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The social function of intellect

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Henry Ford, it is said, commissioned a survey of the car scrap yards of America to find out if there were parts of the Model T Ford which never failed. His inspectors came back with reports of almost every kind of breakdown: axles, brakes, pistons – all were liable to go wrong. But they drew attention to one notable exception, the *kingpins* of the scrapped cars invariably had years of life left in them. With ruthless logic Ford concluded that the kingpins on the Model T were too good for their job and ordered that in future they should be made to an inferior specification.

Nature is surely at least as careful an economist as Henry Ford. It is not her habit to tolerate needless extravagance in the animals on her production lines: superfluous capacity is trimmed back, new capacity added only as and when it is needed. We do not expect therefore to find that animals possess abilities which far exceed the calls that natural living makes on them. If someone were to argue – as I shall suggest they might argue – that some primate species (and mankind in particular) are much cleverer than they need be, we know that they are most likely to be wrong. But it is not clear why they would be wrong. This paper explores a possible answer. It is an answer which has meant for me a re-thinking of the function of intellect.

A re-thinking, or merely a first-thinking? I had not previously given much thought to the biological function of intellect, and my impression is that few others have done either. In the literature on animal intelligence there has been surprisingly little discussion of how intelligence contributes to biological fitness. Comparative psychologists have established that animals of one species perform better, for instance, on the Hebb–Williams maze than those of another, or that they are quicker to pick up learning sets or more successful on an 'insight' problem; there have been attempts to relate performance on particular kinds of tests to particular underlying cognitive skills; there has (recently) been debate on how the same skill is to be assessed with 'fairness' in animals of different species; but there has seldom been consideration given to why the animal, in its natural environment, should *need* such skill. What is the use of 'conditional oddity discrimination' to a monkey in the field (French, 1965)? What advantage is there to an anthropoid ape in being able to recognise its own reflection in a mirror (Gallup, 1970)? While it might indeed be 'odd for a biologist to make it his task to explain why horses can't learn mathematics' (Humphrey, 1973*a*), it would not be odd for him to ask why *people can*.

The absence of discussion on these issues may reflect the view that there is little to discuss. It is tempting, certainly, to adopt a broad definition of intelligence which makes it self-evidently functional. Take, for instance, Heim's (1970) definition of intelligence in man, 'the ability to grasp the essentials of a situation and respond appropriately': substitute 'adaptively' for 'appropriately' and the problem of the biological function of intellect is (tautologically) solved. But even those definitions which are not so manifestly circular tend nonetheless to embody value-laden words. When intelligence is defined as the 'ability' to do this or that, who dares question the biological advantage of being *able*? When reference is made to 'understanding' or 'skill at problem-solving' the terms themselves seem to quiver with adaptiveness. Every animal's world is, after all, full of things to be understood and problems to be solved. For sure, the world *is* full of problems – but what exactly are these problems, how do they differ from animal to animal and what particular advantage accrues to the individual who can solve them? These are not trivial questions.

Despite what has been said, we had better have a definition of intelligence, or the discussion is at risk of going adrift. The following formula provides at least some kind of anchor: 'An animal displays intelligence when he modifies his behaviour on the basis of valid inference from evidence'. The word 'valid' is meant to imply only that the inference is logically sound; it leaves open the question of how the animal benefits in consequence. This definition is admittedly wide, since it embraces everything from simple associative learning to syllogistic reasoning. Within the spectrum it seems fair to distinguish 'low-level' from 'high-level' intelligence. It requires, for instance, relatively low-level intelligence to infer that something is likely to happen merely because similar things have happened in comparable circumstances in the past; but it requires high-level intelligence to infer that something is likely to happen because it is entailed by a *novel* conjunction of events. The former is, I suspect, a comparatively elementary skill and widespread through the animal kingdom, but the latter is much more special, a mark of the 'creative' intellect which is characteristic especially of the higher primates. In what follows I shall be enquiring into the function chiefly of 'creative' intellect.

Now I am about to set up a straw man. But he is a man whose reflection I have seen in my own mirror, and I am inclined to treat him with respect. The opinion he holds is that the main role of creative intellect lies in *practical invention*. 'Invention' here is being used broadly to mean acts of intelligent discovery by which an animal comes up with new ways of doing things. Thus it includes not only, say, the fabrication of new tools or the putting of existing objects to new use but also the discovery of new behavioural strategies, new ways of using the resources of one's own body. But, wide as its scope may be, the talk is strictly of 'practical' invention, and in this context 'practical' has a restricted meaning. For the man in question sees the need for invention as arising only in relation to the external physical environment; he has not noticed – or has not thought it important – that many animals are *social* beings.

You will see, no doubt, that I have deliberately built my straw man with feet of clay. But let us nonetheless see where he stands. His idea of the intellectually challenging environment has been perfectly described by Daniel Defoe. It is the desert island of Robinson Crusoe – before the arrival of Man Friday. The island is a lonely, hostile environment, full of technological challenge, a world in which Crusoe depends for his survival on his skill in gathering food, finding shelter, conserving energy, avoiding danger. And he must work fast, in a truly inventive way, for he has no time to spare for learning simply by induction from experience. But was that the kind of world in which creative intellect evolved? I believe, for reasons I shall come to, that the real world was never like that, and yet that the real world of the higher primates may in fact be considerably *more* intellectually demanding. My view – and Defoe's, as I understand him – is that it was the arrival of Man Friday on the scene which really made things difficult for Crusoe. If Monday and Tuesday, Wednesday and Thursday had turned up as well then Crusoe would have had every need to keep his wits about him.

But the case for the importance of practical invention must be taken seriously. There can be no doubt that for some species in some contexts inventiveness does seem to have survival value. The 'subsistence technology' of chimpanzees (Goodall, 1964; Teleki, 1974) and even more that of 'natural' man (Sahlins, 1974) involves many tricks of technique which appear *prima facie* to be products of creative intellect. And what is true for these anthropoids must surely be true at least in part for other species. Animals who are quick to realise new techniques (in hunting, searching, navigating or whatever) would seem bound to gain in terms of fitness. Why, then, should one dispute that there have been selective pressures operating to bring about the evolution of intelligence in relation to practical affairs? I do not of course dispute the general principle; what I question is how much this principle *alone* explains.

How clever does a man or monkey need to be before the returns on superior intellect become vanishingly small? If, despite appearances, the important practical problems of living actually demand only relatively low-level intelligence for their solution, then there would be grounds for supposing that high-level creative intelligence is wasted. Even Einstein could not get better than 100% at O-level. Can we really explain the evolution of the higher intellectual faculties of primates on the basis of success or failure in their 'practical exams'?

My answer is no, for the following reason: even in those species which have the most advanced technologies the exams are largely tests of knowledge rather than imaginative reasoning. The evidence from field studies of chimpanzees all points to the fact that subsistence techniques are hardly if ever the product of premeditated invention; they are arrived at instead either by trial-and-error learning or by imitation of others. Indeed it is hard to imagine how many of the techniques could in principle be arrived at otherwise. Teleki (1974) concluded on the basis of his own attempts at 'termiting' that there was no way of predicting *a priori* what would be the most effective kind of probe to stick into a termite hill, or how best to twiddle it or, for that matter, where to stick it. He had to learn inductively by trial-and-error or, better, by mimicking the behaviour of Leakey, an old and experienced chimpanzee. Thus the chimpanzees' art would seem to be no more an invention than is the uncapping of milk-bottles by tits. And even where a technique could in principle be invented by deductive reasoning there are generally no grounds for supposing that it has been. Termiting by human beings is a case in point. In northern Zaire, people beat with sticks on the top of termite mounds to encourage the termites to come to the surface. The technique works because the stick-beating makes a noise like falling rain. It is just possible that someone once upon a time noticed the effect of falling rain, noticed the resemblance between the sound of rain and the beating of sticks, and put two and two together. But I doubt if that is how it happened; serendipity seems a much more likely explanation. Moreover, whatever the origin of the technique, there is certainly no reason to invoke inventiveness on the part of present-day practitioners, for these days it is culturally transmitted. My guess is that most of the practical problems that face higher primates can, as in the case of termiting, be dealt with by learned strategies without recourse to creative intelligence.

Paradoxically, I would suggest that subsistence technology, rather than requiring intelligence, may actually become a substitute for it. Provided the *social* structure of the species is such as to allow individuals to acquire subsistence techniques by simple associative learning, then there is little need for individual creativity. Thus the chimpanzees at Gombe, with their superior technological culture, may in fact have *less* need than the neighbouring

baboons to be individually inventive. Indeed there might seem on the face of it to be a negative correlation between the intellectual capacity of a species and the need for intellectual output. The great apes, demonstrably the most intellectually gifted of all animals, seem on the whole to lead comparatively undemanding lives, less demanding not only than those of lower primates but also of many non-primate species. During two months I spent watching gorillas in the Virunga mountains I could not help being struck by the fact that of all the animals in the forest the gorillas seemed to lead much the simplest existence – food abundant and easy to harvest (provided they *knew* where to find it), few if any predators (provided they *knew* how to avoid them) . . . little to do in fact (and little done) but eat, sleep and play. And the same is arguably true for natural man. Studies of contemporary Bushmen suggest that the life of hunting and gathering, typical of early man, was probably a remarkably easy one. The 'affluent savage' (Sahlins, 1974) seems to have established a *modus vivendi* in which, for a period of perhaps 10 million years, he could afford to be not only physically but intellectually lazy.

We are faced thus with a conundrum. It has been repeatedly demonstrated in the artificial situations of the psychological laboratory that anthropoid apes possess impressive powers of creative reasoning, yet these feats of intelligence seem simply not to have any parallels in the behaviour of the same animals in their natural environment. I have yet to hear of any example from the field of a chimpanzee (or for that matter a Bushman) using his full capacity for inferential reasoning in the solution of a biologically relevant practical problem. Someone may retort that if an ethologist had kept watch on Einstein through a pair of field glasses he might well have come to the conclusion that Einstein too had a hum-drum mind. But that is just the point: Einstein, like the chimpanzees, displayed his genius at rare times in 'artificial' situations – he did not use it, for he did not *need* to use it, in the common world of practical affairs.

Why then do the higher primates need to be as clever as they are and, in particular, that much cleverer than other species? What – if it exists – is the natural equivalent of the laboratory test of intelligence? The answer has, I believe, been ripening on the tree of the preceding discussion. I have suggested that the life of the great apes and man may not require much in the way of practical invention, but it does depend critically on the possession of wide factual knowledge of practical technique and the nature of the habitat. Such knowledge can only be acquired in the context of a *social* community – a community which provides both a medium for the cultural transmission of information and a protective environment in which individual learning can occur. I propose that the chief role of creative intellect is to hold society together.

In what follows I shall try to explain this proposal, to justify it, and to examine some of its surprising implications.

To me, as a Cambridge-taught psychologist, the proposal is in fact a rather strange one. Experimental psychologists in Britain have tended to regard social psychology as a poor country cousin of their subject – gauche, undisciplined and slightly absurd. Let me recount how I came to a different way of thinking, since this personal history will lead directly in to what I want to say. Some years ago I made a discovery which brought home to me dramatically the fact that, even for an experimental psychologist, *a cage* is a bad place in which to keep a monkey. I was studying the recovery of vision in a rhesus monkey, Helen, from whom the visual cortex had been surgically removed (Humphrey, 1974). In the first four years I'd worked with her Helen had regained a considerable amount of visually guided behaviour, but she still showed no sign whatever of three-dimensional spatial vision. During all this time she had, however, been kept within the confines of a small laboratory cage. When, at length, five years after the operation, she was released from her cage and taken for walks in the open field at Madingley her sight suddenly burgeoned and within a few weeks she had recovered almost perfect spatial vision. The limits on her recovery had been imposed directly by the limited environment in which she had been living. Since that time, in working with laboratory monkeys I have been mindful of the possible damage that may have been done to them by their impoverished living conditions. I have looked anxiously through the wire mesh of the cages at Madingley, not only at my own monkeys but at Robert Hinde's. Now, Hinde's monkeys are rather better-off than mine. They live in social groups of eight or nine animals in relatively large cages. But these cages are almost empty of objects, there is nothing to manipulate, nothing to explore; once a day the concrete floor is hosed down, food pellets are thrown in and that is about it. So I looked – and seeing this barren environment, thought of the stultifying effect it must have on the monkey's intellect. And then one day I looked again and saw a half-weaned infant pestering its mother, two adolescents engaged in a mock battle, an old male grooming a female whilst another female tried to sidle up to him, and I suddenly saw the scene with new eyes: forget about the absence of *objects*, these monkeys had *each other* to manipulate and to explore. There could be no risk of their dying an intellectual death when the social environment provided such obvious opportunity for participating in a running dialectical debate. Compared to the solitary existence of my own monkeys, the set-up in Hinde's social groups came close to resembling a simian School of Athens.

Several of the other contributors to this book consider the dialectics of social interaction, and do so with much more authority than I can. None of them,

I think, would claim that scientific study of the subject is yet far advanced. Much of the best published literature is in fact genuinely 'literature' – Aesop and Dickens make, in their own way, as important contributions as Laing, Goffman or Argyle. But one generalisation can I think be made with certainty: the life of social animals is highly problematical. In a complex society, such as those we know exist in higher primates, there are benefits to be gained for each individual member both from preserving the overall structure of the group and at the same time from exploiting and out-manoeuvring others within it (see later). Thus social primates are required by the very nature of the system they create and maintain to be calculating beings; they must be able to calculate the consequences of their own behaviour, to calculate the likely behaviour of others, to calculate the balance of advantage and loss – and all this in a context where the evidence on which their calculations are based is ephemeral, ambiguous and liable to change, not least as a consequence of their own actions. In such a situation, 'social skill' goes hand in hand with intellect, and here at last the intellectual faculties required are of the highest order. The game of social plot and counter-plot cannot be played merely on the basis of accumulated knowledge, any more than can a game of chess.

Like chess, a social interaction is typically a *trans*action between social partners. One animal may, for instance, wish by his own behaviour to change the behaviour of another; but since the second animal is himself reactive and intelligent the interaction soon becomes a two-way argument where each 'player' must be ready to change his tactics – and maybe his goals – as the game proceeds. Thus, over and above the cognitive skills which are required merely to perceive the current state of play (and they may be considerable), the social gamesman like the chess player must be capable of a special sort of forward planning. Given that each move in the game may call forth several alternative responses from the other player this forward planning will take the form of a decision tree, having its root in the current situation and growing branches corresponding to the moves considered in looking ahead from there at different possibilities. It asks for a level of intelligence which is, I submit, unparalleled in any other sphere of living. There may be, of course, strong and weak players* – yet, as master or novice, we and most other members of complex primate societies have been in this game since we were babies.

* 'Weak players grow short bushy trees, looking a short way ahead at a mass of poorly differentiated possibilities; strong players prune the tree much more efficiently and... construct long thin trees, looking much deeper into a few critical variations. This pruning is the heart of the problem... Which branches are critical, and which are redundant and can safely be cut off?' – from an article in the *New Scientist* (vol. **66**, p. 119, 1975) on the first World Computer Chess Championship. It may be that the acquisition of social skill involves the learning of standard 'gambits' and 'defences' – relatively stereotyped patterns of interaction – which allow transactions to proceed quickly and smoothly from one critical decision point to another.

But what makes a society 'complex' in the first place? There have probably been selective pressures of two rather different kinds, one from without, the other from within society. I suggested above that one of the chief functions of society is to act as it were as a 'polytechnic school' for the teaching of subsistence technology. The social system serves the purpose in two ways: (i) by allowing a period of prolonged dependence during which young animals, spared the need to fend for themselves, are free to experiment and explore; and (ii) by bringing the young into contact with older, more experienced members of the community from whom they can learn by imitation (and perhaps, in some cases, from more formal 'lessons'). Now, to the extent that this kind of education has adaptive consequences, there will be selective pressures both to prolong the period of untrammelled infantile dependency (to increase the 'school leaving age') and to retain older animals within the community (to increase the number of experienced 'teachers'). But the resulting mix of old and young, caretakers and dependents, sisters, cousins, aunts and grandparents not only calls for considerable social responsibility but also has potentially disruptive social consequences. The presence of dependents (young, injured or infirm) clearly calls at all times for a measure of tolerance and unselfish sharing. But in so far as biologically important resources may be scarce (as subsistence materials must sometimes be, and sexual partners will be commonly) there is a limit to which tolerance can go. Squabbles are bound to occur about access to these scarce resources and different individuals will have different interests in participating in, promoting or putting a stop to such squabbles. In the last resort every individual should give priority to the survival of his own genes, and following the theoretical analysis outlined by Hamilton and Trivers (see Bertram and Clutton-Brock & Harvey, this volume) we may predict considerable conflicts of interest among the members of any community which spans more than a single generation; the greater the number of generations present the more complex the picture becomes. Thus the stage is set within the 'collegiate community' for considerable political strife. To do well for oneself whilst remaining within the terms of the social contract on which the fitness of the whole community ultimately depends calls for remarkable reasonableness (in both literal and colloquial senses of the word). It is no accident therefore that men, who of all primates show the longest period of dependence (nearly 30 years in the case of Bushmen!), the most complex kinship structures, and the widest overlap of generations within society, should be more intelligent than chimpanzees, and chimpanzees for the same reasons more intelligent than cercopithecids.

Once a society has reached a certain level of complexity, then new internal pressures must arise which act to increase its complexity still further. For,

in a society of the kind outlined, an animal's intellectual 'adversaries' are members of his own breeding community. If intellectual prowess is correlated with social success, and if social success means high biological fitness, then any heritable trait which increases the ability of an individual to outwit his fellows will soon spread through the gene pool. And in these circumstances there can be no going back: an evolutionary 'ratchet' has been set up, acting like a self-winding watch to increase the general intellectual standing of the species. In principle the process might be expected to continue until either the physiological mainspring of intelligence is full-wound or else intelligence itself becomes a burden. The latter seems most likely to be the limiting factor; there must surely come a point where the time required to resolve a social 'argument' becomes insupportable.

The question of the time given up to unproductive social activity is an important one. The members of my model collegiate community – even if they have not evolved a run-away intellect – are bound to spend a considerable part of their lives in caretaking and social politics. It follows that they must inevitably have less time to spare for basic subsistence activities. If the social system is to be of any net biological benefit the improvement in subsistence techniques which it makes possible must more than compensate for the lost time. To put the matter baldly: if an animal spends all morning in non-productive socialising, he must be at least twice as efficient a producer in the afternoon. We might therefore expect that the evolution of a social system capable of supporting advanced technology should only happen under conditions where improvements in technique can substantially increase the return on labour. This may not always be the case. To take an extreme example, the open sea is probably an environment where technical knowledge can bring little benefit and thus complex societies – and high intelligence – are contra-indicated (dolphins and whales provide, maybe, a remarkable and unexplained exception). Even at Gombe the net advantage of having a complex social system may in fact be marginal; the chimpanzees at Gombe share several of the local food resources with baboons, and it would be instructive to know how far the advantage that chimpanzees have over baboons in terms of technical skill is eroded by the relatively large amount of time they give up to social intercourse. It may be that what the chimpanzees gain on the swings of technical proficiency they lose on the roundabouts of extravagant socialising.* As it is, in a year of poor harvest the chimpanzees in fact become much

* MacFarland (see his discussion of 'optimisation' in this volume) might like to draw an isocline linking points of 'equal net productivity' in a space defined by the two axes, 'technical skill' and 'time given over to social activity'. It is, of course, intrinsic to my argument that these axes are not independent, since I am suggesting that social activity is a prerequisite of technical skill. However, the same is probably true of his own illustrative example (p. 62), since a university lecturer's teaching ability is almost certainly not independent of his research ability.

less sociable (Wrangham, 1975); my guess is that they simply cannot spare the time (cf. Gibb, 1956; Baldwin & Baldwin, 1972). The ancestors of man, however, when they moved into the savanna, discovered an environment where technical knowledge began to pay new and continuing dividends. It was in that environment that the pressures to give children an even better schooling created a social system of unprecedented complexity – and with it unprecedented challenge to intelligence.

The outcome has been the gifting of members of the human species with remarkable powers of social foresight and understanding. This social intelligence, developed initially to cope with local problems of inter-personal relationships, has in time found expression in the institutional creations of the 'savage mind' – the highly rational structures of kinship, totemism, myth and religion with characterise primitive societies (Lévi-Strauss, 1962). And it is, I believe, essentially the same intelligence which has created the systems of philosophical and scientific thought which have flowered in advanced civilisations in the last four thousand years. Yet civilisation has been too short lived to have had any important evolutionary consequences; the 'environment of adaptiveness' (Bowlby, 1969) of human intelligence remains the *social* milieu.

If man's intellect is thus suited primarily to thinking about people and their institutions, how does it fare with *non-social* problems? To end this paper I want to raise the question of 'constraints' on human reasoning, such as might result if there is a predisposition among men to try to fit non-social material into a social mould (cf. Hinde & Stevenson-Hinde, 1973).

When a man sets out to solve a social problem he may reasonably have certain expectations about what he is getting in to. First, he should know that the situation confronting him is unlikely to remain stable. Any social transaction is by its nature a developing process and the development is bound to have a degree of indeterminacy to it. Neither of the social agents involved in the transaction can be certain of the future behaviour of the other; as in Alice's game of croquet with the Queen of Hearts, both balls and hoops are always on the move. Someone embarking on such a transaction must therefore be prepared for the problem itself to alter as a consequence of his attempt to solve it – in the very act of interpreting the social world he changes it. Like Alice he may well be tempted to complain 'You've no idea how confusing it is, all the things being alive'; that is not the way the game is played at Hurlingham – and that is not the way that non-social material typically behaves. But, secondly, he should know that the development *will* have a certain logic to it. In Alice's croquet game there was real confusion, everyone played at once without waiting for turns and there were no rules; but in a social transaction there are, if not strict rules, at least definite constraints on

what is allowed and definite conventions about how a particular action by one of the transactors should be answered by the other. My earlier analogy with the chess game was perhaps a more appropriate one; in social behaviour there is a kind of turn-taking, there are limits on what actions are allowable, and at least in some circumstances there are conventional, often highly elaborated, sequences of exchange.

Even the chess analogy, however, misses a crucial feature of social interaction. For while the good chess player is essentially selfish, playing only to win, the selfishness of social animals is typically tempered by what, for want of a better term, I would call *sympathy*. By sympathy I mean a tendency on the part of one social partner to identify himself with the other and so to make the other's goals to some extent his own. The role of sympathy in the biology of social relationships has yet to be thought through in detail, but it is probable that sympathy and the 'morality' which stems from it (Waddington, 1960) is a biologically adaptive feature of the social behaviour of both men and other animals – and consequently a major constraint on 'social thinking' wherever it is applied. Thus our man setting out to apply his intelligence to solve a social problem may expect to be involved in a fluid, transactional exchange with a sympathetic human partner. To the extent that the thinking appropriate to such a situation represents the customary mode of human thought, men may be expected to behave inappropriately in contexts where a transaction cannot in principle take place: if they treat inanimate entities as 'people' they are sure to make mistakes.

There are many examples of fallacious reasoning which would fit such an interpretation. The most obvious cases are those where men do in fact openly resort to animistic thinking about natural phenomena. Thus primitive – and not so primitive – peoples commonly attempt to *bargain* with nature, through prayer, through sacrifice or through ritual persuasion. In doing so they are explicitly adopting a social model, expecting nature to participate in a transaction. But nature will not transact with men; she goes her own way regardless – while her would-be interlocutors feel grateful or feel slighted as the case befits. Transactional thinking may not always be so openly acknowledged, but it often lies just below the surface in other cases of 'illogical' behaviour. Thus the gambler at the roulette table, who continues to bet on the red square precisely because he has already lost on red repeatedly, is behaving as though he expects the behaviour of the roulette wheel to respond eventually to his persistent overtures; he does not – as he would be wise to do – conclude that the odds are unalterably set against him. Likewise, the man in Wason's experiments on abstract reasoning, who, when he is given the task of discovering a mathematical rule typically tries to substitute *his own* rule for the predetermined one (Wason & Johnson-Laird, 1972), is acting as though he expects the problem itself to change in response to his trial solutions. The comment of one of Wason's subjects is revealing: 'Rules are relative. If you were the subject, and I were the experimenter, then I would be right'. In general, I would suggest, a transactional approach leads men to refuse to accept the intransigence of facts – whether the facts are physical events, mathematical axioms or scientific laws; there will always be the temptation to assume that the facts will respond like living beings to social pressures. Men expect to argue *with* problems rather than being limited to arguing *about* them.

There are times, however, when such a 'mistaken' approach to natural phenomena can be unexpectedly creative. While it may be the case that no amount of social pleading will change the weather or, for that matter, transmute base metals into gold, there are things in nature with which a kind of social intercourse is possible. It is not strictly true that nature will not transact with men. If we mean by a transaction essentially a developing relationship founded on mutual give and take, then several of the relationships which men enter into with the non-human things around them may be considered to have transactional qualities. The cultivation of plants provides a clear and interesting example: the care which a gardener gives to his plants (watering, fertilising, hoeing, pruning etc.) is attuned to the plants' emerging properties, which properties are in turn a function of the gardener's behaviour. True, plants will not respond to ordinary social pressures (though men *do* talk to them), but the way in which they give to and receive from a gardener bears, I suggest, a close structural similarity to a simple social relationship. If Trevarthen (1974) can speak of 'conversations' between a mother and a two-month old baby, so too might we speak of a conversation between a gardener and his roses or a farmer and his corn. And the same can be argued for men's interactions with certain wholly inanimate materials. The relationship of a potter to his clay, a smelter to his ore or a cook to his soup are all relationships of fluid mutual exchange, again proto-social in character.

It is not just that transactional thinking is typical of man, transactions are something which people actively seek out and will force on nature wherever they are able. In the Doll Museum in Edinburgh there is a case full of bones clothed in scraps of rag – moving reminders of the desire of human children to conjure up social relationships with even the most unpromising material. Through a long history, men have, I believe, explored the transactional possibilities of countless of the things in their environment and sometimes, Pygmalion-like, the things have come alive. Thus many of mankind's most prized technological discoveries, from agriculture to chemistry, may have had their origin not in the deliberate application of practical intelligence but in the fortunate misapplication of social intelligence. 'Once Nature had set up

men's minds the way she has, certain 'unintended' consequences followed – and we are in several ways the beneficiaries' (Humphrey, 1973*b*).

The rise of classical scientific method has in large measure depended on human thinkers disciplining themselves to abjure transactional, socio-magical styles of reasoning. But scientific method has come to the fore only in the last few hundred years of mankind's history, and in our own times there are everywhere signs of a return to more magical systems of interpretation. In dealing with the non-social world the former method is undoubtedly the more immediately appropriate; but the latter is perhaps more natural to man. Transactional thinking may indeed be irrepressible: within the most disciplined Jekyll is concealed a transactional Hyde. Charles Dodgson the mathematician shared his pen amicably enough with Lewis Carroll the inventor of Wonderland but the split is often neither so comfortable nor so complete. Newton is revealed in his private papers as a Rosicrucian mystic, and his intellectual descendants continue to this day to apply strange double-standards to their thinking – witness the way in which certain British physicists took up the cause of Uri Geller, the man who, by wishing it, could bend a metal spoon (e.g. Taylor, 1975). In the long view of science, there is, I suspect, good reason to approve this kind of inconsistency. For while 'normal science' (in Kuhn's sense of the words) has little if any room for social thinking, 'revolutionary science' may more often than we realise derive its inspiration from a vision of a socially transacting universe. Particle physics has already followed Alice down the rabbit hole into a world peopled by 'families' of elementary particles endowed with 'strangeness' and 'charm'. *Vide*, for example, the following report: 'The particles searched for at SPEAR were the *cousins* of the psis made from one *charm* quark and one *uncharmed* antiquark. This contrasts with the *siblings* of the psis...' (*New Scientist*, vol. **67**, p. 252, 1975, my italics). Who knows where such 'sociophysics' may eventually lead?

The ideology of classical science has had a huge but in many ways narrowing influence on ideas about the nature of 'intelligent' behaviour. But no matter what the high priests, from Bacon to Popper, have had to say about how people ought to think, they have never come near to describing how people *do* think. In so far as an idealised view of scientific method has been the dominant influence on mankind's recent intellectual history, biologists should be the first to follow Henry Ford in dismissing recent history as 'bunk'. Evolutionary history, however, is a different matter. The formative years for human intellect were the years when man lived as a social savage on the plains of Africa. Even now, as Browne wrote in *Religio medici*, 'All Africa and her prodigies are within us'.

Postscript

My attention has been drawn to a paper by Jolly (1966) on 'Lemur social behaviour and primate intelligence' which anticipates at several points the argument developed here. I have not attempted to re-write my own paper in a way that would do justice to Jolly's ideas; I hope that people who are intrigued by the relation between social behaviour and intelligence will refer directly to her original and interesting discussion.

In relation to both Jolly's paper and my own the question arises how can the hypotheses be tested. My central thesis clearly demands that there should be a positive correlation across species between 'social complexity' and 'individual intelligence'. Does such a correlation hold? It is not hard to find confirmatory examples; nor is it hard to find excuses for rejecting examples which are seemingly contrary – e.g. wolves (high social complexity without the requisite intelligence?) or orang-utans (high intelligence without the requisite social complexity?). But the trouble is that too much of the evidence is of an anecdotal kind: we simply do not have agreed definitions or agreed ways of measuring either of the relevant parameters. What, I think, is urgently needed is a laboratory test of 'social skill' – a test which ought, if I am right, to double as a test of 'high-level intelligence'. The essential feature of such a test would be that it places the subject in a transactional situation where he can achieve a desired goal only by adapting his strategy to conditions which are continually changing as a consequence partly but not wholly of his own behaviour. The 'social partner' in the test need not be animate (though my guess is that the subject would regard it in an 'animistic' way); possibly it could be a kind of 'social robot', a mechanical device which is programmed on-line from a computer to behave in a pseudo-social way.

SUMMARY

I argue that the higher intellectual faculties of primates have evolved as an adaptation to the complexities of social living. For better or worse, styles of thinking which are primarily suited to social problem-solving colour the behaviour of man and other primates even towards the inanimate world.

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