

Perception of effort, not muscle fatigue, limits endurance performance

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(PhysOrg.com) -- The physiological theory that underpins all endurance training and coaching for the last 100 years has just been disproved.

As recently as 2008, scientific research papers were citing the theory that endurance performance is limited by the capacity of the skeletal muscles, heart and lungs and that exhaustion occurs when the active muscles are unable to produce the force or power required by prolonged exercise.

Dr Sam Marcora, an exercise physiologist at Bangor University, has now disproved this for the first time and proposed an alternative - that it is your [perception](#) of effort that limits your endurance performance, not the actual capability of your muscles. He showed that the muscles were still able to achieve the power output required by endurance exercise even when the point of perceived exhaustion had been reached.

This will inevitably lead to new training and coaching techniques, based on this new understanding of the role of perceived effort in endurance performance.

What Marcora has found is that athletes give up endurance exercise, feeling that they are [exhausted](#), before reaching their absolute physiological limit. In fact, immediately after exhaustion, the leg muscles are capable of producing three times the power output required by high-intensity cycling exercise.

Like other [bodily sensations](#), perception of effort is a powerful feeling that is there for a reason. The perception that we have reached exhaustion prevents us from injuring ourselves by exercising too much. Marcora uses the analogy of pain- if you twist your ankle you might still be able to undertake the mechanics of walking, but the pain prevents you- and so prevents you from causing further injury- so it is with perceived exhaustion, he argues.

The question for sports scientists, coaches and athletes has to be how far can athletes go beyond that perceived exhaustion to improve performance still further?

"We are already developing and testing new training techniques based on the neurobiology of perceived effort that will help endurance athletes improve their performance," says Marcora.

The original theory led to the development of countless training developments, such as heart rate monitors, eating carbohydrates to replenish glycogen in the tired muscles and even blood doping, so that the haemoglobin carries more oxygen to the active muscles.

"These techniques have been proved to be effective- and are still effective," says Sam Marcora, "but we now have a new theoretical model of endurance performance and this in turn will lead to further techniques and coaching strategies to help endurance athletes to improve their performance."

More information: The limit to exercise tolerance in humans: mind over muscle? Samuele Maria Marcora, Walter Staiano, *European Journal of Applied Physiology*, [DOI:10.1007/s00421-010-1418-6](https://doi.org/10.1007/s00421-010-1418-6) published online March 11 2010.

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