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Natural Imperfection: Evolution doesn't care if you have back pain…just as long as you can breed

http://saveyourself.ca/articles/natural-imperfection.php

How did giraffes get such long necks? When kids first learn about natural selection, they often quaintly assume that giraffes must stretch their necks, and somehow all that reaching is passed inherited by longer-necked giraffe babies. But that is wrong, of course.

Natural selection actually works like this: ancient giraffes who just happened be born with longer necks were better at surviving to breed, because they could reach more leaves.

More leaves
= more survival
= more breeding.

Because they had long necks, so did their offspring. Short-necked giraffes just slowly disappeared, for lack of being born as often.

But can you imagine the cricks that giraffes get in THOSE necks? Wow! This is perhaps the ultimate no-brainer example of evolutionary compromise — of natural imperfection. Ridiculously long necks = orthopedic nightmare! This article is about the evolutionary trade-offs that sacrifice our comfort.

Evolutionary medicine is a (surprisingly new) field of medical science that helps us understand why we get sick. Diseases and physiological imperfections that seem otherwise mysterious can often be understood easily by applying the principles and perspective of natural selection.

What can evolutionary medicine do for orthopedics, for musculoskeletal pathology? How can natural selection illuminate the more ordinary aches and pains of humanity, things like low back pain and neck pain, myofascial pain syndrome (knots in your muscles), or common sports injuries like plantar fasciitis and iliotibial band syndrome, or the vulnerability of shoulders to dislocation, of knees and ankles to sprains?

The evolutionary perspective can also be used to help understand my own medical turf. This has never really been done before, but I'm going to take a stab at it in this article. Please let me make it clear from the start that this is all just "food for thought": I am simply not expert enough to do anything but speculate. But it's interesting to speculate!

Look, Ma, hands!

Consider bipedality. Walking on two legs is a novelty in nature, and it's got a high price tag, so it must be pretty good. Biologists have spent a lot of time wondering just what it is about being upright that made it worth giving up the speed and stability of being on all fours. One plausible explanation (there are many others) is that standing up freed us to use our hands to make tools. Proto-humans who were inclined to stand up more probably tended to use their hands more — with excellent results.

But what was the cost? We didn't just give up the speed and stability of four legs. Most people think that the spine is a marvel of biological engineering, and so it is — but it is engineered by natural selection mainly for quadrupeds, not bipeds. We have the same basic spinal anatomy as every other vertebrate on Earth, but we are the ONLY ONES using it in an upright position regularly. That's bound to be uncomfortably awkward — and it is.

Backs may well have some problems with modern lifestyles, but the biomechanical awkwardness of bipedality may be the one factor to rule them all, the most obvious reason by far why we our species appears to be prone to pain in that department — and something we got saddled with a stupendously long time before agriculture, let alone office chairs. If there is ANY biomechanical factor that does predispose us to back pain at all, bipedality has got to be the big one — and we can't do anything about it.

Even the design of the visceral anatomy does not suit bipedality. The organs are contained in connective tissue compartments which are ideally hung from a horizontal spine. Those structures didn't change when humans stood up: we simply started carrying our guts around as though they were in a bag tied to a pole. And as if that weren't bad enough, imagine PREGNANCY …

Why don't pregnant women tip over?

Pregnancy is the ultimate way to demonstrate the evolutionary and comfort problems with walking upright.

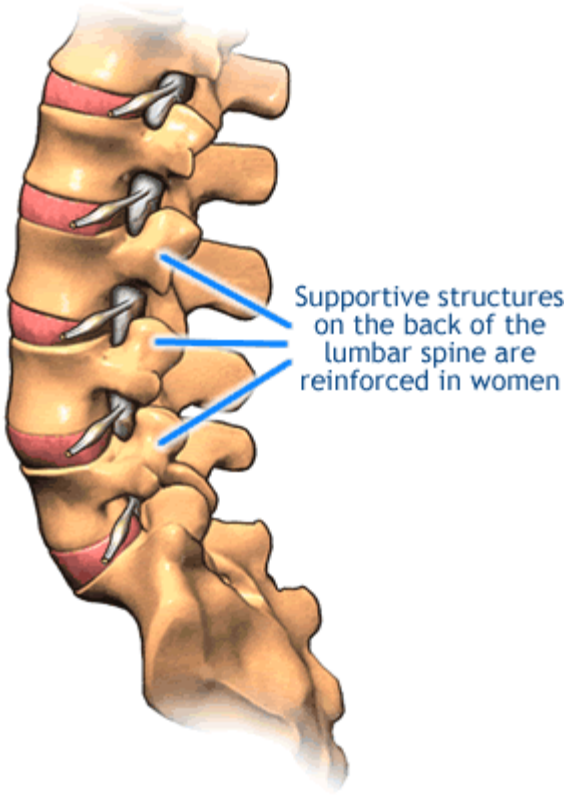
Horizontal spines are a good tool for hanging a heavy pregnant belly from, with no obvious compromise to stability, but human mothers have to deal with an awkwardly off-centre weight that absolutely makes staying upright more of an effort. How do women do it?

Well, by leaning back, of course!

> We often say the reason people get lower back pain is because we became bipeds and being a biped is a stupid way to use your back. But actually that doesn't make any sense, because if back pain is so difficult, such a challenge, natural selection surely would have acted to lessen the prevalence and severity of back pain.
>
> Dr. Dan Lieberman, evolutionary biologist, Brains Plus Brawn

Natural selection HAS "acted to lessen the prevalance and severity of back pain," and in fact that is shown by some of Lieberman's own research. It turns out that female backs have larger, stronger supportive structures at the posterior of the spine than men, so they can get knocked up without getting knocked down. In a word, female spines are REINFORCED. They are flat-out better evolved for a deeper lordosis ("lordosis" is the curvature of the lumbar spine). In 2007 in

the journal *Nature*, Whitcome, Shapiro and Lieberman showed these features in modern women, and also in the fossil record at least as far back as 2 million years.2 The change presumably occurred relatively early in the history of walking upright.



These anatomical differences probably only PARTIALLY compensate for the stresses of pregnancy — pregnant women still tend to suffer from quite a lot of back pain, as I'm sure they would be quick to agree, while at the same time they suffer from it RATHER A LOT LESS than many people might suspect would result from such a necessarily extreme lumbar curvature. We men, with our wussy, unreinforced backs, would certainly suffer more — hard evidence that men are less fit to withstand the rigours of pregnancy! As if you needed any.

As a gratuitous side note, I would like to point out that this research also emphasizes — yet again — that excessive concern about lumbar curvature is probably unjustified (like most structuralist theories). This is very common among therapists and doctors, in spite of a pile of contradictory evidence. An entire industry of bad back pain advice is based on the idea that lumbar curvature — either too much or too little — is THE important factor in whether or not you get back pain.

But Whitcome's research shows that women are actually adapted for coping with increased lumbar curvature, demonstrating in one elegant scientific stroke that, even as women evolved a mechanism for coping, it is almost certainly an imperfect mechanism, good enough to keep women from actually breaking their backs during pregnancy, but not good enough to prevent all pain. Such deviations from normal curvature are not critical, or pregnancy would be biomechanically unviable, and bipedality would have resulted in a rather short-lived species of crippled moms. As always in evolution, the result is a compromise: enough adaptation to make breeding possible, not enough to actually make pregnancy COMFORTABLE for the back.

Shoulders and knees

My clients often ask me, "Why did this happen?" Sometimes the only answer I can give is, "Design flaw." I suggest that they take it up with The Management, and roll my eyes heavenward. But I'm not giving the divine enough credit: natural selection NEVER creates "flaws," it just makes deals.

Consider the shoulder, a fabulous joint: so loose and mobile that it would fall apart if it weren't for a very clever arrangement of muscles, the infamous "rotator cuff," which is often injured in spite of, or rather because of, its clever arrangement. The shoulder is a perfect compromise between mobility and stability. Any more mobile, it would fall apart. Any more stable, we wouldn't be able to scratch our backs at ALL. That compromise comes with a price tag: lots of shoulder injuries! The alternative, however, is to have upper limbs that don't do nearly as much.

Or consider knees, another spectacular joint, also prone to injury. In the knee, the compromise is between enormous power and vulnerability. The arrangement of the kneecap allows for spectacular leverage on the lower leg. Knee extension is by far the most powerful movement in the human body, and pressures underneath the kneecap can be "greater than three times body

weight during stair-climbing and eight times body weight during squatting and deep-knee-bending."[4] This power requires a joint that with more parts than most, mechanically complex, and prone to failure. But the alternative would be to give up most of the lifting power in our knees!

So, design flaws? Or design genius? Your opinion probably depends on whether or not you have a busted knee!

Other limitations of natural selection

The necessity of compromise is not the only limitation of natural selection. Something more like actual "design flaws" occur as a result of the incremental nature of evolution.

Traits evolve in baby steps, small changes to existing features — because the only way for change to occur is through minor random mutations to existing genes. Major mutations are EXTREMELY unlikely to be beneficial. However, any slight change that makes you better at breeding is likely to get passed on. But it's not possible to innovate, to skip steps, or even to get rid of old stuff and replace it with something different and better. An improvement that requires even a single leap of logic is not an option.

This would drive any designer or engineer absolutely crackers. Imagine if you could only improve a car by making one small modification to an EXISTING part — you could never just chuck it out and start over, or even make an improvement that depended on another improvement. Bodies cannot, for instance, develop a trait, no matter how brilliant, that requires a prerequisite modification to another system — mutation would have to provide the prequisite trait by chance, and then the dependent trait by chance. That's a lot of luck, and it tends not to happen much, even over huge time frames.

If cars were designed the same way that evolution works, they might well still have cranks. Or, imagine if you could only improve a computer operating system by making slight improvements to what's already there … oops, no need to imagine that one, we all work with the consequences of that every day!

When you look at evolution like this, it's amazing how marvelously well everything actually works. But, of course, even though natural selection has limitations, it never, ever — by definition — perpetuates a trait that doesn't make you a better breeder. So, in the big picture, everything always works miraculously well.

But that doesn't make it comfortable, unfortunately!