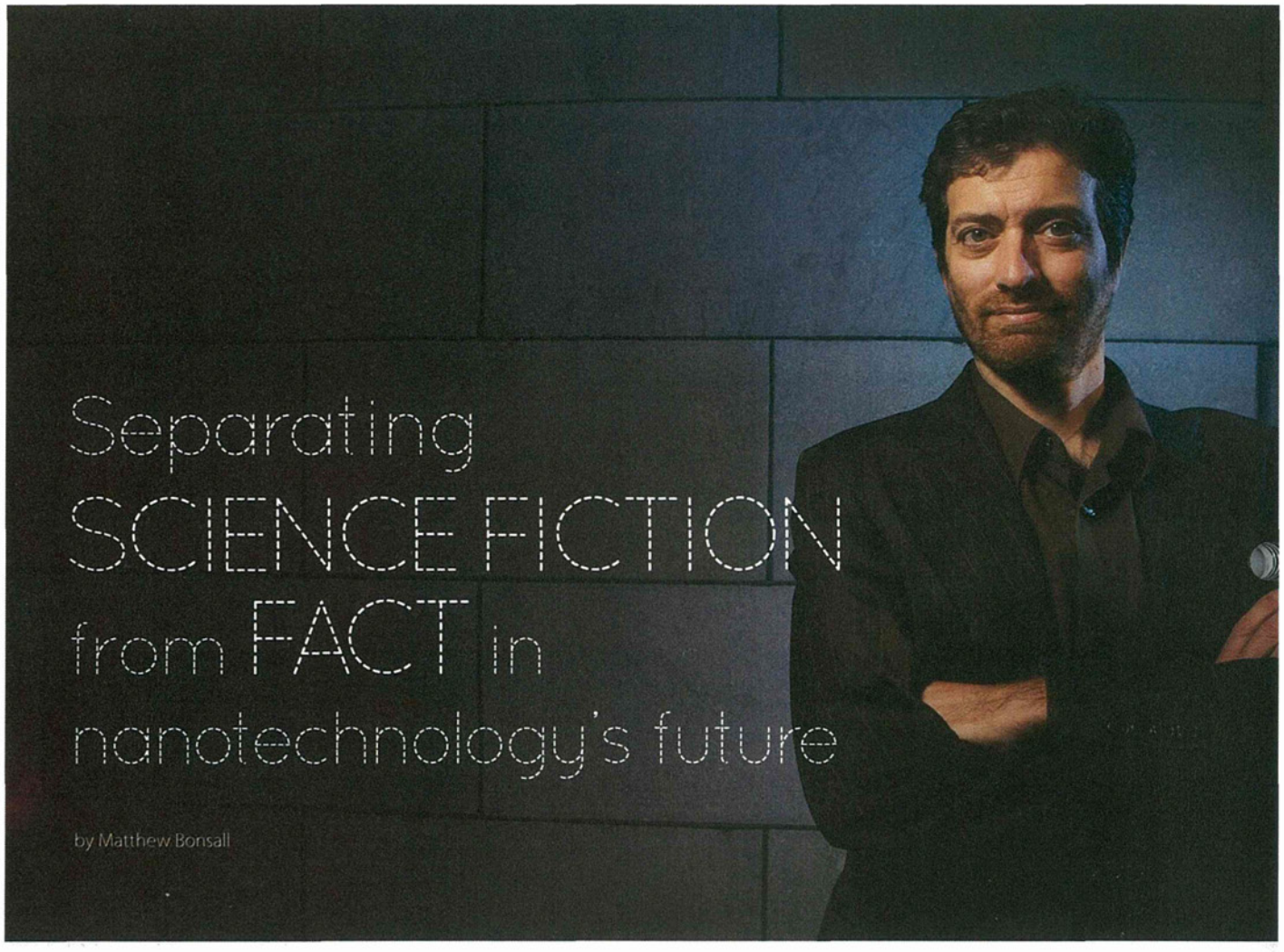


Separating SCIENCE FICTION from FACT in nanotechnology's future

by Matthew Bonsall

Sociology professor **José López** uses science-fiction metaphors to deliver a reality check in the emerging world of nanotechnology.

Nanotechnology has led to exciting advances in everything from medicine to engineering to telecommunications. And its potential is even more exciting, as people develop ways to build things the way nature does—atom by atom, and molecule by molecule. But nanotechnology's vast promise means the hype and hyperbole surrounding it can get in the way of a rational scientific discussion of its true potential, and implications for society.

José López, an associate professor in the University of Ottawa's Department of Sociology and Anthropology, is influencing the way we look at nanotechnology. His research papers are challenging the often uncritical way we accept the boldest claims made by nanotechnology enthusiasts—who have proposed building carbon-nanotube space elevators, and tiny robots that could be used to deliver medicine internally. There are even predictions that nanotechnology advances might allow humans to evolve into beings with such greatly expanded capabilities that we would call them "post-human."

Reputable science organizations generally describe nanotechnology in glowing terms. In Canada, the National Research Council describes nanotechnology as "opening up vast new horizons in virtually all sectors of the economy, from materials sciences, to biomedicine, to communications and information technology." The United States federal government's nanotech program, the National Nanotechnology Initiative, uses the tagline: "Leading to a revolution in technology and industry that benefits society."

"Vast new horizons" and "revolution" are words that carry a lot of weight. If we are to avoid getting caught up in the hype, we need a way to understand how we perceive nanotechnology and why we choose certain words to describe it.

"Looking at science fiction helps us understand how we talk about nanotechnology. Science fiction usually relies on revolutionary technology or a major event to define how society works. Nanotechnology gets talked about like that—some argue that it will change everything," López says.

This world-changing technology or event is called a *novum*—time travel and parallel universes are classic examples. Science fiction

"Looking at science fiction helps us understand how we talk about nanotechnology. Science fiction usually relies on revolutionary technology or a major event to define how society works. Nanotechnology gets talked about like that—some argue that it will change everything." – José López

Nanotechnology: small but mighty

Nanotechnology works with matter measuring between one nanometre (a billionth of a metre) and a few hundred nanometres. A human hair is 80,000 nanometres thick. A single nanometre is just eight to 10 atoms long. Nanotechnology provides a key to unlocking how atoms are arranged. This gives us the key to building new materials with a vast range of uses.

then typically includes a master builder who interacts with the novum and drives the story line. "With this mindset, we perceive nanotechnology—and the scientists driving it, the master builders—as a way to reconstruct a new world," López says. "We're speaking the language of hubris to think we can control the future in this way. We have to remember that nanotechnology is still in its infancy."

López recognizes the enormous potential of the field, and acknowledges that it would be unreasonable to deny that it will "probably lead to some rather amazing and beneficial applications." He intends no discredit, but he does want people to recognize the inherent danger of not perceiving the "ultimate conceit" in claims that nanotechnology will rebuild the world. He is not alone. The U.S. National Nanotechnology Initiative is working closely with public health organizations like the Food and Drug Administration on safety concerns.

López is also concerned that by investing nanotechnology with the ability to resolve all manner of social, cultural and political problems, potential non-technological solutions might not be pursued. "All our problems can't be solved by science," he says. "We still need to think of some challenges as political and social problems."

He feels that science-fiction thinking about nanotechnology ignores critical thinking, and glosses over the gap between what is possible today, and what might be possible in the future. This ability to bridge gaps extends beyond technical questions. "By generating a fictional future world that contains beneficent social implications with only minor ethical complications, we are ignoring, or bridging, social and ethical gaps as well," López says.

In fact, if nanotechnology follows the path of most ground-breaking technologies, there will likely be an ethical lag between the arrival of the technology and our understanding of its social implications. Consider the privacy concerns that dominate today's discussions of the role of the Internet, or the worries over discrimination that arise from genetic testing.

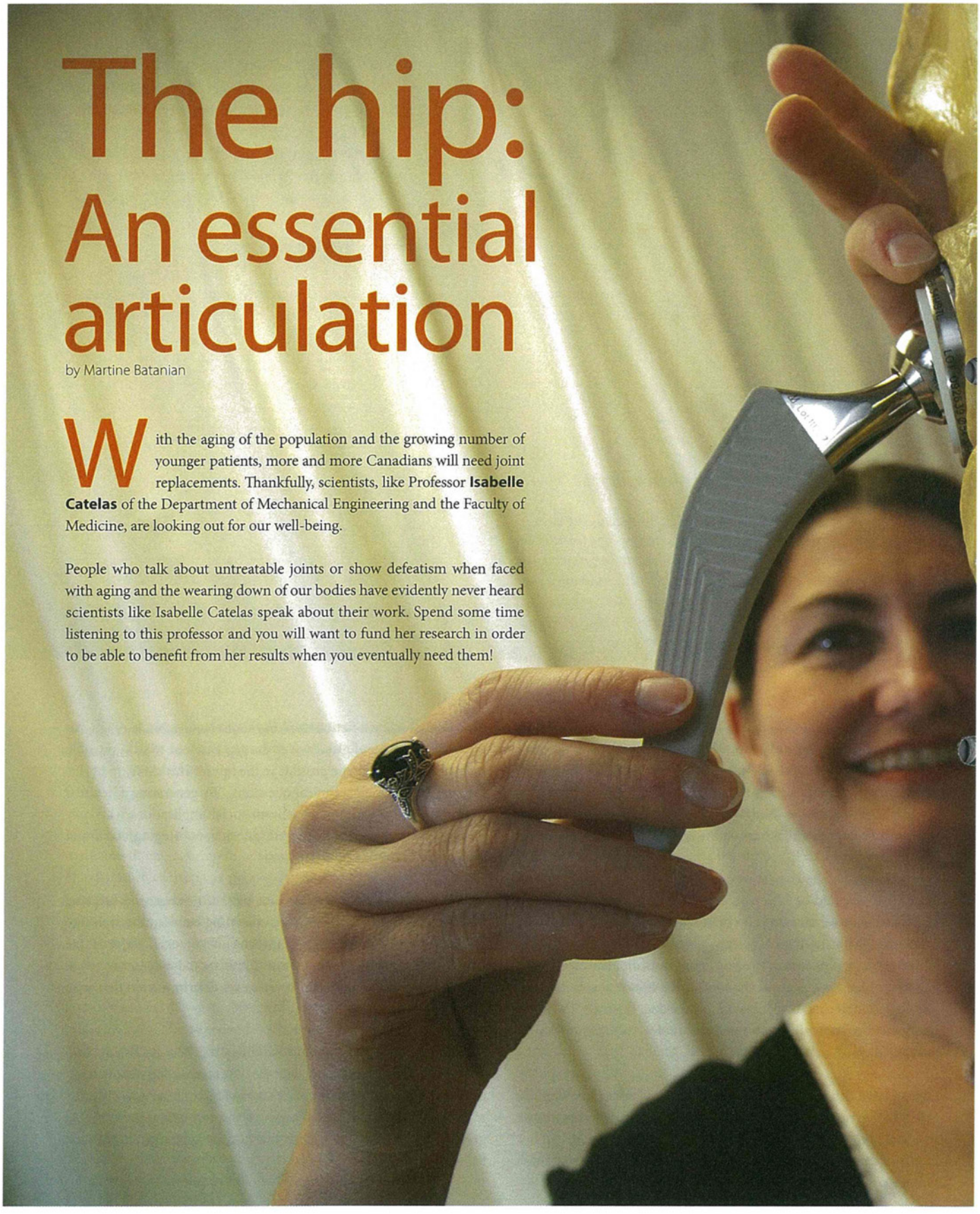
"We need to make policies and decisions that will be able to deal with social issues. We can't wait for nanotechnology to develop, and then react," López says. "The technology of hubris, typified by science fiction, must be replaced by the technology of humility grounded in science's true spirit that acknowledges just how much we don't know." RP

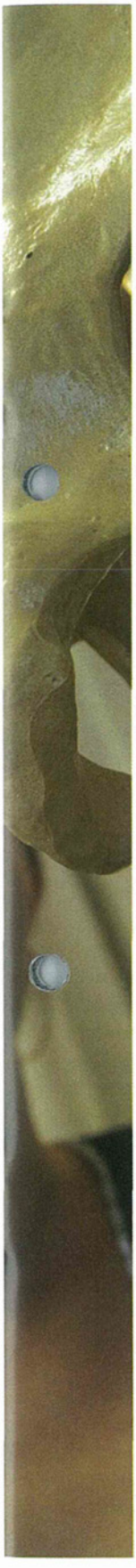
The hip: An essential articulation

by Martine Batanian

With the aging of the population and the growing number of younger patients, more and more Canadians will need joint replacements. Thankfully, scientists, like Professor **Isabelle Catelas** of the Department of Mechanical Engineering and the Faculty of Medicine, are looking out for our well-being.

People who talk about untreatable joints or show defeatism when faced with aging and the wearing down of our bodies have evidently never heard scientists like Isabelle Catelas speak about their work. Spend some time listening to this professor and you will want to fund her research in order to be able to benefit from her results when you eventually need them!





Professor Catelas holds the Canada Research Chair in Bioengineering in Orthopedics. Her research includes developing therapeutic approaches to extend the lifespan of joint implants, and in particular hip implants. According to the Canadian Joint Replacement Registry, over 30,000 hip replacements were performed in Canada in 2008–2009, and approximately 35% of the recipients were under the age of 65. Although joint replacements are very effective at eliminating pain and restoring joint function, unfortunately they do not last indefinitely and many patients eventually need to have their implant replaced.

Hip implant failures are often due to bone loss around the implant, which is caused primarily by an inflammatory response to small particles breaking off as the implant wears down. "Each implant replacement becomes increasingly complex, because the patient has less and less bone left. Extending the lifespan of the implants would improve patients' quality of life and result in lower healthcare costs," explains the researcher, who hesitated between studies in engineering and medicine and whose work in the field of biomaterials now places her at the intersection of these two disciplines. "There are many ways to achieve this. The industry is working on improving implant materials and designs, while my team and I are working with the surgeons to better understand the reasons for failures. We retrieve and analyze the implants and samples of tissues from patients who are getting their implant replaced." Understanding the biological mechanisms responsible for implant failures would allow this scientist to develop new therapeutic approaches—using molecules capable of controlling these mechanisms—and thus extend the lifespan of the joint replacements.

An important part of this research program focuses on hip implants with a metal head and a metal cup. Hip implants currently available on the market can be made of various combinations of metal, ceramic and polyethylene, each with its own advantages and disadvantages. "Metal-on-metal hip implants are resistant to wear, but, in some cases, they may cause hypersensitivity reactions that we still don't fully comprehend. We are trying to understand these reactions in order to improve the implants and develop new methods for diagnosing patients more prone to developing such a reaction."

Logically, a second important aspect of Professor Catelas' research is bone regeneration, a field in which she had worked during her time with healthcare giant Baxter and at the University of California, Los Angeles (UCLA). "Patients getting their implant replaced or those suffering from a complex bone fracture, for example, suffer from bone loss. Bone is a vascularized tissue, so it often regenerates on its own," explains the researcher. "However, when the bone loss is too great, the bone can't overcome the loss on its own.

"One day, thanks to tissue engineering and regenerative medicine, we may be able to regenerate joints within the human body itself, thereby eliminating the need for artificial implants, for the greater good of the patients." – Isabelle Catelas

We then need a substitute that will reconnect and regenerate the bone. If the substitute is biodegradable, it will be gradually replaced by the regenerated bone."

In order to improve bone regeneration, Professor Catelas and her research team are developing new bone substitutes that will be mineralized and vascularized like the natural bone. To do so, they are using biomaterials such as fibrin (the protein-based natural polymer responsible for clot formation). "We will be using fibrin as our starting matrix, along with other biomaterials, to grow stem cells and endothelial cells. The stem cells will produce bone cells, resulting in mineralization, while the endothelial cells will promote vascularization. In fact, we have just acquired a bioreactor that we will be using to develop our bone substitutes." These approaches will make it possible to offer new treatments for patients suffering from bone loss.

"Ultimately, the goal of our research is to improve the quality of life of patients with joint problems. This improvement is generally huge. I also saw this in my personal life, because my mother could no longer walk before she received hip implants. One day, thanks to tissue engineering and regenerative medicine, we may be able to regenerate joints within the human body itself, thereby eliminating the need for artificial implants, for the greater good of the patients." RP

WHO DO WE THINK WE ARE?

by Tony Martins

What constitutes our ego? How does brain activity translate into subjective ideas of our selves and our environments? **Georg Northoff** seeks answers using multiple modes of inquiry and a research team that spans the globe.

Georg Northoff has adopted an age-old strategy when grappling with the complex idea of "self": he's got it surrounded. With doctoral degrees in neuroscience, psychiatry and philosophy, and a transdisciplinary research group with global reach, Northoff peers into the mystery of consciousness from almost every conceivable angle.

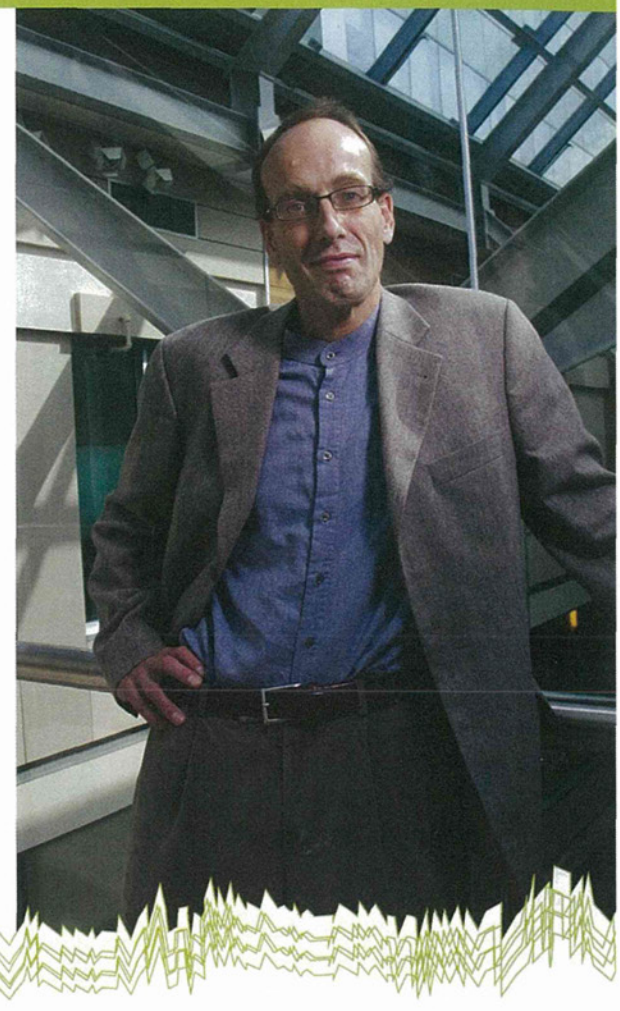
"We are sure that such a transdisciplinary approach will open the door to a world of exciting findings that will shed new light on our very human self, and our very human brain," Northoff has written.

A *world* of findings, indeed. While most Northoff-led investigation takes place at the University of Ottawa Institute of Mental Health Research and McGill's Montreal Neurological Institute, Northoff also collaborates with other scientists in Berlin, Bologna, Vienna, Beijing, Hong Kong, Shanghai, Zürich, and other cities.

At the root of it all is the following question: How do our brains constitute subjective experience of our selves and environments? Through what mechanisms do we fashion what Northoff calls "the basic sense of subjectivity"?

As an example, Northoff points to the personal significance individuals might attach to their iPhone. "How is it possible that this little thing acquires such a personal meaning for you, and not for me?" he asks.

Northoff holds the Canada Research Chair for Mind, Brain Imaging and Neuroethics, as well as the EJLB-CIHR Michael Smith Chair in Neurosciences and Mental Health. Despite his titles and distinctions, he's genuinely humbled by the complexity of his research.



That said, however, Northoff dismisses as irrelevant such tangential questions as the perennial debate on whether there's a distinction between mind and brain/body.

"Consciousness and self are deeply ingrained in how the brain functions," Northoff contends. "It is not something that comes on top. It is something that is always already there."

Northoff and colleagues use a range of functional imaging techniques to investigate drug-induced changes in the prefrontal neural activity of depressive and schizophrenic patients. One breakthrough on the subject of depression in recent years stems directly from how we experience the self.

"In depression you completely focus on your own self, and you are completely detached from your environment," Northoff notes, "something that corresponds with abnormally high activity in the midline region of the brain." One application he sees for such knowledge: better drugs, and more targeted therapeutic approaches.

In his latest book, released in the fall of 2011, Northoff offers another innovative blend of disciplines: neuroscience and psychoanalysis. *Neuropsychoanalysis in Practice* grapples with the essence of the Ego, and explores how the brain makes distinctions between states that are neuronal (of the brain) and psychodynamic (of the psyche).

Northoff is at work on two further volumes exploring consciousness and the brain. Far from ascribing to a quest for some kind of post-human Utopia, he's much more interested in human *im*perfection—particularly "how that must be somehow based on how the brain functions." "We can learn much more about the opportunities when we know about the limitations," Northoff reasons.

A rare kind of curiosity that spans disciplines began when an inspiring high-school teacher engaged him in philosophy. "I wanted to study philosophy in conjunction with a particular science, something more concrete," Northoff says. "At the time you couldn't really study neuroscience, so if you wanted to know something about the brain, you had to go into medicine."

Medical school led to psychiatry, but neuroscience beckoned. Philosophy was always firmly in the picture, along with Northoff's willingness to blend disciplines and genres. His 2009 book, *The Search for the Ego,* was billed as a "neuro-philosophical mystery novel" that crosses academic boundaries to address a wider audience.

With neurophilosophy, as with the rest of his work, Northoff is not afraid to innovate. The central question that keeps arising in his research is this: Which definition of self should be used? "There are as many definitions as there are philosophers," Northoff points out with a laugh.

He believes, however, that a research methodology must be rooted in hard science. "Which of the logical definitions of self match with the actual empirical data?" Northoff asks. "Which is in line with the brain?"

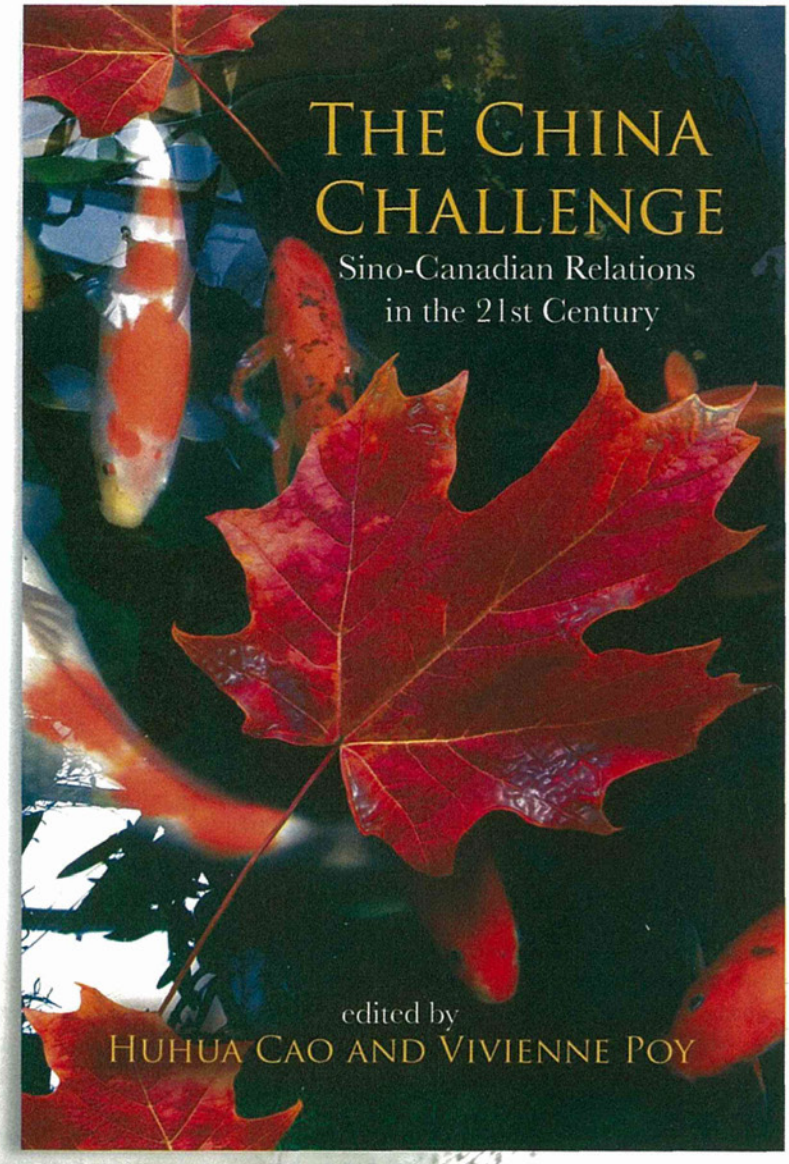
"And then, after considering the data," he concludes, "maybe we should change the definition." RP

The China Challenge

Sino-Canadian Relations in the 21st Century

edited by Huhua Cao and Vivienne Poy

With the exception of Canada's relationship with the United States, Canada's relationship with China will likely be its most significant foreign connection in the twenty-first century. As China's role in world politics becomes more central, understanding China becomes essential for Canadian policy-makers and policy analysts in a variety of areas. Responding to this need, *The China Challenge* brings together perspectives from both Chinese and Canadian experts on the evolving Sino-Canadian relationship. It traces the history and looks into the future of Canada-China bilateral relations. It also examines how China has affected a number of Canadian foreign and domestic policy issues, including education, economics, immigration, labour and language. RP



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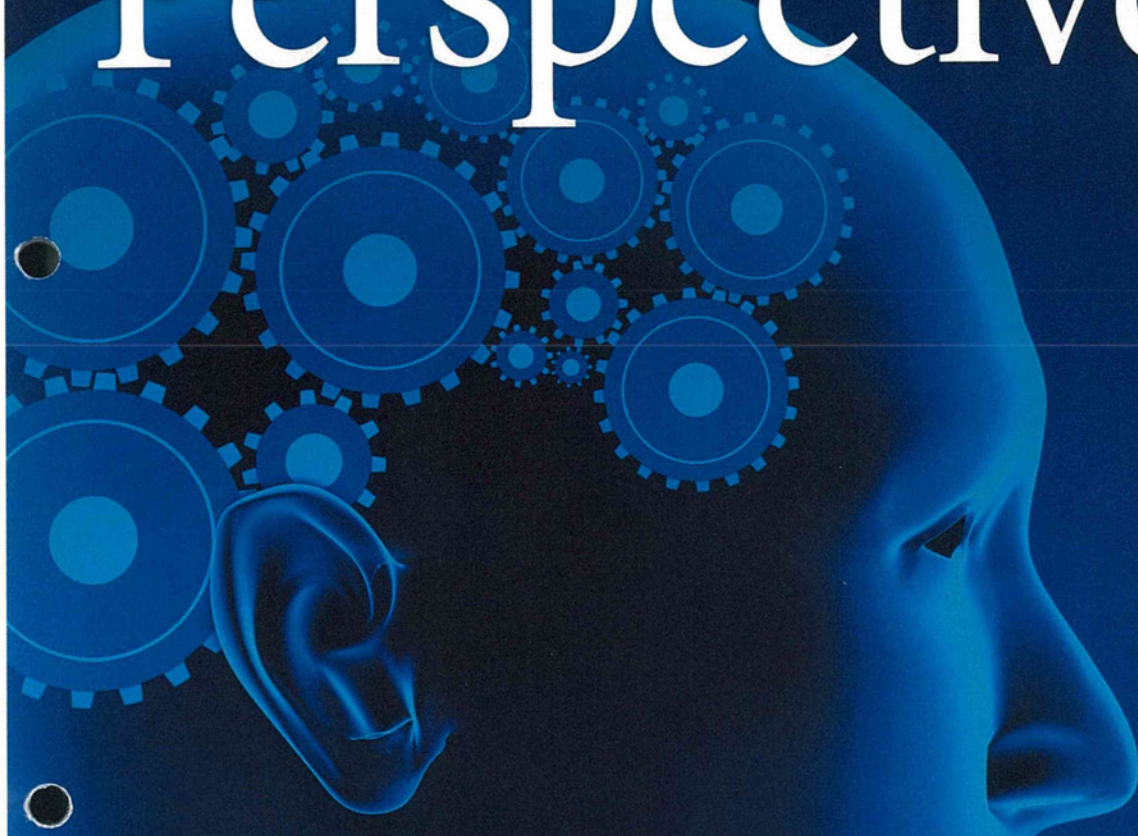

BRAINSTORM

Unravelling the inner workings of the brain and mind

uOttawa

Mona Nemer
Professor and Vice-President, Research

Minding our brains

You are the caretaker of the most incredible and complex creation known to exist—your brain.

Containing nearly 100 trillion neural connections, yet weighing less than 1.5 kilograms, your brain is the cradle of your mind. Its maze-like bundles of grey matter give rise to this precious thing we call consciousness and house your most cherished memories of the past and dreams for the future.

Although the human brain is marvellously complex, it is also profoundly sensitive to external stimuli, to other organs and to our own mental health. From depression and anxiety to stroke and Parkinson's disease, problems with our brain affect how we function, feel, think and behave. To feel and be healthy—from birth to death, in slumber and in action—we need to promote and preserve the health of this master of all organs.

The University of Ottawa is home to some of Canada's best and brightest interdisciplinary researchers and clinical investigators working to unravel the mysteries of the brain and its functions. As we lay the foundations of the University of Ottawa Brain and Mind Research Institute, we are broadening our focus more than ever before, uniting medical research, the sciences and the social sciences in groundbreaking new ways.

How do we make sense of noise? Is junk food aging our brains? Are we on the threshold of a cure for Alzheimer's and Parkinson's? In this issue of *Research Perspectives,* it is my pleasure to introduce just some of the extraordinary people who are tackling these questions and forging the University of Ottawa's continued excellence in brain and mind research.

Research Perspectives

A journal of discovery and innovation from the University of Ottawa

Research Perspectives

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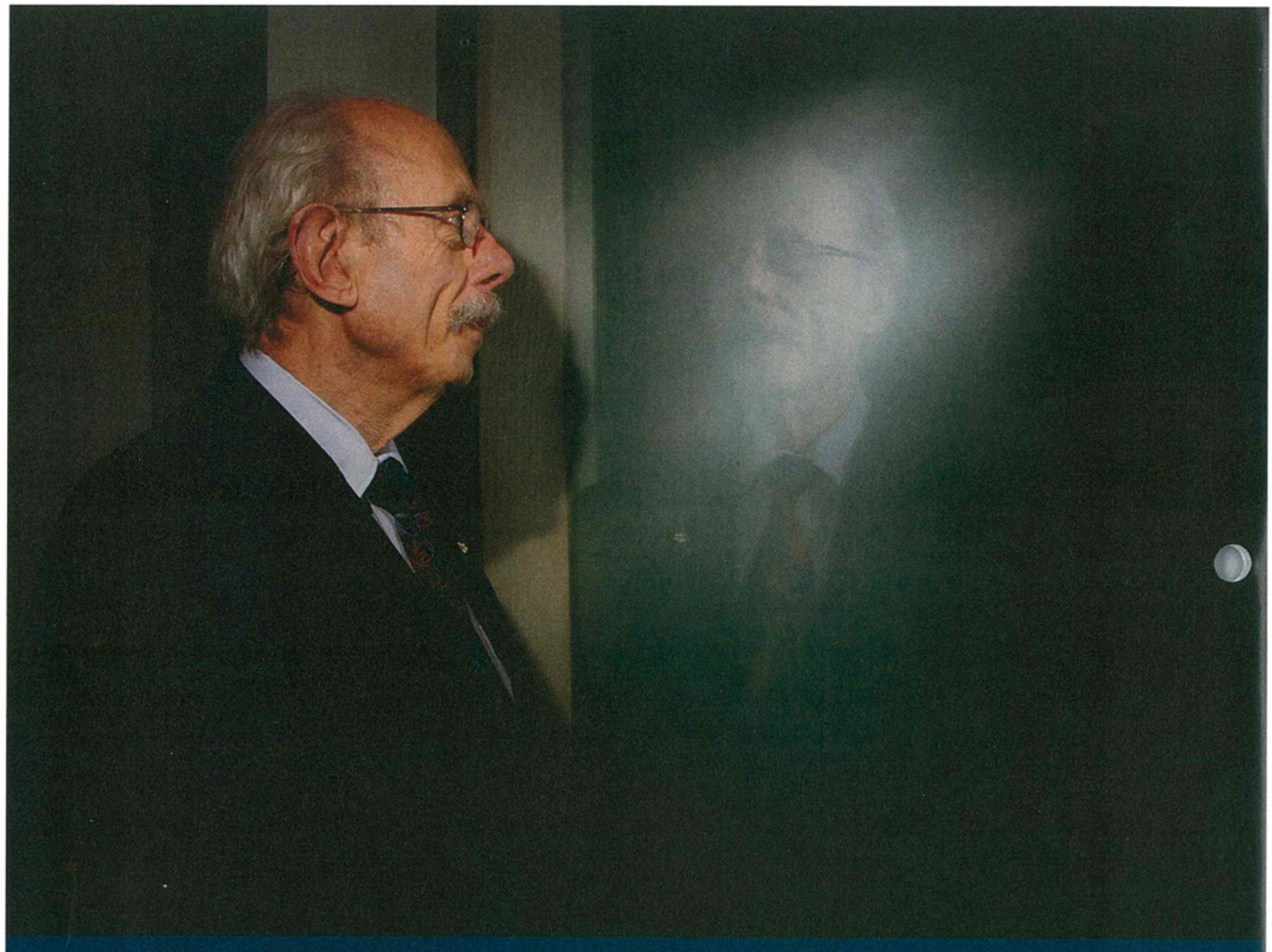


Close connections

A new institute at the University of Ottawa will explore the remarkable partnership between the brain and the mind

by Monique Roy-Sole

After years of treating stroke victims, **Antoine Hakim** came to an important realization. His patients were less worried about the physical impacts of this debilitating neurological disease—the third leading cause of death in Canada—than they were about how it affected their brain.

"My patients didn't complain that their arm may be weak or that their leg may drag a little," explains the University of Ottawa neurology professor, director of Neuroscience Research at the Ottawa Hospital Research Institute and recent inductee to the Canadian Medical Hall of Fame. "They really complained about the fact that their brain wasn't working as well as before the stroke, that they weren't thinking quickly enough, that they weren't able to figure things out."

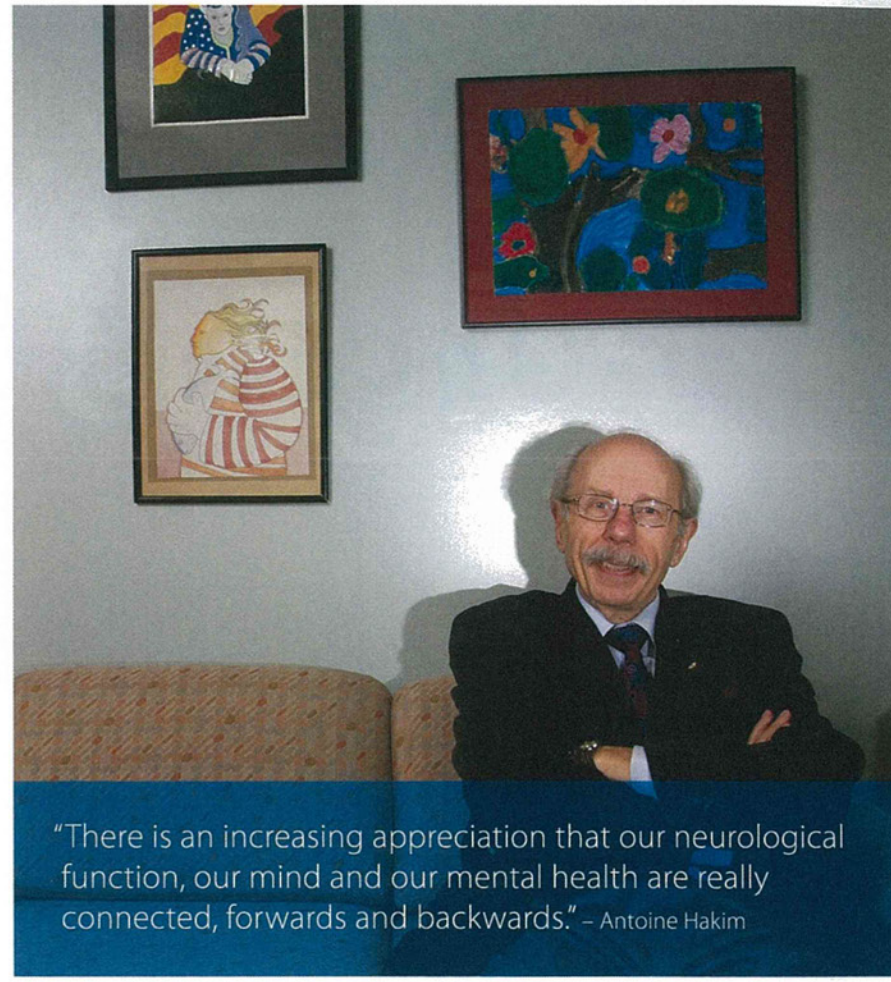
Colleagues who cared for those suffering from multiple sclerosis and Parkinson's disease also reported similar concerns from their patients. What's more, studies showed that the likelihood of suffering a stroke or other kinds of brain damage increased for people afflicted with depression. That's when Hakim, one of the world's foremost experts on stroke, began

to think about the relationship between mental health and brain functionality and the idea for the University of Ottawa Brain and Mind Research Institute (uOBMRI) was formed. The University approved the concept in 2011.

Still in its infancy, the uOBMRI has become one of the University's main priorities. As its founding director, Hakim has high expectations for the institute. Based on its current strengths in neuroscience research and neurological care, he says, the University "has an opportunity to establish itself internationally as a centre of excellence in brain and mind."

The scope of the health issues to be tackled by the institute is extensive. Cognitive impairment and dementia represent the largest cost to Canada's health care system. Caring for dementia alone, which affects almost one million Canadians, is estimated by the Alzheimer Society of Canada to cost $33 billion a year.

But Hakim points out that the uOBMRI will not focus solely on problems affecting aging Canadians. It will promote brain and mind health across the age spectrum, from children to seniors. "A lot of psychiatric problems in our young citizens," says Hakim, "arise from the fact that they have cognitive impairments." In other words, a child who doesn't think as quickly or as well as his or her peers because of genetic predisposition, a poor social environment or poor nutrition is more likely to develop psychiatric problems.



The symbiotic relationship between the brain and the mind is at the core of the institute's vision: to maintain our overall health, we need to keep a fit brain and a bright mind. For instance, explains Hakim, it makes no sense to study Parkinson's disease without knowing how to evaluate or treat the brain's cognitive functions. Nor does it make sense to care for depressed people without taking into account their significantly higher chances of suffering a stroke.

"There is an increasing appreciation that our neurological function, our mind and our mental health are really connected, forwards and backwards," he says.

One of the keys to understanding those connections is to increase the interdisciplinarity of the research performed by the more than 100 basic and clinical investigators who currently work in neuroscience at the University of Ottawa. Affiliated with faculties as diverse as medicine, science, social sciences and education, as well as with local hospitals and hospital-based research institutions, these researchers will bring a range of expertise to the new institute. So far, a dozen University-based partners are committed to working together to develop the uOBMRI.

Hakim's dream is to bring these researchers together in a central hub and to link them to partners across Canada and around the world. He would also like to recruit scientists and clinicians specialized in the brain's cognitive functions and build new space to house the Brain and Mind Research Institute. It's an ambitious goal, but Hakim, whose research and public education efforts have been instrumental in making Canada a world leader in the prevention and treatment of stroke, is no stranger to building from the ground up. It's a question of mind over matter. RP

The BRAIN NEVER Forgets

Bullying is not only hurtful, it can leave long-lasting neurological scars

by Dana Yates

Sticks and stones may break bones, as the saying goes, but names will never hurt. Not so, says researcher **Tracy Vaillancourt**. She argues all bullying leaves a lasting mark on victims, including a neurological one.

A professor in the University of Ottawa's Faculty of Education and School of Psychology, Vaillancourt holds the Canada Research Chair in Children's Mental Health and Violence Prevention. Among her many research interests are the biological effects of bullying and victimization.

While some people see bullying as a part of growing up and a way for children to learn how to defend themselves, Vaillancourt has found that it has long-term physical and psychological consequences. In fact, bullying is a traumatic experience that the brain seems to never forget, which is why the professor is collecting evidence to convince government and education officials to develop more stringent anti-bullying policies.

"The physical effects of bullying are hard to ignore, but there are no telltale signs of emotional bullying and social aggression," she says. "The reality is that policy-makers are more likely to make changes if they see visible proof of the brain damage caused by bullying."

According to the *2011 Ontario Student Drug Use and Health Survey*, nearly a third of Ontario students in grades 7 to 12 reported being the victim of bullying while at school. The study, which is conducted on a biennial basis for Toronto's Centre for Addiction and Mental Health, also looked at cyberbullying for the first time last year. It found that one in five students had reportedly experienced online harassment.

Regardless of the type of mistreatment—verbal abuse, threatening text messages, physical punches or public humiliation—Vaillancourt says all bullying leads to social pain. "It's probably the worst stress that you can endure," she explains. "People have a fundamental need to belong and bullying thwarts that need."

But social exclusion doesn't just lead to depression and anxiety. It also increases the amount of cortisol (the "stress hormone") in the body. And, as Vaillancourt has found, when a child's brain is bathed in cortisol, it can lead to memory problems.

What's more, the anguish caused by bullying appears to be built to last. Previous research by other scientists has shown that physical and social pain activates the same region of the brain. This overlap, says Vaillancourt, may explain why children who have been bullied often use physical metaphors to describe their feelings, such as, "it broke my heart" and "I felt like I had been punched in the stomach." The key difference between physical and social pain, however, is that memories of the former are usually forgotten while recollections of the latter endure over time.

Photo: Mélanie Provencher

Researchers have shown that people have strong, visceral responses when discussing past experiences of rejection and humiliation. "Even when a story is just being recounted, the brain reacts as if the event is really happening," explains Vaillancourt. "It's a memory imprint of rejection."

So how do victims interpret the experience of being ostracized? To find out, Vaillancourt is conducting an electroencephalography (EEG) study on 12- to 16-year-old victims of bullying. Her hypothesis: kids become "threat sensitized." They come to believe that people cannot be trusted and look for evidence to confirm this belief. In the end, this negative bias can lead to anxiety and depression and cause victims to expect that everyone, at some point, will hurt and reject them, a perception that can adversely affect future relationships.

But Vaillancourt is convinced it doesn't have to be this way. She wants every Canadian province and territory to adopt a "safe schools" policy. The strategy would include a universal definition of bullying, as well as clear and consistent consequences for bullies. It would also educate teachers on how to handle physical and emotional bullying, and offer children better protection.

"We expect kids to thrive and do well in school, but we put them in environments where they experience mistreatment and can't reach their potential," says Vaillancourt. "Often, they suffer in silence and feel that they have nowhere to go."

She believes, however, that there is hope. If citizens pressure policy-makers to pass laws against bullying, Vaillancourt says the results will be positive: future generations might avoid the devastating effects of peer victimization. RP

"Bullying is probably the worst stress that you can endure. People have a fundamental need to belong and bullying thwarts that need."
– Tracy Vaillancourt

A NEW CASE FOR CANNABIS?

An international study dispels long-held beliefs about the effects of marijuana on memory, opening the door to its use in treating ailments of all kinds

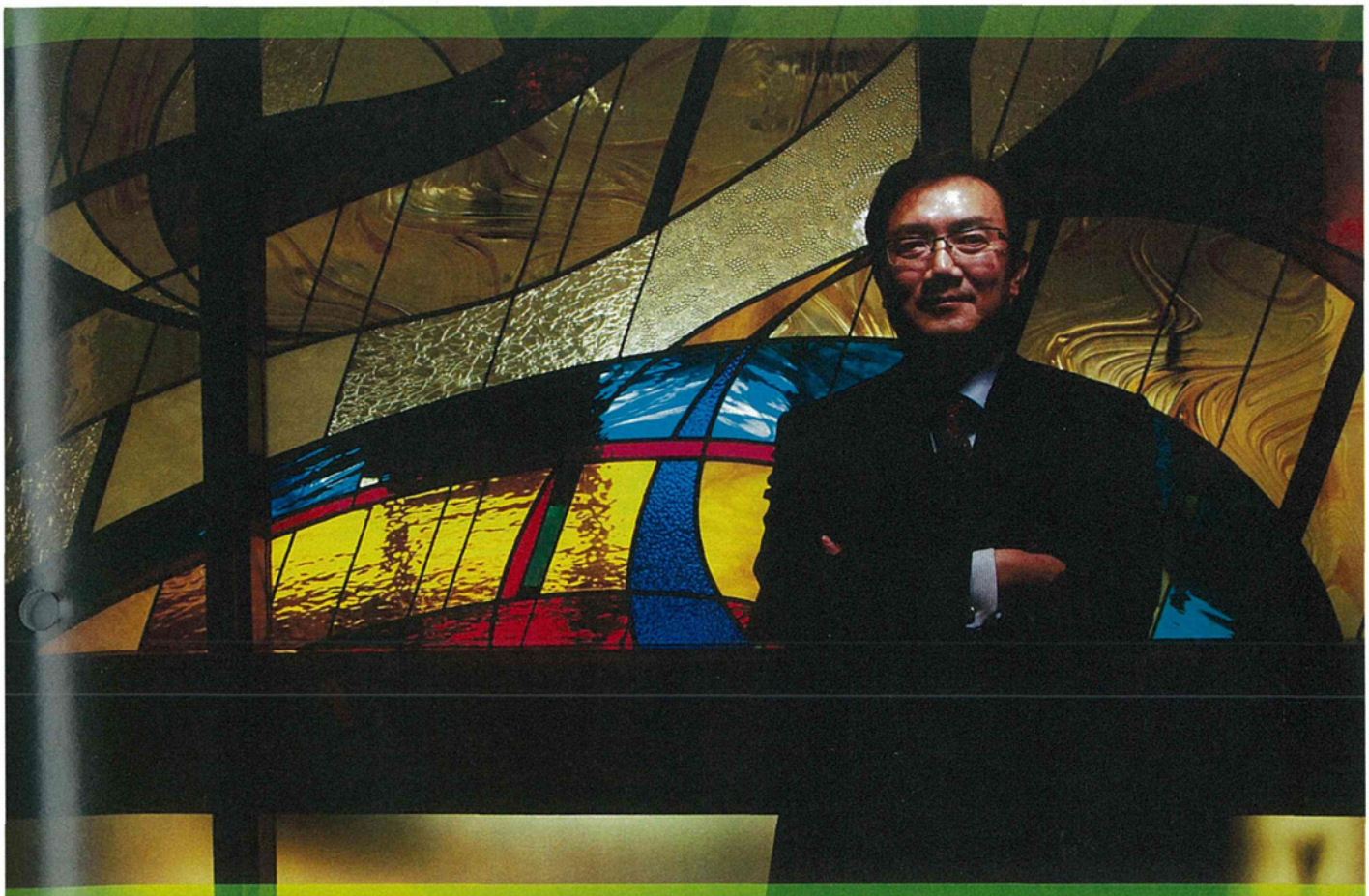
by Nancy Ceresia

The use of cannabis to treat various illnesses has long polarized the medical community, partly because of its undesirable effects on memory. But a major international study led by University of Ottawa researcher **Xia Zhang** throws new light on how memory is affected by marijuana—and may help lay that controversy to rest.

The groundbreaking study, which was published in early 2012 in the scientific journal *Cell*, has created a buzz in the science world that has propelled Zhang, a professor in the departments of Psychiatry and Cellular and Molecular Medicine and the director of the Translational Neuroscience Laboratory at the University of Ottawa Institute of Mental Health Research, to star status. "I have been receiving phone calls from all over the world," says Zhang. "China, France… it has been very busy."

The research shows for the first time that astrocytes, or astroglial cells, the most abundant cell in the human brain, play a pivotal role in regulating memory and controlling neurons. This contradicts the long-held notion among scientists that the starburst-shaped cells act only in a supporting role by protecting and assisting in the function and repair of neurons. Zhang and his team of 17 scientists from North America, Asia and Europe found that neurons do not operate alone in impairing memory under the effects of marijuana. In fact, marijuana's unwanted side effects on memory arise from the drug's action on astroglia.

Zhang has also discovered a link between cannabinoid type-1 CB_1 receptors—receptors that react to marijuana—and working memory. These particular receptors are located in the hippocampus, the area of the brain responsible for higher brain function, while working memory is the brain system that allows you to simultaneously store and process information for complex tasks such as learning and reasoning.



"We should allow pharmaceutical companies to use marijuana in developing new drugs to treat brain and other types of disorders." – Xia Zhang

This is extremely significant because it may be possible to isolate which CB_1 receptors are activated by cannabis and which are not, making it easier to determine which cells and body systems are affected. In treating illnesses such as epilepsy and Alzheimer's, for instance, it might be possible to trigger a response from receptors in the corresponding brain systems governing these conditions, while mitigating unwanted side effects such as memory impairment.

CB_1 receptors react to both cannabinoids (the active chemicals in marijuana) derived from the cannabis plant and endogenous cannabinoids produced naturally by our bodies. Since the human body makes its own endocannabinoids, why would it be necessary to turn to marijuana? Unfortunately, explains Zhang, the regulation and production of endocannabinoids by the human body is still a mystery. The most consistent and effective source of the compounds remains cannabis.

With this study, Zhang has taken brain research to a new frontier, where it is possible to harness the medicinal benefits of cannabis while controlling certain receptors, turning them on and off to elicit specific responses without hurting memory. Ultimately, his discovery has the potential to aid in the treatment of pain, seizures and a whole series of ailments and to expand our knowledge of the human body, from sleep and sexual function to memory and neurological processes.

"I believe our findings can be used in neuroscience research," says Zhang. "People can find out more about the importance of astroglial cells in high brain function such as working memory and thinking."

After the excitement of his breakthrough dies down, Zhang plans to continue working on ways to turn his knowledge on the effects of marijuana on the brain into practical application. "In my opinion," he says, "we should allow pharmaceutical companies to use marijuana in developing new drugs to treat brain and other disorders." While the concept is still contentious, Zhang's research is a major step in building a case for cannabis in medical treatment. RP

IS JUNK FOOD AGING YOUNG BRAINS?

Unhealthy diets increase the chances of developing serious diseases at a much earlier age, find Dale Corbett and Mariana Gomez-Smith

by Sean Rushton

In early 2012, the international press reported widely on a British teenager who was hospitalized after having eaten almost nothing but chicken nuggets for 15 years. But you don't have to restrict yourself to an exclusive, decade-long diet of fast food to find yourself at risk of suffering stroke or death in your early 30s or 40s.

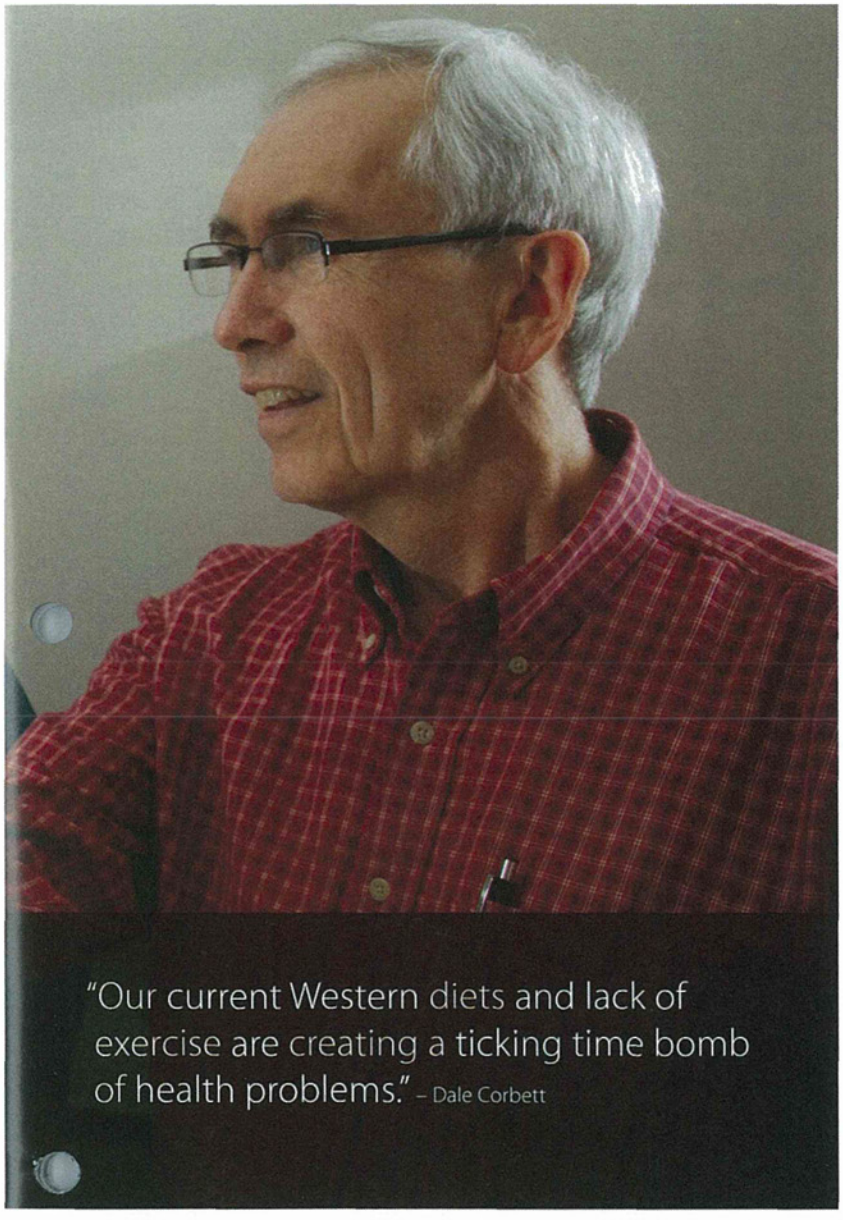
A recent and alarming study by University of Ottawa researcher **Dale Corbett** and doctoral student **Mariana Gomez-Smith** suggests that a typical high-calorie, high-sugar, high-sodium Western diet induces most symptoms of metabolic syndrome—a combination of low levels of good cholesterol, high blood sugar and blood pressure as well as obesity—in animal subjects after only two months.

Fed what was nicknamed the Cafeteria diet or CAF, the rats used in the study were at an age roughly equivalent to 16 to 22 years in humans at the time that many of the symptoms of metabolic syndrome began to manifest.

"I don't think it will be long before we start to see more people in their 30s or 40s having strokes and eventually developing dementia at an earlier age because of common junk food diets and adoption of a sedentary lifestyle," says Corbett, a professor of neurosciences in the Faculty of Medicine and the scientific director of the Heart and Stroke Foundation Centre for Stroke Recovery (CSR).

"Young people eating this way today are going to have major problems much earlier in life," he says.

According to Gomez-Smith, who led the experiment and developed the animal model on which the study is based, two groups of young, newly weaned rats were given a different diet. Both groups were



offered healthy foods, but one of them was allowed access to common cafeteria junk food items, including cookies, sausages and cupcakes. Animals on the junk food diet were also given access to both water and a 30-percent sucrose solution designed to imitate colas and other soft drinks. Like many humans, the rats greatly preferred to eat the treats and drink the sugared water over the healthier foods.

Within two months, the rats on the high-fat, high-sugar, high-salt CAF diet had developed symptoms of metabolic syndrome, including low HDL, or good cholesterol, raised blood sugars and obesity—all factors that increase the risk of stroke and other serious health issues.

"Our current Western diets and lack of exercise are creating a ticking time bomb of health problems," insists Corbett.

One of the most disconcerting consequences of a diet high in junk food is that it may also lead to premature aging of the vasculature of the brain.

"In young healthy people, blood vessels are smooth and straight," explains Corbett. "Yet as people get older, these become twisted and encrusted with plaque, which restricts blood flow and increases the risk of stroke."

"We think a Cafeteria diet of junk food is prematurely doing a similar thing to the brain of much younger people," he says.

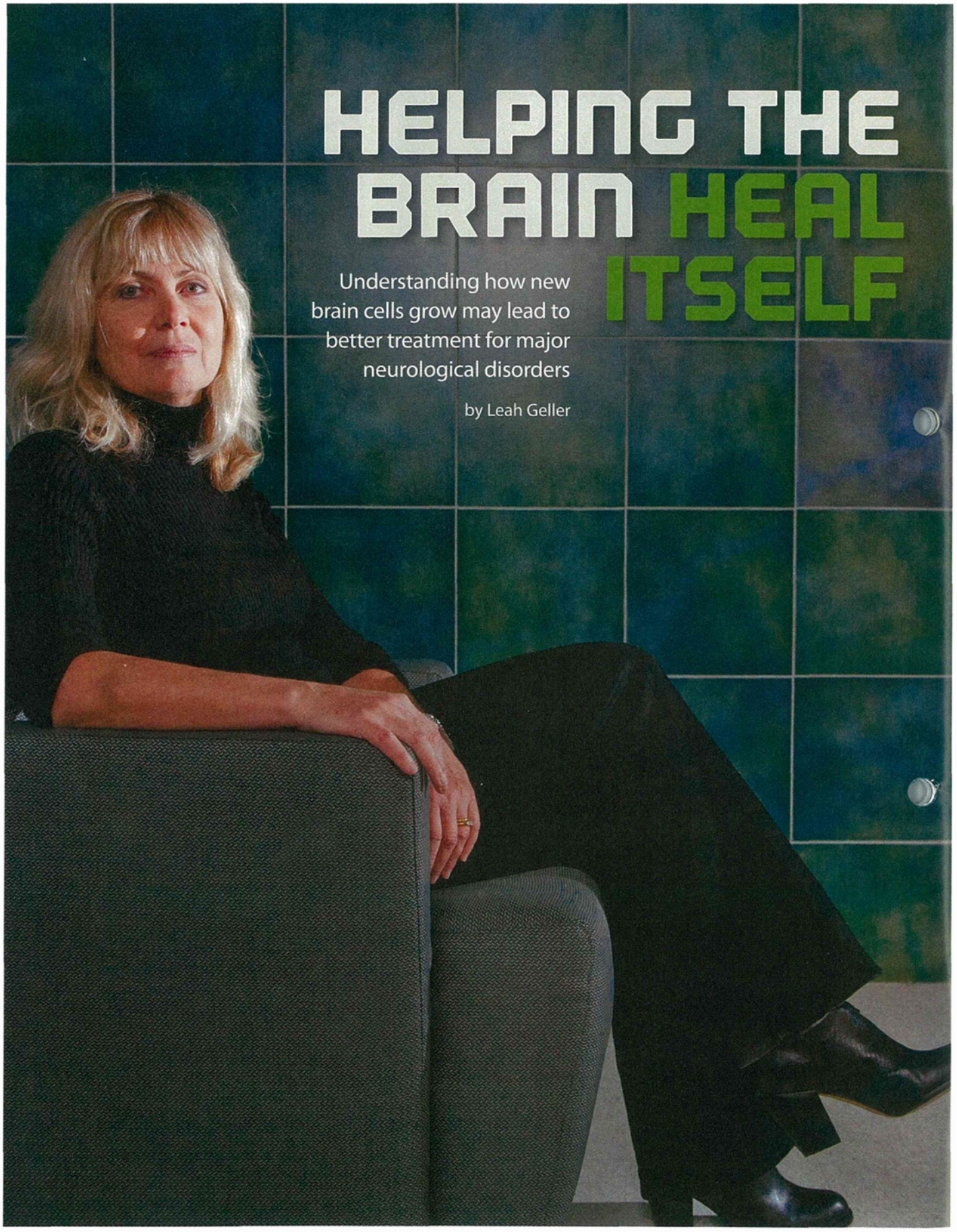
To further investigate their suspicions, Corbett and Gomez-Smith will probe the small blood vessels in the brains of their rats using magnetic resonance imaging (MRI) and two-photon fluorescence microscopy, in collaboration with CSR colleagues at Sunnybrook Hospital in Toronto. The brain imaging will examine, at a very fine level, how the rats' brain vasculature might be changing. By understanding the impact of the Cafeteria diet metabolic syndrome on cerebral vasculature and inflammation in their rats, the researchers will gain a better understanding of its effect on humans, including how much premature brain aging may be taking place in today's population.

Corbett highlights the importance of the rat model that Gomez-Smith developed for characterizing metabolic syndrome in humans.

"What makes Mariana's Cafeteria diet-induced rat model of metabolic syndrome such a good model of the human disorder is that it captures most of the characteristic symptoms of metabolic syndrome where other models capture only one or two at most," says Corbett. "It's not just being obese or hypertensive; it's the combination of several things in the metabolic syndrome that makes it so dangerous."

In addition to helping inform the Canadian public about the health dangers of a poor diet, Corbett and Gomez-Smith hope that their study will inspire other scientists to further research the problem.

"How reversible is the damage caused by junk food?" asks Corbett. "This is one of many questions we just can't answer yet. Hopefully our research will encourage others to help look for the answers." RP



HELPING THE BRAIN HEAL ITSELF

Understanding how new brain cells grow may lead to better treatment for major neurological disorders

by Leah Geller

Your brain is growing. And **Ruth Slack** wants to know how.

For more than a century, scientists believed that no new neurons ever formed in the adult mammalian brain. We were born, it was argued, with all the neurons we would ever get. Then, about 15 years ago, scientists discovered something revolutionary—that your brain *can* generate new neurons throughout your entire adult life in a process called "neurogenesis."

In patients suffering from stroke, Alzheimer's and Parkinson's disease, brain cells are destroyed or damaged. Imagine if you could figure out exactly what it is that signals the brain to create new brain cells—that is, trigger neurogenesis—and then find a way to expand these cells and direct them to damaged areas.

This is what Slack and her team are hoping to do.

"We know that as we get older, neurogenesis slows down," explains Slack, a professor in the Department of Cellular and Molecular Medicine at the University of Ottawa. "We generate fewer and fewer new cells, and this may contribute to memory loss and impaired brain function in the elderly. On the other hand, we also know that things like exercise increase the rate of neurogenesis. So there's obviously several mechanisms, some signals, which are encouraging new cells to form, or at least 'slowing down the slowing down.'"

"In cases like stroke, we see new brain cells migrating to areas where there's damage, but it's just not happening fast enough," adds Slack. "If we can unlock the mechanisms that control neurogenesis, we can probably speed up recovery for stroke victims and improve treatment for diseases like Alzheimer's and Parkinson's."

Adult neurogenesis in humans was first discovered in the late 1990s in the hippocampus, an area of the brain involved in learning and memory. There is also some evidence of new neurons being generated in the cerebral cortex, the part of the brain responsible for thinking, perceiving and understanding language.

All of these new neurons are born not from mature brain cells, but rather from neural stem cells that remain in our brains throughout life. Stem cells are unspecialized cells that have the remarkable ability to develop into virtually any kind of cell type, including specialized brain cells.

"We're looking at the proteins that control stem cells in the brain, and in turn the genes that produce those proteins," says Slack. "The idea is that these proteins not only regulate the rate at which stem cells develop into mature brain cells, but also the rate at which stem cells replenish themselves."

Although her research is cutting edge, Slack has been studying neurogenesis for more than 20 years. As a graduate student, she looked at tumour cell differentiation, the process by which these cells become more specialized—similar to how stem cells develop into specialized cells such as brain cells. For over 15 years, she has also been studying how cell cycle proteins affect the development of the embryonic brain.

Today, she is part of an interdisciplinary team at the Centre for Stroke Recovery, the only centre in the world that focuses purely on stroke recovery. Located at the Ottawa Hospital campus, the Centre is a partnership between the University of Ottawa, the Heart and Stroke Foundation, the Ottawa Hospital Research Institute and three other Canadian research centres.

"You can't really predict how quickly our research will spin into a treatment for stroke, Alzheimer's or Parkinson's," Slack explains. "What I do know is that if we don't work on this, we'll never solve the problem."

"If we can unlock the mechanisms that control neurogenesis, we can probably speed up recovery for stroke victims and improve treatment for diseases like Alzheimer's and Parkinson's." – Ruth Slack

Along with her research into neurogenesis, Slack also acts as the assistant dean of Graduate and Postdoctoral Studies in the Faculty of Medicine and was an associate editor of the *The Journal of Neuroscience*. She also serves on several review panels for research funding agencies and foundations and supervises eight graduate students and several postdoctoral fellows.

Despite her many roles, Slack's number one passion and focus is research. "It's so exciting, seeing new things and discovering the unexpected," she says. "I have students who work into the night because they just can't wait until the next day to see what's going to happen next.

"It's hard work, but it's important work and so motivating. I love the sense that I might be able to make a difference to people's lives in the future." RP