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INSIDE JEB

How parkour enthusiasts scramble up walls

A time-lapse image of a traceur scaling the 3 m high wall. Photo credit: James Croft.

When Sebastian Foucan burst onto our screens in the opening sequence of Casino Royale as a terrorist pursued by James Bond through a building site, the gravity-defying art of freerunning – and parkour, its more formal predecessor – hit the mainstream. Scrambling up vertical steel girders, bounding effortlessly across roof tops and leaping down stairwells, Foucan's acrobatics are breathtaking. However, when James Croft from Edith Cowan University, Australia, watches parkour enthusiasts – known as traceurs – he wants to understand how they use their bodies to pull off such daredevil stunts. 'Currently, we depend on interpretations of leg action based on how we move when running normally', says Croft, but running up a vertical wall presents a completely unique set of challenges. Having worked previously with John Bertram from the University of Calgary, Canada, to understand why traceurs crumple into a roll after dropping from height, the duo reunited to find out how the daring athletes scale a wall.

'I first approached the Perth Parkour Association … at one of their workshops for children', says Croft, who recalls that the athletes were keen to collaborate with scientists in the hope of improving their skills. Knowing that the freerunners kick off from vertical structures to propel themselves upward, Croft, Bertram and Ryan Schroeder, also from Calgary, constructed a 3 m plywood wall with a force plate embedded where the athlete's foot would land. 'Many of them could have scaled much higher walls, but they are adaptable' admits Croft. The team then filmed each runner as they strode down the runway and pushed off from a force plate embedded in the ground before glancing off the second force plate in the wall, so that the team could measure the forces involved.

After recording 67 successful ascents, the trio reconstructed the traceurs' movements and realised that they were moving almost horizontally at the instant when their foot landed ready for take-off. The traceurs then propelled themselves upward as their trailing leg came forward. 'This allows the athlete to glance off the wall', says Croft, describing how the foot lands below hip height on the wall, allowing the runner to conserve much of the momentum gained during the run-up as they propel themselves upward. Most surprisingly, the athletes never straddled the floor and wall simultaneously, even though their coaches advised them to.

Wondering which factors spelled the difference between success and failure, Schroeder built a computer simulation – based on the assumption that the most successful strategy would use the least energy – to predict the athlete's optimal tactic. Surprisingly, he discovered that the recipe for success lies in an intermediate run-up speed, rather than a full-speed charge. Croft explains that the athletes are able to convert the energy they built up during the intermediate approach and use it to redirect themselves off the ground for a successful and efficient lift-off. But why don't the athletes use an even slower run-up, as it would be more efficient? According to Croft, a slower approach would result in the traceur hitting the take-off with less momentum, requiring more exertion from the take-off leg to make up for the slower approach – which is less efficient at the muscle level. And, if the athletes charged at full speed down the runway, the take-off leg would have to act as a shock absorber, which, again, would waste energy and wipe out the benefits of a faster approach.

So, traceurs naturally select an intermediate run-up speed, allowing them to use the least amount of energy as they effortlessly bound up walls to continue vaulting and defying gravity.

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Croft, J. L., Schroeder, R. T. and Bertram, J. E. A. (2019). Determinants of optimal leg use strategy: horizontal to vertical transition in the parkour wall climb. *J. Exp. Biol.* **222**, jeb190983.

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