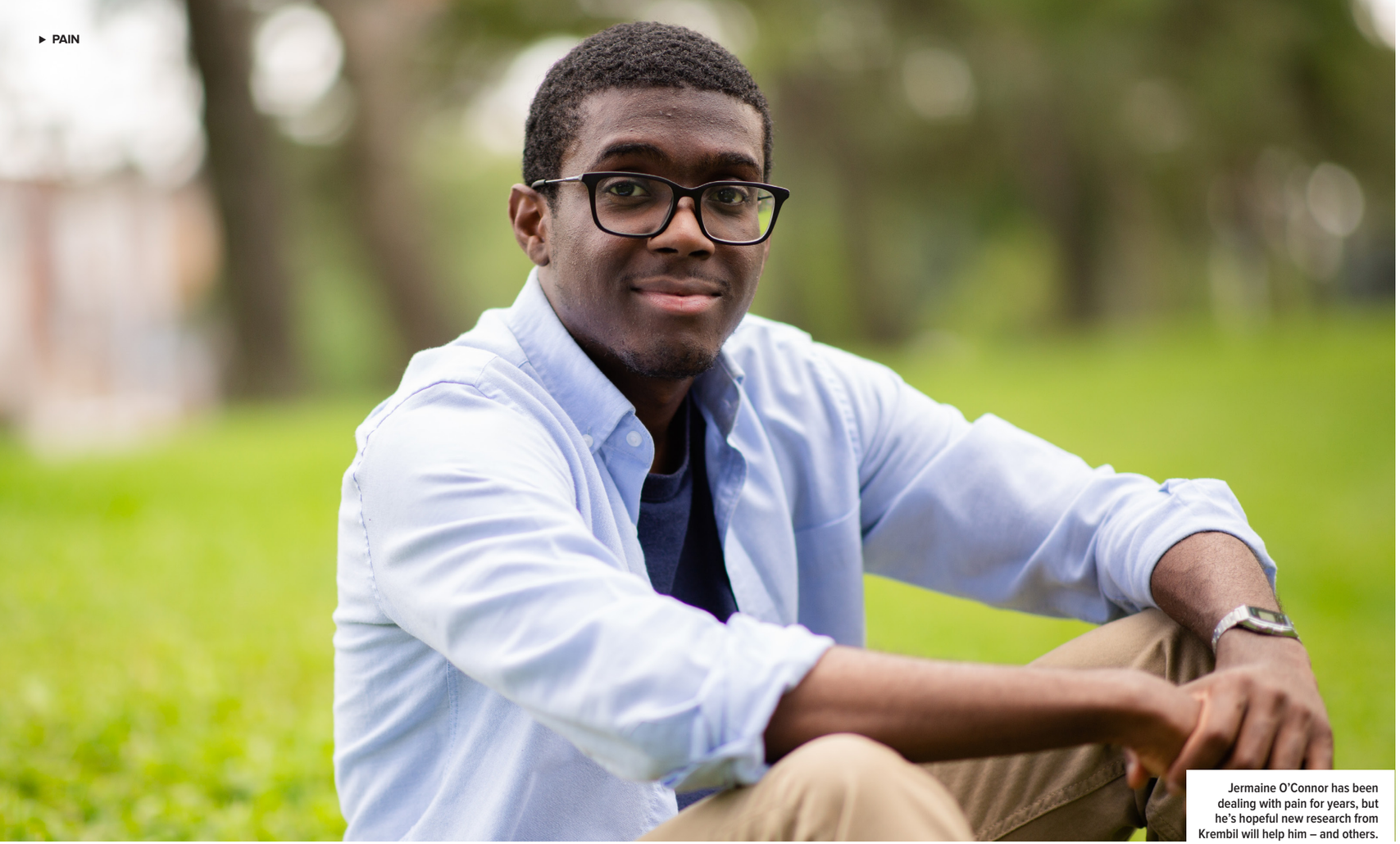


Jermaine O'Connor has been dealing with pain for years, but he's hopeful new research from Krembil will help him – and others.

Mapping the pathways of pain

Researchers haven't quite figured out what causes this feeling, but new imaging tests may help people put pain in a different perspective

Wendy Glauser

Jermaine O'Connor has struggled with pain for as long as he can remember. The Toronto-based digital marketer often has trouble moving his arms and legs – he suffers from excruciating joint pain caused by sickle cell anemia – and has been to more hospital emergency rooms than he'd like to admit. When he was younger, he struggled to keep up with his friends during gym and recess, and he often had trouble concentrating in class, and later, at work.

A few years ago, Jermaine, who is 26 – an age most people don't associate with chronic pain – started his first office job. Within the first few weeks, he developed hip pain that lasted for several months. He would just grin and bear it, in part because he thought no one would understand. "I wanted to avoid all the explanations of what I have and what I'm going through," he says.

One reason why Jermaine may feel people haven't taken his disease seriously enough is most of us think we know what it's like to experience pain. We also think chronic pain is something only older people deal with. Unlike in most of us, though, Jermaine's pain doesn't completely go away, and, to make matters more confusing, researchers still aren't sure why chronic pain persists.

It's vital Jermaine pays attention to how he feels because new pains in new areas could be a sign of a complication – or it could just be that he slept wrong. He makes note of his new pains so he can ask his specialists about them. "I'll say, 'Is this something I should pay attention to?'" As with a lot of people who deal with chronic pain, it can feel like a constant battle.

Fortunately, research is being done to create a better understanding of how pain works and where it comes from. Soon, doctors will be able to map neural signals in the brain – we'll be able to see the path pain takes in our bodies – helping to answer the many pain-related questions still outstanding.

TUNING OUT

To map those signals, researchers like Dr. Karen Davis, head, Division of Brain, Imaging and Behaviour-Systems Neuroscience at the Krembil Brain Institute, are using functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG).

Dr. Davis has spent much of her scientific career working with these imaging technologies to make the pain people like Jermaine feel – pain that's internal and invisible to others – visible in brain images.

One of Dr. Davis's landmark studies, which has helped researchers understand the relationship between the brain and pain, screens how pain interferes with people's attention. It was believed pain always disrupts concentration, but Dr. Davis found that some people can perform challenging mental tasks faster when they are prodded with a painful stimulus. She calls these people attention-dominant types, or A-types, while those who are slower at a task when in pain are called pain-dominant types, or P-types. She then discovered the A-types' minds could wander away from pain, while the P-types' could not.

Using an fMRI, Dr. Davis's lab looked at brain activity in people working on a challenging task at the same time as receiving pain stimuli. Her studies found A-types have stronger and more flexible connections between key brain areas relating to attention and sensory signals. These networks include the salience network, which responds to pain stimuli; the executive control network, which is responsible for high-level cognition; the default mode network, which can draw our minds away from immediate stimuli; and the pain modulation system, which releases neurotransmitters such as the body's internal opiates to combat pain.

What this means is A-types can better turn their attention away from pain signals and toward tasks at hand, likely because they have strong and dynamic brain connections to their internal opioid system. According to Dr. Davis, we're all on a spectrum. Some of us are clearly A- or P-types, but many of us fall somewhere in the middle.

Those with chronic pain have their salience network – the part of the brain that makes us more attentive to our discomfort – stuck in an "on" mode, even when the "mind wandering," or default mode network, is activated. "So, you can imagine, with chronic pain, they're constantly paying attention to it," Dr. Davis explains.

The brain research Dr. Davis and her students conduct is more complicated than described here. For instance, she's using machine learning algorithms to calculate patterns of brain communication among various neural pathways that represent how the brain responds to different types of pain, including the aching, inflammatory pain from a back injury, and the burning, shooting neuropathic pain that can result from nerve damage.

Dr. Davis's research – and the many studies conducted by other neuroscientists – may help us identify people whose brains are not optimally wired to combat chronic pain. Instead of a doctor only asking a patient how much pain they feel on a scale of one to 10, brain scans could show why they have chronic pain. That's useful for someone like Jermaine, who often finds it difficult to explain the kind of pain he feels. It may also lead to more understanding, less stigma and better treatment. Some people, though, are worried about these kinds of objective fMRI pain tests. They're concerned doctors, insurance companies and employers could use them as a "lie detector" against people's own subjective experiences with pain.

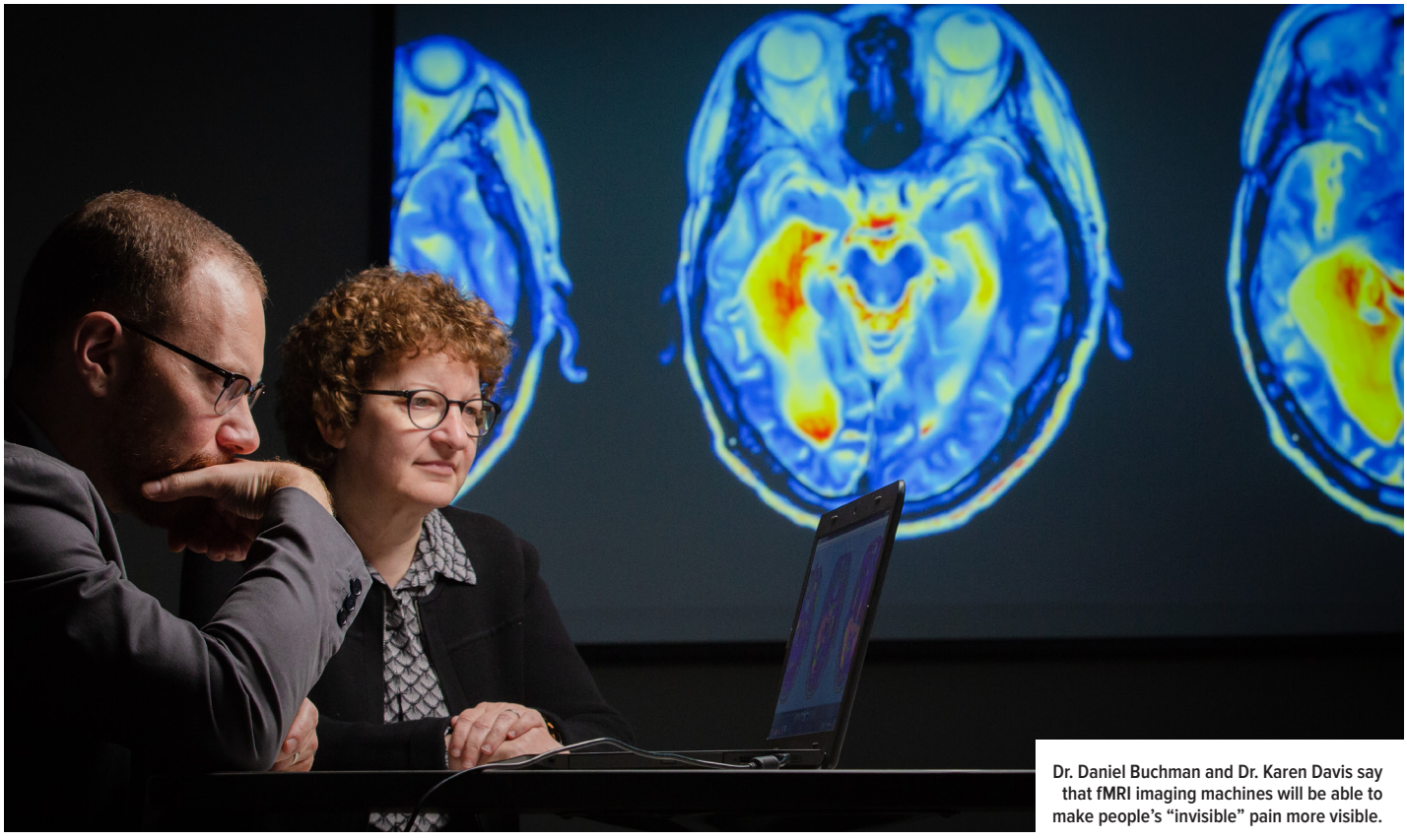
6 million

Canadians who suffer from some sort of chronic pain due to a neurological condition.

(Statistics Canada)

FINDING PAIN IN OUR BRAINS

While this kind of test is still too inaccurate for widespread use, fMRI scans are getting closer to revealing the brain mechanism behind how we're feeling. One of Dr. Davis's earlier studies involved people who had irritable bowel syndrome (IBS) and fibromyalgia. Medical tests such as X-rays and standard clinical MRIs weren't showing something was wrong, but fMRI scans revealed highly ›



Dr. Daniel Buchman and Dr. Karen Davis say that fMRI imaging machines will be able to make people's "invisible" pain more visible.

abnormal brain activity. For the first time, the patients felt like their pain could be truly seen by someone else. Brain imaging data "has been tremendously useful to legitimize people's pain," Dr. Davis says.

However, research conducted by Dr. Davis and her students has shown there is tremendous variability in brain activity, even for people who are experiencing similar amounts of pain. This is partly because people experience chronic pain differently – it's not just a matter of pain intensity. Pain is an individual experience and includes a complex mix of sensory qualities and emotions. There are also gender differences in how the brain is wired, and brain communication can also be different for people of different ages. fMRIs reflect all these nuances.

Dr. Daniel Buchman, a bioethicist and clinician investigator with Krembil, is concerned doctors could trust a brain scan more than how patients say they're feeling. He worries people could be required to "prove" their pain before treatment is given via an fMRI test. This could increase stigma, he says. While brain imaging research for chronic pain is important, policymakers should be more concerned with the urgent ethical issue of population-level inequalities in access to pain management, he says.

SEARCHING FOR BETTER TREATMENTS

While those ethical issues are being worked out, Dr. Davis's research continues to forge ahead. She and her team now want to see if fMRI scans can be used to suggest what treatments are likely to work.

There are numerous ways to treat pain, including drugs that interfere with pain messages sent to the brain, drugs that work on specific nervous-system chemicals and non-pharmaceutical options like physiotherapy, psychotherapy and more. By conducting brain imaging on patients before treatment, and following these patients to see which treatments worked and which didn't, and who they worked for, clinicians may be able to create "personalized" treatment approaches. "If we can prevent somebody from undergoing multiple treatments that are time-consuming, costly, exhausting and don't work, and get them more quickly to the treatment that does work, then that's great for the patient, and it's great for the healthcare system," she says.

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>
> **Dr. Karen Davis**
> Head, Division of Brain, Imaging and Behaviour-Systems Neuroscience at the Krembil Brain Institute

As for Jermaine, he's waiting to see how this research plays out and if there may be a way to better treat, if not cure, his pain. While he has been feeling better lately, he knows the searing pain could return. In the meantime, he's speaking up for himself, telling his managers when he needs to take a break, stretch or go for a de-stressing walk. He's learned, in other words, how to make his "invisible" condition more visible to others. The fMRI research is promising, he says, as it could help doctors treat pain more holistically, with more attention being paid to how pain affects emotions and concentration. "We know chronic pain isn't solely a somatic experience," he says, meaning pain doesn't just involve the body. "Treatment should reflect that."