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# The Mosaic Lifeway of our Australopithecine Ancestors: Piecing in Some Fragments From The World of The Chimpanzee

*Kevin D. Hunt, Indiana University*

October 7, 1986 began as a sunny, pleasant day, though the dark horizon hinted that rain was a possibility. I had set off at dawn to find chimpanzees in the hills above my small house on the shores of Lake Tanganyika, Tanzania. At midmorning I sat near a small tree watching Chausiku, an adult female who was to become one of my favorite chimpanzees at Mahale.

In this early part of my study I was still mesmerized by nearly everything the chimpanzees did, and Chausiku was being especially interesting this day, moving gracefully among the tiny twigs at the outer reaches of the Garcinia tree. She was eating the small cherry-tomato-like Garcinia fruits, and she was going about it in a very business-like way. Half hanging from an overhead twig and half standing on a lower branch, she popped the juicy flesh of one fruit after another into her mouth, dropping the empty skins onto what was becoming a carpet of detritus under the tree. Nearby her infant Chopin killed time by alternately capering among the small branches of the fruit tree and studying Chausiku's movements, mostly concentrating on shirking the chore of gathering his own fruit. He was still young enough that he knew he could count on mother's breast to complete his meal. Another chimpanzee arrived and began gathering fruit by reaching into the lower branches of the tree from the ground. As I sat on the grass near the Garcinia for an hour and a half, a number of chimps came and went, feeding either from the ground or, like Chausiku, in the tree. After a while it began to rain. For the next two hours, as I sat shivering with Chausiku and Chopin, huddled against the persistent downpour, in my mind I replayed the image of Chausiku's seemingly oversized figure weighing down the tiny fruit tree, and of how gracefully she moved among the dangerously small twigs as she fed. Yet I had no idea that what I had seen was in any way important; it was the beauty of it that had caught my attention.

*Figure 1*

It was only two years later, as I pored over a printout that was a distillation of my year of observation that I realized the significance of Chausiku's bipedalism. Chausiku's behavior, sieved through the filter of my scratchy field notes and neatly typed out in a computer summary, turned out to be an important clue to the way of life of our australopithecine ancestors – indeed, to the very origin of humanity.

## Background

With the aid of a Leakey Foundation grant, I went to Tanzania in August of 1986 to study chimpanzees at the Mahale Mountains and Gombe Stream National Parks. My aim was to follow chimps for a year, recording their locomotion and posture (together referred to as "positional behavior"). Although chimpanzee anatomy is well known, until a colleague of mine, Diane Doran, and I began our studies, no long term study had quantified their positional behavior. Such data is necessary to explain why chimps have such peculiar bodies – and their bodies are peculiar. Chimps are a patchwork of parts seemingly borrowed from several animals. They have long arms, long curved fingers and rather mobile hips, traits otherwise found only among fellow apes. They resemble humans and other apes in having a broad short chest, mobile wrists, mobile shoulders and no tail. Monkeys look rather like dogs with hands instead of paws; they have deep, narrow chests, long torsos, and approximately equal fore- and hindlimb lengths. As most primates do, chimps have a grasping foot and rather short hindlimbs. The combination of traits make apes look rather like long-fingered humans with absurdly short legs with hands at the ends of them.

## Locomotor and Postural Study

The study of locomotion and posture in primates may seem abstruse, but in fact it has a long history. Since the late 19th century, anthropologists have been furtively creeping around Africa spying on the apes in hopes of understanding their unusual shape. Sir Arthur Keith believed that ape anatomical peculiarities were due to their unique brachiating adaptation, that is, their propensity to get around using hand-over-hand swinging underneath branches. A drawer full of scientific publications documented the elegant adaptations of the apes to brachiation: Their internal organs sat on a bowl-like pelvis instead of being suspended from the spine; their mobile shoulders allowed them to orient their arms above their heads; their mobile wrists allowed first one and then the other hand to be fixed on a branch while the body rotated underneath it; their arms were elongated in response to their increased locomotor responsibilities; their spine was short because their arms, not their back, propelled them; their chest was flattened to give the arms better clearance of the thorax; and their scapulae (shoulder blades) were long to help lever up the arm when reaching during brachiation. Even though a few chimpanzee specializations, such as their narrow-shouldered, hunched appearance and their cone-shaped torso, were unexplained, such details were not a cause for concern. They were merely loose ends to be tied up later.

To the consternation of anatomists, studies of wild apes stubbornly refused to yield data that fit with this elegant theory. Brachiation was found to be rare among the larger apes. Some scholars reacted by liberalizing the scope of the term brachiation to include behaviors that had similar movements. Other researchers took a different tack. They pointed out that whereas brachiation was uncommon in many apes, there was one thing that all apes did – climb. Matt Cartmill and others proposed that long arms ( and fingers) might be useful for reaching around large vertical trunks during climbing, and that mobile wrists might be useful in orienting the hand around oddly angled branches and among twigs at the edges of trees. Mobile shoulders might be necessary for reaching up to grasp a new hand-hold while climbing. A short back might be an adaptation to stabilize the spine against the forces of the powerful hindlimbs pushing the body upwards.

In confirmation of this new hypothesis, laboratory studies of muscle activity (electromyography or EMG) revealed that muscles that were large in apes were typically more active during vertical climbing than during brachiation. The climbing hypothesis seemed even more elegant and seamless than the brachiation hypothesis – except for one annoying glitch. While it is true that all apes climbed, climbing had not been very rigorously defined. It was really catch-all locomotor category consisting of not only vertical climbing but a number of behaviors that were nothing like what we do when, for instance, we climb a ladder. Even regular

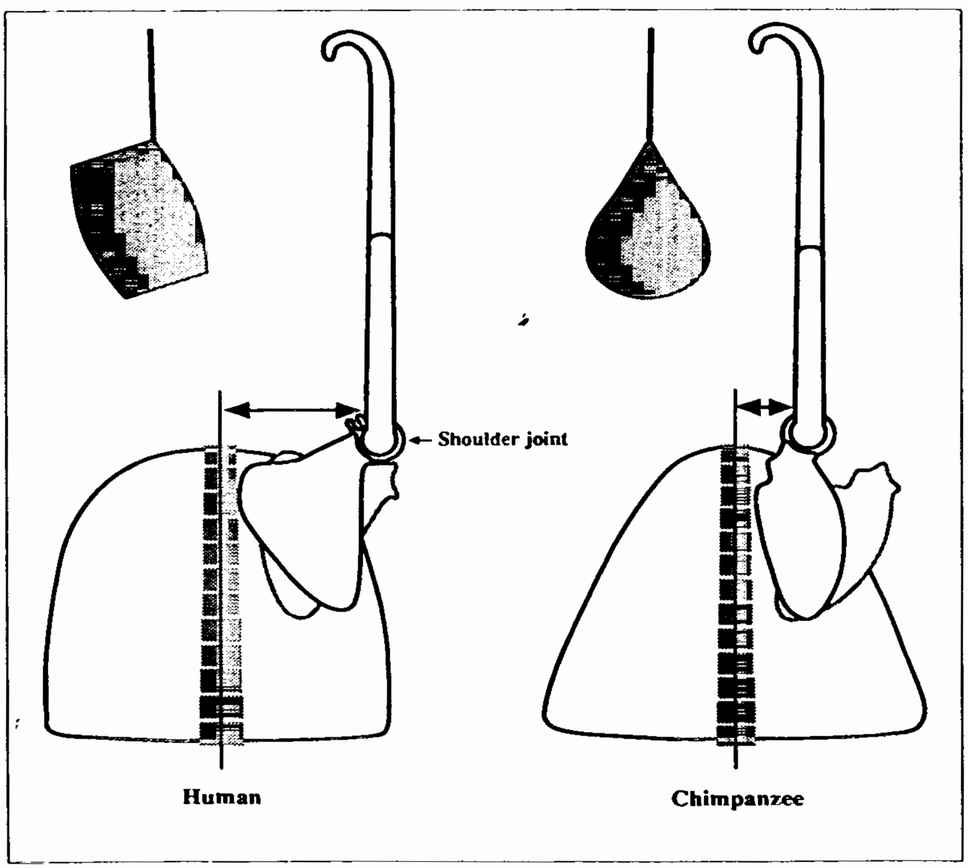


*Figure 2*

monkey four-footed walking on inclined branches was called climbing.

## Chimpanzee Positional Behavior and Morphology

The results from my study showed that 90% of what chimps did could not account for their specializations either because the behaviors were unstressful or they were too much like those of monkeys. This meant that the remaining 10% of chimpanzee positional behavior must be responsible for all of the substantial ape-monkey differences. In such a small piece of pie, a sliver can mean a lot. Still, brachiation seemed too rare (0.1%) to have caused chimp anatomical specializations. Climbing (ascents or descents on surfaces >= 45 degrees) made up 0.9% of all behavior, but that's not very different from baboons (0.5%). Unimanual arm-hanging made up by far the largest proportion of that important remaining 10% (4.4%), and it was also extremely rare in baboons (<0.5%).

Hanging by one arm presents some difficult and unique physical problems. The torso of the typical primate is rather barrel-shaped, with the arm attached far to one side. One-armed hanging causes stresses like those in a barrel that is lifted by a single point on its rim. When the barrel is lifted stresses are very high in some places (and likely therefore to fail there ) and low in others (so that the strength there isn't being used). If it were suspended from a hook in the center of its top, stresses would be nearly the same on every stave, and lower on the most stressed. An arm-hanging primate, therefore, might be expected to suspend its "barrel" from a center point, but how can they? Primates are more or less laterally symmetric, and they have a midline that is already occupied by a can't-do-without-it head. Never underestimate evolution. Chimpanzees evolved narrow shoulder blades (scapula) to help reduce such stresses. In humans the scapula runs into the spine before it can rotate far enough to allow the shoulder joint to move to the midline, but the narrow scapula of the chimpanzee allow it to swing far up, so far that when an arm-hanging chimpanzee is viewed from the front, the shoulder has all but disappeared behind the neck (Figure 1). To make arm-hanging still more comfortable, the chimpanzee shoulder joint is tilted up. Humans, in contrast, have a socket for the humerus (the upper arm bone) that faces sideways (Figure 2).

There is still stress that wants to make the top and the sides of the barrel one smooth line, more like a cone. In other words, a cone shaped object lifted by a hook at its apex has its stresses distributed more evenly than a barrel. One might take this to its logical extreme by imagining an object hanging from a single point that has all of the stress distributed perfectly evenly. Nature provides us with an example of this in a water droplet, which settles into its shape by a balance between surface tension and gravity. Stress is exactly equal on all parts, and the result is a distinctive teardrop shape. A chimpanzee thorax resembles a teardrop, cone-shaped at the top and bulging at the bottom, more like a water droplet than a barrel (Figure 3).

## Australopithecine Anatomy

What does the anatomy of the celebrated Lucy fossils look like? Jack Stern, Randall Sussman and William Jungers of SUNY Stony Brook, Russ Tuttle of the University of Chicago, and Bruce Latimer and C. Owen Lovejoy of the Cleveland Museum of Natural History and their colleagues have given us a good idea. The torso is cone-shaped and the shoulder joint points upward, like the chimpanzee. The arms are long in relation to the legs, mostly because her legs were very short. Lucy's hips, unlike what would be expected of efficient walkers and runners, are extremely wide. Bill Jungers showed that compared to humans, Lucy's joints are systematically smaller below the waist, and larger

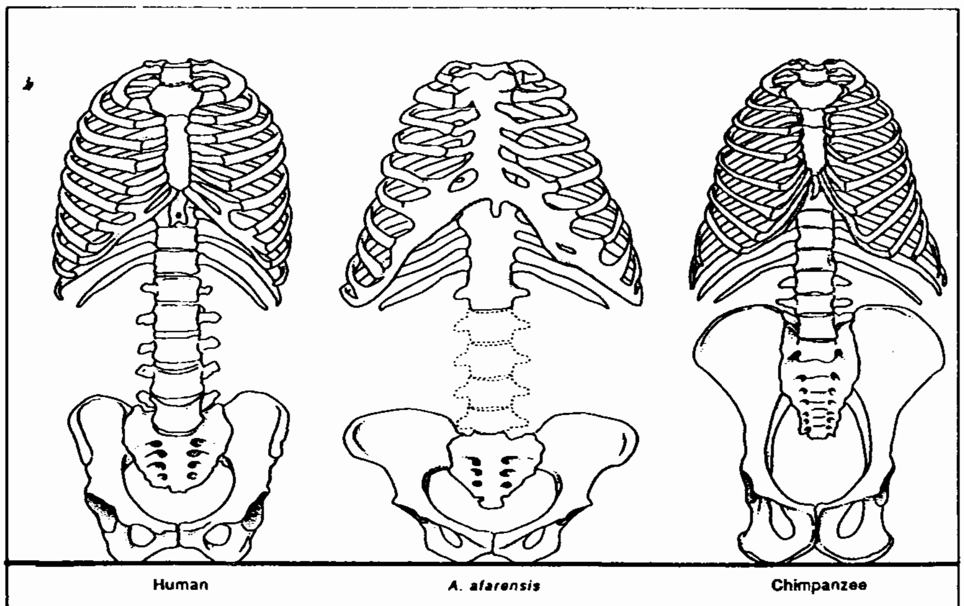


*Figure 3*

from the waist up, similar to apes. A.afarensis toes are curved and longer than those in modern humans. Long, curved digits like these are found among animals that rely on strong gripping. Joint shape and toe proportions suggest rudimentary gripping abilities. In contrast, Lovejoy and Latimer have shown that aside from width, the hip bones of Lucy are almost modern in shape. The foot (except the toes and big toe joint), knee joints and ankle joints are strikingly similar to those of modern humans.

These features suggest a creature rather ape-like from the waist up, and fully bipedal from the waist down, but her bipedality seems to have chimp-like edges here and there, seemingly wherever it does not compromise the bipedalism too much. How can this be? Could an animal that spends time in a tree stride bipedally like ourselves? You cannot walk in a tree, not like we do, so bipedalism must mean terrestriality. How can one part of the body clearly indicate arboreal arm-hanging when the other part is so clearly adapted to bipedality? If Lucy was adapted to the ground-living, why would she retain so many features from her more ape-like ancestors, especially those features that make striding bipedalism inefficient, such as short legs, long toes, wide hips and small hindlimb joints?

## Why Are We Bipedal?

I have sometimes imagined how wonderful it would be to follow an australopithecine, just for a single day. When I think of the curious mixture of human-like intelligence I saw in chimpanzees (their social skills were uncanny) and animal dumbness (they certainly don't have engineering minds), I can only imagine how intriguing the mix would be in australopithecines.

Alas, watching living primates is the closest we can come to watching Lucy. Perhaps not surprisingly, many hypotheses about bipedalism come from primate watchers. Russell Tuttle postulated that our ancestors were preadapted to bipedal locomotion by a long history of arboreal bipedal feeding postures and bipedal locomotion on large branches, an exaggeration of gibbon behavior. Clifford Jolly and Michael Rose pointed out primates are bipedal most often when feeding, especially when collecting plentiful small food items found in bushes. Richard Wrangham added that a bipedalist would not have to spend extra energy to raise and lower the torso when alternating feeding and walking. But if australopithecines are arboreally adapted, how did their bipedalism become so well refined? If australopithecines had a bipedal **locomotor** adaptation, why did their locomotion remain so inefficient? And if bipedalism evolved **as a posture** to aid in terrestrial gathering, why the arboreal adaptations?

## Chimpanzee Bipedalism

My data clearly supported a feeding hypothesis. 85% of the time chimps were bipedal was while eating or gathering food. On the ground, most observations of bipedality were made when they fed from two rather short trees, one merely a large bush. Both had small fruits. This finding was quite exciting, since it closely conformed to the Jolly/Rose terrestrial feeding hypothesis. But that could not be the whole story, because more than half of my bipedal observations were arboreal, as expected by Tuttle's hypothesis. When I looked at the list of trees chimpanzees fed from arboreally with bipedal postures, I found that two of the three most common species were the same trees they fed from on the ground.

The third common tree, it turned out, was even more exciting, because it was Garcinia huillensis. The vivid memory I had of Chausiku feeding in a tiny Garcinia tree came rushing back. It was important because I had seen a number of other chimpanzees feeding on the fruits of this tree from the ground (my data collection protocol, however, only allowed observations of Chausiku to be used in analysis). Chimps tended to feed bipedally both from the ground and up in the tree – in the very same trees! Terrestrially, chimpanzees ate fruits by standing bipedally and working their way around the periphery of the tree, sometimes holding onto a branch to stabilize their lower body, but most of the time using both hands to harvest fruits. Sometimes they reached high into the tree, grasped a branch and fed in an arm-hanging/standing posture. Bipedalism and arm-hanging seemed closely associated since chimps often harvested fruits using bipedal postures that involved partial suspension from a forelimb.

## Australopithecus afarensis Bipedalism

Might our earliest ancestors have harvested fruit in a similar manner? This might explain how A. afarensis upper bodies could have been adapted for arm-hanging, while their lower bodies are more like ours. If the original function of bipedalism was as a feeding **posture**, the imputed inefficiency of bipedal **locomotion** in A.afarensis suddenly fits perfectly. Although Lucy's short legs and delicate joints seem poorly suited to the wear and tear of heavy carrying or long distance travel, her anatomy **was** well suited for short-distance locomotion and efficient arboreal and terrestrial postural feeding. Compared to humans, australopithecines were **postural bipeds**.

So it seems ape study has left us with a clearer picture of our ancestors. As Louis Leakey predicted, we can see them better peering over the fuzzy shoulders of chimpanzees. They were not spear carrying hunters striding across grassy savannahs, fixing skittish mammals with a steely hunter's eye, but fruit eaters, spending much of their day standing and gathering rather than striding. Our ancestors were frugivorous, bipedal apes.

## Epilogue

Science has its price. Among African primates I felt a little closer to our ancestors, but it did little to emphasize my humanity. After a year among apes, my wife complained that I had become nearly as silent as the animals I had studied. My temporary reticence was a small price to pay, for speechless as they are, my chimp friends Chopin and Chausiku had something to say which I found fascinating, even if it was a little gossip about the lifestyle of a relative --Lucy.

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