The Brain Issue

BRAIN EXPLORERS

The quest to understand what makes us human

Baycrest researcher Jennifer Ryan: understanding memory through eye-movement monitoring.
How did a weak-jawed, slow-moving, featherweight of a primate climb to the pinnacle of the food chain? How did these slightly-built bipeds turn their most deadly predators into prey? How did this frail species come to dominate desert, jungle and tundra — the harshest climates on the planet?

It’s all thanks to the 1.3 litres of neurons and chemicals that make up the human brain. Human intelligence was an evolutionary shift like no other, allowing us to overpower claws and fangs, withstand freeze and flood, and survive famine and disease.

A human being has a body mass similar to that of an antelope, but our brains are 10 times as large, and they use a fifth of our metabolic energy. We learn, solve problems, create and process information with unmatched speed and flexibility. Even our closest living relatives, bonobos and chimps, don’t come close.

Details are sketchy about the state of affairs three million (or so) years ago when our ancestors’ brains started to change. It appears, though, that the very products of human intelligence that make us so powerful — use of tools, complex social structures and language — were also the exact forces that created the modern brain.

“There’s feedback between technological change and developments in the brain,” says paleoanthropologist David Begun. “As technology develops, it becomes increasingly valuable as a support mechanism. Technology becomes the selective agent, rather than the environment.”

In other words, there was a shift in human evolutionary history after which a superior brain became more important to survival and reproduction than the ability to run, climb or throw a punch. Once natural selection started favoring those who could use a weapon, build a fire, tie a knot or forge an alliance, our evolutionary course was set.

“It wasn’t a punctuated event,” says Begun. “We see over time a gradual increase in brain size, both in absolute terms and relative to body size.”

Somewhere around two million years ago, though, came a turning point: intelligence went from being merely valuable to being essential. The species could no longer survive without technology.

Even as our brains were getting bigger and more complex, our jaws and biceps were receding.

“Once you lose the very powerful chewing apparatus, you are dependent on tools to process food,” Begun says.

The same goes for hunting and gathering, and for defense from predators and the elements. As our brains became more sophisticated, so did our language and culture. We developed spoken and written language, art, systems of government, music, science, philosophy, morality, religion, hobbies, humour and romance. Every new facet the human brain fed back into the evolutionary cycle, making this amazing organ that much more valuable to subsequent generations.

This process continues, and is, in fact, accelerating.

Every technological epoch — from the Stone Age to the Information Age, is superseded more quickly than the last. And at each stage, our brains become more central to survival.

Nobody knows if or when the human brain will reach the peak of its ascension. From ancient weapons to particle accelerators to the brain itself, we are still finding new ways to understand and exploit our world. One thing is certain: the journey isn’t over yet.
The brain in the machine

Geoffrey Hinton is chasing a learning algorithm to make machines think like us by Patchen Banns

It took nature more than two billion years of incremental change to get to the first complex cells to the sophisticated thinking machine that is the human brain. Artificial intelligence researchers have covered much of that same ground in under a century. Digital brains continue to gain on people.

Just in the past year, artificial neural networks took a big leap forward in their ability to recognize objects — one of the basic skills necessary to understand the world.

Today, a person and a computer who are flashed the same image have similar accuracy rates at identifying its content, though the person wins if she can move her eyes to focus on different parts of the image.

Quick object recognition, though, is just a small component of human intelligence. “The thing that is special about people is recursion. We’re good at instant vision and recognition, but we’re excellent at putting these instants together,” says computer science professor Geoffrey Hinton. “The neural-net people haven’t gotten very far with the sequential aspect of it — putting together those rapid glimpses into a coherent whole.”

You look at a tree. You think, “It’s a tree.” Then the interesting part happens: your neurons and signaling pathways subtly shift — feedback messages shoot back and forth, and neural patterns change.

Experiencing that tree alters your overall understanding of the world, better preparing your brain to interpret the next sensory input. This adaptive “learning algorithm” is what allows us to have complex intelligence.

“We’re still trying to match the intelligence of cats and pigeons,” Hinton doesn’t speculate on when computers will make the leap that humans made millions of years ago — a learning algorithm that efficient is still some way off.

In nature, such an algorithm developed through gradual change over thousands of generations. Researchers aren’t limited to such a process — they can look for solutions in places evolution might not have covered much of that same ground in under a century. Digital brains continue to gain on people.

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“Suppose I grow a plant in a flowerpot with a very complicated internal shape. Then I remove the flowerpot, leaving a root system with that same shape. Where did that complexity come from? All you need is an adaptive algorithm in the plant’s DNA that tells it to fill up space,” says Hinton. “It’s similar with the brain: a simple and very powerful learning algorithm creates complicated knowledge structures by adapting to complex structure in the external world.”

In nature, such an algorithm developed through gradual change over thousands of generations. Researchers aren’t limited to such a process — they can look for solutions in places evolution-ary biology couldn’t go. It turns out, though, that nature’s model provides the most promising results.

“Curiously, making an artificial neural network similar to the brain appears to make it work better,” Hinton says. “It doesn’t have to be the case, but for perception, it seems to be.”

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“We’re still trying to match the intelligence of cats and pigeons,” he says.

Mammals and birds, though, only emerged 200 million years ago — they represent the last 10 per cent of the evolutionary arc.

Neural networks and the computers on which they run are still in their infancy. “It is usually someone like Ferdinand Magellan finding his way around the world by way of the oceans, or aboriginal peoples travelling across the former land bridge in the far north into what we now know as North America, or even astronauts flying far into the skies above us,” Hinton says. “We understand exploration well from these perspectives.

The brain, however, doesn’t have the vastness of the continents, or the oceans, or outer space. Still, the brain is very much like undiscovered territory, holding mysteries that have fascinated researchers in myriad fields for years.

You will meet some of the University of Toronto’s leading brain explorers in this special issue. Given the size of our research community — with 5,000 full-time scholars and researchers and the incredible breadth they study — it is always a challenge to represent them all in an issue of Edge.

But this issue on the brain presented a particular challenge. If the brain is what makes us human, then it can be said that every professor at U of T has something intelligent to say about how the brain works, what it is capable of, and how it can be repaired. Indeed, this issue of Edge could literally be hundreds of pages in length.

In the 12 pages that make up this issue, you will still meet an impressive array of brain explorers — educators, neurosurgeons, psychiatrists, psychologists, religion scholars, anthropologists, computer scientists and philosophers who are examining everything from how children learn to why the human brain developed rel-
How do kids learn?

Educator Jan Pelletier says it begins with their natural curiosity by Paul Fraumeni

Jan Pelletier can explain how kids learn by telling a story about cockroaches.

Pelletier is a Canadian leader in the education and early development of children. A former elementary school teacher and school psychologist, she is director of the Dr. Eric Jackman Institute of Child Study (ICS) and a professor at U of T’s Ontario Institute for Studies in Education (OISE).

The ICS has a three-fold mandate — research, teacher-researcher training and operation of a renowned laboratory school for 200 children from nursery school to Grade 6. And it is in this school where ICS researchers, teachers and student teachers aim to improve on traditional models of how children learn.

That’s where the cockroaches come in.

“In our Grade 4 class, the teacher once had Hissing Madagascar Cockroaches in an aquarium,” she says. “She didn’t say to the students, ‘This is what their exoskeleton is like and this is how they eat.’ Instead, she got them to form ‘inquiry groups,’ and let them learn by asking questions. One child wondered if they could teach the cockroaches to negotiate a maze, for example. Later, they tested their theories on a hybrid learning discussion site called KnowledgeForum and they built on each other’s theories. They sent e-mails with their observations to U of T entomologists and analyzed the responses together. This is what we call ‘knowledge building.’ It’s a huge piece of the learning process. Children are naturally curious, so the best way to help them learn is to let that curiosity rise.”

Pelletier points to a core set of other factors:

**Security:** “It’s important for young children to feel safe in their home life, in their social lives and at school,” says Pelletier. “Without a solid feeling of safety and security, they may be less motivated or unable to capitalize on their curiosity. This comes from a long line of research around the need for ‘secure attachment’ between children and parents. It starts when they are babies and they give out signals, anticipating their parent’s response. As the parent or caregiver continues to respond in a sensitive way, an attachment is formed. This process, called ‘serve and return,’ is the basis of the sense of security young children need for later learning.”

**It’s OK to be wrong — especially when you have a great teacher:** “We had one class discussing how leaves change colour on trees. One child said, ‘The clouds get too heavy and dump a lot of rain on the tree and then the leaves have to protect themselves.’ That idea may be wrong — but that’s OK. Some people worry that we’re letting children purposely do the wrong thing. But gradually with a skilled educator, we bring the children to a more logical understanding. Just think how much deeper your learning is when you have discovered it for yourself with the guidance of a great teacher. Because you started it yourself, you remember it better.”

**Motivation and interest:** “There has to be a connection between the parent and the school. Take literacy, for example. Teachers can share their knowledge of helping a child to learn vocabulary and parents can take those tips home. My graduate students and I developed a program around key concepts in literacy. This sharing of learning is often life-changing for children.”

“I know how tough it is for parents to engage in their children’s learning. Parents are busier than ever before and society is more hectic. But, there is more understanding among researchers and the general public that early child development is absolutely critical to our future.”

The eyes have it

Jennifer Ryan monitors eye movements to understand how memory works by Jenny Hall

They say eyes are windows to the soul — turns out they might be windows to the brain, too.

Eye movements, says Jennifer Ryan of U of T and Baycrest, can tell us a lot about how the brain is — or is not — working as we get older.

An associate professor of psychology and psychiatry at U of T and senior scientist and academic director at Baycrest’s Rotman Research Institute, Ryan is interested in how memory works and what parts of the brain are involved.

“I’m interested in understanding memory as a series of relations we put together,” she says. “If a face triggers a name, for example. Or passing a restaurant might make these kinds of relational memories declines. For example, using eye movement monitoring, Ryan has shown that as we age, our ability to make these kinds of relational memories declines.

“If you walked into my office and saw an object that isn’t traditionally in an office — say there was a blender on my desk — your eyes would go to that unexpected object faster than to other items in the room. That’s because of the knowledge and memories you bring to the situation. You know the blender doesn’t belong.”

Ryan came to her interest in memory from an unusual source. “I used to watch soap operas with my grandmother and mom and everyone has amnesia on a soap at one point or another. I thought it was fascinating and wondered if it could happen like that.”

Today, some of her research participants are amnesiacs. The kind of amnesia that Ryan studies comes from a loss of oxygen to the brain, a tumour or an epileptic episode (the soap opera version; it turns out, doesn’t really exist) and they don’t involve a complete loss of memory.

These patients sometimes succeed at tasks they shouldn’t be able to, given which areas of their brains are damaged. Ryan wants to know why — and to figure out if the strategies they use can be transferred to conditions like Alzheimer’s.

Even though the soaps exaggerated the condition, Ryan never lost her curiosity about amnesia and the brain. Today she holds the Canada Research Chair in the Cognitive Neuroscience of Memory. But, she says, it was when she was interviewed by Soap Opera Digest that her family was really impressed.

Jennifer Ryan was the Eye Link: a head-mounted video eye tracker that gives researchers insight into how memory works.
what makes a mother?

Alison Fleming, a behavioural neuroscientist and professor of psychology at the University of Toronto Mississauga, has spent three decades asking this question. She’s carried out dozens of experiments over 30 years, trying to understand what’s on mothers’ minds — literally.

Fleming began her career investigating the psychological changes mother rats undergo as a result of pregnancy hormones. She later became interested in identifying which parts of the brain were involved in the psychological changes she observed.

“In a new rat mother you see a very rapid proliferation of cells in the hippocampus that migrate to various places elsewhere in the brain,” she says. The mother’s dendrites — thread-like extensions of neurons that receive electrochemical stimulation — become more complex when she’s interacting with her babies. “We found through a variety of experiments that a part of the brain called the amygdala is also very important for mothering.” In rats that had never given birth she found that this part of the brain, which mediates emotion, was inhibited. In mothers, hormones worked to remove that inhibition.

Later, she started looking at humans. “I began thinking about how mothering is so complicated. Mothers undergo not just hormonally-regulated changes in mood, but also changes in cognition — how they think, pay attention, remember and plan. We call this executive function.”

Fleming’s main focus today is on the long-term effects of mothering. “How you are mothered yourself influences your neurotransmitters, neurogenesis, emotion and executive function.” It even shapes what kind of mother you will be to your own kids.

Sound like a lot of pressure? No need to worry: Fleming says there is no one right way to mother.

“On the extremes,” she concudes, “there can be bad mothering. Flemming a baby, for example, is definitively bad. But there is huge variation in the way that people interact with babies. If you look cross-culturally, what would be considered optimal mothering in one culture would not be in another. Some cultures, like ours in North America, believe in autonomy and individual development. Other cultures think that interdependence is what matters, so the way women mother is different. For example, they might strap their babies to them. But one way isn’t better than the other.”

Fleming stresses that “biology is not destiny.” Early experiences of being mothered combine with all kinds of inputs ranging from genetic to nutritional to social to shape a person. Scientists are just beginning to untangle these factors.

In fact, “mothering” doesn’t even have to come from a mother: Fleming once gave female rats that had never given birth newborn rat pups to care for. Initially they rejected the pups, sometimes even going so far as to bury them. But after about five days, they started acting like mothers, licking their “babies” and adopting nursing postures even though they didn’t have any milk.

Human studies by Fleming and others have shown the same effect: hormones might “turn on” mothering in rat brains or “prime” it in humans, but sensory input, usually in the form of exposure to a baby over time, can create the same outcome — a compulsion to nurture — in both men and women.

“The brain mechanisms are in place in everyone,” she says. “I don’t believe that the only person who can raise a child is a mother. It’s really about being attuned and sensitive and responsive.”
Deep brain stimulation: how far can it go?

Pioneering neurosurgeon Andres Lozano achieved groundbreaking results using a landmark surgical procedure on Parkinson’s and depression. Now he’s trying it on Alzheimer’s by Mark Witten
“We’re dealing with big problems, devastating diseases where a bold approach is needed.”

In 2003, neurosurgeon Dr. Andres Lozano was performing an experimental procedure designed to supress the appetite of a 53-year-old, 420-pound man with a lifelong history of obesity. When Lozano switched on electrodes surgically implanted in the hypothalamus, a brain area that controls hunger, the patient suddenly remembered a visit to a park with his girlfriend 30 years earlier. As the clock is ticking in patients with Alzheimer’s. We’ve shown in the lab and in a small number of patients that when you inject a drug delivery vehicle directly to the brain of animal models, you can see that new brain cells are formed. Two to three times a day the rats that make more neurenes get better and you have a better memory. If this were to happen, it would be a tremendous breakthrough. But it is still far off, if Ofer Levi of the Institute of Biomaterials and Biomedical Engineering and the Department of Electrical and Computer Engineering has his way. He’s developing a low-cost, portable, optical imaging system to monitor brain dynamics in patients with epilepsy, stroke and other disorders. Current techniques, Levi says, “are large systems such as MR or CT that are of the size of a room. You have to be immobile. You can’t leave a patient in the MRI machine, medical center. It’s too expensive and too dangerous for the patient, and the MRI machine is in the lab in the hospital. It’s built with the sorts of lasers you find in an optical computer mouse and the cameras found in a cell phone.”

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Ofer Levi

PROBING THE BRAIN’S RECOVERY MECHANISMS AFTER TRAUMATIC INJURY

BRAIN imaging: It calls to mind massive MR machines or CT scanners, with a patient immobilized while the machine does its work. But if you could go about as you normally do but carry the equipment around in backpacks. It’s built with the sorts of lasers you find in an optical computer mouse and the cameras found in a cell phone. Once proven, it’s hoped the technique will allow doctors to monitor the brain stem of a severely injured patient over a long period of time—on the order of days, rather than the hour or so allowed by current technology. —Henry Hall

“if patients respond to the treatment within three months, they tend to respond over the long term.”

In a groundbreaking study published in Neuron in 2003, Lozano and neuroscientist Dr. Helen Mayberg (formerly of U of T and now at the University of Toronto’s Women’s Hospital, in the front line as the first neuroscientist to test and show promising results in targeting the brain’s mood circuit for depression and memory circuit for Alzheimer’s. He and others in the field are also exploring the use of DBS to treat for epilepsy, obsessive compulsive disorder, bipolar disorder, chorea, Tourette’s syndrome and severe anorexia. “A large number of neurological and psychiatric disorders are not well addressed despite our best drug therapies. We’re dealing with big problems, devastating diseases where a bold approach is needed,” says Lozano, holder of the Dan Family Chair in Neuroscience at Neurosurgery at U of T and the Munk Research Chair in Functional Neurosurgery at UHN.

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The idea of a higher force — the spirits of aboriginal peoples, the gods of the Romans, or the supreme beings that modern religions worship — is uniquely human. Today, we call this idea “religion.” And it has played a powerful role in human history since our species evolved from apes.

Our other major innovations — such as the use of fire, the invention of the wheel, language, music, literature, cooking, understanding of the scientific forces that govern our existence — have an obvious, tangible purpose.

But why religion?

Marsha Hewitt doesn’t claim to have an answer. In fact, she says, no one definitely knows why humans developed religion. She is, however, fascinated by the cognitive ability — or to put it in more blunt terminology, the brain power — of humans to imagine a force or forces beyond what we can see and touch here on Planet Earth.

“What we call religion is hard to define and there’s a great amount of debate, even confusion, over a definition,” says Hewitt, a professor in the Department for the Study of Religion and in the Faculty of Divinity at Trinity College. “I work with the definition that it involves belief in superhuman or supernatural agencies that impact our life and that we, in turn, can impact through certain kinds of rituals.”

Hewitt is also a practising psychoanalyst, helping patients deal with their lives and life situations and how the unconscious influences behaviour.

“Our brains give us the capacity for symbolic thought. My particular interest is in what are the cognitive and affective mechanisms that enable people to imagine and believe in these counterintuitive beings.”

While she notes that although the reasons humans seemed to need religion are hazy, there is evidence of us reaching out to a spiritual world from our earliest times.

“The first kind of evidence we have is seen in the evidence of burials. What has been found appears to have been ritualistic or carried out at least in an organized way. But what does it mean?”

She points to South African scholar David Lewis Williams, who has explored the meaning behind Paleolithic art on the walls of deep caves, such as the Chauvet caves in France featured in Werner Herzog’s Cave of Forgotten Dreams. “Williams looks at ancient cave paintings and wonders what motivated people to go into the caves. He believes the spiritual focus of the art is neurologically based, the images generated from within their minds. But the people who made that art put themselves at great risk to venture that far underground. They didn’t take this risk just to make pretty pictures. There must have been a ritualistic meaning, the walls of the caves representing a membrane between this world and the spirit world.”

Hewitt’s own research into the motivation for religion is currently focussed on Sigmund Freud, the founder of psychoanalysis. She is working on a book on Freud and religion.

“There’s a lot of misunderstanding about Freud’s critique of religion. Many people feel Freud was just an atheist and had nothing but contempt for religion. That’s really not true.”

She says Freud anticipated attachment theory, which is now considered relevant in evolutionary psychology. “Think of the infant who calls out to the world for survival — ‘Feed me, comfort me, help me to survive.’ That attachment system is an evolutionary endowment that helps in the survival of the species. When we are adults it quiets down, but it may become activated when we experience severe stress. Freud says that in certain people, maybe those who didn’t resolve conflicts of early infancy, the anxiety that is part of living may be so unbearable they have to find external sources of comfort. So he wondered if religion is a product of the human response to feelings of helplessness, vulnerability or terror.”

“Marsha Hewitt explores the roots of religion — and the psychology that drives our need for a spiritual connection by Paul Fraumeni

The BRAIN ISSUE

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CONSCIOUSNESS AND THE SOUL

PHOTO: JOHN HRYNIUK

PHOTO: JOHN HRYNIUK
Who are you? A funny person who loses her temper easily? A hard-working late-bloomer who tends to run late? Or maybe you have a deeper sense of self beneath these kinds of traits.

Evan Thompson wants to know how you know.

As a philosopher of the mind, he grapples with some of the oldest and most enduring questions around: What is the mind? What is the relationship between the mind and the world? Thanks to no small part to advances in brain imaging technology, these timeless questions are being examined anew with insights from such seemingly disparate fields as neuroscience, psychology, and linguistics.

Thompson’s particular interest is the self. “What is the self?” he asks. “What are the different ways we experience being a self?”

One sense of self we have is autobiographical. “We have a sense of our life as a storyline. We project ourselves back into the past through memory and into the future. This sense of self is very much bound up with personality traits we attribute to ourselves: I’m confident, I’m easygoing, I’m anxious.”

Another completely different sense of self is our awareness of being in our bodies in the present moment.

Thompson collaborates with neuroscientists who use the minds of meditators to help illuminate the self. If you or I tried to meditate, we would likely find our minds wandering, typically because our autobiographical sense of self kicks in. We mentally compose our grocery list for later, or replay conversations from earlier in the day. Skilled meditators can turn off this autobiographical sense of self and shift into the embodied sense of self. Switching between these two senses of self while having their brains imaged can show researchers which parts of the brain govern which senses of self.

For his part, Thompson wants to understand our overall sense of self. A book due out in 2013 will explore how sense of self changes across different states of consciousness like daydreaming, being attentive, sleeping, dreaming and different kinds of meditation.

“There’s never been a better time to be a philosopher of the mind,” says Thompson. As a member of the Mind and Life Institute, he works with researchers studying the minds of Tibetan monks as they meditate, and believes that as much as philosophy benefits from advances in neuroscience, it also contributes a great deal in return. In the case of studies of meditation, for example, “Neuroscientists need people who know the philosophical tradition of the meditators and theoretical underpinnings of the practices that come from that tradition.”

In other words, it’s not just about the brain. “Saying that you can understand the mind in terms of the brain is like saying you can understand a Gothic cathedral in terms of the stones that make it up,” he says. “Stories are crucial, but so is architecture, iconographic traditions, the overall environment—that’s what makes it a Gothic cathedral.”

“Our identity as persons isn’t just a matter of the brain.”
CMR’s Jeffrey Meyer: “Ultimately, we’d like to say, ‘Here are four things you should do to avoid depression.’”
Depression is a disorder of many names. Winston Churchill, for example, called his depressive episodes the “black dog.” Others, meanwhile, refer to the condition as the blues or blue Mondays. Despite the term, for depression the reality is the disease can feel like a dark, endless tunnel — one that researcher Jeffrey Meyer hopes to prevent people from entering.

Meyer, an MD/PhD and professor in the University of Toronto’s Department of Psychiatry, and Pharmacology and Toxicology, is head of neuroscience imaging for the Mood and Anxiety Disorders program at the Centre for Addiction and Mental Health (CAMH). Also the Canada Research Chair in Neurochemistry of Major Depressive Disorder, Meyer is focused on answering this question: what is needed to have a healthy brain?

To that end, Meyer wants to create specific recommendations to help people sidestep major depressive disorder. Typically just called depression, the condition is much more than a brief period of melancholy — it involves ongoing feelings of deep despair.

“Ultimately, we would like to say, ‘Here are four things you should do to avoid depression,’” Meyer says. “It would be similar to the strategies for avoiding heart disease, which include eating right and exercising, but in the case of depression, the strategies would be more complicated than simply saying ‘avoid stress.’”

The UTSC program small so as to provide intensive instruction in both research methods and the development of clinical skills, including psychotherapy training and the diagnosis and treatment and assessment. “Toward the end of their graduate training, students will be able to apply their skills in the clinical setting and practice evidence-based psychotherapy,” says Ruocco.

Tulving’s renowned discoveries in how human memory works. The Department of Psychology streams both involve research, the key difference with the clinical psychology program is that it also is focused on the provision of care to those with mental disorders and on identifying the causes of those conditions.

Bagby explains that while experimental and clinical psychology both involve research, exploring primarily the workings of the mind/brain from a multitude of perspectives, and producing notable advances in a number of areas — such as Endel Tulving’s renowned discoveries in human memory work. The Department of Psychology at all these U of T campuses continues to offer outstanding undergraduate and graduate training in experimental psychology but still does not offer a formal training program in clinical psychology.

So what happens in depressed brains? Meyer is focused on monoamine oxidase A (MAO-A), an enzyme that breaks down the chemical messengers serotonin, dopamine and norepinephrine. When the brain is depleted of those mood-related substances, people experience a sad emotional state. And those feelings, along with pessimism, are hallmarks of depression.

Although scientists long believed that a chemical imbalance in the brain caused depression, in 2006 Meyer and his colleague discovered conclusively how that process actually works. Using a brain imaging technique called positron emission tomography, the researchers found that the level of MAO-A was considerably higher in the brains of those with untreated depression. Meyer subsequently made other landmark discoveries. For instance, he found that MAO-A is elevated in several high-risk states for clinical depression, including prior to the woman's recurrence, during early withdrawal from heavy cigarette smoking and just after childbirth.

Meyer says: “Ultimately we would like to say, ‘Here are four things you should do to avoid depression.’” Meyer’s research is focused on answering this question: what is needed to have a healthy brain?

“Ultimately, we would like to say, ‘Here are four things you should do to avoid depression,’” Meyer says. “It would be similar to the strategies for avoiding heart disease, which include eating right and exercising, but in the case of depression, the strategies would be more complicated than simply saying ‘avoid stress.’”

The UTSC program is small so as to provide intensive instruction in both research methods and the development of clinical skills, including psychotherapy training and the diagnosis and treatment. Toward the end of their graduate training, students will be able to apply their skills in the clinical setting and practice evidence-based psychotherapy, which has been the aspiration of many in the field since the early 1990s. Today, Meyer is using that information to study and assist those with high MAO-A. For example, he has developed a natural health product to help regulate the MAO-A of new mothers with postpartum depression. After giving birth, a woman’s estrogen levels drop considerably triggering a surge in MAO-A. Meyer also aims to develop interventions to adjust the MAO-A of people at increased risk of depressive symptoms, including premenopausal women and those with substance addictions.

U of T Psychology enters a new era
UTSC readying to launch graduate training in clinical psychology by Paul Fraumeni

U of T has long been an international leader in psychology research. In 1891 — just a year after a mental health grant Sigmund Freud was beginning to make his mark — the university established North America’s 10th psychology lab, with a full-fledged department founded in 1927.

The UTSC Psychology program in previous decades has been in “experimental” research, exploring primarily the workings of the mind/brain from a multitude of perspectives, and producing notable advances in a number of areas — such as Endel Tulving’s renowned discoveries in how human memory works. The Department of Psychology at all these U of T campuses continues to offer outstanding undergraduate and graduate training in experimental psychology but still does not offer a formal training program in clinical psychology.

Mental Health (CAMH). Also the Canada Research Chair in Neurochemistry of Major Depressive Disorder, Meyer is focused on answering this question: what is needed to have a healthy brain?

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Finally, in the future, on top of designing preventative strategies to help the general population avoid depression, Meyer hopes to bring peace of mind to those with the treatment-resistant form of the disorder. That two-step process will involve identify- ing subtypes of depression and determining which treatments best normalize brain changes in each subtype.

U of T Psychology enters a new era

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Can Jeffrey Meyer ease what Churchill called “the black dog?” by Dana Yates

The image that comes to many people’s minds is of a patient entering a hospital. It’s rewarding in the sense that assessment of mental disorders. Toward the end of their graduate training, students will be able to apply their skills in the clinical setting and practice evidence-based psychotherapy, which has been the aspiration of many in the field since the early 1990s. Today, Meyer is using that information to study and assist those with high MAO-A. For example, he has developed a natural health product to help regulate the MAO-A of new mothers with postpartum depression. After giving birth, a woman’s estrogen levels drop considerably triggering a surge in MAO-A. Meyer also aims to develop interventions to adjust the MAO-A of people at increased risk of depressive symptoms, including premenopausal women and those with substance addictions.

Finally, in the future, on top of designing preventative strategies to help the general population avoid depression, Meyer hopes to bring peace of mind to those with the treatment-resistant form of the disorder. That two-step process will involve identify- ing subtypes of depression and determining which treatments best normalize brain changes in each subtype.

UTSC’s clinical psychology team (from left) Michael Bagby, Amanda Vlasic, Anthony Ruocco, Marc Fournier; Konstantine Zakzanis and a high level of expertise is needed to implement them effectively.” Ruocco notes that the launch of the program is timely given the need for psychologists. “Ortina per capita, has the smallest number of licensed psychologists in Canada. This is an area that people are experiencing significant stress and of those suffering from mental disorders are currently not treated. That’s why it’s so important for U of T to develop this program. U of T is particularly well positioned to embark on such an initia- tive given its size, its large number of schools and its reputation for high-quality education and intensive research training in an area that makes a tangible impact on the health of Canadians. We’re eager to get started on this program.”

Says Ruocco: “It’s an intensive undertaking because you have to be not just an excellent researcher but also an excellent clinician. It’s rewarding in the sense that research is informing your care, with the ultimate goal of alleviating the psychological pain of those suffering with mental disorders.”

Training in psychotherapy, for example, requires significant time and work. “Most people think that a psychologist just closes the door and talks with the patient,” says Bagby. “But scientifically informed psychotherapies are typically highly structured. There are many different types of psychotherapeutic interventions. For example, empirically supported psychotherapies such as interpersonal psychotherapy and cognitive-behav- iour therapy are highly effective in the treatment of major depression.”

Similarly,” says Ruocco, “behavioural therapy, which is also an empirically supported psychotherapy, is highly effective in treating those with borderline personality disorder. All of these evidence-based psychotherapies require significant training, and a high level of expertise is needed to implement them effectively.” Ruocco notes that the launch of the program is timely given the need for psychologists. “Ontario per capita, has the smallest number of licensed psychologists in Canada. This is an area that people are experiencing significant stress and of those suffering from mental disorders are currently not treated. That’s why it’s so important for U of T to develop this program. U of T is particularly well positioned to embark on such an initia-
Donald Stuss is a professor of psychology and medicine at the University of Toronto, where he holds the title University Professor — the highest honour U of T bestows on its faculty — and a senior scientist at Baycrest’s Rotman Research Institute. A pioneer in the study of the frontal lobe, he’s recently taken the helm of the newly-formed Ontario Brain Institute (OBI), where he serves as president and scientific director. Here, he’s tasked with coordinating and accelerating brain discovery and innovation in Ontario, which is home to more brain scientists than any other jurisdiction in Canada.

Why is research into the brain important?

The brain is everything. It’s important for two major reasons. First, if you want to optimize people’s quality of life, it will come primarily through the quality of their brain function. That’s true whether they’re healthy or have disorders. Second, there is no greater cost to society, both direct and indirect, than the cost that’s incurred by brain disorders.

Why is the creation of the OBI important?

The OBI is integrating basic research into care, and patient advocacy groups into research, so research discovery will have much more rapid impact on patients. OBI will bring industry to the table to accelerate cures and discovery. And because it works across institutions, it will maximize the impact of research. I’ll give you an example. Say researchers are going to look at the genetics of Alzheimer’s disease. They used to study a group of 100 or 200 patients. Now researchers are publishing studies looking at 8,000. If Ontario wants to be a leader, it has to increase the number of patients in its studies. OBI can help with that by having researchers and clinicians work together.

What are your goals?

In this initial stage of development of OBI, we are starting with three diseases: cerebral palsy, epilepsy and neurodevelopmental disorders. That last one is a category that includes autism, attention deficit disorder, obsessive compulsive disorder and intellectual disability. It will be important to extend these programs to other brain disorders, both neurological and psychiatric.

The idea is that a disease is not just a single thing. What is the relationship between autism and attention deficit disorder, for example? There are relationships between them — some are behavioural, some are genetic. We are setting up the system so we can actually start to look at the relationships across diseases. This system will also enable us to study how the underlying mechanisms influence the initiation and progression of disease.

The integrative nature of the data is key. The comprehensiveness of our data will provide the power to understand these relationships. And it may be that a cure or a treatment will be found for five per cent of the population, but you would never find it without having tested the entire population to find that five per cent.

So is the goal a cure for some percentage of the population?

Goal number one is treatment — improving the quality of life for individuals and families. But if you set up the discovery system properly so you’re studying the mechanisms of disease, you can potentially also look for something that stops the development of the disease — or significantly slows its progression. The OBI is getting people to work together across the province, across disciplines, across institutions. We’re combining data. We’ll be able to ask things in the future that we don’t know to ask now. Because we’ve set the data up properly, we’ll actually be able to go back to it in the future. And as our understanding of diseases unfolds, people will be able to ask more and better questions.

How much do we understand about the brain right now?

A lot more than we did a long time ago. But do we know enough? No. We need to know a lot more about the brain itself — and then apply that knowledge to more fully understand brain disorders.