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Mark Lake

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Starting to Think

*The Thinking Ape: the Evolutionary
Origins of Intelligence*
by Richard Byrne, 1995.
Oxford: Oxford University Press, 266 pp.

Mark Lake

Students of human evolution beware: despite a first chapter berating the speculative nature of palaeo-anthropology, this book is not about the evolution of the modern mind. It is — exactly as the sub-title suggests — about the evolutionary origins of intelligence. Intelligence is of course a slippery concept, but insofar as Byrne takes it to be the ability to adapt to unpredictability and change using mentally represented information, then the subject matter of this book is largely pre-human, and indeed pre-hominid. This does not mean that *The Thinking Ape* is irrelevant to those who wish to explain the evolution of the modern mind: such an endeavour can only benefit from knowledge of the ancestral condition and its evolutionary history. It is, however, unfortunate that Byrne opens his book with a claim that much of palaeoanthropology is 'simply not science' and that as a result we will never know with confidence much of what happened in the last five million years of human evolution. This might suggest to the unwary reader that the 'comparative method' used by Byrne *can* provide reliable information about human evolution: in fact Byrne makes no such claim. Consequently, although one can argue with Byrne's bleak assessment of the usefulness of palaeoanthropology, it is more constructive that *The Thinking Ape* be judged first and foremost for what it tells us about the starting point, rather than the course of human evolution. In this respect it is essential reading.

The Thinking Ape is structured around a method which Byrne claims can reliably inform us about some of the mental abilities possessed by the last common ancestor of the extant great apes and hominids. Essentially this involves three stages. The first (Chapter 2) is to reconstruct the evolutionary history of extant primates by applying the method of cladistics to molecular markers. The second stage is to find reliable differences between the intelligence of the living species. This requires some notion of intelligence and what it is for (Chapter 3), which equips Byrne to look in depth at learning (Chapters 4–6) and insight (Chapters 7–11) in monkeys and apes. The final stage is to map the differ-

ences in intelligence onto the evolutionary history established in Chapter 2, and then by 'reversing' cladistic analysis to establish an evolutionary taxonomy of intelligence (Chapter 15). Byrne attempts to explain this taxonomy by testing (Chapter 14) whether environmental (Chapter 12) or social (Chapter 13) selection pressures best account for the origin of enhanced primate intelligence.

The primate evolutionary history presented in Chapter 2 of *The Thinking Ape* contains no surprises for those already familiar with the findings from molecular taxonomy. Byrne places the ape-monkey divergence at 30 My ago followed by a succession of divergences until the human and chimpanzee ancestors part company at 6.2–6.7 My ago. These results are well known, but Byrne's discussion of the methods used to obtain them is unusually clear. His discussion of the cladistic method is particularly helpful in that he is careful to distinguish between establishing the evolutionary taxonomy of extant species and reconstructing the evolutionary origins of specific phenotypic traits. Once the relationships between modern species have been established from derived (new) characters that are extremely unlikely to have evolved more than once it is then possible to run the method in 'reverse' and use the distribution of phenotypic characters in modern species to deduce those of extinct ancestors. As already noted, *The Thinking Ape* is structured around the application of exactly this two-pronged approach.

Establishing the distribution of intelligence in modern primates requires a suitable operational definition of intelligence. Byrne is forced to develop his own since there is no adequate precedent: psychometrics seeks to measure intelligence differences between individuals, while developmental psychology, which is concerned with commonalities within species, has encountered numerous difficulties. Byrne's own background in cognitive psychology is reflected in his focus on thinking about what animals must be doing mentally to produce observed behaviours. He suggests that intelligence must involve an animal's ability to (i) gain knowledge from interactions with the environment and other individuals, (ii) use that knowledge to organize effective behaviour in familiar and novel contexts, and (iii) in some cases put together separate pieces of knowledge to create novel action. Accordingly the core of *The Thinking Ape* is an assessment of how animals, especially primates, gain knowledge (learn) and how they use that knowledge (insight).

The traditional model of knowledge gain distinguishes between individual learning, imitation and

insight. Individual learning is an associative process in which an animal records correlations among what it perceives in the world and the results of its own exploration. Such learning is widespread and probably has little to tell us about the special mental abilities of monkeys and apes, although as Byrne notes, individual learning is genetically channelled to provide useful (adaptive) information. Social animals often appear to learn from the individual learning of other animals. Such social learning is widespread among monkeys and apes: the classic example is the spread of potato-washing among a population of Japanese macaque monkeys. It used to be assumed that all social learning occurred by a process of imitation, but in many cases this is now doubted. Byrne stresses that true imitation requires copying of novel actions which are not already present in the behavioural repertoire of the learner. In contrast, other forms of social learning, such as stimulus enhancement, response facilitation and emulation, merely serve to direct normal associative learning and therefore cannot build up truly novel behaviours. The particular significance of true imitation for intelligence is that, at minimum, it requires the learner to take the model's geometrical perspective, and in some cases to know the model's intention. In a welcome clarification of the debate engendered by Tomasello *et al.* (1993) Byrne labels the first of these 'impersonation' and the second 'program-level imitation'. Although several species, including parrots and dolphins, appear to be capable of impersonation, only great apes provide evidence of program-level imitation.

Insight is less about how an animal gains knowledge and more about what it can do with the knowledge it has. Byrne discusses knowledge about physical events and then, at somewhat greater length, knowledge about other animals. Understanding the cause and effect between physical events, or simply 'how things work' requires a knowledge of the properties of objects and the relationships between them, and this in turn requires a representation of objects as enduring entities which still exist when not in view. Byrne tentatively suggests that apes acquire a concept of object permanence early in their development, but that monkeys do not acquire this until much later. If so this might explain why object play is well documented in apes but (with the exception of capuchins) largely lacking in monkeys. Object play is especially interesting because it appears to be closely connected with tool use. Tool use occurs in many species, but only a few learn to use a range of tools for a range of purposes and choose between

methods; those that do (the great apes and capuchin monkeys) are the very same species which engage in object play. Furthermore, it appears that instances of genuine problem-solving by great apes depend on 'noticing a solution when it comes by, not calculating it by some logical process'. Consequently successful problem-solving depends upon having a large repertoire of past experiences, and one way of building this up is by play. It is perhaps no coincidence that in the wild only common chimpanzees regularly invest much time in object play, and that it is they who also exhibit the most extensive tool use. Byrne draws attention to the enigma that all (but probably only) the great apes have the mental capacity to use objects to solve problems, yet only chimpanzees profit from tool use in the wild. Does this imply a tool-using common ape ancestor, or that the understanding of object properties required for tool use was originally selected for in the context of other tasks? This is a question to which I shall return.

Great apes have and use knowledge about physical events and objects, but according to Byrne they treat other animals differently: they have a 'theory of mind'. In other words, great apes attribute mental states to other individuals, and to varying degrees act according to what they think those individuals think. Understanding others involves comprehending what they know and appreciating that their goals and intentions may be different. It seems likely that both require a distinction between other and self. Self-recognition in a mirror is the classic test for whether an animal has a self-concept. On the basis of current experimental evidence Byrne suggests that all great apes, but not monkeys, have the *potential* to understand whether reflections in mirrors are of themselves: whether they actually do may be dependent on developmental circumstances. More direct experimental evidence for mental state attribution is limited to chimpanzees. At least some chimpanzees can reliably pick which of two human helpers knows where food has been hidden, suggesting comprehension of others' knowledge. And at least one chimpanzee has shown understanding of the difference between accident and deliberate malice, a result which if replicated would suggest that chimpanzees can judge intentions, at least of humans in experiments.

In addition to experimental evidence Byrne also presents anecdotal evidence that the great apes have a theory of mind. He suggests that having a theory of mind is useful because it allows one to alter other individuals' beliefs, and consequently he discusses the anecdotal evidence for tactical deception and teach-

ing. Crucially though, it is only *intentional* deception and *intentional* teaching which provide evidence for a theory of mind. Both monkeys and apes practise tactical deception: they employ acts from their normal repertoire in such a manner that another individual is likely to misinterpret what the acts signify, to the advantage of the deceiver. According to Byrne, however, only great apes intentionally deceive, that is, know that they have made the dupe believe something untrue. Similarly, although teaching has been claimed for several primate species, only chimpanzees have been observed to behave in ways that suggest an intention to change the *knowledge* on which the learner's behaviour is based (and even then the evidence for intentional teaching of nut-cracking seems rather weak given that it apparently (Boesch 1991) takes the novice ten years to become fully proficient).

The argument that great apes have a theory of mind is contentious. Heyes (1993, 177) has argued that none of the existing evidence for attribution of a mental state to an interactant is sufficiently robust to rule out explanations based on associative or inferential learning about observable properties of the interactant's appearance or behaviour. Heyes, however, does not argue that apes do not attribute mental states — only that it is not proven that they do. I accept the logic of Heyes' argument, but suspect that Byrne's claim for a theory of mind will ultimately prove correct even if some of the evidence he presents has not been correctly interpreted. If one accepts that great apes do have the mental capacity to manipulate others by changing their knowledge, and indeed to use objects to solve problems, then it is reasonable to suggest, as Byrne does, that there is a sense in which they can think. Such activities involve simulating or computing outcomes without performing them, and Byrne asks whether this ability is more widely used to imagine future states of the world in general. His answer is, effectively, no: the evidence for anticipatory planning, that is, forethought not related to current motivational state, is flimsy. Given that mental state attribution is widely regarded as a prerequisite for language, Byrne also asks how far great apes can be helped to achieve linguistic communication. His thesis is that although spoken language requires specific biological adaptations, such as precision motor control of the tongue and superlaryngeal tract, language itself is a matter of software: programmes which even an ape might have sufficient brain hardware to run. Although great apes do not naturally acquire language, chimpanzees and to a lesser extent orang-utans and gorillas can use it;

they understand and use the concept of reference, and use words for real communication. They do not, however, acquire much in the way of syntax or grammar, and even chimpanzees' abilities are limited to those of young (two-year-old) children.

Even if great ape 'thinking' is limited by human standards, it marks a significant discontinuity between monkeys and apes. This is perhaps the most striking message of *The Thinking Ape*. While monkeys can learn fast enough to appear clever in their environmental and social interactions, only the great apes can be considered truly insightful. Byrne maps these differences in intelligence onto the evolutionary history established in Chapter 2, and then by 'reversing' cladistic analysis proposes an evolutionary taxonomy of primate intelligence. He suggests that the earliest primate species for which we have modern descendants available to study, the lemur/human ancestor, was small-brained and no more intelligent or socially sophisticated than other mammals. The monkeys and apes represent an important quantitative shift from the primitive condition. The monkey/human ancestor was group-living and possessed a larger neocortex of the brain. Byrne concurs with the increasing consensus that larger neocortex is an adaptive response to the increased social complexity of living in semi-permanent groups. He rather elegantly supports existing arguments by demonstrating that the ratio of neocortex to brain is closely related to the frequency with which members of a species practice deception. Insightless social intelligence is most developed in Old World open-country monkeys (such as Baboons), where it underwrites the social skills required to maintain complex alliances. Byrne suggests that the final shift to great ape intelligence is qualitative rather than quantitative. The capacity for insight is not obviously related to brain size: the only measure that completely sets the great apes apart from monkeys is raw weight of cortex, and this differs among apes in ways unrelated to any measure of behavioural complexity. On this basis Byrne supposes that some more subtle, organizational brain change must have occurred with the common great ape ancestor.

Byrne's attempt to account for the increased intelligence of the great apes is particularly relevant for palaeoanthropologists who wish to understand the starting point of distinctly human evolution. All great apes, and it follows the first hominid, could 'mentally represent and conjure with other "possible worlds"', whether they be the thoughts of other animals, the uses of novel objects, or the solutions to current problems. Byrne doubts that these abilities

are the result of further social selection pressures of the sort that drove monkey/ape evolution since it is unclear what additional social pressures apes face. Instead he suggests that environmental challenges were more important. His list of possible candidates includes

the need to use and learn complex programmes of manual action, in which imitation and teaching would help; locomotor problems, in which advance calculations about the self would help; hunting large mammals, in which anticipation of future actions of prey and companions would help; tool use and tool-making . . . in which symbolic representation of object properties and the ability to imagine unseen objects would help. (p. 232)

We presently lack enough information about early ape locomotion to understand what selective pressures it may have posed for ape cognition. Of the remaining candidates, I suspect we can rule out hunting large mammals and tool use and tool-making. Among extant great apes only humans hunt large mammals so it seems unlikely that this is a primitive behaviour. Perhaps more importantly, it is not clear that anticipation (the specific selective pressure proposed by Byrne) is a significant feature of chimpanzee hunting (Stanford 1996), and indeed Byrne himself is of the view that the evidence for anticipatory planning in any domain is generally flimsy. In contrast, there is no doubt that all great apes can make and use tools. The problem here is that only chimpanzees (and humans) routinely profit from tool use in the wild and a behaviour that is seldom practised (unless it is in some way critical) is unlikely to provide a strong selective pressure. Byrne notes that comparison between tool use by wild chimpanzees and that by other apes in captivity is complicated by the fact that wild chimpanzee tool use has a component of social tradition. There is some evidence that social insight may play at least as great a role in chimpanzee tool use as insight about objects. If chimpanzees have a particularly developed ability to think about mechanical relations then one might expect their material culture to show greater innovation than it does (Tomasello *et al.* 1993); instead, much of wild chimpanzee tool use can probably be attributed to application of the social insight required for imitation, and this might also be true for the complex leaf-folding techniques of gorillas. I suspect that the chief selective pressure for ancestral ape insight was a continued need to better anticipate and manipulate the behaviour of conspecifics, and this was answered by the ability to attribute mental states. If ape tool use is largely maintained, or, in the case of trained

captive animals, initiated by imitation, then it may be an epiphenomenal consequence of mental state attribution.

The thinking ape described by Byrne is the starting point for human cognitive evolution. Using the comparative method, Byrne has traced the evolution of the social skills that underpin what it is to be a great ape, humans included. It is the task of palaeo-anthropologists to document and explain the evolution of the traits which separate humans from the other great apes. Principal among these are language, more sophisticated tool-making, more complex interaction with the natural environment, and greater awareness of past and future. Making inferences about such traits is fraught with difficulty, indeed, according to Byrne, impossible. His main objection to palaeo-anthropological endeavour is that it is not founded on an experimental method, and so the story of human evolution changes with each chance discovery. If palaeoanthropology is more vulnerable in this respect than any other historical science then it is surely as much due to a lack of bold theorizing as any constraint inherent in the subject matter: a reason for renewed vigour rather than acceptance of defeat.

In any case, science is rarely easy. Even the comparative method is not without its problems. Experimental data from captive chimpanzees may be more robust than anecdotal evidence from the wild, but the evolutionary significance of specific abilities depends on the use to which they are actually put. It may be possible to improve the quality of anecdotal evidence, but in practice, funding constraints and other contingencies are likely to intervene; and there is always the possibility that the increased access required to improve anecdotal evidence will change the nature or frequency of the observed behaviour — a biological version of Heisenberg's uncertainty principle. That said, it remains true that Byrne has told us more about the intelligence of the great ape/human ancestor than we could hope to learn from the fossil record, but the fact that he can say nothing about the evolution of specifically human traits does not preclude others from making an attempt. *The Thinking Ape* is the natural starting point.

Mark Lake
Department of Archaeology
University of Reading
Whiteknights
P.O. Box 218
Reading
RG6 6AA

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