although in different societies what counts as success may be something different. As shown by Chagnon, it is important in a Yanomamö society to be known as ferocious. Their societies are characterized by continuing tribe wars, physical combats between men and the abduction of women. Probably it is in the interest of everyone to have ferocious allies. Apparently, women prefer ferocious men, too, because ferocious men may defend them and their children better. Ferocity could also correlate to some extent with other characteristics, like ambition, responsibility, industriousness, concern about the welfare of their kin and willingness to take risks (Chagnon, 1979). In societies in which property plays a large role, the accumulation of properties may prove the same series of characteristics. At the same time, wealth itself may also be attractive, because it affords an economical basis for raising offspring.

As a result, human societies can often be analyzed using the same `polygyny threshold' model as is used for other species, especially birds. This models states that a species may tend to be polygynous as a result of a female preference for males that have access to relatively superior resources. At some point, mating an already-paired male may result in more offspring than mating a bachelor with inferior resources (Borgerhoff-Mulder, 1997). Monique Borgerhoff-Mulder has shown that at least in one society, the Kipsigis of Kenia, the patterns of polygyny can be very well explained using this model.

If such a model would apply to human societies everywhere this would explain the human tendency to accumulate more properties than one needs for the maintenance of a small nuclear family. Almost everywhere, males do not stop accumulating resources if the requirements of their own nuclear families are met. Today, in societies around the world, the rich become richer often by making the poor poorer. This irrational tendency to accumulate resources would be strange if economic or social success would not have correlated with reproductive success at least in the past. As we saw, our own apparently monogamous societies are possibly an exception (yet, to some extent, our `mating system' of serial monogamy may be disguised polygyny; children may also benefit from having relatively rich and powerful parents.)

What counts, however, is not one's properties only, but one's power and status. Even in societies without properties males do not work only for their own nuclear families. Among the Ache of Eastern Paraguay males are `showing off' by catching large prey which is distributed evenly throughout the whole community (Hawkes, 1991). Apparently good hunters have more relationships outside their own nuclear families and therefore also more illegitimate offspring. Thus, the correlation between economic and reproductive success found by Irons (which we can thus call `Irons' rule') and others is probably only one example of a more general correlation between *social status* and reproductive success (which we can thus call the `generalized Irons' rule').

5.12 INTELLIGENCE, SOCIAL SUCCESS AND SELECTION FORCES

According to a series of authors, there seems to be also a correlation between social success and intelligence in western societies. The general intelligence factor *g*, for example, is a better predictor of job performance than any other single personality trait. It can be understood as the ability to deal with complexity and is perhaps linked to the overall speed and efficiency with which the brain processes information (Gottfredson, 1988). The heritability of IQ rises from about 40% to 80% during a lifetime and behavioral geneticists are starting to find genes that may be responsible for it.

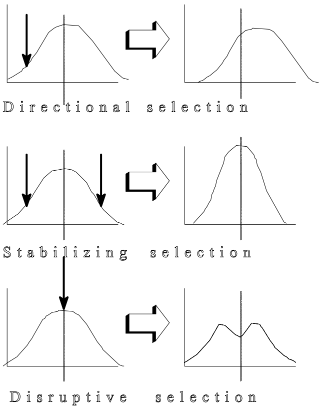


Fig. 5-5. Three types of selection, after Trivers (1985). Arrows represent selection pressures on one end of the spectrum of varieties (directional selection), on both ends (stabilizing selection) or on the average (disruptive selection).

Of course, not everyone agrees that the concept of `intelligence' refers to a `natural kind', something that can be exactly quantified, rather than a vague collection of overlapping qualities. Howard Gardner has tried to distinguish eight or nine different kinds of intelligence, for example (Gardner, 1998). As long as one does not confuse evolution and progress, an evolutionary perspective does not commit one to expect *one* monolithic `success factor' which evolves by `directional' selection (selection in one direction). As the differences between the psychologies of males and females show, at least some personality characteristics have arisen as a result of `disruptive' selection (selection pressures which force subpopulations with different genes in different directions). If there was only one trait responsible for one's social and reproductive success and if this trait was inheritable, *everyone* would have it already as a result of the reproductive success of its possessors in the past. From an evolutionary perspective, one would rather expect a kind of trade-off between opposing factors, as a result of which the actual population exhibits a spectrum of characteristics. As so often in nature, there is not *one* final stage, but a flexible and dynamic equilibrium which shifts according to the circumstances.

Perhaps the strong correlation between intelligence and social success is not the whole story, therefore. Perhaps, intelligence is a factor which should be combined with other factors to result in *reproductive* success. One of the possibilities is that intelligence also poses a risk in traditional, conformist societies and that sexual selection is directed at a mix of intelligence and at least some opposite characteristics (as argued by a series of philosophers, including Ortega y Gasset, 1960). If this is true, individuals with an average intelligence could be most successful and both individuals with a less-than-average and with a more-than-average type of intelligence would be at a disadvantage. Intelligence would then be a typical product of `stabilizing selection', as a result of which deviations of some optimal average are selected against (see figure 5-5 for the three types of selection). This would explain the sinus-like curve of the distribution of intelligence throughout the population. (Of course, this curve can also be explained simply as a result of biological factors which make it difficult to orchestrate an intelligent brain.)

A recent study seems to confirm this intuition. Mueller and Mazur (1998) investigated the reproductive success of all graduates of the 1950 class of the U.S. Military Academy. They found that high rank (and thus, presumably, intelligence) predicts reproductive success, but that the competitive qualities leading to top rank probably have a negative effect on fitness. Lieutenant generals and full generals had fewer children and fewer grandchildren than brigadier and major generals. It would not surprise me if this same tendency could also be found for, for example, artists, scientists and philosophers. It is a well known phenomenon that the most brilliant minds often die childless, while apparently only the somewhat less devoted know how to find a balance between reproduction and spiritual self-realization. In reproductive terms, perhaps it is not excellence that pays, but versatility and even some `mediocrity'.

All this points to the role of stabilizing selection in maintaining an optimal level of intelligence within the population. This does not mean, however, that intelligence is necessarily a constant factor in modern populations. In fact, the relatively old idea that intelligence is deteriorating in modern populations has recently found new adherents, who seem better able to underpin their claims with data than ever before (Miller, 1998). If this is true, and if this claim is not simply the expression of the concerns of the elite finding themselves on the most right part of a sinus displaying intelligence as a function of reproductive success, this would imply that human culture in the long run is undermining its own foundations.

This issue needs not to be resolved here, however. It is obvious that intelligence has increased over the last five million years. The evolution of culture since the common ancestor of humans, chimps and bonobos (huchibo's) will have depended both on directional and stabilizing selection, and probably also on a lot of disruptional selection. Whether there is a general *g* factor or not, the evolution of culture must have depended on and still depends on a large spectrum of specialized mental (and cultural) abilities which form the `missing link' between genes and memes.

5.13 DOES SEXUAL SELECTION EXPLAIN THE EVOLUTION OF CULTURAL ABILITIES?

Whatever the role of a general intelligence or of a series of specialized talents is, there seems to be a correlation between something like `social status' and reproductive success, as is attested by a series of sociobiological studies. Apparently, human culture is the product of the cumulative efforts of individuals to attain social esteem and prestige. The correlation between social and reproductive success could be compared, then, to the correlation between tail length and reproductive success in male swallows or to the correlation between number of tail feathers and reproductive success in peacocks, - both of which are products of sexual selection. Perhaps human culture should be compared to the `lek' system which we find in a series of bird species, in the Netherlands represented by the Ruff (*Philomachus pugnax)* and the Black Grouse (*Lyrurus tetrix;* alas, almost extinct in our country now). In these species males defend small territories on a communal display ground at which they display their feathers (and `sing' or make gobbling, popping, rattling or bubbling noises as in the Black Grouse). If females are in need of a package of good genes they can inspect the males here and can select the most impressive ones.

At least some theorists think that human cultural abilities are products of sexual selection (Miller, 1996; 2000). Indeed, it has been found that there are at least some similarities between the behavior of birds on leks and the behavior of humans on `communal display grounds', for example in bars or at universities. Robin Dunbar and his student Anna Marriott have studied the subjects of human conversation (Dunbar, 1996). Surprisingly, they found relatively few differences between males and females. What they found, however, was that males start talking more about their work, about difficult academic subjects or about religion and ethics at the moment that women are present. In young adults males talk about two thirds of the time about themselves, whereas females talk only about one third of the time about themselves. Clearly, a lot of self-advertisement is going on in human conversation. Male `cultural displays' are often at least partially fuelled by potential female admiration.

Ranked	Ratings by Males			Ratings by Females		
Value	**Variable Name**	**Mean**	**Std.Dev.**	**Variable Name**	**Mea n**	**Std. Dev.**
1.	Mutual Attraction - Love	2.81	0.16	Mutual Attraction - Love	2.87	0.12
2.	Dependable Character	2.50	1.46	Dependable Character	2.69	0.31
3.	Emotional Stability and	2.47	0.20	Emotional Stability and	2.68	0.20
4.	Maturity	2.44	0.29	Maturity	2.52	0.30
5.	Pleasing Disposition	2.31	0.33	Pleasing Disposition	2.45	0.25
6.	*Good Health*	2.27	0.19	*Education and Intelligence*	2.30	0.28
7.	Education and Intelligence	2.15	0.28	*Sociability*	2.28	0.30
8.	Sociability	2.09	0.50	Good Health	2.21	0.44
9.	Desire for Home and Children	2.03	0.48	Desire for Home and Children	2.15	0.35
10.	*Refinement, Neatness*	1.91	0.26	*Ambition and Industriousness*	1.98	0.49
11.	*Good Looks*	1.85	0.35	Refinement, Neatness	1.84	0.47
12.	Ambition and Industriousness	1.80	0.48	*Similar Education*	1.76	0.38
13.	*Good Cook and Housekeeper*	1.51.	0.42	*Good Financial Prospect*	1.46	0.28
14.	Good Financial Prospect	1.50	0.37	Good Looks	1.46	0.39
15.	Similar Education	1.16	0.28	*Favorable Social Status or*	1.28	0.27
16.	Favorable Social Status or	1.06	0.69	*Rating*	1.21	0.56
17.	Rating	0.98	0.48	Good Cook and Housekeeper	1.03	0.35
18.	*Chastity*	0.92	0.36	Similar Religious Background	0.75	0.66
	Similar Religious Background			Similar Political Background		
	Similar Political Background	1.87	0.57	Chastity	1.94	0.63
	Mean			Mean		

Table 5-5. Prefered characteristics in potential mates. Summary of ratings by sex using entire international sample of 37 cultures. From Buss, 1990. I have italicized variables which seem relatively important to one of the two sexes.

This brings us to the question whether this potential female admiration is merely a male chimera. Are females really impressed by these male displays? The largest cross-cultural study on mate selection criteria is that of David Buss (1990; 1994). With the aid of native residents of 33 different countries, he has succeeded in interviewing (using questionaires) 9,474 individuals from 37 different cultures across the planet. The result shows, once again, that there are a lot of similarities between male and female preferences with respect to potential partners. Humans are really a pair-bonding species, which distinguishes us from other apes. At the same time, however, Buss found a series of interesting differences between the sexes. In one of his summary tables, which is reprinted here as table 5-5, I have italicized those preferences which are ranked relatively high in the respective sexes.

As can be seen *Education and Intelligence, Sociability, Ambition and Industriousness, Similar Education, Good Financial Prospect* and *Favorable Social Status or Rating* are more important to females. *Good Health, Refinement and Neatness, Good Looks, Good Cook and Housekeeper* and *Chastity* are more important to males. Of course, Buss found considerable cultural differences. The largest effect of culture occurred for the variable of *Chastity*, followed by *Home and Children* and *Good Housekeeper.*

In all, however, it is not unfair to claim that females on the whole are relatively sensitive to characteristics of males that make them more likely to attain higher social positions in the future and that make them more likely to earn a lot of money. It is not unlikely that males which are more productive culturally are not doing bad with the girls. At the same time it is clear that women look to a surprising spectrum of other characteristics as well. If there is sexual selection for culture creating traits this could well be a kind of stabilizing selection which promotes intermediate forms. In that case, a genius is simply the embodiment of an extreme version of a trait which is normally maintained in the population as a part of a much larger package of adaptive characteristics.

That means, at the same time, that the differences between the sexes are not big enough to justify the idea that man is simply a typical `lek-bird', like the Ruff, the Peacock or the Black Grouse, although there are some surprising similarities. On the whole, however, human culture seems to be much more than a mere beauty contest, even if the concept of beauty is enlarged so that it also includes internal beauty. It is time to reflect on the kind of social and `mating' system that underlies human culture.

5.14A DUAL SELECTION THEORY OF CULTURAL ABILITIES

What surprises most, if we compare the human `mating' and social system with that of other species is that we can compare humans with at least two other different *groups* of organisms. On the one hand, we are clearly descendants of a chimpanzee-like ape with a social hierarchy in which power and politics play a dominant role (Wrangham & Peterson, 1996). What makes chimpanzee groups unique among primates generally is the cooperation among males. Most primate societies are centered around a group of related females. In apes, however, females have become exogamous at least since the common ancestor of gorillas and chimpanzees. In gorillas we see a trend in which dominant silverbacks may share a group of females. In chimpanzees cooperation among males has become the rule rather than the exception. Thus, male chimpanzees, who are more related to us than gorillas and who probably are more similar to our common ancestor, are not only selected on their ability to impress females but also on their ability to cooperate. That is one reason why we would also expect human male characteristics to be not exclusively the product of sexual selection by females.

On the other hand, marriage and the nuclear family seems to be a universal human feature (although in most cultures, males may have more than one wife or may take mistresses and concubines). This suggests similarities between our species and pair-bonding species, for example, most birds, which behave somewhat differently from *lek*-birds anyway. While there are about 37 monogamous primate species, among mammals generally a system in which males assist in the raising of offspring is rare.

Something very strange seems to have happened with our ability to cooperate. In chimpanzees, dominant individuals, males and females alike, seem to need each other to attain and maintain power within the group. This has created a relatively sly and intelligent ape, but an ape nonetheless, with a relatively small dependence on cultural inherited habits and technologies. In humans the ability to cooperate seems to have taken over completely. Not only are we completely dependent on each other at almost every level, but we are also completely dependent on culturally inherited habits and technologies in almost every realm of life (Slurink, 1994; chapter 7).

This ability to cooperate seems to go hand in hand with our tendency to form nuclear families. In almost all societies the institution of marriage creates at least some clarity with respect to relationships and paternity, as a result of which at least some of the tensions resulting from sexual competition are abated. Paternal uncertainty in most cultures lies within the realm of 10% to 20%, which moralists may deplore, but which contrasts favorably with the 100% paternal uncertainty in chimpanzees.

Thus, on the one hand we form societies which remind one of colonies of birds, each pair with its own nest, on the other hand we cooperate and compete in networks throughout the whole `colony', as a result of which our societies evoke reminiscences to ant or termite colonies. Yes, we have descended from something like the apes, but at the same time, we have turned into something very dissimilar, apparently an eusocial, very cooperative ape which has become completely dependent on culture. Extraterrestrial exobiologists would be enthusiastic about finding such a termite-like ape with such un-termite-like mating habits. To some extent, we are stranger even than naked mole-rats, which are mammals with a mating system with much more similarities to termites (Jarvis, 1994).

Our strange social system suggests a solution to the problem of apparently sexually selected cultural abilities. Our cultural abilities, properties like the control over language, our aesthetic sense, our dexterous skills which are expressed in various crafts, our logical and mathematical talents, are apparently not only products of sexual selection, but also of a selection-process which favors individuals that are particularly useful for the group generally and for the dominant elite in particular. This forces us to accept a version of the generalized Iron's rule in which there is a link between at least some culture creating talents and reproductive success (without assuming that cultural talents are directly sexually selected): gifted individuals are useful allies and are admitted to the dominant elite, as a result of which they are allowed to share in its privileges, which includes reproductive advantages as well.

Apparently, the key to the problem of the relationship between genes, mind and culture lies in the fact that we have evolved as `culture cooperators', who have a unique talent for the groupwise exploitating of natural resources. Individuals of our species form naturally hierarchies and at the top of those hierarchies are dominant individuals who are most skillful at coordinating a collective effort to exploit the available natural resources. Originally this cooperation enabled our ancestors to hunt relatively large prey and to defend the group, but with the advent of agriculture and industry this has led to the evolution of complex states in which many specialized individuals contribute to collective interests.

In chimpanzees hunting and `warfare' are some of the activities which are undertaken groupwise and which may constitute a motor behind social evolution. In humans we see that cooperative activities have invaded all realms of life: all fundamental `biological' activities are `culturally mediated' (if we are not alert, perhaps the very act of procreation will even be replaced by a cultural substitute). Social learning has become so dominant that sometimes individuals don't dare to think for themselves: culturally inherited paradigms even influence the way they interpret their most intimate experiences. Dominance hierarchies are to a large extent based on the proficiency of individuals in the command of culturally acquired skills and knowledge.

It seems to me that the only way to understand this transition from a chimpanzee-like social system to a human-like one is to compare different evolutionary scenario's to the available archeological and paleontological evidence. I will try this in the third part of this book. At this point, we can conclude that it is reasonable to assume that human culture is not something which was created *ex nihilo* by an unspecialized ape, but a way of living which is only possible on the basis of a unique social system, which is part of human nature. Human culture requires a series of physical and psychological specializations which can only be explained by a process of gene-mind-culture coevolution which was cranked up when a particular kind of ape became more and more dependent on culturally inherited ways of solving its problems.

We thus come to a model which includes elements of sociobiology, evolutionary psychology and primatology. Sociobiological is the idea of gene-culture coevolution (Lumsden & Wilson, 1981, 1983) and the idea that sociocultural success translates into reproductive success. Evolutionary psychological is the idea that culture is based on a series of specialized modules or `talents', which somehow must have been evolved by natural selection. Primatological is the idea that human uniqueness should be understood as the result of a unique social and mating system. Figure 5-6 is an attempt to summarize the model that I have outlined so far. In principle, this model does not only schematize the relationships between genes, mind and culture, but it does also explain why culture evolved in the first place, or, at least, what kind of stabilizing selection maintains cultural abilities within the human population.

Fig. 5-6. An evolutionary theory of culture.

5.15 STRUCTURE OF THE CULTURAL `SUBSTRATUM'

Thus, we come to a model in which cultural abilities may be linked directly (via sexual selection) and indirectly (via the membership of a dominant group) to reproductive success. The `substratum' in which memes or cultural inherited ideational phenomena are replicated is maintained by natural selection. One could argue, however, that this is still consistent with the idea that cultural evolution is somehow independent, `supervenient' on the biological process. Of course, much depends on the meaning of words. One could claim that the evolution of bird song `supervenes' on processes of sexual selection and competition in birds. It seems to me, however, that such a terminology would obscure the fact that the evolution of bird song is driven by sexual selection and territorial competition. In the same way, I think that abstract `dual inheritance' models obscure the fact that cultural evolution is *driven* by processes of cooperation and competition within our species which directly arise out of the patterns of biological interests.

How? In figure 5-6 I have made an attempt to show what drives individuals (especially males) to establish themselves as members of a society of cooperating individuals. Individuals cooperate by participating in a particular culture, which represents a solution to problems posed by a specific ecological situation. This `culture-cooperation' is possible as a result of their overlapping interests and is based on the mechanisms of direct and indirect reciprocal altruism (chapter 4). Within the culture cooperation, the egoistic drives of the individual are legitimized and turned into motivational energy that can be used by the society: hence the difference between `egoistic' sex drives and socially accepted love and marriage and between machiavellistic power politics and socially accepted ambition and responsibility.

As shown by figure 5-7, males have both to be accepted by females and by other males to become reproductive members of the cooperation. The two motivational systems within their psychology are, however, not incompatible, because, as Kissinger once said, power is an important aphrodisiac: status is often important to women. To become accepted as a part of the society, males must fight, because the cooperating males tend to keep new males out (as in chimpanzees). A series of tests and barriers are created to keep new males out, to establish a hierarchy and to defend the system against free riders (parasites). Females often reinforce the male hierarchy by preferring high status males over low status males both as sexual partners and as cooperators in obtaining power. As a result no one can attain social and reproductive success by discarding the preexisting culture and its underlying power hierarchy (rapists try to take a short-cut, but theirs is a high-risk strategy). Everyone striving for social and reproductive success will have to respect the `rules of the game' dictated by a particular culture, that is, by the network of dominant individuals. That means that culture can be compared to a kind of arena in which individuals compete for resources and for status, both because these are prerequisites for being sexually selected and because they enable them to raise offspring.

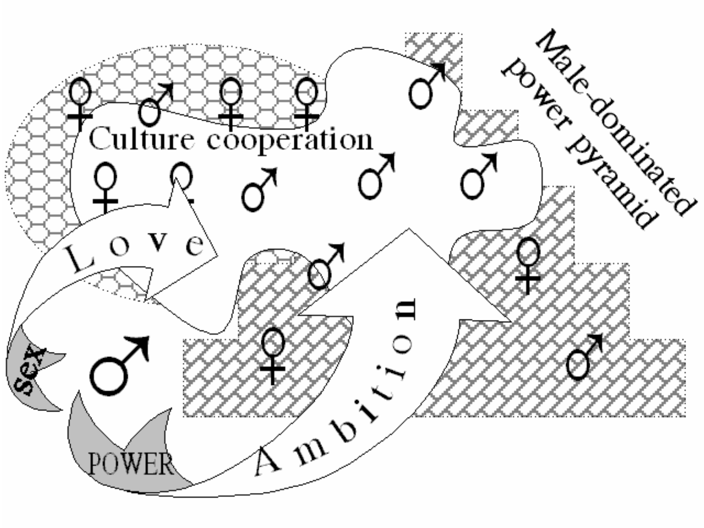


Fig. 5-7. To become reproductive members of a society, males have to be both sexually selected by females and to be socially accepted within the usually male-dominated power pyramid.

5.16 CULTURE AND THE HANDICAP PRINCIPLE

One of the similarities between arenas of different types is that one can only win in them by really being the best (Zahavi & Zahavi, 1997). If it were possible to fake impressive antlers, one could be the top deer without being the strongest. In the same way it has been shown that Barn Swallows with artificially lengthened tails did not gain in reproductive success and that Great Tits with artificially broadened bands on their chest were in need of extra testosterone to beat dominant Great Tits (Smith & Montgomerie, 1991; Järvi & Bakken, 1984). One of the characteristics of cultural expressions, too, is that it is hard to fake to be good in them. One can, perhaps, fake to be an artist by wearing extravagant clothes or by behaving in a nonconformist way, but often one look at a painting will convince almost everyone about one's real talents. At the same time, in every cultural activity that I am aware of there is a struggle going on between different talents which correlate with different strategies: there are `originals', `imitators', `fads' and so on, there are those who profit from having good connections, being socially clever, or being able to foresee what the public wants. Because there are always established reputations that set a high standard, the road to recognition is long and painful. Thus, if an artist finally arrives in the public limelight, there is a lot clear about his talents.

Of course, the cultural expressions themselves are also direct manifestations of the artist's genotype quality. Qualities that are displayed via cultural expressions may vary from good sense-organs to sheer discipline and perseverance, or from a healthy body to supposed aesthetic and moral qualities, but their common denominator is that they require innate talents of some sort. As a result, in at least the germanic languages the etymology of `art' refers to abilities: thus one could claim (in German), "*Kunst* zeigt was man *kann*", or (in Dutch), "*kunst* toont wat je *kunt*". This link between art and talents explains also why the public has often problems with modern art: the real problem with some `abstract' modern art is not that it does not `represent' anything, but that it does not *prove* anything about the artistic talents that gave rise to it - it seems relatively easy to imitate.

An essential point of the theory of the `Handicap principle' of Amotz and Avishag Zahavi is that animals can only convincingly display their genetic quality with signals that incur real costs to them. Only if a signal costs a lot of surplus energy can an individual demonstrate that it can permit itself this waste. According to them, this is the reason that swallows and peacocks with artificially lengthened tails will in the long run become exhausted.

The handicap principle can be directly applicated to almost all levels of cultural activity that I am aware of. Perhaps it is possible for a mediocre artist to paint one relatively nice painting each year, but a characteristic of a real genius, like Picasso, is that he is able to attain high levels again and again, sometimes at the price of periodic depressions. Talents in many areas of culture are often a burden to their owners, many of whom have to suffer a lot as a result of their extreme sensitivity, some of whom are prone to mental illnesses of different kinds. Many studies have independently found increased rates of depression, manic-depression and suicide among artists (Jamison, 1997). This link between manic-depression and `talent' is probably not an accident. Intense emotional fluctuations seem to offer a kind of Husserlian `eidetic variation' which forces particular individuals via involuntary learning routes to all kinds of `esoteric' wisdom (at least wisdom unattainable to others). Perhaps manic-depressive illness constitutes a kind of cognitive zoom lens which allows the tormented mind to observe many different aspects of reality and enables it to become familiar with the full range of human experience, a familiarity that is conditional to true wisdom and perhaps to great art, too.

5.17 CULTURAL EVOLUTION DRIVEN BY BOTH COOPERATION AND COMPETITION

This brings us to other biopsychological roots of culture. I wrote about `culture-cooperation'. Of course, however, I did not mean that culture is only characterized by cooperation and harmony. If there was only cooperation and harmony, culture would probably not have evolved. Cooperation and harmony, at least in a culture-producing ape species like we are, probably requires dictatorship and censorship: they thus would make a culture rigid and static. In the terminology of the anthropologist I.M. Lewis (1971), culture is normally characterized by both central and peripheral cults. Central cults are those cults that are in the interest of the dominant group, normally a group of cooperating males and the subdominant females around them. Peripheral cults are cults that are in the interest of minorities that don't find their interests represented well in the central cult.

As my formulations already show, I see a direct link here between the sociology of beliefs and memes and ethological findings about dominance hierarchies in apes. Beliefs and memes are not floating above the bipedal, naked apes that produce, transmit and obey them, but they represent the viewpoints and interests of particular groups and subgroups of those apes vis-à-vis other groups and subgroups. It is only natural that dominant individuals tend to have viewpoints that represent not only their sometimes superior cognitive abilities, but their interests as well, and that their cooperation with other individuals is to some extent symbolized by an overlap between their viewpoints. As not everyone shares the interests of the leading group, it is to be expected that other, relatively `subversive', viewpoints will arise, probably originating from subdominants that are excluded somehow.

Thus, differences in viewpoint ultimately represent differences in cognitive-competitive abilities and genetic interests and memes do in part arise as weapons in the struggle for life. There is a direct, evolutionary link between the power struggles of the chimpanzee or the common HUCHIBO ancestor and the power struggle between, for example, the catholic church and a series of heresies or between the way in which in chimpanzees groups grow, split and finally become enemies and the way in which protestant churches grow, split and decry each other.

Of course, science and philosophy do not transcend this struggle for life at the level of ideas. Here too, we can often witness sabre-rattling between central and peripheral cults. Here too, we can observe how hierarchies are established and how groups split. This is only partly the result of scarce resources; in principle other species could have evolved in which those scarce (funding) resources were distributed in a completely different way. Scientific minded or philosophical inclined ants or termites would probably have much more unanimous scientific or philosophical communities that would, however, wage wars with other such communities.

At this point it may be worthwhile to remember the Kuhnian notion of a paradigm (Kuhn, 1961). In his later years Kuhn has stressed that this was not purely meant as a relativistic notion, although it has often been taken that way (perhaps on the basis of seductive suggestions of Kuhn himself). The notion of a paradigm is meant to express the fact that there is much more to theories than just observations and experiments. As the original meaning of the word *theooria* already shows, theories are ways of viewing things. That does not only mean that they arise from particular perspectives, but also that they are products of a commitment to particular theoretical values. These values can be seen as the weight given to the properties of theories that I have listed in chapter 2.5.

5.18 WHAT COMPETITION?: SIBLING RIVALRY?

One of the dimensions in which choices between paradigms happen to fall wide apart between different groups of people is their correspondence to the received wisdom of a particular field or of a particular group or tradition. Abandoning traditionally held beliefs implies an enormous risk, because one always knows what one has, but not what one gets. Often traditional held beliefs embody an accumulation of knowledge acquired during generations, and it often seems frivolous to throw all this away in favor of something that simply may be a new fashion or trend. Also, one often has to show adherence to a particular belief to be admitted to a group and to be able to rise in its hierarchy; it may not always be possible to change one's beliefs afterwards.

On the other hand, the fact that a theory has worked for many years does not say anything about the future. The situation may have changed, new data may have arrived, etc. Revolutions in science and philosophy are sometimes necessary to enforce a fundamental *Gestalt-switch* as a result of which things are seen in a completely different light. Traditions often have to be blown apart, because they may stand in the way of progress, sometimes by offering misleading `intuition pumps' (Dennett, 1984), sometimes simply by offering a false certainty and an excuse for intellectual laziness.

Thus, sometimes it may be `rational' to be conservative, sometimes it may be `rational' to believe in a more revolutionary attitude. It is not possible *a priori* to decide which attitude is better and often both attitudes simply offer different sides of the same story. What, then, makes particular scientists and philosophers more conservative and some more revolutionary?

Almost anyone will agree that probably some personality factors are involved. Biologists will associate different personalities with different strategies. Both innate and acquired factors may be involved. As far as I know, the heritability of conformism has not been studied by behavioral geneticist, but of course the innateness of novelty seeking, harm avoidance and intelligence are all relevant, and they have been studied (e.g. Hammer, 1998).

At the same time, it is more than likely that people will become more conformist over time at least in some dimensions. A revolutionary attitude is a high-risk strategy which all primatologists will associate with young, subdominant males that still have to rise in power. The conformist attitude is easily associated with the defensive attitude of the accomplished territory-holders or those who try to cooperate with them.

Another factor that may influence a person's conformist or revolutionary attitude is his position in his family. As I noted before, Frank Sulloway claims that first-borns tend to be more conformist, whereas later-borns tend to have a more revolutionary attitude. In his *Born to Rebel* (1996) Sulloway tries to show that almost all proponents of revolutionary theories were later-borns. The idea is that first-borns have many advantages over later-borns, even in societies without primogeniture. First-borns are simply earlier on the world, they are stronger, and they simply have to defend what they have got: to them, change means decline. Later-borns meet a world in which they have to fight for their position, in which alternative strategies may be needed, in which justice means change.

The idea that birth order may affect personality development is not strange to anyone familiar with birds. In most birds of prey, for example, eggs do not hatch at the same time and the second and third chicken that is born stands only a chance if there is enough food. If food is scarce, one or more of the youngest chickens will simply die, because the older chickens will eat everything that is brought in by the parents. In times of extreme scarcity, sometimes the youngest birds are even eaten by their older siblings. It has now been found that the theoretical concept of `sibling rivalry' can even throw light on plant biology (Furlow, 1999). If sibling rivalry is such an omnipresent, powerful phenomenon, it is not unlikely that it has led to a series of psychological adaptations as well.

Frank Sulloway claims to have discovered that a person's level of conformism is just such a trait. He claims that during radical ideological revolutions later-borns are about 10 times as likely to support innovations, whereas first-borns display a tendency to resist them first and to accept them only after a considerable lapse of time. That would mean that sibling rivalry is one of the motors of cultural evolution.

Being myself a later-born, I felt initially very attracted to the hypothesis of Sulloway. It explains wonderfully why my own philosophical perspective is so much deeper than that of my two older brothers (of course, they disagree). The fact that later-borns often disagree with the theory (Rowe, 1997; Ruse, 1997; Harris, 1998) fits in very nicely, too. The fact that Galilei, Newton, Einstein, Luther and Freud were all first-borns may only show that their theories were not so revolutionary after all.

Yet, Sulloway has some serious problems. First, as two first-borns have stressed, he has his own idiosyncratic means of `measuring' conformism and the revolutionary mindset (Rowe, 1997; Ruse, 1997). Second, there are reasons to believe that genetic effects overrule birth order effects and that the behavioral differences between siblings are context-dependent. As soon as children are outside the family context, completely different laws start determining their behavior (Harris, 1998).

There are also studies that seem to confirm Sulloway's theory, however, at least to the extent that there are significant birth order effects and that niche formation within families does occur. Jennifer Davis (1997) found that older children are more status oriented than later-borns. Catherine Salmon and Martin Daly (1998) found that firstborns and lastborns both are most parentally and familially oriented, while middleborns are the least. They suggest that "the combination of firstborn favoritism, lastborn freedom from competition from successors, and maternal age effects appears to result in greater family interest and reliance on the part of the first and lastborns, whereas middleborns apparently invest more of their efforts in non-kin reciprocal relationships" (Salmon & Daly, 1998: 311).

As a philosopher, who happens to be a middleborn as well, I do not feel competent to decide who is right in the ongoing debate on birth order effects. Perhaps it is still to early, too. One thing I know for sure is that in large families (I come from a family of five) a lot of niche formation is going on, but whether the patterns of parental investments and character formation can always be predicted from such a simple phenomenon as birth order I do not know. In a generalized form, Sulloway's ideas make a lot of sense to me, however. Cultural evolution is driven by an equilibrium of opposing strategies within the population, such as conformism versus rebelliousness, cooperation versus competition. In that respect his theory seems to me to point at least into the right direction. Once again, a picture emerges of individuals with `biological' interests, who have to join in the `culture play' to attain their goals. Culture is shown to be an `arena' and cultural abilities are really fighting abilities which demonstrate the vitality and genetic qualities of their owners.

5.19 WHAT COMPETITION?: DIFFERENT CHARACTERS?

As far as we now know, the difference between firstborns and laterborns is entirely nongenetic. If culture should be seen as a kind of `arena', perhaps some innate personality types or tendencies can also be seen as the embodiment of opposing evolutionary strategies. Traditionally, evolutionary psychology has paid little attention to the possibility of adaptive genetic variation within the human population. Yet, in a large number of species adaptive individual differences have been observed and these differences are typically caused by a mixture of genetic polymorphism and phenotypic plasticity (D.S. Wilson, 1994). In recent years, Dutch researchers like Koolhaas and van Drenth have discovered two types of individuals in mice, great tits and pigs: an impulsive, aggressive type and a more cautious, thoughtful type. The fastness and brutality of the first type is thought to be particularly favorable in social environments, whereas the prudence and tact of the second type is thought to be favorable in new, unknown environments. It is almost impossible to resist the temptation of drawing parallels to humans, for example to the differences between extraverts and introverts which have a heritability between .32 (`narrow-sense', purely additive effects) and .49 (`broad-sense', that is including nonadditive effects; Rowe, 1994).

A somewhat more complex polymorphism has been found in the Ruff (*Philomachus pugnax)* in which three different types of males all seem to embody different strategies (Ehrlich *et al.*, 1994; Van Rhijn, 1991). This species is especially interesting to me in the context of this chapter, because it is a species with `leks' or communal display grounds and I have been comparing culture with a kind of arena. In the Ruff, there are on the one hand `independent' males (`honkmannen' in Dutch) who aggressively defend a territory on the lek, while displaying their dark display plumage, especially their ruff of neck feathers. On the other hand there are `satellites' (satelietmannen) who generally do not display and are more or less tolerated by the independents. They can be easily recognized by their light or even white ruff. A third group of males are the marginal ones (`randmannen' in Dutch): they have not yet succeeded in establishing a territory on the lek.

The strategy of the `independents' probably costs most energy, because they have to fight a lot. Their strategy has evolved, because it affords the best mating opportunities. In one case one independent male on a Dutch lek was seen to participate in 52 of 100 copulations. It is still unclear why independent males tolerate satellites, but it is likely that they help to attract the females, who sometimes copulate with them opportunistically. It is not hard to see why it is better to be a satellite male than a marginal one.

Of course, there are no exact parallels between the lek-system of the Ruff and the human cultural arena. The underlying mating system is also completely different: male Ruffs do not help feeding the young. Yet, one can argue that, if the relatively simple lek system of the Ruff gives rise to different strategies, the complex lek-plus-pair-bonding system of man should have allowed for the evolution of even more specialized strategies which all find their own niche in the system. Models in game theory show that behavioral strategies can give rise to opposing strategies which coexist in a stabile equilibrium (e.g. Ridley, 1996). Certainly, if we look at the ways in which it pays to be specialized in cultures around the globe, even in `primitive' ones (in which one specialize in being a good hunter, a skilled toolmaker, a craftsman, a midwife, a shaman, a leader, etc.), it seems not unlikely that a lot of disruptive selection (see figure 5-3) has been going on for many, many millennia.

At the same time, as geneticists are gradually decoding the human genome, it gradually becomes both tempting and inevitable to speculate on the adaptive meaning of variations that can be found in certain genes. The moment a genetic basis for homosexuality, depression, schizophrenia, novelty-seeking etc. is found (as we discussed in 5.9 and 5.10), at least some theoretians will start wondering why these genes evolved in the first place, why they did not go extinct long ago and whether they are, perhaps, part of an adaptive human polymorphism. It has been suggested, for example, that homosexuals are really a kind of satellite males who apparently pose no thread to the macho `independents', but who turn out to be occasional bisexuals or `cryptic heterosexuals' if there is an opportunity (Badcock, 1990). If we accept the notion that man is a pair-bonding species with male competition over women and resources and with women trying to bind resourceful or dominant men and force them into more paternal investment, homosexuality can be interpreted as a strategy which both evades direct competition with other males over women ànd female sexual selection and manipulation. Because homosexuals are able to evade many of the pitfalls of male-male competition over women as well as the burden of paternal investment, they could be relatively joyful and carefree - thus, gay - and they could have plenty of time to attain high positions in their societies. In the end the fitness loss of having no official children could be compensated by the extra, occasional bisexual opportunities offered by their power and freedom. (While this hypothesis is at the moment pure speculation inspired by indications of a hereditary basis of homosexuality (5.10), it could be made testable easily.)

An intriguing speculation with respect to a polymorphism that could be relevant with respect to the origin and nature of human culture, concerns the adaptive meaning of schizophrenia. Price and Stevens (1998; see also Stevens & Price, 1996) note that schizophrenia has a genetic base and affects 1% of the population, although it leads to a 30% fertility reduction in patients. The rates of schizophrenia in parents and siblings of patients are about the same, which excludes the possibility that genes for schizophrenia are protected from selection by recessivity. Price and Stevens speculate that schizophrenia is an extreme manifestion of the schizotypal personality, first noted by characterologist Kretschmer (see, e.g. Helwig, 1972). Schizotypes often display highly idiosyncratic perceptions and beliefs and the delusions and hallucinations of schizophrenics are really only extreme manifestions of this characteristic. Shamans, prophets, gurus, cult leaders and other religious personalities have apparently been schizotypal personalities and their auditory hallucinations have given them authority as divine mediators or oracles. They often have a talent for forming new ways of seeing things - new theories or `paradigms' - through a radical rethinking of what they have learned.

Price and Stevens refer in this context to the work of the psychologist Wallace about `mazeway resynthesis' (1956). The mazeway is the individual equivalent of culture and comprises an individual's values, goals, beliefs, and his experience of himself, other people, and the world as a whole. The mazeway may come under strain in difficult periods and some individuals may go through a period of illness or depression to emerge afterwards with new ideas about themselves and the world. Wallace calls this phenomenon `mazeway resynthesis'. Philosophers of science, after Kuhn, would, of course, speak about `paradigms', because ultimately, according to Kuhn, the transition from one paradigm to another has no foundation and can be compared to a conversion. It is never `proven' that one paradigm is wrong, but if anomalies accumulate and if someone finds a new a way of explaining the data, a *Gestalt switch* may occur in which a new paradigm arises. (Of course, mazeways are to some extent more encompassing, but less rigid, than specialized scientific theories.)

Price and Stevens place the notion of mazeway resynthesis in the context of group formation and group splitting. They argue that human groups are normally organized under ideological banners and that it is possible, within groups, to relate in different ways to this banner. One can, for example, cooperate with other males to defend the ideology, one can also use it more hypocritically or neglect it altogether. They propose that it is the `schizotypal strategy' to form a new ideology and to attempt founding one's own group. Schizotypes who succeed are cult leaders, prophets, gurus etc., schizotypes who do not find a following are considered to be madmen or schizophrenes.

Whether true or not, their speculation shows how the traditions of characterology and personality psychology might help evolutionary psychology in finding alternative strategies. Informed by an increasing knowledge about different individual strategies within animal societies, by new knowledge about the genes and hormones that influence specific patterns of behavior, and by better techniques to find patterns in an overwhelming amount of data, psychologists of the future will gradually be able to separate the wheat of human adaptations from the chaff of pure accidental variation. At this moment, human personality psychology is just starting to think about the adaptive advantages of certain traits and the first hypotheses are still either overcautious or rather speculative (Buss, 1996; Winter, 1996). Let us look at two systems and investigate whether they in principle could reveal something like an adaptive human polymorphism: the relatively old-fashioned `constitutional' system of Sheldon, and the currently more popular five-factor model of personality.

Character type ------->	Viscerotonic	Somatotonic	Cerebrotonic
Development of embryo layer	Endoderm (stomach and intestines)	Mesoderm (muscles and bones)	Ectoderm (skin and nerve tissue)
Related body type	Endomorph	Mesomorph	Ectomorph
Prominent physical characteristics	Soft & round.	Hard & angular with heavy bones, muscular.	Long, fragile bones; dry skin.
Temperamental characteristics	Likes comfort & luxury. Very social, emotionally extraverted, conformistic.	Likes to excercise & to conquer. Extraverted at the level of action (not feelings).	Needs to be alone & to reflect. Sensitive and irritable. Introverted and complex.
Relation to `big five' personality dimensions	Agreeableness Extraversion (emotional)	Emotional stability Extraversion (action)	Intellectual openness Introversion
Relation between conscious and unconscious	Direct and immediate contact.	`Horizontal barrier': no direct contact.	`Vertical circulation': complex relation to oneself.
Sociocultural niche	Social specialist: networking properties & social glue.	Discipline specialist: dependable and hard worker.	Dreaming and planning specialist: visionary that can inspire people.
Characteristic subcultures	Gastronomic & social events.	Sports & military.	Arts & Intellectual.
What it promotes in a society	Social cohesion & well-being.	Safety, discipline & productivity.	Creativity & wisdom.

Table 5-6. The three main character types according to Sheldon and a speculation about their role in different societies. According to Sheldon, each individual is a mixture of these three types and can be given a `score' for each trait.

Sheldon. I have to admit that I feel some kind of personal commitment to the system of Sheldon, perhaps because I learned about it already at a relatively young age via the book of Helwig (1972) and have been trying to understand my world in `Sheldonian' terms ever since, although not always with much success (personality differences are not only a big scientific problem, they are often the source of the most fundamental questions that one can have with respect to human destiny, freedom, justice, meaning, good and evil). Yet, I find it very strange that the few references to Sheldon's system in modern textbooks of personality psychology do not offer me decisive reasons to reject his system. Instead, they give me the impression that Sheldon's system has simply been forgotten too fast. There are a few very positive references, but most textbooks (e.g. Winter, 1996; Pervin, 1996) simply neglect both Kretschmer and Sheldon, jumping from Jung's to Eysenk's introverts in a hurry to end up singing the joyful message of the five factor model. Are personality psychologists forgetting that the research of Sheldon was very thorough indeed and was based on physical and psychological examinations of hundreds of individuals? To me Sheldon seems still very interesting as a biological thinking psychologist - it seems as if it was no accident that his godfather was nobody less than William James, *the* godfather of evolutionary psychology as a whole.

Thus, let us have a look at his system (e.g. Sheldon, 1942; Helwig, 1972; Verdonck, 1972). On the basis of the physical examination of 4000 male students, Sheldon first developed a classification of body types. To his surprise he found that the best way to order the data was by giving each individual a `score' for three body components that `happened' to correlate with the relative weight given to functions related with the three layers of the embryo, the endoderm, mesoderm and ectoderm (the score for each component is from 1 to 7, originally the total score was thought to be between 9 and 12, later Sheldon found individuals with total scores up to 15).

The real surprise, however, came when Sheldon started to look for correlations between the body types and characters of 200 students. The psychological research of each student consisted of 20 interviews in which 60 different traits were scored. This research forced Sheldon to group theses traits to his surprise into three groups, with a very high correlation (.80) to the three body types. The *viscerotone* correlates with the *endomorph,* the *somatotone* with the *mesomorph,* and the *cerebrotone* with the *ectomorph*. Because psychological characteristics correlate with body types, Sheldon is able even to `classify' historical figures: he recognizes Jesus, for example, as a typical 235 or 236 (viscertonic component 2, somatotonic component 3, cerebrotonic component 5 or 6). One of the reasons, of course, that his classifications has appeal for the evolutionists, is that Sheldon relates his components to the development of the three different layers of the embryo. This makes it more easy to imagine that there already have been `master genes' related to the development of these layers which simply had to be developed further by disruptional selection.

A summary of the first decades of critical evaluation of Sheldon's work can be found in the work of Verdonck (1972). Some studies show that the exact `determination' of a specific body type can be reliably replicated by independent researchers. It seems that Sheldon's body types are also independent of diets and sports and that it is not extremely hard to classify them independent of age. A critical point mentioned by Verdonck is that Sheldon both supervised the `somatotyping' and the psychological measurements. Yet, other studies, in which the psychological measurements were based on various systems of self-assessment, found also correlations, sometimes higher (Cortés en Gatti, 1965, 1972), sometimes lower (Child, 1950).

In principle, Sheldon's classification into three main character types could clarify a lot with respect to culture. The fact that one even feels resonances of Plato's and Aristotle's division into a life of `pleasure', `honor' and `theory' makes it sound familiar to philosophers, who are themselves the typical `cerebrotones', according to Sheldon. While most other culture creators and bearers (including artists, educators, psychological mentors) at least have a strong cerebrotonic component in their personalities, cultures are more or less dominated by other personality types as a consequence of a complex interplay between ecological, political and technological-economical circumstances. In cultures which are dominated by the military, like ancient Sparta and nazi Germany, a whole set of values which are especially embodied in the `somatotonic' personality type are cultivated: discipline, a distaste for the aberrant, a strong competitive spirit. Thus, cultures are dominated by character types that are mostly needed as a result of particular circumstances. As these circumstances change over time, the whole profile of a culture may shift. At the same time, there are constant factors which have had an influence over centuries in some parts of the world. As a result, selection may have promoted particular personality types for such a long period that they have become part of the national character. The existence of a national character would thus not be a myth, nor a biologistic and deterministic dogma, but a real consequence of the processes of interaction and reinforcement which are going on between genes, ecological circumstances and culture.

Of course, it should be stressed at the same time that the dominance of one character type in a culture will almost automatically create peripheral subcultures in which alternative strategies are stressed and defended. This is especially the case in very large societies like our own in which the amount of cultural niches is enormous and in which the dominant group is limited in its power to enforce her rules and values. Individuals that do not fit the dominant culture are not reinforced by that culture in their personal strategies and will not feel at ease in that culture. They will, consequently, either look for a subculture in which their strategies and values are reinforced, or create one themselves. Of course, their lives will not be as easy as those individuals that do fit the dominant culture and often they will never find their own niches and simply end up in chronic depression or other diseases. Naturally, patterns of reproductive success will to some extent reflect the different success of different characters and strategies. In this way, different genes will be tested in one population throughout its cultural history creating a gene pool which harbors adaptive properties for a wide variety of economic and cultural circumstances.

Figure 5-8 is an attempt to remodel my hypothesis in Sheldonian terms. A particular culture becomes dominant because it offers the best solutions to the collective problems as they arise within particular ecological and economic contexts. As a result, a `working force' is needed with particular talents. Individuals displaying those talents are selected and stimulated with awards which enhance their status and/or their reproductive success. Because each culture selects particular properties from a `talent pool' which is at least partially based on a series of genes (and partially reinforced by different subcultures), it automatically has consequences for the `gene pool' also.

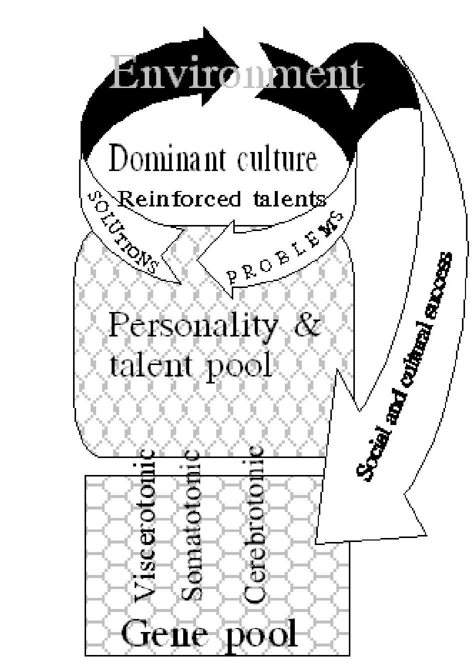


Fig. 5-8. Interactions between culture and different character types.

The spectrum of human characterological differences thus reflects the history of selection during the series of cultures which a population has created in interaction with its environmental and economic problems throughout the millennia. Because different ecological and economic circumstances are beneficent to different characters, however, an unused reservoir of human possibilities survives each generation. As long as the resources of the population permit this, such talents are nurtured and reinforced within all kinds of subcultures. The selection pressure becomes tighter, however, in harder times. In these circumstances, competition becomes fiercer and the dominant culture may become less tolerant with respect to different subcultures. As we have often seen during the twentieth century such intolerance may even climax in internal genocide, a process which is difficult to explain by means of the standard theories of social science.

Extraversion: Surgency, Introversion-Extraversion, Dominance, Positive Emotionality	
Is outgoing, decisive, persuasive, and enjoys leadership roles	Is retiring, reserved, withdrawn, and does not enjoy being the center of attention
Neuroticism: Anxiety, Emotional Stability, Stress, Reactivity, Negative Emotionality	
Is emotionally unstable, nervous, irritable, and prone to worry	Quickly gets over upsetting experiences, stable, and not prone to worries and fears
Consientiousness: Conformity, Dependability, Authoritarianism, Constraint	
Is planful, organized, responsible, practical, and dependable	Is impulsive, careless, irresponsible, and cannot be depended upon
Agreeableness: Likability, Friendliness, Pleasant, Aggression	
Is sympathetic, warm, kind, good-natured, and will not take advantage of others	Is quarrelsome, aggressive, unfriendly, cold, and vindictive
Openness: Culture, Intellect, Sophistication, Imagination, Absorption	
Is insightful, curious, original, imaginative, and open to novel experiences and stimuli	Has narrow interests, is unintelligent, unreflective, and shallow

Table 5-7. The five factor model of personality as it is presented by Bouchard, 1994: 1700.

The five factor model. Such speculations, however, could also be based on other characterological systems. As I said already, the five factor model of personality traits is currently much more popular than Sheldon's system. Table 5-7 gives an impression of the `OCEAN'- version of this model with both poles for each trait. One of the strong points of this model is that it has emerged as a consensus between many independently working researchers. At the same time (as we have seen in 5.9), behavioral geneticists have found relatively high heritability scores for each of the `big five' personality dimensions. In figure 5-3, I already gave the parameters as they are estimated by Rowe (1994; compare Bouchard, 1994, who does not give exact numbers). According to Rowe, there is a small influence of the rearing environment on all five personality dimensions (2% to 9% of the total variation), but the parent-child environmental influence is negligible. (To place these figures in perspective, the heritability of height is .80; for weight it is .60; for IQ it is .50, for TV viewing it is .20; Pervin, 1996).

At the same time, psychologists are gradually starting to speculate about the possible adaptive meaning of the five traits (Tooby & Cosmides, 1990; Bouchard, 1994; Buss, 1996). Strangely enough, however, there is one factor that often complicates the search for this adaptive meaning. This is the tendency to evaluate a trait as desirable or not. What I often find missing in discussions about the possible adaptive meaning of personality traits is an awareness that both ends of the spectrum of scores for each trait could point to a particular adaptive strategy. If only one pole of the continuum would be adaptive, this would point to a simple process of directional selection (see figure 5-5): this would mean at the same time that large differences would be unlikely. If, however, personality differences reflect a real human polymorphism these differences would somehow have to be maintained by stabilizing and/or disruptive selection (again, see figure 5-5). That would mean that it is not *always* good to be extraverted, open to experience, conscientious, nonneurotic, and agreeable. Otherwise, why wouldn't genes for introversion, authoritarianism, non-conscientiousness, neuroticism and hatefulness go extinct? Ideally, the distribution for each trait could give us clues about the kind of selection involved, but I do not know whether such data exist.

The first steps into the direction of an adaptive interpretation of personality traits can be found in the literature, however, as was already indicated in § 5.9. Much speculation is going on, for example, with respect to the biological basis for each trait, and with respect to the role that each trait plays in the context of the whole behavioral repertoire of an individual. For example, extraversion is linked to a `behavioral approach system' (BAS) which drives the individual forward towards the challenges that it faces, while neuroticism is linked to an opposite `behavioral inhibition system' (BIS) which forces an individual to be cautious (Gray, 1987; McAdams, 2001). The underlying neurotransmitter could be dopamine in the first case and serotonin in the second case (Cloninger, 1991). Thus, we would come back to the differences between tits at the feeding station observed by Drenth and others. Opposite personality traits thus would reflect fundamentally different strategies with respect to the struggle for life.

Another dimension in which opposite traits/strategies could be adaptive could be the tension between the egotistic drive towards self-fulfillment and the tendency to behave socially acceptable and desirable. The psychologist John Digman (1997) suggests, for example, that the `big five' boil down to a `big two'. Agreeableness, conscientiousness and emotional stability (nonneuroticism) help a person to remain part of a cooperation group by loving and working, while extraversion/introversion and openness to experience help a person to develop his own possibilities (McAdams, 2001).

These suggestions still do not explain, however, why there are such differences with respect to each trait. An attempt to find the adaptive value of the *variation* for each trait, inspired by Tooby and Cosmides (1990), can be found in Winter (1996: 522-524) who, however, thinks in very `group selectionistic' terms:

> ... social organization may require `surgent' leaders, but it also needs nonsurgent followers; thus both types would coexist in a mutually beneficial relationship... Agreeable and conscientious people may be necessary to get the routine work of a society done, but creative innovation may come from the disagreeable and lazy people who ignore social conventions and think up new and better adaptations (Winter, 1996: 522).

Extraversion: Surgency, Introversion-Extraversion, Dominance, Positive Emotionality	
Leadership: reproductive advantages	Accepting a subdominant position to avoid conflict: it is better to loose than to die
Neuroticism: Anxiety, Emotional Stability, Stress, Reactivity, Negative Emotionality	
Recognizing & avoiding danger at an early stage	Striving for one's goals in life, resistance to stress
Conscientiousness: Conformity, Dependability, Authoritarianism, Constraint	
Being a helpful and dependable cooperator: fitness advantages of cooperation	Being able to follow one's own ideas and needs: being innovative and creative (?)
Agreeableness: Likability, Friendliness, Pleasant, Aggression	
Being part of a social network	Being able to defend one's own interests, resisting social pressure and too much obligations
Openness: Culture, Intellect, Sophistication, Imagination, Absorption	
Being able to adapt a culture to new circumstances	Relying on `received wisdom' and conformism

Table 5-8. Possible reasons why variation in the `big five' personality traits is maintained. Changed after Winter, 1996: 522.

In table 5-8 I have reworked a table by Winter partly by stressing advantages of each trait at the individual level. The idea behind this table is that variation in the big five personality factors is maintained, because the process of competition and cooperation within a society creates opposing strategic niches like leading ←-→ following, networking ←-→ resisting social pressure, cooperating ←-→ following one's own needs, resistance to stress ←-→ avoiding of stress, creativity ←-→ conformism. Of course, over time the selection climate will also fluctuate as a result of which the `equilibrium point' between both poles of a trait is continually moving. It is quite possible, for example, that all Neanderthals were much less open to experience than even a relatively conforming modern *Homo sapiens*. From an evolutionary point of view personality traits are, of course, just the opposite behavioral dispositions of individuals at a given point in their species' history.

5.20 CONFLICTS BETWEEN THE SEXES

While evolutionary psychology has been neglecting characterology and personality psychology to some extent, it has stressed the evolutionary roots of sex differences. At least one third of the literature on evolutionary psychology is devoted to this subject, probably as a consequence of its relevance in an era which is dominated by an egalitarian ideology and a large demand for female workers. Much of this literature is devoted to differences in sexual strategies between the sexes, which arises from the facts of anisogamy (in most plants and animals) and internal incubation (in mammals).

type of mating	what men want	what women want
short-term	❍ many partners ❍ clues about sexual accessibility, fertility ❍ minimizing cost, risk and commitment	❍ increasing their resources (rewards, gifts) ❍ evaluating their short-term mates as possible long-term mates ❍ good genes ❍ backup partners
long-term	❍ paternity confidence ❍ large residual reproductive capacity ❍ clues about youth and fertility ❍ commitment ❍ good parental skills ❍ high-quality genes	❍ men who are able and willing to invest ❍ clues with respect to wealth & success ❍ physical protection from aggressive men ❍ commitment ❍ good parental skills ❍ high-quality genes

Table 5-9. Differences in the reproductive priorities of man and women as reflected in different attitudes towards short-term and long-term relationships. Changed after Buss, 1994.

As I have explained in chapter 3.2, Trivers postulated in 1972 that differences in sexual strategies between the sexes derive from differences in parental investment. Members of the most investing sex are a scarce commodity to the less investing sex, because they limit their possibility to reproduce their genes. As a result, members of the less investing sex compete with one another over the access to members of the most investing sex. In fish and birds the most investing sex is sometimes the male sex. As a result of pregnancy and lactation, the female sex is the most investing sex in most mammals. In opposition to chimpanzee males, human males exhibit some paternal investment in their offspring. As a result, one would expect in humans much competition between males, but also a moderate degree of female competition over males. One would also expect sexual selection in human females not entirely to be directed at `good genes', but also to be directed, to some extent, at `good fathers'. On the basis of these two theoretical expectations one can understand large parts of Western literature and many of the intricacies of everyday live.

One of the largest studies with respect to sexual selection in both sexes of our species has been conducted by the evolutionary psychologist David Buss of the university of Michigan. In table 5-5 I have already reproduced (within the framework of the discussion of the sexual selection of cultural abilities) some of his findings (Buss, 1990). His studies show that there do exist universal patterns in mate preferences. It would thus be wrong to assume that human mate preferences are simply idiosyncratic or culture-bound. Instead, human males and females continue to exhibit sex-specific strategies that reflect the adaptive problems that they have faced during their evolutionary history. The differences between male and female strategies stand out especially clear if we study their priorities in both short-term and long-term relationships (Buss & Schmitt, 1993; Buss 1994a; 1994b). On the basis of the `low cost' of their gametes one would expect males to be more specialized in increasing their partner number, while minimizing cost, risk and commitment. Within long-term relationships with paternal investment one would expect males to be especially obsessive about their paternity, because they alone run the risk of being ignorant of the fact that all their investment is directed at children which do not carry their genes. On the other hand, one would expect females to be more cautious, selective and directed at gaining access to resources within both short-term and long-term relationships. Table 5-9 is adapted from Buss (1994) and shows the different priorities of men and women as these result from differences in the size of their gametes and in their `obligatory' reproductive investment. I have changed the table in such a way that it shows more clearly that there is some convergence of male and female interests in the context of long-term relationships.

By collaborating with 50 scientists in 37 countries Buss was able to survey the mating patterns of more than 10.000 individuals and to confirm these patterns. Of course, there are some exceptions. Happily enough, The Netherlands is the only country in which women place relatively small value on the financial prospects of their long-term mates. On the whole, Buss' research has confirmed the expected cross-cultural mating patterns. Other studies have shown how sex differences result in differences in sexual jealousy (Buss *et all,* 1992) or in the reasons given for divorce (Betzig, 1989). All these studies together have seriously undermined the old feminist assumption that gender differences are entirely products of culture.

Of course, the male and female mind do not only differ in mating preferences. Man and women have somewhat different brains (Moir & Jessel, 1991; Kimura, 1992), which are to some extent (disruptively) adapted to their specific roles in the atavistic economy. Because male and female chimpanzees do already exhibit a sexual division of labor in which males do most of the hunting and females are typical gatherers (McGrew, 1992) and because we see this division of labor in most primitive societies, it is not unreasonable to assume that early man lived in a hunter-gatherer society with a similar division of labor (more about this in part III). As we already saw in chapter 2, many cognitive differences between man and women can be explained if we assume that human males are typical hunters while human females are more specialized in gathering and caring.

Cognitive domains or emotional priorities	Male specializations	Female specializations
Sensation	Better vision in brightly lit environs	Better vision in poorly lit environs; more acute hearing and sense of smell
Perception	Recognizing a simple shape within a complex figure	Perceptual speed: finding matching items
Spatial abilities	Mental object rotations; reading maps	Object memory
Motor skills	Target-directed motor skills, throwing, intercepting projectiles	Precision manual tasks, involving fine motor coordination
Mathematical skills	Mathematical reasoning	Mathematical calculation
Linguistic skills	Lower verbal fluency, more often dyslexic	Slightly higher verbal fluency
Social skills	Building dominance hierarchies	Building social networks
Interests	Oriented on objects/matters	Oriented on persons/relationships
Self-image	Based on power/influence	Based on interaction
Evolutionary context: supposed tasks in environment of evolutionary adaptedness	Hunting: searching throughout large areas, locating & catching prey, perhaps by throwing. Defending the group.	Gathering food near the camp, tending the home, preparing food and clothing, caring for children.

Table 5-10. Some differences between men and women, according to Tyler, 1965; Hutt, 1972; MacCoby & Jacklin, 1974; Kimura, 1992; Eals & Silverman, 1992; Eibl-Eibesfeldt, 1995; Potts & Short, 1999, Lopreato & Crippen, 1999.

Table 5-10 summarizes some of the cognitive and motivational differences between men and women that have been found.Note that this table does not simply state that `boys are better than girls at math' or that `males are superior in spatial ability' (Hyde, 1996). From an evolutionary perspective one would not expect simply a difference in magnitude in male and female talents, but different male and female talents. This has inspired, for example, Eals and Silverman (1992) to search for alternative spatial skills in women.

Of course, some feminist still tend to play down differences between man and women. For example, Hyde (1996) looks at some textbook wisdoms in a refreshing way and shows that many textbooks tend to overgeneralize and exaggerate differences. She does not deny differences altogether, however, and admits, for example, that males outperform females in three-dimensional mental rotation tests. The most important difference between the sexes that she finds is a large difference in aggression and also one the attitude towards casual sex. Hopefully she would agree with my improved list in table 5-10, but I fear that she still would find it too biased.

Course (+ number of years)	% Men	% Women	Course (+ number of years)	% Men	% Women
Consumer (2 years)	3	97	Natural sciences (3)	72	28
Clothing manufacture (2)	4	96	Agriculture	58	42
Social services (2)	7	93	Natural science-technology (2)	72	28
Nursing and care (2)	8	92	Processing (2)	88	12
Distribution and clerical (2)	17	83	Technology (4)	89	11
Liberal arts (3)	24	76	Woodworking (4)	94	6
Social sciences (3)	24	76	Operation and maintenance (2)	96	4
Social (2)	37	63	Technology (2)	96	4
Economics (2)	38	62	Workshop (2)	96	4
Economics (3)	42	58	Motor engineering (2)	97	3
Food manufacturing (2)	48	52	Forestry (2)	98	2
Horticulture (2)	49	51	Electro-telecommunications (2)	98	2
Music (2)	51	49	Building and construction (2)	98	2

Table 5-11. Sex distribution of applicants for courses in Swedish secondary schools, autumn 1980. Data from B. Wistrand, Swedish Institute (Potts & Short, 1999).

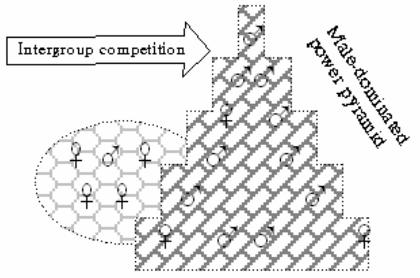
Yet, from an evolutionary perspective one expects huge differences between the sexes and there is no reason to dismiss all studies with respect to these differences altogether. In recent years differences between male and female brains have been found (for example the female *Corpus callosum* contains more connections between both halves of the brain) and a phenomenon like the *adrenogenital syndrome* shows that these cannot be explained as a result of enculturation alone. The andrenogenital syndrome results from an abnormality in the adrenal glands of the kidneys as a result of which some female babies receive a doses of a substance similar to male hormones. These babies develop into individuals with a series of male psychological characteristics (Ehrhardt, 1985; Moir & Jessel, 1991).

It is clear that sex differences have results at the level of occupational interests and choices (see table 5-11) and thus have consequences for the type of culture in which one lives. Because men and women have different interests, cultural arrangements of things and the organization of a culture will often be more advantageous to one sex than to the other. A culture that is dominated by men will be different from a culture that is dominated by women. Often there is, of course, a kind of balance of power, even in cases in which males occupy most dominant positions.

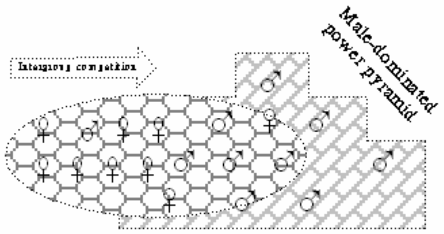
Almost everyone will agree that western culture has changed during the last decades in such a way that the role of women has become more prominent or at least more visible. The explanation of this process of cultural change could be a testcase of the theory exposed in this chapter. If culturalistic theories (including theories of ideational selection) would be right, this change would be purely the result of (the selection of) feminist ideas. If cultural materialism would be right, it would be the result of a series of environmental changes with respect to a very small collection of human needs. Evolutionary psychology would predict that the revolution is a consequence of the ways in which males and females and their interaction react to environmental and technological changes.

The weakness of culturalism is that it does not explain why feminist ideas would become more influential instead of, for example, fascistic ideas. If a human population is `influenced' by a small collection of creative minds, it is unclear who selects this collection of minds. A cultural materialistic explanation would have the benefit of introducing environmental variables, but would at the same time restrict itself unnecessarily by limiting the number of causal factors involved. The evolutionary psychological explanation would have the benefit of introducing a more complete model of human nature, thus allowing environmental variables to have an influence on factors which do not only concern food, convenience, sex and safety.

It seems to me that the `feminization' of our culture can only be explained as a result of the ways in which technology has improved the lives of women - and has made men less indispensable in some respects. Pure muscular power has become less important. Hunting and even the role of men as physical protectors of women have become less important. On the other hand, in our `information society' social networking, some precision manual skills (type writing) and verbal fluency have become very important (Roele, 2000). Anticonceptiva have enabled women to invest more time in education and in improving their position in the social hierarchy. Because the pill helps women to stay young and beautiful longer, dominant males may even sometimes tend to hire women as a kind of harem substitute. Certainly the pill has an influence on our mating strategies, too, allowing partners to test each other longer and reinforcing a tendency towards serial monogamy, which can be seen as a mild version of polygamy. Because the pill does strengthen the position of women, it has probably the overall effect of making sexual selection more severe.



a. Hierarchical society



b. Egalitarian society

Fig. 5-9. A speculation with respect to the influence of intergroup competition on the balance of power between the sexes.

Although it seems that most cultures in the past have been relatively male-dominated, there is enough historical documentation to prove slight fluctuations in this respect. On the basis of Alexander's model of intergroup competition, on which I shall digress in part III, we can postulate that competition between societies forces the males within those societies to cooperate more intensively, to form more disciplined hierarchical social structures and to be less tolerant also towards parasitic tendencies within a society. In such societies the male power pyramid becomes steeper and `vertical' social competition (between classes) fiercer.

Of course, in a culture in which women have more power, female values will be more influential. The male power hierarchy will flatten and on the whole, egalitarian tendencies will become stronger (fig. 5-9). In our times, this may have contributed to the rising popularity of the idea of human and animal rights. That does not mean, however, that a more egalitarian society is `better'. The moment the male power hierarchy becomes weaker there is less defence against both external and internal threats and the whole edifice of the `culture cooperation' can be weakened. As a result, cultures tend to zigzag between more hierarchical and more egalitarian structures.

This should not seduce us into thinking that societies in which women have more power are advantageous to all women equally. If societies of the past have always oscillated between different power structures, it is to be expected that women are ambivalent about male power and some women will have an advantage in male-dominated societies, while others profit in a more egalitarian system. Of course, the same goes for men. In a world in which power is always scarce, there is no reason to suppose that there could be a distribution of power which would satisfy all possible parties. Consequently it is implausible that the `feminization' of our own culture implies an improvement for everyone.

5.21 CONFLICTS BETWEEN GENERATIONS

Conflicts between generations can be seen in almost all societies, animal and human alike. Natural selection has designed mortal and sexual creatures, because immortal and asexual ones would not be able to cope with environmental and parasitical challenges (at least according to the theories of Williams and Hamilton). Individual animals, however, are survival machines of their unique collection of genes. If those genes are served best by a powerful position within a society, it is always best to maintain and defend that position as long as possible. From the point of view of a new generation it will be profitable, however, to gain access to powerful positions as early as possible. Consequently, apart from the usual parent-offspring conflicts, one would expect a more general conflict between individuals of subsequent generations, especially but not exclusively, the males (there is probably not much more to the `Oedipus conflict').

In our species, the struggle between generations is fought out partly in the arena of culture. Different generations are often encultured in slightly different types of culture. The older generation will often cling to its own type of culture with its own solutions, obsessions and status symbols, the newer generation will come with renewals which are supposed to be improvements given new ecological and economic realities. As a result, the conflict between generations will deepen at the moment that a culture is forced to change as a result of new circumstances.

Of course, in many societies the older generation has sought to protect its power by creating proofs and symbols of its experience. The almost universal initialization rituals function to create a bridge between the inexperienced and the experienced, those who know and those who have to be initiated. Again we see here why it is necessary to master skills and to create objects which are very hard to imitate. If it were easy to imitate their art and skills, the experienced would fall from their pedestals.

Of course, to the extent that a society becomes dependent on knowledge or skills which are hard to attain, members of the different generations have to cooperate in a training process in which knowledge or these skills are passed on. A species in which the conflict between generations would be total would have to create a new culture each generation. In our own society which is entirely dependent on elaborate technologies which are only understood by professionals who have been trained specifically to do so, cooperation between generations is imperative and is much stronger than conflict. Yet, an underlying conflict may still be the motor of cultural change, especially in areas in which quality is to some extent a matter of taste.

5.22 COMPETITION AND COOPERATION AS MOTORS OF CULTURE

I have argued that conflicting biological interests are expressed at the level of culture. At the same time, I have to admit that human culture by its very nature is characterized by intense cooperation. The explanation of this extreme level of cooperation is as difficult as the explanation of other kinds of `bio-altruism' (see chapter 4). A long series of authors, between Darwin and Richard Alexander have sought to explain it with reference to the competition and arms races between different human societies. If one society is a threat to another society, both societies have reasons to have the best weapons, the best discipline, the best type of cooperation (see part III).

In principle, many elements of culture could be explained with reference to their ability to unite a people, to give them an identity, a sense of belonging and meaning. Certainly morality and religion seem to fulfill this function. Even human language itself seems to have an inherent tendency to diversify into local dialects which separate one group from another. Local dialects enable people to distinguish `us' from `them' the moment that someone opens his mouth to speak (Dunbar, 1996: chapter 8). Thus, David Smillie can write that

> ... culture might best be seen as a way of establishing a symbolic system of social coherence and coordination rather than as a means of transmitting knowledge from generation to generation analogous to genetic transmission systems (Smillie, 1996).

Whether these two possibilities are really in opposition is another question. Culture could have evolved to such an extend in the human species because there were arms races between groups - arms races in which those groups with both the best group-uniting symbols and those with the best functional knowledge had an advantage over other groups.

In the same way the *inter*group competition hypothesis and the *intra*group competition hypothesis of culture could supplement each other as I have claimed: competition *between* groups could enhance the intensity of both cooperation and competition *within* groups (5.20 and fig. 5-9). This idea supplements the dual selection of cultural abilities that I introduced in 5.14. On the one hand, human males have to compete with other males of the same group to be able to climb on the social ladder and to improve their chances of being sexually selected, on the other hand they have to cooperate with them and to be accepted as a cooperator by them, because cooperation is indispensable if one wants to compete with other groups. The complexity and intelligence of the human mind could well have arisen from the resulting mixture of sexual and social selection. All this could help to give the evolutionary psychological model of culture (model 6) more flesh and blood, but it shows at the same time that this model is necessarily complex and hard to explain. Reality is of such a complexity that it is hard to abstract it into a simple model in which all selection forces are pushing and pulling into the same direction (e.g. `more intelligence'). It is quite possible that sexual and social selection are to some extent working in opposition and that different intelligent strategies are co-evolving in ever fluctuating divisions of power. In the third part of this book I will come back to the many complexities of human cultural and physical evolution.

5.23 TESTS, STRESS, WEALTH AND WELL-BEING

Is this model of culture compatible with our own subjective experience? Of course, scientific models do not always fit our personal feelings and experiences, some of which are based on illusions. That is one of the reasons we cannot always trust our intuitions: science is often counter-intuitive or trans-intuitive and meant to correct pure intuition. If science would not be trans-intuitive we would not need it: intuition alone would be sufficient. Yet, with respect to the model of culture that I have outlined, I firmly believe that it is to some extent compatible with our own subjective experiences, at least mine, if interpreted properly. (Even phenomenologists, who tried to base a whole philosophy on the oracle of intuition, had finally to admit that intuition needs interpretation, and turned themselves into `hermeneutics').

Let us try to step back and return to ordinary experience and look whether it fits our interpretation. Is there really so much competition in our societies? Is our culture really such an arena? Does sexual selection really play such a role? I think these questions all need to be answered positively. What to think, for example, of the fact that individuals in our societies are continually tested? Our whole educational system is based on tests which contribute a lot to the continuation of a relatively stratified society. Those tests can be explained as attempts at giving each individual its proper place within society, a place at which it can fully develop its potential, etc.. Yet, at the same time it is clear that at least some of those tests are biased and that they fit the description of a Darwinian struggle at a series of essential points: there are individuals with different genes, there are scarce resources which offer different reproductive opportunities, and there is a lot of stress involved.

If we take stress as a factor betraying the level of competition, it is clear that despite the wealth of western societies, competition has never decreased, but has been actually increasing. It is as if the wealthier we become, the more we have to compete. Instead of finally becoming happy and celebrating the success of our joint economic efforts, we are increasingly fighting over our shares in the booty (Slurink, 2000). Actually, differences in income have increased since the eighties and if we measure wealth in terms of having access to public goods it is not certain whether we have become wealthier or happier. All our collective efforts are to some extent spoilt in the pursuit of luxuries which we only need because we do not want to stay behind our neighbors. Collective progress seems to be the result of arms races and it is a characteristic of arms races that they do not allow one to sit back and enjoy.

Of course, there will always be people claiming that a particular model does not fit their subjective experiences. At the same time, models have to be continually improved to fit all data and all experiences. That does not mean, however, that there ever will be a moment that everyone's intuition is fully compatible with current scientific modelling. The relationship between intuition and science remains a complex one and even if they ever will be married one day, no one can know for sure whether they ever will be happy together.

5.24 CONCLUSION

This chapter had a more humble goal, however. I hope to have shown that culture does not float above the `biological facts' that constitute our physical existence. Culture itself is a biological fact constituted by our long learning period, our need to distinguish ourselves (to demonstrate our superior genes or group) and by our dependence on all kinds of technologies. Cultural change is not the result of our transcendental wanderings through the realms of eternal ideas (as in model 1 and 3), but emerges out of changing ecological situations resulting in changes in the power distribution of different sex-age classes. Instead of forming a kind of `superorganic realm', or even an independent realm (as in models 2 and 4), culture is a battle-ground for a fight over scarce resources in which the interests of the parties engaged are hidden underneath their explicit ideologies. Of course, individuals engaged in cultural battles are by no means genetically determined robots (as in model 5), but they are flexible decision systems unable to choose or fundamentally change the values themselves that they apply in their decisions (model 6, see chapter 3). Thus, model 6 is the most successful, but still needs a lot of refinement and a historical framework.

6

** Genes, Memes and the Environment: Culture in its Ecological Context \\\

6.1 GENES, MEMES, AND THE MISSING LINK

Culture is not simply a `superorganic' phenomenon. To defend this thesis I have shown in chapter 5 how culture reflects intraspecific conflicts: to some extent it is the medium in which individuals, groups and even peoples compete in different alliances. Culture is modified almost constantly as a result of arm races caused by sexual selection and both intra- and intergroup competition. Cooperation seems often to exist only because it enables different groups to compete even better with one another.

Yet, there are still other reasons to reject the idea that culture is purely a superorganic phenomenon. Often, it seems impossible to explain human behavior in terms of sociocultural habits, rules, roles, institutions and traditions only. For some reason or another, cultural rules, roles and institutions are different in different regions of the world and are changing continually. Why would they change? Somehow, they have to be inadequate sometimes. Inadequate to what? Although everyone agrees that sociocultural rules, roles and institutions are no `biological givens', opinions will diverge here.

Social constructivists and many thinkers trained in the social sciences will stress the `underdetermined' nature of sociocultural phenomena. According to them, cultural differences and cultural change both are inexplicable. In this context they will often refer to the fact that man is a `cultural being'. Yet, the history of science proofs that the claim that `we will never be able to explain x' often is a precursor of an explanation of x. Sometimes most pieces of the puzzles are simply already available; and I believe that is the case here. The statement that man is a cultural being is, of course, true, but it is simply not really an explanation.

To explain cultural differences and cultural change one would have to refer to something that makes that sociocultural rules, roles and institutions are becoming obsolete or at least inadequate. If one does not accept some `divine law of nature', sociocultural rules, roles and traditions can only prove to be `inadequate' if they do not fit certain biopsychological needs and necessities.

In table 6-1 I have depicted a series of links between ethological or biopsychological and sociocultural phenomena - between the level of `genes' and the level of `memes'. Most culturalists will agree that some of these links are obvious. No one doubts that different cultures have different ways of satisfying the human need for food. The further we come in my list however, the more people will turn off and think that I am exaggerating. They think I have forgotten all I have ever heard about human uniqueness (which is a lot if one has studied philosophy). But it is not my intent to deny human uniqueness nor to `reduce' sociocultural phenomena to biopsychological phenomena. My purpose is to show that the more we know about animals, the more we find phenomena that we also find at the level of human culture. Seen in the context of our current ethological knowledge, many cultural phenomena are not so strange after all. They have obvious parallels in the animal kingdom. Could it be that most cultural phenomena arise out of the same needs and necessities that animals feel or have to deal with?

Yet, even if this were true there still would be missing something, which is also indicated in table 6-1. Even if this table would not contain speculative elements and even if everyone agreed that sociocultural phenomena emerge from biopsychological phenomena, we would still need some other principle: a `missing link' that explains the gap between the two levels. This missing link has to explain why biopsychological phenomena are transformed at the human cultural level. It has to explain why cultures are different from another and why they change. What explains the creative `translation' of biopsychological needs and necessities to sociocultural rules, roles and institutions?

In this chapter I will try to bridge that gap by introducing the environment, as this is done especially in the tradition of behavioral ecology (for reviews, see Cronk, 1991; Borgerhoff-Mulder, 1991; Low, 2000). The claim is that cultures differ not because they are created *ex nihilo* out of the fancies of a creative elite, but because they reflect the ways in which large numbers of individuals throughout many generations have tried to cope with the demands of particular environments. Cultures are to some extent `frozen' packets of experiences of life, yet, those experiences of life reflect particular ecosystems and climates which force individuals to choose particular strategies from their reservoir of possibilities. The ways in which individuals react to those environments are certainly determined partly by social learning and culture. Yet, I will claim that individuals are determined by particular cultures largely, because it is in their interest and because the suggested options raised by those cultures fit in well with innate options emanating from their natures. Particular cultures can only become prevalent among a people, because they offer adaptive solutions to the problems experienced by most of individuals and because those solutions fit their behavioral repertories.

BIOLOGICAL /ETHOLOGICAL PHENOMENON	HUMAN SOCIO-CULTURAL CORRELATES
Need for food (carbohydrates, proteins, vitamins, etc.)	Hunting, gathering, horticulture, agriculture, industry, administration
Biological rhythms /clocks	Schedules
Sex, sexual selection, mate-guarding	Prostitution, marriage forms
Physical protection, self-ornamentation	Clothing
Safety, physical protection, home base	Huts, iglos, tents, houses
Health & hygiene	Medicinal plants, pharmaceutical products
Safety in numbers, sociability	Clans, groups, clubs, societies, schools, sects, churches
Strive for dominance	Social stratification
Physical and behavioral sex differences	Gender roles
Individual differences	Different tasks, roles, functions
Dominant individuals caring for harmony within group	Shamans, priests, prophets, ministers, psychologists

Table 6-1. Well-established and more speculative links between biopsychological/ethological and sociocultural phenomena.

Of course, traditional anthropology has always recognized the influence of an environment on a particular culture. The influence of the environment on a given culture is even placed central in cultural materialism. Yet, the model stressed within this approach seems often too simplistic. In figure 6-1 I have schematized the traditional approach, whereas I have tried to render my own approach, which follows the tradition of sociobiology, evolutionary psychology and behavioral ecology in figure 6-2.

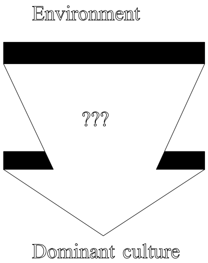


Fig. 6-1. The relationship between environment and culture in a simple, traditional model.

As can be seen, the notion of `conditional strategies' is placed central in this figure. Contrary to what it is often thought (e.g. Rose & Rose, 2000), sociobiology, evolutionary psychology and behavioral ecology do not advocate a simplistic `genetic determinism' in which *only* genes determine behavior and in which one set of genes correlates to one behavioral strategy. Many animals do know different conditional strategies which are activated by different environmental conditions and man is no exception in this respect.

One can even go further: given the human cortex and the human ability to master and manipulate enormous amounts of symbols a much greater behavioral flexibility in man is to be expected than in any other animal. The difference between sociobiologist, evolutionary psychologist, behavioral ecologist and non-evolutionary or half-evolutionary theorists is, however, that their explanation of behavioral variations is more in terms of an innate range of *potential* strategies which are activated by particular environments. They do admit behavioral flexibility, but do also expect mechanisms that guide flexible animals into alternative adaptive routes. There is an element of choice, perhaps even of `free choice', but the different options are to some extent already given in the form of different strategies. Human nature is not infinitely malleable, but given certain conditions it will generate such-and-such behavior, whereas in other conditions it will develop completely different strategies. This approach fits well to the common wisdom in psychology that the environment is partly responsible for personality structures, but is at the same time much more specific about the types of causal relations involved. The claim is that *different environments generate different types of behavior as a result of the activation of partly innate conditional strategies.*

Of course, the social environment of an individual is one of the most important causal elements in its behavior. Therefore, I have depicted a `reinforcement arrow' between the level of interaction (competition and cooperation) and the level of individual conditional strategies in figure 6-2. Individuals will, of course, adapt their level of commitment and altruism to the general level of cooperation and `justice' that they will find in their social surroundings, as is to be expected from the theory of direct and indirect reciprocal altruism. Another `reinforcement arrow' in figure 6-2 shows the selection pressures that cultures do exert on personality types, as claimed in chapter 5.

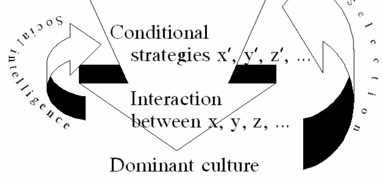


Fig. 6-2. The environment determines culture via a plurality of individual, conditional strategies.

In the rest of this chapter I will present three studies to find indications for conditional strategies. Each time I will try to unravel the complex relationships between biopsychological needs and necessities, ecological circumstances and sociocultural phenomena in the hope of finding the adaptive mechanisms that enable humans to adapt their culture to particular circumstances.

First, I will turn to the relationship between sex differences in mating strategies and the different marriage systems that exist across cultures. Is it still possible to believe that there are universal psychological and behavioral sex differences, if one faces the evidence of different marriage practices in different cultures? I will try to show how certain human characteristics that are largely innate nevertheless fan out in a wide variety of cultural practices as a result of different environmental conditions. These conditions activate certain conditional strategies which then are crystallized into culture or are `culturalized' (`to be reinforced into a culturally accepted and promoted practice by imitation or teaching'). Yet, this does not mean that there are no stable elements in human nature that manifest themselves cross-culturally. I will defend the thesis that actual marriage practices reflect a mixture of culturally reinforced conditional strategies and hard-to-suppress natural proclivities with a long evolutionary history.

Next, I will investigate two particular cases of environmental influences that are sometimes thought to reinforce particular conditional strategies. First there is the impact of factors like environmental stability, predictability and safety on the dilemma faced by all organisms between reproducing more or giving more parental care per offspring - the dilemma between more chickens or more love. Animals are known to adopt different strategies in environments characterized by different degrees of predictability. Some species which live in unpredictable environments are specialized in producing as many offspring as quickly as is possible (known as the *r* strategy); some species which live in predictable, stable environments specialize in having relatively few offspring and securing a maximum number of grandchildren by protecting and educating their offspring as long as possible (known as the *K* strategy). Some species can react adaptively to different types of environment. Although humans are a relatively *K* selected species, they are characterized by large differences in family size. The question is whether different human cultures reinforce conditional strategies that best fit particular environments; and whether they do so as a result of genes and/or memes.

Finally, I will study the influence of the social environment by having a look at the impact that sheer size of a population has on the structure of a particular culture. The hypothesis advanced is that larger societies consisting of more non-kin need more moralistic language and ideas than smaller societies. Smaller societies are kept together better simply by nepotistic and reciprocal altruistic relationships. `People know each other better'. That may be a truism, but it explains some important cultural phenomena, as I will show.

Together these three studies give a picture of the ways in which humans are adapted to the environment via conditional strategies. Because our ancestors have faced fluctuations in their environments from generation to generation, because they sometimes were born poor, sometimes rich, because they sometimes lived in small groups and sometimes in big ones, we are able to follow different trajectories and strategies according to different circumstances. If large numbers of people follow certain strategies particular traditions and cultures are produced. Differences between cultures thus do not show simply that man is a cultural being, being able to create himself from nothing. It may show primarily the elasticity of the human motivational system which is triggered by different environmental conditions to establish different priorities and to follow different courses.

6.2 STUDY 1: FROM SEX DIFFERENCES TO MARRIAGE SYSTEMS

As we have seen in chapters 4.2 and 5.16, evolutionary theory suggests that sex differences do ultimately result from differences between gametes (anisogamy). At the moment that one type of gamete contains a maximum of nutrients which it can use after fertilization, another type will evolve which does not contain nutrients, but is specialized in moving quickly to be the first to hit upon the first type. Females are producers of a relatively small collection of big gametes with a lot of nutrients, males are producers of a large army of small gametes which are relatively mobile. Because it pays (in terms of reproductive success) to be female at the moment that females are scarce and it pays to be a male at the moment that males are scarce, the numbers of females and males are normally kept in balance automatically (as Fisher noted in 1930; Hamilton (1967) found a lot of interesting exceptions to the rule).

As a result of anisogamy, it can also be predicted that males and females in mobile species will behave quite differently before and after fertilization. Females have invested a lot in their gametes: it is in their interest to have them fertilized only with the best genes and to protect them, and assure their survival, as long as possible. Males can permit themselves to sow their gametes here and there and to refrain from investing in their offspring, as long as females are in no position to force them to invest. For females, internal hatching of eggs (viviparity) becomes an attractive strategy, although it forces them into a position in which males can further blackmail them.

Apart from a few exceptions (the Australian Duckbill, for example), almost all `modern' mammals are viviparous. Most mammals are also polygamous and do not know paternal investment. Oviparity may induce males to share some of the parental effort, because eggs can also be incubated by males. As a result of this starting-investment they will tend to help females also in later stages. Thus it is no wonder that in birds, many species are either monogamous (± 90%) or at least know some form of paternal investment. In mammals, female pregnancy constitutes such a large initial investment, that the female cost of abandoning her brood after birth becomes too large to `punish' non-investing males this way. Males can permit themselves to stop investing in their offspring after a successful fertilization and will tend only to hinder other males from fertilizing the female (mate-guarding). Because females have an interest in good genes, males with good genes are able to `collect' females in a harem.

Humans belong to the relatively small class of mammals in which fathers may invest in their own offspring. Instead of dividing their attention to a number of females, human males will often `fall in love' with one particular specimen (folk psychology for a physiologically driven process of cognitive and erotic fixation). A long-term commitment may result and both partners may raise their offspring together. However, as we can learn from many species of birds, the tendency to form pair-bonds often goes together with a tendency to sow or collect genes outside the pair-bond. Above that, as typical mammals, humans seem to be slightly polygynous. In many cultures males will try to obtain additional wives and start more than one family. In other cultures, this practice is absolutely forbidden and the only alternatives to monogamy are celibacy, homosexuality, promiscuity or serial monogamy.

Yet, there are cultures that are described as being polyandrous, too, and at this point the relatively simple sociobiological story about two sexes and their different investment patterns becomes so complicated that many think that it can only be saved by piling up *ad hoc* hypotheses. Humans seem to have such a long list of `conditional strategies' that it seems easier to drop this notion altogether and to stick to `culturalistic' belief that humans are the products of their cultures. One particular strong argument in favor of this position is that terms like `monogamy' and `polygyny' are not used in the same way for humans as they are used for other animals. In humans they refer to marriage patterns, based on the cultural institution of marriage, whereas they simply refer to mating patterns in other animals. The gap between humans and other animals is simply to large for one set of terms.

Or is it? Despite the fact that human bonding practices are mediated by the cultural institution of marriage, they express the same convergence in the interests of sexual partners and the same need for cooperation-in-reproduction as sometimes exists in other species. Humans are not the only species with a variety of alternative, conditional mating strategies. One only needs to think about the Dunnock, *Prunella modularis*, who can be just like humans monogamous, polygynous, polyandrous, or polygynandrous depending on the circumstances (Davies and Lundberg, 1984; fig. 6-3). Humans are not the only species with culture, either, as we learned already. They happen to be a species though, perhaps the only one, in which culture may help to decide between several behavioral options with respect to mating.

As I have been defending continually, however, from an evolutionary perspective `culture' cannot be equated with pure individual creativity and freedom. Rather, cultural prescriptions with respect to sexuality and marriage are expected to represent a compromise between collective interests (or the interests of a dominant elite) and the reproductive interest of the individual. Perhaps the needs of the individual have to be bended and curbed to fit a particular economy, power-distribution, and, ultimately, ecology. To enable it to survive in a particular society and by means of a particular economy, the human individual should perhaps be tamed and molded by a series of cultural patterns that matches that economy.

Sometimes this insight is taken too absolute and it is claimed that human marriage is primarily an economic agreement, which is not exclusively about mating and reproducing. As Daly and Wilson (1982) show this could also be said of the pair-bonds of many non-human animals, who may also have more on their minds than just mating and reproducing:

> The hornbill who feeds his incubating mate, the pair of beavers maintaining their dams and domicile - we could call these unions, with their division of labor and exchange of benefits, `economic' too. In people, as in other animals, the mundane interactions of mated pairs are seldom of immediately reproductive function, and yet the union can only be understood as a fundamentally reproductive alliance (1982: 288).

Of course, the mistake is that economic activity in any species is not contrary to reproductive activity. As Daly and Wilson claim "to contrast economic and reproductive goals is to confuse proximate and ultimate considerations" (1982: 289).

Nor does the fact that humans are able to adapt their life to a particular ecology and economy imply that the human animal does not possess original drives and needs (whatever that may mean). To the contrary: hidden underneath the cultural variation, caused by specific ecological and ecological variables, there are universal psychological characteristics, including cross-cultural sex differences, which express themselves differently in each culture apart.

Instead of being more or less biologically arbitrary choices between different possibilities, marriage patterns seem to be the result of culturally transmitted and reinforced compromises between the optimal male and the optimal female solution to particular ecological conditions, of course depending on the respective power of both parties in a particular society. Often they simply constitute officially accepted or sanctioned mating habits which do not necessarily reflect choices of all individuals within a society.

Individuals in each society will choose their own strategies and compromises, depending on their sex, age, and position in the dominance hierarchy. (Sometimes they are `above the law'; sometimes they simply have nothing to loose and are indifferent to rules of their own society; often they are simply opportunistic hypocrites.)

Let us have a look at the behavioral ecological literature and try to find plausible explanations of the different cultural patterns. Murdock's ethnographic atlas (Murdock, 1967) is often used by behavioral ecologists as a tool to study a variety of cultures. It allows us at least to get an idea of the spectrum of human possibilities: of the 849 societies listed, 708 are polygynous, about half of those societies highly, about half mildly so. 137 Societies are monogamous; 4 are listed as polyandrous (fig. 6-3; Flinn & Low, 1986). From the view-point of behavioral ecology the marriage customs of a culture have to be explained with reference to the particular ecologies and economies in which they have arisen.

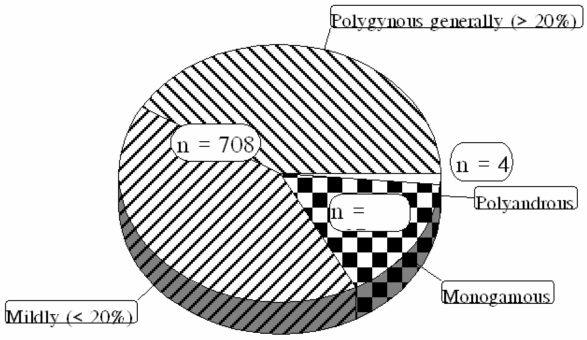


Fig. 6-3. Marriage patterns in 849 societies. Data from Murdock, 1967 (after Flinn & Low, 1986).

Polyandry and poverty. On the basis of their study of polyandry in Tibet and Ladakh, Crook and Crook (1988) come to the conclusion that polyandry is ultimately caused by the low carrying capacity of the environment, reinforced by the necessity to meet the burden of taxation, imposed by landlords, governments and religious authorities. In most cases the men that share a woman in a polyandrous marriage are brothers and the marriage is arranged by the parents at the moment that the men are still young. The reason of this arrangement is that the parents have only one large resource to inherit to the next generation: one piece of land with one farm. The division of the estates would make them inviable and would make it impossible to meet the tax demands. Thus, polyandrous marriage patterns are determined by a lack of reproductive opportunities for males.

Throughout the history of Tibet and Ladakh, areas in which polyandry is best known and best studied, landlords had a strong interest in reinforcing the `monomarital system' according to which estates would not be divided. Parents would inherit their estate to the eldest son, with or without brother, on the day of his marriage. Whereas polyandrous families are slightly larger than monogamous ones, eldest sons tend to have more reproductive success. In Zangskar, Ladakh, Crook and Crook found in 1980 that 30 % of brothers were monks.

Sometimes the males in a polyandrous marriage will try to acquire additional wives. In the north Indian Pahari this may even result in a unique polygynandric group marriage. A single household will then contain two or more men and two or more wives, all men considered to be married to all women (Daly & Wilson, 1982).

Thus, the fact that polyandry does exist in some societies does not mean that human males do not have certain innate, largely mildly polygynous tendencies. The cultural system of polyandry is simply the best solution given the limitations posed by the environment. Flinn and Low even compare the system to the `helpers at the nest' phenomenon seen in about 1% of bird species (about 10.000 species are known), in which reproductive opportunities are limited by a limited number of available territories or nest-sites.

The link between poverty and polyandry is further established if we look at the behavior of women. Form the view-point of women, marriage is both about love and resources. Women with men which are unable to earn enough money to raise a family are known sometimes to resort to `facultative polyandry' (we will come back to this point in 6.3). The most stable marriages are obviously those in which a man is able to support his own family. Thus polyandrous tendencies in women are suppressed in ecological optimal conditions; in a situation of poverty they may come to the surface. Apparently some cultures have acquired enough wisdom to ensure women an income even if their partner dies or is unable to support his family. In the bible we find that if a man died his brother was more or less obliged to marry his wife; in the polyandrous systems of Tibet and Ladakh, women were simply already officially married to a kind of emergency or assistant husbands. A documentary by Desmond Morris suggested that brothers in polyandrous marriages do indeed claim their sexual rights. It would be interesting to know, however, whether this is always the case.

Of course, the most radical polyandrous practice is prostitution. Prostitution is, however, not a culturally reinforced marriage form, but an escape route of polygynous (and perhaps sometimes hypergamic) tendencies in an officially monogamous system. It seems to me that both the official marriage form of polyandry and all kind of unofficial polyandrous activities of women including prostitution show that the importance of marriage for women lies in a combination of love, sex and economic certainty. Perhaps prostitution shows best that if love, sex and money are uncoupled, men and women have completely different priorities, men opting for sex where (at least, some) women opt for money. Polyandry shows that at least some societies have recognized the necessity of ensuring women an income, even without a partner that is able to support her alone. For men, polyandry is no doubt not an ideal solution, and that is the reason that it occurs relatively seldom worldwide as an official marriage form.

Ecologically imposed monogamy. In a situation in which males have more opportunities to monopolize resources, either monogamy or polygyny will result, depending on the possibility to accumulate those resources. In harsh, unproductive environments it is difficult to provide enough food to sustain more than one wife plus offspring. Thus, only the very skillful hunters or clever negotiators are able to acquire more than one wife. It is therefore not surprising to find that peoples which inhabit the arctic or the dessert, like the Copper Eskimo or the Kalahari Bushmen respectively, are monogamous in most cases (Flinn and Low, 1986; among the Kalahari Bushmen about 5 percent of men have two wives).

The fact that such relatively poor and `primitive' societies know monogamy could seduce us into thinking that monogamy is the most `original' marriage system. Perhaps the story of Adam and Eve still has some deeper meaning and our unique evolutionary trajectory started with exclusive pair-bonds (see chapter 8 on the theory of Lovejoy).

Studies on such `primitive' societies as the Ache, a native hunting people of eastern Paraguay, reveal a completely different picture, however (Hill & Kaplan, 1988; Hawkes, 1991). The Ache do not practice formal marriage rites, but do know pair-bonds and nuclear families. One would expect, then, that males would provide their own families as long as their wives remain faithful to them. What happens, instead, is that males that have caught some game, hand it over to another male who will distribute it more or less evenly among the members of the foraging band. More than 90% of the meat acquired by a male is consumed by individuals outside his nuclear family (Hill & Kaplan, 1988: 282). Women and children do not get more meat acquired by their husbands and fathers than would be expected by chance if all food were simply pooled and redistributed.

What follows is that it is not in the interest of a man to be good hunter as a result of the direct profit for his own nuclear family. The advantages of being a good hunter are of a different kind: first, women and children of good hunters are slightly favored, because it is in the interest of everyone that they remain in the band and continue sharing food; second, good hunters have more extra-marital relationships and more illegitimate offspring. It is also likely that good hunters are less likely to be cheated on or abandoned by their wives.

All in all, at least the Ache do not confirm the idea of an original symmetrical monogamous system. It is much more plausible that monogamous systems simply arise out of ecological necessity and that they are, in fact, always characterized by some paternal uncertainty (see the research of Grammer and my summary in chapter 2). In most monogamous species which have been studied closely enough, including the gibbon which was long thought to form an exception, ethologists have been able to score at least some E.P.C.'s (extra-pair copulations). This follows directly from the asymmetrical interests of both sexes, which in monogamous relationships both have an interest in being unfaithful, but for different reasons: females are potentially adulterous, because they sometimes can collect better genes or some extra investment outside the pair-bond; males are potentially adulterous, because adultery may enlarge their reproductive success without necessarily enlarging their paternal investment.

All this does not mean that the idea of romantic love, at least as a temporal phenomenon, is entirely a cultural creation. Although this culturalistic explanation of romance is widely accepted in the social sciences, this idea is implausible, because the phenomenon of falling in love occurs cross-culturally, is documented in myths and legends from a variety of cultures and is driven by a series of chemical substances which definitely are not cultural in origin. Apart from that, the phenomenon of falling in love is compatible with the idea that humans are a pair-bonding species with elaborate courtship displays followed by in-depth interviews and tests of the suitor's genes and his current condition and position. In principle, the so-called consortships of chimpanzees (see chapter 10) could be a first stage in the evolution of pair-bonding, because there seems to be going on something exclusive and personal between such consorts. This does not mean, however, that we are an originally monogamous species, because in principle one can have several sequences of pair-bonding, mating and reproducing during one life and one can even, during such sequences, accumulate partners, which is an officially approved practice in most cultures.

Polygyny: happy the healthy and wealthy. Ethologists studying birds have developed the `polygyny-threshold' model to explain why female birds may prefer an already mated male above an unmated one (Orians, 1969). To stay close to home, a male wren (*Troglodytus troglodytus*, Europe's second smallest bird) with a poor territory may build a series of nests and invite a series of females, but all those ladies may prefer his neighbor, who has conquered a territory with more insects which will enable them to collect enough food for their young. This may sound unfair, but these female wrens have good reasons to choose the better territory. Perhaps they automatically choose also the best genes this way, because it need not to be an accident that a particular male owns a good territory: perhaps males with good territories have also better genes. (Alas, apart from that, evolution can never be fair, because one is unable to choose one's own genes).

Of course, the polygyny-threshold model could, but does not need to, apply to humans. On the one hand, it is possible that female humans, also, start seeing advantages of being a second wife in resource-abundant areas of the world, the moment that particular males succeed in accumulating disproportionate large amounts of power and resources. On the other hand, human females are at least sometimes forced to marry polygynously. This complicates a comparison with birds. Another complicating factor is that polygyny does occur in a wide variety of human societies, in some of which polygynists do appear to be preferably the healthy, the clever and the fierce, while they in other societies seem to be simply the wealthy. Flinn and Low (1986) speak in this context about `mate control polygyny' and `resource control polygyny' respectively, but the adequacy of the first term is unclear as a result of unclarities about the role of female choice in such societies.

What is clear, however, is that there is a male power pyramid even in societies in which there are almost no differences in wealth, because there are almost no material goods. Some men are simply better hunters, warriors, cooperators and leaders and this advantage is translated into relative reproductive success. Among the Yanomamö, for example, one's status is defined by the number of enemies one has killed and this number correlates by and large with one's number of wives and one's reproductive success (Chagnon, 1988). Of course, powerful men earn a lot of respect, but they have to do a lot for it. Again, in the Yanomamö, headmen have to support a large group of co-resident kin, who they need to support them in return.

Apparently, `male' values play an important role in such societies. There is a strong tendency to control one's female relatives and sometimes sisters are even taken as co-wives, a situation which seems to make polygyny relatively pleasant for females (Chisholm & Burbank, 1991). Often, marriages are allowed only between certain types of cousins, called `cross-cousins'.

Yet, the polygyny in such societies need not to be the product of male coercion, only. It could be adaptive for females to choose an already mated or married man if he simply has better genes and is better able to ensure the safety of one's children. In a situation of intense intra- or intergroup competition it is relatively important for women to bet on the potential winners.

An important discovery supporting the idea that good genes count is Bobbi Low's discovery that polygyny correlates with pathogen stress (Low, 1988). She compared the marriage patterns of 93 societies of the standard cross-cultural sample with distribution maps of pathogens like malaria and leprosy and found that monogamy is absent in high-pathogen areas and that there is a significant positive relationship between the total pathogen exposure and the degree of polygyny. To do justice to this kind of research I propose to call polygyny in such societies `polygyny based on good genes'.

Polygyny based on power or resources. In societies which dispose of goods that can be accumulated, status is often defined by wealth. Often the pursuit of wealth seems to be an almost autonomous psychological goal, which defies an evolutionary explanation. Yet, as I have shown in chapter 5.8 a number of studies have clearly shown that the pursuit of wealth in many societies is an approximation of inclusive fitness maximization. If I am allowed to phrase it somewhat rude, children are expensive, and so are women in most societies - even decent ones. In many slightly polygynous societies there are large economic prerequisites for marriage, which are tested by demanding a `bride-price', which may be payed in pigs, sheep, cows, oxen or cash. In at least one society the height of the bridewealth could be calculated on the basis of knowledge about the residual reproductive capacity and reproductive condition of the bride and the distance between the home of her parents and her future home (Borgerhoff-Mulder, 1988; Ruse, 1989).

On the basis of both the *Ethnographic Atlas* and the *Standard Cross-Cultural Sample* (Murdock and White, 1969) John Hartung (1982) has shown that there is a strong positive relationship between polygyny and bride-price (in opposition to dowry, see below). He even claims that this correlation is strong enough to claim that human polygyny is essentially `resource control polygyny', polygyny based on differences in the wealth. Above that, using again the *Atlas* (corrected for Galton's problem[1]) he shows that polygynous societies display a typical male bias in the inheritance of wealth. This is easily explained as a result of the greater ability of sons to `translate' an excess of wealth into an excess of grandchildren. A logical extension of this idea is that poor families, from which sons do not have much reproductive possibilities, will invest more in their daughters, because females in mammals, including man, have typically less variation in reproductive success and because female humans are typically hypergamous. As was mentioned in chapter 3.3 this idea, a consequence of the Trivers-Williard hypothesis, was successfully tested by several sociobiologists (e.g. Voland, 1984, Boone, 1988, Cronk, 1989).

As we have seen, most societies are slightly polygynous and, consequently, show a slight male bias. Such societies form a tendency to form male elites at the top that accumulate resources and use them to allure young, attractive and fertile women from other socioeconomic strata. Perhaps one of the reasons that such societies are common is that they do fit those parts of our `deep structure' that we still share with the chimpanzee. After all, our last common ancestors probably lived only five to seven million years ago and it is not unreasonable to assume that it looked much like chimpanzees do today (Wrangham & Divale, 1996).

If we take this reasoning one step further it is not unreasonable to assume also that both the male coalitions that dominate chimpanzee societies and the male coalitions that dominate many human societies, especially the polygynous ones, owe much of their power to a climate of intergroup competition. That means nothing less than that behavioral ecological analyses of human societies do have to look not only to ecological factors, but to the threats posed by other human societies as well. I would expect societies that have evolved in places that were worth fighting for to be particularly male dominated.

One way of making this claim plausible is by pointing to convergent tendencies in a number of famous despotic societies. Laura Betzig has shown that there are a number of striking resemblances between the first six civilizations, which all seem to have been based on the political and military power of one people that was able to subject and unify a series of other peoples (Betzig, 1992). All these civilizations were ruled by power maniacs who often seem to have been sex maniacs as well, often collecting young and beautiful women in harems and often even claiming the rights to the wives of their subjects (`le droit du seigneur'). Contrary to what one would expect on the basis of the beliefs of many cultural anthropologists, at least in a number of variables many civilizations are monotonously similar.

Apparently, power transforms male personalities in somewhat predictable ways. Females seem to be attracted to such personalities in somewhat predictable ways, too. The male tendency to acquire power and the female tendency to hypergamy are complementary in this respect. The resulting societies show a characteristic power pyramid, which I have tried to picture in figure 5-7 (compare also the figure of Mildred Dickeman in Dickeman, 1979).

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[1] In the *Ethnographic Atlas* (Murdock, 1967) even societies which are are mutually interacting are treated as seperate entities. This may confuse results. The *Standard Cross-Cultural Sample* (Murdock & White, 1969) includes only one culture from each region and does not have this problem (Galton's problem). One can also solve the problem by ordering societies in language-groups (this is done also by Hartung).

At this point it becomes clear why it is so difficult to decide whether human polygyny is the product of female choice or male coercion: both can be reinforcing one another instead of working divergently. It is also not easy to decide when and why polygyny is fitness-enhancing for women. Apparently, polygyny is disadvantageous for females in most situations, although sororal polygyny (in which co-wives are sisters) at least seems to lessen the burden of parental investment as a result of the enhanced mutual help of the co-wives (Chisholm & Burbank, 1991). On the whole however, polygynous married women have smaller families than monogamous married women, as was shown for the Aboriginals of Arnhem Land (Chisholm & Burbank, 1991) and for the Mormons (Josephson, 1993). Why would women want to marry an already married man if they end up having fewer children then they would have if married to an unmarried man?

It turns out that we have not evolved to have a maximum number of children. In technical terms: fertility is not an exact measure of fitness. Remember, children, too, are only a means to an end. We have evolved to `spread our genes' maximally, because genes that support opposite tendencies have vanished for long, are still dying out and will die out forever. As an *approximation* of fitness the number of grandchildren is much better than the number of children. Josephson shows that, at least for his nineteenth-century Mormon sample, both sons and daughters of polygynists had more children then did monogamists. The effect is almost strong enough to make up for the lower number of first-generation polygynist offspring. Probably the cause of this reproductive enhancement is that children of polygynists had simply more resources than the children of monogamists. As we all know, love and children cannot be bought, but one should be able to afford them.

Thus, polygyny can be an adaptive strategy for females not as a way to increase their number of children, but rather as a way to increase their number of grandchildren. Apparently, to understand human reproductive decisions, we have to take into account the fact that the human life-span covers at least three generations. Within this context at least part of human polygyny that we would otherwise tend to explain using the idea of male coercion, can now be explained by using the female choice model.

To sum up, "it appears that when resources and custom permit, men tend toward polygyny, and when any factor (e.g. health, resources) makes some men much better mates than others, women too, can profit reproductively from polygyny (Low, 1988). "Yet", according to the same author "humans are [in one way], highly unusual polygynists. In other species ... typically males compete and females choose. But `third party' patterns in humans extend to mate choice. In many societies, others, not the bride-to-be, make the choice" (Low, 2000).

Socially imposed monogamy: a product of egalitarianism or simply of agriculture?

With that, we come to the central problem of the behavioral ecology of human marriage patterns which makes them occasionally difficult to compare with nonhuman mating patterns. Marriage patterns are by definition `third party' patterns, the `third party' being not only relatives, but often other powerful individuals and/or institutions like the state. The term `socially imposed monogamy' was introduced by Richard Alexander (1979) to discriminate between those societies in which monogamy is purely the consequence of limited resources and those societies in which group processes are such that no one, not even dominant members, are officially approved of having multiples wives or husbands. It can be claimed that the very necessity to make this distinction in *Homo sapiens* is what makes this species so special. Indeed, this is what is done by Flinn and Low when they claim that "socially imposed monogamy has no homolog in nonhuman species, unlike ecologically imposed, or resource limited, monogamy (Flinn & Low, 1986)". Yet, something special is not necessarily something unexplainable.

It have been especially Richard Alexander and Laura Betzig who have attempted to explain the rise of socially imposed monogamy. Richard Alexander explained socially imposed monogamy in the context of his balance of power theory of human groupings (Alexander, 1979). Human groups with more internal discipline have continuously been stronger than groups with a lot of internal tensions. The `reproductive opportunity leveling' which is expressed in socially imposed monogamy can be seen as an attempt to take away the most important cause of internal group conflicts (see Daly & Wilson, 1988, for data about conflict over women).

Laura Betzig (Betzig, 1986; 1994; 1995; see also MacDonald, 1995) also places the rise of monogamy in the context of the cooperation between dominant and subordinate men. The moment dominant men become dependent of subordinates and subordinates have more possibilities to escape from exploitation, their relationships becomes more based on equality. An official commitment to monogamy minimizes potential conflicts over women and strengthens the cooperation. Betzig has done her best to prove that, despite the official teachings of the church, monogamy did not completely succeed in western Europe until the industrial revolution. Only since the industrial revolution did ordinary men gain `bargaining power' and become irreplaceable as specialized workers. Also, an increased mobility helped to strengthen the independence of modern workers. With more political equality came more reproductive equality. Ordinary men were better able to compete for women with their superiors.

It seems to me that Betzig has become somewhat too cynical about the role of polygyny. While it is undoubtedly true that polygynous tendencies have always been part of human nature, it is true at the same time that monogamy, including an undivided paternal investment in offspring, has many advantages for women. The unstable equilibrium between monogamous and polygynous tendencies, between `good fathers' and `good genes', may indeed be very old.

In this respect it could be worthwhile to pay some attention to the ideas of Helen Fisher (1982, 1992). Helen Fisher does not see polygyny, but serial monogamy (in which individuals have a sequence of temporally exclusive relationships) as the original human mating system and from this perspective she gives a different explanation for western monogamy. Serial monogamy works best in small bands of hunter-gatherers where children of about four or five years become part of a collective peer group and do not need their parents to stay together any longer (the idea that children become socialized partly in peer groups is also consistent with Judith Harris' `group socialization theory of development' (1995)). According to Fisher agriculture has been the force which broke this original pattern of serial monogamy. Agriculture requires families to stay at their somewhat isolated farms, which require a steady investment over many, many years and which also can best be inherited as single units. The best solution in this situation is to ensure the survival of a single farm as an economic unit by running it by a single reproductive unit, a family.

An argument in favor of Fisher's model is that industrialization may not so much work in favor of monogamy simply, but actually seems to increase divorce rates which are interpretated by Fisher as a return to the original mating pattern of serial monogamy. As a consequence, contemporary western societies can hardly be described as purely monogamous. Serial monogamy can also be interpretated as disguised polygyny, however, because the system allows some men to jump from marriage to marriage. Just like polygyny, in a serial monogamous system there exist wide differences in reproductive success between different men. (Low, 2000, sees serial monogamy as `really a sort of temporal polygyny, and also cites the Ache and the Cuna Indians, both non-agricultural, as examples).

What can we conclude from this complex mixture of theories, speculations and data about `socially imposed monogamy'? Perhaps they illustrate again that there is a gap between human nature and its innate sex differences and the requirements of particular cultures (Low, 2000; Mealy, 2000). First, let me repeat why I believe that mating systems are not entirely cultural in origin. If we compare the degree of human dimorphism with that of other primates, humans stand out as a mildly polygynous species (Wilson, 1978). If we compare human testicle size with the testicle size of gorillas and chimpanzees, humans show an intermediate level of sperm competition. This suggest that we are somehow intermediate between gorilla polygyny and chimpanzee promiscuity (Harvey & Harcourt, 1984). Finally, if we study the psychology of human males and females there is clearly a tendency of males to be somewhat more polygamous and females to be somewhat more monogamous.

Given the fact that human babies are extremely dependent creatures and that paternal assistance in raising them is not purely a luxury, given the fact also that human males occasionally tend to fall in love, it is certainly not simply a romantic *idée fixe* to suppose that there exists a natural capacity for pair-bonding in humans as an unstable power balance between male and female interests. As in many birds, a strong tendency towards adultery and divorce may simply be the reverse side of the coin. Every individual simply tries to get the best of both worlds: females may be continually looking for good genes outside the pair bond or for better matches, males may be continually looking for extra reproductive opportunities elsewhere, but that does not mean that a pair bond does not exist, at least temporally. Apart from that, we definitely seem to have inherited a strong polygynous tendency from our primate ancestors which again and again re-emerges if the right opportunities exist.

It is not implausible to assume that dominant individuals have always felt the necessity to cope somehow with this mix of possibilities. The moment they were able to subject their subordinates completely, they have tended towards polygyny, although most polygynous men will have had their official wives and their favorite mistresses. The moment there were no opportunities for despotism, cooperation on the basis of fairness became important, and forces proclaiming monogamy would prevail. The moment a society is stratified, but at the same time polygyny is prohibited, relatively rich or powerful men are a scarce commodity and women are expected to compete for them. Apparently, it is in such societies in which families of potential brides may compete with one another over a groom by offering a dowry.

A dowry is, as mentioned, the opposite of a bride-price. The dowry is paid by the bride's family to the groom's family. It may consist of a smaller or larger trousseau, consisting of clothing, household instruments, servants, jewelry, livestock, land, money and even lifelong obligations of support. If anisogamy and the initial investment of pregnancy did not produce a divergence of the reproductive

	Dowry	No Cost	Bride-Price
MONOGAMY	20 = 80%*	70 = 28%	42 = 7%
OCCASIONAL POLYGYNY	3 = 12%	137 = 55%*	153 = 25%
GENERAL POLYGYNY	2 = 8%	41 = 17%	407 = 68%*
Sample: 875 societies	25 = 100%	248 = 100%	602 =100%

Table 6-2. Financial rewards (dowry) or costs (bride-price) related to different marriage systems. Based on Murdock's Ethnographic Atlas by Hartung, 1997.

strategies of the sexes, one would expect dowry to be quite as common as bride-price. In fact, it is much rarer: woman are more often `bought' than men. John Hartung has shown that dowry is even more strongly associated with monogamous marriage than bride-price associates with polygynous marriage. These associations are shown with asterisks (*) in the table 6-2, based on a sample of the *Ethnographic Atlas* (Hartung, 1997; $p < 6.6 \times 10^{-58}$, sample not corrected for Galton's problem). Apparently, in most (that is: 602 out of 875) societies women are seen as representing an economic and reproductive value that has to be compensated for at the moment they are `given away'. Only in a small portion (25 out of 875) of societies men have to be compensated for binding themselves to a woman and apparently this is most often the case if it prohibits them from marrying other women.

Serial monogamy, the pill, and marital satisfaction in our own culture. Some extra comments about serial monogamy in our own culture are now at stake. First, it seems likely that the balance of power between the sexes may be decisive with respect to the favored type of mating system. Although modern industrial societies of North America and Europe are officially characterized by socially imposed monogamy, the emancipation of women and the increasing differences in income have created a situation in which marriages are particularly unstable. As in a polygamous system, women can easily marry `upward' (hypergamy) and rich men have more opportunities than poor men. Because polygyny is officially not accepted, the polygynous tendencies of both men and women have adopted the form of serial monogamy. As we have seen, serial monogamy may at least sometimes look like a disguised version of polygamy. Some men will choose at each stage in their socio-economic life a partner of a residual reproductive potential that reflects their status, while some women will try to improve their economic position by marrying upward the economic ladder.

The most important argument of Fisher (1992) for her belief that serial monogamy is most close to the original human mating system is that she sees a link between the supposed duration of marriages and the period of time that children need a father. Yet, given the problems faced by stepchildren it is doubtful whether a system of serial monogamy has ever been adaptive. Thus, I am not yet convinced that serial monogamy is the original human mating system. It could simply constitute a mild and socially accepted version of polygyny.

It should be remarked also that our `civilization' (that is how we sometimes call our culture) is characterized by a series of environmental influences that are totally new: for example, the pill. Women can use the pill (or other contraception techniques) to lengthen their phase of partner-testing and social climbing. Contraception can also reinforce monogamy by wiping out traces of adulterous relationships, at least sometimes. The study of Daniel Pérusse in Quebec (Pérusse, 1993), which I already mentioned in the last chapter, points to a widening gap between pure mating success and reproductive success. According to Pérusse the fact that the relationship between cultural and reproductive success breaks down in modern industrial societies can be explained by both contraception and socially imposed monogamy. In modern societies status still accounts for 62% of the variance in male copulation frequency, but this variance does no longer result in differential reproductive success.

In all, these data point to a mild polygynous tendency in man. Although we have gone a long way from our original way of living and mating, we are still haunted by many of the accompanying themes and passions. Our preoccupation with status and a series of largely innate sex-specific emotional reactions are still in place. Two of such sex-specific emotional reactions can still be demonstrated. First, men and women have different concerns about their relationships expressing themselves in different types of jealousy.

Males, especially experienced males, are obsessed with their partner's sexual fidelity; females are more concerned about their partner's emotional commitment. In two different studies Buss and his team found that about 30% more men than women reported greater distress over a partner's sexual involvement with someone else. Women, however, were found to be more distressed when their partner fell in love with someone else (Buss, Larsen, Westen & Semmelroth, 1992). Of course, a good sociobiological explanation is that men have more reason to care about their partner's sexual fidelity: they are never certain about their paternity the way women can be certain about their maternity. This explanation, however, is still compatible with the idea that the lowered level of female sexual jealousy points to a mild polygyny in man with women being somewhat more tolerant about their partner's sexual infidelity. Of course, modern feminists will object vehemently about this interpretation, but it is nevertheless striking how forgiving women married to high-status males sometimes are (Hilary Clinton being only one example).

A second example of an atavistic emotional reaction can be found in the factors contributing to marital satisfaction. Despite our modern political correct notions of equality, the mutual expectations of men and women are all but symmetric. Of course, it is true that a certain level of *homogamy*, or similarity in couples, contributes to the success of a relationship. Yet, disturbingly, there are also factors in which differences between partners are good for relationships. Both in their review of the literature and in their own research Weisfeld *et al.* (Weisfeld, Russell, Weisfeld & Wells, 1992) find that the happiest couples are those in which the men are slightly more dominant than their wives and in which those wives are slightly more attractive than their husbands. Although male household tyrants definitely can make their wives unhappy, on the whole women are certainly attracted to relatively dominant men.

Weisfeld *et al.* cite studies from different parts of the world which all show that couples in which the wife dominates the decision making are the lowest in terms of happiness. Dominance is even more important than wealth; more often, wealth seems to be a sign of dominance. At the same time there are studies which show that the economic power of women has a negative effect on marriages. Weisfeld *et al.* show that, cross-culturally, women's labor force participation is related to divorce. There are many indications that women are attracted to men that are higher on the social ladder than themselves, while men are simply preoccupied with signs of fertility, health and residual reproductive capacity in their partners. It seems to me that this all fits in well with the idea that man is naturally a slightly polygynous species, because when women like dominant men, not all men are liked alike and some men will be able to have more partners, either in the form of a polygynous marriage system, by having mistresses, or working their way through a series of relationships.

Yet, the situation in man is much more complicated than that in other polygynous species. This is not only due to the flexibility with which we adapt ourselves to different environments by means of culture, but also to the fact that we are a species with paternal investment in highly dependent offspring. We can conclude that we have a behavioral preference for polygyny which is counter-balanced somewhat by a tendency of human males to care for their own offspring if there is a high degree of paternal confidence (certainty that one is really the biological father of one's official offspring), which may be actually reinforced by the institutionalization of pair-bonds by means of marriages. In most cultures the fidelity of the wife is judged much more important than that of the man (remember Tony Braxton's line: why is it that men are forgiven, and, women aren't?).

This tendency towards polygyny is, of course, not the product of `blind' `genetic determinism'. It is a mere psychological tendency which can be switched off and on to some extent as a result of ecological and social circumstances. Although it is probably based on physiological factors, it can be brought into balance with other psychological tendencies, e.g. the loyalty to one exclusive pair-bond or the demand to be socially accepted. Nor does the human tendency towards polygyny imply that females are passive creatures, who adjust themselves to male choices. To the contrary, if marriage patterns are compromises between the optimal male and female solutions to a particular ecological condition, we would expect females, too, to have an interest in polygynous systems under particular conditions. Perhaps the female tendency to hypergamy, her tendency to prefer sexual partners higher on the dominance hierarchy, plus the female tendency to collect `good genes', force females in many situations to join an in fact polygynous system, which may make it sometimes more difficult to obtain paternal support in the raising of children.

Conclusion Although marriages are socio-cultural conventions, the patterns in which they are contracted reflects the different interests of the sexes and the power distribution within a society. The apparent conflict between the mild polygynous tendencies of the human species and the fact that there exists marriage systems ranging from polyandry to monogamy results from different strategies of the sexes and from the effects of different ecologies on those strategies and their interaction, not on a simply disjunction of `nature' versus `culture'. Different cultures have promoted different marriage systems depending on the power and interests of the creators of these cultures. Cultural forms thus start from natural `givens', but these givens already have a natural elasticity themselves and can be manipulated and idealized in different ecological contexts conforming the interest of the individuals that have the power to create, manipulate and use culture.

Despite the fact that man is a `cultural being' there is thus really hidden a human nature underneath the spectrum of human cultures, albeit one that is full of conditional strategies. One can even situate human mating patterns among those of other primates as I have done in table 6-3. To place human marriage patterns in the context of primate mating patterns I have included all homonoids, including the African pongids, which are so related to us that it is sometimes proposed to place them together with humans into a new

1.a.Males apparently do not cooperate or do not need each other to defend the group → 2
b. Multiple males → 3
2.a.Birdlike system of monogamous couples defending their own territories by making calls → Gibbons
b. Males and females roam at different speeds through overlapping territories → Orang-utan
c. One dominant silverback male with a harem → Gorilla (sometimes)
3.a.Paternal care not very important; paternal certainty nihil; high level of sperm competition; third party interference in sexual relationships limited → Chimpanzee and Bonobo.
b.Paternal care not very important; paternal certainty high; low level of sperm competition; dominant `silverback' male tolerates a few other, often younger, males → Gorilla (sometimes).
c.Paternal care necessary; paternal certainty high; medium level of sperm competition; very dependent children; slow maturation and long learning process; extreme level of third party `cultural' interference in sexual relationships at the level of groups/societies → Humans, different types of culturally reinforced mating or marriage patterns, 4.
4.a.Females to some extent able to sustain and protect themselves; can look for best mates in different stages of their lives → Serial `mono'gamy.
b.Females in need for male provisioning or protection → 5.
5.a.Males are unable to sustain more than one wife → Ecologically imposed monogamy.
b.Some males are able to provide for or protect more than one family or to monopolize more resources → 6.
6.a.Superior hunters or warriors can have more than one wife, but there is not much power to monopolize → Polygyny based on good genes.
b.Power can be monopolized in the form of arms, land, production means, education; subordinates unable to bargain or to flee → Polygyny based on power or resources.
c.Dominant males are dependent on cooperation by subordinates, their social status based on `democratic' decision on the basis of their supposed superior intellectual and moral qualities → 7.
7.a.Females powerful → Serial `mono'gamy (or, officially, socially imposed monogamy with a high level of divorce).
b.Females less powerful → Socially imposed monogamy.

Table 6-3. Speculative key to the most important mating patterns of extant hominids (see text).

category of `hominids' (Martin, 1992). Hopefully, this table shows that human marriage patterns do not arise simply as a result of some kind of uncaused, superorganic `culture', but do emerge as a result of a series of almost chemical reactions between two ingredients (males and females) which are mixed in a series of different circumstances, all which have their own catalytic effects..

Paradoxically, human cultural marriage forms show culture to be (on the one hand) a natural force that (on the other hand) forces some individuals in some ecological contexts into straitjackets which are experienced as highly `unnatural'. Perhaps this is one of the origins of this strange nature-culture dichotomy, which could be hard to transcend, because it is so often used by different parties either to defend their version of what ought to be `culture' opposed to brutish nature or to defend what they see as `nature' against tendencies of the prevailing culture to neglect or oppress it.

In our own country we are currently experimenting with allowing homosexuals to marry. This reflects the attitude in our highly developed, very `unnatural', technological society to try to transcend inequalities forced on to us by nature. While some Dutch theorists will oppose this, one can still claim, however, that on the whole the cultural institution of marriage is designed to ensure an optimal micro-environment for reproduction and child-rearing. At the same time, the different marriage forms which arise in different ecological and historical contexts are *never* ideally suited for the underlying nature. Monogamy is often a cage, both for women who desire better genes than those of their husbands, and for men with their mildly polygynous tendencies. Polygamy is not ideal either, however. In an american documentary which was brought out by Discovery Channel polygynous Mormon men tell us how difficult it is to live with more than one wife and Mormon women tell us how they have to cope continually with jealousy and the fear to be the second. While monogamy is to some extent a very unnatural institution, opposed to human nature, polygamy is probably not ideal either.

Perhaps it is the essence of humans to be always separated from their `true nature', to be always forced to `invent it'. In that respect there is certainly a trace of truth in Sartre's dictum that human nature does not exist. Of course, human nature *does* exist and the human genome project is part of the process of its gradual discovery, but at the same time we are as cultural and existential (conscious and free) beings always forced to adjust it to both our unruly needs and the ever-faster-moving film of our external circumstances.

6.3 STUDY 2: MORE EGGS OR MORE PARENTAL CARE?

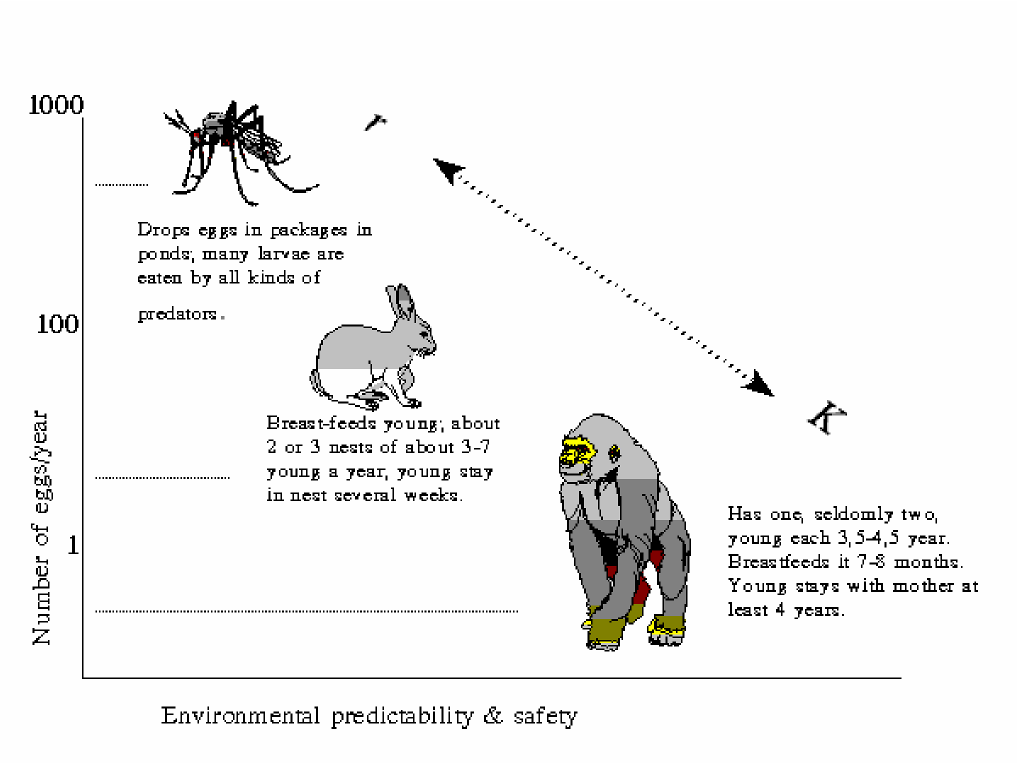

Fig. 6-4. *r* And *K* strategies are related to the predictability of the environment: only the *K* strategist are able to risk high investment per offspring.

Our next investigation concerns the effects of different types of environments on individuals and the sociocultural structures which they create and in which they are imbedded. Many of the speculations on this subject have been engendered by the, at first sight, somewhat obscure and clumsy concepts of `*r*' and `*K* selection'. Although I find these concepts ugly (I would have preferred something like `quantity' versus `quality' selection), they refer to such a fundamental issue that it would be wrong to neglect it completely. They refer to one of the most fundamental problems faced by all organisms, including man. This problem is that all organisms, in order to reproduce efficiently, have to make priorities and have to choose between a number of possible activities, some of which are mutually exclusive. For example, it is not easy to be occupied with finding new sexual partners (`mating effort') and be devoted to rearing offspring at the same time (`parenting effort'). Organisms with a wrong energy-budget or following a wrong strategy can be expected to be `punished' by natural selection. However, in some habitats one strategy may be adaptive, in other habitats almost the opposite strategy can be adaptive.

The two most fundamental opposite strategies within this dilemma were called `*K* selection' and `*r* selection' by MacArthur and Wilson (1967). They refer to two opposing kinds of selection which produce an optimal compromise between

- (*r*) a strategy directed at maximally reproducing (maximal intrinsic *r*ate of natural increase) and
- (*K*) one directed at conquering and defending resources in an environment close to its maximal carrying capacity (*K*).

Imagine a pool that is still uninhabited by fish. The first couple of fishes released in that pool can permit themselves to devote all of their time and energy to reproduction. To be able to produce a maximum number of offspring they will minimize the amount of investment per offspring. Because there is almost no competition they do not need to defend a territory; they can simply eat one place empty; leave a number of eggs or larvae there, and move to the next place.

Inevitably, if this process of care-free multiplication is not stopped by a cold climate or by predators, the pool will start becoming overcrowded. Another strategy becomes adaptive, then. As a result of the presence of a large quantity of competitors, one must first carve out a territory and try to monopolize a partner. Next, one can reproduce. To ensure, however, that offspring will survive it becomes necessary to defend and rear them some time, and, ideally, leave them a territory after your death. This strategy is directed at increasing one's competitive ability and that of one's offspring in a saturated environment.

	r Selection	*K* Selection
Climate	Unpredictable	Predictable, stable
Mortality	Often catastrophic, nondirected (resulting from environmental circumstances)	Directed (selection for competitive abilities)
Population size	Variable, unsaturated environments which are recolonized each year: opportunistic exploiters	Constant, near carrying capacity of environment: stable occupation of habitat
Competition	Not strong: one simply has to be the first there	Keen: one has to occupy and defend a territory
Selection favors	Rapid development Early reproduction Small body size High energy utilization Low encephalization	Slow development Delayed reproduction Large body size Efficient energy utilization High encephalization
Life span	Short	Longer
Families	Large litter size Low degree of parental care	Small litter size High degree of parental care
Social systems	Low degree of social organization and altruism	High degree of social organization and altruism

Table 6-4. *r* And *K* selection according to Pianka (1970) and Rushton (1990).

MacArthur and Wilson predicted that with the occupation of an ecological vacuum, selection would shift from *r* selection to *K* selection. One would expect many animals to embody a compromise between both strategies or to be able to shift from the one strategy to the other.

One can also claim that whole groups, e.g. insects, are relatively *r* selected, while other groups, e.g. primates, are relatively *K* selected (Pianka, 1970; Rushton, 1997; fig. 6-4). Sometimes it is claimed that humans belong to the most *K* selected species of all, but this is not completely certain (Lovejoy, 1981). Some of the correlates of *r* and *K* selection are contrasted in table 6-4.

The *r/K* model is helpful to understand within-species differences of clutch size (Cody, 1966) and population cycles in small rodents (Krebs *et al.*, 1973; Silverman, 1990). Apparently, strategies on the *r/K*-continuum are not completely genetically determined and individuals of at least some species are able to adapt their reproductive strategies to the ecological and social circumstances in which they find themselves.

The Gypsies and r-selection. Several attempt have been made to apply the concepts of *r* and *K* selection to humans at different levels. As Silverman (1990) remarks, at a minimum these concept could be used to explain the classic paradox regarding human birthrates, which are inversely correlated to the quality of child care. In many societies impoverished conditions do *not* lead to a lower birthrate and do, therefore, lead to an increased infant and child mortality rate. It is the essence of the so-called demographic transition, which is characteristic of industrialized nations, that the birthrate drops only *after* the deathrate has gone down, too. This could be interpretated as a transition to a more *K* selected investment pattern as a result of a change in the environment, which becomes more predictable. Also, in modern industrial societies the first priority is no longer to survive the contingencies of climate and crops, but to compete on a market which requires certificates and specialized know-how.

Western societies have much in common with the above mentioned pool at the moment it has become saturated with fish. Many people have highly specialized jobs which require specific training and certificates. Family size has dropped dramatically and often parents invest in two or three children as much energy as would be invested in four to six children only one generation ago. Yet, not everyone in Western societies follows the same strategy. *r* And *K* selection produce a conglomerate of opposite traits and there are several subgroups in modern societies in which a series of typical *r* selected traits manifest themselves. Such typical *r* selected traits include larger families, lower birth weights, twinning, earlier onset of sexual activity, higher copulatory rate, shorter menstrual cycles, higher mortality rates, more child abandonment, neglect, and abuse.

A study which gives the concepts of *r* and *K* selection flesh and blood is the one of Tamas Bereczkei of Hungary, who compared Hungarian Gipsies with other Hungarians (called simply `Hungarians', Bereczkei, 1993). According to Bereczkei the Gipsies can be said to follow a typical *r* strategy. Not only do Gipsies have more children than Hungarians, their infants also have a significant lower birth weight than Hungarian children. At the same time, Gipsy children with a low birth weight have better prospects than ditto Hungarians, as if their lower birth weight constitutes an adaptation which allows their mothers to get more children. There are born significantly more girls than boys and girls are cared for better than boys, showing the `Trivers-Willard-effect' (see chapter 4.3.3) in action (Bereczkei & Dunbar, 1997). Both boys and girls mature earlier and start their sexual career at an earlier age. Sexual and marital relationships are generally less stable and father-absent households are characteristic. Yet, children are well-cared for, because the extensive kinship networks of gypsy societies do more than compensate the instability of Gypsy marriage bonds (Bereczkei, 1998).

Social stratification and different strategies. If a minority group such as the Gypsies can be said to take a position on the *r/K* continuum it is not strange to assume that dominant groups in a society, with a relatively luxurious prospects, will take the opposite position. In fact, the American sociologist and criminologist Lee Ellis has postulated that the whole edifice of human social stratification can be derived from the intersection of two continuums: the *r/K* continuum and the continuum between pro- and antisociality. In western societies the upper classes can be understood as tending towards the *K* strategy, whereas the labor class can be understood as following an *r* strategy. Of course, the reason for these different strategies has a lot to do with the expectations of individuals within these classes. Especially, if one cannot expect to live long, the best thing to do is to start reproducing early. It is perhaps no accident that teenager pregnancies are clearly linked to relatively poor conditions. Apparently, the reason that Ellis also needs the pro- versus antisocial continuum is that there are large differences in the amount of social concern and investment, especially in the middle classes.

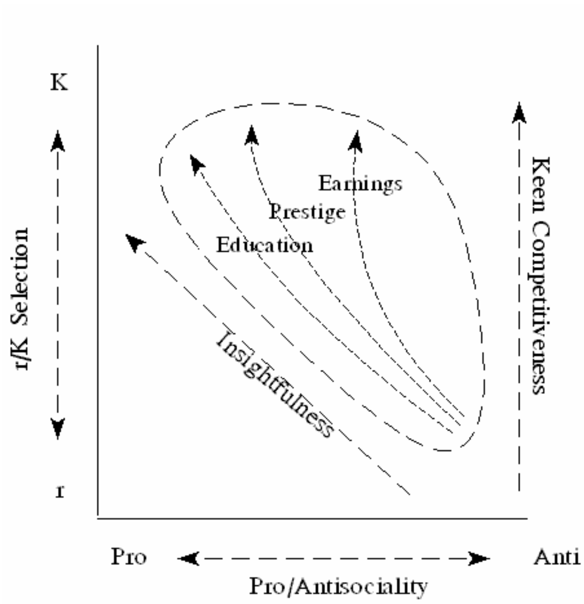

Fig. 6-4. Ellis' (1991) theory of social stratification.

It should be stressed that all this is not just speculation. Ellis uses an extensive literature to document the genetic basis of both traits on the *r/K* and the pro/antisocial continuum. Of course, in principle one could draw a picture like figure 6-4 for many traits. It is not unreasonable to assume, however, that the variation in some traits have more influence on social stratification than other traits.

Yet, at the moment there is much disagreement on the question of the heritability. As I have shown in chapter 5, behavioral geneticists are inclined to stress `the limits of family influence', as in the title of Rowe's book (Rowe, 1994). Other researchers, however, are interested in possible effects of the family environment on the variation in strategies on the *r/K* continuum. There are many species which can react flexibly to their environment by adopting a particular position on the *r/K* continuum and it is often claimed that humans belong to this category. Given the variations of the environments in which our ancestors have lived and given the complexity of the human psyche, it is not unreasonable to assume that the *r/K* dilemma is reflected in the human psyche as a continuum of conditional strategies which are triggered by different types of environment. It is not implausible to assume that individuals have ways to access at an early age in what kind of world they are born and what kind of strategies are likely to be adaptive. One twin study suggested that the orientation towards romantic love has a relatively low heritability (Waller & Shaver, 1994) and arises during childhood. Is it possible that this reflects an ability to adapt one's mating strategies to the environment in which one finds oneself?

The genesis of alternative strategies. A series of new theoretical investigations in developmental psychology seem to support this hypothesis. There is evidence which shows that absence of the father during one's development may be a critical factor in the constitution of one's adult personality and love life (Draper & Harpending, 1982). Generally speaking, stress during early childhood may predispose individuals to follow a different developmental trajectory directed at faster maturation, earlier reproduction and a less committed love style (Belsky, Steinberg & Draper, 1991). Belsky, Steinberg and Draper connect their ideas to those of Bowlby (1969-1980) and propose that the different attachment types classified by Bowlby and his school are used by the developing individual as a means to prepare itself to the conditions in which it probably will find itself in adult life. If the mother or father is unwilling or unable to give a child a `secure attachment' an adult will result which is itself unable to provide comfort and safety to its own children. However, whereas Bowlby himself was typically moralizing and typifying the `securely attached person' as the one who is better off and "more capable of making use of opportunities in life, both personal and professional, than others" (Bowlby, 1986), Belsky, Steinberg and Draper (1991) and Chisholm (1996, 1999) now postulate that insecure attachment can also be understood as an adaptation, inciting a strategy that is simply adaptive to a different type of environment with much more uncertainties.

Attachment classification	Parental reproductive strategy	Child's developmental (i.e. incipient reproductive) strategy
Insecure, Avoidant	• Short-term • Unwilling to invest • High mating effort • Dismissing, rejecting of child	• Maximize current survival • Avoid rejecting, potentially infanticidal parent
Secure	• Long-term • Able and willing to invest • High parenting effort • More unconditionally accepting, sensitive, responsive to child	• Maximize future learning, quality of development • Maintain investment from `rich' parent
Insecure, Ambivalent	• Short-term • Unable to invest • Parenting effort with inadequate resources • Inconsistent, preoccupied but not rejecting of child	• Maximize rate of maturation; minimize age at first reproduction • Maintain investment from `poor' parent

Table 6-5. According to Chisholm attachment types could result from the effects of the reproductive strategy of the parents on the child.

According to Chisholm (1996, 1999) the three typical attachment types that are identified in child studies (secure/autonomous, avoidant/dismissing, resistant/preoccupied) are conditional strategies that make sense in different situations (table 6-5). The securely attached person is simply the person that has been raised in a context in which it pays to trust beneficial interpersonal relations and in which high investment parenting is the best strategy. The avoidant/dismissing attachment evolved to cope with situations in which it pays to be opportunistic. Finally, the resistant/preoccupied attachment evolved to foster `helper-at-the-nest' behavior and indirect reproduction. It is probably no coincidence that these strategies can be placed on an *r/K* continuum and form the psychological correlates of Ellis' theory of social stratification. That would mean, however, that these strategies have both genetic and environmental bases, a hypothesis which is not entirely contrary to common sense.

In his most recent book James Chisholm (1999) explicitly tries to link this evolutionary interpretation of attachment theory to life history theory. In a stable environment with low risks, both human males and females tend to form relatively stable two-parent families in which paternal investment helps to create an extra buffer against all kinds of uncertainties. Under such conditions children have the time to develop slowly, to invest in the future and to postpone reproduction. In a less protected, more uncertain or dangerous environment, bonds between males and females become weaker and their behavior starts to fall back on behavioral strategies that ultimately have their origin in the time that two-parent families still did not exist. Because they do not know how long they will live, it becomes rational for individuals not longer to postpone reproduction and not to invest in a future which is still far away. As a result the `young male syndrome' and the `young female syndrome' arise, both directed at maximizing current reproduction. Young males take more risks, are more aggressive, and tend to use sexual coercion in order to increase their number of copulations; young females start their sexual and reproductive careers earlier, tend to have a relatively large number of babies, in which is invested relatively less individually, and do no longer believe in monogamy. According to Chisholm these syndromes constitute alternative strategies which have their origin in a time that the two-parent family still did not exist. The two-parent family which propagates itself through generations via secure attachments is dependent on favorable ecological and economic conditions; if these break down the interests of men and women start diverging and they fall back on the `typical male' and `typical female' strategies (the `young man syndrome' and the `young female syndrome' respectively), which are nongenetically inherited via insecure attachments. In the terminology of *r* and *K* theory, factors like a happy childhood and the presence of a father stimulate children to adopt a *K* strategy in later life, whereas early stress and the absence of a father stimulate them to adopt a *r* strategy. Safety, good economic prospects and a stable family environment allow children to spend more time on education and climbing the social pyramid. Such children can afford themselves the luxury of a *K* strategy, whereas children in poor conditions are (biologically) wiser if they adopt a *r* strategy.

	More *r* selected	More *K* selected
Strategy	Maximizing current reproductive success	Maximizing future (+ cumulative) reproductive success
Relationship between sexes	Diverging male and female interests; protohuman lifestyles	Converging male and female interests: two-parent families
Male strategies	Risk-taking & aggression; Sexual coercion; Low investment & polygyny	Taking responsibility for children; Provisioning & protecting; Commitment
Female strategies	Teenage pregnancies; High birth rate; Facultative polyandry	Relatively late first sexual contact; Higher investment in fewer children; Monogamy

Table 6-6. An interpretation of Chisholm's life-history theory of alternative reproductive strategies in humans in terms of *r* and *K* selection.

Although they sound very plausible, Chisholm's speculations have one weak point and that is that they are based to a large extent on the `myth of early experience' which is criticized by behavioral geneticists (Rowe, 1994; Bruer, 1999). As Rowe (2000: 356) in a review of Chisholm's book writes, "Good mothers do tend to have more securely attached babies, but this may reflect the commonality that both parent and child share the kind of genes that make for complementary and pleasant social interactions". Instead of attributing the different reproductive strategies to early family experiences, one could in principle also attribute them to genetic or cultural influences or a mix of these. Rowe cites several studies that show a genetic influence on life history traits that Chisholm tends to attribute to early family experiences.

The cultural reinforcement of different strategies. Even behavioral geneticists admit, however, that not all behavior is genetically determined. As shown in chapter 5.9 and figure 5.2 behavioral genetic research shows that a large part of human behavior is influenced by non-family influences. Many environmental variables are not only shared between members of families, but are also shared by whole societies. Could such variables, including climatological or economic factors, drive a large number of individuals within a society into the direction of the same strategy? Could this have an influence on the type of culture which they create? It is here that the research of the British anthropologists Reynolds and Tanner (1983; Reynolds, 1991) becomes illuminating. They have investigated the relationship between different types environments and the cultures, especially religions, created by peoples living in those environments.

Reynolds and Tanner notice that religious beliefs are often closely related to reproductive strategies. Religious teachings are continually expressing pro and con attitudes towards issues which are relevant to reproduction, for example sexuality, marriage, divorce, widowhood, celibacy, contraception, abortion and infanticide. They then divide religious teachings in `pro-natalist' and `anti-natalist': pro-natalist precepts favoring reproduction and population growth, anti-natalist not doing so. A typical set of pro-natalist precepts is one which applauds many births, which stimulates early marriage and reproduction, which disapproves of abortion and infanticide and which encourages remarriage, polygamy and reproduction into middle and old age (table 6-6). It is clear that the pro-natalists are the *r* strategists, the anti-natalists the *K* strategists.

Area of concern	Pro-natalist	Anti-natalist
Conception	Many better	Few better
Infanticide and abortion	Disapproved of	Approved of
Birth and childhood	Many births, less care	Few births, more care
Adolescence	Early reproduction	Delayed reproduction
Marriage	Early marriage	Late marriage
Divorce and widowhood	Remarriage encouraged	Remarriage discouraged
Middle and old age	Reproduction continues	Reproduction ceases

Table 6-7. Pro-natalist and anti-natalist religious precepts, according to Reynolds & Tanner, 1983; Reynolds, 1991.

One of the most surprising things found by Reynolds and Tanner (1983) and Reynolds (1991) was that pro-natalists attitudes were more pronounced in areas with more environmental uncertainty. For example, the Islam has always been more successful in large areas of the Middle-East and Asia. It is distinctively more pro-natalist than Christianity, which stresses monogamy, celibacy and discourages remarriage and sex for the sake of sex. In contrast, the Islam allows polygyny with up to four wives and is much more positive about marital sex. In Christianity, much stress is laid on hygiene and health care and the individual is valued more. On balance, one could claim that the Islam is much stronger in creating optimal conditions for an increased `mating effort', whereas Christianity is assisting people in their `parenting effort'. (The history of Judaism, as recorded in the Bible, shows a transition process: remember Jacob married the two daughters of Laban, while in later times polygyny was forbidden.)

Protestant	Birthr	InfMor	_Fert	Lifee	prod$
United Kingdom	13	10.1	1.8	73	9050
Norway	12	7.8	1.7	76	13820
Sweden	11	7.0	1.6	76	12400
Finland	14	6.0	1.7	74	10440
Denmark	10	8.2	1.4	74	11490
Netherlands	12	8.4	1.5	76	9910
North Germany	10	10.1	1.3	74	11420
Switzerland	11	7.7	1.6	76	16370
Iceland	19	7.1	2.2	77	10270
Muslim					
Syria	47	57.0	7.3	64	1680
Jordan	46	63.0	7.4	64	1710
Saudi Arabia	42	103.0	7.2	56	12180
Turkey	35	110.0	5.1	63	1230
North Yemen	48	154.0	6.8	44	510
Algeria	45	109.0	7.0	60	2400
Libya	46	92.0	7.2	58	7500
Morocco	41	99.0	5.9	58	750
Tunisia	33	85.0	4.9	61	1290

Birthr = crude birth rate per 1000 members of population; InfMor = Infant mortality rate per 1000 live births; _Fert = total fertility rate, average number of offspring per woman; lifee = life expectancy at birth; Prod$ = Gross national product per capita in US$.

Table 6-8. Demographic characteristics of selected protestant and muslim countries. World Population Data Sheet, according to Reynolds, 1991.

Now, the interesting thing is that in those areas of the world in which Christianity has flourished for centuries have always had to cope less with natural disasters, food shortages and bacterial diseases than the corresponding areas in which the Islam has been more popular, according to Reynolds and Tanner. Northwestern Europe has a relatively fertile soil cover and a relatively benign climate. Although it has had its epidemics (e.g. the Black Death), they are small compared to the plurality of infectious diseases which have plagued the Middle East and Asia. In these countries there have also always been more famines, as a result of the much harder climatological conditions (most people that I speak are not convinced, thus more study is certainly required here).

Reynolds (1991) compares the demographic characteristics of a series of Protestant and Muslim countries (fig. 6-8). These demonstrate that at least in some Muslim countries both fertility and infant mortality are much higher than in at least some Protestant countries. In contrast, Protestant countries have a much higher life expectancy and gross national product per capita. The implication is that the patterns of ethical prescriptions that are popular in both groups of countries can be understood from their respective ecological contexts. In the words of Reynolds:

> According to our hypothesis, ecological differences give rise to different levels of confidence in the ability to survive, rear children, and solve the family's needs for food and other basic resources. Ecological conditions give rise to different *perceptions*. It is the *perceived* level of unpredictability of the environment that determines family size, that is, how many children they *think* they are going to be likely to lose through death and disaster (Reynolds, 1991: 213).

Of course, these data prove nothing to someone who does not have other theoretical reasons to suspect that religious beliefs reflect particular subjective needs. Much more research is needed to test the ideas of Reynolds and Tanner and it is likely that a more complex picture will arise. At this point, however, the burden of proof may already lie with those rejecting the idea that religious rules may assist individuals in making decisions which are relevant for their reproductive careers. At the same time, it is clear that there is no simple linear causality involved. If there is a relationship between religious beliefs and reproductive attitudes individuals may learn from their surrounding culture as long as this is adequate, but will probably change their religious belief if their reproductive needs require this.

Genetic and racial bases of different strategies. Of course, in principle differences between cultures need not to be entirely non-genetic. The Canadian psychologist Philippe Rushton (1990; 1997) claims that individuals from different groups, societies or races embody a stronger *innate* tendency to adopt one or the other strategy. He claims to have shown in one study that mothers of dizygotic twins who represent a more *r* strategy compared to mothers of singletons (who represent a more *K* strategy), had "on average a lower age of menarche, a shorter menstrual cycle, a higher number of marriages, a higher rate of coitus, a greater fecundity, more miscarriages, an earlier menopause, and a higher mortality rate". It is, then, not unreasonable to postulate also that different lineages of humans, because they have evolved in regions of the world with different climatological conditions, tend to different positions on the *r/K* continuum. According to Rushton Mongoloids are more *K* selected than are Caucasoids, who in turn are, on average, more *K* selected than Negroids. He cites a study which shows that Mongoloids have about 4 dizygotic twins per 1,000 births, Caucasoids 8, and Negroids 16. He claims that there are over 60 different variables in which Caucasoids consistently average between Mongoloids and Negroids and that many of them are linked to positions on the *r/K* continuum, including brain size (Mongoloids, 1,448; Caucasoids, 1,408; Negroids, 1,334) and size of sex organs (Silverman, 1990; Rushton, 1990; 1997).

Because Rushton does not hesitate to use highly `political sensitive data' (like racial differences in IQ and criminal activity) to support his claims, many sociobiologists feel very uneasy about Rushton's claims. Most of them being `Darwinian lefts' (Singer, 2000), they feel that it would be a pity if sociobiology became associated with conservative prejudices. On the other hand, from an evolutionary perspective it would be unlikely if human populations were entirely homogenous, even if they would have a common origin of only 200.000 years. It is to be expected that different human groups embody different positions on the *r/K* continuum, both at the levels of genes and at the level of beliefs. It should be stressed also that these two levels are often reinforcing one another. If one position on the *r/K* continuum has been rewarded in some region during many generations, it is both plausible that cultural prescriptions have been influenced in one direction and that individuals with the right natural tendencies have been increasing. It should be stressed, however, that differences within populations could still be both greater and more important than differences between populations. Rushton's claims, even if they are methodologically sound, are still based on statistical averages, but those same averages can become dangerous prejudices if they are blindly applicated to individuals.

Conclusion. In all, there are good reasons to believe that humans, like many organisms are adapted to a particular position on the *r/K* continuum of possible reproductive strategies and that humans, like some organism, are able to adjust their position somewhat to the environment in which they find themselves. Individual human beings are unique as a result of meiosis; and it is more than likely that each individual embodies a particular strategy has implications for his position on the *r/K* continuum. Above that, there are promising theories which posit that the flexible human personality structure may have evolved to adjust individuals to the world in which they find themselves, especially to some of its ecological, economic and demographic variables.

Because cultures consist of large numbers of individuals which share many of these variables, cultures are likely to reflect the choices of large numbers of individuals. Because individuals that fit in naturally in the culture in which they find themselves have an advantage over other individuals, a certain degree of gene-culture coevolution may have reinforced the genetic tendencies which underlay elements of particular cultures. It would not be surprising, thus, to find particular gene-combinations more often in one culture than in another culture; nor to find that they in part determine the nature of that culture. This does not mean they are completely `genetically determined'; only that a gene-free or gene-transcending culture does not exist.

6.4 STUDY 3: POPULATION SIZE AND MORALISTIC ATTITUDES

Until now we have studied two examples of external ecological conditions on the structure of cultures. An interesting question is whether there are also effects resulting from the *sheer size* of a society on the type of culture that it is producing - of course mediated by particular natural or instinctive reactions of each individual apart. Although there is only a limited collection of literature on this subject on which I can `build a strong case', it is too important to neglect it. For sociobiologists the causes and effects of groups of different sizes are fundamental, because to them groups of individuals and especially societies are in need of an explanation. Why would individuals live together? Is each group essentially a `selfish herd' (Hamilton, 1971) kept only together as a result of a common fear? Thus, I will simply present some of the theoretical views on this subject and an example of research that in my view supports some of these views.

We have seen that small family groups are postulated to be bound together by common interests emerging from shared genes; yet, in many groups individuals are not close kin. Why do fish form schools, deer herds, wolves packs, birds flocks, mosquitos swarms? As I have hopefully explained clearly in chapter 3, a common fear for predators is often the ultimate cause (this goes for many fish, for deer, many birds). Often there is also the need of a meeting place to find partners (mosquitos) and sometimes individuals are able to catch prey together which they would otherwise miss (wolves). Especially in the last case and in intelligent animals cooperation or reciprocal altruism can evolve; individuals are then bound together by an intelligent play of giving and receiving and a series of common interests which do not simply arise out of shared genes.

Of course, human culture could only arise, because humans are extremely social animals. To a sociobiologist the question `What *kind* of sociality binds humans together' becomes fundamental, because he expects this kind of sociality to have consequences. In our own modern, extremely technological societies we are so completely mutually dependent that the original causes of our togetherness are hidden under a thick carpet of additional advantages. Small sized hunter-gatherer societies do probably better reveal why humans live together: in the first place they hunt and gather together. Yet, this can not be the only reason that humans live together. Because group sizes in humans are bigger than would be required purely for hunting efficiency, Alexander and others have postulated that humans form groups also to be safer against enemy groups (e.g. Alexander, 1979, 1987, 1990; see part III). This means that human sociality is not fully explained by kin and reciprocal altruism theory, but that there is a `selfish herd' effect that drives humans together in groups in which many individuals do not know each other personally any more.

As explained in chapter 4, reciprocal altruism-theory can be stretched a little. If the cooperation between two individuals is monitored by a third one, each individual's `moral status' starts to matter, that is: it becomes important what this third individual thinks about the first and second person's attitude, reliability, fairness, etc.. Humans attach a lot of importance to what others think about them; apparently this enables them also to live together peacefully in groups in which most individuals do not know each other. Individuals who transgress the rules that make us feel comfortable and safe even with strangers are punished, partly because they are a danger to the very foundation of our society. At least, if they are unmasked, they lose their attractivity as cooperators. Thus, the theory of `indirect reciprocity' predicts that humans always will do their best to *seem* absolutely reliable and fair while doing their best at the same time to unmask others that do the same.

According to this line of reasoning human sociality is a mixed bag. Kinship and pure reciprocal altruism play a role, but because we are driven together into a `selfish herd' in which it is relatively safe, given the danger of hostile neighboring groups, we are paradoxically forced to cooperate with many strangers to combat the enemy within our own society, the virus of parasitism. As long as we reap the benefits of living together we are inclined to stress our mutual interests and our common good and bad; the moment we feel exploited or harmed by our society we can become cynical and parasitical minded ourselves. On the whole it will be the successful group of powerful individuals that will stress cooperation, because they profit most from it; and it will be the `losers', those who do not succeed in establishing a powerful position in society that will be inclined to develop a cynical attitude towards this cooperation (we have analyzed this already in terms of *r* and *K* selection).

All this is not completely speculative. There is a lot of research that confirms the impression and theoretical expectation that humans are very much preoccupied with the reliability of their social and sexual partners. The evolutionary psychologists Leda Cosmides and John Tooby (which we met already in chapter 4.4 as reinventers of the notion evolutionary psychology) have even tried to prove with psychological experiments that humans have a cheater-detection module which enables them to understand complex social contracts much better than their purely logical analogues (Cosmides & Tooby, 1992). Less than 25% of the people exposed to a *Modus ponens* in an unfamiliar relation were able to use it correctly, while this performance raised to about 75% when it was required to analyze a situation in which the possibility of cheating played a role, for example the situation of a bar-owner who has to decide who violates the rule "If a person is drinking beer, the he must be over 20 years old" (If p, then q; The bar owner has to control to be suspicious about p and not-q and can neglect not-p and q). Their investigations show at least that we are often much better in understanding social relations then in understanding purely abstract logical relations.

Because humans are apes with language, they have found ways to express their attitudes and to manipulate each other's attitudes through language. Moral language with its pushs and pulls, goods and bads, with its referral to a `free will', to responsibility and to the rewards of a good life (a heaven or simply a meaningful life) seems thus to bind societies together. In fact, one could even speculate that moral language really is a language *about* something, a common good, as an emergent virtual property which grows out of the mutual interests of a group of cooperating individuals (fig. 4-9). Morality can then be seen as an `emergent' `holistic' `network' property that arises out of the cooperation of a large number of direct and indirect reciprocal altruists that together can increase their `utility space', but at the same time still are competitors in demanding their part of the booty (Slurink, 1989; 1994; 2000).

Yet, on the basis of evolutionary theory it is easy to predict that the size of such moralistic networks matters enormously. One sociobiological theory and one mixed sociological-sociobiological theory both predict that moralistic networks become substantially weaker with an increasing group size: kinship theory and the theory of social control. Kinship theory enables us to predict that small groups with many relatives will be characterized by more pure altruism than the theory of reciprocal altruism alone can predict. Because kinship and reciprocal altruism can reinforce one another, it can be predicted that moralistic networks will become weaker the moment that groups are larger and contain less relatives.

The notion of social control, which was used often by the Chicago sociologist Robert E. Park (Coser, 1977), but became also part of our common language, seems to imply that cooperation will decrease with an increase of group size, as a result of decreasing opportunities for continued mutual monitoring. Social control constitutes a kind of virtual `supervision' of the cooperation between reciprocal altruistic parties as they can be represented with the iterated prisoners dilemma (Axelrod, 1981). The notion fits well into the theory of indirect reciprocal altruism (Alexander, 1987), which also predicts that cooperation will decrease in larger, more anonymous societies. According to Alexander morality arose in the human species largely to enable individuals to live in larger groups which were necessary as a defense against other human groups.

As we saw in chapter 4, Robert Trivers has pointed to the possibility that a series of Freudian concepts like the *id* and the *super-ego* constitute internal representations of the two parties in the parent-offspring conflict between which the *ego* has to manoeuvre (Trivers, 1985: 163). *Id* (as pure self-interest) and *super-ego* can also be said to represent the two parties in the moral systems emerging from a society of indirect reciprocal altruists, each individual's *super-ego* representing the common good and the requirements posed by it on the individual (Badcock, 1986).

The idea of a God which monitors an individual's intentions from above (`Thou who has tested my heart and kidneys', Ps. 7: 10), seems to be an almost ideal way of imprinting such an *super-ego* in the minds of a people, and thus to jack up the general level of cooperation. In contrast to the Platonic idea of the Good, Kantian Duty or the Greatest Happiness Principle advocated by the utilitarianists, a personal God which bears resemblances to a real father, leader or sage, although being completely fictional, may instill real feelings of respect or fear (`the fear of the Lord') and may command a moral attitude in individuals who would otherwise mistrust the moral demands of real-world authorities or would be indifferent to purely abstract commands. (As Tooby and Cosmides saw, humans are better in understanding social relations than purely abstract relations.)

Such a non-human God has also the advantage of being perfect or at least non-partial. Whereas moral rules which are dictated by human leaders could in principle be suspected to reflect their personal interests, moral rules which descend from heaven, whether inscribed into stone tables or descending via divine inspiration in the words of a prophet, may be impartial without being dull and non-convincing like Kant's categorical imperative. Raised in a very protestant family, I have been speculating about such issues already for a long time:

> Human nature, like that of other primates, consists of a relatively large collection of innate reaction patterns which enable interpersonal relationships. Charismatic leaders or shamans used those innate reaction patterns to breathe life into `collective fantasies' which would inspire other group members to devotion towards common ideals. They had thus to

> provide the collective fantasies with properties (key stimuli) which would evoke a mood of submissiveness or ardent devotion. Therefore they created Gods which would pre-eminently bind human attention and which would arouse feelings between fear and wonder in the believers. The gods had to generate the same feelings which in a group of apes are evoked by dominant individuals in their `subordinates'. Sometimes they had to make people shake, but sometimes they also had to be long-suffering and sensible to ardent prayers. Never should their behavior be predictable and their authority had to be indisputable and *taboo* (Slurink, 1986: 36).

I found a similar approach to religion in a lucid argument by the Dutch sociologist Frans Roes:

> High gods do not compete with humans for resources, and they seem free of self-interest. For these reasons, moral rules serving the collective interests of the members of a society, and proposed by high gods, are more likely to be accepted than similar rules proposed by human individuals (Roes, 1995: 74).

If this is true, however, and if larger societies have more problems coping with the problem of evil or internal parasitism, one would expect larger societies to belief more often in high gods producing impartial moral rules than smaller societies. It is here that Roes has offered an important contribution. He has tried to show that the relationship between high gods which are supportive of human morality and the size of societies can be tested using Murdock and White's *Ethnographic Atlas* (1986). Because the *Ethnographic Atlas* has a variable called `high gods' about which is even noted whether they are `supportive of human morality' or not, it is relatively easy to get quantitative data on the belief in high gods supportive of human morality. Strangely enough, it is somewhat harder to get data on the sizes of such societies, but by combining six variables (less dependence upon 1. gathering 2. hunting and 3. fishing; 4. more intense cultivation, 5. more permanent settlements, 6. larger mean size of local communities), Roes constructed a reliable variable. This variable `society size' showed a .4987 correlation with the variable `high gods'. A graphical representation was possible by defining 14 values for the variable `society size' and showing the correlating percentage of those societies believing in high gods. I have redrawn Roes' figure in figure 6-6. (Roes shows that this correlation is not an artifact of regional differences; he also discusses the influence of stratification. For details, see Roes, 1995.)

One can, of course, criticize Roes, because his correlation could simply be the result of the relatively large influence of monotheistic systems in large, literate societies (Hans van der Dennen, pers. comm.). It is true that some relatively large societies, like India and historical Egypt and Greece, are/were characterized by polytheistic systems (in the words of the social philosopher Voegelin these social system were of the `cosmological model'). Yet, one could argue that these societies are in fact loosely organized conglomerates of smaller units that all have their own favorite cults. Perhaps the point is that large societies, the moment that they become more united and organized, simply need a unifying deity (think of the roman empire that at some point turned into a christian empire). Thus one could still defend Roes, although more studies are clearly needed.

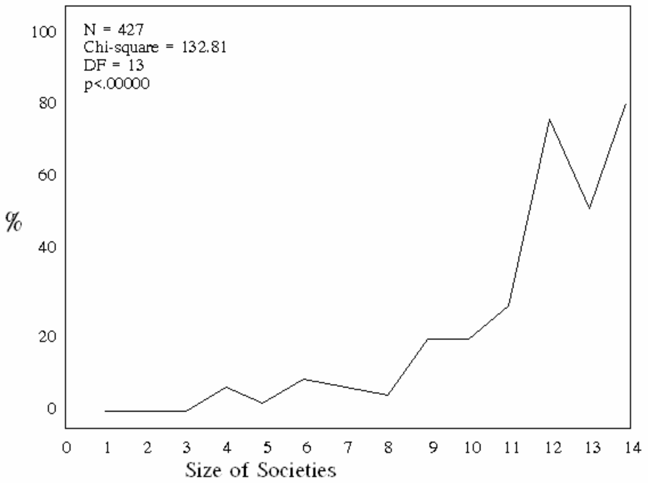

Fig. 6-5. Belief in High Gods Supportive of Human Morality by Society Size. Redrawn after Roes, 1995.

For our purposes the ideas of Roes are important because it shows how something as `personal' and as cultural as the belief in a high god can be linked through ecological variables to elements inherent in human nature. Of course, as we have seen in 6.3, there are also other variables which are reflected in a particular religion. Above that, just as phylogenetic inertia' (Wilson, 1975) plays a role in ordinary evolution, it does so in cultural evolution. Gods evolve and the landscape to which they have to adapt are the needs of the people that change from generation to generation. Yet, it are exactly those needs which can be partially predicted by applying some simple behavioral ecological laws.

This example can also be used to show the inadequacy of pure `selfish meme' theory, according to which memes are `replicators that compete to get copied for their own sake' (Blackmore, 2000). Of course, there has been going on variation and selection of deity-memes all the time since prehistoric times. The question is, however, whether this explains the evolution of gods, angels, devils and other virtual creatures and `memes'. To understand this evolution one has to discover the function of those memes and the landscape to which they are adapted. One also has to understand how and why they were *manufactured* and *manipulated* at least partially intentionally. That is, they are *not* products of purely accidental mutations that were subsequently sieved out by selection; they do *not* compete to get copied for their own sake; they were designed somehow to instill particular feelings. Probably they were designed by a series of relatively clever or even wise leaders and prophets on the basis of an intuitive understanding of human nature. Thus, they are not self-serving `selfish memes' but efficiently constructed mind viruses at least partially serving the interests and hopes of their creators.

6.5 CULTURE IN ITS ECOLOGICAL CONTEXT

Hopefully, these three examples demonstrate sufficiently that culture is not created *ex nihilo* outside any ecological context. Of course, creators of culture, like prophets and poets, have their own idiosyncratic visions and phantasies, but these will be neglected if nobody needs these somehow. Prophets and poets who somehow know how to touch a sensitive chord in their public are cherished, because they apparently offer something which their public needs for its own purposes. Without people needing guidance, inspiration, and justification, prophets and poets would have no power at all and would, indeed, remain voices crying in the wilderness. Of course, the relationship between cultural leaders and the people that they lead is also determined by the amount of power of those leaders and by their talents in convincing, negotiating, manipulating and advertising their to some extent completely sincere preparedness to serve. From a sociobiological point of view one would expect a lot of mutual deception between leaders and followers, between the creators and consumers of ideas, especially if one assumes that group selection was not a strong force during human evolution.

If my examples in this chapter are well-chosen, however, both creators and consumers have an interest in cultural ideas, forms and customs that make sense given the ecological situation of a particular culture. In figure 4-9 we could introduce a third dimension, which would show that any morality-loaded world-interpretation is not only a compromise between the interests of the group and the individual, but is also dependent on the means of support and the ecology within a particular society. As we have seen, some ecological situations promote monogamy, other ecological situations enable some individuals to indulge in their polygamic desires. Some ecological situations stimulate people to have many children, others inspire them to have relatively few of them. People living in relatively large societies have more reason to be moralistic than people in smaller societies. Human behavior and culture is influenced by the ecological context at almost all levels.

6.6 WHY DO SOME APES NEED CULTURE?

In chapter 5 I have stressed biological conflicts of interests within societies as motors of cultural change and culture as the medium in which humans compete with one another. In this chapter I have shown how culture enables humans to adapt to different ecological situations. We end up with a picture of culture as a biological phenomenon at many levels. On the one hand culture is a weapon which we use to compete with other humans, both at the level of groups and at the level of individuals; at the other hand culture enables us to adapt our relatively flexible collection of instincts to a way of live which makes sense given a particular ecology. Taken together, these two approaches make us suspect that cultures reflect a large number of individual creations rather than collective projects designed by groups purely for the welfare of the group. Cultures will always reflect the conflict of interest that exist between collective and individual interests, between mutual and incompatible interests, as shown in figure 4-9. Within the sociobiological approach the fundamental antithesis is thus not the opposition between `nature' (or `biology') and `culture', but rather the opposition between individual and group interests as these are reflected in culture.

Yet, even if we would all agree that `culture' should not be conceptualized in opposition to `biology' or `nature' and even if we agree that many animals have forms of culture, there still remains an enormous gap between most animals and man, the only animal that seems to be completely dependent on culture in all aspects of its life. Why are humans standing apart in being dependent on this kind of life? Why would some apes, ancestral to man, have started increasingly to create and use culture? Within an evolutionary perspective is seems still strange why something like culture can ever have been evolving.

In chapter 5 I have suggested that intelligence and cultural abilities could have been the product of some sort of arms races. Yet, it is still unclear how these arms races have started. Above that, culture is characterized by a lot of apparent `useless' phenomena. How should we explain these? Of course, it would be ideal if it proved to be possible to understand the series of selection pressures that gave rise to man as distinct from chimpanzees. In part III I will investigate this possibility.

III

*** A unique evolutionary trajectory \\

In part II I have shown that the traditional disjunction between `nature' and `culture' is too simplistic. Human culture does not transcend the `struggle for life', it is simply another way in which this struggle is fought. Different cultural expressions can be ways in which individuals demonstrate their fitness, including their superior senses, skills and mental abilities. At the same time, cultural systems often represent adjustments to particular environments. Ecologically flexible as humans are, they can often profit from cultural traditions (from clothing to ethical prescripts) to cope with particular environments.

Thus, human culture does not make humans unique in the sense that humans, and humans alone, are able to transcend their evolutionary roots. If humans are considered unique they have to be unique for some other reason, for example, because their unique evolutionary trajectory has bred unparalled capacities in them. Part III is an attempt to explain human uniqueness with reference to a unique evolutionary trajectory which worked as an `ecological recipe for a bipedal predator ape which has grown completely dependent on language and culture'.

Chapter 7 starts by criticizing a series of attempts to define our human uniqueness. Several characteristics that were thought to be uniquely human have been demonstrated in other species. Instead of trying to point to one uniquely human trait I try to show that it is a combination of traits which is uniquely human. Those traits have not evolved at the same time, but have been acquired during several evolutionary episodes. I try to explain them with reference to the specific selection pressures which play a dominant role during these episodes. Together they cumulatively molded the human animal with its bipedal gait, its unique family system and its complete dependence on language and culture.

One of the results of chapter 7 is that climatic change plays a dominant role in human evolution. Climatological circumstances changed the habitats in which our ancestors lived and favored those that walked upright and that relied on meat as an extra ingredient to their diet. A transition to a more carnivorous diet could explain a series of human characteristics, including the altriciality of human infants and other aspects of the human mating system. Yet, given the fact that there are other large predators that are not as dependent on language and culture as humans, it remains uncertain whether the hunting hypothesis explains other characteristics of the human social and ecological/economic system. Are additional hypotheses needed to explain our elaborate language and our extreme cultural flexibility?

In chapter 8, I compare the hunting hypothesis with two other hypotheses, sexual selection theory and the intergroup competition hypothesis. Both these theories stress that there is really something unique about human cognitive and moral capacities. These unique properties must be explained as results of a kind of `runaway selection', because it seems that they have developed to such a degree that a purely ecological explanation is insufficient. While sexual selection theory sees the exaggerated cognitive possibilities offered by the human brain as a kind of `fitness indicators', evolved to seduce the opposite sex, intergroup competition theory places them within the context of arms races between *groups in which groups as teams needed and favored loyal and intelligent members. Of course, the question is why this arms race has not occurred in other species. Alexander postulates that this arms race started because our ancestors at some time became `ecological dominant'. Ecological dominance would have diminished the effects of `extrinsic' forces of natural selection such that within-species intergroup competition increased.*

One of the results of chapter 8 is that both the sexual selection theory and the intergroup competition theory presuppose a version of the hunting theory and that all three theories may refer to aspects of the same process. Only because early hominids were at times dependent on the extra calories offered by meat, a division of labor could evolve in which some paternal investment could become necessary, as a result of which the moral and intellectual capacities of sexual partners started to matter more and more. Only because early hominids became at some time became very fierce group hunters could they become a threat to other groups of their own species, which forced them to become even better and more cunning cooperators, dedicated to their own group's well-being.

In all, some readers may well accuse me of being eclectic and indecisive, because I try to integrate all attractive theories in an overarching hypothesis. Yet, it seems to me that many theories try to isolate only one causal factor and ascribe too much power to it. Like it or not, we live in a complex, multicausal world, being part of all kinds of multicausal processes. Although many would prefer a theory in which human evolution resulted from one powerful causal mechanism it seems that in reality several mechanisms worked together. If this is true, human evolution is a coincidence, the result of an accidental combination of contingencies. In that case the chances that we will ever find a similar species somewhere in the universe will be very small indeed, even if we continue to find other planets in other galaxies which are not too close and not too far from their stars.

7

*** Why some apes became humans: ecological and climatological factors \

7.1. INTRODUCTION

Philosophers have long believed that man is in some respect a unique species. This belief has seduced them often to reflections which are somewhat comical in hindsight. Often these reflections show more love for dichotomies and `speciïstic' (Dawkins, 1976) distinctions than real self-knowledge. So we read in a paper about `Die aufrechte Haltung' or `the upright attitude' the following sentences:

> Ein Tier, das sich in der Längsachse seines Körpers fortbewegt, ist immer auf die Dinge zugerichtet. Der Mensch aber, der sich in einer Richtung senkrecht zu seiner eigenen Längsachse vorwärts bewegt, den aufgerichteten Körper parallel zu sich selbst verschiebend, findet sich allen Dingen einsam gegenüber (Straus, 1949: 370).[1]

The writer seems to have forgotten that already many dinosaurs were walking upright (bipedal) and that their modern descendants, the birds, do the same, as do kangaroos, while there is little evidence in all these groups of an ability to objectivity and critical distance toward the world that surrounds them. Would kangaroos display more objectivity than, for example, deer, that outside Australia occupy the same kind of niche?

In the course of its still short history, ethology has often revealed the superficiality of such easy characterizations of our own supposed uniquenesses. Ethologists have discovered that man is not the only animal that makes tools and has complex social relations and commitments, that has belligerent inclinations, that recognizes itself in front of a mirror, and that can use symbols. This did not, however, stop the stream of claims about man's uniqueness. Revisionists are always very inventive in devising new versions. For example, now that linguists can no longer deny that at least some animals are able to understand symbols, they have shifted their attention to the ability to structure meaningful utterances by means of some kind of grammar (Bickerton, 1990). About the same time that this new essential human characteristic was proposed, reports began to appear about the linguistic capabilities of Kanzi, a bonobo brought up by Savage-Rumbaugh, who can discriminate between sentences on the basis of word-order (e.g. Greenfield & Savage-Rumbaugh, 1990). Also, the equally surprising linguistic skills of a series of dolphins trained by Herman (Herman, 1984) and those of Alex, a grey parrot trained by Pepperberg, began to get public attention (Pepperberg, 1990; Vauclair, 1996). This should warn us that we cannot be cautious enough in making claims about our uniqueness. Of course, we are the only animal

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[1] "An animal that moves itself along the longitudinal axis of its body is always directed towards the objects. Man, however, who moves himself at right angles to his longitudinal axis, displacing the upright body parallel to himself, finds himself facing all things in solitude."

devising nuclear arms, making interplanetary excursions, and disturbing whole ecosystems and climates, but some other animals display certainly rudiments of the talents required.

However, the fact that several characteristics of humans are more or less exhibited by other animals throws up the question why we are the only ones who exhibit them to such a degree. Many other animals show culture or the non-genetic passing on of information between successive generations (Bonner, 1980), but we have built cultures around every individual biological function of our body, be it feeding, sexuality, sleep, stools, cleaning, etc.. Above that we have built cultures around every individual social interaction, be it parent-offspring relations, friendships, or relationships between the sexes. Many other animals more or less create their own environment by building nests or even by building dikes (think of beavers), but no other animal lives so continuously in a self-created environment that can be adapted continually to the caprices of climate and seasonality. Many other animals have complicated communication systems, but very few of them rely so totally upon them as we humans do.

From our arrogant man-centered perspective it may seem as if our capabilities to create culture and to live in a self-created environment are inevitable products of evolution. Looking back on the course of evolution we see a gradual increase of representational capacities. The linguist Bickerton did repeat the old belief:

> As long as there are creatures whose motor capacities and environmental conditions allow them to benefit from it, evolution will always favor an increment in representational power ... Thus, given freedom from catastrophe and sufficient time to work in, normal evolutionary processes inevitably bring about the progressive development of representational systems... If no catastrophe had eliminated them, then fifty million years ago there might already have been three-toed lizardlike creatures sitting around wondering how language could have evolved out of dinosaur communication (1990: 103-4).

There are three things that Bickerton doesn't mention, however. First, there are many taxa and only in some of them can we indicate cognitive progress. Second, there are many indications that there has not only been one, but many catastrophes during the process of evolution on earth (Muller, 1989) and it could well be that they were not obstacles but *necessary conditions* for further evolution - given the conservative way in which niches are filled during the more stable periods. Third, cognitive progress is not a goal in itself, but only the consequence of the *temporary* survival value of cognition. The moment stupidity would bestow more fitness upon its possessors, stupidity would be selected for. There is no guarantee that the most intelligent individuals will always outreproduce the lesser ones. (At least among human beings we see that many famous philosophers and scientists died childless.)

Representational progress or progress in the direction of culture is thus not an inevitable consequence of the process of variation and selection which Darwin originally called `descent with modification' and which we are accustomed to call `evolution'. Many animals manage quite well to live without extraordinary intelligence or without extraordinary communicative, reflective or cultural skills and only a series of special selection pressures may be able to explain why we humans have evolved such an excessive curiosity, creativity and reliance on culture. Let us examine, then, whether we can explain why man is apparently the only animal on this planet that seems to be totally trapped in `the cognitive niche' (Tooby & DeVore, 1987) or, better, the `cognitive-technological niche'. To explain this, we will need a scenario about our evolution, in short an `evolutionario' (Wrangham, 1987). But as there exist evolutionarios of all sorts and varieties, many of which are ridiculized by critics as paleofiction and `just-so stories', we have good reason to impose some extra demands upon our own favorite:

1. First, it should be *phylogenetically plausible* - that is: it should be in concert with our best present knowledge about the possible characteristics of the common ancestor of both ourselves and the great apes that are most related to us.
2. Second, it should be *paleontologically/paleoclimatologically adequate* - that is: it should be at least compatible with our best knowledge concerning the paleontological record and concerning paleoclimates and palaeoenvironments.
3. Third, it should be *evolutionary feasible* - that is: compatible with our best current understanding of the principles of evolutionary biology.
4. Fourth, it must exhibit *explanatory specificity* - that is: it should not have the characteristics of an easy explanatory *deus ex machina* that could also be invoked to explain, for example, why wolves or dolphins are dependent on culture, whereas in fact they exhibit culture only to a limited degree. It should explain not only why humans have become completely dependent on culture, but *at the same time* explain why other animals *did in fact not.*

One of the ideas behind these requirements is that evolution is not a creative process in which *`Dieu se fait'* as Bergson thought (Bergson, 1907). Evolution does not have goals and it does not experimentate on purpose. Design reflects the past, not the future. Each species that exists has already been tested and proven to be `evolutionary stable': it has already shown to be reproducible under particular circumstances. Of course, it can be perfected, but radical changes are unlikely to spread through a population that is already stable and healthy. New species do often arise as a consequence of the reproductive isolation of small subpopulations enduring different circumstances, as is demonstrated, for example, by varieties of plant species in different isolated areas of the Alps. Evolution is thus to some extent driven by the environment, as postulated by Vrba in her socalled `turnover pulse hypothesis' (Vrba *et al.*, 1995):

> Evolution is normally conservative and speciation does not occur unless forced by changes in the physical environment. Similarly, forcing by the physical environment is required to produce extinctions and most migration events. Thus, most lineage turnover in the history of life has occurred in pulses, nearly synchronous across diverse groups of organisms, and in predictable synchrony with changes in the physical environment (Vrba, 1985, cited in Vrba *et al.,* 1995)

Of course, this idea (see also figure 0-1) is important also, because it may constitute, together with our four requirements, the difference between a well-based evolutionario and another fanciful just-so story.

Let us start working with our four requirements, then. First, to make a phylogenetically plausible model we have to begin with a reconstruction of a possible common ancestor that we share with the great apes that are most related to us. After that we will have to look at what we can learn from paleontology and paleoclimatology about the environments in which human evolution occurred. With those clues in hand we can begin to reconstruct an evolutionary sequence in which human characteristics emerged. To meet our third requirement we will try to account for the story of human evolution as a multi-stage process in which each step is adaptive in its own right. Finally, it is important that our explanation *specifically* applies only to our branch on the evolutionary tree, because the riddle that we will try to solve is the riddle of our own unique complete dependence on culture. When our explanation presupposes the evolutionary inevitability of cognitive progress the price we would have paid for it would have been too high: we would then have to explain why other animals did not reach our stage (and drop requirement 4).

Finally, an evolutionary approach opens our eyes for the fact that the present constitutes only a tiny slice of time. The earth is always in motion and that thin layer of life to which we owe our temporary existence reflects all kinds of geological and climatological forces. There have been much more species in the past than those that currently exist. For primates the total number of species has been estimated 6000, of which only 180 exist today (Foley, 1992). For hominids the total number of species is about 17, of which only one survives today.

7.2. PERSONALITY TRAITS OF THE COMMON HUCHIBO ANCESTOR

During the Miocene (23.3-5.2 myr ago) tropical forests stretched from Beijing to Madrid and from Paris to Johannesburg, long before these cities arose. A lot of fossil apes or homonoids from this period have been found, for example *Proconsul*, which may give a fairly good idea of the ancestor of all apes and humans, and *Sivapithecus* which was formerly considered a possible ancestor of the Australopithecines, but is now viewed as an ancestor of orang-utans. The evolution of hominids (all species of *Australopithecus* and *Homo*) is now considered to be a largely African event: biomolecular studies show that humans are closer to African apes than to Asian apes (fig. 7-1). There are good reasons to suppose that the evolution of hominids was put in motion by climatological changes that started to make the forests smaller and large parts of Africa dryer and cooler during the late Miocene.

The gorilla seems to have split from our lineage about 8 to 10 million years ago. A plausible explanation of its evolution was put forward by Boaz (1997) on the basis of its present occurrence in three isolated populations in mountain-forests. When the climate became cooler and dryer during the late Miocene, savannas started to spread through Africa and protogorillas became isolated in their mountain-forests, unable to cross the savanna. The fact that the three populations represent three subspecies of gorillas shows that there were periods in which the isolated populations still interbred.

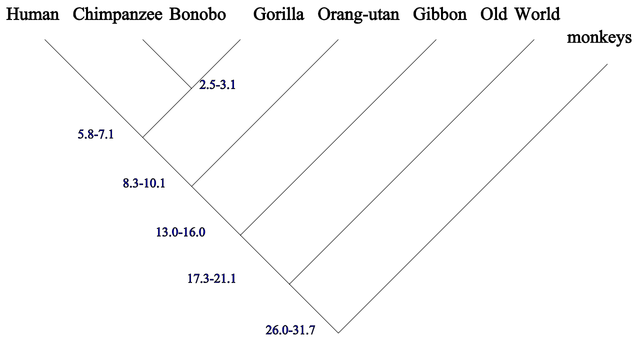

Fig. 7-1. Cladogram with dates for the divergence of homonoid lineages obtained from DNA hybridisation and from fossils (changed after Sibley, 1992).

Ethologists (especially primatologists) have speculated a lot about the evolution of the social structures of the great apes and human ancestors and on the basis of their inferences at least something can be said about the possible `personality' of the common ancestor (e.g. Kinzey (ed.), 1987; De Waal (ed.), 2001). Wrangham (1986) first concentrated on the resemblances in social structures between the African apes and humans, because the molecular data suggested their relative relatedness. From the correspondences in the behavioral repertoire of these species he concluded that the common ancestor of all African apes and humans

> had closed social networks, hostile and male-dominated intergroup relationships with stalk-and-attack interactions, female exogamy and no alliance bonds between females, and males having sexual relationships with more than one female (Wrangham, 1986: 68).

Ghiglieri (1987) showed that it was still possible to improve upon this model by concentrating on the resemblances between chimpanzees, bonobos and humans, who are genetically most related and who may be all post-Miocene phenomena. His analyses show that the chimpanzee-bonobo-human clade (the HUCHIBO-clade) is characterized by a unique cooperation of closely related males who cooperatively defend a common territory and who only exhibit moderate sexual dimorphism, "presumably because success in male-male competition hinges on having larger *group* size (of kin-related males) during conflicts rather than larger individual size" (Ghiglieri, 1987: 339).

The general pattern of hominoid evolution that he reconstructs is the following:

- Before the split between African and Asian apes, societies were largely structured around female kin groups like most primate societies: young subdominant males have to leave their native group and to find or found a harem elsewhere. Bonds between kin-related females were strongest. This pattern can still be devised rudimentary in orang-utans, where females stay close to their mothers and young males start to wander and emigrate from their natal ranges looking for estrous females and reproductive opportunities.
- All African apes share traces of a decline of the matriarchal core characteristic of other primate-groups: the females in a gorilla harem are generally unrelated to one another and female exogamy is more pronounced than male exogamy, because some adult males stay in their natal groups. In contrast to the HUCHIBOS, gorillas are not territorial, however, and most groups contain only one silverback male, who in aggressive encounters has to rely on his extreme body size to defend his harem.
- Between the common ancestor of gorillas and HUCHIBOS and the common ancestor of all HUCHIBOS (a period of more than two million years) a new revolution occurred: males stayed in their own natal social groups and kin-related males started increasingly to cooperate. This cooperation between males sets HUCHIBOS apart from the other great apes:

> Unlike gorillas and orang-utans, males of the chimpanzee-bonobo-human clade retain their male offspring predominantly, live in closed social groups containing multiple females, mate polygynously, restrict their ranging to a communal territory, are *cooperatively* active in territorial defense, and, apparently, when a neighboring community weakens, the males of some communities make a *concerted* strategic effort to stalk, attack, and kill their rivals as do men (Ghiglieri, 1987: 346).

According to Ghiglieri it was this propensity for cooperation and solidarity between kin-related males that could well have been "the critical preadaptation for male cooperation in dangerous scavenging or hunting in the hominid ancestor". Above that, the fusion-fission sociality characteristic of HUCHIBOS may have functioned as "a preadaptation for a division of labor on a daily basis and a diversification of ecological modes" (Ghiglieri, 1987: 347).

Not everyone agrees with this model, however. Ghiglieri boldly states that bonobos and chimpanzees largely fit the same pattern, while it has become clear during the last decades that there is a huge difference between bonobos and chimpanzees. It has been especially the writings of Frans de Waal in which the bonobo is portrayed as a species that makes `love, not war'. Sex is continually used for appeasement in bonobos and is completely separated from reproduction. Lethal aggression has thus far not been observed in bonobos and, while there is some hostility between groups, peaceful mingling also occurs. According to De Waal (2001) the bonobo and the chimpanzee can equally be used as a model of the common HUCHIBO-ancestor, and there is thus nothing sure about the common ancestor and his aggressive proclivities[2].

There are good reasons, however, to consider the chimpanzee as the better model for the common HUCHIBO-ancestor. They are summarized by Richard Wrangham (2001:263-4) thus:

> In many ways gorillas are merely a large version of chimpanzees - for example, in their cranial and postcranial anatomy. Bonobos, on the other hand, are more gracile, smaller headed, and relatively juvenilized and sexualized compared to the other apes. Gorillas are thus more similar to chimpanzees than to bonobos, which are at best thought of as a specialized offshoot of the gorilla-chimpanzee line.
>
> What, then, are we to make of traits shared by bonobos and humans, but not by other apes? Examples are a tendency to ventro-ventral copulation, a trend toward female-female bonding, and canines that differ little in size between females and males. Convergence appears to be responsible for these similarities. For example, reduction in sexual dimorphism of canine teeth is known to have developed more in later than in earlier australopiths (Wrangham, 2001: 263-4.)

According to Wrangham, the pattern of reduced aggression and female dominance in the bonobo has evolved after the split between a chimpanzee-like *Pan prior* and *Ardipithecus/Australopithecus.* This is consistent with the idea that the common HUCHIBO-ancestor, or *Pan prior*, already exhibited retention of males in their natal groups and cooperation between males, as it is stressed by Ghiglieri.

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[2] In a recent paper Stanford (2001) points out that the contrast between bonobos and chimpanzees, as painted by de Waal (e.g., 2001) derives largely from a comparison of wild chimpanzees with captive bonobos. In bonobos, intercommunity encounters, too, often involve aggression, and within the group it often are the females that are `demonic'. Preliminary data on the sexuality of wild bonobos even relativize the picture of the bonobo as a hypersexual species. All this could well imply that the contrast between chimpanzees and bonobos is not as sharp as postulated by De Waal c.s.. The idealization of the bonobo might well fall in the long tradition of the belief in the Fall of man which led to the `romanticization' of the unknown societies during millenia and which seduces us now to hope that we have at least a related ape which is somewhat friendlier than we are.

It is interesting to speculate about the evolutionary mechanism behind the origin of male HUCHIBO-cooperation. What factor could have promoted the transition from male exogamy towards female exogamy? First, the social structures of orang-utans is already different from other primates. Although it has been found recently that orang-utans are by no means solitary (Van Schaik in Bartlett, Boyd & Whiten, 2001), males and females often wander separately, because of their differences in size. In orang-utans solitary females and their offspring are an easy target for solitary males (see Wrangham, 1986, on rape in orang-utans). A change to a more abundant food-source (as in the gorilla) may have triggered the transition to a one-male group. Instead of being harassed time and again by solitary males, females could thus secure themselves the superior genes of a strong male who at the same time could defend their offspring against foreign males and the threat of an infanticidal take-over (infanticide is a well-known phenomenon in gorillas). In a next stage the competition of such strong males for harems may have started an arms race in which dominant males where forced to rely on the help of kin-related males more and more. In the Virungas 40% of gorilla groups contained more than one adult or nearly adult male (Ghiglieri, 1987). It is also possible that groups simply had to become larger, because this afforded the necessary safety against predators in a more savanna-like environment. Chimpanzees do not always live in dense forests and it is also thought that the bonobo has evolved in a not completely wooded environment (Boaz, 1997).

In any case, we now know something about the common ancestor of all HUCHIBOS. Chimpanzees, bonobos and humans share some unique behavioral traits, which partially seem to derive from male retention in their natal groups. Chimpanzees are known to hunt cooperatively in some regions (Boesch & Boesch, 1989; Stanford, 1999) and at least part of their diet consists of meat. There are even reports on scavenging (Hasegawa, 1983). (Yet, they are not very well in digesting meat; they do not chew it well and apparently their guts do not digest it well; Boaz, 1997.) Chimpanzees also engage in cooperative intergroup aggression (Goodall, 1986). Finally (and this could be more a consequence of their omnivorous diet than of their unique social structure) chimpanzees are skilful makers and users of tools (McGrew, 1991; Boesch & Boesch, 1984) who pass on their skills in a cultural way: different techniques are applied in different regions (McGrew, 1992; Whiten & Boesch, 2001).

Of course, the common HUCHIBO-ancestor need not to have been identical to the chimpanzee. It is unlikely, however, that the reliance on tools and other cultural traditions has evolved twice. The really enormous (r)evolutionary transition is that between an anthropoid ape towards a human being. We share many ingredients of a cultural way of life with the chimpanzee and thus, likely, with the common HUCHIBO-ancestor. The question is how those ingredients were molded into a recipe for the totally culture-dependent species that we are.

7.3 AUSTRALOPITHECUS AND THE ORIGIN OF BIPEDALISM

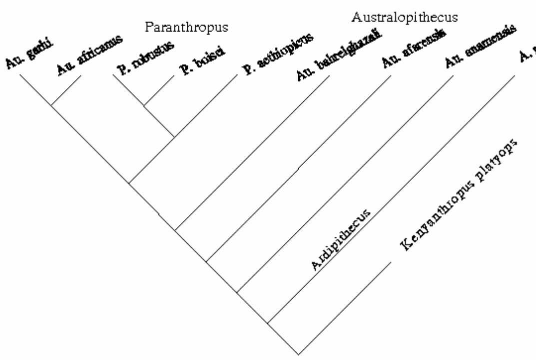

Fig. 7-2. Speculative cladogram of early hominids. Changed after Tattersall & Schwartz (2000).

From what we know about the common HUCHIBO-ancestor it would seem that the recipe for humans can simply be derived by studying paleoenvironments and the fossil record (Foley, 1987; Vrba *et al.*, 1995; Boaz, 1997). However, it is not necessarily that simple. The fossil record is very patchy and interrupted indeed and, in principle, it is possible that the main events in hominid evolution have not left any traces or that researchers are looking in the wrong places. It is well possible that human evolution resembles in this respect the origin of life: it could also be a transition that has wiped out its own traces. Although spectacular finds are again and again filling in major gaps in the human evolutionary story - the last decade the finds of *Ardipithecus* (White *et al.*, 1994, 1995), *Australopithecus anamnensis* (Leaky *et al.*, 1995) *Kenyanthropus platyops* (Leaky *et al.*, 2001), *Orrorin tugenensis* (Pickford & Senut, 2001) and *Sahelanthropus tchadensis* (Brunet *et al.*, 2002) - as long as there remain many gaps to be filled in, knowledge and speculation will remain entangled.

A good example of this entanglement is shown by the explanation of the heterogeneity of the Hadar materials (attributed to *Australopithecus afarensis*). If we interpret the differences in size of the individuals found there as reflecting sex differences, we have to conclude that the hominids living there approximately 3 million years ago showed a sexual dimorphism more within the range of the gorilla than within that of the chimpanzee. We do not know for certain, however, whether the skeletons found together, for example `the first family', belong to one species (Schmid, 1989). Another example is constituted by the recent find of *Kenyanthropus platyops*. The whole idea of placing this specimen in a new genus seems to result from the preconception, very popular within the Leaky-clan, that *Homo* represents a distinctive lineage that has evolved separately for a long time. As long as this preconception is kept compatible with the genetic similarity between man and chimpanzee it could be true. Whether a final decision about this issue can ever be made will largely depend on future discoveries. In figure 7-2 I have redrawn a recent speculative cladogram by Ian Tattersal (Tattersal & Schwartz, 2000: 99) in which the various species of *Australopithecus, Aridipithecus* and *Paranthropus* are placed in a relationship to one another. I have added *Kenyanthropus* (Cohen, 2001) to be complete, not because I think I know its proper position (the same would go for *Sahelanthropus tchadensis*).

To begin a reconstruction of the selection pressures responsible for our divergence from the common HUCHIBO-ancestor we need knowledge about the environment in which the first hominids evolved. During the last decades, such knowledge has accumulated, but there is still conflicting evidence. There are still at least three main possibilities:

- A savanna. This model has for a long time been the most popular model among paleontologists. It is supported by data that show that, as a consequence of a colder and drier climate, tropical forests in Africa have given away to more mosaic environments, with much savannas, at least since 10 million years ago. Many dramatic changes in the fauna of this period seem to be a result of this transition (Tobias, 1991; Vrba *et al.*, 1995). It was originally thought that the evolution of Australopithecines coincided with the spread of savannas and that bipedalism was an adaptation to a savanna-like environment. The site at which the oldest human footprints have been found, Laetoli, was probably a grassland savanna at that time (Andrews, 1995).

- A forest. During the last decades, the picture of the protohuman environment has become more complicated. Plio-Pleistocene rainforests in East Africa have been found (Williamson, 1985); more extensive pollen analysis also show forests in different periods (Bonnefille, 1995). Australopithecines have also been founded in an apparently wooded area in Chad (Brunet *et al.*, 1995; later to be called *Australopithecus bahrelghazali*). Lucy (*Australopithecus afarensis*) proved to have relatively long arms and australopithecines proved to have a long and flexible first toe which may have enabled the climbing of trees (Susman, 1986; Oliwenstein, 1995). The Hadar australopithecines apparently lived in a forest. *Orrorin tugenensis* and *Australopithecus anamensis* were found close to formerly wooded areas, too.
- An environment characterized by the presence of water in the form of marshes and lakes. At the site where the `first family' fossils were recovered (at Hadar) there is found pollen from bulrushes which invariably inhabit marshes (LaLumiere, 1991). Most sites where early hominids were recovered are in the close vicinity of lakes or rivers (for example: Tabarin, Hadar, Omo, Koobi Fora, Olduvai) (Foley, 1987: 195; table 7-1). The 4.1 million years old *Australopithecus anamensis* is even named after the Turkana word *anam*, meaning `lake' (Leaky *et al.*, 1995).

All three models have inspired different explanations of the origin of human bipedalism.

- Explanations derived from the savanna-model differ most widely. It has often been suggested that bipedalism increased the visual horizon of our ancestors on the savanna and enabled them to notice both prey and predators from a bigger distance. Some theoreticians stress the possibility of carrying food and tools when walking bipedally (Hewes, 1961, Lovejoy, 1981). Others concentrate on the supposed energetic efficiency of bipedal travel in a large home range (Rodman & McHenry, 1980; Pickford, 1989). The human ability to run over very large distances and for prolonged periods of times is projected sometimes back far in time: it enables modern hunter-gatherers to run down prey. Further, it is noted that the body surface exposed to sunlight is relatively small in an upright stance (Wheeler, 1984; fig. 7-3) and that this could have enabled early hominids to

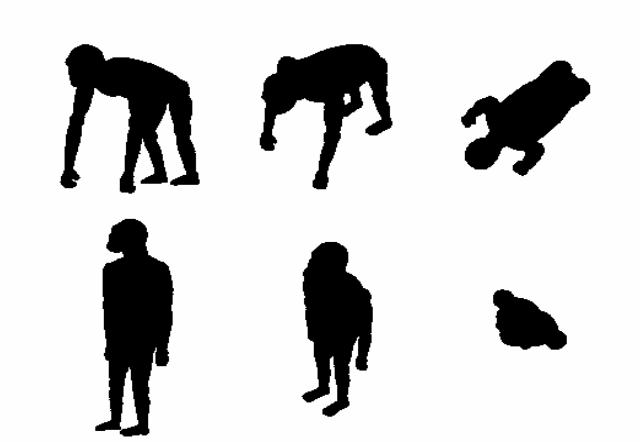

Fig. 7-3. Body surface areas of a quadruped (*Pan*) and a biped (*Pan*/*Australopithecus*) exposed at 5°, 45° and 90° to direct solar radiation. From Wheeler, 1984.

forage during the mid-day when all predators were asleep (Foley, 1987). Finally, bipedalism also frees the hands for throwing. Calvin (1983; 1993) has even suggested that the lateralization enabling our ancestors to throw has also preadapted them to speech. (Alas, subsequently it has been found that many species exhibit lateralization.)

- As said, proponents of the forest model point to some primitive characteristics of the limbs of the early *Australopithecus* (short lower limb, long forelimb, curved toes, long forefoot) which enabled it to climb into trees. A partial foot skeleton of a 3.5-3 myr old Australopithecine from Sterkfontein shows a long, flexible toe still useful for climbing trees (Oliwenstein, 1995). It seems that, on the whole, the skeletons of female Australopithecines were better suited to climbing than those of males. Thus, it has been suggested that females still got more food from the trees, while males spended more time on the ground (Simons, 1989). (This reminds one of the sexual dimorphism in the orang-utan which is also compatible with this species' dimorphism in body size. Another anthropoid ape spending much time on the ground while living in a wooded environment is the bonobo (it is hypothesized sometimes to have evolved in a less wooded environment; Boaz, 1997). If bipedalism evolved in woods, it may have been functional for reaching up for foods (Jolly, 1970) or it may have been functional for the production or efficient use of tools (Marzke, 1996). Recently, the forest model has gained new support as a result of the find of *Orrorin tugenensis* (`Millenium man'; six million years old), a supposed ancestor of the Australopithecines, which both lived in woods and walked bipedal. There has been found also a Miocene ape, *Oreopithecus*, which is thought to have been bipedal (Köhler & Moyà-Solà, 1997). Such finds seem not to fit the model according to which the evolution of bipedalism corresponds with climatalogial changes that enlarged the savannas. There are even researchers who have turned to the occasional bipedalism of the Urang-utan and who claim that it provides us with a better model for the original hominid locomotion than the African apes.
- An explanation based on an environment with much water is the aquatic ape theory (Morgan, 1990; Roede *et al.*, 1991). Originally inspired by the striking parallel between the human subcutaneous fat layer and that of different aquatic mammals, most of whom happen to have lost their fur as well, it was expanded by Morgan and Verhaegen into an all-encompassing theory that could account for the human transpiration system (that would amount to spoiling too much water and salt in a savanna-environment), for the threefold brain expansion (aquatic mammals have also an enlarged brain) and for the origin of language (possible as a consequence of two adaptations of a diving mammal: a descended larynx to inhale large quantities of air in combination with conscious control of respiration). Bipedalism could have evolved from wading: bonobos have been observed also wading bipedally and catching fish (De Waal, 1988). If this is true our anatomy was at some stage so completely adapted to wading upright with our heads above water that those ancestors that returned to the land remained upright.

Let us try to weigh the different *pro* and *con*-arguments. First, the force of the aquatic theory seems to lie in the incompleteness of the savanna-theory as it is often envisioned. Some of the criticism leveled by aquatic ape theorists against the savanna hypothesis are certainly right. Especially Verhaegen's argument that the human cooling system is extremely water and sodium-wasting and therefore unfit for a dry environment seems very convincing (Verhaegen, 1987). On the other hand, the danger has to be avoided that a theory is devised which can not be verified but nicely fills all the gaps in the fossil record with explanations for supposed uniquely human characteristics (Lalumiëre, 1991). To explain human tears as a device to get rid of a surplus of salt (Morgan, 1990) seems to me an explanation which creates more problems than it solves: why do we so seldomly see people weep on the beaches or after a too salty meal, for example? Why would tears be linked to sadness if it is the sea that makes us happy?

If we study several of the arguments of the aquatic ape theory closely, these arguments remind one of the apostles who were rereading the prophets after the death of Jesus. For example, it is true that humans have a subcutaneous fat layer, but it has another structure than that of sea-mammals and does not prevent us from the dangers of hypothermia. If women conceive their children in water the water temperature has to be controlled precisely, because a slight aberration can be fatal (Taylor, 1996).

Locality/age/species	Paleoenvironment
Tabarin, Kenya, 5.0-4.0 myr, *Australopithecus afarensis*	Lake margin, with locally variable savanna elements
Middle Awash, Ehtiopia, 4.5-3.9 myr, *Australopithecus/Ardipithecus ramidus*	Fluvial conditions, with extensive tectonic activity associated with the formation of the East African Rift
Laotoli, Tanzania, 3.7-3.2 myr, *Australopithecus afarensis*	Savanna woodland, with well-defined wet and dry seasons
Hadar, Ethiopia, 3.6-2.6 myr, *Australopithecus afarensis*	Lake and associated floodplain, with braided streams and rivers
Omo, Ethiopia (Shungura), 3.3-1.4 myr, *Australopithecus africanus, boisei; Homo erectus, sapiens*	After 2.1 myr ago, dry savanna flanking river banks with gallary forest and dry-thorn savanna; before this date, the environment was probably forested
Koobi Fora, Kenya, 3.3-1.4 myr, *Australopithecus boisei, sp., Homo ergaster, erectus*	Before 1.6 myr ago, a freshwater lake with floodplains, gallery forest and dry-thorn savanna; during later times, the lake fluctuated from fresh to brackish
Olduvai, Tanzania, 1.9-<1.0 myr, *Australopithecus boisei, Homo habilis, erectus*	Salt lake with surrounding floodplains with seasonal streams and rivers and dry woodland savanna; tectonic changes after 1.5 myr ago resulted in the drying up of the lake
Transvaal, South Africa Makapansgat 3, Sterkfontein 4 and 5, Swartkrans 1, Kromdraai and Taung), 3.0-1.4 myr ago, *Australopithecus africanus*, *robustus, Homo habilis*	All were mosaic environments, with Makapansgat Member 3 and Sterkfontein Member 4 less open (more bush/woodland) than Swartkrans Member 1 and Sterkfontein Member 5; this suggests a trend from wetter to drier conditions through time

Table 7.1 Early hominid environments in Africa. Changed after Andrews, 1992.

If it is true that most sites where hominid fossils are found lay in the vicinity of ancient lakes, marshes or rivers (Andrews, 1992; table 7-1) this suggests that early hominids may have preferred border-areas between forests, waters and savannas. Their most favored biotope could well have included a mix of trees, waters and open country like our favorite parklands nowadays. The fusion-fission social structure and the in part omnivorous possibilities of HUCHIBOS may have been factors enabling early hominids to profit maximally from this mixed environment (one clue is a carapace of a giant turtle found among the hominid deposits in lake Turkana, Reynolds, 1991; another, *Homo habilis* and *Paranthropus boisei* skulls apparently crushed by crocodiles, Taylor, 1996). At a first stage they may foraged at the border of the savanna and at the edges of marshes and lakes during the day and they may have climbed into the trees during the nights. In later stages, when the climate became cooler and drier during the Pliocene, they may have been forced to rely more and more on the ability to migrate across the savannas looking for suitable environments.

Apparently, *Australopithecus* and probably *Homo habilis* was still adapted to some extent to a partial arboreal life style. Yet, bipedality as such would not have evolved if the environment had stayed the same. The human foot and pelvis are too specialized to have arisen without strong selection pressures. The problem with finding `the' ultimate explanation of bipedality may be that several advantages may have worked together. Originally, bipedality may have been a way of moving from tree to tree for apes that walked upright on branches, too, like urang-utans. Subsequently, the advantages of bipedality in a more open environment may have become apparent: it allowed a clear overview to scan an open environment for both food and predators while traveling in a relatively cool (Wheeler, 1984), non-exhausting way (Rodman & McHenry, 1980). Gradually, its advantages with respect to carrying and throwing may have become apparent and it may have opened a new series of possibilities with respect to making signs and gestures. In all likelihood there is a big difference between the original functions and the additional advantages of bipedality.

Although bonobos have split from chimpanzees only about 3 à 2 million years ago, a series of similarities with humans suggest an interesting case of convergent evolution which may give clues about human origins. Bonobos walk more often bipedally than chimpanzees and their upper-body parts are not so heavy. Their societies are not as male-centered (De Waal, 1988; Wrangham & Peterson, 1996), or their females have found ways to overcome the problem of cooperation among males, and as a result their societies are much more egalitarian. Sex is not restricted to a period of estrus and functions as a social glue. It is often used in exchange for food and functions thus as a kind of currency in an exchange economy. Although bonobos currently live in a forested environment, it is postulated by Boaz (1997) that they evolved in an isolated area south of the Zaïre in which forests became more mosaic between three and two million years ago. Bipedality enabled them to cross open areas between patches of wood and their increased group-size enabled them to survive in relatively harsh conditions in which fruits and other food were much scarcer than in the habitats of the chimpanzee. Contrary to the views of ecologically minded primatologists (Wrangham, 1986; Wrangham & Peterson, 1996), Boaz believes that the greater degree of bonobo sociality is a result of natural selection for intragroup cooperation under situations of very scarce resources.

> Bonobo groups survived by cooperating in locating and sharing environmental resources. Large groups with many cooperating individuals would have been at a clear competitive advantage because wide areas could be effectively surveyed for resources. Forming affiliation, `friendships', and sexual liaisons would have been very important in such a cooperative adaptation. It is unlikely that such elaborate social mechanisms would have evolved simply in response to environmental abundance of food resources. Cooperation thus evolved in the bonobo as a consequence of ecological scarcity, not abundance. The scarcity was brought on by climatic change (Boaz, 1997: 85).

Of course, what Boaz claims about bonobos is an inference based on other inferences (the turnover pulse hypothesis; an adapted savanna theory). Yet, the ecological argument is strong, particularly when we do not believe in *l'évolution créatrice*. There have been woods during the whole Miocene and both gorillas and chimpanzees are still happy with knuckle-walking in their mostly wooded environments. There must have been something which forced our ancestors to walk upright more and more. Paleoclimatology shows clearly that forests became more mosaic during the Pleistocene. This tendency corresponds nicely with the evolution of Australopithecines. The evolution of the bonobo corresponds with a period of aridity which is documented widely in the fossil record. It is more than reasonable to assume that bipedality offered a series of advantages in a more open environment. Vervet monkeys, marmots, and many other ground-living species, even hares, do sometimes stand upright to scan their environment if there is danger nearby. Kangaroos probably have lived in more open environments than deer and have evolved an upright posture in which they find themselves *allen Dinge einsam gegenüber*, as Straus would say. A combination of the need for continual alertness in an open environment and the need to scan this environment for pockets of food may have been the original selection force initiating the evolution of bipedality. Further advantages may subsequently have turned an occasional bipedalism in an obligatory bipedalism in which it was more profitable to have efficient feet than another pair of hands.

If it is true that the Miocene ape *Oreopithecus* was bipedal this may also throw light on the evolution of bipedalism. *Oreopithecus*, found in Tuscany and Sardinia, is found within an assemblage of species characterized by dwarfing, which probably resulted from living on an island without predators (Köhler & Moyà-Solà, 1997). It is thought that bipedalism in *Oreopithecus* could have evolved because the lack of predators allowed a more vulnerable way of locomotion. If this is true, one wonders whether bipedalism in Australipithecines started also in a relatively predator-free environment or whether Australopithecines had special ways to overcome their vulnerability, for example weapons (Wrangham, 2001). Apparently, bipedalism has not only advantages, but disadvantages as well.

7.4 THE APE THAT STARTED TO EAT MORE MEAT

As we can also learn from *Oreopithecus* and other bipeds, explanations of bipedality are not automatically also explanation of uniquely human properties. The existence of the robust australopithecines proves that it is a healthy strategy to separate explanations of bipedality and explanations of, for example, the enlarged brain. Clearly, the climatic changes of about 2.5 million years ago, when for the first time an ice-cap covered the poles and the climate in Africa became drier and colder than ever before, coincide with the origin of two new types of hominids - *Paranthropus* and *Homo* -, of which only one is characterized by an enlarged brain.

According to Brain (1981) and Foley (1987) the two different evolutionary trends among hominids can best be explained as different strategies in coping with the problems posed by the dry season. When dry seasons were increasingly characterized by a scarcity of plant food, one trend was the evolution of robust australopithecines - I like the name *Paranthropus* to stress that they constitute a specific lineage. With their heavy teeth they could live from coarse, hard and dry fruits and from seeds: this is inferred from the heave ridge on top of their skulls to which heavy jaw muscles were connected and form their patterns of teeth-wear. Another reaction to the problems posed by a dry environment could be a shift to more meat consumption. During the dry season many savanna animals tend to congregate around the remaining water resources and the early hominids could have used this opportunity. Certainly, the dentition of early *Homo habilis* is compatible with an omnivorous diet of which meat was a part.

There has been much discussion concerning the question whether the first hominids were scavengers or hunters (e.g. Blumenschine & Cavallo, 1992). The presence of toothmarks of large carnivores on about 11 to 15 % of the bones at the hominid sites at Olduvai George suggest that at least a part of the meat was first used by large carnivores: toothmarks are sometimes found on the more meat-rich parts of the bones, while human cut marks appear at the non-meat-bearing bones (Shipman, cited in Binford, 1986).

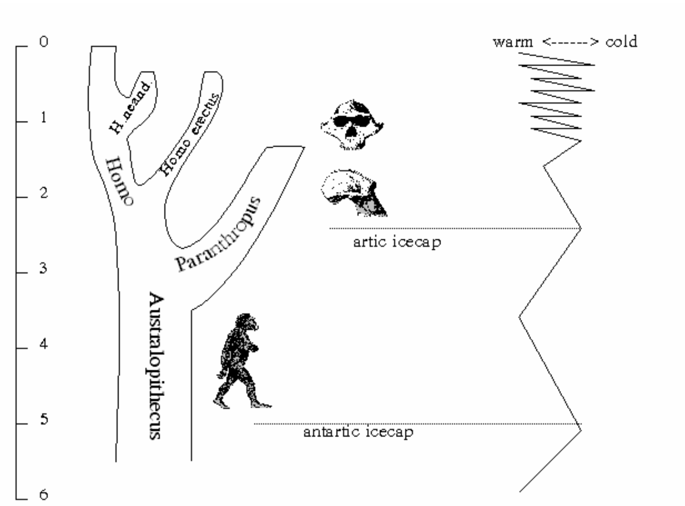

Fig. 7-4. Major climatic coolings at 5, 2.5, and 0.9 myr ago may have caused speciation-events in human evolution. Changed and redrawn after Brain (1981), Lambert (1989), and Lewin (1993).

Tooby and DeVore (1986: 221) have criticized the idea that early hominids were scavengers on the ground that scavenging would be inefficient and dangerous, given the risks of returning predators and the risks that the flesh is poisoned by micro-organisms. Observations on chimpanzees show, however, that in this species scavenging is at least sometimes practiced (Hasegawa, 1983). Clearly, it would be wrong to rely totally on *a priori* arguments in excluding scavenging. Early hominids may have had an advantage over other scavengers, because they had tools at their disposal with which they could have opened the thick skin of very large animals (Toth, 1986; Foley, 1987: 22). Above that, they may have had the wits to understand the habits of a leopard and to use this knowledge to steal its preys from the trees in which they were stored (Cavallo, 1990). Finally, unambiguous proof of systematic hunting does not show up in the archeological record of Africa (Voormolen, pers. com.).

All in all, the most accurate description of the original *Homo* survival strategy could well be characterized as ecological opportunism optimized by tool use. The increase in brain size of *Homo habilis* and particularly of *Homo rudolfensis* may have been in part a consequence of the general higher encephalization quotients of predators (Jerison, 1973) or of animals living on variable and unpredictable resources (Eisenberg, 1981) and it may at the same time reflect an increase in meat consumption. It would be very naive to suppose, however, that hominids relied totally on meat, as apes have difficulty in digesting meat and there is even a ceiling to the amount of protein that can be processed by the human liver and kidneys (Speth, 1988). There is more reason to assume that in hominids scavenging and hunting were male strategies for obtaining rich quality food with which they could `show off' and which they could exchange for higher status and other favors (Hawkes, 1991). This hypothesis is compatible with the observations of Boesch and Boesch (1989) on chimpanzees in Tai-forest, where only male chimpanzees participate in hunting.

According to Hawkes (1991) men in hunter-gatherer-societies preferentially target resources which are more widely shared, also outside their nuclear families. Their strategy is less directed to a constant provisioning of daily food and more to an occasional big bonanza that can be widely shared and with which they can gain status. When hunting is conceived as a risky male strategy to obtain high quality food, constant gathering of resources by women is just the other side of the coin.

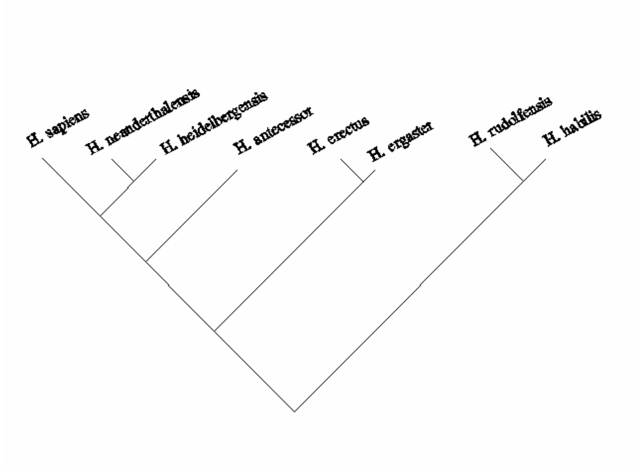

Fig. 7-5. Cladogram representing a splitter's view of the genus *Homo*. From Tattersall & Schwartz, 2000.

I therefore do not believe that the hunting hypothesis (Tooby & DeVore, 1986; Stanford, 1999) and the gathering hypothesis (Tanner, 1986) are incompatible. Tanner (1986) uses observations by Boesch & Boesch (1984) to show that female chimpanzees both use tools more than males and use them in a more complex way. To me this only proves that the different and compatible food strategies that Hawkes noted by hunter-gatherers and that inspired her to her `showing-off hypothesis' were in principle already there at the times of the common HUCHIBO-ancestor.

Happily enough, different hypotheses with respect to early human food habits need not to be completely speculative. A transition to more meat eating will cause many changes which directly or indirectly leave traces in the archeological record (Shipman & Walker, 1989; chapter 10). Changes in dentition are well known; more recently Aiello & Wheeler (1995) have pointed to a possible link between changes in the digestive system and the increase in brain size. According to their `expensive tissue hypothesis' the enormous energy requirements of growing a large brain could only be obtained by a radical shortening and simplification of the digestive system. Thus, the amount of meat consumption may well have correlated with brain size, leaving a clear trace in the archeological record. Also, changes in the structure of the vertebral column and the rib cage may reflect the size of the guts and the belly. In this context a comparison of the stature of Lucy with that of the Nariokotome boy is enlightening: Lucy was relatively thick-waisted and potbellied, the Nariokotome boy had narrow hips and a long torso (Walker & Shipman, 1996). Both the relative brain size and the general figure of the Nariokotome boy (*Homo ergaster*) would thus already point to an increase in meat intake. Yet, brain size would cross a critical Rubicon only much later, perhaps correlating with a point during prehistory in which hunting became a systematic, highly specialized cultural activity, often directed to one species of prey, which did not only offer some extra proteins in hard times, but which had become completely indispensable for the supply of food.

7.5 HOMO: A LARGE BRAIN, DEPENDENT CHILDREN, AND FATHERS WHO CARE

By now a series of fundamental differences between *Australopithecus* and *Homo* have become clear. *Australopithecus* was probably at least partially arboreal, it was largely a vegetarian, and it probably was polygamous. All this is based on the analyses of its feet, its teeth, its rib-cage and hips and its degree of dimorphism. In the discussion between

Holloway and Falk on the properties of the australopithecine brain, I tend to believe Falk who thinks that the australopithecine brain was ape-like (Falk, 1992). There are good reasons to suppose that *Homo*, at least *Homo ergaster* (the Nariokotome boy), was different and was distinguished by an at least partial carnivorous diet, a complete transition to bipedal walking and running, and a different social structure in which cooperation and possibly mutual defense of a `focal site' played a major role.

This does not sound quite spectacular. Our genus apparently evolved simply because its progenitors started to eat more meat in reaction to certain climatological changes. But why would a hunting ape evolve a large brain, extraordinary social habits, and start creating an enormous array of different cultures? Why would it become a visionary, an artist, a scientist? There are many other predators, even group hunters, who are not by far as intelligent as humans are. Certainly the hunting/scavenging/gathering model does not explain everything.

Perhaps we have to look for clues elsewhere. Humans are different from other apes in several aspects and each of those could give us a clue. One of them is that we are, apart from the gibbon, the only great ape forming nuclear families. We are apparently the only HUCHIBO-ape in which fathers at least sometimes care for their children. We are also the only ape that not only builds sleeping nests each night - this is also done by chimpanzees and gorillas -, but that lives in more or less permanent homes. Finally, compared to other apes, we mature very slowly. Our children are extremely dependent for a relatively long period. Could all those properties somehow have something to do with each other?

The idea that there is something special about the human maturation process is by no means new. The dutch anatomist Bolk claimed already that man, in his bodily development, is a primate fetus that has become sexually mature [*eine zur Geschlechtsreife gelangen Primatenfetus*] (Bolk, 1926, cited in Gould, 1977). The swiss biologist Portmann claimed that man, given its growth rates, `should' have a gestation period of 21 months (Gould, 1977). Apparently, we are born premature. This is further proved by the fact that we keep growing at a rate which is characteristic of the fetus for at least a year.

But why would we be born too early? The simple answer may be that it is simply the best compromise given, on the one hand, our relatively big brains, and, on the other hand, the shape of our pelvis, which is adapted to bipedalism. The female pelvis is already somewhat broader than the male one as a result of which women cannot run as fast as men do. At the same time, even after nine months, human child-birth is a risky, painful event, which often caused death to women in the past and which currently still causes much consternation. An early birth combined with an extended period of postnatal brain-growth seems simply the only solution that evolution could devise to build an extraordinary big brain.

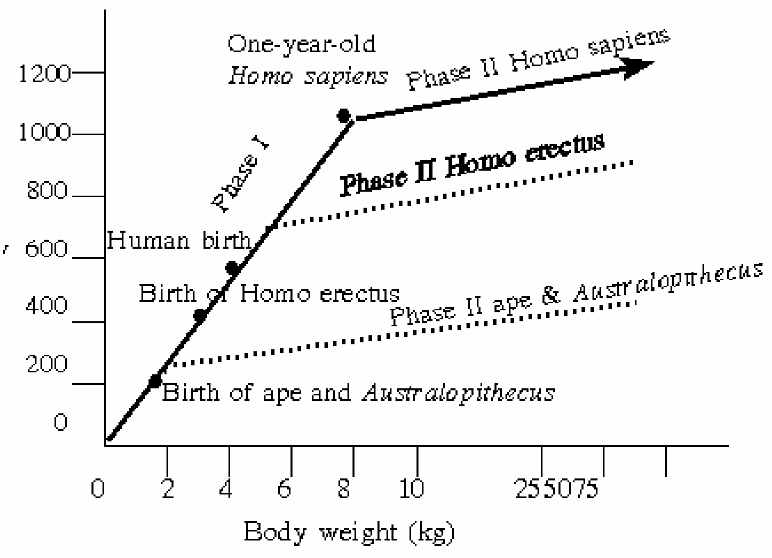

Fig. 7-6. Patterns of brain growth. In humans and *Homo erectus* the relatively fast fetal growth continues after birth. Based on Stanley (1996: 155) and Walker & Shipman (1996: 224).

Given these considerations, it is not unreasonable to assume that the essence of the transition from *Australopithecus* to *Homo* had something to do with the increasing dependency of the child. The transition to meat-eating enabled brains to grow, but growing brains cause birth problems. These may only be solved simply by giving birth `too early', which is what was claimed by Portmann. The idea was taken up by Robert Martin in 1981 (Walker & Shipman, 1996). One of its defender is Steven Stanley in his *Children of the Ice Age* (Stanley, 1996). According to Stanley climatological changes initiated by the closing of the isthmus of Panama between about 3.1 and 2.5 million years ago, and resulting in an accumulation of a permanent ice-cap at the north pole, forced our ancestors to leave the trees and to live on the ground. It was "the need for self-defense while living freely on the ground [that] was the primary driving force behind the natural selection that created the large brain of *Homo* (Stanley, 1996: 175)". The evolution of this large brain was achieved by the revolutionary new maturation pattern with many behavioral implications which according to Stanley arose relatively fast in *Homo rudolfensis*.

> After birth a monkey or chimpanzee fails to maintain the high rate of fetal brain growth that endowed it with such a large head when it entered the world. It embarks almost immediately on the second phase of growth - what I call phase II - in which its brains expands much more slowly all the way to adulthood. Humans differ from lower primates in retaining high fetal rate of brain growth - phase I - through the first year of life after birth. The result is a one-year-old infant who is endowed with an enormous head that houses a brain more than twice as large as that of an

> adult chimp. Not until an age of about one year do humans settle into the sluggish Phase II of brain growth...
>
> In humans the persistence of the high fetal rate of brain growth beyond birth amounts to a retardation of the brain's development. It is not simply our brain that matures slowly, however, but our entire body. This condition arose because natural selection found no way of singling out the brain for delayed maturation. It accomplished the delay by slowing down the overall rate of bodily development immediately after birth. The result is that, although we grow rapidly in physical size after birth, we remain physically helpless while the fetal pattern of brain growth more than doubles our brain size by the time of our first birthday. Although our brain then switches from the [fast] Phase I to the [slower] Phase II, our slow overall rate of maturation lingers on. We continue to lag far behind apes in the level of physical development throughout our growing years (154-55).

Stanley then goes on to argue that the evolution of the large brain of *Homo* by means of a slowing of the development amounted to a profound trade-off, "one of the most remarkable evolutionary compromises in the history of life". On the negative side were the physical and mental deficiencies of immature offspring that, from the earliest days of *Homo*, constituted a great ecological handicap for the parents. "From the beginning extended child rearing has robbed parents of time that they could otherwise have spent gathering food, making tools, or constructing shelters, and it has restricted mobility and complicated confrontations with enemies". On the positive side were the vast benefits of the new brain. In the game of natural selection, the positive value of the large brain clearly outweighed the negative side effects of infantile immaturity. "Otherwise, quite simply, our brain would never have evolved."

> For the natural selection to create the large brain of *Homo*, the many benefits conferred by the incipient brain not only had to outweigh the problems imposed by helpless infants but also those imposed by the high rate of metabolism of the large brain itself. Recall that brain tissue requires an enormous supply of energy. Fatty meat and bone marrow are rich sources of energy, and ... we can imagine that early *Homo* turned to them increasingly as its brain evolved toward larger size. The brain itself would have played an important role in the capture of animals that supplied the meat and marrow. In other words, the large brain of early *Homo* must have played an important role in stoking its own metabolic furnace (173-74).

Stanley then argues that, while Australopithecus probably did not engage in pair-bonding (on the basis of its level of sexual dimorphism), complex cooperation in hunting and self-defense may have required less competition in sexual affairs.

> Human ancestors may have had little reason to engage in pair-bonding until members of a troop were cooperating in complex ways. Males could have worked more compatibly within hunting parties if, instead of vying

with each other for females on the home front, each understood that a particular mate awaited him on return from a hunting expedition.
It is also easy to see how pair-bonding would have benefited *Homo* in rearing physically immature offspring. Natural selection probably favored any male who became part of a nuclear family in order to help train his own offspring. These progeny were more likely to survive and reproduce, passing on their father's genes, than were offspring that a father left in the care of an unaccompanied mother during their lengthy childhood.
Likewise, natural selection probably favored females who were inclined to enter common-law marriages, which favored dependent children with two devoted parents (177).

Fig. 7-7. An attempt to schematize the causal relationships postulated by Steven Stanley in his *Children of the Ice Age* (1996).

In figure 7-6 I have tried to schematize some of the causal relationships illuminated by the synthesis of Stanley. There are certainly weak points in his argumentation. For example, I doubt that the need for self-defense while living on the ground was the only cause of the evolution of the large brain. *Paranthropus* was also living on the ground and did not evolve such a large brain. It seems to me that the initial cause of hominid brain expansion must be sought in a relatively complex survival strategy which required a relatively complex social system, a relatively detailed memory, a relative long learning period and relative complex communication skills. I have already referred to the higher encephalization quotients of predators and animals living on variable and unpredictable resources. I can also refer to the relatively long learning period of juvenile sea-birds compared to continental birds corresponding with the relative difficulty of foraging on open seas. In this context Stanley's remark about the large brain of early *Homo* that must have been stoking its own metabolic furnace is to the point.

His arguments referring to the dependency of the human child also fit in this context. Apparently evolution has slowed down the maturation process in order to lengthen the learning period. Also, the idea that there has to be some kind of link between the dependency of the human child and the structure of the human family is old and was put forward already by Pope and Locke in the seventeenth century (Gould, 1977). Paternal investment is something which distinguishes us from chimpanzees in which the paternity of a child is uncertain. The fact that human testes are much smaller than those of chimpanzees also points into the same direction: direct sperm competition in humans is not as strong as in chimpanzees.

Yet, we do not know when pair-bonding became an important factor in our lineage. It probably did not come in one strike. At the time it did become important, however, it may have had far-reaching consequences in combination with other factors. At the moment that a sexual division of labor arose, sexual selection may have given a new twist to human evolution. Apart from pure fertility, new criteria may have become important. Both males and females had more reason to choose partners with whom cooperation, perhaps communication, was possible, and which to some extent were reliable and exhibited parental skills. To assess these qualities in advance is a talent, and perhaps a large part of the brain of modern man is devoted to it. To what extent we owe our large brains to sexual selection remains unclear, however (Miller, 2000). Something must have changed fundamentally at the moment that pair-bonding became necessary as a result of the increasing dependency of the human child.

This increasing dependency can also be interpreted as an altriciality brought about by the transition to a predatory life-style (Walker & Shipman, 1989; 1996). Many predators are relatively altricial. A predator has to learn more than a herbivore or a fructivore and it needs a longer time to mature, therefore.

All this remains rather speculative, however. We still have to find ways to fit this story into the paleontological record. Perhaps we first have to study another dimension of the ape-human transition to find more empirical clues. In table 7-2 I have listed some of the differences between *Australopithecus/Paranthropus* and *Homo* which I have discussed and/or postulated.

7.6 AUSTRALOPITHECUS, HOMO, HOME BASES, AND FIRE

As can be seen in table 7-2, one of the changes that may have been brought about by the transition from a largely herbivorous diet to a more carnivorous diet, may have been necessity of more complex geographical routines. Although apes are territorial and do make sleeping nests, they do not have permanent home bases as most humans currently do. As a result, many researchers have concluded that the first home bases constituted a crucial phase in the process of hominization (Isaac, 1978).

Why wouldn't *Australopithecus* have had home bases? At least one important researcher has claimed they had. Lovejoy's paper on `the origin of man' (1981) was written in the wake of the finds of Lucy and the `first family' (*Australopithecus afarensis)* and Lovejoy projects the origin of the human family back much further than Stanley, to *Australopithecus*. Lovejoy argues that the unique reproductive system of humans, in which females and males form lasting bonds and males provision their own offspring, arose all of a sudden, *ex nihilo* as a reaction to the extreme K-selected reproduction strategy of their

	Australopithecus	Homo
Life-style	Terrestrial/arboreal	Terrestrial
Food	Largely vegetarian	Partly carnivorous
Sexual system	Polygamy without paternal investment	Perhaps increased paternal investment
Geographic routines	Probably still sleeping in trees or cliffs, no permanent home bases	Increasingly complex as a result of tools & food exchange, altriciality, group defense
Children	Relatively precocial	Secondary altricial
Learning period	Relatively short	Increasingly long
Group size	Kin groups	Increasingly large

Table 7.2 Some discussed and/or postulated differences between *Australopithecus/ Paranthropus* and *Homo*.

prehominid ancestors. In chimpanzees females are busy for more than two years with only one child. They always have both to carry the child with them and to provide it with food. It would be more efficient, according to Lovejoy, when the female could stay home with the children while daddy would look around for food in the dangerous outside world, and would be able to carry it homewards in his hands, walking bipedally. The time between two births could become smaller and one female could produce more children. Once upon a time, apes - Lucy's grandparents, for example - suddenly discovered this more efficient reproductive strategy and males started to walk upright and started returning at home with their freed arms full of food. Once this strategy was discovered it was so successful (in terms of reproductive success) that the upright walking apes seized the world from all other ape species.

Thus, Lovejoy sees a connection between upright walking on the one hand and pair-bonding, home bases and paternal investment on the other hand. However, there are several new concepts and data that make Lovejoy's theory implausible. First of all, most researchers conclude from the size differences of the Hadar hominids that there was a strong sexual dimorphism in *Australopithecus*, which points to polygamy (males have to be larger to defend more females). Second, Lovejoy seems to dream about a kind of paradise in which Adam and Eve lived largely solitary. However, the idea that one mutant female would leave her group and start a solitary life is improbable given the evidence on predation of leopards on australopithecines (Brain, 1981). The idea that her partner could leave her alone and still be sure of his paternity is also improbable. As we have seen, there are also enough other explanations of bipedality. Most explanations cluster around the savanna-model and this is still the most likely explanation. Further, the idea that such an extreme transition in reproductive strategy as the one from polygamy to monogamy could arise *ex nihilo* and not in reaction to a major change in food strategy following a major change in the environment is very naive. At the moment it seems likely that this change was constituted by an increase in meat consumption. Finally, even in modern humans monogamy is only practiced in some societies and the model of Lovejoy assumes that is was already universal around three million years ago.[3]

At the moment the model of Lovejoy shows, above all, how we should *not* try to model the transition to a more modern live-style. Much more is needed than a series of reasons why humans are `better adapted' than their ancestors. Perhaps they were not: who claims that it is always better to be smarter? At least Ecclesiastes and Dostoyevsky knew better. One cannot claim that something is `better adapted' without knowing to what circumstances it is supposed to be adapted. Evolution does not strive `to make things better' apart from a climatological/ecological context.

To explain things like the origin of male parental investment and the home base in humans we have to ask ourselves, first, why a situation could arise in which females could become increasingly dependent on male provisioning. This situation could be the above mentioned dry season in an increasingly savanna-like Africa. When the home ranges that males had to cross in their search for food became very extensive and when there were at least some periods during the year in which male provisioning, became an indispensable extra food source for females and offspring, a situation could arise in which both parties could profit from a meeting area to exchange food (Tooby & DeVore, 1986: 224). Probably the food brought in by males was meat.

Second, it would be nice if we at least tried to formulate a testable hypothesis. If we had reason to believe Lovejoy, it would make sense to start looking for 4 myr old home bases. The idea that the *Australopithecus-Homo* transition, the *AH-Erlebnis*, was essentially a herbivore-carnivore transition, makes Stanley's idea that Adam and Eve belonged to *Homo rudolfensis* much more plausible. But there are also good reasons to drop the `atavistic pair-bonding hypothesis' - Adam-and-Eve theory-II' - altogether. Some of the same arguments against the theory of Lovejoy can be raised also against an the idea of an Adam and Eve *Homo rudolfensis.* Living in groups is much more safe in the context of the savanna's high predation levels, for example. It is not clear whether the encephalization of *Homo rudolfensis* had progressed enough to require pair-bonding. Why would we assume that the transition from polygamy without specified gene-conscious paternal investment to occasional monogamy with caring, responsible fathers happened overnight? It seems to me that we are still in the midst of this transition today.

For one thing, archaeologists are very critical even about early *Homo*-home bases. The interpretation of some important Olduvai sites, where stones and bones were concentrated, as `living floors', `home bases' or `central places' (e.g. Isaac, 1978) has been contested by Binford (1981) who claimed that the assemblages could also have been created by carnivores and water. Since then it has become clear that hominids did indeed process large quantities of meat at some of these places (e.g. Bunn & Kroll, 1986), but that does not mean that these were home bases.

One of the most important researchers of the sites thinks that early hominids kept their stone tools there and processed meat quickly to evade competing predators (the `stone cache hypothesis', Potts, 1984; 1987). Other authors have proposed that hominids instead defended such places against predators: they call this the `resource-defense model' (Rose & Marshall, 1996; fig. 7-7). These authors refer, for example, to the behavior of chimpanzees

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[3] However, monogamy is present times is common in stressful (temperate) environments. Under savanna conditions scarcity of food may have caused monogamy (pers. comm. Hans Roskam).

in front of stuffed leopards as shown in the famous experiments of Kortlandt (1980), and claim that "early hominids would have responded similarly to the risk of carnivore predation by intensifying cooperative behaviors, perhaps using branches or stones as simple defensive weapons" (Rose & Marshall, 1996: 314). If the resource-defense model is right it is to be expected that the `focal sites' which were defended were lying very strategic, with a panoramic view on the surrounding landscape.

It seems to me that the resource-defense model is compatible with the find of the 1.7 million years old *Homo erectus* female `1808' who stayed alive despite having hypervitaminosis A, probably as a result of eating carnivore liver (Shipman & Walker, 1989; Walker & Shipman, 1996). If sick individuals were cared for and kept alive, there probably were save places to do so. The same goes for the increased length of the period of infant dependency. The pattern of dental development of the Nariokotome-boy shows that he matured at a different speed than either chimpanzees or humans (he was a nine-year-old comparable to a thirteen-year-old human). His relatively slow maturation speed compared to chimpanzees - and probably also compared to australopithecines - can be interpreted as implying a relatively long learning period. This would be compatible with the idea that the juvenile hominids during this period (1.5 myr ago) became increasingly dependent and that it required more and more cooperation to raise them.

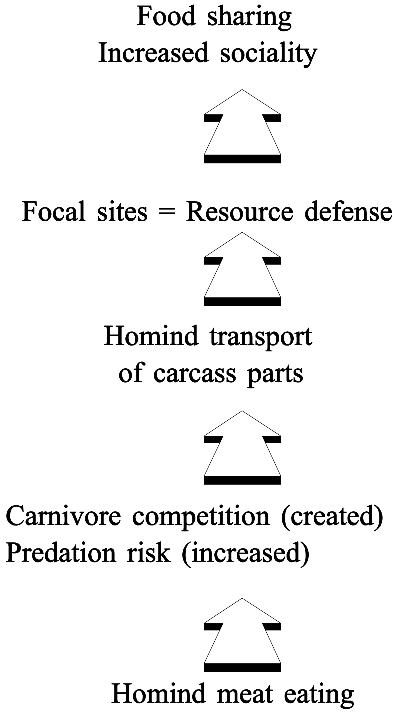

Fig. 7-8. The resource-defense model according Rose & Marshall, 1996.

Also, it is probably no accident that the first signs that fires may have been generated stem from around 1.3-1 million years ago from the cave of Swartkrans (Brain & Sillen, 1988). Could this not imply that this cave was used around this time as a refuge or home-base? At least Brain and Sillen themselves, the discoverers of these oldest known hearths, suggest that they functioned as a defense against predators, because the bones in them were heated to such high temperatures that any meat on them would have been inedible. With the find of these hearths, with the find of `1808', together with our knowledge of a beginning of a longer maturation phase in *Homo ergaster,* we now have at least good reasons to suppose that something like `home bases' existed at that time.

At the same time, it has to be admitted that certainty is hard to get. A recent expedition to the Zhoukoudian (reported in Tattersall & Schwartz, 2000) has undermined older claims about hearths and home bases at this important chinese `*Sinanthropus'* or *Homo erectus* site. As a result Tattersall and Schwartz conclude that it is still possible that "the initial exodus of humanity from Africa, and more specifically the penetration by hominids of harsh northern climes, was accomplished without the aid of fire" (Tattersall & Schwartz, 2000: 156). The first compelling evidence of fire and cooking comes from a 700,000-year-old site in Thailand, where a hearth (a circle of fire-cracked basalt cobbles) plus artifacts and animal bones was found.

On the other hand, during the whole Pleistocene the posterior teeth of *Homo erectus* are gradually becoming smaller (Wolpoff, 1993), which could point to a gradual increase of the role of cooking. Certainty with respect to hearths and fires is, of course, very hard to get, and, at the same time, *Homo erectus* is a very different species than anything that existed before. This explains why recently a group of theorists could come with the bold claim that it was the accidental discovery of cooking that made us who we are. They claim that the improvement in nutrition that enabled the brains of protohumans to expand was not just the result of more meat intake, but the result of the new possibilities afforded by cooking. As a result of the drier climate around 1.9 myr ago, wood fires would not have been unusual. Some australopithecines (*Homo habilis* in this view has to be seen as *Australopithecus habilis*) may have discovered that there were highly edible foods, such as roasted roots, left in the burned areas and that it is even possible to transport or create up the required fire yourself. The result would not only have been completely new food sources, but also completely new social structures, because cooking required premeditation and protection of collected items. Wrangham (2001) speculates that females may have started to bind with one male to have their `kitchens' (collected vegetables and fruits) protected. If you had a bad hunting or gathering day, it must have been relatively easy to steal some of the food that your neighbors had just collected. (As every student of insect behavior knows, kleptoparasitism is a very widespread phenomenon in nature.)

Whether the first humans were hunters, gatherers or cooks, apparently the amount in which their behavior was directed at future goals has increased. Early humans found themselves in an increasingly dangerous environment in which food was increasingly hard to get and had, at the same time, increasingly dependent children. Something must have changed dramatically and it seems to me that Wrangham (2001) is right in claiming that the AH-transition as witnessed by anatomical changes must have been more dramatic than all later changes together.

> In comparison to the great shifts from our ape past, there has been little change for 1.9 million years in features such as body size and degree of sexual dimorphism, or shape of the foot or the shoulder, or nature of the teeth or the face. This relative conservatism of human morphology suggests an equivalent conservatism in selective pressures (Wrangham, 2001: 143).

Both the hunting and the cooking hypothesis suggest that this change was brought about by a transition to a more delayed consumption of food. Indeed, many of the no doubt exaggerated claims about the animal-man distinction focus on subjects like planning and premeditation.

Given the fact that the great apes build sleeping nests each night, the concept of making yourself comfortable at a safe site has a history much longer than the human genus. But the new kind of predator ape that arose at the African savannas and woodlands about two million years ago, could have profited a lot by more permanent home bases were their increasingly dependent children were safe, their foods prepared and shared, and which they could defend to large carnivores. The idea that already early *Homo* had some form of home bases should not be dismissed too fast. Instead, it is to be hoped that archaeologists and paleontologists continue to look for traces of such places, because we may still simply miss some essential pieces to be able to complete the puzzle.

7.7 DID HOMO ERECTUS INVENT LOVE?

All this does not point to a nice place under a tree where *Homo rudolfensis* Adam and Eve were playing with Abel while enjoying their daily meal. Even a close reading of the book of

Genesis reveals that there must have been other people around already, because Cain was afraid of them after having killed Abel (Gen. 4:14). Apparently, there was already more than the primary family if there was such a family at all. The increased dependency of the human child in *Homo ergaster/ erectus* could well point to a change in the mating system during the ape-human transition in which fathers started to care more for their offspring, but the resulting system of pair-bonding must have been different from that in many monogamous birds and the gibbon in which pairs remain on their own small territory. In humans, families have their `territories', but males remain at the same time mutual dependent and do cooperate in a group territory (I do not claim that there are no birds or other animals with systems with both family- and group territories).

The human `mating system', if such a thing exists (see chapter 8), seems to consist of temporary or more stable pair bonds embedded in a tight system of male cooperation. It is possible that it did not arise full-blown in one strike, but that there existed a stage with some parallels to that of the bonobo, in which males and females exchanged sex for meat. Like the bonobo, early *Homo* may have had a proto-economy, based on the universal currency of sex. The human mating system, however, may also have evolved from a more polygamous system, in which gradually more dominant males had to cooperate and in which they were gradually forced to accept and respect each other's sexual relationships as a result of the power of women and in order to evade conflict.

A series of authors defend the hypothesis that monogamy did only arise with the appearance of archaic *Homo sapiens* and its relatively big brain (Foley & Lee, 1989; 1991; Aiello, 1996, Knight, 1991). Initially, a network of female kin may have helped pregnant and nursing *Homo ergaster/erectus* females with the extra work required by dependent and relatively large-brained children (Kohn & Mithen, 1999).

It is not unlikely that paternal investment has started as a system of exchanging meat-for-sex on a regular basis. In chimpanzees meat is shared also to some degree, in contrast to plant food, and males seem to know very well what they are doing when giving meat to particular females. Males use the sharing of meat to entice females to have sex; females in estrus are more successful at begging for meat from males; and, males are also more apt to hunt if a sexually receptive female is present (Haviland, 2000). Paternal investment may have started within a polygamous system in which the best hunters were motivated to translate their hunting success into mating opportunities. Yet, at the moment that females became increasingly dependent on extra proteins from males, and that their children became increasingly dependent, it would become increasingly difficult for one male to provision his whole harem. At least for some, less popular females, it would become advantageous to motivate also the less dominant, less successful males to start collecting meat and other food for them. It is not unlikely that the transition to a more egalitarian mating system was brought about partly by female strategies (Turke, 1984; Knight, 1991).

Kohn & Mithen (1999) suggest that *Homo ergaster /erectus /heidelbergensis* males may have used their skills in producing relatively sophisticated Acheulian handaxes to impress and attract females. Although they probably exaggerate the extent to which there was a dichotomy between a purely artistic technology and a functional technology, it seems not unlikely to me that craftsmanship contributed to social status, and with that, ultimately, to reproductive success. It seems unlikely to me, however, that artistic skills were the only skills on the basis of which males where selected. In modern humans, artists are sometimes those boys that initially are not selected by the girls and that have to go to extreme lengths to draw their attention. Also, contrary to the suggestions of Miller (1997, 1999) - and according to the above mentioned `dual selection theory of cultural abilities' (5.14) -, art may not only attract females, but it may also enhance one's status within the male network. Sexual selection may have played an enormous role during human evolution, but the context in which humans choose their partners differs enormously from the context in which, for example, peahens choose peacocks.

The human mating system is deeply affected by the fact that human males are both cooperators and competitors. This ambiguity in the relationships between males can already be seen in chimpanzees (De Waal, 1981), but must have augmented further with the relative importance of group hunting and groupwise self-defense. When at some time during prehistory females became increasingly dependent on occasional extra food provisioning by males, but males could obtain such extra resources by cooperation only, dominant males could no longer monopolize all females as a matter of course. Young successful hunters would otherwise abandon the group and certainly some females would follow them. Also, to get as much extra food as possible, females had both to compete increasingly with one another and to ensure themselves part of the booty. They could do so by introducing extra elements of conditionality and exclusivity to sexual relationships which increased the certainty of paternity for males. Of course, this would not lead to a system of pure monogamy, but simply to an increase in special bonds between males and females, ignited by feelings of love and secured by sentiments of jealousy (based on preadaptations like chimpanzee `consortships' as described by Tutin (1975) and Goodall (1986: 453)). At least in modern humans this system can explain such characteristics as concealed ovulation, continual receptivity and patterns of reciprocity in courtship and sexual selection (Alexander & Noonan, 1979; Turke, 1984), although some claim that continual receptivity simply is an effect of the higher hormonal levels required for bipedalism (Spuhler, 1979).

There are, however, several reasons to assume that this typical human mating system started in *Homo erectus*. An important indication is that the degree of sexual dimorphism decreases in early *Homo* (table 7-3). As we have seen, dimorphism usually correlates with polygyny, and apparently the degree of polygyny decreased already in *Homo erectus*. This could be a sign that more permanent relationships existed between males and females which softened male-male competition.

Length (m)	Average individual	—	—
Australopithecus	1.26	1.38	1.13
Homo	1.71	1.80	1.60
Weight (kg)			
Australopithecus	31	35	26
Homo	48	51	43

Table 7.3 Estimated mean body size and weight of *Australopithecus* versus *Homo*. Calculated from data from Swisher, Curtis & Lewin, 2000, who cite McHenry, 1994.

Another line of reasoning starts from parallels with the mating systems of carnivores. Walker & Shipman (1989; 1996; see also Swisher, Curtis & Lewin, 2000) have always stressed that the Australopithecus-Homo transition is explained as a result of a herbivore turning carnivore. The teeth of the Nariokotome boy show a wear pattern reminiscent of the teeth of meat- and bone-eating carnivores, such as hyenas (Walker & Shipman, 1996). According to Walker & Shipman, the spread of *Homo erectus* from Africa resulted from the need of carnivores of a larger feeding area. If the recent quite spectacular dates are correct (not all paleoanthropologists agree), and *Homo erectus* has lived in Java from 2 million years ago up until 27.000 years ago (Swisher, Curtis & Lewin, 2000), and this spread beyond Africa was indeed prompted by the relatively low population densities of predators, then *Homo erectus* was a predator around that time. Both the problems and the temporary salvation of `1808' points to a predator life style with a tight social structure around a home-base around 1.7 million years ago. One-and-a-half-million-years-old stone tools from Koobi Fora exhibit wear patterns caused by cutting meat, wood and soft plant tissue (Keeley, L.H. & N. Toth, 1981). Note that this is also consistent with the cooking hypothesis, which however also requires a change in mating system.

All this could point to a transition from an occasional scavenger in early *Homo* (*Homo habilis/ rudolfensis)* to an obligatory hunter in *Homo ergaster* and *Homo erectus*. It could also point to a transition of a opportunistic here-and-now consumer to a species specialized in delayed consumption and in food preparation. This could mean that Stanley was too `optimistic' about *Homo rudolfensis*. Of course, only more complete evidence about early *Homo* can help to resolve these issues. In essence it have been the more complete skeletons, like Lucy and the Nariokotome boy, which have helped paleoanthropology beyond pure speculation. While Lucy has proven once and for all that bipedalism and brain size did not evolve together, the 1.8 million-year-old Nariokotome boy has demonstrated that early *Homo ergaster/ erectus* was already a tall, relatively modern-looking meat eater with an already somewhat longer youth or learning period (Walker & Shipman, 1989; 1996).

Although apparently not everyone agrees, the reduced sexual dimorphism at this stage points to a different relationship between males and females, perhaps a system of pair-bonding. As we all know, at least all novelists and song-writers, pair-bonding or `love' in the context of a multimale society is a very thorny and complicated affair which requires a lot of brain-power. Certainly, it could have been an extra factor promoting the evolution of a large brain, although many animals manage without this. Bigger brains, however, cause children to be more dependent, and so we come full-circle.

7.8 GRADUALISM AND THE GAP BETWEEN ANIMAL COMMUNICATION AND HUMAN LANGUAGE

Sometimes it may seem although we know almost nothing about our own evolutionary story with certainty. There are gorillas, chimpanzees and bonobos, there are us, modern humans, and there is a collection of fossils. How we should destile a story on the basis of these three components is not at all clear. Yet, if we would immediately stop all attempts to do so we would be certain that our curiosity would never be satisfied. And although there is not much certain, we at least have an impressive collection of fossils and tools, including two very complete skeletons of two very old hominids, Lucy and the Nariokotome boy. The best thing we can do is to continue building models and to hope for more finds that either weaken or strengthen particular models.

So far we have concluded that humans have probably split off from the Australopithecines, because they were forced as a result of climatological changes to rely more on ecological opportunism, meat-eating, perhaps cooking or other forms of delayed consumption, at least in times of scarcity with respect to fruits. This specialism required a large brain which was also furnished by it, causing problems at childbirth, subsequently solved by a `premature' parturition. The resulting dependent children forced males and females increasingly to cooperate to be able to raise them. At what time during prehistory the transition to a system with at least some pair-bonding and paternal investment occurred is unclear. Probably Lovejoy and perhaps even Stanley are wrong in their attempts to project an Adam-and-Eve system back more than two million years. The Nariokotome boy, however, shows evidence of regular meat-eating and a lengthened youth period. The anatomical changes between *Australopithecus* and *Homo* are more fundamental than any changes that happened in *Homo* thereafter. So perhaps we have to believe that all happened already then. Perhaps Adam and Eve belonged to *Homo ergaster/ erectus.* God knows, although the book of *Genesis* contains conflicting stories and does not add any dates.

There is also not much certain about the origin of home bases and the controlled use of fire, apart from the fact that they originated somewhere between 2 and 0.7 million years ago. Some claim that humans left Africa without fire, others that humans were already cooking their meals 1.9 million years ago. Is it really wise, then, to go on and speculate about the origin of language? Yes, because speculation may inspire hypotheses which may throw new light on phenomena and in the end may even prove to be testable. As is proven again and again, in science one never knows what one will be able to know in the future by approaches and techniques yet unfathomed.

Some have linked language to the home base. The linguist Bickerton has suggested, for example, that home bases have functioned as an instigator of language evolution. At least one other species with a `home-base', the honey-bee, has developed a reporting system with which scouts can reports their observations to the home-front (Bickerton, 1990: 154). In a similar way, *Homo erectus* could have developed a rudimentary language to point other group members to potential food sources or dangers. According to Bickerton it was *Homo erectus* that first used a system of `protolanguage', a presyntactical language which allowed a rough classification of food-items and in which information about the environment could be communicated. According to Bickerton protolanguage enhanced the ecological flexibility of *Homo erectus* and was thus responsible for its spread beyond sub-Saharan Africa.

Paleoanthropologists use different clues to assess an early hominid's linguistic talents. One clue may be the small enlargement of the cortex called Broca's area which is sometimes visible in endocasts of skulls. It is already exhibited in *Homo habilis/rudolfensis.* Broca's area, associated with motor control of speech, is also visible in endocasts of the Nariokotome boy, *Homo ergaster.* In principle, it is possible to infer from this that *Homo* started to speak early on (e.g. Taylor, 1996). Yet, it is not sure whether Broca's area may not have had, or even still has, other motor functions.

The behavioral and cultural evidence is sometimes seen as standing in complete opposition to the brain evidence. Desmond Clarck is reported to have said with respect to the stone tools of *Homo erectus* that if their makers were talking which each other, they must have been saying the same things over and over again for a very long time (Potts, 1996: 140). As a result, many anthropologists and psychologists (Lock, 1999) opt for a relatively recent language origin. Walker's research on the Nariokotome-boy shows that its vertebral canal was not wide enough to contain a spinal cord like that of humans which enables us to control our respiration during speech. The spinal cord of the Nariokotome-boy cord was small like that of other animals (Walker & Shipman, 1996). The communication system of this hominid, taken into consideration also its brain size, apparently did not contain the enormous range of sounds that modern humans are able to produce.

That does not mean, however, that *erectus* was either stupid or mute - a *Pithecanthropus alalus* (speechless ape-man) as postulated by Haeckel. Recently, it has been discovered that *erectus* lived already on Flores Island, Indonesia, across the so-called Wallace's Line separating the faunas of Asia and Australia, at about 900.000 - 800.000 years ago. That means nothing less that this species was intelligent and socially organized enough to construct rafts to cross the seventeen kilometers water separating Sunda from the other parts of Indonesia. According to the linguist Fischer the crossing of this strait required planning and cooperation.

> This implies use of language allowing conditional syntax: `If we do this, then this and this will happen'. It seems appropriate to infer from the Flores Island evidence that already nearly a million years ago *Homo erectus* was capable of expressing just such a form of conditional proposition in her and his speech (Fischer, 1999: 39).

There is also new anatomical evidence that language is not exclusively associated with anatomically modern people. The linguist Lieberman has for a very long time contributed to a pessimism with respect to the language abilities of Neanderthals on the basis of their postulated larynx morphology (Lieberman, 1984, 1991). This pessimism has now been relativized by the find of a nearly complete hyoid bone with a Neanderthal in Kebara, Israel. This free-floating bone is attached to the larynx and to throat muscles that are important to speaking (Johanson & Edgar, 1996). The presence of this bone in the Neanderthal suggests that they may have been able to speak. In all, there is much evidence showing that there has been going on some language evolution during the more than million years of *Homo erectus* presence.

Perhaps we should care not to focus one-sidedly on a human-like physical vocal apparatus. The linguist Steven Fischer defines language even as a `medium of information exchange' (Fischer, 1999). Language is to some extent a `multiple realizable' talent, because it can be fulfilled by many media as shown by the variety of communication systems displayed in the animal kingdom (recently one even speaks about communication between plants and the predators of their parasites). Obviously, one can work with a narrow and a wide definition of language, including only a few or many elements in one's definition, just as this is the case with respect to knowledge (chapter 1; tab. 7-4). The human vocal apparatus has evolved to transmit fast amounts of information in a very short period of time. As part of the language system of a `winner' it does its job so exceedingly well that we are seduced to think that it is the only system possible. Yet, if it is true that one can learn some bonobos, chimpanzees, dolphins, sea-lions, and even parrots to communicate meaningfully using symbols and that, for example, vervet monkeys have different alarm calls for different predators (see chapter 1), there is reason to doubt that we are the only animal with language - at least with symbols. Now that the secret codes of more and more animal communication systems are being cracked, it becomes clear that they often contain referential elements that go beyond expressing emotional states only. A series of field observers acquainted with chimpanzees believe that the about three dozen different call-types of chimpanzees may contain more information about the world than is currently known - information not only referring to subjective emotional states (Goodall, 1986; Boehm, 1992). Researchers of the State University of Ohio have recently found that chimpanzees can refer via their calls to different, specific kinds of food (Bartlett, Boyd & Whiten, 2001). In the wild, they can probably at least differentiate between food-calls referring to meat and to vegetarian food (Boehm, 1992). Christophe and Hedwige Boesch discovered that a dominant male in the Taï National Park was giving directions to subgroups that were out of sight by a combination of drumming initiated by pant-hooting. After the alpha male had drummed the group abruptly changed direction.

	Insects	Birds	Crows/Parrots/Mammals	Dolphins/apes	Homo erectus	Man
Grammar				x	?	x
Arbitrary symbols with meaning			x	x	?	x
Signal-object reference			x	x	?	x
Personal call			?	x	?	x
Expression of emotional states		x	x	x	x	x
Information exchange	x	x	x	x	x	x
Signals	x	x	x	x	x	x

Table 7-4. Some elements of language competence as they are spread through the animal kingdom. Included are results from training programs. For data see Herman, 1984; Parker & Gibson, 1990; O'Connor & Peterson, 1994; Vauclair, 1996.

Another consideration is that there is a vast difference between understanding and speaking a language, and between categorization of things and relations, and being able to transmit such knowledge. My just two-year old son Bram understands many things but is still largely unable to speak. He fills the gap with a few gestures which he has picked up (for example a gesture which can mean `it has gone away'/ `it is not there'/ `empty'/ etc.), by pointing and by expressing his moods. The meaning of such gestures is often very clear in combination with these expressions, though understanding is completely context-dependent and requires knowledge of his habits, hobby's and personality. The total number of meaningful signals he is able to emit is large[4]. This goes no doubt also for chimpanzees, which also know each other's psychology, a large number of physical and facial displays, and which are also able to learn and understand all kinds of gestures. At this point the series of chimpanzee sounds and gestures discovered in the wild is gradually becoming larger. Yet, even if chimpanzees would be able to communicate with each other via sounds, gestures and other displays, there need not be a one-to-one relationship between knowledge and ability to communicate. Chimpanzees certainly know a lot of plant and animal species, but I doubt that they have specific signals for each of them. Our familiarity with and intimate knowledge of the world is always bigger than our capacity to express it.

The psychologist Merlin Donald has attempted to break the dogma that cognition and language always evolve together. In his *Origins of the Modern Mind* (1991) he claims that a series of cognitive evolutionary innovations *preceded* the evolution of language. The

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[4] Since I wrote these lines his vocabulary has increased dramatically in just a couple of months.

`missing link' between the ape's knowledge of its environment and human symbol-mediated knowledge is a cognitive style characterized by conscious imitation and conscious controlled learning without language. Donald calls it mimetic culture and claims that prelinguistic children, illiterate deaf-mutes, and artists other than writers prove that human cognition is not based exclusively on language. According to him "without language, the human mind is still far superior to that of the ape" (165). *Homo erectus* was the embodiment of this kind of knowledge. The culture of *Homo erectus* includes tools which could not have been made by apes, because they require a level of planning and control far beyond their `episodic' (here-and-now-bound) culture, but this does not necessarily presuppose language.

> The stone tools of *erectus* required expert fashioning: archaeologists require months of training and practice to become good at creating Acheulian tools. They have to learn, and remember exactly how to strike a sharp edge and not break off the finished part with the next blow. The appropriate materials have to be remembered; to flake or chip a stone, two stones of relatively different hardness must be employed, the harder one as the shaping tool. The blows have to be modulated as a function of the type of stone; certain stones break in such a way that their edge is sharp and elongated, others flake in a different way. Such skill would not have been restricted to the use of stone: since there were so many other easier, but perishable and breakable, materials available, tools were almost certainly made first from materials like bones, teeth, shells, skins, and wood.
>
> Toolmaking was probably the first instance of behavior that depended entirely upon the existence of self-cued mimetic skill. The reproduction could not be dependent on immediate environmental reinforcers or contingencies. Tool manufacturing is usually done at a time and place remote from those where the tool is finally used. By contrast, apes use as tools objects the find in the immediate temporal and spatial vicinity of the task. Tool manufacture, in other words, demands an ability to self-cue and reproduce or re-enact the scenario leading to the tool's manufacture in the absence of immediately present materials or even an immediate need for the tool (179-180).

According to Donald, language could have evolved only on the basis of an already existing mimetic culture. Language involves the invention of an arbitrary set of symbols: apes and other animals can be taught elements of such a language, but *they did not invent it themselves*. "The invention of symbols, including words must have *followed* an advance in thought skills, and was an integral part of the evolution of model building." Only after humans had started inventing systems of symbols there was a selection pressure directed at the modification of the vocal apparatus. As always, behavior *precedes* anatomical adaptation.

If Donald is right this could explain at the same time the relatively sophisticated level of *Homo erectus*-culture, its conservatism, and the absence of some of the later anatomical adaptations for speech in this species. Yet, the evidence seems far from conclusive to me. The fact that the brain of *Homo erectus* became larger over time could point to a gradual increase in intelligence; and I do not see why this would not include some linguistic skills. As my son Bram proves to me, there is a lot you can tell with only a small collection of gestures and words, and *Homo erectus* gives the impression of having done just that. Over time this collection of gestures and words may have become larger, gradually. It seems to me that Donald is artificially widening the gap between chimpanzees and humans. Detailed studies of chimpanzees (e.g. De Waal, 1981) have pointed to elements of planning and conscious control in chimpanzee behavior. Should the evolution from the probably chimpanzee-like mind of the common HUCHIBO-ancestor to the human mind not be analyzed as the result of selection pressures improving particular skills that are already present in chimpanzees? Despite all these criticisms, however, I still find Donald's idea that language and cognition should be separated very important.

In this respect the hypotheses put forward by the archeologist Steven Mithen in *The Prehistory of the Mind* (1996) could be relevant, too, although he comes with a different approach with which Donald disagrees (Donald, 1999). While Donald sees the evolving hominid mind as an integrative whole that has gone through three different stages, Mithen tries to explain the different cognitive stages during hominid evolution as a result of the independent development and subsequent reintegration of a series of cognitive modules. He is a believer in the modular version of evolutionary psychology of Tooby and Cosmides (e.g. 1992) with their `Swiss-army-knife' metaphor of the mind, but he links the `Swiss army knife mentality' especially with the early human mind. The `big bang of modern human culture' would be explained by new connections between these independently evolved cognitive modules (fig. 7-9). In this context he speaks about the `cognitive fluidity' of the modern mind.

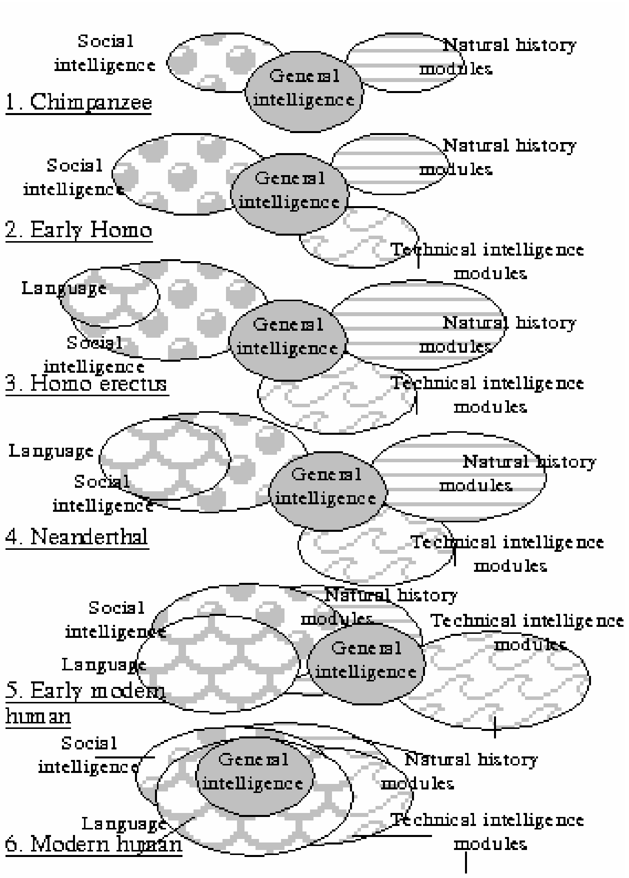

Fig. 7-9.The multiple intelligences of *Pan* and *Homo* according to Mithen (1996: figs. 4, 10, 15, 16, 17, 26 combined). The modern human mind is seen as a reintegration of the independently working modules of early humans.

Although I find such models very appealing, I find it hard to decide between them or to judge about them on the basis of our current knowledge. It is always risky to speculate about cognitive stages between the apes and man as long as we do not know enough about apes. As I said before, chimpanzee researchers still feel that they have not yet cracked the `code' of chimpanzee communication. At the same time, a whole range of higher cognitive abilities have been found in chimpanzees, both in the wild and in labatories, that strengthen the case for a gradualistic approach. For example, in her overview, Goodall (1986) refers to abstraction and generalization, symbolic representation, displacement in time and space, concept of self, inferring purpose to others, and intentional communication, among other things. She finishes her list with recounting the story of Vicky playing with an imaginary doll. It seems to me that especially Merlin Donald makes a caricature of the chimpanzee mind when he attributes exclusively `episodic culture' to it, but that even Mithen is too focussed on downplaying chimpanzee intelligence.

With respect to the evolution of language, I found a paper by Christopher Boehm (1992) very revealing. He discusses the approximately seven long distance vocalizations of chimpanzees (*pant-hoots*, food-calls, whimpers, screams, *waa* calls, hunting calls, predator *wraas*) and speculates about their proto-linguistic properties. These calls do not require additional nonvocal information and are often used in short exchanges in which both parties take turns as in human conversation. According to Boehm, the tendency of chimpanzees to split and reorganize continually within their often forested group-territory (to form a `fission-fusion society'), may explain their vocally-dominated communication system. Chimpanzees are very good listeners and without seeing each other they often know exactly where `everyone' is. Their calls, while containing a strong genetic component, are improved by imitation: infants imitate their mothers (remember, in captivity, the bonobo Kanzi learned a series of symbols that researcher's tried to teach her mother). Chimpanzees may have the ability to extract so much information from each other's calls that they are highly `pre-adapted' to decode strings of signals that refer to specific contexts, objects or situations. Boehm even finds back rudimentary versions of most of Hockett's `design features' of language.

All this shows that Donald's diagnosis of chimpanzee culture as completely bound to the here-and-now is almost certainly a caricature. I am tempted to postulate that his diagnosis of *Pithecanthropus alalus* is a caricature, too. *Homo erectus* must have had certainly the cognitive skills of a chimpanzee, but as a result of its transition to a more delayed consumption, it must have been even better at categorizing, planning, and making complex reciprocal altruistic calculations. Donald is probably right in his diagnosis that *Homo erectus* had developed the ability to train oneself and to transcend one's immediate situation much further than the chimpanzee as testified by his sophisticated tools. The same goes for other skills that may have served as pre-adaptations for the acquisition of language, like the urge to classify (Aitchinson, 1997) and to share knowledge. Given the fact that chimpanzees and bonobo's can be taught at least a collection of symbols, it is very unlikely that *Homo erectus* did not at least have a rudimentary language with which it could share its knowledge with respect to the natural environment and with which it could perhaps even discuss social matters.

This brings me to a final theory which I find highly relevant within the discussion about the origins of language. During the last decade the idea was launched that there are perhaps connections between language evolution and both group and brain size. Robin Dunbar (1993; 1996) hypothesizes that language was invented at the point that grooming no longer sufficed to maintain the increasing number of social contacts resulting from increasing group size. Because the complexity of the social network also correlates with group size, brain size would have evolved parallel to group size. Dunbar points to a parallel in bats, in which some hypersocial species also have larger brains. If Dunbar is right, the brain sizes of extinct humans reveal the complexity of their social lifes. Language would have evolved as a kind of social glue which holds relatively large network of direct and indirect reciprocal altruistic relationships together. Certainly, most language that we use helps us to make promises, appointments, etc.. Language plays also an essential role in advertising one's qualities and has certainly been one of the focal points of sexual selection. Most conversations are not much more than a clean and standoffish way of grooming. The fact that sometimes information is exchanged which not only refers to the weather shows that our reciprocal altruism is not only about services, but most of all about information. Language as a form of grooming and language as a form of information exchange are two sides of our specific system of reciprocal altruism.

With that we come to the question of cooperation and groups size. At that point evolutionists and, especially, sociobiologists will immediately return to the level of ultimate questions. One of the key questions in which sociobiologists are interested is why group sizes increased during human evolution. What drove the process toward larger groups with more direct and indirect reciprocal altruism? Why was language more and more needed in humans in contrast to other apes and other animals? What selection pressures are responsible for the evolution of such specialized abilities, which require not only such a large brain, but also such an extended learning period? It seems to me that theories like those of Donald and Mithen remain at the proximate level and do not address these questions. To find theories that try to answer *ultimate* questions (questions not referring to *how*, but to *why*) we have to return to sociobiology and evolutionary psychology.

Yet, sociobiology and evolutionary psychology do not offer one standard explanation of human origins. At the moment there is not really a consensus about the forces that `drove' human evolution. In the next chapter, I will try to compare the three theories that seem to have the best papers to me and decide which one is right, and to what extent.

8

*** Why some apes became humans: the role of runaway selection \\

I will not attempt to prove this theory in any absolute sense, for I am not sure that there is such thing as `absolute proof'. Both the theory and the evidence for and against it are presented only as food for thought, as a possible approach to the study of human evolution and human nature which has not yet been fully explored. If the theory is sound, however, it has many far-reaching implications. It implies that there is no sharp line between `good' and `evil', and that cooperation, communication, courage, and love are very closely related indeed to conflict, deception, terror, and hatred. It implies that every increase in the size of the brain was produced by the force of mixed emotions of love and ferocity. It implies that every step of the long, bloody journey from ape to man increased not only the size of the brain but also its ability to recognize more and more people as friends. It implies that the hand-axe not only killed `them', but also swelled the ranks of `us'. Today our brains can understand `us' in terms of social groups as large as 700 million. But the hand-axe has been chipped and polished and fashioned into the hydrogen bomb, and we still aim the bombs at `them'.

Robert Bigelow, 1969

8.0. INTRODUCTION

Let us assume that I have until now succeeded in explaining human bipedality, some aspects of the human mating system, and the human tendency to eat meat. With that I have not come close to my initial demand of giving an explanation of human evolution that is phylogenetically plausible, paleontologically adequate, evolutionary feasible and explanatory sufficient and specific. What is needed is an explanation that bridges the gap between a special, bipedal hunting ape (let us say, *Homo erectus*) and the highly culture-dependent and linguistic ape that we currently are. In this chapter I will compare, evaluate and to some extent mix and integrate three competing hypotheses with respect to the last phase of our evolution. Because these hypotheses all relate to properties of human behavior, I will try to delve somewhat deeper into behavioral changes that accompanied human evolution, particularly changes in social structure and in the mating system.

What has to be explained? I have already pointed out that we cannot start from the assumption that nice properties like the ability to learn and speak a language or the ability to feel empathy are of such inherent value that evolution can be understood as a process of breeding them (as some exobiologists seem to think). Instead, we have to explain why there is one species of ape with a brain that is three times larger than that of its closest living relatives and why this ape needs linguistic abilities and sometimes even moral qualities that seem unnecessary for the simple task of surviving and reproducing with which most organisms fill their days and which form the ultimate `reason' for the existence of any living species whatsoever. We have to explain why this species is completely dependent on culturally transmitted habits, traditions, symbols, and tools in every domain of its life, and why it lives in societies that are larger than that of `ordinary' hunting species, like lions and hyenas. We have also to explain why there is only one such species on earth and why there are not much more transition forms, for example hominid species with smaller brains, smaller vocabularies, and more modest ambitions.

8.1. ALTERNATIVE EXPLANATIONS

Hunting and gathering. To some extent this is the standard hypothesis, supported by many sociobiologists, evolutionary psychologists, and behavioral ecologists. Because chimpanzees are both fructivores and occasional carnivores, this is also a very safe theory to start with. I have shown already (chapter 7) that it is supported both by the new evidence on chimpanzee hunting and by new analyses on the Nariokotome boy which show that it was a hunter. An (ultimately climatologically induced) transition from omnivore, herbivore or fructivore to partial carnivore can explain a series of characteristics which emerge in *Homo ergaster.* Yet, even within the frame-work of the theory that our ancestors were hunter-gatherers, a series of questions remain unanswered, for example:

1. Why did humans evolve high intelligence in contrast to other hunters (gatherers)? Lions and hyena's do not need language, morality and a capacity for abstract thought to hunt their prey; ants do not need a big brain to gather food.
2. Why do humans, even in primitive societies, tend to live together in groups that are *above* the optimal size required for group hunting (gathering)? Why did not group size *decrease* as hunting weapons and skills improved during human evolution? (Alexander, 1987: 79)?

Given the good credentials going with the hunting and gathering hypotheses, we should not dismiss them too fast, and investigate their explanatory potential and limits further.

Sexual selection. The two other theories that I want to discuss, are both based on the assumption that human uniqueness requires a special (albeit naturalistic) explanation. The excessive talents displayed by humans fall outside the scope of ordinary natural selection, and point to a kind of runaway selection in which traits become `hypertrophied'. Runaway selection can be defined as a process of directional selection that works autocatalytic and cumulative. Runaway selection is often the result of sexual selection, because it is here that it is important to exceed all others, again and again. The moment that, for example, peahens have to choose between different males, any trait that indicates fitness and health can become a criterium. Hence, an apparently arbitrary trait, like the number of `eyes' in the peacock's tail, can become important enough to become a strong selection factor. At some point in their evolution peahens started to prefer peacocks with longer tails with more `eyes' in them, and as a result the peacock's tail became `hypertrophied'.

The sexual selection theory of human origins assumes that the human brain is comparable to the peacock's tail (e.g., Parker, 1987; Mestel, 1995; Ridley, 1994; Miller, 1996; 2000). If either protohuman males or protohuman females with relatively larger brains or with more cognitive abilities have become relatively attractive, runaway selection could have shaped a series of unique human abilities. In most species, sexual selection breeds special characteristics in the sex that has to compete for access to the most investing sex (Trivers, 1971; see chapter 4), but if we assume that those characteristics are not linked to sex-specific chromosomes they might well be inherited by the other sex as well. Above that, there are enough species in nature in which a kind of mutual sexual selection of the sexes is going on and in that respect, sexual selection needs not to be disruptive, but might well be directional (see fig. 5.5).

Yet, there are still a whole series of problems with sexual selection as an explanation of human uniqueness. Perhaps most important, sexual selection theory fails to explain why it only occurred in the human lineage (and not in that of, for example, chimps). To some extent it is a somewhat easy hypothesis: if you can not explain, for example, why birds started to fly, just suppose that at some point female protobirds (some kind of dinosaur it is currently thought by most paleontologists) were attracted to males that could jump and stay in the air longer and longer. If you cannot explain why a brontosaur was so big or a shrew mouse is so small, you can just refer to the specific tastes of female protobrontosaurs and proto shrew mouses. That would mean that an ecologically uninformed sexual selection hypothesis lacks explanatory specificity.

Thus, there must have been already special conditions under which sexual selection was promoted and a sexual selection theory of human evolution should be able to show what it put in motion, and when.

Intergroup competition theory. Like sexual selection theory, the intergroup competition hypothesis invokes some kind of runaway selection process. Like sexual selection theory, intergroup competition theory goes back to Darwin. In his *Descent of Man* he writes:

> When two tribes of primeval man, living in the same country, came into competition, if (other circumstances being equal) the one tribe included a great number of courageous, sympathetic and faithful members, who were always ready to warn each other of danger, to aid and defend each other, this tribe would succeed better and conquer the other. Let it be borne in mind how all-important in the never-ceasing wars of savages, fidelity and courage must be. The advantage which disciplined soldiers have over undisciplined hordes follows chiefly from the confidence which each man feels in his comrades. Obedience, ... , is of the highest value, for any form of government is better than none. Selfish and contentious people will not cohere, and without coherence nothing can be effected. A tribe rich in the above qualities would spread and be victorious over other tribes: but in the course of time it would, judging from all past history, be in its turn overcome by some other tribe still more highly endowed. Thus the social and moral qualities would tend slowly to advance and be diffused throughout the world (Darwin, 1871: 498).

Thus, the general idea of the model is that an arms race between different groups of protohomomids could lead to the runaway selection process for social and moral capacities of which the human psyche is postulated to be the outcome.

This idea was further expounded by a large series of authors in some form. Yet, during the last fifty years a much smaller collection of authors has tried to give it a scientific basis. Bigelow (1969) uses it in his brilliant *The Dawn Warriors* to explain the threefold brain enlargement during human evolution. It was, however, Richard Alexander (Alexander, 1987; 1989; 1990) who tried to place it into the solid framework of modern evolutionary biology and who introduced a whole series of new concepts to do so. His reasoning can be summarized as follows (see fig. 8-1):

- At the moment that early hominids reached `ecological dominance' the threat from predators was replaced by intraspecific `balances of power'.
- Bigger, stronger and more disciplined groups were better able to defend a territory. As a result of this group sizes increased far beyond the optimum size for hunting/gathering bands.

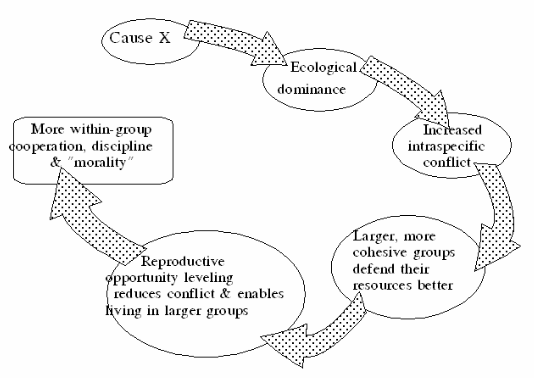

Fig. 8-1. Alexander's `balance of power' hypothesis.

- To be able to live together in large groups with many non kin-related conspecifics, humans developed reciprocal altruism to a degree in which it became `generalized' reciprocity (Trivers, 1971) or `indirect' reciprocity (Alexander, 1979; 1987), meaning a form of reciprocity in which third parties record reciprocal relations to learn about the reliability and `moral profile' of group members who are potential cooperators for themselves.
- In such a situation it becomes important to look like a very reliable and generous cooperator. This can either be achieved by really being a generous cooperator or by deception, which costs less energy but more intelligence. A runaway selection for mental proficiency and complexity arises.
- Because dominant males were increasingly dependent on cooperation with other males, they had to renounce their reproductive monopolies. `Reproductive opportunity leveling' enabled big groups to overcome potential sources of internal disruption (Alexander, 1979; 1987: 71).

8.2. SOME UNIVERSAL HUMAN BEHAVIORAL CHARACTERISTICS THAT HAVE TO BE EXPLAINED

Evolution works just like any alchemist, starting with one material, for example iron, and turning it into some other material, for example gold, via a series of distinctive steps. The ingredients with which human evolution started were those of the common HUCHIBO-ancestor (7.2.), which as far as we now know may not have been completely unlike the chimpanzee in many aspects. The bonobo has split apart from the chimpanzee at a later stage and its similarities with man are probably products of convergent evolution. In chapter 7, we have looked to some of the selection pressures that may have molded the common HUCHIBO-ancestor into a predator ape. We are now interested in the selection pressures that molded this predator ape into a highly cultural species.

But what is culture? In part II we have already concluded that culture as a body of not genetically inherited customs, knowledge and ideas shared by groups does not float above its biological substratum. It is a way in which particular species fulfill particular needs which have to be adapted to environments which cannot be foreseen by selection. At least some aspects of culture seems to be somehow driven by forces within the power pyramids of societies. Cultural abilities could thus be linked to the drive for status or by sexual selection. It is now time to apply this rather abstract model and look how `gene-culture coevolution' has started and worked within our evolution.

Somehow cultural abilities and our large brains must be linked to underlying changes in behavior. For example, culture as we know it nowadays is intimately linked to an extremely long learning period of youngsters, which is a biological given. It is also linked to our lives in the enormous societies with which we share a language or languages. From a sociobiological point of view, all this inspires research in behavioral changes that somehow have propelled gene-culture coevolution and in the socio-sexual structures in which our ancestors lived their lives. Thus, before we go on with our exploration of the three models which we want to compare, let us try to make an inventory of some of the domains in which behavioral changes took place during the process of directional selection that produced our species.

An increased group size. One of the most important behavioral characteristics of modern humans is that they live in relatively large societies almost everywhere in which groups maintain contacts with other groups and in which relatives and friends are remembered, even when they have moved to other groups. Some of the social intelligence required for this way of living is certainly present in the chimpanzee which lives in `fission-fusion' societies in which subgroups are continually formed, for example at a particular fruit tree of which the fruits are ripe at that moment and in which, at the same time, a system of complex alliances within the group determines the dominance hierarchy. Yet, party size in chimpanzees is generally smaller than that in, for example, baboons and bonobos.

What forces may have initiated a tendency to form larger groups? Perhaps Foley and Lee (1989) are right when they point out that the patchy grassland/bushland habitat, in which they suppose that *Australopithecus afarensis* lived, would promote larger group sizes because of predator avoidance (also, Mithen, 1994). If the idea of Aiello & Dunbar (1993) is right and relative brain size correlates with group size, groups may have become gradually bigger during the evolution of the genus *Homo.* This would mean that predation levels would have increased or at least would have remained constant. There are some clues about the predators that must have made the lives of Australopiths sometimes extremely hard. There has been found an *Australopithecus* head with two holes in his head corresponding to two leopard teeth and several authors have suggested that the Taung child has been killed by a large eagle (Berger, *et al.*, 1994). Australopiths coexisted with a series of sabertooths and other large cats, including *Dinofelis* which could well have been a specialized hominid consumer (Brain, 1981)[1]. These cats all went extinct, however, and one wonders what predators forced groups of hominids to become larger then, if Aiello and Dunbar are right.

It has been suggested also that larger groups were functional in the context of a dependency on animal carcasses: larger groups would be better able to deal with competing scavengers and they offer more "opportunities for food sharing and/or tolerated theft" (Kohn & Mithen, 1999: 521). In that case, we would have to compare our ancestors with vultures jostling and quarrelling around carcasses, perhaps with the difference that they sometimes dragged away the carcasses and cooperated in defending and butchering it. This might give us clues about the size of those groups.

Apart from the inference that one could make on the basis of their theory (which links brain size with group size) it is, however, generally hard to find data on group size during human evolution. On the basis of their excavations archaeologists tend to believe that group size increased with the coming of modern *Homo sapiens*. One of the few clues to group sizes in human evolution is constituted by the travelling distance of materials and artifacts, which starts to become impressive in modern *Homo sapiens*, too.

Moderate sexual dimorphism. Sexual dimorphism in all HUCHIBOs is relatively

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[1] Some of the bones of the even older hominid, millenium man, *Orrorin*, six million years old, also show signs of predation by leopards.

mild compared to more distantly related hominoids like gorillas and orangutans. Sexual dimorphism may have been relatively large in the common ancestor of all anthropoids, because a candidate for this species, *Aegyptopithecus*, which has been found in the Fayum Depression in Egypt and is dated approximately 27 million years ago, shows considerable dimorphism (Frayer & Wolpoff, 1985). In orangutans and gorillas it is relatively large. The measures of the sexual dimorphism of *Australopithecus* differ: if one uses the canine teeth, it seems relatively large (Frayer & Wolfpoff, 1985); if one uses the length of the hindlimb joints, it is somewhat above that of chimpanzees and bonobos, but below the sexual dimorphism of gorillas and orangutans (McHenry, 1991). On the basis of mandibular canines Frayer and Wolpoff (1985) have calculated a gradual decline of the sex differences from *Homo habilis* to *Homo erectus* and *Homo sapiens*, with a somewhat bigger difference in the European Neanderthals. Other authors, however, postulate that the sexual differences within the genus *Homo* were small from the very beginning (Stanley, 1996, pp. 178-179).

Sex differences in size are often thought to correlate with the amount of polygyny. They also result in different food habits. In chimpanzees females spend much more time in fishing for termites than males (McGrew, 1992, p. 91) and females also eat more insects generally. On the other hand, it is the males who do most of hunting, especially on prey that is relatively difficult to get, like monkeys. Females sometimes catch ungulates, but generally they are more gatherers than hunters (McGrew, 1992, p. 103). McGrew notes cautiously that `it is tempting to interpret this difference as a possible `pre-adaptation' for the evolution of a system of sexual division of labor' (McGrew, 1992, p. 105). I am tempted to add (in the spirit of chapter 7) that this sexual division of labor could have made a longer period of childhood dependency possible, because it created a situation in which females and juveniles could stay behind longer at a relatively safe `home base', were males would return at regular times with a surplus of extra proteins. All this would fit the hunting hypothesis nicely.

Although sex differences in size are only moderate in our species, there are a series of important physical and psychological differences between the sexes. The physical differences must probably be explained as a result of encephalization (width of the pelvis) and of sexual selection for neotenous mothers (relatively light complexion of the skin, hair, breasts). Within evolutionary psychology, a series of profound psychological differences between the sexes are often attributed to a long stage of hunting and gathering during human prehistory. Females are better at remembering spatial configurations and objects and are very good in incidental, nondirectional learning of such configurations. Males are better at performing mental rotations and (as a result of that) at reading maps (Silverman & Eals, 1992). Women do better on precision manual tasks and on mathematical calculation tests. Men, however, are more accurate in target-directed motor skills, such as aimed throwing, and do better on tests on mathematical reasoning (Kimura, 1992). In the use of speech, studies of aphasia suggest that women use their hemispheres more equally than men do (Kimura, 1992), which is also supported by the fact that their corpus callosum is bigger (e.g. Moir & Jessel, 1991). One of the effects seems to be that women have less difficulty in `finding the right word' to express their feelings and are generally more close to their feelings and to their body. Several other female psychological characteristics suggest that women are somewhat more inclined to stay at the homebase and embellish it. It may be argued that throughout a large part of human evolution, females were somewhat more linked to the homebase and relatively more involved in the raising of children, which would also explain their linguistic superiority (Dunbar, 1996).

Male dominance. While chimpanzee societies seem to be relatively male dominated, female bonds seem to be much stronger in bonobos (Parish, 1994). In chimpanzees, coalitions of males seem to form a center of power in the midst of the group; in bonobos, males are thought to be more markedly linked to particular females (De Waal, 1995). Male bonobos often need the support of their mothers to become powerful, and males can only become dominant if they have the support of equally dominant females in the group (Kano, 1992).

These far-reaching social differences are thought to have arisen as a result of banal ecological causes. Female bonobos are thought to be much more powerful as a result of the omnipresence of terrestrial herbaceous vegetation: groups do not have to split at any moment, which enables females to stay together and form relatively strong coalitions. Adolescent females can become part of the female social network of a group by starting an emotional and sexual relationship with more adult females. As a result of the power of these `lesbian matriarchies', bonobo males have become much less aggressive and `demonic' than chimpanzees. Whereas gorillas and chimpanzees both are very aggressive toward females and children, this strategy does not seem to work in bonobos (Wrangham & Peterson, 1996).

The fact that species which are so closely related as chimpanzees and bonobos can have almost completely opposite social systems demonstrates the far-reaching consequences of small changes in power and dependency. It may show also that particular oscillations during human history which are normally attributed to `culture' could result from changes in ecological and economic conditions (as I have demonstrated in chapter 6). It would be interesting to make a list of the probable causes of female versus male dominance during the evolution of all primates. The more female-dominated social systems probably could be promoted by a lack of predators (e.g., on Madagascar: Richard, 1987), relaxed food competition, and a low dependence on meat; the more male-dominated systems could be promoted by a situation in which males can take advantage of the competition between females, by a dependence on meat, or by an increased level of intergroup competition. Wrangham explains the similarity of humans with chimpanzees (and not with bonobos) to an inability to form female coalitions in a savanna-like environment as a result of the scarcity of food. Yet, if females at some point in our evolution became dependent on male provisioning or protection this could have been a factor of even more importance, because female competition over male support could easily have broken down female coalitions. Also, it would be interesting to investigate whether human societies that live under the threat of war become relatively male dominated (which could, of course, support, the intergroup group competition hypothesis).

Feminists have often speculated about an original human society in which females were more powerful than males and sometimes have referred in this context to Bachofen's work *Das Mutterrecht* (1861), which had considerable influence on Engels and thus on the Marxist tradition. Given the fact that in apes - in contrast to most monkeys - females disperse, that chimpanzee societies are mostly dominated by a small coalition of often related males, and that there are no human societies that are really female dominated, such an original matriarchal society is extremely unlikely. Even Hatshepsut could only become pharaoh by wearing an artificial beard. Whether we like it or not, there are good reasons to suppose that patriarchies are at least as old as gorillas and chimpanzees (Hrdy, 1997). The original female dominated society has probably been at least ten millions years old. Yet, as the case of the bonobo shows, small ecological changes can have dramatic consequences in a relatively short time.

Multimale groups with some sperm competition. If sex differences in size correlate with the amount of polygyny, australopithecines may have been relatively polygynous, even compared to chimpanzees. According to some theorists, the fact that chimpanzees live in multimale groups does not prove anything about the common HUCHIBO ancestor: it can have been like the gorilla in this respect. Schröder (1993) gives three arguments for a more gorillalike social system:

1. The remarkable sexual dimorphism in *Australopithecus*, `more likely indicating an intense competition between males to control access to females than gametic competition'.
2. The fact that modern humans exhibit moderate polygyny, but not promiscuity.
3. The fact that female gorillas do not show sexual swellings and that the sexual swellings of chimpanzees and bonobos could be a derived trait.

However, the idea that early hominids had a social structure somewhat more similar to that of gorillas than to that of chimpanzees remains implausible. Not only are we much more related to chimpanzees, as indicated by most molecular analyses, but one of our oldest recently discovered hominid ancestors, *Ardipithecus ramidus* (White, Suwa & Asfaw, 1994, 1995), displays many similarities to chimpanzees as well. Given the fact that the environments in which chimpanzees have lived have shrunk and expanded several times, but never completely vanished, it is not unreasonable to assume that the chimpanzee is still similar to the common HUCHIBO ancestor (Wrangham & Peterson, 1996). In that case, bonobos and hominids are the product of isolated populations that have drifted apart into regions that were more deeply affected by the climatological and ecological events of the last five or six million years (Boaz, 1997).

As I noted already, Foley and Lee claim that the patchy grassland/bushland habitat in which they suppose that *Australopithecus afarensis* lived would promote larger group sizes because of predator avoidance. Larger group size implies that adult males must have associated together. Even in gorillas a dominant silverback male often tolerates one or more silverbacks - one extraordinary group in Rwanda even includes seven silverbacks (Wrangham & Peterson, 1996, p. 147) - so even gorillas cannot be said to live in unimale groups. Further, the discovery of the `First Family,' a place were at least 13 individuals of *A. afarensis* were found together (Afar Locality 333; e.g., Johanson & Edgar, 1996, p. 126), may give us a real hint of the group composition of that species. This group consisted of at least three large individuals who probably were males and at least two small-bodied individuals who may have been females.

Finally, Schröder's suggestion that the human mating system could have evolved directly from a more gorilla-like polygynous system is implausible given the behavior of human females. It is probably a universal rule that the degree of female promiscuity correlates with the amount of `sperm competition' and, therefore, testes size in males (Martin & May, 1981; Harcourt, Harvey, Larson & Short, 1981, 1981; Hrdy, 1997; sperm competition is the competition between ejaculates of different males for the fertilization of a female's eggs, Birkhead, 2000). If the human mating system was really characterized only by moderate polygyny, but not by promiscuity, the size of the human testes would be smaller. Given the fact that the human testes are halfway between those of gorillas (small) and chimpanzees (big), it is much more plausible to assume that the human mating system has evolved out of a more chimpanzeelike, partly promiscuous system as a result of a process of reproductive monopolization of females, which started as a result of some kind of ecological crisis.

Special bonds between males and females. All in all, although we don't know anything with certainty about the mating system of the original HUCHIBO ancestor and that of *Australopithecus*, we have good reason to use the chimpanzee as a model. In chimpanzees there exist three different types of mating relationships (Nishida & Hiraiwa-Hasegawa, 1987, p. 169, order changed):

1. Possessive matings of alpha males who may prevent other males from mating (and may occasionally use force or threats).
2. Opportunistic matings in which males copulate freely in the presence of other males.
3. Consortships in which a male and a female seclude themselves from the rest of society to have an exclusive relationship for a few days or even weeks. Often these consortships are initiated by males, and sometimes a male forces a female aggressively to follow him (Wrangham & Peterson, 1996).

Because the tendency to monopolize females in an aggressive way is shared with the gorilla, this probably has to be seen as the oldest mating pattern. It is interesting to speculate about the circumstances that would promote a specialization in one of these mating strategies:

1. Possessiveness is probably favored in situations in which males are not mutually dependent and are able to monopolize as many females as possible, and in which females are unable to form strong coalitions,
2. Promiscuity is probably favored in circumstances in which males are related or mutually dependent, in which aggressive possessiveness does not work as a result of female coalitions, or in which females may promote some competition to ensure fertilization by the strongest males.
3. Consortships are promoted by a situation in which females have an interest in having special relationships with particular males, perhaps because they need some extra support for their childrearing activities.

While the first strategy reminds one of gorillas, bonobos seem to have dropped this strategy altogether and to have evolved in the direction of promiscuity (Kano, 1992; De Waal, 1995, 2001). The human mating system can be seen as descending from the third mating strategy. If this is true, the human mating system may have been promoted by a situation in which females had an interest in having special relationships with particular males. What would have promoted this tendency?

Helpless infants and prolonged childrearing. In chapter 7, we discussed already some hypotheses with respect to human `altriciality'. It is currently thought that the increased encephalization during the evolution of *Homo*, together with the limits posed to a broadening of the hominid pelvis, necessitated a revolution in which babies were born relatively premature (an idea already defended by Portman in 1941, see Gould, 1977, it is also defended by Waters, 1996). In fact, in comparison with other primates, a species with the general retardation in growth rate, with the brain size and the longevity of humans would need a gestation length of twenty-one months (Leakey, 1994). The early birth of the human baby has created a situation in which it lives as a kind of extra-uterine embryo for more than one year, during which it needs much attention and care by the parents - which defines us as a clearly altricial species. Even in our modern, extremely egalitarian and efficient industrialized societies, many women stop working temporarily after childbirth. In most cases fathers are sorely needed in the raising of children, and some extra assistance by grandparents is very welcome as well. It is clear that this creates a social situation that is completely different from that which we see in bonobos and chimpanzees and that at best shows a dim resemblance to the behavior of a series of New World primates.

The retarded growth rate of humans extends far beyond the baby phase, however, and this could be a clue to the selection pressures responsible for its origin. As a result of this retardation, human children have a very long period in which they can play and learn and in which they thus can train their social and cultural abilities. It seems likely that this extended learning period is the original reason that the growth rate was slowed down in humans. Table 8-1 shows the sequence in which permanent molars erupt in macaques, apes, and humans. Following the anatomist Adolf Schultz, these ages are taken to represent the end of infancy, the beginning of adolescence, and the beginning of adulthood, respectively.

One of the few clues to the evolution of this retardation is offered by the analysis of the age and developmental stage of the Nariokotome boy. On the basis of data on brain size and dental development, Holly Smith has calculated that the Nariokotome boy was about 65 to 75 percent of the way toward adulthood, but followed a growth pattern different from both chimpanzees and humans. He had his second permanent molars and lower permanent canine erupted, but his upper canine still emerging. She estimates that the boy was about nine year old, but was comparable to a twelve- or thirteen-year-old human child. This means that if her calculations are right, *Homo ergaster* was about 1.8 million years ago already on the road towards an extended youth. That would mean that already 1.8 million years ago at least some extra paternal care was needed and at least some extra learning was required to

	Macaque	Chimpanzee	Homo erectus	Modern human
End of infancy, 1st permanent molar	1 year, 5 months	3 years, 4 months	?	6 years
Beginning of adolescence/ puberty, 2nd permanent molar (twelve-year molar)	3 years, 3 months	6 years, 5 months	?	11/12 years
Beginning of adulthood, 3rd permanent molar (wisdom tooth): end of growth in height, complete fusion of most parts of skeleton	5 years, 10 months	11 years 5 months	?	18 years
Brain weight [body weight] in Kg	0.09 [7.28]	0.41 [36.36]	0.83 [58.60]	1.25 [44.00]
Encephalization quotiens acc. to Martin [Jerison]	1.78 [1.95]	2.38 [3.01]	3.34 [4.40]	6.28 [8.07]
Estimated maximum age, defined as 12-15 x infancy (fits Goodall, 1996; no data on macaques found)	17-21 years	40-50 years		72-90 years

Table 8-1. Ages at which permanent molars erupt in macaques, chimpanzees and humans (based on Walker & Shipman, 1996), combined with brain weights, encephalization quotients (Aiello & Dean, 1990), and estimated mean maximum ages.

be prepared for the life that protohumans then lived.

A recent study relativizes the data gathered by Smith, however. On the basis of a comparison of the growth patterns of teeth and enamel of *Proconsul, Australopithecus, Homo erectus*, Neanderthals and modern humans the study concludes that the extended growth of modern humans evolved relatively late. It is even unclear to what extent Neanderthals display modern human growth patterns (Mayell, 2001). It is to be hoped that this kind of research will at some point settle the moment that modern human growth patterns evolved, because this will make a lot clear about our evolution.

Increased paternal investment and grandparenting. In many regards, the whole group of primates stands out with behavioral patterns that are somewhat unusual for mammals. The behavioral patterns of our ancestors were already extremely diverse if we go back to the period in which New World monkeys and Old World monkeys were not separated (Small, 1995). In the New World monkeys we find a series of characteristics that are typical for some hominids, for example, female dispersal, the existence of groups within groups (spider monkeys, Robinson & Janson, 1987), and, finally, monogamy and paternal investment (marmosets and tamarins, Hrdy, 1981; Kinzey, 1987). The enormous behavioral potential of our ancestors is further proved by rich variety of hominoid lifestyles: from monogamy (gibbon) to polygamy (gorilla), from almost solitary (big males in the orangutan) to extremely social (bonobo). Such lifestyles are, of course, a product of both phylogenetic inertia and ecological factors, like the presence of predators, the threat of conspecifics, and the dispersion and variety of food items. Yet, the fact that one can find a series of hominid traits back in the New World monkeys means that they did not have to arise *ex nihilo* and that primate behavior may apparently change relatively easy with changing ecological circumstances.

In both chimpanzees and bonobos there does not seem to exist a special father-offspring bond, as it is unknown who has fathered a particular child. It may actually be in the interest of females to leave the question open as to who the father is, as an anti-infanticide strategy (Hrdy, 1981). Perhaps this can explain why infanticide in chimpanzees occurs much more seldomly than it does in gorillas, in which about one out of every seven children is killed and in which `it looks as though most infants unprotected by a silverback are killed' (Wrangham & Peterson, 1996, p. 148). However, even in a situation in which paternity is not certain, males may behave in accordance with an (unconscious) calculation of probabilities. In baboons there is no paternal certainty either, but males do sometimes help the children of their female `friends', partly to please their mothers, partly because they might be the fathers themselves (Strum, 1987). In chimpanzees there is a positive relationship between survival of offspring and the amount of meat that their mothers get at kill ((McGrew, 1992, p. 110, combining data from Goodall, 1986, pp. 62 and pp. 310; Stanford, 1995). Sometimes alpha males share their meat exclusively with females with which they have consorted. This is especially revealing if we realize that consortships do often result in successful conception (Goodall, 1986, p. 471-477). Thus, although chimpanzee behavior gives us no indication of the existence of a father-child bond in the common HUCHIBO ancestor, `sex contracts' could have evolved as a result of an increased dependence on meat, and paternal investment could have increased gradually parallel to an increased paternal certainty.

In our own species, probably about 80-90% of all children in all cultures have been fathered by their purported father. (Russell & Wells, 1986, estimate that p or paternity certainty is 87% and compare this with the p of 91% in Yanamamös, obtained via genetic research; Thornhill, Gangestad & Comer, 1995, point to figures from 1957 in which p was 93% and Bellis & Baker, 1990, found that 6% of a sample of British women with one main partner reported their last act of sexual intercourse to be outside this relationship). As `extra-pair copulations' have simply to be considered part of monogamous breeding systems (this even goes for gibbons, as shown by Reichard, 1995), such figures show that it pays for human males to exchange paternal care for paternal certainty. In that respect Murdock could claim that the nuclear family was universal and that polygyny simply means that one man has more than one family (cited in Kinzey, 1987). Many psychological theories exist proposing effects of the presence or absence of the father at home (e.g., Chisholm, 1993), and there is reason to assume that the presence of a father of relatively high rank may have profound influences on the future rank and possibilities of a human child. Even in modern cultures, children in father-absent households have significantly less time to stay at home and absorb culture (Chisholm, 1993). Children from unstable families tend to start their sexual and reproductive career at an earlier age (Kim, Smith & Palermiti, 1997) and therefore have less time for education. Children from small families, in which parents have relatively much time to invest, have more chance in getting jobs and becoming socially successful (Terhune, 1974, cited in Boyd & Richerson, 1993). I suppose that all of this has to be considered as the ultimate consequence of a trend which already started in the chimpanzee in which males with more meat mate more and in which females that receive more meat produce more offspring (McGrew, 1992, p. 110, combining data from Goodall, 1986, pp. 62, 310; Stanford, 1995). This tendency must have become decisive at moments that our ancestors, perhaps during dry seasons during the ice ages, became exclusively dependent on meat.

If we could observe the whole trajectory from ape to human we would note an increased level of parental investment. Parental care in humans often continues well beyond the age at which children are able to reproduce themselves. Different authors have hypothesized that menopause is an adaptive phenomenon enabling older women to invest in their grandchildren rather than in their own children (Williams, 1957; Alexander, 1979, 1990; Hill & Hurtado, 1991; Pavelka & Fedigan, 1991). This may have been especially functional if the mother was high in rank and had many grandchildren. Apparently a mother who gradually has lost the advantage of being young and attractive can better use her acquired wisdom and power to assist several children at significant moments in the raising of grandchildren rather than simply to continue exhausting her own body and having children of her own. The evolution of menopause can probably be best explained within the context of the need of an increased period of dependence of young individuals on their family and especially within the context of the increased helplessness of the babies (Peccei, 1995).

An interesting possibility is that grandmothering is an older phenomenon that paternal investment in our lineage. According to some authors the extra costs of giving birth to a large-brained babies was first carried by female kin alliances and only later by provisioning males (Kohn & Mithen, 1999). This would place the almost universal tensions between mothers-in-law and husbands in a wide evolutionary context.

Concealment of Ovulation and Sexual Privacy. It is generally agreed that the loss of estrus and the concealment of ovulation constitute a major difference between chimpanzees on the one hand, and humans, on the other hand. Without calendars, many women themselves do not have even the slightest idea when they are ovulating, let alone their potential partners. Several hypotheses have been proposed to explain this difference;

some of these are compared by Alexander (1990), who has given them eloquent names. The `prostitution hypothesis' explains concealment of ovulation in human females as a result of the necessity for females to obtain meat in exchange for sex. Females could obtain more meat by increasing their period of sexual attractivity (Symons, 1979, scenario A). The `cuckoldry hypothesis' sees concealment of ovulation essentially as a female reaction to a more monogamous lifestyle. By not advertising the exact moment of ovulation, females may have made it, in some situations, difficult for their partners and easy for their lovers to fertilize them, enabling them to get just the genes that they need most (Benshoof & Thornhill, 1979; Symons, 1979, scenario B; see also Schröder, 1993). Alexander's own favorite is the `paternal-care hypothesis,' which stresses the ability of women to conceal the exact timing of ovulation in order to force a specific male partner to a more continuing investment (Alexander & Noonan, 1979).

An ingenious explanation of both estrus and its loss is offered by Hrdy (1981). Hrdy argues that the promiscuity of many female primates is a very effective way of confusing the issue of paternity and reducing the possibility of infanticide. By mating with a whole series of males, a female forces these males to consider her children as possibly their own. In a situation in which females are monitored by harem leaders or husbands, the best way of continuing to confuse both these partners and extra-pair males about their possible paternity would be to conceal the moment of fertility. This would provide females the flexibility they need to spread illusions or at least confusions about the paternity of their children. Probably we should call this hypothesis the `confusion hypothesis.'

Fortunately, some new empirical discoveries have gradually been made that may help us to choose among such hypotheses. The Austrian ethologist Karl Grammer discovered, for example, that the behavior of women may change around the time that they are ovulating as a result of a changed perception of androstenone: most of the time this odor repels them, but not so around the time of ovulation (Grammer, 1993). Grammer himself interprets this as proof for an explanation for concealed ovulation that stresses the female's chances of obtaining good genes outside the pair bond by mating quickly and at the right moment. Other researchers have shown, or claimed, that women can to some extent regulate the effectiveness of an insemination by having an orgasm or not (Baker & Bellis, 1993). Both discoveries can be cited as evidence in favor of a version of the cuckoldry hypothesis in which even females themselves are ignorant about their own intentions.

There is also evidence that can be used in support of other models, however. For example, if one compares the sexual behavior of chimpanzees and bonobos, it is striking that the duration of the maximum swelling in estrus is much longer in bonobos (20 days compared to 9.6 days; Kano, 1992)[2]. Whereas chimpanzee males compete intensely for copulations at the time that ovulation approaches, bonobos are much more indifferent and seldomly fight. It can be argued that female bonobos conceal their ovulation (Wrangham & Peterson, 1997) in order to be able to protect their choice of the right father, which in their society need not be the most aggressive male. The advertising of ovulation in chimpanzees could be interpretated, then, as an adaptation to a male-dominated society that ensures both confusion about paternity and fertilization by the most dominant males. In bonobos the most aggressive males are no longer the most desirable fathers, and females no longer need to

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[2] However, these figures are based on bonobos in captivity and wild bonobos seem not to be as sexually obsessed as captive ones (Stanford, 2001).

stimulate aggression between males: they only need to confuse. This would strengthen the confusion hypothesis, especially for bonobos.

One can argue that humans have evolved in an opposite direction, however. As noted, humans differ from both bonobos and chimpanzees in that females need some assistance of the father in the raising of helpless offspring. If they would advertise their exact moment of ovulation, those males would not be interested anymore at other moments. Human females are therefore both attractive to males at each stage of the monthly cycle and cryptic about their exact moment of ovulation. Originally this system may have evolved out of the habit of male chimpanzees of sharing meat preferentially with females with which they have consorted. For *Australopithecus* the prostitution hypothesis may have been right. During the period of encephalization (*Homo*) such ephemeral exchanges would have become insufficient for the sustainment of the dependent mother and the helpless baby, however. Instead of an exchange of one copulation and one piece of meat, an exchange between an enlarged possibility of paternity and a lasting favoritism must have evolved, with a matching psychological motivation system (falling in love). For that period, the paternal-care hypothesis could well be right.

Perhaps the paternal-care hypothesis also needs to be supplemented by both the cuckoldry and confusion hypotheses. At the moment that societies started increasingly to consist of pair-bonded couples, females could still feel that they needed the protection of the most dominant males, which were not necessarily their own providers. The same concealment that helped them to bind their permanent partners may also have helped them to get the support of these dominant males and allowed them to swap partners at any moment that they found favorable.

We can conclude, therefore, that the different explanations for the concealment of ovulation do not exclude each other. If the original HUCHIBO ancestor exhibited a mating system similar to that of chimpanzees, an increased dependence on meat may well have made it more attractive to females to join males in consortships and to exchange sex for meat. These consortships may have changed into somewhat longer bonds at the time that more paternal investment was needed. Concealment of ovulation in such a situation may have helped females to keep their special friends or partners sexually interested while at the same time enabling them to collect a set of superior genes occasionally.

8.4. WHICH THEORIES ARE COMPATIBLE WITH THIS KNOWLEDGE?

A. THE HUNTING HYPOTHESIS.

Apparently, the increased period of helplessness of human infants and, simultaneously, the increase in male investment have been the crucial factors that changed the mating system of the common HUCHIBO ancestor and *Australopithecus* into the human lifestyle. As I said already, this increase in paternal care could be explained by assuming a period of increasing dependence on meat. The ice ages started 2.5 million years ago and Africa became drier and drier; to assume that one line of australopithecines became increasingly dependent on meat is by no means unreasonable. There is much other evidence as well that could point to an increased dependence on hunting. In their analysis of the changes one would expect in a vegetarian species that is becoming carnivorous (which I already mentioned), Shipman and Walker (1989) enumerate the following:

1. An increase in either speed or sociality (adaptations required to catch prey),
2. A change in dentition or the appearance of a meat-processing industry,
3. An increase in `free' time,

4. Changes in the digestive tract,
5. Either a decrease in body size or an increase in geographic range as a result of the availability of less food per square kilometer,
6. A change to a more altricial pattern.

One can find most of these changes in the transition from *Australopithecus* to *Homo*:

1. The increase in brain size could point to a social life of increasing complexity (Aiello & Dunbar, 1993). This increased brain size may have been possible only as a result of an availability of more proteins (Aiello & Wheeler, 1995).
2. The Oldowan stone technology featuring sharp edges capable of slicing meat appears at about the same time that *Homo* appears. Compared to the molars of *Australopithecus*, the molars of early *Homo* were small, while the incisors were larger, which seems to point to a diet in which coarse plant foods were less important.
4. Whereas Lucy was relatively potbellied, analyses of the Nariokotome boy show that he had a long torso and narrow hips, like modern humans. Walker and Shipman (1996) attribute the differences to the much smaller guts of *H. erectus.*
5. As Shipman and Walker noticed already, geographical expansion is characteristic of *Homo erectus*. Since 1989, when they wrote their article, it has appeared that the geographical expansion of *Homo erectus* happened much earlier than originally thought, which strengthens their argument that it resulted from changing food habits necessitated by the first ice age.
6. Shipman and Walker argue that the relative brain size of early *Homo* was only possible as a result of an increase in gestation length, which they see as the most unambiguous sign that *Homo* is a `herbivore-turned-carnivore.'

Shipman and Walker also provide other evidence of both increased sociality and carnivorism in *Homo erectus* at about 1.7 million years ago. They mention a female skeleton of *Homo erectus* from this period, KNM-ER 1808, with a large amount of ossified blood on her bones, which proves that she suffered from acute hypervitaminosis A and yet survived for several weeks prior to her death. They claim that the only way in which this would have been possible is if this unlucky female was supplied with water and possibly food and protection from predators during this period. At the same time, hypervitaminosis A is best explained by the consumption of meat: one can get it by either eating something like one hundred pounds of carrots or by eating one pound of carnivore liver. It seems likely that KNM-ER 1808 happened to eat somewhat too much liver, as is also suggested by the microwear of her teeth, which is comparable only to the microwear patterns that show up on the teeth of meat-and-bone-eating carnivores, like hyenas (Shipman & Walker, 1989; Walker & Shipman, 1996).

Another change that may have been the ultimate result from a change to a more carnivorous lifestyle is the increased dependence on a home base for the exchange of meat and other goods (Tooby & DeVore, 1986). The increased helplessness of the babies also may have necessitated such a change. The amount of offspring that a female could raise could increase by no longer bearing them individually, as in chimpanzees, but simply `storing' and feeding them at home base (Lovejoy, 1981; see chapter 7). This tendency would reinforce the necessity of reliable paternal aid, which could only be obtained by giving the male an increased sense of paternal certainty. If *Homo* lived in a fission-fusion society centered at a home base, this may also have created the desirability of a communication system of increased complexity, either to report on the environment *to* the `home front' (Bickerton, 1990) or to form complex coalitions *at* the home front (Dunbar, 1996). If *Homo* was an efficient hunter, there may also have been more `free' time, which could be used for `cultural' displays. Of course, at the moment it is unclear whether we should project all these adaptation back as far as *Homo habilis* or *Homo rudolfensis*. They may have only emerged gradually, or as a result of additional crises.

In an analysis that still is close to that of Lovejoy (1981), Hill (1982) speculates that the transition to hunting would lead to male provisioning, which would allow females a greater freedom to concentrate on parental care.

> This change would probably reduce infant mortality considerably, and thus, the *average* life span would increase. More importantly, with a greater number of organisms living to older ages, the advantages that could be obtained from averting causes of death later in life (aging) would increase greatly and thus provide the selection pressure for greater longevity. Organisms with a longer juvenile developing period might then be more able to outcompete others in adulthood (through learning, etc.), but such a longer period of development would necessitate an *increase* in the birth interval. This long period of juvenile dependency would, however, have an even more important consequence. If juvenile offspring had a very low probability of surviving their mothers' death at, for example, under ten years of age, it would be an unwise strategy for a female to continue to bear offspring when the probability of her death within the next ten-year period was quite high. Old females with a low probability of surviving another ten years should shift their reproductive strategy. The optimal strategy for a female under these conditions is to assist in the parental care of her own daughters' offspring, and to cease reproductive effort herself (p. 539).

Thus, a whole set of human characteristics seems to be explained by applying a version of the hunting hypothesis. Above that, it is strengthened by the analysis of fossilized bones and stone artifacts from several sites along the African Rift Valley (e.g., Bunn & Kroll, 1986).

Of course, as is well known, these same bones and artifacts are sometimes used to defend the hypothesis that early man was a scavenger, but several writers have pointed to the fact that this would bring our ancestors into serious competition with a list of other scavengers (Tooby & DeVore, 1986; Walker & Shipman, 1996). Also, scavenging and hunting are completely compatible and both chimpanzees (Hasegawa, Hiraiwa, Nishida & Takasaki, 1983) and Hazda hunter-gatherers in northern Tanzania (O'Connell, Hawkes, Blurton Jones, 1988) use both techniques at the same time, although scavenging in the Hazda accounts for only 20% of the carcasses and scavenging in chimpanzees is only rarely observed. The same pattern is found at the middle Pleistocene site at Aridos (Spain), where undisputed proof of elephant butchery was found that differs fundamentally from marginal scavenging (Villa, 1990). It should also be noted that many predators, from buzzards to lions, occasionally indulge in scavenging.

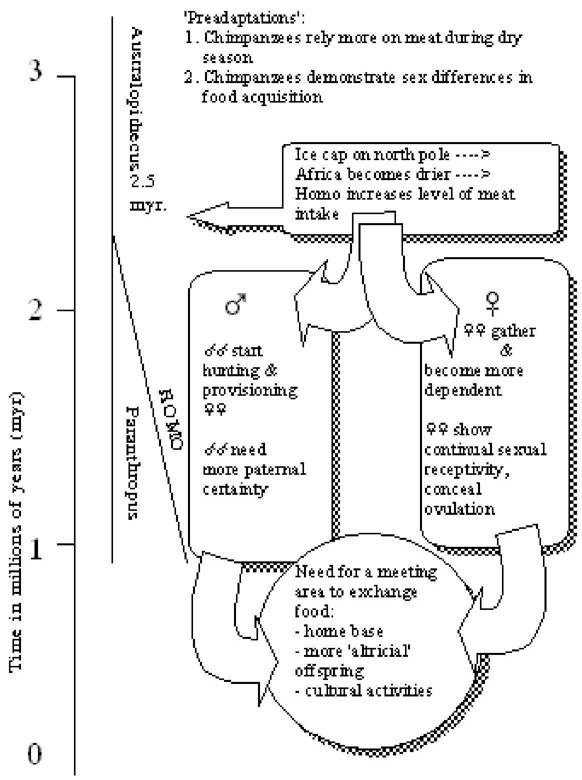

Fig. 8-2. Components of a hunting hypothesis of human cultural abilities.

Another question is whether meat has ever been the exclusive nourishment of our ancestors (Tanner, 1987). This is unlikely, as we have a maximum sustained protein intake below about 50% of calories. It is even speculated that the ability of Eskimos to live on a diet with a protein intake of about 45-50% is due to a unique genetic capacity not seen in other populations (Speth, 1989). To discover the difference between the diet of a hominid and a real carnivore, one only has to compare one's dinner plate with the bowl of one's cat. Of course, as KNM-ER 1808 and the modern race of hamburgereaters demonstrate, meat is sometimes eaten more than is healthy and often is venerated as a supreme source of energy. As both chimpanzees and hunter-gatherers are predominantly vegetarian, the safest conclusion is that our ancestors have always been opportunists. Meat, however, may have enabled them to survive during periods of the ice ages in which the dry season became relatively long and exacting and, at a later stage, during the long winters on the Eurasian continent.

Does the hunting hypothesis explain the origins of culture? This brings us finally back to the question of whether the hunting hypothesis can explain the origins of the complex culture in which we live now. To some degree, it can. Hunting may have afforded the extra proteins needed to grow a big brain; it may have necessitated a more complex stone industry; and it may have encouraged increasing cooperation and the need to pass on skills and techniques from generation to generation; and it may have encouraged the use of complex communication. Indirectly, it may have brought together individuals from three generations, thus encouraging cultural transmission. Finally, it may have eventually stimulated the occupation of home bases at which individuals from different generations could pass on their skills.

As shown by the data of our maximum meat intake and actual food habits show, the hunting hypothesis must be combined with a theory about gathering. Several writers have stressed that gathering may have been as important as hunting and that chimpanzees use tools predominantly in the context of nut cracking and insect collecting (Tanner, 1987). The first step that may have enabled *Australopithecus*, used to living along the border of tropical forests, to survive in a relatively dry environment may have been the opening up of new food sources below the ground: roots. In fact, in Tongo, a forest in eastern Congo with almost no rivers and lakes, a small population of chimpanzees lives with a tradition of digging and eating roots as a local adaptation to water shortage (Wrangham & Peterson, 1996). It seems that the skill of root digging is complex enough to stimulate a new dependence on the acquisition of skills through social learning, mainly between mother and offspring, as envisioned by Parker and Gibson (1979) and King (1994). From this perspective, the fact that *Australopithecus* has a brain that is slightly larger than that of the chimpanzee can be explained. Australopithecines may have been dependent on foods that were already hard enough to get to force them to relatively intelligent behavior, which may have pre-adapted particular populations for the even more demanding task of hunting and the processing of meat and bone marrow.

Thus we can speculate that an increased dependence on difficult food sources, necessitating `extractive foraging' (Parker & Gibson, 1979), may have forced our ancestors to become smarter. Parker and Gibson even postulate that such a transition may have furthered their linguistic proficiency:

> The prehistoric ecological transition to extractive foraging on foods that were both difficult to obtain and process would have resulted in mandatory parental provisioning of post weaning children. Abortive attempts by children to open tough nuts, dig deep tubers from the ground and engage in other complex activities would have resulted in need for parental aid. Many parents would have anticipated their children's difficulties in accomplishing these tasks and would have come to their aid as soon as interest was evidenced by the child by pointing, vocalizing, reaching, etc. The probable result would have been that certain vocal or manual gestures would have acquired specific meaning within individual mother-infant pairs.

Yet, some questions remain. The first is why big brains and culture did not arise during the evolution of *Australopithecus* already. This question was given a first sketchy and speculative answer by Stanley (1996): their brainsizes may have been limited because they were unable to care for the helpless infants that need to be born if babies with big brains have to be born. As australopithecines probably were still partly adapted to a life in the trees, to which they had to flee from predators, they did not have their hands free to carry such infants. Only as a result of a climatic change that created an environment with fewer trees and with less food generally was a small population of australopithecines forced to start specializing increasingly on meat during the dry season, while they were unable to climb back into the trees for safety. The same skills that may have allowed them to hunt in groups may have enabled them to defend themselves from predators.

The second question is why our culture is so complex if it only evolved to enable us to hunt and why we tend to live in groups that are much bigger than would be efficient for group hunting. Obviously, living in relatively big groups has many disadvantages, especially for hunters. Also, as is shown by a variety of carnivores, one certainly needs to be clever to be able to hunt, but one does not need to be able to write poetry. Why would humans have started to live in groups of increasing size, and why would their brains have become bigger and their culture much more elaborate than would be required for mere hunting?

It is especially this last question which forces us back to theories which assume a certain role for runaway selection mechanisms, like sexual selection and intergroup competition. A certain amount of sexual selection has certainly be going on during our past, because both males and females show characteristics that are sex-specific and apparently not very functional in terms of pure natural selection: beards and breasts, for example. Certainly, hunting-and-gathering can be combined with sexual selection, because a cooperation between the sexes based on an exchange of food, sex, and care could complicate the solicitation procedures for new partners. Such complicated solicitation procedures could have driven the evolution of intelligence. On the other hand, human intelligence seems to be designed to do much more than to impress potential partners. Humans cooperate within large networks and, strangely enough, they feel sometimes obliged to invest in a common good. Certainly they are sexual creatures, but they are to some extent extremely social creatures as well, even in their most private thoughts. Why would they tend to live in groups that are much larger than would be efficient for hunters and gatherers?

It is wise to delve into the theories on runaway selection, thus, not because the hunting-and-gathering theories are misguided, but because they seem incomplete. We should keep in mind, thus, whether these theories are meant as replacements or as supplements.

B. SEXUAL SELECTION THEORY.

A possible link between sexual selection and neoteny. Explanations of human evolution, based on sexual selection, sometimes give the impression of being meant as complete and self-sufficient models. Recently, there has been a revival of interest in such models (perhaps beginning with Parker, 1987). Geoffrey Miller has refined a model in which the threefold brain enlargement during human evolution is explained as a result of the bilateral sexual selection of the sexes or of sexual selection in which the selected properties of one sex happen to be inherited by offspring of the other sex as well (Mestel, 1995; Miller, 1996; 2000). Normally one would expect properties that evolve as a result of sexual selection to be represented especially in one sex, but as both sexes share most chromosomes, it is at least possible to imagine the sexual selection of properties that are highly advantageous to one sex and neutral to the other sex. Miller proposes that the most important trait that has been selected during human evolution is simply the ability to produce impressive courtship displays in the form of music, dance, poetry, rhetoric, and the like. Male humans would create art and culture just `to impress the girls', thus for the same reason that male peacocks display their feathers and ruffs defend their leks. Females also would need at least some creativity to be able to bind the males and lure them into investing in their offspring. This is called the `Scheherezade strategy' by Miller after the heroine of the *Arabian Nights* who had to tell the sultan a story every night to seduce him not to kill her after having slept with her. Miller claims that most artists have their peak at a relatively young age, just when they are most sexually active (or most actively pursuing sex).

In his popular book *The Red Queen: Sex and the Evolution of Human Nature* (1994), Matt Ridley connected the idea of sexual-selected creativity with the already somewhat outmoded idea of neoteny, the idea that many human characteristics can be explained simply by the persistence of youthful characteristics in adult life, caused by the workings of genes that slow the maturation process. He reasons that in a situation with a certain degree of monogamous pairbonding and paternal assistance in childrearing, males should be particularly interested in females with a lot of residual reproductive capacity. If mating is just a transitory, noncommittal activity for males, there is no reason to be selective about female partners, but the more time it takes to concentrate on one particular female and the more the road to polygyny is blocked, the more important it becomes to have as many children with one female as possible. As a result, it would become adaptive for females to look as young as possible and neoteny genes in women would continually be selected and even be inherited by their sons. As neoteny genes are supposed not only to cause someone to look younger, but also to influence brain-body ratio and overall behavioral flexibility and inclination to play and to learn, this would mean that they could cause an increase in general intelligence as well.

Neoteny is often too easily used as an explanation for human uniqueness, however (e.g. Gould, 1977). Brian Shea (1992) warns that theories that refer to neoteny are often too simple to account for uniquely human properties. Almost none of the morphological features associated with bipedal locomotion can be related to neoteny, for example, and while it is true that an adult human looks like a juvenile ape in that she or he has a relatively big brain and little prognathism, this resemblance is caused by completely different patterns of bone distribution. In particular, the construction of the pharynx of an adult human does not look like that of an juvenile ape, and the evolution of speech therefore cannot be attributed simply to neoteny (Shea admits, however, that neoteny *can* account for the resemblance between the skull and face of a juvenile common chimpanzee and those of an adult bonobo, so he does not completely exclude the possibility of the mechanism in some evolutionary trajectories). All in all, neoteny theory suffers from an overdose of explanatory monism, and it is not advisable to invoke neoteny as an explanatory *deus ex machina* that can be invoked for all kind of gaps in our theories.

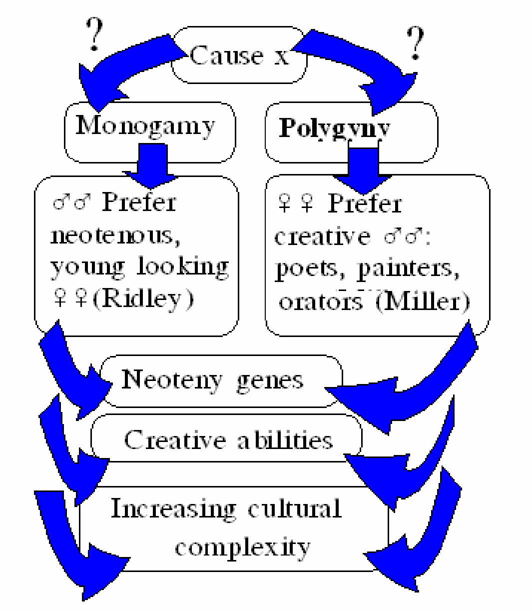

Fig. 8-3. Sexual selection explanations for properties that cause humans to create culture already pressuppose specific mating patterns.

With respect to the question whether sexual selection should be considered as the only theory, Ridley himself admits that there is a general problem with sexual-selection-based theories of human evolution in that they are circular. As Hans van der Dennen notes, `prime-mover' theories of human evolution often are unable to reply to the question "What moved the prime mover?" (Van der Dennen, 1995). Ridley himself answers that evolution often is circular and works by bootstrapping. There need not be a single cause-and-effect relation, because "effects can reinforce causes". "If a bird finds itself to be good at cracking seeds, then it specializes in cracking seeds, which puts further pressure on its seed-cracking ability to evolve" (Ridley, 1994, p. 332).

Ridley forgets here, however, that birds do not "find themselves good at cracking seeds" on any given day of their evolutionary history and do not specialize apart from the rest of an ecosystem. If they change their food habits, the most likely cause is a slight disturbance within the ecosystem because of geological or climatological factors (e.g., Grant, 1991). His argument that "evolution is circular" fails because evolution is driven by many external factors, such as the amount of solar energy, the composition of the atmosphere, and geological and climatological factors. If something like bootstrapping happens in evolution, there are always forces that set this bootstrapping process in motion.

Thus we have to conclude that if something like the sexual-selected neoteny mechanism has worked during specific periods of human evolution, it presupposes at least a series of environmental pressures that drove human evolution it in the first place. To be more specific, at least the unique combination of paternal investment and long-term `sex contracts' (Fisher, 1982) between males and females have to be explained first, as these are absent in chimpanzees and bonobos. At the moment that these sex contracts were in place and males had to invest in particular females for a relatively long time, they also had good reasons to look especially for young (neotenous?) females with a lot of residual reproductive capacity. At the same time, females would have good reasons not only to look for good genes, but for good fathers as well.

The link between prolonged childhood, paternal investment, and cultural abilities. It may even be postulated that these long during sex contracts underlay the whole spectrum of human cultural abilities in a very direct way: culture presupposes learning and a complex culture presupposes a very long learning period. It is difficult to imagine that a chimpanzee mother, without the aid of a father, could give her child so long a period of carelessness with relation to subsistence that the child could go on learning for decades, as children in our culture often do. Of course, it is true that in many cultures the periods in which children are dependent and the amount of paternal investment are limited. Nevertheless, it is reasonable to assume that there is a link between the unique property of our mating system - paternal investment coupled to an obsession with female fidelity (e.g., Daly & Wilson, 1988) - and the prolonged period of parental investment that might be a *sine qua non* for the acquisition of complex culture. Even in modern cultures, children in father-absent households have significantly less time to stay at home and absorb culture (Chisholm, 1993). Children from unstable families tend to start their sexual and reproductive career at an earlier age (Kim, Smith & Palermiti, 1997) and therefore have less time for education. Children from small families, in which parents have relatively much time to invest, have more chance in getting jobs and becoming socially successful (Terhune, 1974, cited in Boyd & Richerson, 1993). At the other end of our evolutionary spectrum, there is the correlation that I mentioned already between the meat received by female chimpanzees and the amount of offspring that survive.

But such a link between prolonged childrearing and the evolution of culture does not yet give an explanation for either of them. We still have to explain why some ancestral males started to invest in children and their mothers in exchange for a certain degree of paternal certainty (partly achieved by female fidelity, partly by male possessiveness, which was at some later stage reinforced by the cultural practice of marriage). We have to assume that there was a period in hominid evolution in which mothers simply could not do without the help of fathers, as a result of which children for which the mother was not able to obtain paternal investment were seriously at a disadvantage. Thus, again, we have to return to the hunting hypothesis, which is also compatible with our knowledge of chimpanzees. We now know that the chimpanzees at Gombe hunt on a regular basis, especially during the dry season (Stanford, 1995). We also know that females that are able to obtain meat have more offspring and we know that, from the perspective of males, more meat means more matings. McGrew (1992) mentions an alpha male who distributed meat mainly to females with whom he consorted and to his mother. Together, these tendencies may have been enough to push some populations of australopithecines or hominids which became increasingly dependent on meat on the road towards `sex contracts' in which paternal investment and paternity, or paternal certainty, were exchanged.

Yet, all this leaves a series of questions unanswered. If an increased paternal investment was at some point necessary, why would this tendency work in an apparently autocatalytic way to produce more dependent children with longer learning periods? From the viewpoint of sexual selection theory the answer could be that females started to choose good hunters and fathers[3], which, however, require a longer learning period, and thus more paternal investment. A feedback loop was thus created in which more an more paternal investment was needed every generation to make better hunters and fathers (fig. 8-4).

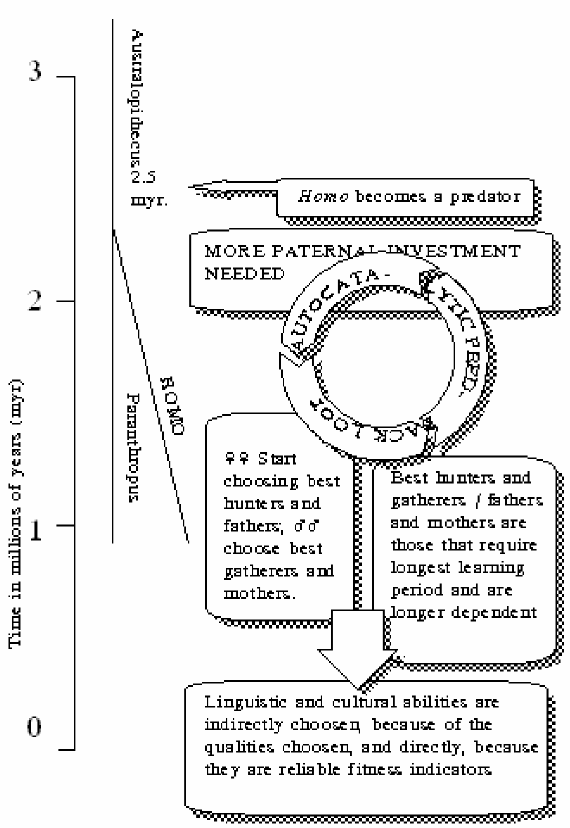

Fig. 8-4. As a result of an increased necessity of paternal investment, sperm competition was to some extent replaced by the sexual selection for best mates at some point during prehistory.

The question lingers, however, how successful this process is in explaining cultural abilities. It is here that we have to return to Miller (1997; 2000) and his thesis that language, art, and perhaps morality are all products of sexual selection. Kohn & Mithen (1999) have made a first attempt to test the potential of this explanatory model by applying it to the production of handaxes, especially those that are much too big and beautiful to be `just' functional tools:

> We propose that handaxes functioned not just to butcher animals or process plants but as Zahavian handicaps, indicating `good genes'. Those hominids ... who were able to make fine symmetrical handaxes may have been preferentially chosen by the opposite sex as mates. Just as a peacock's tail may reliably indicate its `success', so might the manufacture of a fine symmetrical handaxe have been a reliable indicator of the hominid's ability to secure food, find shelter, escape from predation and compete successfully within the social group. Such hominids would have been attractive mates, their abilities indicating `good genes' (Kohn & Mithen, 1999: 521).

On the basis of these assumptions, Kohn and Mithen do an attempt to trace sexual selection back into the paleontological record. According to them, sexual selection was coupled with `substantial male provisioning' only in late stages of human evolution. If they would be right not only Lovejoy and Hill (see chapter 7) would project paternal investment back into

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[3] In fact, females started probably to zigzag between good hunters and good fathers, as they still do, their sexual careers being a long learning process resulting in the best compromise they are able to bind.

prehistory far to much, but I would do the same when I postulate a link between hunting and paternal investment. Probably we simply need more study and more data to settle this issue. At this point, the most important point, however, is that they agree that sexual selection presupposes particular mating systems. Sexual selection supplements the hunting hypothesis, but does not replace it.

Personally, I doubt, however, whether sexual selection theory is complete itself. If all cultural expression could be understood as indirect sexual displays, why would so many of them not be directed at women, but to other men? I certainly believe that a rock start has many sexual opportunities that ordinary mortals do not have, and that this may partially motivate someone to be a rock star, but I doubt whether this same kind of reasoning works for a cosmologist or for a philosopher (yet, see Dunbar, 1996, for interesting experiments showing that male academic conversations change and that males start to display their erudition more when women are present). If the hunting theory augmented with sexual selection would explain all there is to human culture, I would expect much less cooperation and much smaller societies. As Wilson put it already: "sex is an antisocial force in evolution" (Wilson, 1980 [1975]: 155). In a society dominated purely by sexual selection, art would probably be a more important segment of society, because it constitutes more opportunities for bluffing and displaying mental complexity. Thus, I certainly believe that sexual selection theory is partially right, but I think there are other forces active as well which have made us the extremely social species that we currently are. The rest of this chapter is dedicated to the intergroup competition theory, a theory that seems necessary to explain the structure and size of modern human societies.

8.5. INTERGROUP COMPETITION AND GROUP SELECTION

As we saw, according to the intergroup competition hypothesis of Darwin, Bigelow, and Alexander, protohumans had to form relatively large communities to defend themselves against other such communities, apparently trying to exploit the same area. Arms races between different groups of protohomomids could lead to a runaway selection process for social and moral capacities of which the human psyche is postulated to be the outcome. As we saw already, Darwin had already envisioned such a process, but he was not very clear about the exact level of selection involved. Bigelow, who in his *Dawn Warriors* (1969) uses the theory as an explanation for the threefold brain enlargement during human evolution, is more precise in his formulations. He writes:

> Those groups with the most effective brains, and hence with the greatest capacity for effective cooperation in attack or defense, maintained themselves longest in the most fertile and otherwise desirable areas. In these areas they produced more offspring, and additional groups. Those with the most effective brains and the most efficient in-group cooperation were less often massacred wholesale by other groups, and less often driven into deserts to starve (Bigelow, 1969: 5-6).

This passage immediately reminds us of Maynard Smith's article on group selection in which he clearly distinguishes group and kin selection and states that "in the long run evolution by group selection requires group extinction just as evolution by individual selection requires individual death" (Maynard Smith, 1976). According to Maynard Smith the features favoring group selection are "small group size, low migration rates, and rapid extinction of groups infected with selfish alleles" (idem) - a situation which probably does not often prevail (Williams, 1966). Only when these conditions are met, group selection might simply `override' individual selection even in a situation where individual and group interests conflict (Wynne-Edwards, 1962).

Originally, sociobiologists tended to identify the mechanism of intergroup competition with group selection. For example Alexander and Borgia write in 1978 that

> Human groups represent an almost ideal model for potent selection at the group level. First, the human species is composed of competing and essentially hostile groups that have not only behaved toward another in a manner of different species but have been able quickly to develop enormous differences in reproductive and competitive ability because of cultural innovation and competitive ability because of cultural innovation and its cumulative effects. Second, human groups are uniquely able to plan and act as units, to look ahead, and to carry out purposely actions designed to sustain the group and improve its competitive position, whether through restricting disruptive behavior from within the group or through direct collective action against competing groups (Alexander & Borgia, 1978: 470).

The mechanism proposed by Edward Wilson is somewhat less clear. In his *Sociobiology* he speculates about a special evolutionary mechanism which he calls *genosorption*, which, not only *causes*, but also *results from* increased mental powers (Wilson thinks of an `autocatalytic process', Wilson, 1975):

> If any social predatory mammal attains a certain level of intelligence, as the early hominids, being large primates, were especially predisposed to do, one band would have the capacity to consciously ponder the significance of adjacent social groups and to deal with them in an intelligent, organized fashion. A band might then dispose of a neighboring band, appropriate its territory, and increase its own genetic representation in the metapopulation, retaining the tribal memory of this successful episode, repeating it, increasing the geographic range of its occurrence, and quickly spreading its influence still further in the metapopulation. Such primitive cultural capacity would be permitted by the possession of certain genes. Reciprocally, the cultural capacity might propel the spread of the genes through the genetic constitution of the metapopulation. Once begun, such mutual reinforcement could be irreversible. The only combination of genes able to confer superior fitness in contention with genocidal aggressors would be those that produce either a more effective technique of aggression or else the capacity to preempt genocide by some form of pacific maneuvering. Either probably entails mental and cultural advance. In addition to being autocatalytic, such evolution has the interesting property of requiring a selection episode only very occasionally in order to proceed as swiftly as individual-level selection. By current theory, genocide or genosorption strongly favoring the aggressor needs take place only once every few generations to direct evolution. This alone could push truly altruistic genes to a high frequency within the bands (Wilson, 1975: 573-74).

In 1981 Daniel Vining jr. tried in his article `Group selection via genocide' to produce a mathematical simulation which shows that group-selection-induced altruism (= a gene-induced talent for Bigelow's cooperation-to-compete) can evolve. According to Vining

(E.O.) Wilson is too optimistic about the frequency of the genocidic episodes needed. He comes to the rule of the thumb that "the group extinction rate must be of the same order of magnitude as the rate of selection against individual deleterious trait within the group", independently postulated by D.S. Wilson.

In their attempt to make the whole debate on group/individual selection in human evolution more testable Soltis, Boy and Richerson (1995) have gathered data on group extinction rates in five regions of Papua New Guinea and Irian Jaya from the anthropological literature. In their sample, the percentage of groups suffering extinction each generation (every 25 years) ranges from 1.6% to 31.3%. They conclude that it may be "a plausible mechanism for the evolution of widespread attributes of human societies over the long run" (1995: 483).

Yet, intergroup competition theory should not be identified with group selection. In fact Wilson's term `genosorption' suggests another mechanism than pure genocide: the dual strategy of genocide directed at males, and abduction or even rape directed at fertile women. It is this dual strategy about which we can find many historical reports, from the Israelite's way of dealing with the Midjanites (Num. 31: 17-18) to the Serbs selectively killing Muslims men at Srebreniza. Often, cooperation in warfare, or the `male coalitional strategy' (Van der Dennen, 1995) underlaying it, has direct effects on one's individual reproductive success: think of the concubines gained by the Greek heroes like Achilles and Agamemnon or by Roman generals, think of the reports on the abduction of virgins (Sabines, etc.), think of the link between warfare and rape (the weird lecture of Prof. Crammacher in Vestdijk's *Schandalen*, 1953), think of the Yanomamös. According to the reports of Chagnon fierce warriors have more reproductive success, because of their apparent popularity among females and/or because it offers them opportunities to collect women (Chagnon, 1988). In the Yanomamö 10 to 20% Yanomamö women have been captured in raids, the number increasing in ecological desirable areas (Chagnon, 1992). All this would imply that it is in the interest of individuals to join a raid or war. It is thus not necessary to invoke group selection to explain the tendency of males to cooperate in intergroup competition.

Since Dawkins radical criticism of group selection (which was continuous with Williams (1966) criticism of the concept and Maynard-Smith's analyses) group selection could not be used anymore as a *deus ex machina.* It is one of the merits of Alexander that he has freed the balance of power hypothesis from its identification with and its complete dependence on group selection (see especially, Alexander 1989: 462-64). The effect of competition between groups is not necessarily complete genocide or extinction (and at least during history the genetic borders between groups are often blurred by the effects of slave-making, rape and the occupation of concurred countries). Rather, the competition between groups creates an environment in which the conflict between the interests of group and individual are minimized and in which individuals are selected on their abilities to cooperate in large networks. The genetic mechanism underlying individual altruism and heroism is not comparable to kin selection (not based on the sharing of genes) but is a complex form of reciprocal altruism in which more than two parties can remember each individual contribution to the group's well-being and in which `moral status', as the running account of one's signs of benevolence towards the group, becomes therefore desirable in its own right (see also Slurink, 1989). Trivers has called this form of reciprocity `generalized reciprocity' (Trivers, 1971; 1985), but Alexander prefers the term `indirect reciprocity' because generalized reciprocity "has a history of usage that is vague because it includes, among other things, nepotism" (Alexander, commentary to Slurink, 1992). In a system of indirect reciprocal altruism individuals are selected on their ability to attain high moral status not only through genuine altruism but also through convincing show.

8.6. ECOLOGICAL DOMINANCE AND THE PALEONTOLOGICAL RECORD

Another major clarification in Alexander's version of the intergroup competition theory, christened by him the `balance of power' theory or `cooperation-to-compete' hypothesis, is the realization that the hypothesis would be incomplete without an explanation why the process occurred in protohominids and humans and not in other species. As we saw, his answer is the *ecological dominance* of evolving humans which "diminished the effects of `extrinsic' forces of natural selection such that within-species competition became the principal `hostile force of nature' guiding the long-term evolution of behavioral capacities, traits, and tendencies, ... more than in any other species" (Alexander, 1989: 458).

The idea is that levels of intergroup conflict increase on the moment that predation by other species decreases. The moment that the population levels of a species are not corrected by predators of other species the new limits will be fixed by intraspecific conflicts over territory and resources. Alexander speculates that the `turning point' at which `ecological dominance' is achieved and at which predation pressure is replaced by interspecific `balances of power' already could have been passed by the chimpanzee (Alexander, 1989: 458, 473-75). This means that the `initial kick' that started the process could be given more than five million years ago, at the level of the common ancestor of hominids, chimpanzees and bonobo's - which I call the common HUCHIBO-ancestor.

However, as we saw already, chimpanzees, orrorins, nor australopithecines can be called completely ecologically dominant. Chimpanzees are sometimes predated by leopards. According to Brain's `Swartkrans leopard hypothesis' the collection of australopithecine bones in the Swartkrans cave may have been the result of the leopards' habit of taking prey into a tree in order to avoid competition with hyena's (Brain, 1983). The holes in one of the autstralopithecine craniums, SK 54, match exactly with the canines of a leopard. To account for the fact that in the oldest member of the Swartkrans cave more than 50% of the macrovertebrate remains are from either hominids or cercopithecoids, Brain has more recently speculated that leopards exploited the sleeping sites of the Baboons and Australopithecines. Also, it is very plausible that there existed a specialized predator of primates, a plausible candidate of which is the false sabertooth, *Dinofelis*.

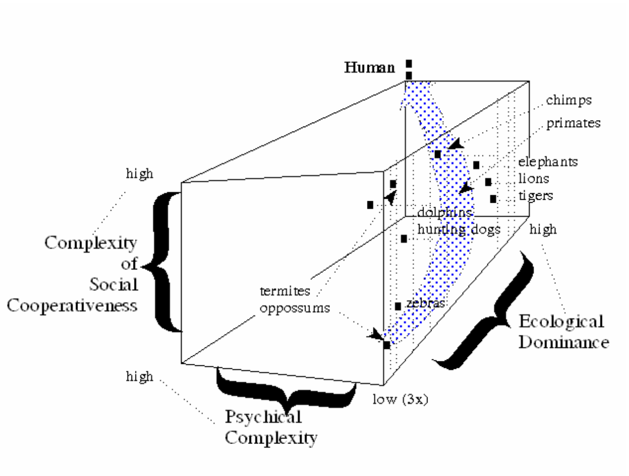

Fig. 8-5. The human evolutionary trajectory. In humans, a combination of ecological dominance and social complexity triggered a further evolution of psychical complexity via intergroup competition (redrawn from a handout of Alexander).

Above that, there are other animals (bears, lions, tigers, elephants) `ecologically dominant' and some of these (lions) even exhibit signs of intergroup conflict, but nevertheless we see no signs of runaway selection on brain size in these species. To make things even more complicated, intergroup conflict seems to be a characteristic of more savanna-dwelling primates (Ciani, 1992), but none of them shows runaway selection either. In response to one of my papers (1992), Alexander sent me a handout with figure 8-5 which, however, gives no causal mechanism. It would be nice if we could more exactly point to the factors that singled protohominids out and that brought them at some point in the position of becoming a predator above other predators (Slurink, 1993).

Clearly, we have discussed already some of the preadaptations that destined our ancestors, contrary to other species, to become both ecological dominant and involved in intergroup competition. For example, all HUCHIBOs share a tendency towards female exogamy and towards cooperation between kin-related endogamous males (Wrangham, 1986; Ghiglieri, 1987). They all have group territories that they defend in a cooperative way and chimpanzees sometimes try to enlarge this territory by raiding into a weakened neighboring community, like humans do (see Ghiglieri as cited in 7.2). This new kind of reproductive strategy could be a consequence of the opportunities offered by the shared interests of a group of kin-related males. In most primates males are exogamous and therefore more competitors than cooperators. The development of a high-risk/high pay-off strategy like organized aggression is highly unlikely to arise in females, because they are not likely to gain much reproductive advantage from it.

In a response to one of my papers in which I claimed that chimpanzees are not yet ecological dominant, Alexander stressed that this cooperation between kin-related males is "an effective anti-predator device that pre-adapts for a balance-of-power race". Apparently, he thinks of observations and experiments, like that of Adriaan Kortlandt which showed that groups of chimpanzees can be very aggressive towards a stuffed leopard (this experiment was filmed). It would be interesting to know to what extent males take the initiative in such cooperative assaults and to what extent they are indeed unique, as suggested by Alexander. (Many species are aggressive towards their predators; owls and birds of prey are often teased by crows and other birds).

Of course, we have mentioned a whole series of adaptations which could have made some early hominids relatively more ecological dominant than other species. The combination of bipedalism with the regular use of stone tools could have improved the efficiency of throwing (throwing forms a part of the way in which chimpanzees deal with predators). If early hominids at some point started to eat more meat, as suggested by the hunting hypothesis, this could have given new impulses to their creativity with weapons.

Above that, it could have stimulated their search for safe home bases, which were also relatively predator free. The most tempting hypothesis, not only cherished by me, but by many other thinkers on this topic, is the idea that the increased dexterity with tools combined with the discovery of relatively safe and dry home bases led to the discovery of fire, which may have been used to get these home bases even safer. This idea seems to be supported by the research of C.K. Brain in the Swartkrans and Sterkfontein caves. At the end of this end of his extensive report (Brain, 1983), he concludes that the different layers in the cave represent a fundamentally different ecological position of the successive hominids. The change is summarized in the statement that "the hunted became the hunters" (Brain, 1983).

> At Sterkfontein, the interface between the top of Member 4 and the bottom of Member 5 represents a time interval crucial in the course of human evolution. During this interval the gracile australopithecines disappeared from the Transvaal scene and the first men appeared. In this interval, too, the evolving men mastered a threat to their security that had been posed by the cave cats over countless generations. During Member 4 times the cats apparently controlled the Sterkfontein cave, dragging their australopithecine victims into its dark recesses. By Member 5 days, however, the new men not only had evicted the predators, but had taken up residence in the very chamber where their ancestors had been eaten.
>
> How the people managed this is not recorded, but it could surely have been achieved only through increasing intelligence reflected in developing technology. It is tempting to suggest that the mastery of fire had already been acquired and that this, together with the development of crude weapons, tipped the balance of power in their favor... (Brain, 1983: 273)

Many other writers have speculated that the discovery of fire could have initiated a transition to a completely different life style (Poirier, 1987; Goudsblom, 1989). The discovery of fire may have enabled the conquering and defending of caves and with that it may have created a place of relative safety from predators and climatic uncertainties. With that, however, it may have given the impetus for new levels of intraspecific conflict, focussing on the most desirable home bases.

It is a pity for this beautiful idea that opinions on the first discovery of fire were not at all converging during the last decade. More than a decade ago Brain and Sillen (Brain & Sillen, 1988) claimed to have found evidence of the use of fire in the Swartkrans cave of more than one million years ago. It was claimed that traces of hearths were found in Zhoukoudian, were thick layers of ash seem to indicate that the fire was kept burning for long periods (Rukang & Shenglong, 1983). However, currently some leading paleontologists seem to doubt that the thick layers of ash in Zhoukoudian derive from human activities and Tattersall & Schwartz even cite an Israeli-Chinese team that has concluded that the ash layers in Zhoukoudian derives from fires outside the cave of which the ashes have washed into the cave (Tattersall & Schwartz, 2000: 156). On the other hand, there is now the hypothesis of Richard Wrangham and others according to which the transition to cooking made humans distinct from the very start, 1.9 million years ago (Wrangham *et al.*, 1999; Wrangham, 2001). One argument in support of this hypothesis is that the teeth of *Homo erectus* are gradually becoming smaller during the Pleistocene (Wolpoff, 1984). It seems to me that, while indisputable evidence of hearths is hard to get, fossil evidence is much harder to refute. *Homo ergaster/ erectus* is characterized by a decrease in sexual dimorphism, a reduction in the size of the gut and a growth in brain volume that all point to a revolutionary change in diet. The argument of Wrangham (2001) that this need not to be a transition to meat eating, but that it could be caused by a transition to cooking could well be right given our present degree of knowledge or ignorance. This hypothesis is compatible with the intergroup competition hypothesis, because the discovery of fire could well explain the transition to ecological dominance. For all these reasons, it is to be hoped that paleontologists will give us finally some definite answers with respect to the origin of the control of fire.

We have now arrived at a somewhat improved version of Richard Alexander's model (figure 8-1) in which the unknown `cause x' is replaced by at least a hypothetical explanation of ecological dominance and in which the feedback system of causes leading to a runaway selection of moral and intellectual capacities is revealed (see figure 8-6). With this model at hand, we are now able to have a fresh look at the paleontological record. Are there any signs that may show that hominids at some point became increasingly `ecological dominant'?

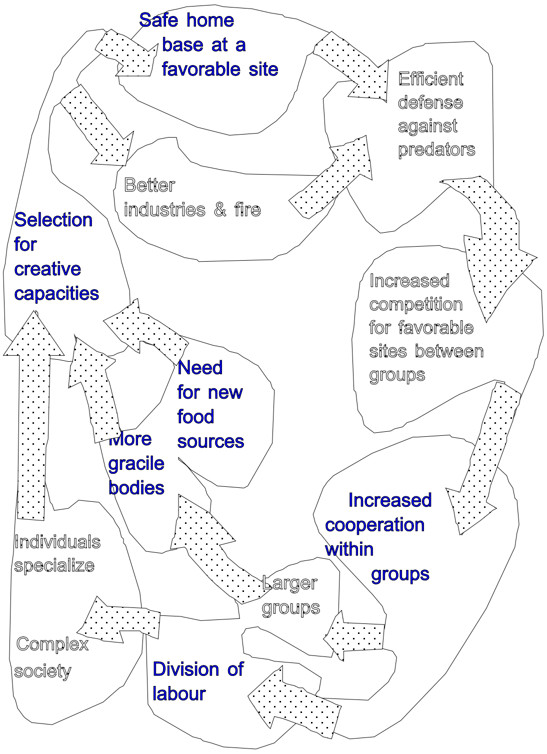

Fig. 8-6. A slightly modified version of Alexander's theory of human evolution.

Extinction of other species. At the moment that some hominids became ecological dominant, their numbers were no longer controlled by predators. Subsequently, we might expect them to increase in numbers, which must have had led to local over-exploitation, which may have led to the extinction of prey animals. Especially at later stages of human evolution, such effects can be discerned. For example, researchers found that at different places people changed their hunting habits with respect to small game. While they were first harvesting easy-to-catch prey, like tortoises and shellfish, at some point (in Israel at 100.000 years ago, in Europe around 30.000 years ago) they turned to species that are much harder to catch, like birds, hares and rabbits. This could indicate that the easy-to-catch prey species were probably in short supply, as a result of over-exploitation (Palmer, 2000). Another example is offered by the effects of mass hunting. In later stages of human evolution, and especially with Neanderthals and modern humans can we discern very clear traces of mass hunting techniques that probably have driven many prey species into extinction (`prehistoric overkill', Martin, 1967). At the same time many large species of mammals go extinct. Although some of these extinctions coincide with climatic changes, it is highly plausible that modern man played a large role in them, because the patterns of extinction coincide with his presence, especially outside Africa. One example of a very fast process of extinction was the extinction of different species of American land animals that coincides with the first Americans, the Clovis people.

Larger groups, more gracile individuals, more hierarchical social structures, higher population densities. There are many signs betraying deep social changes and an increase in group size during the Middle/Upper Paleolithic transition (Pfeiffer, 1983). The very fact that people were more lightly build can be interpreted as an indication that cooperation within the group became more important than the sheer force of the individual. Apparently it was more important to belong to a strong group than to be strong yourself. The appearance of body ornaments (White, 1989) and status burials indicate a compartmentalization of society that can only have resulted from a division of labor and a new sense of hierarchy. An indication of the higher population densities in Cro-Magnon man compared to the Neanderthal is given by the fact that on the central Russian Plain there are only half a dozen known Neanderthal sites, while there are more than 500 Cro-Magnon sites (Pfeiffer, 1983).

A need for new food sources, ultimately resulting in the origin of agriculture. After the colonization of new areas by *Homo sapiens* we often see a succession of food habits starting with big game hunting and ending with agriculture (Martin & Klein, 1985). As the life expectancy of farmers compared to hunter-gatherers actually *decreases* (Cohen, 1987: 269), there is no reason to assume that this series of changes is a result of `progress'. Rather the changes are born out of necessity. As Cohen (Cohen, 1977) shows the discovery of agriculture could have been the result of prehistoric overpopulation. This fits very well in the intergroup competition model, because it shows that modern humans were ecologically dominant and their numbers were not corrected anymore by `external forces'.

In all, while the Sterkfontein research suggests that the relative vulnerability to predators may have been a difference between *Australopithecus* and *Homo*, many signs of ecological dominance are scarce until the appearance of *Homo sapiens* (see Slurink, 1996, for a review on the ecological position of *Homo erectus*). Intergroup competition may have been an important force during human evolution - as testified by some evidence of violence and autopredation in early humans (see below). At the time of *Homo sapiens*, however, we see a whole series of fundamental changes that very clearly show an increased level of intergroup tension.

It is plausible, therefore, to assume that this increased level of intraspecific tensions is linked - via an increase in the need for within-group cooperation - to the sudden acceleration in the evolution of cultural and creative abilities introduced in Europe by Cro-Magnon man. Specifically, an increasingly sophisticated language may have enabled our ancestors to cope with an environment in which old habits of living in relatively small groups had to be abandoned as a consequence of an increasing hostile within-species environment. Paradoxically, a runaway selection for creative and moral capacities may have been the result of within-group arm races resulting from increased between-group arm races. An increase in group size as the result of arm races between groups may have given new reproductive opportunities to leaders that were able to manage such larger groups. Their skills as leaders must have been based on the ability to manipulate the group with symbols and on the abilities to cooperate in networks, to plan forward and to think strategically. The idea is that selection on this abilities happened both within the group at the level of individuals and between groups, in the sense that groups that were better organized were able to gradually or suddenly replace or invade less well organized groups.

Yet, at the moment this is all speculation. In my first paper on this subject (Slurink, 1992), I speculated that only *Homo sapiens* crossed the `ecological dominance barrier'. Alexander, who had to review the paper, retorted that ecological dominance is never a completely absolute concept: there are degrees of ecological dominance. Thus, perhaps we have to design a figure like 8-7, in which different hominid species are ecological dominant to different degrees: apes with cooperating males (e.g. chimps) are more ecological dominant than other apes, for example, and hominids that use fire are more ecological dominant than those without. This could imply that intergroup competition may have been a causal influence already in the evolution of the chimpanzee mind (as suggested by Alexander), but that its role still increased in the hominid lineage. To me, this seems the most plausible idea, but it is also an idea which is rather difficult to test.

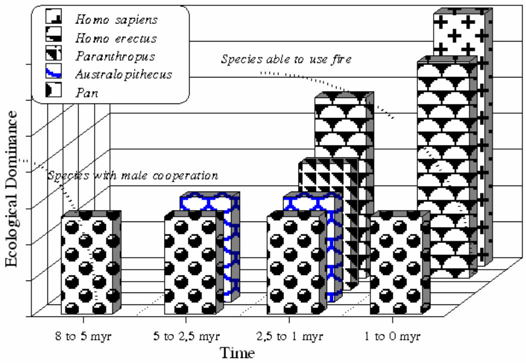

Fig. 8-7. Speculative degrees of ecological dominance in a few homininae. Ecological dominance is inversely proportional to number of individuals killed by predators or parasites.

8.7. COMPATIBILITY OF HUNTING AND INTERGROUP COMPETITION

All this points to the idea that our ancestors were ecologically dominant predators that gradually became more fierceful and thus more dominant over other animals. This means that the hunting hypothesis and the intergroup-competition hypothesis are compatible, but refer to some extent to different phases within the evolution of the genus *Homo*. An increase in parental care and a home base to exchange food and to protect increasingly helpless juveniles can already have been a characteristic of a carnivorous primate like *Homo ergaster/erectus*, although recent research stresses the relatively late origin of the extended youth phase (as we saw, see Mayell, 2001; more research is forthcoming). A situation in which there were no longer other predators powerful enough to cope with *Homo ergaster/erectus* and its protected home bases could have given rise to increased competition for favorable sites and to the necessity to join relatively big and strong groups.

Thus the home base may have played a crucial role during human evolution. During the transition to a lifestyle as hunter it enabled our ancestors to find a place to exchange food; gradually it became more important as a place where children could be reared and protected; but finally, it became itself a scarce resource and the object of competition among different groups. Only this last factor can explain adequately why group sizes in our species seem to be above the optimum with relation to cooperative hunting (Alexander, 1979). Also, only this last factor can explain a tendency to socially respected monogamy.

Pair bonds and reproductive-opportunity rewards in a multimale society. All in all, the pattern that suggests itself is that man started as a predator, but at some relatively late point in prehistory increasingly turned into a warrior. Probably this can help us to explain the typical paradox of a species in which males to some extent mutually respect each other's relationships to particular females. The external pressure of a threat from foreign groups created a situation in which group members became mutually dependent and were forced to extinguish sources of intragroup conflict like conflict over females. There was a need for rules that would curtail an escalation of intragroup conflicts, and a tendency toward `reproductive-opportunity leveling' (Alexander, 1987) would do so.

At first sight the concept of reproductive-opportunity leveling might seem an artificial *deus ex machina*. However, one can find many examples in the anthropological literature that show how it might work. For example, the Mehinaku of Brazil have very outspoken ideas about what it is to be a real man: a real man is someone who is not lazy, who regularly provides food for the people and who shares it altruistically. A real man is also a good wrestler and a strong personality. Anyone who does not fulfill this image is looked down upon by both men and women. The important point is that the women of these disrespected men, as a result of this lack of respect, also deceive them. According to David Gilmore (1993), who uses studies of Thomas Gregor, "the sexual norms of the Mehinaku allow tacitly that a women deceives a bad wrestler. Knowing this, most of these women have adulterous relationships while their husbands are sulking helplessly" (p. 129). The important point is, of course, that a bad wrestler also makes a bad warrior and that the norms of manhood refer to some extent to cooperativeness and potential heroism.

This is even more clear in the Yanomamö. Chagnon (1988) has shown that Yanomamö men who have made the most victims in intergroup conflicts, that is those who are the best killers *(unokais)*, also have the most women. Of course, it would be important to show that cowardice and desertion are also punished and thus that satisfying the norm of the society is the only way to be reproductively successful.

Perhaps these examples show that Alexander's concept of reproductive-opportunity leveling is not entirely correct. Probably it should be replaced by `reproductive opportunity trading' or even by the idea of a `reproductive-opportunity rewards system'. The point is that not just anyone in a society gets reproductive opportunities, but rather, the coalition of dominant individuals rewards those men whom they find helpful or indispensable. We should not forget that the balance-of-power model is not a model of Wynne-Edwardsian group selection, but a model explaining why human societies are characterized by so much moralistic aggression toward noncooperators and why such a relatively high level of cooperation can be achieved among nonrelated individuals.

The idea behind the model of Alexander is that the only way in which a multimale society in which paternity was totally uncertain could turn into a society in which paternity was certain, but in which children were nevertheless safe from other males, was by introducing an extra motivation for males to cooperate. To cite Alexander:

> Prevention of infanticide ... would be a massively important way that a male might help his female and the offspring he sires. Suppose a female begins to restrict her copulations, excluding certain males or excluding all but a single male. In a primate resembling chimpanzees we are justified in assuming that such a female would place her offspring in jeopardy of infanticide by the disenfranchised males within her own group. Because of her loyalty to the male who mated with her, it would profit him to defend her offspring against attack, at least under circumstances where this would not have been the case before, and assuming that his loyalty had some chance of being effective in preventing infanticide. If unity among males is sufficiently important, then rudimentary social reciprocity among males in connection with defense of the group or the `exporting' of aggression ... could cause a male's importance to the group, and the importance of overall amicability among males, to prevent males who could not

> copulate with a particular female from attacks on her offspring or on the male who undertakes to defend them. Obviously respecting the right of the offspring of other individuals or families to exist and go about their business is also part of the social cooperativeness - the moral system - of humans today (1990, p. 32).

As might be expected from an evolutionary perspective, human culture seems to be the coincidental product of a series of cumulative adaptive changes. These may have started as a result of climatological change and ecological instability (Potts, 1996), which forced particular groups of chimpanzeelike HUCHIBO ancestors to open up new food sources, which required new cognitive abilities. Probably the genus *Homo* resulted from a group of australopithecines that no longer was able to retreat into the trees and that became increasingly dependent on meat at the beginning of the ice ages. The birth of helpless children may have stimulated the origin of more or less exclusive pair bonds within the multimale societies of these early humans, although certainly not all authorities agree on this topic and this issue has to be resolved empirically. At some later stage, when early humans became increasingly ecologically dominant, these pair bonds may have been one of the most important requirements of more complex societies because they enabled the origin of a reproductive-opportunity rewards system that allowed the evolution of a complex division of labor within the competing societies. At the same time, these pair bonds may have given the process of sexual selection a new twist, with choices focussing on (for males) residual reproductive capacity and good motherhood and on (for females) good hunters/warriors and good fatherhood.

Anyhow, mutually respected pair bonds in multimale societies are postulated to have been a part of a system which was driven by arms races between these societies. Thus, the `antisocial' force of sex, could become subjugated by the binding forces of a common goal, the defense and well-being of one's own group. All this seems to be reflected in the structure of our own mind, which is to some extent a living fossil, in which often the forces of sexual and social imperatives (but almost never categorical imperatives) clash. There is reason to believe that we would be much simpler, and perhaps much happier, creatures without these internal conflicts.

Human evolution as a multicausal process. The idea that human evolution is a multicausal process could, in principle, be an all-too-easy solution for someone who wants to stay friends to everyone or who has not the courage to draw clear conclusions. On the other hand, however, simple monocausal models of human evolution have a seductive charm, certainly for philosophers since Thales. Would it not be nice if we were able to summarize our understanding of human evolution in a simple formula that one could write down in one's handpalm? Ten years ago I often thought of Alexander's theory as just such a simple model and I asked myself questions about the possibility of a relationship between the size of a planet and the chances of the evolution of complex cultures or the premature death of such cultures as a result of the mutual annihilation of conflicting parties in the arms races required.

I have to admit that I still find such speculations very interesting, but I have become milder with respect to multicausal models. Sometimes it is not unreasonable to assume complex causal sequences and the real challenge is to choose between `Thales' (the mono-causalist) and `Aristotle' (the multi-causalist) in each different case. The complex sequences of actions that are needed for baking a cake or developing a photograph are examples of causal `programs' that overrule (but not transcend) the law of entropy or nature's tendency towards chaos (Slurink, 1991). One needs not to believe in the analogy between baking a cake or creating a human being to believe that human evolution was driven by a complex sequence of phylogenetic and climatological causes. Perhaps the most important insight here is the realization that human beings have never been nature's goal and that all subsequent stages of human beings represented adaptative solutions in their own right. Human beings need to have been bred as simply perfect hunters, perfect gatherers, perfect cooperators/warriors, or perfect lovers, but their natures probably reflect a history in which at different times different skills were crucial, and in which at all times trade-offs existed between the necessity to exercise different skills. Different adaptations may have accumulated as a succession of different deposits and, just as piles of deposits are molded by all kinds of forces in geology, a pile of such adaptations can still be further molded by natural and sexual selection.

The best way to find the causal chains that created humans is to start looking at our similarities with chimpanzees. Like chimpanzees, males in humans do cooperate, hunt, and do compete with males from other groups. An increased level of intergroup competition could well have characterized hominids during all of their history. Yet, it is not unreasonable to assume that only when humans became fierce predators they became fierce competitors with their own kind. It is not unreasonable to link this transition to a more carnivorous habit to climatic change and the growth of African savannas on the one hand and to the one distinctively human characteristic which separates us from chimpanzees on the other hand - which is male-female bonding and the existence of at least some paternal investment. As carnivores are more altricial, need more time to learn, and are often more intelligent than herbivores, an increased meat consumption could thus have initiated a socio-sexual revolution with deep consequences. The resulting extended childhood could have played a role in enabling humans to climb on top of the whole food pyramid and bringing them into competition with their own kind. Thus, we come to a multicausal model which integrates several models at the same time, but which is not simply another piece of oecumenic eclecticism (fig. 8-8)[4].

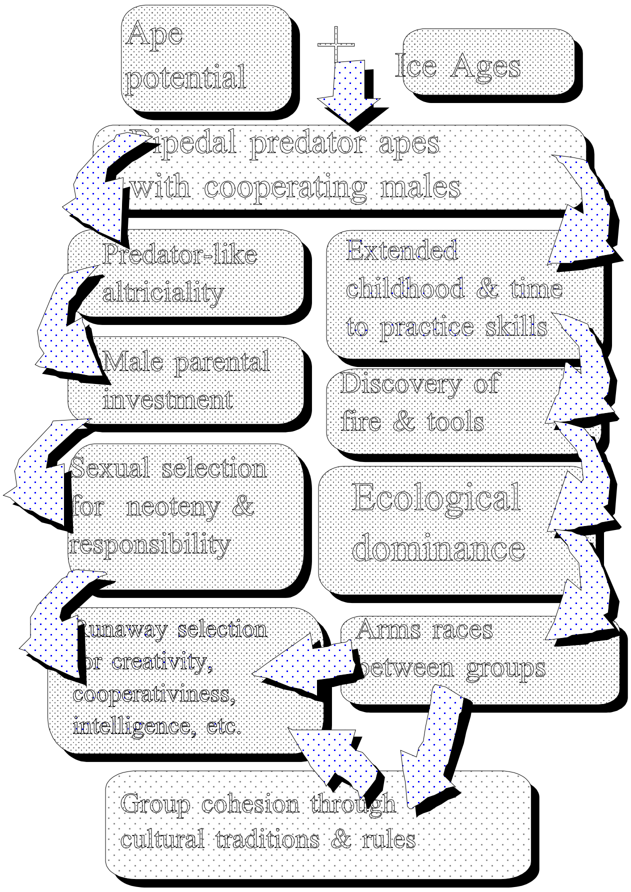

Fig. 8-8. Two or more causal chains may have reinforced each other in producing the bipedal social & culture-dependent predator apes that we are.

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[4] The following sentences from the above mentioned handout show that Alexander, too, believes in multiple causes or is at least aware of the role of all kinds of preadaptations, including group hunting: "Presumably, primates became

8.8. EVIDENCE FOR A LINK BETWEEN INTERGROUP VIOLENCE AND HUMAN EVOLUTION

Beautiful as this multicausal model may be, however, all this would remain speculation without at least some evidence that there really has occurred between-group-competition-induced arms races which have driven the evolution of the human mind. Is there such evidence? As I claimed in chapter 2, one cannot ask for a definite *proof* of theories that refer to the world - one can only show that a particular theory has more verifiability, `robustness' (a consilience of inductions à la Whewell), and explanatory power. These virtues distinguish promising and less promising theories. As many evolutionary epistemologists stress, theories have to compete and their humble proponents are only their temporary hands and brains. Instead of trying to proof my favorite theory, I will just put the weight of the evidence and the arguments on a virtual scale and compare it with the weight of the contra arguments. If I succeed in tipping the balance in favor of the intergroup competition hypothesis, this should cause a paradigm shift in the heads of my readers. What evidence and arguments do we have to place on the scales in favor of the intergroup hypothesis?

1. *The argument based on the necessity of an extra explanation for the evolution of human intelligence and the human brain.* This is a central point for Alexander: the hunting hypothesis simply does not explain enough. Specifically, it does not explain the largeness of human groupings, the extent of human cooperation and the exaggerated nature of human intelligence.

Of course, the weight of this arguments might be matched by a counter-weight if a competing theory would offer a better explanation. The theory of sexual selection does explain the oversized nature of the human mind, but it does not explain that human males often cooperate. Above that, while girls are sometimes impressed by a nice poem or painting, human males (ànd occasionally females) create complex formulas and machines that are hard to evaluate for relative outsiders. Of course, women are impressed by status, but the fact that humans are so hierarchical and tend to live in such big groups still remains unexplained. If sexual selection could explain it all, why would males and females not just live together in pairs and defend territories while gathering the nuts, fruits and roots and hunting the rabbits within that limited area?

Thus, I tend to combine intergroup competition and sexual selection theory. They seem to me not mutually exclusive, but even complementary to some extent. Even in chimpanzees hunting and raiding into foreign territory is a loaded with sexual interests, because the good hunters can preferentially share meat with fertile women and if a group succeeds in absorbing another group, the dominant males have obviously more females to choose from. At the moment that our ancestors became increasingly dependent on the supplement of meat to their diet, a trade based on sexual opportunities and meat could evolve into a trade based on paternal certainty and paternal investment. If a group of males could suppress the rivalry among themselves by some degree of reproductive opportunity

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evolutionary primed for the production of species likely to give rise to trajectories like those of apes and humans because of a arboreal existence, leading to stereoscopic vision, hands, and eventually a relatively complex mentality and social life. Humans and chimpanzees are also included among the few carnivorous primates, a behavioral tendency that aids group cooperativeness when group hunting accompanies it, and probably sharpens mentality in ways that contribute to success in some kinds of social competition" (Alexander: handout).

levelling, they could both hunt larger prey and dominate larger domains. This would reinforce a system of pair-bonding in which females would be torn between good hunters/fighters and good fathers and in which mutual sexual selection would become complex enough to favor relatively oversized brains.

2. *The argument based on the relatedness of humans and chimps.* Both species are clever machiavellists, have `demonic', cooperating males, which cooperate-to-compete (in the words of Bigelow) and even know `war' in the sense of the intentional crossing of territorial borders, motivated by some kind of aggression. Goodall gives a description of the Chimpanzees patrols that have crossed a territorial border:

> Chimpanzees taking part in patrols tended to travel in close compact groups. Travel was silent, with frequent pauses to look and listen. Often an individual stood bipedally, to see over the tall grass or stare down into a valley or ravine ahead. From time to time the party stopped and sat silently, watching and listening: sometimes they climbed into a tree; at other times they sat, often within arms reach on some ridge overlooking a neighboring valley (cited in Eibl-Eibesfeldt, 1995: 457).

If such patrols meet `foreign' chimpanzees, they will start to threat and to impose at them or throw stones at them. If the `enemy' does not withdraw, lethal aggression will occur. Males will run forward, screaming and barking, and they will kill or attempt to kill whatever `foreign' chimpanzees they meet, including females and children. Goodall even describes how two males start eating an infant while it is still alive. As a result of such aggressive encounters, a strong group can gradually exterminate a weak group (see also Goodall, 1986). Competing theories cannot ignore this striking similarity with human imperialism and should be able to answer the question why such similarities appear.

Of course, it has been attempted to argue that both human and chimp warfare is the exception rather than the rule as it has been argued time and again that prehistoric or `primitive' peoples were/are living peacefully. The idea of peaceful primitive societies is as old as humankind and even after it has been criticized time and again as a myth (for example by Bigelow, 1969; Eibl-Eibesfeld, 1984, 1995), it re-emerges each time in different guises. For example, the anthropologists Knauft argues for "a U-shaped evolutionary trajectory of selected features of human violence", which disturbs the analogies between apes and man. It is shown by van der Dennen's *The Origin of War* (1995: especially chapter 7), however, that peace in humans is a complex phenomenon, which results from complex political and ecological choices. In other words, peace is a choice in the context of the possibility of war. Van der Dennen has collected data on relatively peaceful societies for more than fifteen years, but does not see their existence as a falsification of the similarities between man and chimpanzee. `War' (intentional raiding into foreign territory) in both chimps and man is a `male coalitional strategy', but we are not necessary living in wartime all the time. Rather, peace is "an adaptive response to particular political ecologies" (Van der Dennen, 1995: 537).

3. *The paleontological evidence for intergroup competition during human evolution.* There is good reason to believe that the `U-shaped evolutionary trajectory' of intergroup

aggression refers in reality to our Unknown past or to our general Ugnorance. Let me give some extra evidence.

a. Indirect evidence: cannibalism. In my papers, I refer to cannibalism as a sign of intergroup competition. Cannibalism need not to have been absent, the invention of pathological imagination or the result of a pathological condition. In the animal kingdom, cannibalism is a widespread phenomenon which arises in a variety of contexts. In insects and spiders it is sometimes part of a mating system in which the residual reproductive capacity of males drops after mating. In many owls and birds of prey, the youngest `reserve' chickens are eaten by their older siblings when there is not enough prey to feed them all. Many predators also occasionally feed on their conspecifics simply as a consequence of the difficulty or disinclination to distinguish them (1% of Goshawk prey are other Goshawks). In a series of species, including large carnivores such as hyenas, lions, and leopards, cannibalism seems to be an accidental by-product of overpopulation and ecological dominance. It would be interesting to know who is eating who in such species, specifically whether members of groups do sometimes eat other group-members. Goodall (1986) mentions six cases in which infant chimpanzees were seen to be killed and/or eaten by other chimps, but only three of them were members of other groups (1986: 284). In humans, cannibalism directed at babies or deceased group-members seems sometimes linked to a difficulty to obtain other kinds of meat (the book of Lamentations records that after the fall of Jerusalem in 587 B.C. "mothers, full of tender care, cooked their own children into food in their need, at the ruin of my people", Lam. 4: 10). Thus, cannibalism is not necessarily rare, but it is neither necessarily linked to intergroup competition.

Yet, in many primitive societies cannibalism is clearly directed at members of other groups and often it is thought that one can obtain the spiritual power of the enemy by eating the contents of his skull or by eating the heart (Hurons). In the cannibalistic empires of the Toltecs, Mayas and Aztecs it were prisoners of war that were ritually slaughtered at a daily basis and the flesh was probably used to reward the warlords (Harris, 1977).

Formerly, one needed only to find a broken skull or a skull missing its base to conclude that early humans, too, were head-hunters and cannibals. Von Koenigswald, for example, writes about the `head-hunters' of Ngandong (Von Koenigswald, 1956). In the mean time, however, Binford has come and archaeologists have become reluctant to jump to such conclusions: aren't there always alternative explanations, whether hyenas, watertorrents or other biological or physical forces which can break a skull in some way? Nowadays one has to find almost the `the smoking gun' (or a smoking campfire with charred hominid bones) to justify a claim about cannibalism.

It is also in this critical spirit that one should place Paul Bahn's review on cannibalism in the *Cambridge Encyclopedia of Human Evolution* (1992), which also forms part of the critical discussion of the evidence in Hans van der Dennen's *The Origin of War* (1995). Bahn argues that the few real cutmarks that have been found (he mentions that Krapina Neanderthals) could result from mortuary practices in which bodies are left to decompose and are finally defleshed before being buried. One can point in this context to the habits of the Australian Aborigines, but also to mortuary practices of the inhabitants of the oldest city, Catal Huyuk in which even vultures were used to deflesh the death. He also points out that the Neanderthal skull in a `ring of stones' found at Monte Circeo simply was a hyena den in which a ring of stones resulted from a land slide.

In a recent review, Tim White concludes that nowadays even cutmarks on the skull alone are not considered definite proof, which is probably the reason that he does not even mention the Bodo skull, a *Homo heidelbergensis* skull which shows clear signs of deliberate defleshing according to himself (White, 1981). It has at least to be clear that forceful hammering was used to reach the nutritionally valuable tissues to exclude the alternative hyena-hypothesis. In general one can say that the patterns of cutting, chopping, hammering and burning has to match the hypothesis of the intentional defleshing of a body that is not already rotting.

Yet, White argues that even given such extreme high standards of evidence, cannibalism *can* be attributed to ancients humans, and, according to White, its frequency is striking (White, 2001: 53). While Bahn still argues that definite evidence for cannibalism has never been found, White cites research in which human myoglobin has been found in cooking pots and in human coprolites (of the Anasazi in Colorado). Apparently the accumulation of such evidence in recent years has again tipped the scales in favor of prehistoric cannibalism. According to White, *Homo antecessor*, found at excavations near the Sierra de Atapuerca of Northern Spain dated at about 800.000 years ago, certainly was a cannibal, as was *Homo neanderthalensis* in Krapina (Croatia) and Moula-Guercy (France) and *Homo sapiens* in several young sites in Northern America (White, 1992; Defleur *et al.*, 1999; White, 2001). It was in these last sites, which are only 900 years old, in which a habit of preparing human flesh in cooking pots was demonstrated. Apparently, the meso-american states did not invent cannibalism, but it was already a widespread practice in prehistoric times.

Given the combined evidence of ethnography, history, and archeology, the `weight of evidence and arguments' are thus gradually tipping the scales in favor of prehistoric cannibalism again, but now in an intellectual climate in which the standards of evidence are very high. Currently, according to White "it remains much more challenging to establish why cannibalism took place than to establish that it did" (2001: 55). Given the fact that hominids are *K*-strategists which require a enormous energy to raise, given the value of males in defending their offspring, and given the intelligence of hominids, some forms of cannibalism are extremely improbable. Apart from the incidental consumption of beloved ones in times of extreme scarcity, intergroup competition is the most likely context of cannibalism in hominids. In an environment saturated with ecologically dominant predator apes such apes will occasionally turn to other kinds of flesh, as do all predators at times. Given their talent for intergroup competition, such apes will also increase their raids in foreign territories. If both strategies are combined, of course, one can kill two birds (or other predator apes) with one stone. Cannibalism simply is such an efficient way of overcoming overpopulation that it would be unlikely that it would never be rediscovered by predator apes with so many chimpanzee genes (the six cases of infanticidal cannibalism in chimpanzees reported by Goodall were all observed by humans and thus tips of the iceberg).

It should also be reminded that during long periods of prehistory, there existed more protohominid species at the same time. It is not unreasonable to assume that, for example, Neanderthals sometimes stole a *sapiens*-baby or *vice versa* (as chimpanzees occasionally hunt on baboons, or, in two cases, did attack human children, Goodall, 1986: 282). Such attacks may have inspired `preemptive' strikes by *sapiens*. Such scenarios are as far as I know purely speculative, but that does not mean that they are unlikely or untrue. After all, given the relative short time of their coexistence, somehow *sapiens* must have played a role in the extinction of the Neanderthal. It is much harder to link the extinction of the robust australopithecines or *Paranthropus* with the spread of *Homo erectus*, because they were not competitors with respect to food.

b. *Direct evidence: bones & art.* Of course, to prove intergroup competition in prehistory, evidence for cannibalism is not enough. We need much more direct evidence, and given the scarcity of fossil material and the critical attitudes of modern archaeologists, this will always be very hard. Yet, Lawrence Keeley has succeeded in his *War before Civilization* to collect an impressive series of examples which goes far beyond the data that I have mentioned in the papers above. Keeley discusses, for example, the extraordinary high number of injuries and breakages in Neanderthals, which he however does not find conclusive. He then goes on:

> Whenever modern humans appear on the scene, definitive evidence of homicidal violence becomes more common, given a sufficient sample of burials. Several of the rare burials of earliest modern humans in central and western Europe, dating from 34,000 to 24,000 years ago, show evidence of violent death. At Grimaldi in Italy, a projectile point was embedded in the spinal column of a child's skeleton dating to the Aurignacian (the culture of the earliest modern humans in Europe, ca. 36,000 to 27,000 years ago). One Aurignacian skull from southern France may have been scalped; it has cut-marks on its frontal (forehead). Evidence from the celebrated Upper Palaeolithic cemeteries of Czechoslovakia, dating between 35,000 and 24,000 years ago, implies - either by direct evidence of weapons traumas, especially cranial fractures on adult males, or by the improbability of alternative explanations for mass burials of men, women, and children - that violent conflicts and deaths were common. In the Nile Valley of Egypt, the earliest evidence of death by homicide is a male burial, dated to about 20,000 years ago, with stone projectile points in the skeleton's abdominal region and another point embedded in its upper arm (a wound that had partially healed before his death) (Keeley, 1996: 37).

Keeley then goes on to discuss a series of more recent examples, including the human skeletons found at Gebel Sahaba, in Egypt, a site which is thought to be 12,000-14,000 years old. From his report I learn that the cemetery has been used over several generations. "Over 40 percent of the fifty-nine men, women, and children buried in this cemetery had stone projectile points intimately associated with or embedded in their skeletons." Above that, twenty of the adults had multiple wounds, and the wounds on children were all in the head or neck. The excavator estimated that more than half the people buried there had died violently (see also Wenke, 1984: 285, Klein, 1989, and Wendorf *et al.*, 1970).

According to Keeley both the Mesolithic and Neolithic must have been periods full of conflict, given the archeological evidence. He mentions, for example, the Ofnet Cave in Germany in which "two caches of `trophy' skulls were found, arranged `like eggs in a basket', comprising the disembodied heads of thirty-four men, women, and children, most with multiple holes knocked through their skulls by stone axes" (Keeley, 1996: 38). He also mentions two mass killings from the Neolithic, one in Germany (Talheim, ca. 5000 BC, 34 persons killed by at least 6 different axes) and one in France (Roaix, ca. 2000 BC, more than 100 persons killed by arrows). Keeley summarizes his finding by claiming that "the archeological evidence indicates ... that homicide has been practiced since the appearance of modern humankind and that warfare is documented in the archeological record of the past

10,000 years in every well-studied region" (Keeley, 1996: 39; Van der Dennen, 1995; see also Louwe-Kooijmans, 1990, on an excavation in the Netherlands of a group of prehistoric people apparently all killed at the same time).

Archaeologists since Binford have, of course, been right in being very critical about all kinds of evidence for violence and cannibalism. Yet, it is wrong to assume that they are so keen about finding evidence for violence that they are inclined to overinterpret their data. A good example of this is offered by Ötzi, the 5300 year old man from the glacier at the Austrian-Italian border. First it was assumed that Ötzi had simply died from the cold, but recently (june, 2001) an X-ray has been done from a different angle and a spear-point was found in his left shoulder-blade (Van Loon, 2001). Ötzi is an example of an extremely well-preserved person. One wonders how often archaeologists miss the real cause of death of one of our ancestors.

Art. Another source of direct evidence of prehistoric warfare is offered by participants or observers themselves. It consists of prehistoric drawings or paintings of intergroup conflict. It appears that these are relatively seldom, as realistic portrets of humans are. As prehistoric art was probably not intended to picture the world realistically, but was probably linked with totemism, hunting magic, ritual or education, one can hardly expect that it directly answers our questions. After all, changes are small that from all his work precisely Picasso's *Guernica* will be found in the year 20.000 or so. Yet, even the small sample of books that I am able to consult yields several examples of prehistoric paintings of intergroup competition.

1. While I do not find examples of franco-cantabrian rock art depicting intergroup conflict in the best article on this art that I can find (Breuil & Berger-Kirchner, 1961), rock art from the Spanish Levant contains several hints to intergroup conflict (Bandi, 1961). An old predecessor of Guernica comes from a cave near Morella la Vella, Castily, Spain. I have tried to redraw it with my mouse (fig. 8-9). It depicts a battle between two groups of archers that apparently carry a basket with arrows on their back in two cases. Other paintings depict a group of warriors, an execution, and a warrior hit by arrows (Bandi, 1961). Of course, one can discuss the meaning of some of these individual paintings: the warriors can be dancers, the wounded warrior could be victim of a hunting accident (Van der Dennen, 1995: 210). Yet on the whole there seem to be enough paintings that justify the conclusion that violence and war was not unknown to the painters.

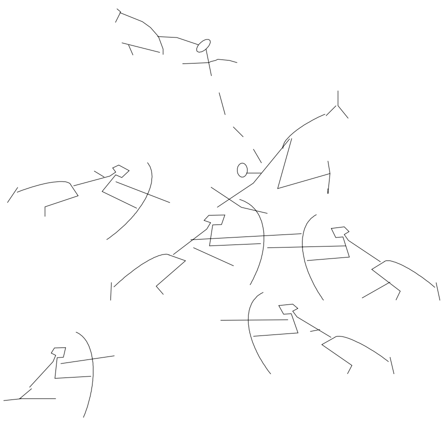

Fig. 8-9. Fight between two groups of archers as depicted in a cave near Morella la Vella, Castily, Spain. Redrawn with computer mouse.

2. While European rock art is wellknown, there is much more African rock art which stems from a period from 20,000 to very recent. Gowlet (1993: 144) shows a picture of intergroup conflict with warriors carrying bows and arrows from Cape Province, South Africa, dated between 8,000 and 3,000 years ago. Eibl-Eibesfeld (1995: 461) shows a photograph taken by himself of an apparently old Bushman painting on a rock found near the farm `Godgegeven', Warden, South Africa, on which we can see relatively gracile Bushmen with spears and perhaps bows and arrows fighting a more robust tribe carrying handaxes. He has also shows a picture from a somewhat more sophisticated painting, dating ca. 4000 BC, in which two groups of warriors fight each other with bows and arrows, one of them

apparently trying to prevent the other from stealing their cattle. Other examples are mentioned in Van der Dennen (1995: 209-211).

3. Van der Dennen (1995) also reproduces on its cover a photograph of an at least 10,000 year old rock painting from Australia. The paintings are from a collection of battle scenes painted on rocks by northern Australian Aboriginals from Arnhem land, dating from 6000 to 10,000 years BP.

> In the earliest works male `dynamic' figures are shown in combat, carrying large spears, hurling boomerangs, dodging spears and chasing one another with raised weapons. Some figures have spears sticking out of their bodies while others are bending down to help fallen comrades. Scenes produced some 6000 years ago show more `modern' weapons such as spear-throwers and three-pronged spears. They also portray more numerous and larger battles involving leaders with special headdresses and dozen of warriors. Most earlier works depict small skirmishes or one-to-one contests (Van der Dennen, 1995: 211).

It seems to me that all this evidence together gives us good reason to believe that there is not necessarily such a thing as a `U-shaped evolutionary trajectory' of intergroup aggression. I am much more inclined to draw a straight line between chimpanzees and us and to hypothesize that a tendency to form male coalitions has existed all the time, while from time to time there have been ecological circumstances which promoted an increased level of intergroup competition. The fact that cannibalism has been documented in *Homo heidelbergensis* and even in *Homo antecessor* could support this view. To me, it seems that there are two further arguments which support a view in which violence is part of the human condition.

4. *The argument based on current human psychology.* One of the presuppositions of - or `ideas behind' - evolutionary psychology is that the structure of the human mind is not a kind of *tabula rasa* which is filled in by the specific culture that is prevalent at some point in time, but that it is an old and sometimes very specific and detailed questionnaire designed by evolution. In that questionnaire a large number of questions is already filled in by genes and hormones even before one's birth, another large number of questions is filled in by genes and socio-ecological circumstances during one's entire lifespan, and the remaining questions have to be answered with an already specialized brain belonging to a specific sex-age class, fighting for its position in a specific social dominance system, carrying the load of a specific history of socio-sexual success and failure. To put is simply, the human mind is old and specialized as a result of a long evolutionary history. It is probably even too simplistic to call it a `stone age mind', because many modules of the mind are probably older than the stone age. It is therefore very sensible to study the great apes, because we have probably more in common with them than we are inclined to realize. The fact that chimpanzees are political animals that continually build coalitions, that ostracize particular individuals that have harmed the current coalition, that can conspire against `enemies', etc., instructs us to look beyond the stone age. We are the reincarnations of an old race which has recently been upgraded, but still carries the marks of its history.

Social psychologists have designed a series of studies that demonstrate that humans are inclined to identify themselves with a group that labels itself in contrast to other groups. Of course, one can do such experiments oneself, for example, by carrying binoculars or by citing Nietzsche, which will immediately attract members of virtual clan of people with common interests. Social psychologists, however, have conducted controlled experiments in which artificially groups of boys were formed that, although they were formed *ad random*, soon started to form their own `culture' and dominance hierarchies. Here is how Oatley and Jenkins describe part of an experiment of the psychologist Sherif:

> In Phase III the investigators moved to studying relations between groups. They arranged a tournament of competitions between the two groups, the Bulldogs and the Red Devils, including tug-of-war, football, and baseball, with cumulating points and coveted prizes of camping knives for every member of the group that got the most points. Success of one group would mean failure for the other. At this point - though not before - boys started to make distinctions between `us' and `them'. Accusations and name-calling began between the groups. Fights between members of one group and the other started to occur. Frustration increased angry attitudes and actions towards the outgroup. A proud self-glorifying attitude arose. Each group believed itself to be strong and fearless - each individual believed himself to possess all the strengths of the whole group. While an affectionate, interreliant attitude was present within the ingroup, the outgroup was seen to have very negative qualities (Oatly & Jenkins, 1999: 306).

In the first real textbook on evolutionary psychology that I know of (Buss, 1999), the possibility of a human `talent' for male cooperative fighting and a human `talent' for homicide is discussed seriously. At a purely theoretical level, Buss shows that it could be adaptive to form coalitions to raid a neighboring tribe, even though this includes the risk of dying. Of course, one has to assume that engaging in warfare has reproductive advantages. One only has to remember the Yanomamös and the dutch children born from our Canadian liberators in world war II to see that this assumption is not as weird as it may seem. In the Yanomamös a significant percentage of women is captured in raids. But even in modern times, women tend to be attracted to uniforms (my wife claims to be an exception) and, especially, to winners.

In an attempt to find the `logic behind warfare' and to explain the fact that men risk their lives in the decision to engage in warfare, Buss argues as follows:

> Suppose ten men form a coalition to raid a neighboring tribe. During the raid, five fertile women are captured. If all of the men survive, then the average gain sexual access is .50 of a fertile woman per man (five women divided by ten men equals .50 average per man). Now suppose five of the men die in the battle and the same five fertile women are captured. Now the gain for each of the five surviving men is a gain in sexual access of 1.0 fertile woman (five women divided by five men equals 1.0). The *average* gain across all the men who went into battle, however has remained unchanged at .50 (five women divided by the ten men who went into battle still equals .50). In other words, the average reproductive gains of the *decision* to go into battle are identical across the two conditions, even though in one case no men died and in the other five men died (Buss, 1999: 302).

Of course, a lot of other factors are involved, which have varied throughout history, for example: the very fear that the other tribe will strike first, the value of the land that is conquered, the value of the resources that are conquered, the risk of death (which is small currently for an American soldier in Iraq or Afghanistan), the consequences of desertion, the internal power relationships within the tribe, kingdom or state itself which may result in the need of an enemy, the possibility of kings, presidents, and generals to stay safe themselves, and currently even the economic value of factories producing arms. Evolutionary psychology does not deny all that. If war is, however, as old as humankind, it is not unreasonable to look for mechanisms in the mind that enable people to make optimal decisions in wartime. This is what Buss tries to do (in the footsteps of Tooby and Cosmides). He points, for example, to studies that indicate that men, in contrast to women, do frequently assess their own fighting ability, that gang membership pays in terms of sexual opportunities, not only in the Yanomamös, but also in American inner cities, that men hate traits in other men that make them more likely to desert. Of course, much more of those studies can be expected in the years to come. It seems to me, however, that there are already many indications that men have a tendency to form coalitions against other groups of men. It is surprising how eagerly people identify with their own sportsclub, their own profession, their own way of life. One only has to look what people do on a sunday afternoon: the very fact that a significant portion of them delights in watching two groups of young men in a ritualized fight should awaken all those thinkers who see prehistory as a time of peace and harmony.

5. *The argument based on the current omnipresence of human war, genocide and genosorption, and their role in the `progress' of human civilization.* With that we come to the last argument. It is an argument which may not be decisive `objectively' - if something like that exists-, but which is decisive for me personally. The omnipresence of war and violence makes it very artificial to assume that it is purely a cultural artifact, which has arisen during historical times or just before history. For some reason, few assume that there was no sex and love before there were poets to write about it, but many assume that there were no wars before there were journalists. Even after a century of almost continuous war and genocide, the humanistic myth that man is `naturally good' still lives on.

Take the question placed central by *Amnesty International*: "Why do we kill people who are killing people to show that killing people is wrong?". The answer, of course: nobody kills for that reason. People kill people not to show that killing people is wrong, but because they feel threatened, hindered or hungry. There are even people who kill because it gives them a kick to do so. Given the fact that homicidal fantasies are in fact quite common among men (Kenrick & Sheets, 1993) and that chimpanzees may even murder formerly friends (e.g. De Waal, 1988), it is not unreasonable to ask the question, as Buss does, whether specialized homicide modules should be postulated (Buss, 1999: 306-09).

For the intergroup competition hypothesis such modules and even a regular repetition of outright genocide is not necessary, however. More important is it to show that arms races are often the motor behind `progress' and solidarity. Good examples are not hard to find. Take the stimulus that world war II had on the development of computers, information technology, and countless other disciplines. Take the race between America and the Soviet Union to be the first to put a man on the moon. Now that America has lost communism as the `enemy' that gives a boost to its self-confidence, identity and solidarity, it has finally found a new enemy in the form of `terrorism' (I do not claim that it is not an enemy, I only claim that an enemy is good for the mutual solidarity within a society). On the other hand, muslim fundamentalists seem to need `America' as an enemy for exactly the same reason. The spirit of antagonism seems to form a part of human nature[5].

Another point that seems necessary for the intergroup competition hypothesis to work is that it pays to be part of a people that is victorious. As I have pointed out before, whether group selection via outright sex-indifferent genocide is more common than male-directed genocide (coupled to female-directed slave-making) and the process called genosorption by Wilson is uncertain. Maybe the nazis planned genocide in the twentieth century, but even they had their `fun department' in their concentration camps as a result of which some young, beautiful and fertile women survived. Genocide `according to Mozes' (who advises to save Midjanite virgins in Num. 31: 17-18), selective slave-making and genosorption `according to Caesar & co', has probably been a more common practice. If we look at the effects of invaders on the fertility of resident peoples, for example in the case of the Australian aboriginals and American indians, it becomes obvious that what counts is not purely a matter of war casualties, but above all the sheer number of babies that a people is able to raise if their land is taken over. What counts is not only who outnumbers who on the battle field, but above all who outnumbers who in the nursery. A socially not very successful Australian or American may have more children than a very wise aboriginal or an indian chief.

If this would be the case (which would require a careful demonstration on the basis of available numbers) it would show that it has advantages to belong to a strong, successful group. Selection at the individual level would have favored individuals who succeed in becoming and staying part of successful tribes by making themselves beloved, deserving, or even indispensable. It seems that this mechanism, coupled to sexual selection directed at `winners', can explain the kind of altruism and heroism that group-selectionists claim to explain, if not the whole gallery of supposedly-uniquely-human virtues from creativity to analytical intelligence.

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[5] In this context, I am reminded of Sheldon, who found that the somatotonic component in human characters were exactly the `war making characteristic': somatotonic thinking is thinking in terms of antagonisms, dualisms, etc. As I said before, Sheldonian characterology deserves new studies.

* Epilogue *

> One of the key questions ... is to what extent the biogram represents an adaptation to modern cultural life and to what extent is a phylogenetic vestige. Our civilizations were jerry-built around the biogram. How have they been influenced by it? Conversely, how much flexibility is there in the biogram, and in which parameters particularly? Experience indicates that when organs are hypertrophied, phylogeny is hard to reconstruct. This is the crux of the problem of the evolutionary analysis of human behavior.
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> E.O. Wilson, 1980 [1975], 272

> In the face of all Darwinism, man represents the triumph of an animal that is unadapted and unadaptable. Without doubt he will constantly achieve partial adaptations, but each one of them serves him for a new adaptation. But an animal at once unadapted and continuing to live is, from the zoological point of view, a sick animal. Hence, without taking it now as a formal theory, but rather as merely an anti-Darwinian, although evolutionist, myth, which tries only to orient our intuition concerning how things could happen, we can imagine human origins like this: ... imagine man as a sick animal, suffering an illness which I will call *symbolically* malaria because he lived in infected swamps. And that illness, which did not succeed in destroying the species, caused in him an intoxicitation which produced a cerebral hyperfunctioning; this was the origin of a consequent excessive growth of the cerebral organs which brought with it, in turn, a greater degree of mental hyperfunctioning, the result of which was that man was filled with images and fantasies - in which, as is well known, even the superior animals are so poor; that is to say, he found himself with a whole imaginary world, therefore an interior world, which the animal lacks; an interior world confronting, separate from, and opposing the exterior world. And from then on, this last beast which is the first man has to live at once in two worlds - the one inside and the other outside - and therefore be irremediably and forever maladapted, unbalanced; this is his glory, this is his anguish.
>
> Man is a fantastic animal; he was born of fantasy, he is the son of `the mad woman of the house'. And universal history is the gigantic and thousand-year effort to go on putting order in that huge, disorderly, anti-animal fantasy. What we call reason is no more than fantasy put into shape. Is there anything in the world more fantastic than that which is the most rational? Is there anything more fantastic than the mathematical point, and the infinite line, and, in general, all mathematics and physics? Is there a more fantastic fancy than what we call `justice' and the other thing that we call `happiness'?
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> J. Ortega y Gasset [1948-49] 1973, 247-248.

It is time to come back to some of the `classical philosophical problems' which I mentioned in the introduction. With all due respect to the classical philosophers, we have come much closer to solving these problems than would be possible by reflection and conceptual analysis only - and without the contribution of evolutionary theory and the research that it has generated. Philosophy and human scientists alike can no longer neglect Darwin's intellectual dynamite - and cement - and the necessity to solve philosophical problems within the wider frame-work of scientific researching, model creating and puzzle-solving. The antithesis created by thinkers of the twentieth century, including Ortega y Gasset, between `Darwinism' and the concept of human uniqueness no longer holds: human uniqueness can be understood within the framework of evolutionary theory. Humans are unique *as a result of* their unique evolutionary trajectories and their uniqueness itself is thus not unique: man is `another unique species' (Foley, 1987), product of ordinary evolutionary processes, although it must be admitted that intergroup competition may be a somewhat unusual process and although we have to admit that there is still a lot unclear about our descent. That, too, is a reason to cite Ortega: he remembers us that a Darwinian explanation of human origins will never be easy, although it is much more than pure mythology, and although there is no reason for despair given the number of fossils that are found almost continually and given also the theoretical progress that is made almost with the same speed.[1]

Thus, let us look what we have got so far and have a look, again, at the list a `fundamental philosophical problems' presented in the introduction.

- *The problem of purpose and goal-directedness*. This is what Darwinism has solved in the very first place. The goals and ends which are abundant in nature and which have been explained by a variety of metaphysical philosophies are postulated by Darwin to be emergent properties of systems that have been designed by a process of trial and error or variation and selection. Thus, Darwinism does not equal a physicalistic reductionism in which there is no place for purpose. It is, however, based on an `*evolutionary* reductionism' in which all ultimate ends and goals have been `tested' by natural selection. An organism that would be designed *exclusively* to write beautiful operas would soon go extinct. That does not mean that an organism writing beautiful operas will go extinct, but that one would expect that a goal like writing beautiful operas can be traced back to other, more fundamental, goals. There are good reasons to expect an overwhelming majority of goals and ends in nature that delay or evade extinction. Of all possible goals and ends, most will directly and indirectly cluster around survival and reproduction.
- *The problem of human uniqueness*. While Darwinism holds that all goals are natural phenomena, it contends at the same time that there is no metaphysical barrier between man and other species. As I have tried to prove in chapter 1 and at several other places throughout this book, this claim has gradually found a solid foundation in all kinds of ethological studies. Many characteristics that once were thought to be uniquely human have now been found in other animals, at least in a rudimentary fashion. Consequently, most researcher now have chosen for the working hypothesis that those characteristics of man, which are (relatively) unique, have probably not arisen as a result of a unique process, but as a result of the same process of variation and selection that has molded the unique characteristics of all other species as well. In part III we have explored the possibilities of this working hypothesis, for which there seems to be no serious alternative.
- *The problem of knowledge*. If one assumes that humans are neither unique nor products of a completely unique process, it is reasonable to relate the phenomenon of human knowledge to information processing systems within other mobile organisms. If one assumes that human knowledge and animal knowledge have a common origin, philosophical skepticism becomes a rather implausible assumption. The same goes for epistemological monism or foundationalism - that is a doctrine in which one aspect of knowledge (sensory input, reasoning, hermeneutical interpretation) is placed beyond all other aspects as the only infallible source of truth. Both skepticism and monism/foundationalism seem to arise from an insufficient awareness of the fact that knowledge evolved to orient organisms in

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[1] It is a pity that Ortega did not study Darwinism deeper, because his *The task of our time* (*El tema de nuestro tiempo*, 1923) is in some aspects so close to an evolutionary naturalism.

their environment. Complex animals are often able to construct an image of their environment on the basis of sensory input from a variety of canals - an image that at a minimum should at least reflect some properties of the real environment to enable the organism to make adequate adaptive decisions in it. If one realizes that all knowledge has both to orient and to incite to adaptive action, both the strengths and weaknesses of the evolved knowledge apparatus become apparent. The adaptive interpretation of the knowledge apparatus thus offers an extra way of evaluating its reliability - supplemented with other ways we thus come to a mature, encompassing theory of knowledge, which is able to transcend traditional dichotomies such as those between empiricism and rationalism, subjectivism and objectivism, idealism and realism. The only sensible overall conclusion of such an evaluation seems to be that the knowledge apparatus is neither completely at loss in this universe, nor completely infallible. Within the realm of everyday live, we have to stumble on with it, occasionally hitting one of its limitations, just as one would expect of an apparatus designed by variation and selection. Within the domain of science, we can to some extent criticize aspects of the ways in which it represents the world, but such criticism is always based on an overall thrust in its pretension to give access to the world.

- *The mind-body problem*. If we assume that minds evolved to guide organisms through a complex environment, we are also much closer to a solution of the mind-body problem. Of course, not every aspect of this problem can be `solved' so easily, but we can exclude a series of positions. For example, simple epiphenomenalism, according to which mental phenomena are purely nonfunctional by-products, becomes implausible. In the words of one of the first evolutionary psychologists, William James "If pleasures and pains have no efficacy, one does not see ... why the most noxious acts, such as burning, might not give thrills of delight, and the most necessary ones, such as breathing, cause agony" (James, 1890: 144). The same goes for a dualism in which the mind has its own causal circuits, making their own calculations which then are subsequently sent to the body which executes the minds decisions passively. Such positions simply do not fit within the kind of evolutionary naturalism which arises in the wake of the Darwinian paradigm. From a Darwinian perspective one would expect the most striking properties of the mind to follow from a design ultimately directed at survival and reproduction. We can, thus, start asking a series of functionalistic questions:
  - First, why would the mind evolve? The mind seems the product of the need for the centralization of information within increasingly mobile animals (the first ones which showed this centralization being the modest flatworm).
  - Second, why would the mind represent `external' phenomena? To orient, to supply a kind of `map' to allow route planning, etc.
  - Third, why would the mind follow its own logic? Because its goal is *to guide* in function of the goals of the organism. Ultimately its own goals are thus more important than the objectivity of its representation of external phenomena.
  - Fourth, why do organisms need subjective experiences of the world? Because it is probably the essence of subjective experience that it is information that cannot be neglected and that is urgent. Subjectivity, then, would be the form in which the urgency of information and the necessity of adaptive action is installed and incarnated within animals.

Within this view, even the *way* in which an animal experiences its world would be an adaptive phenomenon. All experiences, from pain to pleasure, are orchestrated within the experiential `theatre' in such a way that adaptive decisions arise from it *spontaneously* - I use this word, because the alternative word `automatically' would neglect this very experiential dimension. In chapter 3, I have also compared consciousness to a `dash-board', because dash-boards are clearly *designed* in a functional way to enable and facilitate fast and adequate reactions. Consciousness would then be a kind of circular dashboard through which the organism not only views the world, but also itself.

Is the `problem of consciousness' `solved' this way? No, because metaphors are always inadequate and with the dashboard-metaphor an unwanted `homunculus' sneaks in. No, because there is a whole series of design features of consciousness that still have to be explained. Yes, because with the realization that consciousness is an adaptive phenomenon (in the words of James "an organ, superadded to the other organs which maintain the animal in the struggle for existence"; 1890: 138), a framework has been found in which all future discoveries relating to those features has to fit. An evolutionary theory of consciousness will encompass a whole series of insights from a whole series of disciplines that cannot be summarized in one handpalm - yet, the central point of adaptationalism must connect them all, even if the fact that adaptation is never perfect is acknowledged.

- *The problem of self-consciousness.* If this is true, an evolutionary perspective would also offers new insights with respect to self-consciousness. Why would an animal "know itself"? In the first place, this could simply be a question of physical orientation. An animal is always located somewhere and its information of the world changes when it moves. It would help if this fact itself is represented in its neural system. Representations of its own speed, weight, jumping capacity etc. would greatly help it to avoid all kinds of disasters. The moment it starts to reproduce sexually and to live in groups some kind of sexual and social self-representation could facilitate sexual and social functioning. Yet, self-consciousness in at least one primate is much more than the ability to process information about one's own sex and social status. Why would we be able monitor our own experiences and intentions from a kind of meta-level, almost *as if* another individual is able to *peep behind* the scenes? Sociobiologists have approached this phenomenon from the theory of reciprocal altruism or cooperation. Within the context of arms race that emerge from the need both to invest in and to profit from cooperation, representations about plans and intentions from the other party become invaluable. Monitoring both your own intentions and those of that other party could be helpful to control one's investments in cooperative undertakings in function of their probable profits. At the same time, masking intentions, cheating, could be helpful, too, sometimes, and animals are not evolving to approach the Truth. If self-consciousness is an adaptive phenomenon it is to be expected that the knowledge of the self that it offers has evolved to incite optimal decisions. To profit maximally from a reciprocal altruistic relationship it often helps to be able to believe that the other has not done as much as you have done yourself - even if this requires self-deceit and a too optimistic picture about one-self or a too negative picture of that other party. From an evolutionary perspective, thus, self-consciousness is expected to be an essentially limited ability.
- *The problem of freedom and self-determination.* In this book, I hardly addressed this

problem, yet I believe, with Roy Wood Sellars, that evolutionary naturalism forces us to look for solutions in a very specific direction (see also Slurink, 1989, chapter 5; and Slurink, 1996, on Sellars). The kind of transcendental free will, envisioned by philosophers from Plato to Kant, and even by some twentieth century philosophers, does not have any explanatory power - to the contrary, it obscures the fact that decisions are often highly characteristic for a particular person in particular circumstances. This is clearly a death alley and one that happens to be incompatible with an evolutionary perspective (in this case, alas, *despite* William James who was not always very consistent and was an indeterminist). Yet, the alternative to a transcendental free will is not fatalism nor a simplistic genetic or environmental determinism. As highly social and cultural primates, continually adapting our plans and self-images to new circumstances and challenges, we need to be creative all the time. All our decisions are based on interests, needs and emotions on the one side, and ecological and social circumstances on the other side. What we continually need is a kind of working hypothesis about ourselves - for example, about the things that are most likely to make us happy and the things which are most likely to happen, given our experiences so far. On the basis of this working hypothesis, which is continually revised, we make decisions that have consequences about what we are gradually becoming. Clearly, there is something going on here like `self-determination', but it is not a kind of `pre-existential choice' as envisioned by Plato and Origen, nor a *creatio ex nihilo* of one's own nature, as envisioned by Sartre. It is a series of informed choices during which gradually a series of inherited characteristics are activated into a specific behavioral and emotional life, which includes an identity within a specific society. Within an evolutionary theory of mind there is thus no place for an absolute free will hovering above life, but to some extent there may exist something like freedom as a relative independentness of particular needs and motives and an ability to integrate all those drives into a social and cultural identity, even if this requires suppressing some drives in favor of others. On the whole, one would expect that this kind of freedom does not result in maladaptive decision-making, however. It does not stand in opposition, thus, to both physical causality nor to biological teleonomy (as defined by Mayr), but it is - to the contrary - based on both of them. If this is still a kind of determinism, so be it, but let us not forget that it is a determinism in which we are determined to determine ourselves. It is not a determinism that makes us purely into passive victims of causality, but which views us as unique causal processes that are at least partly in control themselves.

- *The problem of values and a meaning of life*. In chapter 3, I introduced Pugh's so-called value-driven design-system theory to illuminate particular aspects of consciousness which would be neglected if we would take consciousness purely as an information processing system. Consciousness is designed to enable adaptive decisions and it is able to do so because it subjectively *experiences* phenomena - the world is presented to consciousness not only as a show-box full of objects and relations, but as a field of meanings and values. It not only gives information and maps, but it gives directions, advice, commissions. To the extent that organisms share niches they often share evaluations about objects and territories as a result of which they often have to compete. One cannot claim, thus, that values and evaluations are purely subjective, but neither that they belong to some kind of platonic realm beyond the struggle for life. Darwinism does not force us to a complete relativism in which the role of `virtual realities' like values is denied, but is simply incompatible with a discourse on values in which these are understood as independent of the conative beings for which they offer some guidance. Above that, if it is true that we are naturally selected value-driven design-systems, our primary values (in the language of Pugh, these are opposed to the partially individually or culturally acquired secondary values) are innate and products of variation and selection. That means that values do ultimately reflect attitudes which have proved to work in the context of reproduction and survival. That may seem a somewhat contra-intuitive insight, because we do not normally associate values with survival-only. Yet, it has to be realized that primate and human survival has always been a matter of social cohesion, social status, and the effective display of moral and aesthetic qualities. Values do not reflect something beyond ordinary life, but do reflect the fact that ordinary life has more dimensions than food and sex only. Within this context, the discourse on `the' meaning of life is also illuminated. Of course, all conscious organisms are designed to experience life as `meaningful', at least as long as they are on the right track and are doing well within the context of their own life program. Organisms that would continually feel that life is futile and without meaning whatsoever, would soon go extinct as a result of their indifference. The experience of life as meaningful is connected to the sense that life has a purpose, and this sense is connected to the human ability to make plans in which biological givens are adjusted to ecological and economic variables. Often the sense that life has lost its meaning is associated with loss and disorientation, the discovery that one's life program does not fit the factual situation anymore. Language in which is referred to `the' meaning of life often contains advice that may help people back on the right track and may help them find a new purpose. Often this language is used, however, to steer vulnerable people in a particular direction, to manipulate them. To make this kind of language more transparent it would be helpful if a discourse on a suppose `meaning of life' was replaced by a discourse on well-being and on more or less fulfilling and successful life-styles (see Slurink, 1989; 1994; 2000 plus references).

- *The quest for the roots or foundations of society*. Especially during the Greek and European Enlightment, both characterized by a belief in reason and education, philosophers started to ask why humans need to be social, why our current society is `rational'. Philosophers from Hobbes to Rousseau created their own fictional scenarios about the rise of the state. Yet, although the `state' is no doubt a relatively late product of human sociocultural evolution, the idea that humans were originally solitary animals, which has sometimes been launched, has become increasingly implausible. Even the oran-utang seems to be more social than previously thought, and the last decades we know that we are much closer related to the social living African apes than was thought before. Above all, most primates are social animals and most solitary animals are not so during all their lives. Sociobiology has generated a series of models which explain sociality and the various kinds and degrees of altruism without recourse to conscious rationality or transcendent values. Both kin selection and reciprocal altruism have been proven to play a role in human social behavior. Yet, to explain why humans live in very large cooperative societies, one has probably to refer to arms races between societies as wholes, which is done by the intergroup competition hypothesis of Darwin, Bigelow, Alexander, and others.

- *The problem of good and evil.* In chapter 4, I introduced a model which shows how a common good emerges as a result of both overlapping and conflicting interests and goals within a group of cooperators that can only together exploit particular aspects of their environment (fig. 4.9). If the interests of such cooperators would completely overlap they would not need words like `good' and `evil' to influence and `e-motivate' each other. In a situation of complete conflict of interests and lack of communication, words like `good' and `evil' have no function either. Thus, moralistic language presupposes or creates a kind of `moral community' in which each individual is approachable and responsible. It refers to a field of common interests and goals, which may even extend into a common concern for such elusive, exotic and far-fetched issues as justice, the well-being of other animals or even that of other generations. To what extent one enters here a domain in which language is purely `emotive' or refers to realities that are at least shared by a group of speakers is, of course, a very complicated discussion. Yet, as animism demonstrates, humans are not by nature perfect ontologists and it is hard for them to believe that the universe is indifferent to their moral categories. Thus, philosophers since Plato have designed metaphysical systems in which the universe is soaked with human values and both science and naturalistic philosophy have a hard time in breaking thinking habits which fit our narcissism so well. Undoing the reification of good and evil and the moralification of nature does not lift us, however, "beyond good and evil", as Nietzsche thought, as long as we are part of a human community knit together by direct and indirect reciprocal altruistic relationships. Thus, a Darwinistic approach to morality should not be identified with moral relativism, although it rejects an absolutistic, metaphysical interpretation of moral categories. To be moral as a human is to be part of a network of cooperation and sympathy, which creates a `field of concern' that sometimes even extends beyond our own species, but mostly remains limited by the laws of direct and indirect reciprocal altruism. It seems to me that there is still a lot of analysis to be done in this area, which can be called `evolutionary ethics' (Again see Slurink, 1989; 1994; 2000, and references).
- *The problem of our origins, identity and destiny.* With all these speculations we have certainly progressed, but many details and nuances remain obscured as long as we do not know precisely what kind of species we really are, where we come from and where we go. To be able to know what we are, we have to know other species as well, especially related species, and especially that aspect of their nature that is the hardest to discover - their mind. We have to reconstruct our origins not by giving the kind of `rational reconstruction' which was sometimes given by social philosophers on the assumption that the origin of human society was essentially a rational choice. What we need is an understanding of the selection processes that shaped humans from the ancestral apes that were their ancestors. Knowledge of paleoenvironments is required and knowledge of a great number of fossils. Thus such an understanding can only arise as a result of the work of many independent scientists. In part III of this book, I have given my own idiosyncratic synthesis of current knowledge. A series of climatological changes must have brought about the divergence of the African apes that we now see. Australopithecines seem to have evolved with both the ability to move in the open field and the ability to climb back into the trees, if necessary. The genus *Homo* apparently evolved, because some Australopithecines carved their own niche of opportunistic meat-eating at the moment that Africa became increasingly dry as a result of a climatic event at 2.5 myr ago. This would

> explain, at least, why juveniles became increasingly altricial and why their maturation process took gradually more time, as demonstrated by the Turkana boy. This would subsequently explain why finally - at what point is unclear - something like pair-bonding and paternal investment evolved within the human lineage. As already said, the evolution of increasingly complex societies and language - these two are understood as mutually connected - may be explained in the context of arm races within groups, yet it is still hard to evaluate to what extent other mechanisms, like sexual selection, worked. Chapter 8 was an attempt to come to a balanced opinion on these subjects. One point is clear at this moment, and that is that we are still hardly certain about our origins, and with that about our identity and destiny. On the other hand, many cherished notions about human uniqueness and human destiny have passed away almost unnoticed while researchers are gradually solving the ultimate human puzzle.

A large part of this book was devoted at demolishing the idea that man is a kind of suprabiological creature, a species that is able to fill in its nature entirely by a mysterious quality called `culture'. Hopefully, it has become clear that suprabiological species do not exist and that culture does not stand in opposition to nature. If man is a culture-creating animal, and I believe he is, than this does not mean that he does not have a nature and instincts. Rather, culture should be seen as the phenomenon of non-genetic transmission of information with which instincts can be better adapted to specific circumstances. It has become increasingly important in the human lineage as a result of specific selection pressures that lengthened the maturation process, probably partly as a result of more complex foraging strategies (hunting). Thus, culture as we know it in our species is a biological adaptation and linked to a long learning period, a large brain, a series of innate learning mechanisms, and a specific social structure (*K*-selection, paternal and grandparental investment, menopause).

The picture of culture as a luxurious way of inventing - from scratch - new ways of life, and experimenting with them, is completely misguided. Cultures are clearly adapted to particular environments, which is acknowledged by many anthropologists, including the cultural materialists. Sociobiologists and behavioral ecologists have gone further, however, and discovered, for example, links between the environment and aspects of the human mating system. They have been able to prove in many cases that cultural habits make sense within the frame-work of the same sociobiological theories (e.g. theories about kin selection, mating systems, parental investment, reciprocal altruism) that have been developed to explain behavior in other animals. They have found both behavioral mechanisms which continue to exist in our lineage despite the origin of culture, which often are somehow transformed by that culture, and behavioral mechanisms which seem to have evolved only after culture became more important. Gradually it has become clear, thus, that culture is not simply superimposed on a *tabula rasa* or on a biological substratum, but that it is an adaptive strategy of some species, which always will coevolve with other characteristics of the species concerned. Apparently our species in particular has become increasingly dependent on it as a result of a series of selection pressures which are hard to trace, but on which it is a challenge to speculate (part III).

Yet, culture as we know it in our species seems to have its own dynamics and restlessness, which make explanations purely in ecological terms incomplete. Apparently, culture is not exclusively designed to allow the adaptation to particular environments, but it is driven by other forces as well. Both sexual selection and the arms races within and between societies almost certainly play some role in stimulating cultural progress. Yet, while there are good reasons to accept that both play some role, the contribution of each factor and their complex interaction remains a problem (chapter 8). Thus, one of the problems we encountered is not the *lack* of possible explanations, but their abundance and their compatibility, which makes analyses complex. As long as this situation continues, critics probably will repeat that any evolutionist can cherish his own favorite cocktail of explanations that gives him the best party. What is now needed, thus, are ways to come to balanced multicausal models.

One way that I have explored is the evolutionary historical approach in which causal factors are traced back to their roots. Thus, the course of sexual selection must be deeply affected by the transition to a mating system with paternal investment at some point after our split with the common ancestor that we share with chimpanzees and bonobos. Intergroup competition may be a factor even in chimpanzees, but it must have been intensified at the moment that our ancestors became ecological dominant. Such a historical approach may finally help us to decide what causal factors are still working today and what we can expect about their relative strength. Another approach is, of course, the ongoing project of analyzing the mechanisms behind modern human behavior. As our knowledge increases, the voices of the critics may gradually start to sound in the same way as a critic of meteorology would sound when he would claim that meteorologists are all wrong because all the factors to which they refer are *ad hoc* hypotheses. Gradually we may succeed in unraveling the complex web of factors that have molded the human species and its cultural activities.

This brings us to another point that the critics have been repeating all the time: the point that much human behavior is probably nonadaptive or maladaptive. This point was often repeated, especially in early twentieth century philosophical anthropology. Many philosophers have thought about man as a sick animal, an animal that somehow needed his extreme intelligence to compensate for his loss of strength or general vitality. Ortega y Gasset apparently even thought this thesis to be a kind of a falsification of Darwinism. According to him we are not only a sick animal, but even an animal afflicted by a maladaptive intelligence, an intelligence which makes us continually crave for the unattainable, like perfect circles, justice and happiness. Whole schools of philosophers and social scientists have thought that Darwin never could be completely right, because he did not explain the human animal, which is not adapted to a particular environment, but is continually creating new environments that suit his ever-changing caprices and mental excesses.

The idea of man's overall maladaption is one of the many unfounded prejudices, exaggerations or stereotypes still nourished by philosophers and social scientists about Darwinism, which are due partly to an incomplete knowledge of both Darwin and the organisms living in their own backyard. Whoever observes a Blackbird for two minutes in his backyard will probably witness already a small collection of `maladapted' jumps and steps. If animals would be completely adapted to their environments, we would not have evolution but Providence. Apparently maladapted behavior increases, of course, at the moment that an animal is learning by trial and error, as we see especially in young animals. Man does not only have an extended learning period, in his whole life he is learning by trial and error - but that does not mean that his overall behavior is completely maladapted. Also, nature has programmed especially males to take many risks and these risks seem maladapted, but their essence is that they sometimes are extremely profitable. Further, it is quite probably that we are a relatively young species and that many of our cognitive modules are relatively young - it would be unreasonable to expect that they are perfect. We are changing our own environment so fast that it is hardly to be expected that we are adapted for all changes that we have brought about ourselves. Finally, from an evolutionary perspective our adaptedness and success is not measured in well-being - it is simply, and exclusively measured in reproductive success. Thus, from an evolutionary perspective the fact that many individual humans lead tragic lives, characterized by emotional instability or unhappiness, does not imply that man is a `sick animal'.

It has to be admitted, however, that dreams are a part of our lives, and that in that respect we are probably a unique species. Indeed, as Ortega argued, we are able to imagine straight lines, perfect circles, equality, and justice. Given the role such dreams play in much of our minds, the actual facts about human life sometimes seem sobering and even shocking. I do not see, however, why our ability to imagine perfect circles should lift us beyond the ordinary realities of growth, reproduction, competition, and death. In the end, these `ordinary realities' are not only the sources of suffering and tragedy, but also those of joy and comedy. It would be unwise to expect happiness and salvation only from what lifts us `above' other animals, and from our ability to combat or transcend nature. In the end, we are dependent on many of the functions that we share with other animals and when we are combatting, transforming or transcending nature we should beware of not combatting, transforming and transcending ourselves. The ideas of many philosophers and social scientists about human superiority reflect an attitude which has probably been disastrous already for many individual animals and many animal species and which in the end could even be disastrous for ourselves.

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* Waarom sommige apen mensen werden. Competitie, bewustzijn en cultuur *

Filosofische vragen komen voort uit de menselijke situatie en gaan altijd gedeeltelijk over de mens. Zij kunnen daarom het best beantwoord worden in samenwerking met die wetenschappen die het meest licht werpen op de mens. De moderne biologie leert ons het wezen van de mens te beschouwen in samenhang met zijn ontstaan.

In dit boek wordt geclaimd dat de evolutieleer cruciale bestanddelen bevat voor de beantwoording van een aantal fundamenteel filosofische vragen. Veel vruchteloze pogingen licht te werpen op kennis, bewustzijn en het wezen van de mens waren het gevolg van een chauvinistisch apart plaatsen van de mens en zijn unieke geest, waarbij de continuïteit van natuur en mens uit het oog werd verloren. Dit had natuurlijk alles te maken met de onbekendheid met het gedrag van mensapen en andere intelligente dieren, maar ook met een neiging de biologische en competitieve aspecten van het menselijk gedrag te verwaarlozen. Het rijk van de geest met haar abstracties en ideeën werd absoluut gesteld, aan de vraag naar de oorsprong en de bestaansmogelijkheid van een dier met zo'n geest kwam men niet toe.

De moderne evolutieleer en de moderne gedragsbiologie dagen ons uit ons chauvinisme te laten varen en bieden ons dan geheel nieuwe mogelijkheden filosofische vragen aan te pakken. Uiteraard berust ook de evolutieleer op vooronderstellingen. Zoals in de *inleiding* betoogd wordt is filosofie niet het denken zonder vooronderstellingen, maar het denkend zoeken naar juiste vooronderstellingen. Een los van alle ervaring zoeken naar het (statische) wezen van een aantal begrippen (de transcendentale benadering) resulteert eerder in een dogmatische houding dan het afpalen van effectieve begrippen binnen de context van het gehele web van kennis (de naturalistische benadering). Begrippen bestaan binnen de context van dynamische modellen van de wereld en ook de evolutieleer is zo'n model met repercussies voor de manier waarop onze begrippen de wereld in kaart brengen. In de inleiding wordt dan ook globaal aangegeven vanuit welk model van evolutie gewerkt wordt, niet om dit model te verheffen tot dogma, maar eerder om uit te komen voor de gehanteerde werkhypothese. Deze werkhypothese is de neodarwinistische evolutieleer waarin aanpassingen van organismen aan specifieke omgevingen het gevolg zijn van een proces van variatie en selectie: relatief aangepaste of succesvolle eigenschappen van organismen nemen toe in de populatie, omdat zij leiden tot de meeste nakomelingen. Binnen het kader van deze werkhypothese moeten de lichamelijke en geestelijke eigenaardigheden van de mens verklaard worden als gevolgen van eigenschappen die ooit voordelen hebben gehad bij het vinden van voedsel, partners en een veilige omgeving voor de voortplanting.

Deel 1, en met name *Hoofdstuk 1 en 2* demonstreren hoe deze benadering licht kan werpen op verschillende aspecten van de kentheorie. De fundamentele kentheoretische vraag "(hoe) is kennis van de wereld mogelijk?" wordt daarbij niet ontweken, integendeel. Het sceptische antwoord dat de mens geen vat heeft op de `ware wereld' en dus opgesloten zit in zijn geest wordt echter als onvolledig ter zijde geschoven. De geest moet immers geëvolueerd zijn om te oriënteren en te sturen. Niet alleen de mens, maar ook andere dieren hebben behoefte aan informatie omtrent de wereld om juiste (de overleving/de voortplanting dienende) keuzes te maken. Deze informatie hoeft niet te vertellen hoe de wereld in elkaar zit los van het dierlijk standpunt van waaruit die informatie wordt verzameld en verwerkt, maar ze moet op een aantal punten wel bij die wereld aansluiten. Het is te verwachten dat de manier waarop die informatie (berustend op fysische aspecten van de omgeving) gefilterd, geïnterpreteerd en ervaren wordt bepaald wordt door de noodzaak het organisme te prikkelen tot de `juiste' (aangepaste) keuzes. Kennis is in die zin wel een soort kooi waarin het organisme zit opgesloten, maar juist een kooi die het organisme op zijn eigen wijze toegang verschaft tot die wereld en die het in staat stelt zich er `vrij' in te bewegen - ofschoon het natuurlijk in feite geleid wordt door de wijze waarop zijn aangepaste cognitieve structuren het de wereld voorschotelen.

Naar analogie van de `kritiek van de zuivere rede' van Kant kan men zo een `rechtvaardiging en kritiek van de vitale rede' opstellen. De evolutieleer wordt dan gebruikt om voorspellingen te doen over de reikwijdte en adequaatheid van onze subjectieve kenstructuren. Er is dan dus geen sprake meer van een kantiaans transcendentaal onderzoek, maar van de ontwikkeling van een serie modellen waarin de dynamische relatie tussen de kenstructuren van het organisme en de fysische eigenschappen van de omgeving in kaart worden gebracht. De betrouwbaarheid van deze benadering is niet gebaseerd op de pretentie van streng redeneren vanuit een paar veronderstelde basiswaarheden (de benadering van de transcendentalisten), maar op een veelheid aan gegevens uit verschillende disciplines, die geïntegreerd worden. Als afzonderlijke details en deducties voor verbetering vatbaar zijn betekent dit nog niet dat de hele theorie als een kaartenhuis in elkaar zakt.

In *hoofdstuk 2* worden zo, naar analogie van Kant, achtereenvolgens de zintuiglijke basis van kennis, de stereometrische `aanschouwingsvormen', de categorieën en de metafysische ideeën besproken. Daaraan worden echter de waardegeladenheid van kennis, en de linguïstische en sociale dimensie van kennis toegevoegd. De bespreking van deze verschillende aspecten van kennis vanuit een evolutionair naturalistische perspectief levert uiteraard een zeer onkantiaans plaatje op, alleen al omdat de tegenstelling tussen *Erscheinung* en *Ding an sich* opgaat in een perspectivistisch realisme. Binnen de context van deze bespreking wordt ook het radicaal sociaal constructivisme gekritiseerd, waarbij gewezen wordt op de divergentie tussen de factoren die de sociale acceptatie en de factoren die de ontologische adequaatheid van een theorie bepalen. Al met al wordt het beeld bevestigd dat evolutionaire kenleer compatibel is met een bepaald soort realisme, dat men `kritisch' (Roy Wood Sellars), `hypothetisch' (Gerhard Vollmer) of ecologisch zou kunnen noemen.

Daarmee is tegelijk gezegd dat vanuit deze benadering de eigenheid van het bewustzijn niet uit het oog wordt verloren. De wereld wordt altijd op een bepaalde manier in het bewustzijn gerepresenteerd. De wijze waarop het bewustzijn de wereld weergeeft is bepaald door de variatie en selectie van brein- en bewustzijnsstructuren en zal van dier tot dier, en dus ook van mens tot mens, enigszins verschillen. In *hoofdstuk 3* wordt geclaimd dat de evolutietheorie een aantal aspecten van het bewustzijn kan verklaren die andere theorieën negeren, bagatelliseren of verwaarlozen. Daartoe behoren de volstrekt private aard van bewustzijn en de volstrekt onontkoombare aard van subjectieve ervaringen, hoe negatief ook. Weer stuiten we op de analogie van kennis en bewustzijn met een kooi: het organisme is niet in staat de wijze waarop het de wereld ervaart (fundamenteel) te wijzigen. Bij de mens blijkt dit doordat er, ondanks een spectrum aan verschillende culturen, in al die culturen een aantal universele basisemoties zijn. Deze emoties worden verklaard met verwijzing naar de theorieën van G.E. Pugh, die emoties vergelijkt met de waarden in de zogenaamde waarden-gestuurd beslissingssystemen, een soort beslissingssoftware, die hij hielp ontwerpen (bij de mens is het dan *hardware* of *wetware*). Met andere woorden: als gevolg van selectiedrukken gericht op flexibiliteit zouden specifieke groepen mobiele organismen niet langer star voorgeprogrammeerd zijn met reflexen en kant-en-klare routines, maar met een systeem dat hen in staat stelt graden van wenselijkheden toe te kennen aan hun opties en simulaties om zo beslissingen op maat te maken binnen zeer uiteenlopende situaties. Ook een aantal eigenaardigheden van de menselijke geest zouden verklaard kunnen worden als we haar opvatten als een door de evolutie ontworpen en bijgewerkt `dashboard', waarop van waarden voorziene informatie, opties en simulaties bij elkaar worden gebracht om tot daden te komen. Dit model zou het ook gemakkelijker kunnen maken om in te schatten welke dieren bewustzijn hebben: dieren die kunnen spelen en dromen, hebben wellicht het systeem van emotionele waarden-toekenning nodig om prioriteiten te kunnen stellen in de wildgroei aan simulaties die hun brein produceert.

In deel 1 bleek al herhaaldelijk dat de mens een door-en-door sociaal wezen is, waarvan de geest niet begrepen kan worden los van zijn sociale omgeving. *Deel 2* van het boek is een verkenning van de evolutionaire wortels van samenleving en cultuur. Ondanks het feit dat de evolutieleer zelf vrijwel onomstreden is, bestaan er dusdanig koppige misverstanden over evolutie dat er een revolutie nodig was om wat meer helderheid te scheppen. Met name de sociobiologie, onderwerp van *hoofdstuk 4*, heeft in feite afgerekend met gemakkelijke verklaringen van verschijnselen in termen van `functionaliteit voor de overleving van de soort/groep'. Dat soort verklaringen gaan al te gemakkelijk voorbij aan de vele vormen van conflict en competitie binnen groepen en soorten en zelfs families. Veel eigenschappen van organismen, inclusief die van de menselijke geest, zijn in feite individuen van nut in hun competitie met andere individuen.

De sociobiologie heeft zelfs laten zien dat het individu geen eindstation is, maar slechts een tussenstation. Altruïsme en samenwerking ontstaan als individuen genen of belangen delen. Een gen dat altruïsme bevordert kan namelijk alleen evolueren als dit altruïsme `wel besteed' is. Bij de meeste diersoorten komt de mate van altruïsme overeenkomt met de mate van verwantschap. Omdat het individu in sexuele organismen het produkt van een tijdelijk conglomeraat van genen is kan men verwanten dan opvatten als `overlevingsmachines van dezelfde, zelfzuchtige genen'.

Dit soort metaforen heeft echter helaas weer veel nieuwe misverstanden opgeleverd, omdat ze een genetisch determinisme en reductionisme lijken te propaganderen. In hoofdstuk 4 wordt eerst geprobeerd de sociobiologische stellingen in de historisch-theoretische context te plaatsen waaruit ze begrijpelijk worden en vervolgens wordt een poging ondernomen ook puur systematisch de misverstanden op te heffen. Historisch-theoretisch wordt de sociobiologie opgevat als een noodzakelijk geworden herfundering van de gedragsbiologie in de evolutiebiologie, systematisch wordt een verschil gemaakt tussen genetisch determinisme en evolutionair reductionisme. Evolutionair reductionisme houdt in dat de aangepastheid van eigenschappen in de holistische context van individuen en omgevingen wordt getest, maar slechts kan beklijven op basis van erfelijkheid en dus een minimale genetische aansturing (ook van leerprocessen en cultuur). Organismen zijn dus geen robotten, maar wel van nature gericht op overleving en voortplanting. Zonder die natuurlijke doelgerichtheid of teleonomie zouden ze namelijk uitsterven. Het gaat hier dus niet om een genetisch determinisme, maar wel om een hiërarchische benadering waarbij het `hogere' berust op het `lagere'.

De feitelijke wijze waarin de natuurlijke doelgerichtheid van organismen is georkestreerd is onderwerp van de evolutionaire psychologie, één van de gedaantes waarin het oorspronkelijke programma van de humane sociobiologie voortleeft. Het basisidee van de evolutionaire psychologie is dat niet alle gedrag adaptief is, omdat het proces van adaptatie heeft geleid tot het ontstaan van specifieke modulen die in het verleden meestal adaptief gedrag genereerden, maar dit niet altijd noodzakelijk doen. Juist in de moderne tijd heeft de mens zelf een omgeving gecreëerd die dermate ver afstaat van de `omgeving van evolutionaire aangepastheid' (term van Bowlby) dat niet te verwachten is dat alle gedrag adaptief is. Een gevaar van de evolutionaire psychologie is dat het ons ertoe kan verleiden bij elk onverklaarbaar gedragssegment al te gemakkelijk terug te grijpen op de traagheid of slordigheid van de evolutie. Alleen door voor allerlei gedragspatronen een veelheid van hypothesen te testen binnen de context van onderzoek betreffende de onderliggende mechanismen en hun erfelijkheid kan men tot de juiste hypothese komen.

In *hoofdstuk 5* worden verschillende hypothesen met betrekking tot de relatie van evolutie en cultuur, vooral bij de menselijke soort, vergeleken. De nog steeds tamelijk dominante modellen binnen de sociale wetenschappen gaan meestal uit van een vergaand plooibare menselijke natuur, waarop de omgeving of de traditie een doorslaggevende invloed heeft. Daarnaast staan modellen volgens welke culturele evolutie een soort autonoom proces is los van of naast de biologische evolutie. De sociobiologie en de evolutionaire psychologie doen ons verwachten dat mensen cultuur accepteren en doorgeven inzoverre en zolang het hun overleving of voortplanting dient.

Geen enkel model blijkt acceptabel dat voorbijgaat aan de autonomie van het psychologische niveau tussen genen en cultuur, zodat alle `dualistische' modellen als onvolledig kunnen worden weggestreept. Modellen die geen recht doen aan de inzichten van de gedragsgenetica en de evolutie van cultuurvaardigheden kunnen tevens worden weggeselecteerd. Er moeten verbanden bestaan tussen cultureel en reproduktief succes om het ontstaan en de instandhouding van cultuur te verklaren. Verschillende studies hebben het bestaan van dergelijke verbanden aangetoond. Het lijkt erop dat cultuurvaardigheden deels rechtstreeks lonen via sexuele selectie, deels indirect via de resulterende dominantie en macht. Het probleem is dat culturen wortelen in samenlevingen, waarin samenwerkingsverbanden en belangen conflicten door elkaar lopen. Juist in dit `substraat' kunnen de wapenwedlopen tieren waarin een veelheid van talenten kan lonen. Het idee wordt dan ook geopperd dat de verschillende karakters, in kaart gebracht door verschillende typologieën, een adaptief polymorfisme constitueren van strategieën die in verschillende socioculturele contexten vruchtbaar zijn.

Al met al is het duidelijk dat een evolutionaire psychologische benadering van cultuur (in een vrij wijde zin van het woord) niet alleen als enige overblijft, maar ook de meeste verklaringskracht heeft. Biologische individuen laten zich geen cultuur opleggen, maar plukken elementen uit bestaande culturen die ze kunnen gebruiken, om deze elementen vervolgens te modificeren en moderniseren conform hun eigen belangen. De evolutie van `memen' (cultuur-elementen) is geen autonoom proces, maar vormt de weerspiegeling van de samenwerking bij een soort roofaap (deze karakterisering wordt echter pas verdedigd in hoofdstuk 7), die moet samenwerken om op een intelligente manier de natuur te exploiteren, maar waarbij onderling om het grootste deel van de buit wordt gestreden en waarbij net als bij alle veel andere dieren wordt gestreden om reproduktieve mogelijkheden.

Dit model zou voor velen toch een beetje te abstract en te algemeen zijn als het niet verhelderd zou worden aan de hand van voorbeelden. Bovendien lijkt het model op het eerste gezicht geen recht te doen aan de veelheid van feitelijke culturen. Het is toch duidelijk dat culturen op de één of andere wijze omgevingsbepaald zijn en samenhangen met een bepaalde levenswijze of vorm van ecologische exploitatie. In *hoofdstuk 6* wordt daarom geprobeerd te laten zien hoe verschillende culturen ontstaan vanuit verschillende milieus *via* de menselijke natuur. Deze is niet zondermeer flexibel, maar omvat een serie conditionele strategieën. Afhankelijk van de machtsverhoudingen tussen de sexen en de mate waarin een cultuur hiërarchisch of niet is, zullen er bijvoorbeeld verschillende huwelijksvormen ontstaan. Afhankelijk van de kindersterfte, de veiligheid van de omgeving, de vorm van de ecologische exploitatie, en de beschikbaarheid van voorbehoedmiddelen, zal het kindertal fluctueren. Zelfs de levensbeschouwingen die mensen aanhangen staan onder invloed van ecologische variabelen, waartoe bijvoorbeeld ook de grootte van de samenleving behoort.

Terwijl in veel *science fiction* intelligente, cultuurscheppende soorten een vanzelfsprekend `eind'produkt van evolutieprocessen lijken te zijn (convergerend in vele afzonderlijke sterrestelsels), is binnen een darwinistische benadering het ontstaan van alle soorten gebonden aan een zeer specifieke opeenvolging van omstandigheden. Vooralsnog is niet precies bekend hoe specifiek de klimatologische en ecologische omstandigheden waren waarin de naakte, rechtoplopende en in culturele verbanden samenwerkende roofaap `mens' gekweekt is, maar er bestaat wel een woud van theorieën over. *Deel 3* is een poging de bomen in dit bos te zien door middel van selectieve kap en zorgvuldige kruisingsexperimenten.

In *hoofdstuk 7* wordt de uniciteit van de mens eerst op een aantal punten gerelativeerd. De werkelijk unieke kenmerken worden vervolgens in een historisch kader geplaatst. De evolutie van mensachtigen lijkt het produkt van een gefaseerd proces dat steeds op gang wordt gebracht door klimatologische veranderingen. Deze dreven eerst groepen mensapen het oerwoud uit en dwongen vervolgens millenia later specieke groepen rechtoplopende aapmensen hun menu aan te vullen met relatief veel vlees. Het unieke menselijke paarsysteem, waarin beide ouders bijdragen aan de opvoeding van relatief lang afhankelijke kinderen, lijkt te moeten worden verklaard in de context van de overgang naar de jacht. De relatief lange jeugdfase, die al begint op te treden bij *Homo ergaster*, vormt vervolgens ook weer een basis voor de verwerving van een relatief complexe cultuur.

Waarom er echter een soort autokatalytisch proces van coevolutie van genen en cultuur ontstond, resulterend in taal en complexe cultuur, is niet eenvoudig te zeggen. Men ontkomt er in deze fase van onze kennis niet aan om hierover te speculeren, wat ik mijzelf ook toesta in *hoofdstuk 8*. In dit hoofdstuk worden drie modellen vergeleken: het al in hoofdstuk 7 verdedigde model waarin de overgang naar jacht centraal staat, het model waarin de extreme intellectuele vaardigheden van de mens worden toegeschreven aan sexuele selectie, en de hypothese van van Bigelow, Alexander en anderen, waarin de evolutie van de mens gezien wordt als een gevolg van wapenwedlopen tussen vroegmenselijke groepen. Het jachtmodel verklaart, zoals we zagen, de relatief lange jeugdfase en de samenwerking in kleine groepen, maar lijkt onvolledig te zijn, omdat het niet verklaart waarom mensen (verhoudingsgewijs) extreem intelligent zijn en dikwijls in wel erg grote groepen leven. De meeste roofdieren overleven uitstekend met een beperkte, gespecialiseerde intelligentie en ondervinden in al te grote groepen alleen maar hinder van elkaar.

De theorieën van sexuele selectie en van competitie tussen groepen zien beide de menselijke intelligentie als de resultante van een doorgeslagen competitie binnen de soort, van een soort op hol geslagen wapenwedloop. Beide kunnen gezien worden als aanvulling op de jachthypothese, niet als haar vervanging. Als paarbanden tijdens de menselijke evolutie steeds belangrijker werden zouden de eisen die aan partners gesteld worden ook steeds verder uit de hand kunnen zijn gaan lopen (net als dat bij pauwen en paradijsvogels het geval is). Niet alleen zou intelligentie en creativiteit geselecteerd kunnen worden als *fitness* indicatoren, maar ze zouden ook nodig kunnen zijn om het complexe spel van de partnerkeuze te kunnen spelen.

Volgens de theorie van competitie tussen groepen (eveneens teruggaand op Darwin) moet de oorsprong van de menselijke intelligentie eerder gezocht worden binnen het kader van wapenwedlopen tussen groepen. Op het moment dat sommige vroege hominiden `ecologisch dominant' werden hadden zij meer te duchten van andere groepen van de eigen soort dan van andere roofdieren. De optimale groepsgrootte die eerst werd bepaald door samenwerking bij de jacht zou nu verschuiven naar een grootte bepaald door samenwerking bij de verdediging van de eigen groep en haar thuisbasis. De menselijke intelligentie zou het gevolg zijn van de noodzaak te overleven en samen te werken binnen dergelijke complexe grote groepen, die op beslissende momenten eensgezind moesten kunnen opereren.

Een groot deel van hoofdstuk 8 worden argumenten voor de theorie van competitie tussen groepen aangedragen, maar daarmee wordt niet betoogd dat sexuele selectie geen rol gespeeld zou hebben. Integendeel: juist binnen de context van complexe, grote groepen is het aangaan en onderhouden van duurzame paarbanden een netelige kwestie, bij de moderne mens niet voor niets gebonden aan regels en rituelen. In die zin kunnen de theorie van sexuele selectie en die van competitie tussen groepen beide waar zijn. Het is dan echter zaak in de overkoepelende theorie de verschillende causale verbanden goed uit elkaar te houden, zodat niet de indruk ontstaat dat men naar believen een portie sex en geweld in een lekker liggend verhaal samenflanst. Hoofdstuk 8 is daartoe een aanzet: het resultaat is een globaal model van de verschillende fasen in de menselijke evolutie waarin bepaalde mechanismen werkzaam zijn geweest. De menselijke ziel kan gezien worden als een soort fossiel, dat de sporen draagt van de verschillende processen.

In de *uitleiding* kom ik tenslotte terug op mijn belofte dat het evolutionair naturalisme antwoorden kan verschaffen op een aantal filosofische vragen. Ik laat zien dat de evolutietheorie doorwerkt in bijna alle belangrijke filosofische probleemgebieden. Omdat de evolutietheorie verklaart waarom wij bestaan neemt zij een centrale plaats in binnen ons huidig wereldbeeld. Omdat de evolutietheorie afrekent met geliefde noties over ons wezen en onze bestemming en ten dele onthult wat wij werkelijk zijn, en zelfs waarvoor wij hier zijn, biedt zij in feite het kader voor een nieuwe, wetenschappelijke gefundeerde levensbeschouwing.

* Curriculum vitae, postscript & acknowledgements *

At the University of Nijmegen, a promotion is a *rite de passage* tied to a series of prescriptions. One of them is a C.V. of the candidate at the end of the dissertation. Hence, the following information: I was born september, 2, 1958 in Heerlen, as third son of a protestant engineer; two daughters subsequently followed (psychologists will note that I am a middle-born). We moved from Heerlen to Lelystad and from there to Ede. In Lelystad and Ede, I became a zealous `naturalist', studying especially birds and insects within the framework of the ethology of Tinbergen (`Vogelleven'). Somewhat later, I also became an avid reader of poetry and novels (my favorite being Dostoyevsky) and dreamt about being an artist myself. After studying Dutch language and literature for two years at Utrecht, I realized that some philosophers, especially Schopenhauer and Nietzsche, both are better writers and address more serious problems than most of the literature I had to read for my study. I moved to Nijmegen and started to study philosophy with the small ambition to solve almost all philosophical questions before my graduation. The conviction that the theory of evolution forms the key to solving philosophical problems was strengthened by my teachers, who almost completely neglected the subject, and by my accidental discovery of E.O. Wilson's *Sociobiology: the New Synthesis*. While I was at the beginnings of my study still looking for some kind of compatibility of evolution and an absolute morality, I gradually started to see this as an illusion. My master's thesis, *Natuurlijke selectie en de tragiek van de menselijke idealen* (written under supervision of Prof. P. van Tongeren), with which I graduated *cum laude*, is an investigation in this (in-)compatibility and deals with the ways in which our opinions on free will, morality, and the meaning of life are affected by the theory of evolution and by sociobiology (my main subject being ethics, then).

This dissertation started its long evolution as a research proposal submitted in 1989, addressed at the Netherlands Organization for Scientific Research (NWO) under the title "Natural selection and the origin of culture; sociobiology, hominization and the human sciences", signed by and written together with my new supervisor Prof. A.A. Derksen. Our original plan at that time was "to situate the origin of the specific human life-style of `culture cooperator' within the framework of hominoid evolution and thus to come to a more concrete model of the biocultural feedback and a better understanding of the role of proximate and ultimate explanations. This should contribute to the integration and mutual transformation of biology and the social sciences, which sociobiologists have promised". This proposal was accepted and resulted in a temporary appointment in the period 1990-1995 at the Department for General Philosophy of Science at the Faculty of Philosophy, Catholic University of Nijmegen.

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