

Machiavellian Intelligence II

Extensions and Evaluations

EDITED BY

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1 Machiavellian intelligence

RICHARD W. BYRNE AND ANDREW WHITEN

After a very slow germination in the more than 20 years leading up to 1988, the 'Machiavellian intelligence hypothesis' has subsequently been evoked as an explanatory theory in a wide range of contexts: neurophysiology (Brothers, 1990), social anthropology (Goody, 1995), medicine (Crow, 1993) and even news broadcasting (Venables, 1993), in addition to its impact on psychology and studies of primate evolution. All of a sudden, the idea that intelligence began in social manipulation, deceit and cunning co-operation seems to explain everything we had always puzzled about. This popularity may, of course, simply reflect its correctness. However, the vagueness of the theory may also have helped, allowing it to be 'all things to all men'. The book that brought in the name did not even contain a single, clear definition of the Machiavellian intelligence hypothesis (Byrne & Whiten, 1988a)! This was not simply carelessness, but a reflection of the reality. In many ways, 'Machiavellian intelligence' is better seen, not as a precise theory, but as a *banner* for a cluster of hypotheses that have been under active investigation since before we coined the label.

All these hypotheses share one thing: the implication that *possession of the cognitive capability we call 'intelligence' is linked with social living and the problems of complexity it can pose*. In the mid-1980s, we thought we could discern a rise in the number of studies that acknowledged the potential explanatory power of the hypothesis. However, these were often rather disparate strands: the time, we felt, was ripe for an attempt to orchestrate them into what we hoped would be the beginnings of a more coherent and focused appraisal. In '*Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes and Humans*', the volume we edited in 1988, we therefore did two things (Byrne & Whiten, 1988a). We reprinted those theoretical and empirical contributions that

seemed to us to have been seminal, and then in addition we invited 18 scientists to make specific new contributions. A measure of the need for integration of the topic in those days was that none of the empirical papers we considered important at that time made much direct reference to the theoretical ones. However, since publication of that volume, the links between the themes it developed have become well recognised and the subject of an exciting flurry of research activity. In this chapter, we aim to orientate the reader – particularly the reader new to Machiavellian intelligence – with an overview of the research strands that seemed most important in 1988, and the subsequent developments that have guided us in preparing '*Machiavellian Intelligence II*'.

Origins of the theory

The origins of the general idea are diverse, and extend back many years before 1988. Perhaps most famously, Nicholas Humphrey (1976) argued that primates appear to have 'surplus' intelligence for their everyday wants of feeding and ranging. So, since evolution is unlikely to select for surplus capacity, we scientists must have been missing something. Humphrey identified that 'something' as the *social complexity* inherent in many primate groups, and suggested that the social environment might have been a significant selective pressure for primate intelligence. Group living, he suggested, must be beneficial overall to each member or it would not occur, yet only individual (and kin) benefits drive evolution. For each individual primate, this sets up an environment favouring the use of *social manipulation* to achieve individual benefits at the expense of other group members, but without causing such disruption that the individual's membership of the group is put in jeopardy. Particularly useful to this end would be manipulations in which the losers are unaware of their loss, as in some kinds of *deception*, or in which there are compensatory gains, as in some kinds of *co-operation*. Intelligence is thereby favoured as a trait, and since this selective pressure applies to all group members, an evolutionary arms-race is set up, leading to spiralling increases in intelligence. (Rather than getting bogged down in the philosophical quagmire of defining 'intelligence', let us – like Humphrey – simply treat it as whatever mechanisms enable an individual to take into account these complexities of social or other life and devise appropriate responses.) Humphrey suggested that the resulting intelligence in social primates would probably be of a sort particularly suited to social problems

and not well-tested by the gadgetry of psychologists' laboratories, so explaining the many failures to find differences in intelligence between animals (see Warren, 1973; Macphail, 1982). This implies that there might in principle be a 'non-social intelligence', which perhaps we might seek in other groups of animals than primates, or indeed in computer science laboratories.

Ten years earlier, Alison Jolly (1966) had had a similar insight. The lemurs she studied in Madagascar *lacked* the intelligence evident to her in monkeys, yet they lived in similar-sized groups. Jolly realized that this was inconsistent with the idea – popular at the time – that monkey-level intelligence is necessary for long-term group living, and she suggested instead that *group living, arising without great need of intelligence, would subsequently tend to select for intelligence*. She did not suggest, as Humphrey later did, that primate intelligence is especially tuned to social problems.

Even earlier, in 1953, Michael Chance and Allan Mead had linked primate social complexity to *neocortical enlargement*, although they did not explicitly mention intelligence. Specifically, they pointed to the extended receptivity of female primates and the conflict situations that this sets up for males, arguing that taking into account the movements of both the female and a competing male during manoeuvring poses a peculiarly difficult problem for a male (Chance & Mead, 1953). In the early 1950s, sexual conflict was still seen as the basis of primate society (Zuckerman, 1932), but by 1988 this exclusive emphasis on male–male conflict as demanding intelligence found little support. Nevertheless, Chance and Mead's theoretical speculations foreshadowed those of Jolly and Humphrey many years later, and interestingly (in the light of future controversies; see Chapter 9) Chance and Mead assumed that the absolute size of the neocortex was linked to dealing with complex problem solving.

This brief recap brings out several of the questions underlying the early variants of the Machiavellian hypothesis:-

- *Sources of complexity*. If intelligence is hypothesised to be an adaptation for dealing with complexity, can we validly compare complexity in social living and complexity in exploitation of the physical environment; and if so, which one is in fact the greater, for a species?
- *Domain specificity*. Is primate intelligence particularly tuned to social problems, making primates less able to deal with

logically comparable problems in non-social domains? If so, are some species tuned to other sorts of problem domain; in particular, is human intelligence socially 'biased'?

- *Mechanisms of social competition.* Where intelligence is shown in the social domain, does it manifest mainly as 'nasty' deceit and exploitation, or is 'nice' co-operation also enhanced? (The more general issue here is whether the terms 'nice' and 'nasty' have any useful meaning in an evolutionary context, since to evolve a behavioural trait needs simply to be adaptive for the individuals that possess it. More sensibly, we might ask: does mutualistic co-operation require more or less intelligence than competitive manipulation?)
- *Brain evolution.* Is greater intelligence reflected in changes in size or structure of the brain, and if so, how are these best measured?

The extent of primate social complexity

Psychologists and primatologists have long asserted and aimed to demonstrate that primates are socially complex animals; indeed, that is many people's reason for studying them. What, specifically, does this social complexity amount to?

A structured society is suggested by the existence of stable dominance hierarchies, extensive matriline, and regular patterns of long-term group membership and intergroup transfer; and these features have been known in primates for many years. In some monkey species, the influence of kin support is so profound that it appears that dominance rank is 'inherited', not earned by demonstrations of power and skill (Kawamura, 1958; Sade, 1967; see Chapais, 1992). Further, the influence of third parties on the outcomes of contests is pervasive (see references in Harcourt & de Waal, 1992). Kummer (1967) was a pioneer in documenting the female hamadryas baboon's use of a powerful male to enable her to make threats with impunity; and Harcourt (1988, 1992) marshalled studies showing that primates use alliances far more than non-primates, and unlike them, choose potential allies on the basis of their competitive value. In Old World monkeys and apes, evidence began to appear that individuals use grooming to build up relationships that can be drawn upon for later support (e.g. Seyfarth, 1977; Seyfarth & Cheney, 1984), and that temporarily

impaired relationships could be patched up with deliberate and distinctive acts of reconciliation (de Waal & van Roosmalen, 1979; de Waal and Luttrell, 1988). In some species, notably chimpanzees, the manoeuvring to gain alliances and influence powerful individuals appeared to be so subtle that the terms 'political' and 'Machiavellian' came to be used to describe it (de Waal, 1982; Nishida, 1983). These issues of alliance formation and repair, coalitions and political behaviour have since been extensively explored in Harcourt & de Waal (1992: see also Chapters 2 and 3).

It is tempting to describe these aspects of complexity as if only we, the primatologists, were aware of them. However, a programme of work by Dorothy Cheney and Robert Seyfarth, in which field playback experiments were used to ask what vervet monkeys know about their calls, has shown that this would be misleading (Cheney & Seyfarth, 1990). Vervets' reactions have demonstrated that they are aware of the relative ranks of third parties (not simply the rank with respect to themselves), the group membership of individuals belonging to other troops, and some aspects of kinship among matriline. The last point has been directly addressed in experiments by Dasser (1988). Macaque monkeys were rewarded for picking the right picture of a monkey face, given a cue of the face of another monkey that was systematically related to the rewarded picture; the particular relationship was, in different experiments, 'mother-daughter' or 'sibling'. Monkeys were able to learn this task, showing that they appreciate the closeness of connection among these pairs of individuals. Cheney & Seyfarth (1990) have explored the social knowledge of vervet monkeys in great depth, but the extent to which other primates are similar to these small Old World species is a topic in its infancy.

Another way in which an intelligent primate can exploit the social group it lives in is in its use of *other* individuals' knowledge or skill. Emil Menzel showed as long ago as 1974 the extraordinary ability of chimpanzees to pick up small cues from the behaviour of others, so learning the location and nature of objects they had not seen themselves (Menzel, 1974). Social learning is invaluable for many birds and mammals (Zentall & Galef, 1988): living socially provides many opportunities for safely learning what predators to avoid, what foods to eat and where to find them, for example. But if primates can in addition imitate the adaptive behaviour patterns of others, their potential for profiting from social living is greatly enhanced. Hauser (1988) carefully documented a case of the rapid spread of a specific feeding technique among vervet monkeys that appeared to rely on imitative learning, and that helped the animals

to exploit a special food during a drought crisis. However, the extent of cultural learning through imitation has become a subject of surprising controversy (Whiten, 1989). Visalberghi & Fragaszy (1990), for example, showed in a series of careful experimental tests that the efficiency of capuchin monkeys' learning of tool use rested on individual discovery rather than imitation. The role and nature of observational learning in primates has thus become the subject of renewed research activity (see Chapter 7).

The issue of whether *any* species of animal can imitate, and if so in what fashion, remains controversial; but several lines of evidence point to some sort of imitative ability in great apes. For example, wild mountain gorillas rapidly acquire complex techniques for preparing plant foods, and the overall structure of the procedures are remarkably standardised, despite great individual variations in the details of finger movements and lateral biases (Byrne & Byrne, 1991, 1993); the inherent improbability of such complex sequences being determined by individual learning has been used to argue that gorillas imitate at 'program-level' (Byrne, 1994; Byrne & Russon, 1998). Such foraging skills are the most likely functional context for imitation in the wild, but identification of imitation as a learning process can be easier under relatively novel, or non-natural conditions: for example, at a forest camp during the process of 'rehabilitation' from captivity to the wild, orangutans copy many distinctive human procedures (Russon & Galdikas, 1993; see Chapter 7). Alternatively, the novel actions may be provided experimentally. The capacity of apes to imitate has been so much *assumed*, that proper experimental tests have only recently been conducted, with unexpected and interesting results; some data suggest that home-rearing by humans imparts an ability to imitate in ways that wild apes cannot, as if the home-reared ape's mind is 'programmed' by distinctively human mother–infant patterns of interaction (Tomasello *et al.*, 1987, 1993; and see Chapter 6).

Alongside the new debates about mechanisms in social learning that this has engendered, researchers have continued to document *cultural* differences in wild apes, most strikingly amongst chimpanzees, which underscore the capacity of these animals to benefit from local opportunities to learn from others (Nishida, 1987; Wrangham *et al.*, 1994). Questions about imitation and other acquisition mechanisms aside, primates can profit from other individuals' skills in more direct ways. Stambach (1988) trained one individual in the skill needed to operate a food-dispenser, and other group members rapidly adjusted to the possibilities

of scrounging, learning to refrain from displacing the skilled individual, whose social status increased (see Chapter 7).

Our own introduction to primate complexity was in discovering that deception was being practised among the baboons whose behavioural ecology we were investigating (Byrne & Whiten, 1985). At the time, deception of a tactical nature, practised on fellow group members, was only known from chimpanzees. Our subsequent surveys (Whiten & Byrne, 1988b; Byrne & Whiten, 1990, 1992), pooling data contributed by a large number of experienced primatologists, showed that deception was used by all families of monkeys and apes, but not definitely by strepsirrhine primates (but see Chapter 5). In most cases, the deception served to manipulate the *attention* of conspecifics: distracting them from their current actions, preventing them noticing things, deflecting their attention onto other stimuli (Whiten & Byrne, 1988a). Perhaps the greatest sophistication in primate deception is shown by the great ape individuals who were reared in human-like ways for 'ape-language' studies (see Savage-Rumbaugh & McDonald, 1988).

Some instances of primate tactical deception may be deliberately planned, but in the great majority of cases it is plausible that the deceptive tactic is learnt, reflecting the very rapid learning capacity of monkeys and apes (Byrne & Whiten, 1992; Byrne, 1995). Monkeys and apes are relatively large-brained compared with strepsirrhine primates or any other mammals (Passingham, 1982; Martin, 1990), suggesting that there could be a link between the extent to which subtle social manipulation is expressed, and brain enlargement allowing rapid learning. This was tested by Byrne (1993), who showed that the amount of tactical deception reported, in excess of that expected from the overall number of field studies done on a species, was significantly related to the species' neocortical expansion (see Chapter 9).

The depth of primate understanding

In parallel with this body of work demonstrating the complexity of interactions among social groups of primates, evidence has also grown that individuals of some species have a deeper, more 'human-like' understanding of each other. Central to these claims is the topic of *theory of mind*. The term was introduced by Premack & Woodruff (1978) to explain the actions of a chimpanzee, but has since become a major topic for other

disciplines including human developmental psychology and philosophy (e.g. Astington *et al.*, 1988; Whiten, 1991; Lewis & Mitchell, 1994; Carruthers & Smith, 1996).

If an individual is able to respond differentially, according to the beliefs and desires of another individual (rather than according only to the other's overt behaviour), then it possesses a theory of mind. In Premack and Woodruff's experiments, a chimpanzee was shown a film clip, depicting a human attempting to solve a problem, and failing; for instance, a man trying to get a bunch of bananas above his reach. The chimpanzee was then offered, without training, a choice of photographs, one of which showed the solution to the filmed man's problem (here, stepping onto a chair, rather than, say, pushing a stick through an opening, or eating a banana). The chimpanzee performed above chance, leading the authors to argue that its behaviour was based on understanding the goals of the human in the film clip, not merely a physical sequence of events: a 'theory' of mind.

A second experimental paradigm, used to support this conclusion, concerns the relation between *seeing* something (an observable) and *knowing* what happened (a state of belief). Premack (1988) allowed a chimpanzee to see that one of two trainers was able to see which container was being baited – but not to see which container it was. The chimpanzee then chose between the trainers by pulling a string, and the one chosen then indicated a bait container (in the case of the trainer who had not witnessed the baiting, this was always the wrong one). Three of the four chimpanzees tested in this experiment chose the 'knowledgeable' trainer significantly above chance. Povinelli and his co-workers (Povinelli *et al.*, 1990, 1991) have conducted an extensive series of experiments on this basic idea, and compared the performance of chimpanzees with rhesus macaques. Whether the 'ignorance' of one trainer was created by absence from the room during baiting, by an occluding screen, or by a paper bag pulled over the head, most chimpanzees were able to successfully follow the indications of the 'knowledgeable' person, whereas the monkeys remained at chance.

Premack (1988) argued that such experiments are the only way we possess of discovering whether animals recognise states of mind, and that they provide *unequivocal* evidence, whereas purely observational data can never resolve the basic ambiguity of whether performance is based on understanding or learning by conditioning. He singled out ourselves, along with Goodall, as relying on mere, unreliable anecdotes. This attack

on observational data was taken up by Kummer *et al.* (1990), Kennedy (1992) and Heyes (1993a). The consensus of these researchers is that unlike observational data, the result of a good experiment is unequivocal. There is no dispute about the value of appropriate experimentation (e.g. see Byrne & Whiten, 1988b, p. 267; de Waal, 1991). However, in the untidy, real world, experiments also require interpretation. Indeed, by 1988, Premack had concluded that the results of his 1978 experiment on theory of mind were equivocal and that 'there is, on the whole, only suggestive evidence for theory of mind in the chimpanzee' (Premack, 1988, p. 179). Heyes (1993a) pointed out that Povinelli's refined version of Premack's knowledge/ignorance experiment is also ambiguous in its interpretation, because only the subject's reaction to the *first* trial in which the trainer's gaze was occluded gives clear evidence that a chimpanzee *understands* the consequences of visual occlusion for knowledge, rather than rapidly learns a new reward schedule. Povinelli (1994) re-analysed his data, and found that on these crucial first trials performance was at chance levels even for the chimpanzees: the 'killjoy' alternative that the animal learns to associate a particular physical arrangement with reward, without understanding mental states, remains distinctly possible. We remain convinced that experiments – no less than observations – require very careful interpretation, and that a single instance of either is unlikely to be a compelling test of a theoretical position.

Fortunately, there is now an extensive body of evidence, from observation and experiment, suggesting differences between apes and monkeys in the ability to take the mental perspective of others. For instance, Povinelli's team (Povinelli *et al.*, 1992a, b) have devised a two-player co-operative task, and tested both rhesus monkeys and chimpanzees. One player can see which handle will provide both with food rewards, but not operate the handle; the other cannot see which to pull, but can reach the handles. Both species learn either role in the task. However, when an individual that has learnt one role is placed in the other, the results are quite different: for the monkeys, the whole task has to be learnt again, while the chimpanzee is able to assume the other role without training. This result shows understanding of the physical cause-and-effect logic of the co-operative task, but whether this requires an understanding of mental states of the other individual is less definite (see Byrne, 1995). Further experiments and observations that relate to this issue are discussed in Chapter 6.

Convergent findings come from our own analyses of deception in

primates. We attempted to tackle the question of intentionality by adopting the approach of constructing the *most plausible history* that might have conditioned each observed tactic (Byrne & Whiten, 1990, 1991; Byrne, 1997). In most cases, we found this *could* be done without having to imagine anything very improbable in the individual primate's history: we treated such cases as probably reflecting a tactic learned without any insight into the mental processes of the deceived victim. However, in a significant number of cases, the scenario we were forced to imagine was so remotely unlikely ever to occur in the lives of the animals, that an explanation based on theory of mind appeared *more* plausible (Byrne & Whiten, 1991). These cases concerned both species of chimpanzee, gorillas and orangutans, but not monkeys.

Intriguingly, a similar monkey/ape rubicon occurs in several other capacities: imitation of actions, pretence in play, mirror self-recognition, and so on. The coincidence of the same pattern – monkeys fail, apes succeed – has perhaps led some authors to relate this to the distribution of theory of mind ability (e.g. Gallup, 1982; Whiten & Byrne, 1991); yet these phenomena are much less obviously dependent upon theory of mind – as we have already discussed in the case of imitation. Similarly, the relevance to Machiavellian intelligence, of recognising that a reflection in a mirror is that of oneself, needs to be established by more than correlation. There is now abundant evidence that some chimpanzees, orangutans and gorillas can show by their behaviour that they can recognise a reflection in a mirror as an image of themselves; whereas monkeys cannot (Gallup, 1970; Suarez & Gallup, 1981; Patterson & Cohn, 1994). Gallup's classic test of this, to mark with odourless paint a part of the anatomy not visible without a mirror, has been criticised for poor controls and possible artefacts due to the use of anaesthetic (Heyes, 1993b). However, a version of this test recently applied to two gorillas did *not* use anaesthetic, yet met with success (Patterson & Cohn, 1994); and much film exists showing the reaction of apes catching sight of their marked faces that leaves no doubt in the minds of viewers that the result is genuine. Its meaning is less clear. Early claims that mirror self-recognition indicates self-consciousness and a sense of mortality seem far-fetched; some would go so far as to argue that no more than cross-modal matching is involved (e.g. Mitchell, 1993; Heyes, 1993b).

On current evidence, then, great apes appear to have a greater depth of social understanding than monkeys or strepsirrhine primates (see Chapter 6). This would interact, of course, with the 'complexity' of their societ-

ies: if great apes have, but monkeys lack, a theory of mind, then apes' social lives would be *inherently* more complex, even where superficially their behaviour may seem the same. Just as Chance & Mead (1953) argued that a monkey, taking the probable actions of a third party into account, is facing a more challenging world than an animal that only interacts dyadically, if an ape in the same circumstance is taking into account the probable thoughts as well as actions of its partners in interaction, then the social problems it is tackling are greater still.

Domain specificity

Humphrey (1976), alone of the original proposers of the Machiavellian intelligence hypothesis, suggested that primate intelligence is biased towards social problem-solving by its evolutionary origins. This idea has been taken up by Cheney & Seyfarth (1988, 1990), who studied the reactions of vervet monkeys to aspects of natural history by experiment and observation. These monkeys, known to take account of subtleties such as rank, kinship and group membership of other vervets, and capable of using alarm calls (of other vervets and of superb starlings) to identify the particular type of predator hazard that is nearby, seem relatively unsophisticated when it comes to general natural history. Confronted with experimentally faked tracks of python, or signs of leopard (the distinctive hanging carcass of an antelope in a tree), they show no reaction. This is unlikely to be because vervets discriminate these fakes as such: when the observers once noticed the group walk across a natural track of a python, the monkeys *also* failed to react – until they encountered the snake, and ran back screaming! (Note this use of Cheney and Seyfarth's carefully recorded 'anecdotal' evidence in validating their experimental data.)

Negative data is always hard to deal with, but – if real – the surprising incompetence of monkeys may be less likely to apply to chimpanzees. When engaged in raids into the range of neighbour communities, they routinely examine signs of chimpanzees on the trail and sniff at old chimpanzee nests, convincing observers they are fairly skilled trackers (Goodall, 1986). Perhaps instead of implying that 'primate intelligence is socially biased', we have here another case of monkey/ape difference in understanding. That is, perhaps skills we recognise as 'intelligent' developed *first* in the early ancestors of all modern monkeys and apes, but at that time only applied to the social arena; more recently, the ancestors of modern great apes developed an enhanced intelligence that gives insight

in both technical and social domains (Byrne, 1995). If this were the case, there might be no reason to expect a legacy of *socially*-biased intelligence in humans (see Chapter 11).

Nevertheless, there has been increasing interest in recent years in a legacy of characteristically social cognitive adaptations in our species (e.g. Barkow *et al.*, 1992; Baron-Cohen *et al.*, 1993; Erdal & Whiten, 1994; Goody, 1995). Smith (1988) showed that children demonstrate concepts of rank and transitivity in dealing with other children, well before these skills can be detected using non-social tests. Cosmides (1989) argues more radically still, that human intelligence consists entirely of discrete 'modules' of ancient (and often social) origin, producing strong biases in current abilities (see Chapters 10, 12, 13 and 14).

Theoretical issues

Several issues of interpretation or disagreement, within the broad compass of the Machiavellian intelligence hypothesis, have already emerged in the course of this summary. Other disagreements exist, some going to the heart of the issue, others more tangential.

In what sense is 'Machiavellian' to be understood?

In an effort to make links with references to Machiavelli by evolutionary biologists like ourselves, Wilson *et al.* (1996) have recently reviewed the literature on what is called 'Machiavellianism' in social psychology. In this psychological literature, which now exceeds 300 references, Machiavellianism is seen as a kind of personality trait, with its own tests on which individuals may score as 'high-Machs' or 'low-Machs'. Machiavellianism is defined by Wilson *et al.* as 'a strategy of social conduct that involves manipulating others for personal gain, often against the other's self-interest', in line with its common colloquial usage.

Wilson *et al.* (1996) suggest that our own use of the term implies something broader than this, such that all forms of social intelligence in primates (and perhaps other taxa) are included. This is true: we include not only actions consistent with Machiavellianism in the colloquial sense of relatively short-term personal gain, such as deception, but also acts such as helping and co-operation that are conventionally seen as alternative strategies. Our reason for this was spelled out in the Preface of *Machiavellian Intelligence*. A central tenet of recent evolutionary theory is

that animals' behavioural strategies are geared to maximising 'personal' gain in the ultimate currency of reproductive success (inclusive fitness). From a biological perspective, we felt we were using the term 'Machiavellian' in an entirely apt way, to describe relatively complex social strategies fulfilling (ultimate) personal gain. In addition, Machiavelli himself actually gave advice more consistent with this broad interpretation than with what we might call 'narrow Machiavellianism'. Not for the first time, we had best quote directly:

For a prince . . . it is not necessary to have all the [virtuous] qualities, but it is very necessary to appear to have them . . . [It] is useful, for example, to appear merciful, trustworthy, humane, blameless, religious – *and to be so* – yet to be in such measure prepared in mind that if you need to be not so, you can and do change to the contrary.

(Machiavelli, 1514/1961, our italics).

However, it is clearly important to recognise the different emphases of usage of 'Machiavellian' in these literatures, each justified by the contrasts that are of interest. In the human social psychology literature, the principal interest lies in contrasting immediate self-interest with alternative attitudes that are unselfish, altruistic, and so on. From the evolutionary, comparative perspective, 'Machiavellian' intelligence is an expression used instead for contrast with the simpler social repertoires widespread in the animal kingdom (as well as with non-social uses of intelligence). It is the complex, indirect nature of the strategies we wish to highlight, and this usage seems to have become commonplace in our discipline. Accordingly, it may sometimes be helpful to distinguish 'narrow Machiavellianism' when referring more specifically to the high-Mach/low-Mach dimension of variation.

What is the scope of the theory: Animals, primates, humans?

Up to now, we have only mentioned non-human primates; however, the subtitle of our 1988 book also mentioned humans, and the considerable subsequent interest in Machiavellian intelligence often seems to be motivated by the hope that it might also explain recent, hominid-line intellectual changes.

Researchers are currently divided in the scope they accord social pressures in the evolutionary line that has led from the earliest primates to

humans. There are at least three principal branch points in primate evolution at which there is some evidence of intellectual change in one descendant line. To sharpen the focus of the Machiavellian intelligence hypothesis, we need to identify the selective pressure causing increased intelligence in each of : (a) the haplorhine (monkey and ape) line, which is characterised by larger brains, relatively greater investment in neocortex, greater social sophistication and greater social complexity than the strepsirhine line; (b) the great ape line, which is characterised by an apparently different level of understanding, absolutely larger brains, but no greater proportional investment in neocortex than the monkey line; and (c) the later *Homo* line, which is characterised by massive brain enlargement, and extensive stone tool use. Some consider social pressures as of proven relevance only to the first, haplorhine/strepsirhine transition, and most unlikely to be related to the second, monkey/ape one (e.g. Byrne, 1995); others attribute all intellectual advances among primates to social pressure (e.g. Dunbar, 1992; Aiello & Dunbar, 1993).

Further, according to the Machiavellian hypothesis, an evolutionary selective pressure towards greater social intelligence must surely apply to any species meeting the basic criteria, of living in large, semi-permanent social groups of long-lived individuals. Signs of this should be visible, for instance, in carnivores, elephants, cetaceans, some bats, and some herbivores (see, for example, Connor *et al.*, 1992; Harcourt, 1992; Zabel *et al.*, 1992; see also Chapter 9).

What is claimed by the theory: Social origin, social bias, social module?

Intellectual advancement in response to social challenge may not result in a particularly social 'kind' of intelligence: a domain-general ability might be incremented, with consequent side-effects on any task benefiting from the increase. Alternatively, the social origin of intelligence may leave a legacy in the cognitive machinery itself, detectable now in various ways (e.g. references in Goody, 1995). If the intelligence is merely *biased* towards social tasks, then we would expect greater efficiency in social versions of a logically identical problem than in non-social ones. There is some evidence that this is the case even for humans (Smith, 1988; Cosmides, 1989). However, a stronger claim would be that it has resulted in specific development of a social *module* or modules, independent from