



Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

Meredith Johnson
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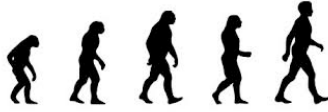
This is Origin Stories, the Leakey Foundation podcast. I'm Meredith Johnson.

We're back with another live episode from the Being Human event series. This talk was recorded in July, 2016 just before the San Francisco Marathon and it's about how humans are adapted for long distance running. Our speaker is Daniel Lieberman. Dr. Lieberman is a professor in the Department of Human Evolutionary Biology at Harvard University. He's also a Leakey Foundation grantee and a member of our Scientific Executive Committee. His research focuses on how and why our bodies are the way they are. He's especially interested in how and why humans are so good at long distance running. He's the author of over 100 scientific papers and several books. His most recent book is called "The Story of the Human Body." Here's Daniel Lieberman recorded live on stage at [Public Works](#) in San Francisco.

Daniel Lieberman

So I'm here to talk about the marathon and running and I'm delighted to see that some of you are planning to run. How many of you are thinking about maybe running in the future at some point? Okay. Good. How many are like there's no way you'd ever want to run a marathon at all in your entire lives? Actually, that's the smallest number of hands that have ever gone up. That's good and I'm guessing a lot of people didn't raise their hand to any of those questions, which is fine. I would like to start by thinking about the kind of world that we live in, just to remind us that the 21st century, if you just watch the news, you realize what a strange world it is today, but as somebody who studies the evolution of the body, I'd like to remind us all that the way in which we use our bodies today is really profoundly abnormal from an evolutionary perspective.

So the average American for example, today watches about five hours of TV. We all watch that, right? Yeah? Exactly. The average American is about 23 pounds overweight. The average American throws out about half a pound of food every single day, which is an extraordinary



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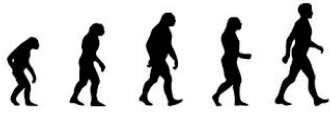
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

amount of food. The average American walks less than 3 miles a day, which is actually about what a chimpanzee walks by the way. The average American wears shoes; I can see everybody here is wearing shoes, myself included. We eat breakfast from a box, which if you think about it, is a really strange thing and the average American, believe it or not, drives 33 miles a day and so these are all from an evolutionary perspective, extraordinarily weird things and yet the average American also thinks that what the people are to be doing on Sunday is also a weird thing, right? Getting out there, starting on the Embarcadero and running 26.2 miles. I gather there's about 26,000 runners this year in total in the marathon, and the average runner is going to burn about 2800 calories; I don't think any of us in this room have a chance of winning, maybe I'm misjudging the physiques of the people the room, but certainly I have no chance of winning and there's going to be a lot of pain, and suffering, and misery, right? There's going to be blisters, and bleeding nipples, and shin splints, and leg cramps, and broken toenails. There's going to be a lot of misery out there on the course, though a lot of very happy people when they finish and people think this is a very strange thing to do, and one of the questions is, you know, why? Why do people do this, right? A lot of people sit in their armchairs or stand along the side of the road in the marathon or just think about it and wonder why are people doing this, right?

Well, there's a lot of other interesting "why" questions. For example, it turns out about a million people run a marathon year. Why do so many people run a marathon? Marathon running turns out to be one of the largest charitable activities on the planet today. Do you know the single biggest charity that happens on a single day is the London Marathon? It raises about \$75 million every year, this London Marathon. The New York Marathon raises like \$25-\$30 million a year, the Boston Marathon etc. The big-city marathons are huge, so runners raise hundreds of millions of dollars in charity and by the way, a bunch of us are raising money for the Leakey Foundation this year.

Runners do all kinds of other strange things like, for example, those of you running, I guarantee you that you will probably be smearing your body with Vaseline and various other sorts of things, and then finally, if you go out and watch the Marathon, people will be doing all kinds of strange stuff. They'll be wearing weird clothes; I mean how many of you have dogs? How many of you have dogs? Not a single person in this room has a pet dog? Okay, just a few. I guess we're in a very urban environment. Well, I have a dog, but people don't bring their dogs on marathons. How come we don't bring our dogs to marathons?

So to answer these questions, and there are many more. We can come up with lots of other questions about the Marathon. There are sort of two levels to think about them and one is proximate explanations. Those are the mechanistic, sort of how questions, right? So, one proximate explanation for why people might run a marathon is that well, you know, they got inspired by that Robert Browning poem and they want to be like Phiddipides. Another is that



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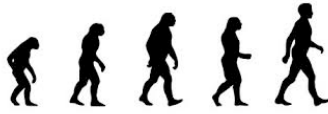
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

there are a lot of people out there who are overweight, or unhealthy, etc., and their doctor tells them that if they don't start exercising, they're going to die and they're type-A personalities, so they invest into exercise just what they did to invest in their careers, or whatever that got them into that physical state the first place, and finally there's a lot of people, an incredible number of people who run marathons because they had a bet, and I'm not sure quite what the percentage is, but it's actually a very high number. But those are all proximate explanations for why people run long distances. What's important about evolutionary theory is that evolutionary theory helps us address much larger ultimate questions; the "why" questions and there's a very famous expression by Theodosius Dobzhansky. Dobzhansky wrote a very famous essay, actually for high school teachers entitled, "Nothing in Biology Makes Sense Except in the Light of Evolution" and that's of course because our bodies weren't engineered; they weren't designed; they evolved and to understand why we are the way we are, we need to understand the evolutionary story behind that and so I'd like to talk today about the why we run.

For me, this journey started many, many years ago when we were studying how pigs stabilize their heads, or actually how humans stabilize their heads while running and we started doing some experiments on pigs and it led to a long series of experiments and ultimately in 2004, a colleague of mine, Dennis Bramble and I published this paper in the journal *Nature*, entitled "Born to Run" and our argument was that humans evolved to run long distances, maybe about 2 million years ago, in order to hunt and to scavenge and that our ability to run distances like the marathon, our ability to go out and run 5 miles, 10 miles, etc., is actually quite an extraordinary talent as a result of natural selection. It helped make us who we are. It's not all that made us who we are, but it's part of that story and to tell that story, since I'm told this is kind of a cool crowd and I shouldn't give too nerdy a talk, I want to do kind of a though experiment.

So, let's imagine it's 2 million years ago and we're all completely naked *Homo erectus*, okay? Maybe that's not a fantasy you want to have, but anyway, so imagine it's 2 million years ago, you're somewhere in Africa, and it's kind of hot and dry and you're hungry and imagine for example, that you're a female *Homo erectus*. So females, for most of human evolution history were either pregnant or nursing and nursing takes much more time. So a typical nursing female *Homo erectus* we can estimate would have needed about 2,500 calories per day in order to pay for her needs, plus the cost of producing milk, but she's also probably got some kids in tow, right? She's probably taking care of a toddler and some other infant, so she needs actually more energy. So she needs a lot of energy. Well more than 2,500 calories a day to pay for her basic energetic needs, plus the needs of her offspring. That's a lot of energy, right?

Where do you get that kind of food? Because they're living in habitats like this, right? If you look out here, in the sort of typical African savanna scene, what is there to eat? Right! It's the zebra, right? So we know that starting around— well, the oldest evidence that sort of secures, around



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Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

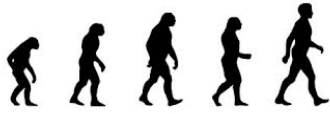
2.6 million years ago— it probably started a bit earlier than that— but by at least 2.6 million years ago, we have really incontrovertible evidence that humans, early humans, our ancestors *Homo erectus* or the ancestors of *Homo erectus* are eating meat, they're making stone tools. Here for example, is a bone that's been cut open, marrow has been extracted, there are cut marks on it; they're eating animals, right? And that raises a really interesting question. So imagine you're going to try to get one of those zebras. The problem is, we have none of the natural adaptations that other carnivores have to get these animals, right?

Hussein Bolt is the fastest guy on the planet at the moment. He can run 10.4 meters a second, for about 10 seconds. He can run a little bit slower for 20 seconds. He can't run at that speed for much longer than 20 or 30 seconds; he completely runs out of gas. So he's the fastest on the planet. The average quadruped out on the savanna can run about 20 meters a second, so twice as fast as Hussein Bolt, for about four minutes. Hussein Bolt would have no chance of catching any of these animals out there on the savanna, right? And probably, you know, this early *Homo erectus* didn't have the fancy training and the shoes, and all the other, you know, the goo and the steroids and whatever helped— I'm not saying that Hussein Bolt takes steroids— the Russians— that's another story, but anyway.

Okay, so Hussein Bolt is not fast enough to catch these animals. The other thing is that humans lack any of the natural weapons of carnivores. We don't have claws, we don't have fangs, we don't have all the fur to protect us, because of course, to be a carnivore not only do you have to be mean and nasty when you try to kill something, but you also have to deal with the other carnivores who try to kill you and we didn't have also any technology. We often think about when we hunt we use technology, but the bow and arrow was invented less than 100,000 years ago. The spear thrower way less than that, maybe 20,000 years ago. Just putting a sharpened point on the end of a stick? The oldest points that we have in the archeological record are about 500,000 years old.

So for millions of years, for maybe 2 million years, the most lethal weapons available to our ancestors were pointed sticks and I can guarantee you if any of you go on safari don't just take a pointed stick and go to try to kill the wildebeest. It's not going to work. The only way to kill it is you have to get up close and personal to the wildebeest, which of course makes you very much in danger of being— well, I just can't imagine people hunted that way. You're much better off being a vegetarian than trying to do that. This is a serious fitness reducing event. The people who make these illustrations they look great. They're complete utter fantasy. Nobody hunts like that. That's really dangerous.

So how did we do it? Our hypothesis is that for millions of years, before the invention of technology, before all the things that, you know, Star Market, or Whole Foods or whatever it is



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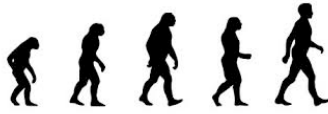
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

you shop out here, what we did was endurance running and we have evidence from skeletons. This is a very famous skeleton of a *Homo erectus* that's 1.6 million years old. It's a beautiful skeleton. We have other bits and pieces, but it's a beautiful, fairly large skeleton. I won't go into all these details, but we have evidence from the fossil record for all kinds of features that we see in the fossil record, some of which would've made the species this piece is really good at walking long distances, but a lot of these features have no relevance to walking whatsoever biomechanically in their adaptations for running, and that's really another lecture. I'm not going to go into those features.

So we can make the hypothesis that we started running about 2 million years ago and here's how it works; so we are able to run long distances at speed that make other animals have to gallop. So, to show you this. This is speed on the X-axis and I've plotted it in the nerdy, scientific way of meters per second, but as a marker here, I put for 6 meters per second, is 21 kilometers an hour, or 4.5 minutes per mile and I've plotted here the human endurance running range. So this is the speed up to which humans can run a marathon. So the fastest runners on Sunday will be running pretty much close to here. Most of us will be running over in this speed range here and here, I've got the trot/gallop transition for dogs, ponies and horses. By the way, I've got really big dogs. I've got dogs the size of humans. These are greyhounds, right?

The important point is of course, these animals can go way faster than humans. Hussein Bolt is here at 10.4 meters per second—the fastest human one the planet, but the important point is that although all of these animals can run way faster than any of us can run, we can run marathons at distances that are above the trot/gallop transition of all these animals. Trotting is the endurance gate of quadrupeds. Quadrupeds cannot gallop long distances. They break down, they overheat, there's all kinds of problems that they encounter. So even I, a middle-aged professor, right? I'm obviously not going to win anything ever in my entire life. I have never won anything in my entire life, but I can run faster than a dog can run at a trot. So I can run above the trot/gallop transition speed. I can run a marathon above the trot/gallop transition speed of a greyhound. I can actually run a half-marathon above the trot/gallop transition speed of a pony and again, I'm never gonna win any race in my life. I'm not a great runner and any decent runner can easily run above not only the trot/gallop transition speed of ponies, they can actually run above the trot/gallop transition speed of full-size horses for marathon distances.

Why is that important? Well, because when humans run, we cool by sweating. So this lady at the Westminster Dog Show looking rather elegant if you ask me, right? She is running with her—I don't know that's a very scary looking wolfhound or something? I don't know. Anyway, she's of course burning a lot of fuel and she's generating a lot of heat, but she's sweating. This animal can't sweat. It doesn't have any sweat glands. It's cooling by panting—short, shallow breaths which cause evaporation in the oral tract, which cause heat loss and that cools the blood in the



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Origin Stories Being Human Episode 19: Born and Evolved to Run

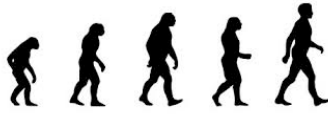
July, 2016

oral track, which cools the body. Now the cool thing about quadrupeds, or the uncool thing about quadrupeds, if you're a quadruped is that when you're galloping, you can't pant. Because a gallop is a seesaw gait, and actually really interesting experiments that were done when I was a graduate student in the lab next to me when I was at Harvard, showed that as quadrupeds gallop, because of that seesaw gait their guts slam at the same frequency as their stride frequency and slam into the diaphragm, so they can't actually have these short little shallow breaths in between their normal breathing.

So they have to train their breathing to their stride frequency as soon as they start galloping and if you don't believe me, take your family dog for a run and you'll notice that the dog will be panting— well, it's so cool here they probably won't have to pant that much— but on a hot day, your dog will pant and if you run fast and you make your dog gallop, the dog won't be able to pant. When it wants to cool down, it'll do all kinds of devious things like my dog does. It will wrap itself around your legs or just have all these needs to pee, etc. That enables the animal to pant and to cool down.

So if you combine the fact that we can run long distances that make animals gallop, and that animals can't cool down when they gallop, that gives us a huge advantage. That advantage is manifested in a kind of hunting called persistence hunting. People still do this today, very rarely though, but what you do is, on a really hot day, the hotter the better, you pick an animal and you pick the biggest animal as you can because bigger things get hot faster, just like bigger humans get hot faster and you chase the animal and you try to chase it above its trot/gallop transition speed. So, you make it run away and of course, it starts heating up. Now it's going to run faster than you can chase it and it's going to go hide in the bushes and then you track it. Of course you track it at a walk and then you chase it again. If you can get to it before it's cooled down and chase it again and use kind of a walking, running, chasing, tracking combination, you can eventually drive that animal into a state of hypothermia— heatstroke— and you can walk right up to it and you can kill it without any technology.

This guy is using a spear, but in some parts of the world, like for example the Tarahumara, where I've been doing research recently, they traditionally just use a rock. They don't bother bringing a spear because you don't need any technology to kill the animal at that point. It's dying already. It's defenseless. You can walk right up to it. It won't kick you, it won't gash you with its' horns or anything like that. So, it's actually not that difficult a thing to do. They're not running that fast; they're actually running at a very leisurely, kind of 10-minute mile pace, generally. They were actually walking half the time. They're not running full marathon distances; they're running more like half marathons. It's not that challenging. The hardest thing about it is not the running. When you talk to these hunters they always say the hardest thing about it is the tracking. Trying to follow the animal's trail. Trying to figure out where the animal is going. That's called



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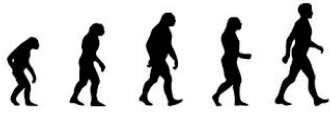
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

persistence hunting and we have ethnographic evidence it occurred all over the world. It was very common here in North America. Here in California, for example, there's lots of data from pretty much every Native American tribe was involved in persistence hunting. It also happened all the way through Maine, like Penobscot, it happened all the way through South America, we know it happens in Africa, we know it happens in Australia, we know what happened in the summer even in places like Siberia. We have evidence that until recently, this was a very common way of hunting and in fact, it's still described like— and if you read Robinson Crusoe— he actually runs down a goat on the island, if any of you know that book, through persistence hunting.

So those of you who are running on Sunday, if you're kind of feeling a little bit tired, it's maybe— I don't know— halfway through the marathon, you're like, “Oh my God, how am I going to make it?” and you're kind of feeling like fading, just think about that animal that you're chasing and of course, here in the San Francisco Marathon they provided us with bison at the halfway point— and I think it's very symbolic of the kinds of animals that we might've hunted. Unfortunately, I think we're not allowed to chase the bison and it will not be good for your time in the marathon. So just think about chasing the bison, but nothing more than that.

So that raises a bunch of questions and so one question is just how good are we running, right? As I already told you before, Hussain Bolt would have no chance in terms of beating any dog or for that matter most sheep or goat or whatever. So we're obviously not any good at running fast, but what about distance, right? It turns out that there are very few animals that run long distances and they tend to be social carnivores; hunting dogs, hyenas will naturally run long distances. Horses will run long distances if you force them, if you put somebody on their back or whip them or something like that. At a gallop, they can go about 20 kilometers and dogs and horses can be— at a trot— be forced to do horribly long distances. There are actually very disturbing experiments that were done in the 1930s where they ran animals basically till their death to find out how far they could go. That was the 1930s. Fortunately, nobody does that anymore, but humans, you know, a lot of people out there training for a marathon will easily run 10 to 15 kilometers a day, which is pretty much what social carnivores do and on Sunday, 26,000 people here in the city are going to run 42 kilometers and there are lots of people who like to run ultramarathons.

So humans actually are able to run distances that match those of the world's best runners— the animal kingdom's very best runners and remember we're not carnivores, right? We're not quadrupeds, we're not horses, we're actually primates and if you look at what other primates do, it's no contest. Chimpanzees will run about 100 meters and that's about it. Patas monkeys, the other— no, it's true. If watch a chimpanzee run, after about 100 meters, it is a very unhappy chimpanzee. It's hot and sweaty and just looking miserable and it just collapses. Patas monkeys



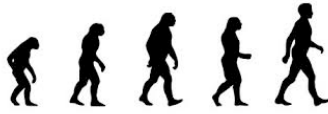
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Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

will run, but again they won't run more than about 100 meters. So we are bizarre compared to other primates. We're quite remarkable. We're also capable at running in context that no other animal will run. So we not only run long distances, but we are also capable of running in the heat. We have all these remarkable adaptations to run when it's really hot out there and I can tell you the last few weeks in New England have been really, really hot and we do that because we have special adaptations, right? We dump heat by breathing through our mouths, of course we sweat. We basically have sweat glands all over our bodies and we lost our fur and you can lose a lot of heat by sweating. You lose 581 calories per milliliter. That's a huge amount of energy or 581 kcal per liter. You're losing a huge amount of energy by sweating, which cools your body and other animals that run long distances can't do it in the heat.

So if you watch for example, hyenas, or hunting dogs, or wolves or those Alaskan dogs, etc. I was in Greenland in March watching dogs. They only can do this kind of running when it's really cold. They cannot do it in the heat. So, these animals run in Africa. They run either at night, or at dawn, or dusk. Wolves and sled dogs run in the winter. We're the only animal that can run in the heat. As I said before, just to remind you, we can run an incredible range of speeds, so humans can run well above the endurance speed of other animals. We're actually pretty efficient. When I was a student, there was a study which showed that humans were really inefficient runners. It turns out that study was based on one Italian who turned out to be not a very good runner. The study was redone fortunately and corrected for body mass. This is actually a graph of how much energy it takes to move per kilo per meter against body mass for a whole bunch of birds and mammals. This is the average line here for mammals and you can see humans are just a little bit above the line, not any different from horses and various other animals that are really good running. We're actually quite efficient at running, and finally we're remarkable in terms of how long we can run really well. Those of you who have ever run the Boston Marathon— anybody here run the Boston Marathon? Yeah? Okay.

So then you know about Johnny Kelly. He was the great Boston runner. He ran every year for almost all his life, from when he was 22 years old up until he was in his 60s or 70s, and you can see that he won several times. By the way, he was the runner who lost the famous year that Heartbreak Hill got its' name Heartbreak Hill, because his heart was broken by "Tarzan" Brown who passed him, but you can see that his best time was 2:14, but he stayed within 20% of his peak time up until his 50s. That's remarkable. He was still able to run some 3-hour marathons up until he was 60 years old. So humans are not only able to run really fast, but we're able to run for a long period of time. If you go out to marathons, you'll see a lot of old people, elderly people—I shouldn't say old people, pardon me. I'm hoping to be one of those too, soon who are able to run. I've seen 90-year-olds running marathons.



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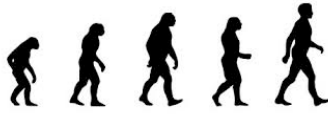
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

Finally, to really put our money where our mouth is; you know that every year there are these races between humans and horses. The first one was started in Wales. You can imagine some drunk guys in a pub making a bet as to whether or not humans could beat a horse and every year they've been running these man versus horse races in Wales. They're 25 miles and to be honest, to be fair, most of the years the horses beat the men, but every time it's hot the humans win, and by the way, these are not elite human runners; these are kind of, well, drunken Welshman. A better race to look at actually is in Prescott, Arizona where every year they have a man versus horse race. There's a 25-mile race, but a 50-mile race. In the 50-mile race, humans almost always beat the horses and again, it's only in very cool years the horses have a chance of beating the humans. By the way, the horses are required to have veterinary checkups, because they are really worried about the horses. There are no doctor checkups for the humans.

Humans actually can only match, but often exceed, the world's best runners, which are horses. So, let's just explore finally, this idea about how important human running is, because I think it helps explain a lot of really interesting things that we're going to see on Sunday. For example, one thing I've already explained is why we're not going to see any dogs. You go to the marathon on Sunday morning, you'll see lots and lots of humans, but nobody's bringing their dog and I didn't see in the race information any prohibition about bringing your dog with you. There was no rule that no dogs allowed, but the reason for that is that it would be really bad for your dog. You would basically kill it, right? It would not be good for your dog unless it was really, really, really cold and it's not going to be cold enough that your dog would overheat while you try to run the Marathon.

Another interesting question is; you know when you got to see runners, occasionally we do see runners all alone, but a lot of running is actually very social. Anybody who runs a lot knows that it's actually a very social thing. A lot of us run in groups. We find friends, and buddies and etc. We train in groups and we run a lot together and that this idea of running as being a very solitary thing I think is extremely modern and I would say a rather bizarre way of running. I would argue that this is actually extremely ancient from millions of years ago when people went running and went to run down an animal. They would not run on their own; they would run in groups because if you go in a group you help each other and of course, you need a number of individuals to bring that animal back. All the evidence we have for persistence hunting from every single society was done not by lone individuals, it was always done by groups of people.

I think that that legacy persists today, that we still run in groups and we're probably still, when we run, we're still gossiping the way people were probably gossiping 2 million years ago. I think it also helps explain why it is that running and runners raise so much money for charity. As I said before, something like hundreds of millions of dollars are raised every year by marathoners for charity and I would argue this is kind of a transference because back in the Stone Age, when we



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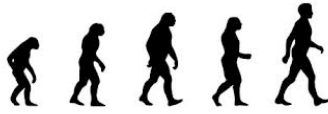
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

ran, we ran in order to help each other and we ran to hunt, to bring back animals, which we would share not just with our family, but with everybody in the group. We ran literally to help each other and I think that instinct hasn't gone away. We still run to help each other, except we no longer— we're not allowed to even kill the bison along the course, and nobody wants to run down animals very much anymore, but we still have that instinct, I believe, in order to run to help each other.

If you get a chance to go to the finish line you'll see some tired people, but you'll see mostly really, really, really happy people and they're not just simply happy because they're not running anymore— although that is part of it— they're actually feeling really good and most people who do run long distances, once you get in shape and you learn the skill of running it's quite remarkable how good it is. Many of you may have had this feeling. You go out for a run and maybe you were 7 or 8 miles in your run, and all of a sudden you realize, I just feel awesome. I feel so good. It's like an effortless thing. Your body is just flowing and that's phenomenon occurs partly because we actually have a huge number of adaptations that make us so good at it. We have all these features that make us superb runners; shoulders that are low and wide and decoupled from our heads, short arms, really big gluteus maximus— which by the way is a running muscle, it has nothing to do with walking— long tendons and our Achilles and no fur, and our muscle fiber types and short toes and the arches in our feet and head balancing systems.

We are filled with adaptations that actually give us the capability of running really well, but there are also other adaptations which are chemical. How many of you ever had a runner's high? It's great! The best thing about a runner's high is that not only do you produce lots of endocannabinoids— the same thing as from pot— but, you also regulate, when you're running the receptors producing the chemical, but you're also enhancing the number of receptors that the chemical binds to and anybody that's had a good runner's high knows that it's way better than anything you can smoke. We have evidence that that system evolved in humans and is present in animals that do a lot of running and not present in animals that don't to running. So, I think the runner's high, which by the way, endocannabinoids help improve sensory perception, may be an adaptation for when we were tracking and hunting to improve our ability to monitor the world around us and see all those tracks and create mental maps and figure out what we're doing when we're running.

Why does running make people so healthy? This is one of my favorite studies. There are many, many, many studies on the effects of exercise on health, but this is a local study. It's just from down the street, so I thought I'd show it today, and it's just on runners and we're talking about running today, but this is the famous Stanford runner's study started by Jim Fries in the 1980s. He took 538 runners. These were not elite runners and marathoners, but members of the Stanford, Palo Alto, whatever running club and he's been following them ever since and



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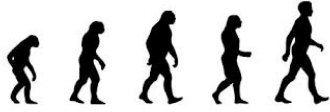
Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

compared them to a group of matched controls. These were not overweight people, they were not smokers, they were not drinkers and he's been studying them ever since and looking at how their health has progressed and not only measuring mortality, but also disability and morbidity. You can see that this is from 2004, so this is 25 years into the study, that the runners 20 years later had 20% lower mortality rates than the non-runners. That's a huge difference, right? The runners had bodies that were on average, based on these disability measures, that were 14 years younger. They were basically aging at half the rate as the non-runners and then of course, there's a lot of interesting biology behind that, but it's not that running, I would say, or physical activity is a medicine that makes you healthy, I would argue it's the reverse that the absence of physical activity is what makes people unhealthy and we sometimes get that wrong.

Our evolutionary history of runners also explains why we can do it barefoot, but that's another lecture. Here is Abebe Bikilia who set the world record in the Rome Olympics in 1960 barefoot. This is Ken Bob Saxton; we were talking about him earlier running the San Francisco Marathon. I don't know how many marathons he's run barefoot. You can see he's wearing a beanie hat, so yes he is a little bit odd and lots of other people run barefoot. You can do it. There's been a lot of hullabaloo about it, but it's not actually that big a deal.

Finally, I think that running can help us understand some human universals. I don't know if you know about human universals, but there's been a lot of efforts over the years try to figure out what's common to all societies. So for example, all societies cook their food, we all have marriage, we all have mother-in-law jokes, we all have music, but it turns out that one human universal is that every culture in the world has underwear. We all have some form of, sort of, modesty accouterments, right? There's lots of different kinds and some of them are more interesting than others, but I would argue that maybe this also has something to do with running, because when you run you're creating substantial accelerations of your body. Running is actually jumping from one leg to another. That's basically what you're doing when you're running, biomechanically. Of course, when you jump, you're accelerating your center of mass up and then as you fall, your center of mass is accelerating downward and you're going up and down and up and down and up and down.

All of you remember high school physics, right? Remember Newton's second law? For every action there's an equal and opposite reaction. So when this guy's body is accelerating downward everything that's not tied down is going to accelerate up and when he's accelerating up, everything that's not tied down, like his penis, is going to accelerate down. It happens with breasts too, right? Anything that's not tied down and so I would argue that when we started running millions of years ago when we had to run really long distances, all that jiggling and flapping was perhaps a little bit uncomfortable and so we figured out how to tie things down. By the way, this is the oldest known underwear and it's found from the archeological record. It's



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Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

from an Egyptian tomb. So the benefit of underwear is that it prevents some of that annoying jiggling. You can think about that on Sunday when you run or when you watch the runners, but of course everything has tradeoffs. There are costs and benefits to everything and the benefit may be less jiggling, the cost of course is chafing. So you'll also see some things like this too on Sunday as well.

So, in short, I would like to argue that everything, nothing in biology including jiggling penises and whatever, but nothing in biology including the Marathon makes sense except in the light of evolution and that running is part of what made us human and that on Sunday when we watch all those folks out there and those of you who are running, I hope you have a great time running. What we're doing is not anything strange or weird. Well, I mean, it's a little bit strange or weird because nobody ever got on the line and ran 26.2 miles without stopping to another line, but beyond that, the basic active running and the reason that we run, actually hasn't changed all that much for over 2 million years. So for those of you who are running good luck on Sunday. Thanks, and thanks to the Leakey Foundation. I look forward to taking some questions.

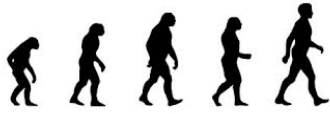
Meredith Johnson

Thanks for listening to [Origin Stories](#). This talk was part of the [Being Human](#) event series, which is a joint initiative of the Leakey Foundation and the [Baumann Foundation](#). Dedicated to understanding modern life from an evolutionary perspective.

If you're in the San Francisco Bay area, please join us for our next talk at the Public Works. Our next event is The Power Paradox. It's happening Thursday, November 3, 2016 just in time for the election. It's part of the Bay Area Science Festival and our speaker will be psychologist Dacher Keltner. Tickets are on sale now. Go to [Leakeyfoundation.org](#) for more information. That's L-e-a-k-e-yfoundation.org. There's also a link in your show notes. I hope to see you there.

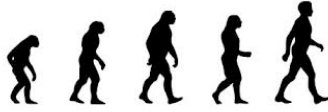
The Leakey Foundation is a nonprofit organization that funds groundbreaking research into human origins and evolution, behavior, and survival. For the past few episodes, I've been telling you about our million-dollar fundraising challenge and I'm happy to say that we met our goal. Thank you so much. We really appreciate your generous support. If you haven't donated yet, I have some good news; our anonymous sponsors have offered to match donations again. Every donation will be doubled up to \$1 million. So make a tax-deductible gift to the Leakey Foundation today and it'll be doubled. Visit [Leakeyfoundation.org/donate](#).

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Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016



THE LEAKEY FOUNDATION

Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

Suggested tags

“

“Tarzan” Brown, 9

A

Abebe Bikilia, 12
accouterments, 12
African savanna, 4
American, 2, 7

B

biomechanically, 5, 12
Born to Run, 3
Boston Marathon, 2, 9

C

charitable, 2
chimpanzee, 2, 8

D

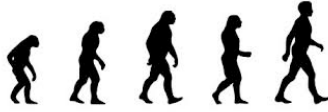
Daniel Lieberman, 1
Dennis Bramble, 3
Department of Human Evolutionary Biology, 1
dogs, 3, 5, 8, 9, 10

E

Egyptian tomb, 13
Embarcadero, 2
ethnographic, 7
evolution, 1, 4, 13
evolutionary perspective, 2, 13

G

gallop, 5, 6, 7, 8
gluteus maximus, 11
greyhounds, 6



THE LEAKEY FOUNDATION

Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

H

Harvard, 1, 6
Harvard University, 1
Heartbreak Hill, 9
Homo erectus, 4, 5
horses, 5, 6, 8, 9, 10
Hussein Bolt, 4, 6

J

Jim Fries, 11
Johnny Kelly, 9

K

Ken Bob Saxton, 12

L

leg cramps, 2
London Marathon, 2

M

marathon, 1, 2, 3, 5, 6, 7, 8, 10
mechanistic, 3

N

natural selection, 3
Nature, 3
New York Marathon, 2
Newton's second law, 12
Nothing in Biology Makes Sense Except in the Light of Evolution, 3

P

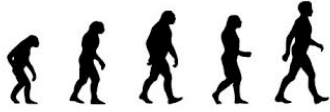
Patas monkeys, 8
ponies, 5, 6
Public Works, 1, 13

Q

Quadrupeds, 6

R

Robert Browning, 3



THE LEAKEY FOUNDATION

Origin Stories Being Human Episode 19: Born and Evolved to Run
July, 2016

Robinson Crusoe, 7
Rome Olympics, 12
running, 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13

S

San Francisco Marathon, 1, 8, 12
Scientific Executive Committee, 1
seesaw gait, 6
shin splints, 2
Stanford runner's study, 11
Star Market,, 5

T

The Story of the Human Body, 1
Theodosius Dobzhansky, 3
transference, 10
trot/gallop transition, 5, 6, 7
type-A personalities, 3

U

ultramarathons, 8
urban environment, 3

V

Vaseline, 2

W

Wales, 9
Welshman., 10
Whole Foods, 5
wolfhound, 6