https://doi.org/10.1038/d41586-d41586-022-00872-3

News & views

Animal behaviour

Orangutan insights into the evolution of tool use

Michael Haslam

Gaining the ability to make stone tools was a useful development for early human ancestors in the hominin branch of the evolutionary tree. Could studying orangutans provide clues to how this behaviour arose?

Stone tools could be considered one of the greatest inventions. They entered the tool-kit of our hominin forebears more than three million years ago[1], and eventually had a variety of functions, from aiding in practical tasks to providing status symbols. They literally shaped our ancestors' lives. What drove this stone-tool innovation? Writing in *PLoS ONE*, Motes-Rodrigo *et al.*[2] bring context to the evolution of stone-tool use through their study of captive orangutans (*Pongo pygmaeus*).

The fact that our pre-human relatives could make stone tools — the earliest tools[1] are associated with species of *Kenyanthropus* or *Australopithecus* that pre-date the emergence of the genus *Homo* — gives the impression that these objects are simple, easy inventions. But that isn't true. Try making a usable stone tool, and you'll quickly learn to appreciate the peril of finger injuries and the years of practice needed to master the techniques involved. This leads to an enduring archaeological question: what prompted the development of the first stone tools?

Motes-Rodrigo and colleagues tackle this issue from an unusual angle. Using zoo-housed orangutans, two in Norway and three in the United Kingdom, the team ran experiments to determine whether the apes could make and use a stone tool for cutting purposes. They partly replicated a study from 50 years ago[3], which focused on a single juvenile orangutan in a UK zoo. That orangutan had been captured in the wild as an infant. After coaxing and human demonstrations of stone-tool manufacture, the juvenile orangutan, following much trial and error, broke a large piece of stone called a core into pieces and then used the broken shards to access a box to get food. Motes-Rodrigo and colleagues sought instead, in their initial experiments, to investigate orangutan behaviour in the absence of direct training efforts by humans.

Neither study was trying to address the evolution of the orangutans' technical abilities, but rather to assess these primates as a way of gaining understanding about the abilities of hominins (species in our lineage that post-date the ancestral split with chimpanzees and bonobos some six or seven million years ago). Orangutans aren't hominins, but the reason for studying them is grounded in the importance of phylogeny: the idea that members of nearby branches in our evolutionary tree probably share more traits with us than do those of distantly related ones, enabling us to reconstruct evolutionary pathways for related species[4]. Physical traits and genetic sequences are commonly investigated in this way, although there is evidence that behavioural patterns can be studied in this way, too.

For example, among mammals, humans are the most-proficient tool users, with our close relatives, wild chimpanzees, placed second on that list[5]. The pattern isn't perfect — wild bonobos and gorillas display much less tool use than chimpanzees do, and all three African great apes are closer to us on the primate family tree than orangutans are — but it provides an incentive to explore those relationships.

Motes-Rodrigo *et al.* reasoned that if — when given the right materials — orangutans could perform the same basic techniques for stone-tool manufacture as early hominins, then the common ancestor of humans and orangutans might have had the same ability. Those materials include a brittle stone core that breaks into sharp-edged pieces (or flakes) when struck, and a target that needs to be cut to access a resource (representing the tough animal hides and sinews that our ancestors would have encountered). Given that orangutans and humans last shared an

MUDIN @ SUAQ PROJECT

Figure 1 | Wild orangutans (*Pongo pygmaeus*) can make and use stick tools to extricate insects. Motes-Rodrigo *et al.*[2] investigated whether captive orangutans can make stone tools.

ancestor around 10 million to 15 million years ago[6], the question might change from that of why hominins started using stone tools a few million years ago, to why neither lineage was using them much earlier, depending on the experimental outcome.

In a series of structured experiments, Motes-Rodrigo and colleagues gradually introduced the orangutans first to concrete hammers and stone blocks, then to human-made sharp stone flakes, and finally offered grape rewards in exchange for flakes and provided direct human demonstrations of stone-tool manufacture. At each stage, food was available in boxes that could be opened by cutting either a cord or an artificial membrane. The reward stage was meant to increase the value the orangutans placed on sharp stones, encouraging more attention to manufacturing them.

The orangutans at both locations reliably picked up the concrete hammers and hit them against the floor and walls. Some pieces broke off the hammers, but the apes ignored them. One enterprising juvenile in Norway first punctured the membrane with a stick he had brought into the room, and later did the same with a human-made flake held in his mouth, whereas the adult orangutans resorted to tearing open the membrane with their hands. However, regardless of the set-up tested, none of the orangutans followed the sequence that might be expected to correspond to early hominin behaviour of striking the hammer on the core, and then using the resulting sharp flake to complete a task (making a cut to access the food box).

Despite this seemingly negative outcome, the experiment nicely foregrounds several interesting debates around animal tool use and its relevance for understanding human evolution. As Motes-Rodrigo and colleagues note, the fact that the orangutans struck their hammers against cage surfaces might mean that the last common ancestor of orangutans and humans had the necessary cognitive and physical capacity to engage in hammering (percussive) behaviour with stones. This is true, although various monkey, bird, fish and even insect species have been shown to bring objects together in a percussive behaviour[7]. It is not clear where we should draw the line in inferring common ancestry for a type of behaviour that seems to be a recurring invention.

Some wild orangutans make and use stick tools (Fig. 1) to extract seeds from tough-shelled fruit and to prise insects from tree holes[8]. However, stone-tool use has never been seen in wild orangutans, despite decades of observations. To some extent, this is unsurprising because orangutans spend much of their time in trees, whereas our human ancestors were already ground dwellers when the earliest-known stone tools emerged. By contrast, in the 1990s, when captive capuchin monkeys (*Sapajus apella*) were given similar equipment to the orangutans, they broke the stone cores and used the resulting flakes to cut through a barrier to get food[9]. The capuchins (who are adept at living on the ground and in trees) even innovated a technique whereby they used one stone piece as a chisel that was hammered through the barrier using a second stone. Unlike modern orangutans, many wild capuchin groups both use and break stones[10]. If extinct members of orangutan lineages had spent more time on the ground, similar to the capuchins, then stone-tool use might have been an attractive option for them.

Motes-Rodrigo *et al*. were careful to ensure that the orangutans were not previously trained to use stones, and had minimal human contact (apart from human demonstration of stone-tool manufacture in the final set of experiments). Captive primates have a greater aptitude for tool use than their wild counterparts do[11], and the exposure of captive apes to humans (or enculturation) is one proposed reason for this difference (along with captive animals' greater amount of free time, potential lower stress levels and greater access to new objects). This highlights the challenges of investigating 'natural behaviour'. Do we want to prompt or guide animals as a way of understanding a species' limits — similar to considering an Olympic champion athlete such as Usain Bolt as a way to explore human limits, even if most humans do not reach the same performance level? Or do we want to understand how real-world conditions generate sustained behavioural innovations?

Both aims are valid, and no one is suggesting that five caged apes are an ecologically comparable model for the hominins who began to make stone tools in Africa. But in a way, the fact that we are turning to our living ape relatives to guide our thoughts on our extinct ancestors tells us something interesting about how we view our place in the natural world. Despite modern humans being physically more similar to *Australopithecus* than to any modern non-human ape species, it is hard to shift the idea that these apes might nevertheless better reflect the simpler, less-cluttered and smaller-brained life of our ancestors. Although analogies are important in evolutionary thinking, especially when using phylogenetically relevant species, we might still encounter a perceived human–animal divide when considering our direct ancestors, making comparisons with apes seem more relevant than comparisons with ourselves.

Motes-Rodrigo and colleagues show that studies of how non-human apes learn strategies and apply causal reasoning — which can often be revealed only by studying captive animals — give us valuable clues to the ways in which large primates behave in their environment. To effectively tie these results to the past of our own technological evolution, another approach can also help. The archaeological exploration of tool use has, for too long, been applied only to artefacts associated with hominin lineages. Meanwhile, our knowledge of chimpanzee and monkey stone-tool use has begun to extend backwards in time, with the advent of primate archaeology[12]. There might be examples of stone-tool use in the orangutan lineage, despite its current absence, but we will know for certain only by digging in search of ape tools in East Asia. With wild orangutan populations decreasing at a tragically high rate, ultimately, studies of captive animals and archaeology might be all we have to reconstruct not only our past, but theirs, too.

Michael Haslam was formerly with the Primate Archaeology project, University of Oxford, Oxford, UK, and is now based in London.
e-mail: mahaslam@gmail.com

1. Harmand, S. *et al*. *Nature* **521**, 310–315 (2015).
2. Motes-Rodrigo, A., McPherron, S. P., Archer, W., Hernandez-Aguilar, R. A. & Tennie, C. *PLoS ONE* **17**, e0263343 (2022).
3. Wright, R. V. S. *Mankind* **8**, 296–306 (1972).
4. Almécija, S. *et al*. *Science* **372**, eabb4363 (2021).
5. McGrew, W. C. *The Cultured Chimpanzee. Reflections on Cultural Primatology* (Cambridge Univ. Press, 2004).
6. Locke, D. *et al*. *Nature* **469**, 529–533 (2011).
7. Shumaker, R. W. *et al*. *Animal Tool Behavior. The Use and Manufacture of Tools by Animals* (John Hopkins Univ. Press, 2011).
8. Van Schaik, C. P. *et al*. *Science* **299**, 102–105 (2003).
9. Westergaard, G. C. & Suomi, S. J. *J. Hum. Evol.* **27**, 399–404 (1994).
10. Proffitt, T. *et al*. *Nature* **539**, 85–88 (2016).
11. Haslam. M. *Phil. Trans. R. Soc. B* **368**, 20120421 (2013).
12. Haslam, M. *et al*. *Nature Ecol. Evol.* **1**, 1431–1437 (2017).

The author declares no competing interests.

ONLINE HEAD
Insights from orangutans into the evolution of tool use