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What's behind the runner's high? It's more likely endocannabinoids than endorphins

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For Jen Martin, the addictive nature of a runner's high spurs her on.(

Supplied: Jen Martin

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Jen Martin was halfway through running a race in Melbourne when she was so overwhelmed by sheer joy that it brought her to tears.

"I pretty much started crying because I just felt so gloriously happy to be in amongst all these people, in a city that I loved, doing a race."

When talking to lucky people like Dr Martin who get a runner's high – a euphoric sense of bliss and general awesomeness – all I feel is a pang of jealousy.

"That endorphin rush," they gush. "It's. The. *Best*."

In 15 years of long-distance running, I've never felt it.

But you know what? Perhaps runners like Dr Martin don't get an endorphin hit either — at least, not in the way they think they do.

In recent years, another group of chemicals has emerged as the main trigger of the runner's high: endocannabinoids.

The rise of endorphins



Neuroscience is starting to untangle which naturally produced chemicals might contribute to the euphoric runner's high.(

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We know exercise affects our mood. Studies have shown, time and again, exercise's [long-term mental health benefits](#).

Most people ([but not all](#)) feel pretty great after a workout too. I call it "happy exhaustion": my muscles feel tired and heavy, but in a good way, and I can look forward to an afternoon of snacking and napping on the couch.

What are endorphins?

- Endorphins are a group of chemicals made in the body when we're stressed or in pain (the word is short for *endogenous morphine*)
- They're produced in the brain and spinal cord, and are also made and churned out into the bloodstream by the pituitary gland
- Endorphins induce a feeling of pleasure and pain relief by latching onto opioid receptors in the brain.

But the runner's high hits while a person is still exercising.

How long that rush takes to appear varies between people, but it typically comes on after around half an hour of running at moderate intensity, says Matthew Jones, an exercise physiologist at UNSW.

This coincides with a rise in endorphins in their blood.

On the face of it, the endorphin high makes sense. Like a key in a lock, endorphins slot into opioid receptors on the surface of brain cells.

This triggers a cascade of molecular activity that ultimately elicits feelings of wellbeing and pain relief.

"But whether or not that [higher endorphin level] actually relates to someone then having those feelings of euphoria and less pain is less clear," Dr Jones says.

If you give a runner a drug that stops endorphins from doing their thing, they can still get a runner's high.

"So while they might be important, endorphins are not the only thing contributing," Dr Jones says.

A new contender emerges

In recent years, research has put forward a different class of self-made drugs: endogenous cannabinoids, or endocannabinoids.

Yep, as in cannabis. The main psychoactive compound in marijuana, delta-9-tetrahydrocannabinol or THC, is a cannabinoid.

And there's growing evidence that the high some runners experience is driven by the same system that's activated during marijuana use.

What are endocannabinoids?

- Endocannabinoids are a group of molecules that activate cannabinoid receptors, which are found throughout the body and mainly in the brain
- The endocannabinoid system is involved in regulating appetite, pain and stress
- The first endocannabinoid, which was discovered in 1992, is called anandamide. Its name is derived from the Sanskrit word *ananda*, which means bliss or joy.

Johannes Fuss, a psychiatrist who now heads up the Human Behaviour Laboratory at the University of Hamburg, started investigating endocannabinoids as a potential source of the runner's high during his PhD studies.

He and his colleagues started with animals. They found mice that were free to scamper on a running wheel for a couple of hours were less anxious and felt less pain than their wheel-less counterparts.

When the mice were given drugs that stop endorphins from latching onto opioid receptors, they still got those good post-run effects.

"But when we gave the mice endocannabinoid receptor blockers, all the positive effects vanished," Dr Fuss says.

This result intrigued him. It was compelling evidence that endocannabinoids were behind the feel-good effects of running, not endorphins.

But, of course, mice aren't people. And a mouse may act less anxious after exercise, but you can't ask it if it felt a euphoric buzz during its bout on the wheel.

So Dr Fuss and his crew developed a similar experiment, but this time, with 63 human runners.

The science behind the perfect running style



Running is one of the most natural forms of human movement but not everyone is doing it well.

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The researchers gave the participants a battery of tests to determine their fitness and anxiety levels, and took blood samples.

Half the runners were given the opioid blocker naloxone, while the other half got a placebo. All then trotted on a treadmill at a moderate intensity for 45 minutes.

There are no drugs that block cannabinoids approved for human use, so Dr Fuss and his team could not recreate that aspect of the mouse study.

Afterwards, participants were asked, among other things, if they felt a runner's high while on the treadmill.

And the results, published in [Psychoneuroendocrinology](#) this month, were in line with previous mouse studies.

Runners given naloxone still felt a runner's high, so it was not solely endorphins responsible for that sensation.

But blood endocannabinoid levels were high.

So, they suspected the euphoria some runners experienced was less a morphine high and more a marijuana-like one.

From blood to brain

So why are endocannabinoids thought to drive the runner's high?

Much of it, it's thought, comes down to their access to the brain.

When we — and mice — exercise, researchers don't know which of our body's cells ramp up endocannabinoid production, but it's likely blood cells, Dr Fuss says.

If running elicits a spike in blood endocannabinoid production, those molecules are free to traverse what's known as the blood-brain barrier, and act on cannabinoid receptors in the brain.

Exercise excuses: are you running right?



Busting myths that prevent would-be runners from achieving their health and fitness goals.

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It's a different story with endorphins.

Even though exercise leads to extra endorphins in our bloodstream, those molecules can't cross the blood-brain barrier.

In other words, endorphins in the blood are restricted to blood, and any made in the brain stay in the brain.

"Endorphin levels in the blood don't tell you anything about what happens in the brain," Dr Fuss says.

That's not to say there's absolutely zero role for endorphins in the runner's high, though.

It's not possible to directly look for endorphins in the brain without using invasive methods, such as threading a needle into the lower spine to sample the fluid bathing the spinal cord and brain.

But we do have *indirect* evidence that something goes on with endorphins in the brain.

[Imaging studies](#) have shown [molecules binding to brain opioid receptors](#) in people after training sessions.

"So there's probably increased [endorphin] activity in the brain," Dr Fuss says. "We just have indirect evidence for it."

Even though they act on different receptors in brain cells, endocannabinoid and endorphin systems ultimately end up doing the same thing.

They increase the amount of dopamine that's released in a bundle of nerve cells deep in the brain called the nucleus accumbens.

That's the brain's reward centre, and that extra burst of dopamine in it makes us feel good.

For Dr Martin, the addictive nature of a runner's high spurs her on.

"There's definitely that sense of reward. [When running] I think that it just might be out there, around the corner, and I'll actually keep running to see if it happens."

So where's my runner's high?

Like me, Dr Fuss is yet to feel the rush of a runner's high.

"Sometimes when I'm listening to music and I'm running it feels great, but never a state of total euphoria and the feeling that I could run forever," he says.

"Nope. Never had it."

Why some people don't feel rapturous while running could simply be a matter of having fewer cannabinoid receptors in the brain.

Exactly when runners might get their high could vary too, Dr Fuss says. Many athletes report it around half an hour into a run, but others may not get it until an hour or two into a run — maybe longer.

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But we may soon have some answers. Dr Fuss and his PhD student are designing a post-pandemic experiment to measure endocannabinoids in the blood of runners, which they hope to conduct during and after the next Hamburg marathon.

"We want to see if there is a certain threshold when people experience a runner's high, and what level of endocannabinoids they need to reach," Dr Fuss says.

"There's no research investigating what happens after one hour of running, or what happens after two or three hours. Do they increase and increase and increase?"

"And then at some point people have this runner's high, or is it a transient phenomenon? We don't know yet."

Then there's everything else

Other compounds in our body get a bit of an uptick or drop during exercise too, and might contribute to that exercise-induced intoxicating effect, Dr Jones says.

Brain chemicals serotonin, which plays a big role in mood regulation, and adrenaline, which is involved in the fight-or-flight response, probably feed into the runner's high, along with stress hormones such as cortisol.

And no, Dr Jones isn't part of the lucky subset of runners who feel absolutely sensational while jogging either.

But he suspects the effect is psychological as much as it is biological.



Plenty of other factors, such as your surroundings and state of mind, feed into the runner's high.(

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For instance, the way clinicians think about pain has changed from focusing on a person's tissues and biology to their psychology and social aspects.

The same is probably true for exercise, he says.

In Dr Fuss's latest study, some 70 per cent of participants reported experiencing a runner's high before the experiment.

But of those, less than a third got a runner's high while running on the treadmill in the laboratory.

"Maybe that context is important if you're outside listening to music or surrounded by nice scenery," Dr Jones says.

"Slogging away on a treadmill in a lab for 45 minutes is different to running around a lake or forest.

"So there are other factors apart from simply how long you're running for to increase those [runner's high] substances.

"It's much more of a biopsychosocial, all-encompassing sort of response."

For Dr Martin, that certainly seems to be the case.

"I do think for me it is sometimes prompted by an emotional sense: I love this song, the sun is shining, I'm outside, and at some point I kind of go, 'Wow, I just feel awesome.'"

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