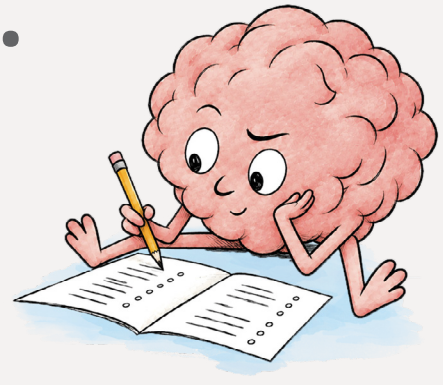
Brain Canada Foundation

THE GREAT CANADIAN BRAIN QUIZ.

IT'S FUN, FAST, AND THERE'S NO PASS OR FAIL, ONLY HOPE.



WE'RE BRAIN CANADA.

AND WE ASKED 36 RESEARCHERS CHALLENGING ASSUMPTIONS ABOUT THE BRAIN TO CHALLENGE YOURS.

True or False: Brain diseases represent the greatest health burden in Canada.

It's true. And if you're surprised, consider this: there are more than 1,000 brain diseases and disorders, including Alzheimer's, brain injury, stroke, brain cancer, mental illness, addiction and more.

That's why Brain Canada, with support from our generous donors, funds the 36 Canadian researchers (and more) you'll meet here, to rethink assumptions and misconceptions about the brain so that bold new breakthroughs can emerge. However, we need a lot more Canadians to care about the brain, so that it gets the attention it deserves.

Welcome to **The Great Canadian Brain Quiz!** It's your chance to go brain-to-brain against some of the sharpest in the country. No pressure!

1

Level One

26 TRUE OR FALSE QUESTIONS FROM 26 TRUE EMERGING LEADERS.

We're starting your Quiz in the same place that research often starts: is what we know, or think... true?

We asked these **Future Leaders in Canadian Brain Research** to share the bold ideas they're investigating right now. Your challenge: decide what's true and what's false.

That's when the real brain gain begins. You'll discover if your guess or assumption was right, but even better, you'll learn how challenging assumptions and misconceptions—and often overturning them – may uncover completely new ways to think about and improve brain health, disease, diagnosis, treatment and recovery.

1 True ☐ False ☐

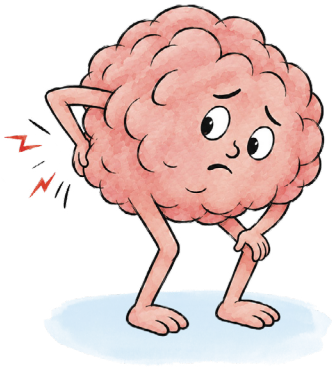
Microglia are harmful immune cells that only drive inflammation after spinal cord injury.

Faith Brennan / Queen's University

2 True ☐ False ☐

The brain changes observed in people living with anorexia nervosa can all be explained by starvation.

Édith Breton / Université du Québec à Chicoutimi



1 **False.** Microglia are the resident immune cells of the brain and spinal cord, but they do much more than promote inflammation. After spinal cord injury, they help clear damaged cells and myelin, the protective insulation surrounding nerve fibres. Our research investigates how microglia process this injury-related debris and how these functions influence tissue damage and recovery after spinal cord injury.

2 **False.** Although malnutrition has various physiological impacts, including on the brain, some brain differences appear to precede the illness and may persist even after weight has been restored in people with anorexia nervosa. My Brain Canada project will explore the genetic and environmental factors that may contribute to these brain changes during adolescence.

3 True ☐ False ☐

Overcoming addiction is simply a matter of willpower.

Benjamin Davidson / University of Toronto, Sunnybrook Health Sciences Centre

4 True ☐ False ☐

The nervous system processes pain differently based on sex.

Annemarie Dedek / University of Waterloo, School of Pharmacy

5 True ☐ False ☐

RNA is only a passive messenger of genetic information with limited influence on how the brain works.

Mathieu Flamand / CRCHU de Québec, Université Laval

3

False.
Addiction was previously associated with stigma, related to the misconception that those who develop addictions lack the willpower to resist. On the contrary, in people with substance addictions, very specific, strong signals arise deep in the brain — in the nucleus accumbens — and these can be used to decode moments of craving. Even more exciting, with deep brain stimulation implants, it is possible to selectively disrupt these signals, and treat addictions.

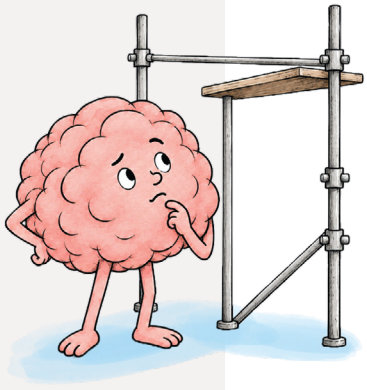
4

True.
We all experience pain, but that doesn't mean the underlying biology is the same for everyone. Much of what we know about pain comes from research that historically relied on male or unsexed animals, leaving major gaps in our understanding of pain biology in females. My research investigates sex differences in the spinal cord circuits that process pain signals, helping build a more complete picture of chronic pain.

5

False.
RNA does much more than carry instructions from DNA. In the brain, RNA helps control which proteins are made, when they are made, and where they are made, including at synapses, the communication points between neurons. Chemical modifications of RNA and RNA-binding proteins fine-tune these processes. Our research investigates how disruption in these processes may damage synapses and contribute to neurodegenerative diseases.

The best global minds choose the best new Canadian ones: all Future Leaders were selected through peer review by established neuroscientists with diverse expertise, and chosen for the notable promise of their work.



6 True ☐ False ☐

A baby's sucking pattern can help detect a brain injury.

Sandra Fucile / Queen's University

7 True ☐ False ☐

Neurons need other cells to protect them from damage.

Samira Ghorbani / University of Toronto

8 True ☐ False ☐

The brain's "scaffolding" simply holds neurons in place.

Antoine Godin / Centre de recherche CERVO, Université Laval

6

True.
The brain controls how babies suck, so changes in sucking patterns may provide important clues about how the brain is functioning. My research is exploring whether a baby's sucking pattern could help identify brain injuries earlier, creating opportunities for earlier intervention and better outcomes for babies born prematurely.

7

False.
We often think of neurons as vulnerable cells that depend entirely on other brain cells for protection. In fact, neurons have their own built-in neuroprotective mechanisms that help them cope with stress and damage. Our research is investigating one of these protective mechanisms and how it changes with aging and progressive multiple sclerosis.

8

False.
The extracellular matrix surrounding brain cells is often thought of mainly as structural support. But the extracellular matrix may do far more than simply provide support. Its electrical charges may shape the local balance of ions around neurons, influencing how brain cells communicate and regulate their activity. We are investigating whether disruption of this ionic regulation weakens inhibition and contributes to atypical brain activity in conditions such as ALS.

9 True ☐ False ☐

fMRI is a neuroimaging tool that measures brain activity using brain blood flow.

Ali Golestani / University of Calgary

10 True ☐ False ☐

Sound can be used to deliver medicine to the brain.

Brandon Helfield / Concordia University

11 True ☐ False ☐

Neurons don't have to die to contribute to dementia.

Sahara Khademullah / Centre de recherche CERVO, Université Laval

9

True.
fMRI is often thought of as a direct window into brain activity, but its signal depends on changes in blood flow and oxygenation. When blood vessels do not respond normally, as can happen with brain tumours or after radiotherapy, fMRI may be misleading. My research combines fMRI with cerebrovascular reactivity to distinguish vascular effects from genuine changes in brain function.

10

True.
Acoustic waves can be tightly focused through the skull and onto regions of the brain to exhibit a targeted bioeffect within brain tissue. My research is exploring how we can use sound waves to modify gene expression and alter immune cell behaviour, essentially enhancing the body's natural defences to better treat brain cancer.

11

True.
Neurons are often considered "lost" when thinking about neurodegenerative disease, but they can become dysfunctional well before they die. Our research focuses on how impaired inhibitory circuits in the brain disrupt neuronal activity in frontotemporal dementia. Understanding this early dysfunction may help explain how symptoms develop and could reveal opportunities to restore neuronal function before cells reach the point of irreversible damage.

12 True ☐ False ☐

Transplanted stem cells automatically reconnect damaged brain circuits after a traumatic brain injury.

Mohamad Khazaei / University of Toronto

13 True ☐ False ☐

Stress is always detrimental to our health.

Leah Mayo / University of Calgary

14 True ☐ False ☐

Humans are the only animals whose brains can feel the beat of music.

Jonathan Michaels / York University

12

False.
Stem cells can survive in the injured brain and become neurons, but most transplanted neurons do not connect with the right partners. Our research is identifying the molecular "connectivity codes" that guide neurons to form precise long-distance connections, particularly those needed for movement. By understanding these codes, we aim to lay the foundation for next-generation stem cell therapies that can rebuild damaged brain circuits more reliably after traumatic brain injury.

13

False.
Stress gets a bad rap, but acute stress is critical for attributing salience to events we experience, can drive neuroplasticity, and promotes memory formation. Many positive experiences (e.g., exercise) activate the same physiological responses as stress. However, context, duration, and intensity matter! My research will explore how activating our stress system through positive AND negative experiences can impact later behaviour.

14

False.
Scientists long believed feeling a beat required the brain of a vocal learner – a human or, at best, a talking bird like Snowball, the dancing cockatoo. But recent evidence has shown otherwise: Ronan the sea lion can keep a beat as precisely as a human, and monkeys and rats can move in time with sound. My research follows the brain as it learns to predict rhythm, revealing how motivation transforms what we hear into how we move.

Building on more than $11 million in anchor funding from the Azrieli Foundation since 2019, the donors supporting the Future Leaders program have funded 157 projects that have garnered international awards and recognition—and five groundbreaking patents.

15 True ☐ False ☐

Two brain tumours that share the same genetic mutation are always the same disease.

Ana Nikolic / University of Calgary

16 True ☐ False ☐

After a century of neuroscience research, we know what most white matter connections between brain regions actually do.

Sami Obaid / Université de Montréal

17 True ☐ False ☐

Migraine attacks are just headaches.

Serena Orr / University of Calgary

15

False.
Many brain tumours in younger adults have mutations in the IDH gene, which is found in two different kinds of tumours with very different outcomes (oligodendroglioma and astrocytoma). While mutations in the genetic code can predict a tumour's behaviour, the way its genes are packaged also affects growth. My lab is examining changes in gene packaging in oligodendroglioma to find clues to why these patients live longer. This work could provide important clues for how we can better treat more aggressive IDH mutant tumours.

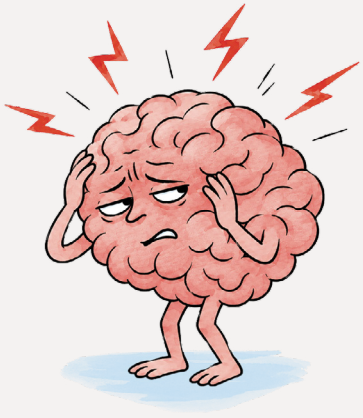
16

False.
Despite decades of brain research, we still know little about white matter: the physical wiring connecting brain regions. My research uses the electrodes already implanted in the brains of people with epilepsy to directly stimulate these connections, revealing their roles in movement, language and thinking. Combined with advanced imaging, these discoveries will lead to a detailed map linking white matter connections to their functions, helping us better understand the brain's wiring and giving neurosurgeons a roadmap to navigate it more safely.

17

False.
During migraine attacks, changes occur in the brain before the headache starts. These changes cause early (prodromal) migraine symptoms, which may include light sensitivity, nausea, and fatigue, among others. 90% of children and adolescents with migraine report prodromal symptoms. In our pilot study, we will test whether treatment with a remote electrical neuromodulation device, which emits weak electrical signals into the body during prodromal symptoms, can prevent the headache phase of migraine attacks.

Revolutionary in its courage, the Future Leaders program doesn't just fund high-risk, high-reward discoveries: it builds the next generation of great researchers in Canada.



18 True ☐ False ☐

Your neurons communicate using genes left behind by ancient viruses.

Thomas Parmentier / Université de Montréal

19 True ☐ False ☐

The brain can no longer adapt and change in old age.

Ke Peng / University of Manitoba

20 True ☐ False ☐

Memories are stable snapshots of events in time.

Zachary Pennington / Djavad Mowafaghian Centre for Brain Health, University of British Columbia

18 **True.**
About 8% of our genome is made of the remnants of ancient viral infections called endogenous retrovirus, relics long dismissed as junk. Yet some of these viral remnants have been repurposed into essential genes that can shuttle molecules called vesicles between brain cells. My research asks whether endogenous retroviruses are also packaged into vesicles and traded between brain cells, revealing a hidden layer of neural communication, and clues to diseases like ALS and multiple sclerosis.

19 **False.**
A common misconception is that the aging brain loses its ability to adapt. While aging can reduce some aspects of brain function, the brain retains an important capacity for change throughout life. Scientists call this neuroplasticity. Our research investigates whether non-invasive electrical stimulation can enhance or reveal these adaptive responses in healthy older adults and people with mild cognitive impairment, helping us better understand brain resilience during aging.

20 **False.**
Memories are incredibly dynamic. Not only do we recollect past events differently with the passage of time—our memories are updated as the result of new experiences—but the very way that memories are stored in the brain changes across time. My research seeks to answer how memories are maintained at all when everything about them seems to be dynamic.

21 True ☐ False ☐

Acting out dreams violently—punching, kicking, shouting—may predict Parkinson's disease or dementia years before other symptoms appear.

Shady Rahayel / Université de Montréal

22 True ☐ False ☐

Maternal sleep disturbances experienced during pregnancy have no impact on offspring sleep patterns.

Jessica Rosin / University of British Columbia

23 True ☐ False ☐

A giraffe only needs two hours of sleep per day.

Maxwell Shafer / University of Toronto

21

True.
During dream sleep, our muscles are normally "switched off," preventing us from acting out our dreams. In some people, this protective mechanism is lost, leading to abnormal movements during sleep. This condition, called REM sleep behaviour disorder, can sometimes appear many years before Parkinson's disease or certain forms of dementia, making it an important early warning sign. My lab aims to characterize the brain changes associated with the sleep disorder to understand the mechanisms that explain why someone develops Parkinson's disease or a related dementia.

22

False.
Brain changes associated with sleep disruptions can occur as the fetus develops in utero during pregnancy. My research is exploring the underlying changes in brain development in the fetus and whether these changes persist in the brain later in life when sleep disturbances arise. These findings will help highlight pregnancy as a critically important period for establishing sleep circuits and lifelong sleep health.

23

True.
Giraffes sleep as little as two hours a day, while fruit bats need more than twenty. My lab studies the sleeping habits, brains, and genomes of different animals to identify the genes and neuronal circuits that control "extreme" sleep physiologies. The goal: to better understand the limits of our own physiology and how those same genes and circuits may be connected to brain dysfunction and disease in humans.

24 True ☐ False ☐

We can help symptoms of addiction by changing the activity of the brain.

Victor Tang / CAMH

25 True ☐ False ☐

Chronic pain may be associated with a higher risk of stroke.

Pascal Tétreault / Université de Sherbrooke

26 True ☐ False ☐

Getting older is bad for your brain.

Alex Wiesman / Simon Fraser University

24

True.
Although a stigmatizing view of addiction often portrays it as a problem of willpower, we now know it is associated with measurable changes in brain structure and function. Effective medications and psychological therapies can help people recover by changing brain activity. My research combines brain recording with direct-to-brain interventions, known as neuromodulation, to influence neural activity. By measuring brain activity and its response to stimulation, we can better understand and target the neural circuits involved in addiction.

25

True.
It may seem surprising that persistent pain could be related to stroke risk, but large population studies have found an association even after accounting for traditional cardiovascular risk factors. Why this happens remains unclear. Our Brain Canada-funded research will examine whether people with chronic low back pain show subtle changes in their brain arteries, and whether inflammation and changes in how the nervous system automatically controls the heart and blood vessels could help explain this connection.

26

False.
Aging affects how your brain processes information, but it's not all bad! My research focuses on brain changes that help people to stay healthy and be resilient against age-related diseases like Alzheimer's and Parkinson's.

Many heads are better than one—so convening and connecting a wide range of partners is a pillar of our approach, advancing understanding, diagnosis and treatment of brain conditions through collaboration.

2

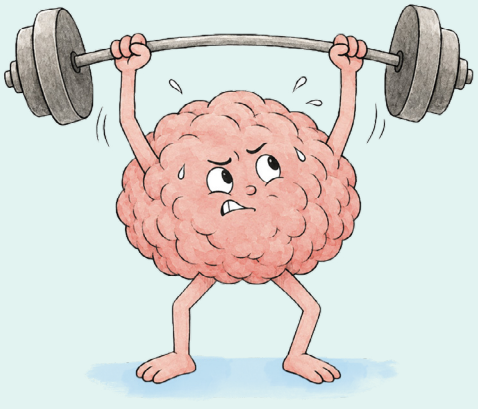
Level Two

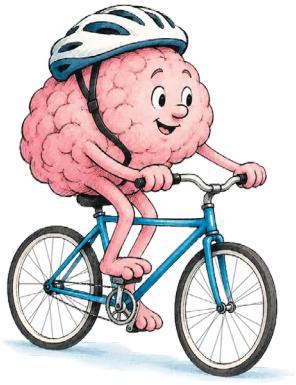
GOT MOMENTUM? YOU'LL NEED IT.

By this point in the Quiz, your thinking should have flow, focus and momentum. Now imagine an early-stage researcher being in the same place: poised for transformative discovery, but lacking the funding to get there.

Brain Canada's **Momentum Grants** provide critical next-stage funding, keeping researchers' momentum accelerating so they can build on the outcomes that our earlier funding enabled. But as Brain Canada President and CEO Dr. Viviane Poupon points out, this isn't simply extending projects. "When we invest in scientists who have already demonstrated the courage to ask difficult questions, we are investing in the answers that will one day change lives."

Try to spot those big answers here, with questions shared by this year's ten Momentum Grants program awardees. They're next-level challenging: multiple choice. Stretch!





27

Anxiety disorders are diagnosed about twice as often in women as in men. Which of the following may help explain this difference?

Bénédicte Amilhon / Université de Montréal

A. Women have more serotonin-producing brain cells than men

B. A specific serotonin-related brain circuit may be naturally more active in females

C. Women's brains use less serotonin overall

27

The correct answer is: **B**

Recent research suggests that a serotonin-producing brain circuit linked to anxiety is more excitable in females, which may contribute to sex differences in anxiety and stress responses. Understanding these mechanisms could lead to more effective treatments tailored to women and men.

28

When learning a new physical skill, such as playing tennis or cycling, what happens in the brain's motor cortex?

Simon Chen / University of Ottawa

A. Brain circuits reorganize themselves to support the new movement

B. New brain regions are created specifically for that skill

C. Existing movement circuits become permanently fixed

29

Which common mineral may play a much bigger role in protecting memory during Alzheimer's disease than most people realize?

Jonathan Epp / University of Calgary

A. Magnesium

B. Iodine

C. Phosphorus

30

Which of the following can influence how the brain's immune cells behave?

Nader Ghasemlou / University Health Network, University of Toronto

A. Time of day, but not biological sex

B. Biological sex, but not time of day

C. Both time of day and biological sex

The programs profiled in this Quiz are just two ways that Brain Canada, a national registered charity, is unlocking the brain and uniting countless partners, under the mission of accelerating, amplifying, and funding brain research across Canada.

28

The correct answer is: **A**
Learning a new movement involves plasticity, the brain's ability to reorganize its neural circuits. Our research is exploring how specific groups of neurons support this process, knowledge that could eventually improve recovery after stroke or brain injury.

29

The correct answer is: **A**
Our research found early signs that vulnerable brain cells in Alzheimer's disease struggle to manage magnesium, a mineral essential for energy production. Restoring healthy magnesium levels could help protect brain function and slow cognitive decline.

30

The correct answer is: **C**
We now know that immune cells are important contributors to diseases from multiple sclerosis to chronic pain to Alzheimer's disease. Research funded by Brain Canada has found that microglia, the brain's resident immune cells, not only change their activity across the day but that these daily rhythms differ between males and females. Our research is exploring how these two factors interact and what that could mean for diseases of the brain and spinal cord.

31

What happens to your brain when you have a lapse in attention and your mind begins to wander?

George Ibrahim / The Hospital for Sick Children (SickKids)

A. The brain briefly "switches off"

B. The brain remains active, but other brain networks compete with those keeping you focused

C. The brain stays largely the same but you become less conscious of what's around you

32

When an fMRI scan shows increased activity in part of the brain, what is it actually detecting?

Ravi Rungta / Université de Montréal

A. Electrical signals from neurons directly

B. Changes in local blood flow

C. The brain's temperature

33

The brain contains fluid-filled spaces called ventricles. How do the ependymal cells lining these spaces help keep cerebrospinal fluid moving?

Jo Anne Stratton / McGill University, The Neuro (Montreal Neurological Institute-Hospital)

A. They use thousands of tiny, coordinated hair-like structures called cilia

B. They rhythmically contract like heart muscle cells

C. They generate electrical impulses like neurons

The brain is the most important organ in our body. It is how we understand, yet it is the least understood. And it's the only one that can't be transplanted.

31

The correct answer is: **B**
A wandering mind isn't an inactive brain. When attention lapses, brain networks involved in internally directed thoughts can compete with those keeping us focused on the outside world. Our research explores how the brain controls this competition and why that battle for our attention may be especially difficult in conditions such as ADHD.

32

The correct answer is: **B**
Most fMRI scans detect changes in blood oxygenation associated with increased blood flow when brain cells become active. Our research is investigating how specialized inhibitory neurons help control these blood-flow changes, which could improve how scientists interpret brain imaging results.

33

The correct answer is: **A**
Ependymal cells are covered in motile cilia that beat together to help move cerebrospinal fluid through the brain. Our research investigates how inflammation and antibodies in multiple sclerosis may disrupt these cells and their cilia, potentially contributing to damage near the ventricles contributing to behavioural changes.

34

Why might a medicine used to treat migraines one day help fight cancer?

Sébastien Talbot / Queen's University

A. It could help cancer drugs cross from the bloodstream into the brain

B. It could block nerve signals that help tumours escape immune attack

C. It could cut off the blood supply that feeds growing tumours

35

Brain imaging has advanced rapidly in recent years—but which of these can scientists actually investigate in a living human brain today?

Sara Tremblay / The Royal and Université du Québec en Outaouais

A. How many memories a person has stored

B. The density of connections between brain cells

C. The exact thoughts produced by different brain regions

36

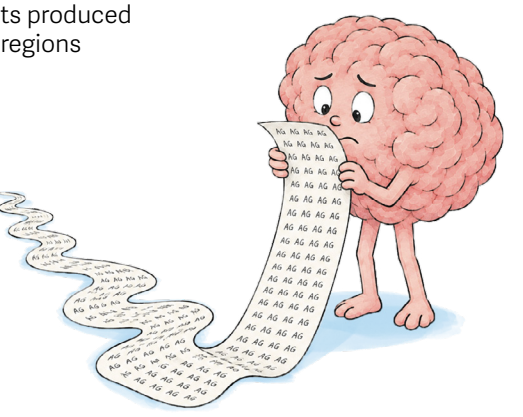
What can happen when a short sequence of DNA letters gets repeated too many times?

Ryan Yuen / The Hospital for Sick Children (SickKids)

A. Nothing, because it is junk

B. It can sometimes cause a genetic disorder

C. It only changes harmless traits, like eye or hair colour



34

The correct answer is: **B**
Our research showed that tumours can exploit a chemical messenger released by pain-sensing nerves to weaken cancer-fighting immune cells. Some migraine medicines block this same messenger, called CGRP, raising the possibility of repurposing them to improve cancer immunotherapy.

35

The correct answer is: **B**
Specialized positron emission tomography (PET) scans can estimate synaptic density, providing a window into the connections through which brain cells communicate. Our research uses this approach to examine whether an accelerated one-week course of magnetic brain stimulation for depression produces measurable changes in these connections.

36

The correct answer is: **B**
Some repetitive stretches of DNA were once dismissed as "junk," but we now know that certain repeats can have important effects on how our cells work. When these sequences become unusually long, known as "repeat expansions," they can contribute to neurological and developmental disorders, which is what our research is helping to understand.

FINAL QUESTION: WHAT ORGAN MAKES ALL THIS POSSIBLE?

THE GREAT CANADIAN HEART.

This is how impact happens: researchers do collaborative brain research, advancing knowledge; knowledge informs development of solutions for brain conditions; health outcomes improve for Canadians.

And big-hearted donors get behind it all. From the Azrieli Foundation's historic Future Leaders anchor gift, to the many foundations and families whose generosity never fails, to the deeply caring organizations you see below. And of course, to Canadians like you nationwide: running fundraisers, rallying workplaces, giving personal or legacy gifts.

Best of all, each dollar spawns more. For example, every $1 of Future Leaders seed money attracts almost eight times more additional funding.

Today, while we challenged your brain, we also hope that we stirred your heart, and that they've both been changed by what you learned. So that our bold researchers can learn even more, for all of us.

Our hearts are touched by the commitment of these generous donors. Thank you.

Fondation Azrieli Foundation

Heart&Stroke

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ALVIN SEGAL FAMILY FOUNDATION

Allan Kliger, Aviva Rajsky & Friends

THE ERIKA LEGACY FOUNDATION

CRABTREE FOUNDATION

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

Lotte & John Hecht Memorial Foundation

Florence Minz

GJ Garden of Life Foundation

AUNE FOUNDATION

The Catherine and Maxwell MEIGHEN FOUNDATION

Health Canada Santé Canada

Anonymous

As populations age, as technology awakens, as research intensifies, this is the brain's big era and you're invited. Subscribe to Brain News, follow our social media, learn more and donate at **braincanada.ca**

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