These Genes Were Made for Walkin'!

Chimps and humans share a **last common ancestor** (LCA) that, based on fossil records, lived about 7 millions years ago in a rainforest environment and probably looked a lot like modern-day chimpanzees. Then, the climate got cooler and drier. The rainforest home of our chimp-human ancestor transitioned to fragmented patches of forest with grass and shrubland in between. Suddenly, there was a benefit to being able to efficiently travel from patch to patch looking for food. The more energy saved when walking from place to place, the more energy would be available for reproduction.

But this raises an important question: Which mode of walking—knuckle-walking like a chimp, or walking on two legs like a modern human—is more efficient? Curious about the locomotor differences between humans and chimpanzees, a group of researchers ran a study to find out.

The purpose of the study was to determine if there is a significant difference in the "energetic cost" (the amount of energy required) of walking on two limbs versus four. To do this, the scientists spent four months training five chimpanzees to walk both ways on a treadmill: on four limbs and on two. While the chimpanzees walked on the treadmill, they wore loose-fitting masks that collected the air they breathed out, as shown in **Figure 1**. The scientists also collected data for four humans walking on two limbs (luckily for the humans, they weren't asked to walk on four limbs!). By determining how much oxygen the chimps and the humans were using during walking, scientists were able to draw conclusions about the energetic costs of the different forms of walking. Since oxygen is needed to provide usable energy to muscle cells, the researchers can infer that the less oxygen contained in the air exhaled by the subject, the more oxygen the subject used up and therefore the more energetically expensive the activity was.

Figure 1. A Chimpanzee Walking on Two Limbs on a Treadmill. The mask is fitted to collect the exhaled air which was analyzed to see how much oxygen was used.
Source: Image copyright Cary Wolinsky.

If you looked only at raw numbers, trends would be hard to detect because chimpanzees and humans are different sizes. Of course humans would use more oxygen than chimps because they are bigger! So, to be able to accurately compare the data, the researcher calculated the cost of transport (COT), which is the amount of oxygen used to move 1 kg of body mass 1 meter. These data are shown in **Table 1.** When they compared COTs, the researchers found some surprising results. First, there wasn't a big cost difference between knuckle-walking on four limbs and walking on two. Second, human walking takes about 1/4 the energy per kilogram than either form of walking in chimpanzees! So, if a chimp needs to use up 100 units of energy per kilogram to walk a certain distance, a human would need to use just 25 units per kilogram to walk the same distance.

Species	Average cost of transport when walking (ml of O_2 per kg per m)	
	Two Limbs (bipedal)	Four Limbs (quadrupedal)
Chimpanzees (n = 5)	0.21	0.19
Humans (n = 4)	0.05	—

Table 1. The Energetic Cost of Walking in Chimps and Humans. Data in the table represent the average for all subjects. Humans were not asked to walk on four limbs, so no data is reported. *Source:* Sockol et al., 2007.

Next, the researchers compared their data to known COTs across many species of birds and mammals, these are plotted as light gray circles in **Figure 2** on the next page. Looking at the data together, it became apparent that overall, chimps spent more energy walking than expected (data points are above the trendline) and humans spent less energy walking than expected (data points are below the trendline).

These findings support the idea that walking energetics played an important role in the evolution of human bipedalism. Modern human walking is approximately 75% less costly than both quadrupedal and bipedal walking in chimpanzees, which means that the *way* chimps walk— on all fours or bipedally with their knees bent and body weight thrust forwards—causes them to spend a relatively large amount of energy to go a given distance. The style of walking that modern humans have developed leads to spending less energy while walking from one place to another, meaning we have more energy left to spend on something else, like reproducing. In this way, it's not just being bipedal that was an evolutionary advantage, but *efficient* bipedality that gave way for our chimp-human ancestor to evolve.

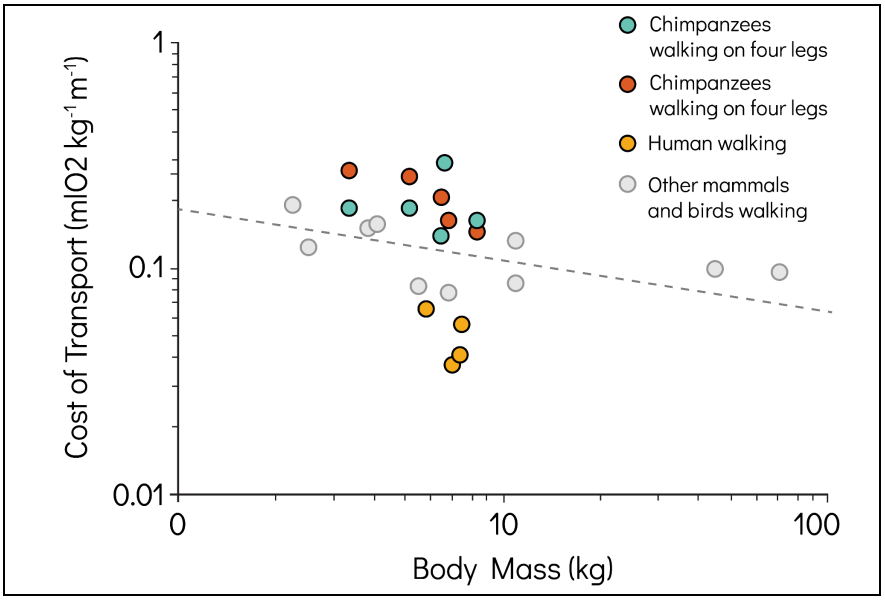

Figure 2. Comparison of Moving Costs in Humans and Chimpanzees. Each teal, orange, and yellow dot represents data collected from a subject in this study. The gray dots represent data from other mammals and birds taken from other studies. The dashed line indicates the trendline. The *y*-axis, cost of transport, is a measure of how much oxygen is consumed during movement. The higher the cost of transport, the more oxygen is consumed and the more energetically "expensive" the movement is. *Source:* Figure modified from Sockol et al., 2007.

Reference

Sockol, Michael D., David A. Raichlen, and Herman Pontzer. 2007. "Chimpanzee Locomotor Energetics and the Origin of Human Bipedalism." *Proceedings of the National Academy of Sciences of the United States of America* 104 (30): 12265–69. https://doi.org/10.1073/pnas.0703267104.

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