Lunar explorers will walk at higher speeds than thought

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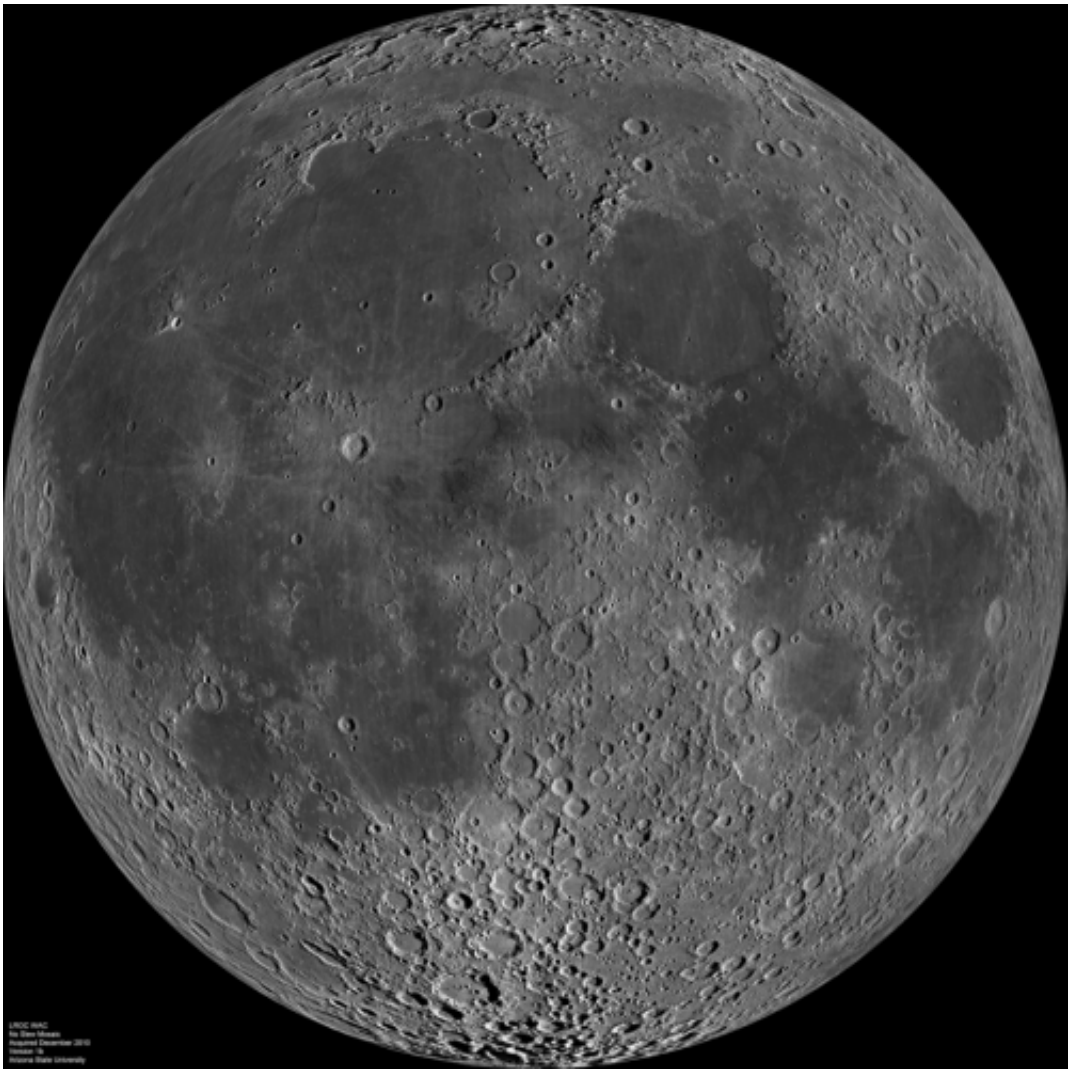

This is a composite image of the lunar nearside taken by the Lunar Reconnaissance Orbiter in June 2009, note the presence of dark areas of maria on this side of the moon. Credit: NASA

Anyone who has seen the movies of Neil Armstrong's first bounding steps on the moon couldn't fail to be intrigued by his unusual walking style. But, contrary to popular belief, the astronaut's peculiar walk was not the result of low gravity. Wyle Science, Engineering and Technology scientist John De Witt explains that the early space suits were not designed for walking, so the astronauts adapted their movements to the restrictions of the suit.

Michael Gernhardt, the head of NASA's Extravehicular Activity Physiology, Systems and Performance Project, wants to learn more about how humans move in low gravity, including the speed at which we break from a walk into a run, to design a modern space suit that permits freer movement. However, the only way to test the effects of true lunar gravity on our movements while based on earth is to hop aboard NASA's adapted DC-9 aircraft – which reduces the gravity on board by performing swooping parabolic flights – and get running. De Witt and his colleagues publish their discovery that astronauts will remain walking at higher speeds on the moon than had been previously thought in *The Journal of Experimental Biology*.

To make this discovery, De Witt and colleagues Brent Edwards, Melissa Scott-Pandorf and Jason Norcross recruited three astronauts and five other registered test subjects that could tolerate the discomfort of the aircraft's bucking flight to test their running. 'There is some unpleasantness,' recalls De Witt, adding, 'if you get sick you're done…. We wanted to be sure we had people that were used to flying.' Once the subjects were airborne, the team only had 20s during each roller-coaster cycle – when the gravity on-board fell to one-sixth of that on Earth – when they could test the runner's walking and running styles on a treadmill as the volunteers shifted over a range of speeds from 0.67 to 2m/s. However, De Witt recalls that the experiments ran smoothly once the team had settled into a routine after the first few parabolas.

Back on the ground, De Witt and colleagues analysed the speed at which the walkers gently transitioned into a run. 'Running is defined as a period of time with both feet off the ground', explains De Witt, adding that the walk to run transition was expected to occur at 0.8m/s in lunar gravity, based on theoretical calculations. However, when the team calculated the transition speed from their experiments, they were in for a surprise: 'The average was 1.4m/s', recalls De Witt.

'This difference is, to me, the most interesting part of the experiment; to try to figure out why we got these numbers', says De Witt, who suggests that the acceleration forces generated by the counter-swinging arms and legs could account for the shift in transition speed. 'What I think ends up happening is that even though the atmosphere is lunar gravity, the effective gravity on our system is lunar gravity plus the forces generated by our swinging arms and legs', says De Witt. He explains that this arm-and-leg swinging effect probably happens here on Earth too, but the forces generated by the swinging limbs are negligible relative to our gravity. However, he suspects that they are more significant in weaker lunar gravity, saying, 'They contribute more to the gravity keeping you attached to the ground.'

De Witt also adds that the higher transition value is not without precedent. He explains that scientists on Earth have simulated lunar gravity by supporting five-sixths of a runner's weight in a sling, and the athletes also transitioned from a walk to a run at speeds of around 1.4m/s1. 'This tells researchers [that] what they have in the lab, which is a fraction of the cost of the airplane, is probably adequate at giving you the information you need', he says.

More information: De Witt, J. K. , Edwards, W. B. , Scott-Pandorf, M. M., Norcross, J. R. and Gernhardt, M. L. (2014). The preferred walk to run transition speed in actual lunar gravity. *J. Exp. Biol.* 217, 3200-3203. jeb.biologists.org/content/217/18/3200.abstract