

SCIENTIFIC AMERICAN™

It hurts so good: the runner's high

By [Scicurious](#) | March 12, 2012 | [10](#)

I just came back from an 11 mile run. The wind wasn't awful like it usually is, the sun was out, and I was at peace with the world, and right now, I still am. Later, I know my knees will be yelling at me and my body will want nothing more than to lie down. But right now? Right now I feel FANTASTIC.

What I am in the happy, zen-like, yet curiously energetic throes of is what is popularly known as the "runner's high". The runner's high is a state of bliss achieved by athletes (not just runners) during and immediately following prolonged and intense exercise. It can be an extremely powerful, emotional experience. Many athletes will say they get it (and indeed, some would say we MUST get it, because otherwise why would we keep running 26.2 miles at a stretch?), but what IS it exactly? For some people it's highly emotional, for some it's peaceful, and for some it's a burst of energy. And there are plenty of other people who don't appear to get it at all. What causes it? Why do some people get it and others don't?

By the end, some of these people will be blissful, some will want to hurl, and others will be both.

Well, the short answer is that we don't know. As I was coming back from my run, blissful and emotive enough that the sight of a small puppy could make me weepy with joy, I began to wonder myself...what is up with me? As I re-hydrated and began to sift through the literature, I found...well, not much. But what I did find suggests two competing hypothesis: the endogenous opioid hypothesis and the cannabinoid hypothesis.

The endogenous opioid hypothesis

This hypothesis of the runner's high is based on a study showing that **enorphins, endogenous opioids, are released during intense physical activity**. When you think of the word "opioids", you probably think of addictive **drugs like opium or morphine**. But your body also produces its own versions of these chemicals (called '**endogenous**' or produced within an organism), usually in response to times of physical stress. Endogenous opioids can **bind to the opioid receptors in your brain**, which affect all sorts of systems. Opioid receptor activations can **help to blunt pain**, something that is surely present at the end of a long workout. Opioid receptors can **also act in reward-related areas such as the striatum and nucleus accumbens**. There, they can inhibit the release of inhibitory transmitters and

increase the release of dopamine, making strenuous physical exercise more pleasurable. Endogenous opioid production has been shown to occur during the runner's high in humans and well as after intense exercise in rats.

The cannabinoid hypothesis

Not only does the brain release its own forms of opioid chemicals, **it also releases its own form of cannabinoids**. When we usually talk about cannabinoids, we think about things **like marijuana** or the newer synthetic cannabinoids, which act upon cannabinoid receptors in the brain to produce their effects. But we also produce **endogenous cannabinoids (called endocannabinoids)**, such as anandamide, which also act upon those same receptors. Studies have shown that deletion of cannabinoid receptor 1 decreases wheel running in mice, and that intense exercise causes increases in anandamide in humans.

Not only how, but why?

There isn't a lot out there on HOW the runner's high might occur, but there is even less on WHY. There are several hypotheses out there, but none of them, as far as I can tell, are yet supported by evidence. First there is the hypothesis of a placebo effect due to achieving goals. The idea is that you expect yourself to achieve a difficult goal, and then feel great when you do. While the runner's high does have some things in common with goal achievement, it doesn't really explain why people get them on training runs or regular runs, when they are not necessarily pushing themselves extremely hard.

Another idea is the idea that we need to run due to our history, that we evolved as persistence runners, outrunning animals not because we could run faster, but because we could run longer. In this case, any system that would allow us to continue running despite the pain of, say, bad knees, shin splints, or a slightly twisted ankle would be beneficial. The hypothesis supposes that the release of the endogenous opioids is for the purpose of killing pain and allowing us to run longer. There is no question that endogenous opioid release reduces our sensitivity to pain, but it's very hard to prove this kind of hypothesis. I also wonder whether it's a GOOD idea to experience the dulling of pain. It's good for the race right now, but if you are being faced with the potential for chronic injury, that will be a major detriment to your hunting in the long term.

A third hypothesis is that the **high may merely be the result of a partial brain shutdown**. Because the **runner's high commonly occurs during glycogen depletion**, the hypothesis is that the brain doesn't have enough glucose on hand to keep it functioning normally while still controlling your workout, and you get a little loopy. I have never seen any support for this, though a PET study looking at brain glucose binding in athletes experiencing runner's high might be able to determine whether this hypothesis holds any water.

Is there a finish line in sight?

Not for these studies. Scientists are still chasing the runner's high, and there's not yet a lot out there. **Right now the evidence appears to support the hypothesis that endogenous opioid release and cannabinoid release in the brain triggers the effects**, but of course, there's **lots of room in the brain for the answer to be more complicated, involving other neurotransmitters such as dopamine** in the exercise-induced bliss. Even less known, however, is the *why* of the runner's high. Maybe it's exhaustion? Maybe it's pain killing? Maybe it's just to get us back out there the next time.

And now, if you'll excuse me. I started this post after my run yesterday. But I finished it today and...I've got to get to the gym. It's time to chase that runner's high.

Galdino GS, Duarte ID, & Perez AC (2010). Participation of endogenous opioids in the antinociception induced by resistance exercise in rats. *Brazilian journal of medical and biological research = Revista brasileira de pesquisas medicas e biologicas / Sociedade Brasileira de Biofisica ... [et al.]*, 43 (9), 906-9 PMID: [20802976](#)

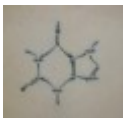
Boecker H, Sprenger T, Spilker ME, Henriksen G, Koppenhoefer M, Wagner KJ, Valet M, Berthele A, & Tolle TR (2008). The runner's high: opioidergic mechanisms in the human brain. *Cerebral cortex (New York, N.Y. : 1991)*, 18 (11), 2523-31 PMID: [18296435](#)

Fuss J, & Gass P (2010). Endocannabinoids and voluntary activity in mice: runner's high and long-term consequences in emotional behaviors. *Experimental neurology*, 224 (1), 103-5 PMID: [20353785](#)

Sparling, P., Giuffrida, A., Piomelli, D., Roskopf, L., & Dietrich, A. (2003). Exercise activates the endocannabinoid system *NeuroReport*, 14 (17), 2209-2211 DOI: [10.1097/00001756-200312020-00015](#)

Hinton ER, & Taylor S (1986). Does placebo response mediate runner's high? *Perceptual and motor skills*, 62 (3), 789-90 PMID: [3725516](#)

Dubreucq S, Koehl M, Abrous DN, Marsicano G, & Chaouloff F (2010). CB1 receptor deficiency decreases wheel-running activity: consequences on emotional behaviours and hippocampal neurogenesis. *Experimental neurology*, 224 (1), 106-13 PMID: [20138171](#)



About the Author: Scicurious is a PhD in Physiology, and is currently a postdoc in biomedical research. She loves the brain. And so should you. Follow on Twitter [@Scicurious](#).