THE TRUTH ABOUT PAIN: IT'S IN YOUR HEAD

More often than most other people, athletes have to ignore pain or endure it for long periods. It turns out that in this endeavor, the brain is a very good ally.

BY DAVID EPSTEIN

Cross-country skiing around a wide, icy curve, Petra Majdić slid off the course during a warmup for last year's Olympic women's individual sprint at Whistler Olympic Park outside Vancouver. She fell 10 feet into a craggy creek bed, her chest hitting rocks. The impact snapped her ski poles and splintered the tip of one ski. When volunteers rushed to her aid, she screamed at them to take her to the start of the qualifying heats, which began in 20 minutes. Her coach, Ivan Hudac, and her sports psychologist, Matej Tušak, told her she could attempt to ski, and if the pain was too great, she could drop out. And so she tried.

Majdić completed the 1.4-kilometer course, finishing 39th of 30 qualifiers, before collapsing and screaming in pain. She still had three more rounds of races to go.

Majdić, a 31-year-old from Slovenia, had come into the one-day competition as the favorite. She was expected to win several medals in Vancouver. Four years earlier an equipment mishap—she used cold-weather skis on an unexpectedly warm day—had kept her from a medal in Turin. Now her Olympic dream would come down to how much pain she could tolerate over the next five hours.

After the qualifier, Majdić was taken to an on-site medical tent for an ultrasound. If her ribs were broken, she wouldn't continue. The excruciating pain from snapped ribs can stop even the toughest athletes, and perhaps no sport puts more strain on the body's core than cross-country skiing. If it was only pain, though, maybe Majdić could go. For the last two decades she had spent hour after hour trudging through snowy woods, her legs and lungs burning, forging a relationship with pain. "The beautiful things in life are born from pain," she says. "For example, a child is born from great pain. In summer, in autumn, in winter, I struggle with pain, so my pain level is really [high]."

In 2008, when her boyfriend of six years couldn't understand her obsessive training any longer, she chose skiing, her first love, and that too hurt. Now, in Vancouver, she couldn't give in to "just pain." With the quarterfinal heat less than 90 minutes away, doctors didn't have much time to assess her condition. On the ultrasound, nothing appeared to be broken. It's just pain, the team doctor told her.

Majdić won her quarterfinal race, but afterward, ashed and hunched, she told Hudac she couldn't go on. It felt, as Majdić later put it, "like when somebody would all the time give you a knife" in your chest.

"She had a crisis," said Tušak. "We tested her, and she could not go five meters up a hill and turn around. She could not sit, so she was lying down, and when she stood up she was [hunched over]. But doctors told us nothing is broken, and I told Ivan, if nothing is broken, we go on. If we let her quit, she will be mad at us. This is her last chance to get a medal."

So Majdić continued. For the semifinals, her coaches again told her just to try. She finished fourth out of five in her heat but, based on time, qualified for the six-woman final.

During the 20 minutes between the semifinal and final, the pain got still worse. Majdić could hear a gruesome click, click in her chest—her ribs moving. "That's when I know it was something serious," Majdić says. She couldn't take an injection of painkiller, though, because it would numb the muscles she needed to race. Tušak talked to her about Kerri Strug, the U.S. gymnast famous for her gold-medal-clinching vault on an injured ankle at the 1996 Olympics, and about Majdić's 22 years of sacrifice. He reminded her that her arms and legs were still working. He talked to her about the pain she was feeling. He convinced her that it was in her head.

"I had a great team—coach, doctor, a [ski] service team," Majdić says. "You have to understand, these are people who are coming from the same [country] as I do. We were just always poor in the cross-country skiing world. Now for four years when I'm on top, we are showing the world, don't joke with small nations because we can beat you!"

In the final Majdić started outside but pushed through and finished third, fending off Anna Olsson of Sweden for the bronze. Five hours of pain had ended in Slovenia's first medal in cross-country skiing.

Later that evening at Vancouver General Hospital, doctors finally saw that five of Majdić's ribs were in fact broken. And the severe pain she had experienced before the final? During the semi, one of the cracked ribs had become dislodged, and a jagged end had pierced her lung, causing it to collapse.
BLOCKING OUT THE AGONY
At the 2010 Vancouver Games, Slovenia’s Petra Majdić showed that the brain can overcome the most excruciating pain.

BADGE OF COURAGE
After winning her country’s first medal in cross-country skiing, Majdić had to be carried off the course. She was unable to compete in her other events or even, for days, to walk.

1 BROKEN BONES
Unbeknownst to Majdić, her coach and her sports psychologist, she had cracked five of her ribs in her fall, one of which punctured a lung and caused it to collapse.

2 MIND OVER MISERY
Having been told that she did not have any fractures and that the pain was in her head, Majdić endured the physical torment and kept competing.

Had the initial examination revealed the broken bones, Majdić’s coach and doctors would have stopped her from competing and her Olympic hopes would have been dashed again. “It was luck we didn’t know,” she said later. Instead, the missed diagnosis was one event in a series that conspired to help her cope with agonizing pain—pain that, for the next four days, would make it nearly unbearable for her to cry (which she did anyway because she had to miss her other events) and, for nearly a week afterward, impossible to walk.

Pain always wins, eventually. It forces sufferers to stop what they are doing, or to turn to surgery or drugs, or simply to live in misery. In his recent book The Greatest Show on Earth, biologist Richard Dawkins struggles with the evolutionary purpose of extreme pain. Certainly such pain sends us useful messages: Don’t touch that hot stove again. Don’t get back up on those skis. And in rare cases in which people are born immune to it—congenital insensitivity to pain, the condition is called—they often injure themselves without realizing it and die from joint infections that arise because they fail to shift their weight when sitting or lying, as the rest of us do instinctively.

But why, Dawkins asks, didn’t humans develop just a “red flag in the brain” instead of something so unpleasant as pain? His answer is that pain evolved because it could not be ignored. In sports, though, pain often must be ignored—or at least endured for as long as possible. Ultimately it sets a limit on what athletes can achieve, and for how long they can achieve it. How a player responds to pain can spell the difference between heroism and failure, between a historic career and a forgotten one. Indeed, many of sports’ most remarkable moments—from Willis Reed in the 1970 NBA Finals to Kirk Gibson in the 1988 World Series to Strug at the Atlanta Games—have involved athletes hobbling through or grimacing past or simply shutting out physical agony.

Pain: the power to shape and control our everyday lives, yet it has been remarkably difficult to determine how pain actually works. The explanation that most of us intuitively understand is known to scientists as “specificity theory,” because it connotes that a painful stimulus is transmitted along a single pathway to a specific pain center in the brain. French philosopher René Descartes first outlined it in his 1664 Treatise of Man. He reasoned that fast-moving particles from a fire...
placed near the foot hit a spot on the skin, essentially moving a “thread” in the skin that sends a signal of pain to the brain—"just as by pulling at one end of a rope one makes to strike at the same instant a bell which hangs at the other end," Descartes wrote.

This model endured, more or less—it is still a cornerstone of college biology textbooks—as the details were filled in. While humans do not appear to have a singular pain center in the brain, a lone master bell as Descartes might have envisioned it, there are known pain pathways. Signals from nerve fibers shoot up the spinal cord to the thalamus, a portion of the brain that serves as a sort of hub of pain. The thalamus then distributes its own signals to other parts of the brain: to the sensory cortex, which determines the location and intensity of the pain, and also to areas in the front of the brain, the anterior cingulated cortex and the insular cortex, which modulate emotional response to the pain.

The basics, however, remain intuitive: Something touches the skin, which stimulates a nerve fiber and ultimately alerts the brain. The more severe the stimulus, the more intense the pain. The harder the rope is pulled, the louder the bell clangs. It makes perfect sense and generally backs up our everyday experience.

Except that sometimes the rope is yanked extremely hard and the bell does not ring.

im (the Maineiac) Sylvia, a 6’8” mixed martial artist, was 30 seconds into a 2044 UFC heavyweight title fight against Brazilian jujitsu black belt Frank Mir when Mir made a feline pivot off the Octagon cage, grabbed Sylvia’s tattooed right arm, flipped on his back with Sylvia’s elbow joint against his hip bone and leaned back like a man pulling a train brake. With Mir’s hip as the fulcrum, Sylvia’s arm bent back cartoonishly and snapped—loudly enough to be heard on television. The Maineiac continued to fight, using his left arm to lift Mir off the ground and shake him off. But referee Herb Dean interceded, yelling for the bout to stop.

An angry Sylvia asked Dean, “What the f--- do you think you’re doing?” and argued for the fight to go on. Sylvia was distracted by thoughts other than his injury; he was mad that he’d let himself get caught in an arm bar and that he would lose his chance at the title because of it. When Mir approached to console him and promise a rematch, Sylvia said, “We’ll fight now, man. It’s not over.” But it was.

“I heard it break,” Sylvia says today of his arm. “But during the fight it didn’t hurt at all.” The first real pain came when he high-fived a fan on the way out of the arena. Later, as he sat alone on a gurney waiting to go to the hospital, the pain rushed in. Sylvia’s arm was found to have multiple fractures that required three titanium plates to fix. “[The ref] probably saved my career,” he says.

Circumstances play a big role in how people experience pain. At the Anzio battlehead in Italy during World War II, anesthetist Joseph Beecher realized that he could not always predict the degree of pain a soldier would feel from a wound. Men came in after bullets had passed clear through them, or with arms dangling and legs missing, and some of the most grotesquely injured among them would smile and express relief that they were alive and out of harm’s way. Often they declined morphine.

It was not that these soldiers were suddenly immune to pain or unaware of their injuries. When medics gave them IVs, they complained just as bitterly as other patients about an ineptly placed needle. It was that they were not feeling the specific pain of the wound that had gotten them out of the crossfire. And this experience could not be explained by shock. Some of the soldiers were fully aware of what had happened, able to calmly analyze the situation in the battlefield and to carry on conversations. When Beecher later treated civilians with similar injuries, he found that they usually experienced far more pain than had the soldiers. The battlefield itself, it turns out, was the painkiller.

Part of the explanation is probably the body’s ancient flight-or-flight mechanism. It can cause immunity to pain—so-called “stress-induced analgesia”—in life-threatening situations. According to Jeffrey Mogil, head of the Pain Genetics Lab at McGill University in Montreal, part of the evolutionary purpose of the pain from, say, a sprained ankle is to facilitate healing. “Humans didn’t have casts in the situation in which we evolved,” he says, “but you know to keep your leg still because it hurts if you move it.” In battle, however, immobility could be deadly. Sudden immunity to pain offers the injured person a chance to flee first and deal with the injury second. The theory is backed up by studies of mice in which, when two are pitted against each other, only the losing mouse, the one that needs to flee, experiences stress-induced pain relief.

The brain has distinct pathways for feeling pain and producing the emotions that cause distress from pain. It appears that alterations in one pathway can change how a person is affected by the other. Battle can cause that sort of alteration, as can mental distraction. In the 1950s, working at a clinic in Portland, Canadian psychologist Ronald Melzack documented a phenomenon in civilians similar to what Sylvia went through. A machine-shop foreman who had just lost a foot felt no pain as he focused on the worry that his fellow workers would think he was stupid. A young woman with a severed leg felt fine but cried because she believed that now no man would want to marry her. The main power of some painkillers lies not in dampening the physical quality of pain but in softening the emotional response to it. “Morphine doesn’t so much decrease the pain intensity,” Mogil says. “It decreases how badly I feel about it.” That pain is in the head is incontrovertible.

The Atlanta Olympics were John Register’s dream. A four-time All-America sprinter and jumper at Arkansas, Register joined the Army’s World Class Athlete Program in 1988 and competed at that year’s U.S. trials in the 110-meter hurdles, though he failed to make the team. In ‘92, having served in the gulf war and switched to the 400-meter hurdles, he again qualified for the trials but missed 17th. By the spring of ‘94, two years before the Atlanta Games, he had run a sub-50-second 400-meter hurdles and had hopes of making the trials finals. But his Olympic dream came crashing down in a single hurdle.

On May 17, 1994, Register was warming up at Fort
Hays in Kansas for a competition the next day. The conditions were windy and he was having trouble getting his 13 steps down between each hurdle. On the third hurdle Register knew that his 13th step would be too far from the barrier. Rather than stutter-step, he attempted an altralong jump off his right leg. Register cleared the hurdle but landed hard on his left foot and collapsed to the track. He knew he'd been hurt badly. His left leg was lying at a right angle, like an L, across his right. But for a moment there was no pain, only heartache. "Man, I just lost my shot at the Olympics." He took another look at his leg and the pain surged.

Over the next few days, Register's pain grew worse. He had severed the popliteal artery, the extension of the femoral artery that brings blood through the knee to the lower leg. Gangrene began to set in. Five days after the accident, he had a choice: have the lower leg cleaned out and keep it but lose so much function that he would have to rely on a walker or wheelchair for the rest of his life, or amputate the leg above the knee and use a prosthetic lower limb. At that point all Register could think about was getting rid of the constant and intense pain. "I just wanted the pain gone," he says. "I thought, shoot, if you cut [the leg] off, the pain has got to go."

Except that sometimes the rope is not pulled, and the bell rings just the same.

At some point in their lives, most people who have lost a leg will feel that leg as if it were still flesh and blood. Many of them will feel pain in it. Others who were born without a leg or arm will nonetheless sense pain in the limb that has never existed.

John Register turned out to be wrong: The amputation didn't get rid of the pain. It did allow him to return to track and field, though; he long-jumped nearly 18½ feet to win the silver medal at the 2000 Paralympics in Sydney. But after the surgery he continued to feel an ankle and foot beyond his stump—at times he would sense a knife being dragged across his nonexistent Achilles tendon. In time the sensations faded, but he still has nights when he feels an electric shock in his phantom foot, and he crawls out of bed so that his twitching doesn't wake his wife.

It is now well-known that there can be pain in the absence of injury, and horrendous injury in the absence of pain, with many shades in between. A kidney stone, for example, is biologically trivial and unthreatening and affects a part of the body with relatively few nerves, yet it causes excruciating pain. These are blows to the sanctity of Descartes's specificity theory.

In 1965, 301 years after Descartes's treatise, Melzack, the Canadian psychologist, and his colleague Patrick D. Wall, a British neuroscientist, proposed that the brain is not a passive recipient of pain information but rather an active gatherer of relevant data from the skin and organs that has ultimate say in dispensing pain as it sees fit. If the nerve fibers compose a web in the body, the brain is the spider at the center, using the web as a data-collecting extension of its body. Each vibration of the web reveals the location and size of the intruding sensation and sets other strands vibrating that the spider must collectively interpret to decide on a course of action. And just as experience in the wild teaches the spider to become an increasingly savvy

HOOKED ON PAINKILLERS

Here's how former NFL quarterback Ray Lucas became addicted to opiates—and how he finally kicked the habit.

It's Super Bowl Sunday morning, last Feb. 6, but for Ray Lucas it feels like a postgame Monday. His stomach is churning, and he's hobbling on swollen ankles. On the bright side, he can finally feel his hands again. In a moment the former Patriots, Jets and Dolphins quarterback will slip what looks like an orange postage stamp under his tongue. It releases a drug called Suboxone, which will help wean him off the painkilling pills he's been gobbling at a rate of close to 500 a month. Lucas, 39, is in his first morning at Behavioral Health of the Palm Beaches (BHP), a rehab facility in West Palm Beach, Fla., where he hopes to reclaim his life from addiction.

On Friday, Lucas, who lives in Harrison, N.J., and works as a football analyst for SNY and as a public speaker, was doing interviews at the Super Bowl media center in Dallas while popping an opiate—Vicodin, Oxycontin or Percocet—almost every hour. Lucas, whose eight-year NFL career ended in 2003, injured his spine while playing for the Jets (left, in 1999) and has been in pain ever since. In 2005 he had surgery to replace a disk and fuse two vertebrae in his lower back, but a severely herniated disk and damaged upper spine still gave him headaches, stabbing pain in his legs and muscle spasms in his shoulders, back and neck. Within four years he needed more surgery, but his NFL health insurance had expired, and he couldn't pay for the $25,000 operation.

By last summer Lucas was living in a fog, induced by painkillers and sleeping pills, that cost him his job in financial services and his house and strained his relations with his wife, Ceci. Finally he contacted Pain Alternatives, Solutions and Treatments (PAST), a coalition of New Jersey–based doctors and facilities that offers former athletes pro bono medical and behavioral health services. PAST got Lucas surgery to fuse vertebrae in his neck, but he was still addicted to painkillers. He had built up a tolerance to them during his playing days, when he would take opioid pills—sometimes five to 10 per day. After the surgery, PAST doctors sent him to BHP, one of many facilities that administer PAST's rehab program.

Prescription painkillers work by exploiting the pathway that evolved for stress-induced analgesia, in which the body's natural opiates, such as endorphins, bind to opioid receptors in the brain and spinal cord and trigger the release of dopamine, which causes a euphoric feeling and mitigates pain. Once the opioid receptors stop getting their fill, the dopamine stops flowing and the brain produces hyperalgesia, or rebound pain. Then addicts are liable to use more pills.

That's where Suboxone comes in. The drug attaches to opioid receptors but triggers a more moderate release of dopamine, allowing an addict to wean himself off the medication more easily.

Today Lucas is clean—off both painkillers and Suboxone. In a call to PAST doctors in February, Lucas thanked them for "giving me my life back" and added, "you can count on me. I won't let you down."
decision maker, so does experience act upon the brain. Among Melzack's revelations was that part of the brain's hardware is what he called a pain "neuromatrix," essentially a blueprint of a full body that exists in the brain whether or not the full body exists in physical space. But to interpret the sensation of pain, he found, the brain has to install specific software.

In the 1950s, Melzack was working toward his Ph.D. at McGill under psychologist D.O. Hebb. At the time there was no such field as pain research—pain was considered a side effect of illness or injury. Hebb was interested in how an extreme dearth of life experience affects intelligence. His subjects were Scottish terriers. He would feed and groom them himself but isolate them from the outside world, then analyze their ability to navigate a maze. What Melzack noticed was that the experience-deprived dogs ran headlong into water pipes in the holding room over and over, with no apparent feelings of pain. The dogs, he found, also had no aversion to fire. Melzack lit a match and held it out to see how the terriers would react to something they had never seen. The dogs stuck their noses in the flame, backed up and calmly did it again. And again and again. Whatever the critical developmental period was for loading pain software into the brain, the dogs had missed it. As Mogil puts it, "The fact that something like pain would have to be learned at all is pretty surprising."

Ivan Pavlov, the most famous dog experimenter, showed that animals' pain perception could be programmed. When dogs were given an electric shock on the paw, they recoiled violently. But then Pavlov presented his dogs with food after each shock on a particular paw. Soon they ceased recoiling—instead wagging their tails and salivating at each shock. If the opposite paw was shocked, however, the dogs reacted as violently as before.

Melzack elegantly summarized all the psychological influences that modify the biological experience of pain by saying that the "meaning of the situation" has a tremendous effect, by actually altering the nerve impulses from the body to the brain and within the brain itself.

Toward the end of his 13-year NFL career, Jerome Bettis had a Monday morning ritual: He would sit at the top of his staircase, then scoot downstairs on his butt because he was simply unable to walk down. Bettis, who finished with 3,479 carries, may have taken more shots than any other straight power back in pro football history. Among his injuries were broken ribs, a torn groin muscle, a bruised sternum and two separated shoulders. Once he played with cotton stuffed inside a broken nose, but a head-on collision sent the pieces up through his nasal passage, down his throat and into his stomach. "My skill was running through people," he says. "That was all I had. It wasn't like I could run away from them."

By the following Sunday he would recover. Sometimes. The older he got, the longer it took before he was fully mobile again. In his final seasons with the Steelers, it wasn't until Thursday or Friday that he felt ready to go.

In 2005, Bettis's last year, he recalls taking a helmet to the quadriceps in a Week 6 game against Jacksonville. "My quad was just on fire," he says. "I was rehabbing and doing everything I could. But on Saturday I said to myself, I can't move. I'm not going to be able to play." Come Sunday, though, he was on the field.

The power of game day to suppress pain should not be underestimated. In 1998, Haverford College psychologist Wendy Sternberg was talking to a student about stress-induced analgesia (SIA)—the temporary absence of pain that Tim Sylvia and Beecher's soldiers experienced after serious injuries. SIA is not fully understood, but part of the pain relief appears to come from the body's ramped up production of endorphins and opioids, natural chemicals that reduce our perception of pain and stress. Sternberg's student told her that SIA was reminiscent of athletes competing through pain. So Sternberg put the hypothesis to the test. She tested the pain sensitivity of track athletes, basketball players and fencers at Haverford immediately after competition, compared to two days before and two after. Sure enough, on game day the athletes were less sensitive to heat or cold. For Sternberg the key implication was that athletic competition kicks in the body's pain-inhibition circuitry. Sunday makes people tougher.

And the more Sundays you play, the tougher you get. As Bettis says, "You become conditioned to the pain."

In studies in which subjects undergo painful tests such as having a heated instrument applied to an arm, they rapidly become less sensitive to the pain. In just one week of daily 20-minute pain sessions, subjects in a study at the University of Hamburg in Germany increased the threshold temperature at which they started to feel pain from about 110° to nearly 138°. But the increased resistance was not restricted to the arm that was exposed to the heated instrument. Subjects became more tolerant in the other arm and in their legs as well, suggesting that the change was occurring in the brain, not the skin. In another Hamburg study, scientists found that the brains of subjects on a similar weeklong pain program grew more gray matter in the sensory area of the brain responsible for the arm that was being heated, as well as in other areas. (Conversely, patients with chronic pain that develops for unclear reasons and has no definitive end become more sensitive to pain over time, and scientists have documented a decrease in gray matter in those patients' brains.) Perhaps, as Bettis says, some of the change is due to knowledge, which is itself a form of brain reprogramming. That which (your brain learns) does not kill you makes you stronger.

Jeroen Swart, an exercise physiologist at the Sports Science Institute in Cape Town and also South Africa's...
2002 cross-country mountain biking champion, has studied how cyclists such as those who climb the Alps in the Tour de France manage pain and fatigue. His work has confirmed that knowledge of what is to come is power—literally measured in watts. In 2009 Swart and colleagues tested competitive cyclists on four successive 40-kilometer time trials and found that the better the athletes learned the course, the better they could withstand a given amount of pain. “In the fourth trial, when they were most familiar with the task,” Swart says, “the pain was actually less even though they continued at the same or faster pace.”

But in a fifth trial, when information about how far they had gone was purposely withheld from the athletes, they were unable to push through mid-race exhaustion, and their power output declined rapidly through the middle of the race, until they caught sight of the finish and surged. “As the end gets closer,” Swart says, “the brain starts to shut down some of the signals such as pain and breathlessness,” allowing athletes in all sports to make the excruciating sprint for the finish. Throughout a task, the brain manages the allowable increase in pain and exertion, according to Swart, and “experience of the chosen distance and accurate feedback of how much has been completed is critical to how well the brain can calculate.” And whether in sports or a chronic-pain clinic, changing the data that the brain uses for its calculations changes the perception of pain.

In fact, most of the breakthroughs in pain treatment over the last few years involve not new drugs but various forms of brain reprogramming—sometimes using electrical stimulation or other, far more basic technology. Some amputees who feel pain from a phantom limb have had success with “mirror therapy,” in which a mirror is placed to make it appear to the amputee that the absent limb is still intact. The idea is to trick the brain, so that it will cease registering the phantom pain. Early results with wounded soldiers have been promising.

There are simpler remedies still. When patients are given control of their own pain—such as women in childbirth who are handed the reins of their own epidural—they often require much less medicine to achieve relief. In studies in which subjects are tested for sensitivity to heat, those people who are led to believe that they have control over the testing machine, even when they do not, show increased activity in the prefrontal cortex and decreased activity in the insular cortex, a part of the brain associated with the emotional dimension of pain.

The large prefrontal cortex is the uniquely human piece of the brain, responsible for functions such as choosing right from wrong, predicting events, interpreting social cues and suppressing sexual urges. The fact that a more active prefrontal cortex coincides with a dampened emotional response to pain is likely not a coincidence. For better and worse, humans have a complex capacity for modulating pain, for dwelling on its unpleasantness or suppressing it altogether. “We think certain parts of the prefrontal cortex can act like a pain governor,” says Jeffrey Bordini, an associate professor of psychiatry at the Medical University of South Carolina. “If you’re really intent on wrapping up in a goal, the prefrontal cortex might turn down the volume on that emotional dimension of the pain experience. We have the ability to override our pain experience. You might be able to press on through the pain.”

That night in Whistler, Petra Majdić showed up at the medal ceremony in a wheelchair, with a tube in her chest to relieve the pressure from air built up around her collapsed lung. But she would never have been on the podium if not for doctors who had told her repeatedly during the competition that what she was feeling was just pain, not injury.

When emergency patients cannot identify a cause of their pain, they are often cured simply by the presence of a doctor, or his or her assurance that there is no serious problem. Mogil, the McGill pain researcher, relates his own experience: He once awoke with a strange pain in his inner thigh. His wife, a chiropractor, suggested it might be a hernia, and he went to the hospital. The pain worsened as successive doctors agreed that it could be a hernia. “Then they called the expert,” Mogil says. “He took one look and said, ‘It’s not the right place for a hernia. It’s a muscle spasm. You’ll be fine by the afternoon.’ The pain was gone before I even got back into my car.”

Majdić was given a degree of control over her pain, being told by her coaches that she could bow out of the race at her discretion. But she also took control of her pain by focusing on the underdog status of her small and underfunded Slovene team. As with the UFC fighter and the injured factory worker, Majdić’s mental state might have made her less susceptible to pain. In multiple studies, women who were told offhandedly that their minority ethnic group was more sensitive to pain suddenly became more tolerant of it. After the experience, Majdić would speak of how important it was that she had been surrounded by her Slovene support team and that when she wanted to quit she reminded herself that she had a chance to show the world that you “don’t joke with small nations because we can beat you!”

And, of course, she was in the heat of a big competition, one for which she’d prepared for two decades. Whether she knew it or not, throughout her years of strenuous training as well as on that medal-winning day in Whistler, Majdić had been constantly telling herself that the pain was in her head.