Knuckle-walking chimpanzees go 3-D with ‘Avatar’ technology

A knuckle-walking chimpanzee with traces showing the motion of the right arm. Image credit: Nathan Thompson.

Although the majority of babies crawl on all fours, some shuffle on their bottoms and others crawl like commandos; but they never crawl like our nearest relatives. ‘Knuckle-walking is a strange hand posture that gorillas and chimpanzees use when walking quadrupedally’, says Nathan Thompson, from the New York Institute of Technology, USA. Yet, no one really knows how this unusual mode of walking evolved. One idea is that the long fingers of ape ancestors got in the way when they descended to the ground, so they simply rolled their fingers into a ball and walked on the knuckles instead. But what really intrigues Thompson is the possibility that the earliest humans may also have descended from the same ancestors, making knuckle-walking part of our history too. However, before we can begin searching the fossils of our ancient ancestors for evidence that they walked on their knuckles, we need to understand how knuckle-walking chimpanzees differ from other primates today, and how this impacts their skeletons to identify key features that could resolve whether our ancestors knuckle-walked.

Thompson turned to 3-D motion capture to record every detail of the chimpanzees’ movements. He painted non-toxic dots on the joints of two animals’ hands and feet, and on their limbs, and then arranged four synchronised high-speed cameras around the runway as the chimpanzees knuckle-walked at their own speed. ‘It’s basically the low-budget version of “Avatar”,’ he says. In addition, Thompson filmed two macaques – which walk either with their palms and fingers flat, or with the fingers flat and the palm tilted up – for comparison with the rolled knuckle movements of the chimpanzees. Then he painstakingly reconstructed how each bone and joint moved.

Looking at the position of the arm and hand as the chimpanzees placed their knuckles on the ground, Thompson realised that the chimpanzee’s hands and forearms were rotated inward more than the macaques’, positioning the chimpanzees’ hands parallel to their bodies as their knuckles contacted the floor, while the macaques’ hands pointed forward. He also noticed that the chimpanzees tended to bend their wrists sideways (ulnar deviation) more than the macaques. ‘The amount of ulnar deviation used seems to be one of the differences between macaques and knuckle-walking chimpanzees’, he says. However, when scrutinising the animals’ wrists, Thompson realised that the positions were often more similar than had been appreciated previously, especially when the chimpanzees were knuckle-walking and the macaques were tilting the palm up while holding their weight on their flat fingers.

In addition, Thompson was surprised by how far back the macaques bent their fingers while walking with flat palms (the fingers bend back as they lift the palm off the ground) and when walking on flat fingers with the palm tilted. Some primates, including chimpanzees and gorillas, have a bony ridge at the base of their knuckles (the metacarpophalangeal joint, where the fingers join the palm), which was thought to help stabilize the joint when walking with the palm off the ground. But because the macaque’s fingers bend back the same regardless of how the hand is positioned, Thompson realised that the ridge cannot be used as a feature to diagnose whether our fossil ancestors walked on their knuckles. ‘The presence of this bony ridge might not have a straightforward relationship to knuckle-walking or other hand postures’, he says.

Having identified which aspects of the animals’ movements distinguish knuckle-walkers from conventional primates to help identify skeletal structures that could be signatures of knuckle-walking, Thompson is eager to learn how chimpanzees use their muscles while striding on their knuckles in the hope of getting to the crux of why apes adopted this unconventional way of getting about.

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