How did the human mind evolve? Why do we appear to be so different from other animals? These rather profound questions have attracted plenty of speculation in philosophy, anthropology and psychology. Yet, many remain appropriately sceptical about the proposals that have been put forward. How could one possibly go beyond just-so stories and make proper scientific progress in this domain? Although there is an ever growing archeological record of our ancestors, minds unfortunately do not fossilise. Many reconstructions, such as those showcased in popular TV documentaries, seem little more than plausible conjecture at best. In recent years, researchers have increasingly looked to extant primates for clues as to how to breathe life into the fossilised remains of our forebears. But there has been little explicit discussion in psychology of how the study of primates can inform us about the evolution of the human mind. Here I will present ways through which real progress may be made.

Humans are primates (see Figure 1). Like other primates, and unlike most other mammals, we rely more on vision than smell and our brains are large relative to our body size. There are clear continuities between the anatomy and physiology of humans and our closest living relatives. Yet, humans are the only primates to have colonised most habitats on this planet, built a diversity of civilisations, gained immense power to create and destroy, and invented elaborate ideas about divine beings that care about humans. These differences may reflect our special minds. Indeed, to many people, human minds appear so vastly superior to anything that can be found in the animal kingdom that it is difficult to reconcile this apparent gap with Darwin’s (1859) notion of descent with modification. Curiously, however, there is no established inventory of uniquely human mental traits. The first way in which the study of primates can help us, then, is in establishing what in fact the differences are that appear to set us apart from other primates.

**Figure 1**

Phylogenetic tree of the hominoidea. Based on latest genetic analysis, the lines that led to humans and to chimpanzees split 5.1 million years ago, the line that led to gorillas split 6.3 million years ago and orangutans diverged 13.8 million years ago. Old World monkeys, on the other hand, split off from the line that led to modern apes some 25.3 million years ago. Other data suggest that gibbons split off some 18 million years ago.¹

**Route 1: Fact finding**

It may be instructive to consider for yourself what you think are uniquely human mental traits. When I ask my students the most common answers involve language, reason, complex emotion, foresight, conscience, self-awareness, and creativity. But these answers are not straightforward.
Consider the most popular answer: language. Clearly non-human animals communicate. So we need to specify what it is about the human communication system that may set it apart from other such systems. Whereas animal communications are typically restricted to specific signals in settings such as mating, predation and territoriality, human language is open-ended and not restricted to a domain. It involves the application of rules that allow us to combine a finite set of arbitrary symbols into a virtually limitless set of expressions. Although researchers have tried to teach great apes such communication systems (e.g., sign language), there is as yet no reason to expect that a chimpanzee will one day address the Academy (as in Franz Kafka’s famous story). Apes can learn hundreds of symbols, but application of rules that allow us to combine and recombine symbols into novel, open-ended sentences appears to be uniquely human.

Similar qualifications have to be made for the other purportedly unique human attributes. For example, apes can solve problems in their minds. They show evidence of means-ends reasoning. Thus, what aspect of human reasoning is unique, and hence needs explanation, has to be determined from careful examination of comparative data. If we want to investigate how the human mind evolved, we need to first identify more precisely what aspects of our mind are in fact unique and what is shared with our closest relatives.

The study of primate cognition has certainly revealed some extraordinary findings of mental sophistication. And some previously cherished notions of human uniqueness have already been eliminated through such work. For example, the ability to use tools, to manufacture tools, to cooperate to kill conspecifics (i.e., members of one’s own species), or to have sex for reasons other than procreation, can no longer be upheld as distinguishing characteristics of Homo sapiens. Even the notion that we are the only species to retain group specific traditions (arguably, culture) had to be abandoned as chimpanzees and orangutans have been shown to have such socially maintained traditions.

Andrew Whiten and I reviewed the evidence in great apes for various cognitive abilities typical of a human toddler of 18 to 24 months. There is evidence for pretense, means-ends reasoning, understanding invisible displacement, interpreting depictions, attribution of intentions and emotions to others and self-recognition in mirrors. These abilities are hence not uniquely human. According to the Perner (1991) theory of cognitive development, these abilities all involve a capacity to entertain secondary representations. That is, the child or ape has to hold in mind more than one model or representation of the world. For example, in pretense, they have to represent the pretend (e.g., a pie) and the real world (e.g., mud), and not confuse one for the other (i.e., not eating one’s mud pies). Apes and two-year-old children seem to share this mental power. Only by around age three and a half do human children reach Perner’s next level of representational skill: to form meta-representations; that is they then can represent representational relations. Meta-representation may be involved on some level or other in many of the characteristics often purported to distinguish human from animal minds. For example, it is required to understand how other people may (mis-) represent the world, to invent symbols, and to reflect on past and future events. There is as yet no convincing evidence that apes, or any other animals, form meta-representations, and this might therefore constitute a fundamental cognitive ability that sets humans apart. Further systematic comparative work needs to be done to establish a proper inventory of what is uniquely human and what is shared with our closest living relatives.

**Route 2: Phylogenetic reconstruction**

Let us assume, for the moment, that we are right in attributing secondary representations to the other great apes. How can this help us reconstruct the evolution of our mind? From an evolutionary perspective, traits can be shared for two very different reasons. One is analogy (or homoplasy) and the other is homology. In the first case, species share the same trait or characteristic because they solve the same problem. For example, wings in birds and wings in insects both solve the problem of flight. However, the morphology is very different. They are the result of different but convergent adaptations – independent evolutionary events. In the case of homology, a feature is shared between species because of common descent. The common ancestor had the characteristic and passed it down to the descended species that currently share the trait. We share the hand characteristic of an opposable thumb with other primates, because
our common ancestor had it already and we inherited it. If we are right and all great apes have the ability to form secondary representations, then we can ask whether that is because of homology or analogy.

To decide between the two options, researchers use phylogenetic reconstruction. The best, or most parsimonious, phylogenetic hypothesis is the one that requires the fewest changes. How then, do we explain that all the great apes do have the ability to form secondary representations? It could be that they each evolved this trait independently. That would require that on each of the branches (see Figure 1) there must have been a time at which each species evolved this capacity. So we would have to make at least four assumptions about change – four times there would have been a separate event in which the capacity evolved (or five if bonobos and chimpanzees also evolved it independently from each other). The alternative hypothesis is that all of today’s great ape species have this trait because of common descent. We would have to propose that our common ancestor some 14 million years ago already had this capacity. Because this homology hypothesis requires only one change, emergence of the ability before 14 million years, this is a far more parsimonious proposal than the alternative.

Phylogenetic reconstruction thus suggests that the great ape common ancestor had the capacity for secondary representation. This is therefore a quite powerful method of inference. We are making a statement about the mind of a creature that lived 14 million years ago without ever having to lay eyes on a fossil of that species. We are currently investigating if secondary representation is older still by studying the capacities of lesser apes (ie, gibbons and siamangs). Phylogenetic reconstruction is an underused method that can significantly expand our knowledge about the minds of our ancestors.

Route 3: Analogy

There is a temptation to animate our extinct ancestors more generally through analogies with living primates. For example, it is often proposed that we evolved from a ‘chimpanzee-like’ ancestor. Wrangham (2001) even goes so far as to suggest that we should call Australopithecene hominids who lived between 4 and 2 million years ago Pan Prior (ie, the earlier chimpanzee). However, such analogies can be misleading. One may, for example, find oneself arguing over which one of two equally distant extant species would be the better model. In our case, some scholars debate whether our common ancestor was more like the chimpanzee or the bonobo. Was it a hunting species like the chimpanzee where males dominate, or was it more of a peacenik like the bonobo, living in an egalitarian society and engaging in an extraordinary amount of sex? Bonobos and chimpanzees are quite different and they are equally far removed from the human lineages, as they branched off from each other approximately 2.5 million years ago (see Figure 1). Rather than argue about which of the two is the better model, I think that the difference between these species of Pan should remind us that they too have evolved since the time of the common ancestor. We are not descended from chimpanzees or bonobos. These apes would have an equal right to claim that they have evolved from humans (or Homo prior). They too have had over 5 million years of evolution since the last common ancestor.

We need to realise that phylogenetic reconstruction only works for an individual trait, not for the entire phenotype. One can say something about a shared trait (eg, the thickness of tooth enamel) that a common ancestor is likely to have had. However, that does not mean that other non-shared characteristics can be extrapolated back into the past. The common ancestor of chimpanzees, bonobos and humans may have had characteristics not present in any of the living descendents, and others that are present in one or another of its descendents. Analogies to living species can be inspirational and can lead to novel hypotheses. But other sources of information are required to substantiate such ideas. For instance, analogies may be related to the archeological record via investigation of how the extant living system would transform into a fossil record. Without such substantiation, the use of analogy may be very misleading and should be treated with appropriate suspicion.

Route 4: Regression models

How else, then, could the study of living primates inform us about the evolution of the human mind? There is a fourth way. We can use models that describe the relationship between variables in the present world and apply them to the past. For example, Robin Dunbar identified a
correlation between neocortex ratio (i.e., the ratio between the size of the neocortex and the size of the rest of the brain), and group size in primates. As the number of average group members increases so too does the neocortex ratio. This finding has been used as an argument for the social intelligence hypothesis, which claims that the driving forces of the evolution of the intellect have not been physical but social challenges. There is good evidence that apes do keep track of individuals’ relative positions in their social hierarchy. They also know how individuals are related to each other. There is even evidence for tactical deception and other forms of social problem solving. The social structure changes with coalitions that are established and maintained through grooming. So the more members there are in a group, the more complex is the web of information of which an astute social player has to keep track – and this may require a bigger cognitive apparatus to process.

The social intelligence hypothesis is only one of several competing proposals. However, one can use the fact that there is an association between group size and neocortex ratio in living primates to make inferences about the past. The archaeological record does feature skulls of our hominid ancestors from which one can infer neocortex ratio. With this variable available, one can use regression to infer the likely group size in which these extinct hominids lived. According to Dunbar’s interpolation, over the last 3 million years there has been a steady increase in the average group size that hominids lived in from 70 to 150. This method, like phylogenetic reconstruction, can therefore produce better than chance predictions about long extinct ancestors.

Dunbar takes the interpolation process one step further. Grooming is an important factor in maintaining group cohesion. More grooming time is required in larger groups. Primates spend up to 20-30 per cent of their time grooming each other. Grooming time can therefore be predicted for our ancestral species because, based on their brain sizes, we have an estimate of their group sizes. Of course we introduce another error term in the equation, but this method is still more likely to be accurate than mere guesswork. Dunbar argues that in line with the previous regression the natural human group size is about 150 (citing evidence ranging from average hunter-gatherer groups sizes to the average number of people that attend funerals). Extrapolating from the regression of grooming time on group size in primates, a group size of 150 would require group members to spend about 40 per cent of their waking time grooming. This would seriously cut into the time required for gathering food and other essentials. Clearly, humans do not groom each other 40 per cent of the time. Dunbar suggests that we talk instead - we gossip. This is not my theory to defend. But the point is that one can use general models about the relationship between variables in primates and use them to reconstruct and make predictions about our past. Ideally, one would then seek to reconfirm predictions through the archeological record, using converging evidence to create a far more convincing account.

Bridging the gap

The study of primates can help us solve the puzzle of the evolution of the human mind. Continuing fact-finding should bring into clearer view what is unique about our mind. Characteristics of the mind of our common ancestor with chimpanzees and the other great apes can be inferred through phylogenetic reconstruction. The question about how to bridge the evolutionary gap then becomes more refined: how did the mind of that ancestor change over 5 million years into our modern human mind? One of the most common mistakes that people make in this context is to presume that our ancestors went straight forward along a single direct trajectory, evolving up the stairway to Homo. This was not the case.

There were a variety of different hominid species. And fossil evidence of new species emerge surprisingly regularly. For example, consider the important period between 1.6 and 1.8 million years ago, a time when some hominids first developed bi-facial hand axes and other stone tools. Although there are debates about some classification this period seems to feature six species of hominids: Homo erectus, Homo habilis, Homo ergaster, Homo rudolfensis, Paranthropus robustus, and Paranthorpus boisei. These were all upright walking, big-brained hominids who probably at times even shared the same valleys. Paranthropus boisei (a heavy build hominid with a wide face) and Homo erectus (the manufacturer of bi-facial hand axes) graced the planet for over a million years, whereas modern humans have merely been here a fifth of that time. Since
there were several branches, the question is why we are the only surviving lineage of this multitude of hominid forms. Why did the others die out?

Radical environmental changes (eg, ice ages) are often responsible for extinctions. However, I suggest that, given what we know about our own recorded history, we ourselves are a suspect. It is clear that humans can be ferocious in displacing other human groups that are inferior in terms of technology. Humans have the frightening habit of quickly displacing previous inhabitants, whether through genocide, through competition, habitat destruction, or, more indirectly, through the introduction of novel germs. The plight of today’s indigenous peoples is a continuation of this process. In Australia, we should certainly be aware of the rapid and devastating effects a technologically advanced population can have on more ancient cultures. Of course, we could do better than that; and we should. In the face of current globalisation, we can and should make ethical choices that take the threat of more such extinctions into consideration. The point, however, is that this is a common pattern in human history.

This tendency must have emerged at some stage. In terms of active destruction, note that evidence for warfare goes back to prehistoric hunter-gatherers. Chimpanzees are the only other primate known to cooperate to directly kill conspecifics. Such aggression may hence have quite ancient roots. However, bonobos, as far as we know, do not engage in such killings. Thus, this characteristic may have evolved independently in humans and chimpanzees, or it evolved in the common ancestor 5 million years ago and bonobos lost it. Evolutionary parsimony cannot decide between these options as both require two changes.

It is clear, however, that humans today, and throughout recorded history have been directly (eg, through force or competition) and indirectly (eg, through habitat destruction or germs) responsible for the demise of other species and of other human ethnic groups. Thus, we need to consider the possibility that the best explanation at present may be that our more ancient forebears similarly were involved in the extinctions of closely related hominid species. The gap between animal and human mind may appear so large, and so baffling, only because we destroyed the missing links. By displacing our hominid cousins, we ourselves may have burnt the bridges across the gap. And we found ourselves on the other side of the divide, wondering how we got there. I am not suggesting that our ancestors deliberately went out to exterminate all other hominid species. The various extinctions were probably complex processes involving a multitude of different factors. However, I do want to emphasise that it is certainly quite possible, if not likely, that our forebears played some role in this. Such a perspective may help demystify the apparent gap between animals and humans. It also raises an intriguing question about our present situation. If we were involved in creating the gap, are we continuing to increase it? We could increase the gap by becoming smarter. If continuing IQ test score increases were anything to go by, that would seem to be the case. However, there is also the perhaps traditional way of widening the gap: we could destroy our closest living relatives, the other great ape species. In fact, we are in the process of doing just that. All the great ape species are under threat. Continued habitat destruction may mean that in a few decades these relatives of ours may become extinct. And with the extinction of the other great apes, our own descendents might wonder about how different they are from their closest living animal relatives: the monkeys. I thus put forward the hypothesis that the perception that we are very unique and different from other animals, is to a large extent our own doing. We came about by natural selection and gradual transitions, but intentionally or unintentionally contributed to the extinction of our closest relatives, creating the appearance of a gap in the evolutionary record.

Conclusions

I discussed four different routes through which we can reconstruct the past by studying living primates. We can find facts in order to identify what is unique and what is shared. We can use those facts to reason about the mind of our common ancestors using phylogenetic reconstruction. We can speculate about analogies, and we can use generalised regression models that work for living primates and apply them to our past through interpolation. There appears to be a vast gap between animal and human minds, but our closest living relatives are far smarter than many people might believe. They have the ability to think about things not currently perceived much like a 24-month-old human child. Phylogenetic reconstruction suggests that our common ancestor...
living some 14 million years ago already had this capacity. Some of our mental characteristics, like the ability to meta-represent, appear not to be shared and hence must have evolved after the time our line split from that which led to chimpanzees some 5 million years ago. I argued that the difference between the human and animal mind may appear so vast because our ancestors displaced our hominid relatives. Our mysteriously unique status on Earth may be our own, rather than God’s, creation.


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