

INSIDE JEB

Hikers trade speed and efficiency for stability



A walker hiking a rugged trail in Israel, wearing the gas analyser mask. Photo credit: Raziel Riemer.

Getting off the beaten track and out into the wild is a liberating experience for anyone stuck in the treadmill of city living. But Raziel Riemer, from Ben-Gurion University of the Negev, Israel, explains that strolling along a well-paved path is a dramatically different experience from clambering across the boulder-strewn landscapes that he encounters on trails near his home. Knowing that people walk naturally at speeds where they use the least energy, Riemer recalls a ‘light bulb moment’ at the American Society of Biomechanics meeting in 2015, where he combined his passion for walking with his love of science. ‘I realised that sometimes it is more challenging to maintain my balance and not slip or fall when walking on a really rough or rocky trail. That got me wondering if and how I choose my walking speed depending on terrain’, he says. Sharing the idea with his colleague, Rodger Kram, from the University of Colorado Boulder, USA, the pair decided to test whether hikers adjust their walking speed on rocky terrain.

Recruiting 10 fit student volunteers, Riemer and Koren Gast laid out a 67 m long trail through rugged landscape on the outskirts of Beer-Sheva and kitted out the hikers with a mask and gas analyser backpack to record their oxygen consumption and CO₂ production, so that they could calculate the volunteers’ exertions later. Once the volunteers were comfortable with walking while wearing the mask, Gast asked them to repeat the hike at slow, comfortable and fast paces to see whether there were any differences in their energy use. ‘The terrain gave them some challenge in maintaining their stability’, says Riemer, who also asked the walkers to repeat the exercise, but this time on a level concrete path for comparison.

After calculating the walkers’ metabolic rates over 124 hiking trials on the flat and more rugged terrain, Gast converted the values into the amount of energy each walker used to travel over a set

distance – known as the cost of transport – and found that the walkers used 115% more energy when negotiating the rough trail than they had on level ground. In addition, the volunteers walked more slowly – at a preferred speed of 1.07 m s⁻¹ – on the rugged route, relative to their preferred speed of 1.24 m s⁻¹ on the flat. And when Gast plotted the walkers’ cost of transport values against the speeds at which they were walking, the U-shaped graphs showed that the volunteers walking on the rough trail moved a little more slowly than their most efficient walking speed, resulting in a slightly less efficient walk.

‘Our interpretation is that people on rough terrain consider other factors, such as stability or foot placement, and as a result they walk slower than the energetically optimal speed’, says Riemer. However, he points out that even though the volunteers were choosing to walk at a less efficient pace, the additional effort that they invested was negligible (0.5%). ‘This means that there is almost no penalty on energetics when a person takes into consideration other factors such as stability. That’s a pretty smart design’, says Riemer. And he is optimistic that he can apply the lessons from watching able-bodied hikers to help older, less stable members of the community. ‘Maybe training based on our finding that walking on rough terrain challenges stability and increases effort could improve their fitness’, he suggests.

10.1242/jeb.204222

Gast, K., Kram, R. and Riemer, R. (2019). Preferred walking speed on rough terrain: is it all about energetics? *J. Exp. Biol.* **222**, jeb185447. doi:10.1242/jeb.185447

Kathryn Knight
kathryn.knight@biologists.com