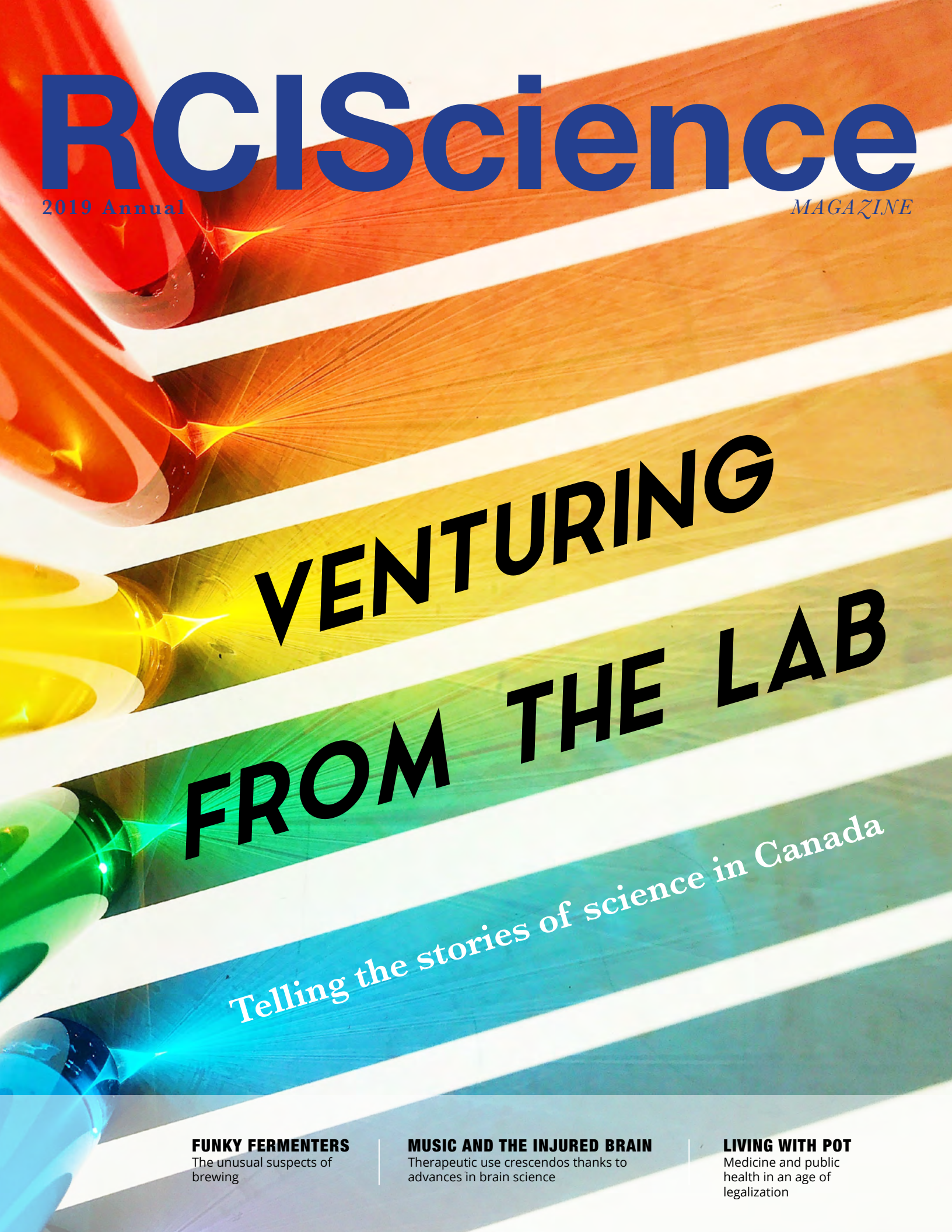

RCIScience

2019 Annual

MAGAZINE

VENTURING FROM THE LAB

Telling the stories of science in Canada

FUNKY FERMENTERS
The unusual suspects of brewing

MUSIC AND THE INJURED BRAIN
Therapeutic use crescendos thanks to advances in brain science

LIVING WITH POT
Medicine and public health in an age of legalization

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RCIScience
Royal Canadian Institute for Science

COVER PHOTO: Joyce McCown
RCIScience is reaching new audiences with innovative programs that tell the stories of science in Canada. We are active in new locations and look forward to expanding more in the coming years.

We would like to thank the following individuals and organizations who have supported RCIScience over the past 5 years.

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2019 Annual

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MESSAGE FROM THE CHAIR

I hope you enjoy this 2nd issue of RCIScience Magazine, the result of our growing community of volunteers, including students interested in science communication.

The mission of RCIScience is to bring science to the public. The past year has been one of dramatic growth and expansion. Our Sunday events at the University of Toronto attracted audiences that increased in both size and diversity. Using a panel format, we presented different points of view on topics of keen interest to the public, examining everything from astronauts to zoos. A personal highlight was the stirring vocal performance during *How Music Helps Heal the Injured Brain*. Our signature event, *Venturing from the Lab*, presented in partnership with ventureLAB in Markham was generously supported by IBM. These partnerships are key to the growth of RCIScience.

RCIScience has an ambitious vision to become a truly national organization reaching a million Canadians in the next 5 years. We have already expanded programming to Mississauga, Waterloo and Ottawa and have events planned in Halifax and Markham during the 2019-20 season. I am pleased to be involved with a venerable organization like RCIScience that is playing an important and leading role in developing a strong science culture in Canada.

RCIScience is a not-for-profit charity, run by volunteers and supported by our exceptional Executive Director Kirsten Vanstone and Programs Manager Carrie Boyce. Our Board has worked hard to ensure that our activities advance the mission of RCIScience through good governance, strategic planning and financial oversight. I thank them for their support and guidance. I also thank our loyal members for continuing to support RCIScience and l look forward to meeting more of them at our events.

Dr. Reinhart Reithmeier

A LIGHT AT THE END OF THE TUNNEL

By Jon Farrow

How policy and technology will lead us to a better transportation future

I almost lost my mind on a recent trip below Toronto on the subway.

It started as a morning commute like any other, surrounded by tired Torontonians looking down, crushing candy and plugged in by the ears to their podcasts or playlists.

The train screeched to a halt somewhere deep underground below Casa Loma, between St Clair West and Dupont stations. This sort of thing happens pretty regularly, so only a few passengers even looked up. Then a scratchy voice came over the announcement system, so we all removed an earbud and cocked our heads.

The delay was caused by "signal problems," a term so vague as to be meaningless. Because we were between stations, leaving was out of the question, as

was contacting anybody to let them know I would be late. With nothing but dark tunnel walls, smartphone screens or other commuters' annoyed faces to look at, I started to think about how I ended up in this situation.

What alternatives did I have? Why don't I feel safe cycling? If I owned a car, would I be happier sitting in traffic instead? Why do I even need to commute? Couldn't I just work from home? Would it help if I offered to go outside and push the train?

Eventually we started moving again, but the normally 20-minute trip was extended to over an hour. And I'm still not sure I understand why it occurred. I am sure, however, that there must be better ways to get around the city.

At the May 2019 RCITalk, *Cities of the Future: Getting Around in 2070*, four panellists presented their vision of that better way. Not just for the TTC, but for Toronto and for cities around the world.

Shauna Brail, an associate professor in the Urban Studies Program at the University of Toronto and a senior associate in the Innovation Policy Lab at the Munk School of Global Affairs and Public Policy, started by reviewing the last 50 years of transportation innovation history.

By her reckoning, transportation in the Western world looked largely the same in 1969 as it does now. It's all still based on cars and paved streets. Over the last decade there has been plenty of excitement about the disruption that ride-hailing apps, electric cars and autonomous vehicles will cause, but infrastructure has yet to change dramatically. So she urged the panel to be realistic in considering what might happen in the next 50 years.

Andrew Miller, Associate Director of Mobility at Sidewalk Labs, then took to the stage to present an overview of his company's vision for Toronto's Quayside neighbourhood. By combining technological innovation with new ways of using existing technologies, he believes Sidewalk Labs can build a hyper-connected neighbourhood with happy and healthy citizens. Highlights of the proposal include:

- An underground system of conveyor belts to handle freight, taking delivery vehicles off the road and decreasing congestion.
- Pavement with built-in heaters that keep snow at bay and coloured lights that can create lanes or parking spots at the touch of a button.
- Adjustable awnings dubbed "building raincoats" that create usable outdoor space year-round, even in the depth of Toronto's winter.

Many of the proposals are aimed at disincentivizing personal car ownership, something Miller considers caustic to the fabric of a healthy city, saying they, "dissolve everything great about a neighbourhood."

Raktim Mitra, an associate professor in the School of Urban Planning at Ryerson University and co-director of the TransForm Laboratory of Transportation and Land Use Planning, gave a cautious view of the future, arguing that while new technologies are exciting and full of opportunity, they must be developed alongside policies that promote health, wellbeing and equity.

Innovations don't always have the effects you might expect. Ride-hailing apps like Uber have been touted as the solution to congestion, by cutting down on personal car ownership and promoting carpooling, but Mitra highlighted research showing that Uber's market share comes largely from lazy pedestrians and cyclists, not car owners. So he encouraged the audience to challenge assumptions and listen to the evidence.

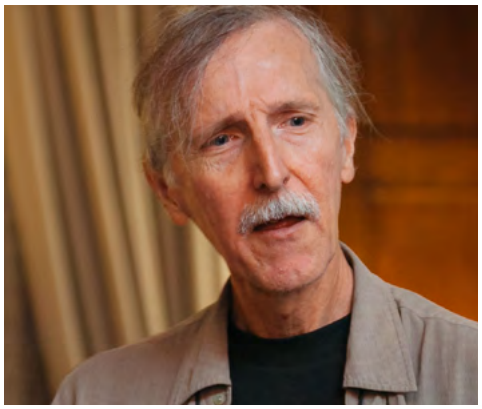
Steven Farber, Assistant Professor in the Department of Human Geography at the University of Toronto Scarborough, suggested that instead of coming up with policies as innovations arise, we should be clear about our priorities. We need a manifesto for what we want out of our transportation systems. Luckily, Farber had one ready:

1. Transportation should be equitable. All people should be able to reach desirable destinations.
2. Transportation should be safe. There should not be disproportionate peril for people who choose to walk or cycle.
3. The full cost of mobility, including environmental effects, should be accounted for.
4. Cost shouldn't be a limiting factor for individuals.
5. Transportation policies and investments should be properly evaluated, taking wellbeing into consideration.

After four insightful presentations and a lively discussion, it was clear that there is no future where all the trains always run on time and commuters are never annoyed. But there are good reasons to be hopeful that our cities can be smarter, safer and healthier.

And it won't all come down to technology. It's not enough for our cars or phones to be smart. In order to live in a happy, healthy future, we must make smart decisions about what matters and how we protect it.

MEMBER PROFILE



Eric Jackson has been a member of RCIScience for about a decade. Before that, he attended events regularly. Eric describes himself as a "lifelong science nerd" who was fascinated by Mr. Spock in Star Trek . Eric's father was involved with the Institute and helped set up events, including one of the first public demonstrations of a laser in Canada.

Eric says that he enjoys the idea of being taken to the cutting edge of science in the course of an hour. Being a member of RCIScience is, for Eric, a, "way of declaring that I am on the side of the scientific approach to understanding the world and more importantly, solving its problems." He suggests that anyone who is considering joining should, "come to an event, do it again, then spend the small bucks it takes to join."

SCIENCE, SOCIAL MEDIA AND GOING VIRAL

Growing up, **Sasha Weiditch** had a natural curiosity for everything around her. It was this inquisitiveness that drove her to study the sciences and ultimately pursue a PhD in biochemistry, working to understand the proteins that build bacteria-killing viruses called bacteriophages.

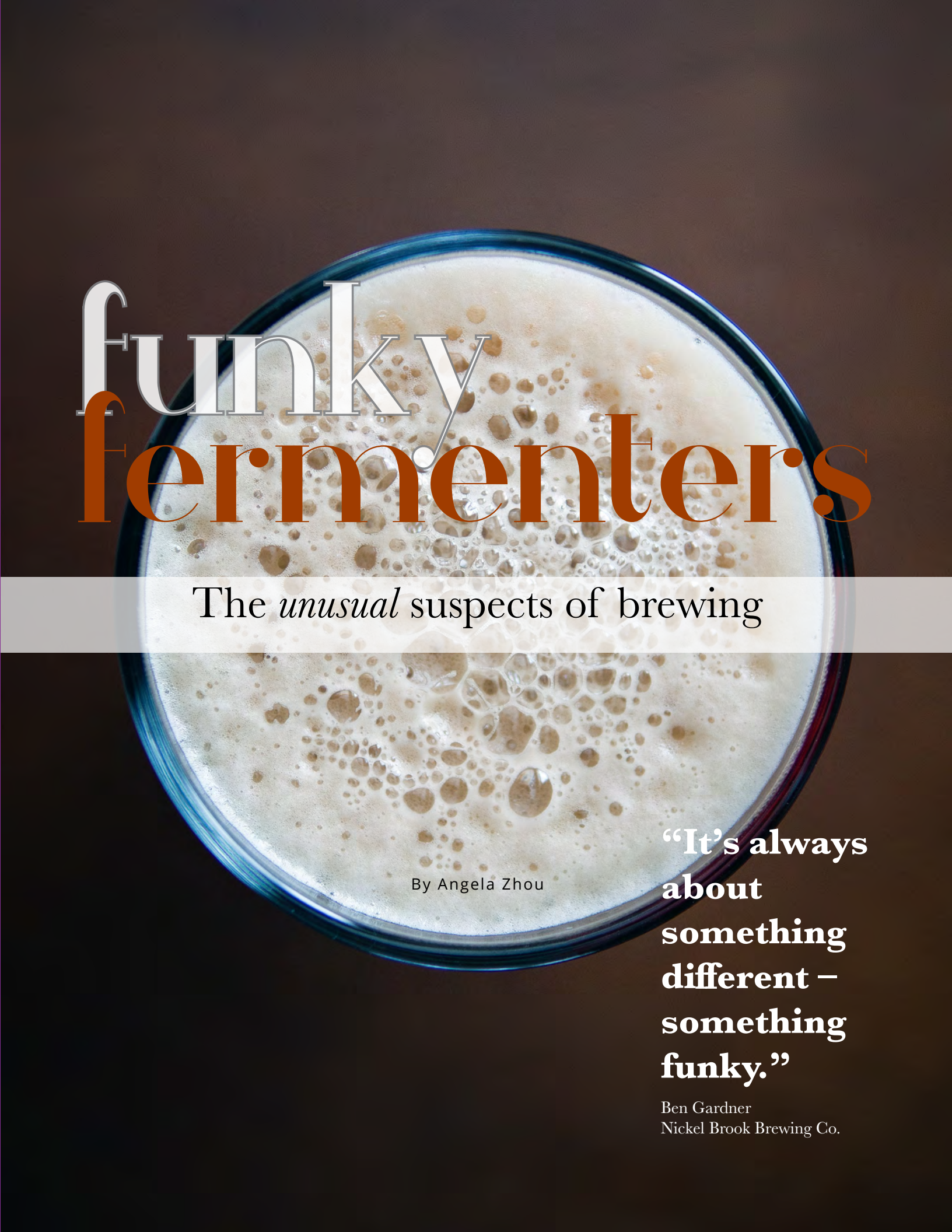
At times, working in the lab felt isolating. People outside of her department seemed to care more about her research than her immediate colleagues. To avoid feeling secluded, Sasha started sharing her experience of lab life on social media. She quickly noticed increasing interest in her work, particularly from aspiring young scientists. Translating her research to a public audience rapidly became a fun and exciting challenge, and before long @SciGirlSash was born. With over 6,000 followers on Instagram, Sasha embraced a novel platform for science communication.

Valuing the mentorship that helped guide her own career in the sciences, Sasha turned her hand to mentoring high school students, specifically girls. She quickly learned that while girls were keen to talk informally about science with someone they could relate to, many said they did not feel capable or smart enough to pursue science. Their perception of what it meant to be a scientist did not reflect reality.

So Sasha created *PhDenomenal PhDemale*, an online series showcasing diverse women working in a range of scientific fields. The platform connects researchers, dismantles stereotypes and ultimately makes science more accessible by engaging a wide audience in scientific conversations. And just as it supports women in their careers, Sasha noticed it also bolstered her own. Since then, she has advocated for women in STEM and science education at numerous events including *Soapbox Science, Girls Metamorphosis* and *TEDx UofT*.

As a researcher and science communicator, and in breaking down the many barriers that hold women back from pursuing a career in the sciences, Sasha has become a firm believer that just as there are many ways to answer a question, there are many ways to question an answer.

You can follow Sasha on Twitter and Instagram @SciGirlSash.



funky fermenters

The *unusual* suspects of brewing

By Angela Zhou

"It's always about something different – something funky."

Ben Gardner
Nickel Brook Brewing Co.

Nickel Brook Brewery Co., a family-owned, Burlington-based brewing company, has become a leading player in Ontario's craft beer scene by always seeking something different. Founders John and Peter Romano, who Mr. Gardner characterizes as, "definitely crazy and fun to work for," steer the brewery's ability to create and innovate with a dedication to getting beer "down to a science."

A devotion to the microbiology and biochemistry of beer-making has allowed Nickel Brook to create original and unique signature flavours, particularly in their catalogue of sour beers. Nickel Brook's Event Coordinator, Mr. Gardner, helped RCIScience open its 2018-2019 season with a lesson in Beer-Making 101 that offered a sneak peek into the brewery's operations all with cases of samples in tow, of course!

Hops are primarily used as a bittering, flavouring, and stability agent in beer.

UNDERSTANDING BEER

Beer contains four main ingredients: malt, water, hops and yeast. In short, beer is made from barley that is malted to release sugars. These sugars are then metabolized by yeast to produce alcohol and carbon dioxide in a process called fermentation. Water makes up the bulk of the beverage, while hops add flavour and aroma. Although this seems relatively straightforward, the opportunity to play with all four of these components opens space for experimentation and inventive exploration.

Malted barley, or malt, is the soul of beer. The malting process begins by steeping barley, allowing it to germinate and release sugars. This process lasts 4 to 6 days and is followed by kilning, a process that uses heat to stop germination and dry the malt. The time spent and temperature used during kilning produces differences in the colour and body of the beer. In fact, a beer's colour is the direct result of the malt. For example, a longer kilning process produces malt that makes a darker beer.

Barley isn't the only grain found in beer. Adjuncts are other unmalted grains, such as rice, corn or wheat, that are often added to provide additional sources of starch. Adjuncts used in beers depend on the desired taste, or simply on the local economy and what's available to add.

Fans of India Pale Ales (IPAs) will be familiar with the presence of hops. Interestingly, the "India" in IPA is derived from using hops to preserve beer for a longer period of time. This practice was useful for keeping British troops happy on long trips to India in the 19th century. Flowers of the female hops plant contain oils and resin that contribute to the aroma and have a bitter taste. An IPA's bitter, "hoppy" flavour is generally added at the beginning of the brewing process, with additional flavours included in the middle, and finally, aromas such as citrus or fruitiness, included late in the process. Unfortunately, ideal hop growing conditions require warm summers and mild winters. "We're trying our best," assured Mr. Gardner, who acknowledged climate as a challenge of brewing in the Great White North.

Nickel Brook Brewing Co. host a beer tasting night for RCIScience's 2018-19 kickoff event.

Brewing is further influenced by geography through the available water. The Coors Brewing Company is well-known for marketing its products as being made with real Colorado Rocky Mountain spring water. Although fans and others alike can

debate whether mountain water makes better beer, the hardness of local tap water certainly plays a role. Hardness refers to the mineral content, notably calcium, magnesium, and bicarbonate. These minerals in water influence the level of acidity in the brew, a lesson that Nickel Brook learned when the company switched its operations from Hamilton to Burlington and noticed a considerable difference in the taste of their products. To this extent, Mr. Gardner identified water as the most important, and often overlooked, ingredient of beer-making.

Science of Beer attendees inspect a Nickel Brook beer bottle.

Never overlooked, however, is the booze. The production of alcohol and carbonation, undisputed hallmarks of a good beer, is accomplished by yeast, a single-celled microorganism of the fungus family. Yeast is initially put through an aerobic (with oxygen) stage during brewing where it is permitted to consume sugars and reproduce, before switching to anaerobic (without oxygen) conditions that facilitate its metabolism of sugars into alcohol and CO^2 through fermentation. As alcohol builds up, the environment becomes toxic to the yeast, causing it to stop growing and ending the fermentation process.

Typically, the yeast strain *Saccharomyces pastorianus* is used in lager-style beers, while *Saccharomyces cerevisiae* is the usual choice for ales. Different yeast strains have unique metabolic capabilities that affect alcohol production, flavour and taste. There are 40 species of yeast and hundreds of strains. Although not all of them are suitable for brewing, the diversity of yeast available certainly allows for experimentation in creating new tastes.

That's where the Funk Lab comes in.

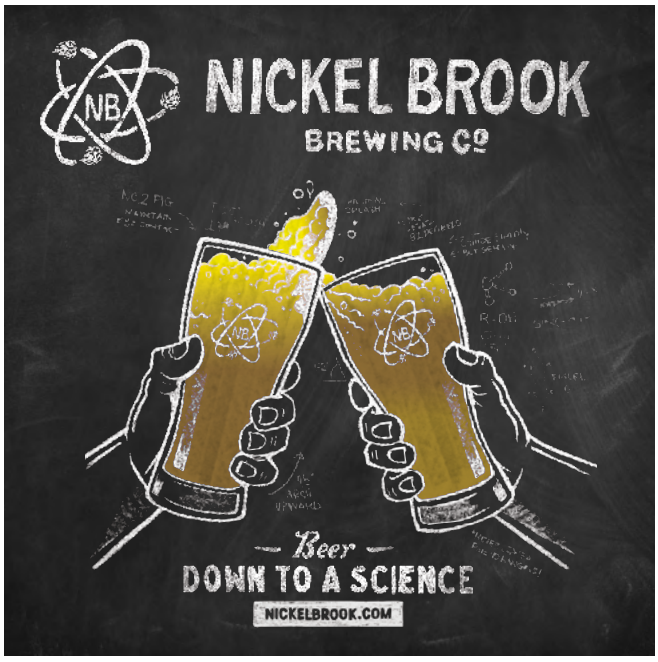
BEYOND THE BREWER'S YEAST

In 2016, Nickel Brook launched its Funk Lab, a brewhouse dedicated solely to small-batch so-called "funky" and sour beers. The objective is to get beyond the conventional brewer's yeast and experiment with wild yeast as well as bacteria to create unique flavours. *Lactobacillus*, a type of bacteria often associated with digestion and probiotics, generates lactic acid that produces a sharp and intense tangy taste that is perfect for dry, sour beers. Lactose pale ales are a new trend with craft breweries. *Pediococcus*, a bacterial genus from the same family as *Lactobacillus*, also produces lactic acid and is known to create an even more potent effect.

In the Funk Lab, Mr. Gardner noted the value of having an abundance of patience and a bit of luck as some yeast and bacterial strains can produce unpredictable results. As an example, he highlighted *Brettanomyces*, a "funky barnyard" genus of yeast with a pungent taste that he described as, "farmy, horse blanket." Although it generates a hugely intense flavour, Mr. Gardner cautioned that it can't be controlled you just have to wait to find out what the final product tastes like.

Mr. Gardner acknowledged the concerns of purists and the naysayers who denounce these wild-brews as frivolous, but defended the need for brewing experimentation. "You can throw in a lot of ingredients and run the risk of [your creation] no longer being beer," he explained. "But until we explore these options, we don't know what tastes we can get out of beer."

Indeed, it is this bold sense of adventure and relentless pursuit of flavour innovation that has made Nickel Brook a leading influence in Ontario's burgeoning craft beer scene. In focusing on the microbiology of beer-making – that is, the microorganisms like yeast and bacteria at the centre of the brew – the Funk Lab sees endless possibilities in concocting unique and tasty brews that are sure to entice beer aficionados everywhere.



THE SCIENCE of HUMAN movement

By Sandhya Mylabathula

I asked some people on the street about movement.

Dillon from Etobicoke, Ontario, said, "Movement is life. We have to be able to move to get anywhere."

We know that moving can be good for us. We hear all the time that we should exercise more and reduce sedentary behaviour to reap the physiological and mood boosting benefits.

Anhara, originally from the Xinjiang region of China, exercises to "feel energetic, happy and motivated" afterwards.

Whether it's a child taking their first steps, a hockey player shooting a puck, or someone recovering from injury, movement is a fundamental cornerstone of daily life.

But our ability to move and exercise is often something most of us take for granted. Can understanding how we move help us to recover when we lose that ability?

Movement itself refers to the motion of the body, or parts of it, and can be active, that is a conscious or planned action, or passive, such as allowing the body to move due to gravity. Several steps take place between our brain and body parts to create even a small movement. Dr. Tim Welsh, Professor in the Faculty of Kinesiology and Physical Education at the University of Toronto, studies movement in the context of everyday life. He believes that it is important to understand how individuals process information to help train people to move well and to recover from injury. He points out that movement is far more complex than it might seem on the surface, involving many cognitive and neurological processes, as well as predictions of others' actions and corrections to adapt to the environment.

Movement is a fundamental cornerstone of daily life.

While many types of movement may look similar, Dr. Welsh explains that each comes with variations in how the mover processes information. "Movements are very much like snowflakes. No two movements are exactly the same. They look very similar on the outside, but when you look at the structure and how each movement has been executed, it's actually quite different."

Social context can bring out subtle differences in how we move. Whether our goal is to push a car out of a snowbank or simply shake someone's hand, when we engage with other people, we need to predict how and why they perform an action in order to work together. Interestingly, ownership of an object can affect movement relating to that object. Most people are unconsciously more cautious when passing an object they own, like a cellphone, to someone else. If the object does not belong to us, we are less careful. So next time you pass your cellphone to someone, pay attention and see if you catch yourself being more resistant to the handover!

Often when we hear the words "movement" and "performance" in the same sentence, we think of athletes, but performance extends beyond sports. Consciously applying the fundamentals of human movement can also help musicians to hit all the right notes. Dr. Joyce Chen, Assistant Professor in the Faculty of Kinesiology and Physical Education at the University of Toronto, studies human movement related to music.

The groovier the music, the greater the activity in certain regions of the brain.

We've probably all, at some point, unconsciously started to tap our toes or snap our fingers when we hear great music. Why? Dr. Chen explains there is an inherent connection between sounds and movement. Certain regions of the brain that are responsible for movement activate when you listen to a rhythm. The groovier the music, the greater the brain activity in these regions. That is, movement connected parts of the brain activate more when music features a strong beat, low bass and syncopation. And not just in humans! This phenomenon has also been observed in trained cockatoos and sea lions.

While the mechanism behind the effect is still unclear, this movement-sound connection can help musicians hone their skills. By practicing the movements needed to play an instrument and learning the sounds that are generated, skilled musicians can predict necessary movements and use, "precisely timed and accurate movements with a high level of control," says Dr. Chen.

EXPLORING BEYOND EARTH

Another road trip complete meant another round of photos to develop. "Why are there so many pictures of the sky?" the developer asked a young **Bhairavi Shankar**'s mother. An early fascination with volcanoes and geology collided with the appearance of the bright Comet Hale-Bopp to stretch Bhairavi's imagination from the Earth into space.

After moving to Canada from the Middle East, Bhairavi set about looking up astronomy organizations in the phone book and called the Toronto Centre of the Royal Astronomical Society of Canada (RASC). The President answered and encouraged her to join the organization and volunteer at public events, which Bhairavi did throughout high school.

Despite her intense interest in planetary science, an undergraduate Bhairavi questioned whether her marks were high enough to pursue graduate studies. Fortunately, she listened to some advice given at a Planetary Science summer school in Whistler, BC, where she was told that grades aren't everything. Experience and interest in the field count too. Bhairavi went on to complete a Masters at the University of Minnesota and PhD at the University of Western Ontario, specialising in using satellite data to understand geological processes on planets other than Earth.

After graduating, Bhairavi realised that her friends and family, especially those with kids, had little idea of the space and astronomy events happening around Toronto. She saw an opportunity to combine her love of science and space outreach with her PhD specialty. To gain insight into how to be an entrepreneur, Bhairavi joined the Science Discovery Zone incubator program at Ryerson University and launched BeSpatial Consulting, which later evolved to Indus Space. Indus Space is an education-focused firm working with communities in and around Toronto, providing a wide range of multidisciplinary teaching and training services in space science and related sectors. Through hands-on engagement, Bhairavi helps raise awareness of planetary science and promotes Canada's active role in the global Space sector.

In addition to running her own company, Bhairavi continues to volunteer with the RASC and partners with various groups to promote women in STEM.

You can follow Indus Space @indusspaceCA on Twitter, Facebook and Instagram.

The connection between movement and music also means that a person with difficulty hearing can compensate by using a different sense. Percussionist Evelyn Glennie, who is deaf, performs by sensing vibrations. Not all senses are good substitutes, however, as Dr. Chen explains. "We are much better able to synchronize our actions with sounds, than with visual cues." This could be because the auditory system is better at processing temporal information, whereas the visual system is be better at processing spatial information. Imagine listening to a piece of music versus looking at a painting. Music takes a specific length of time, while you can look at the painting for as long as you want.

Clearly, movement skills are integral to optimizing function. But what happens when things go wrong? According to Dr. Welsh, we do not have an infinite capacity to process information. This is why it is difficult and sometimes dangerous to multitask, for example, texting and driving. Our ability to perform each task suffers if we do too much at the same time.

Dr. Joyce Chen presenting her research about movement at RCIScience.

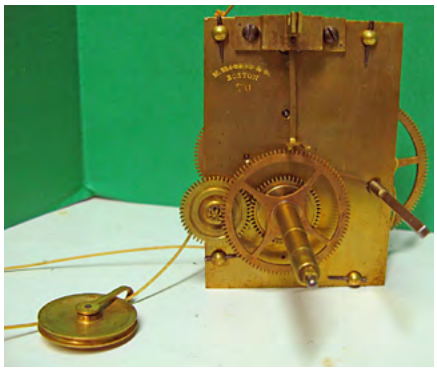
Dr. Chen explains that we can harness the natural link between the auditory system and movement to try to influence rehabilitation. Specifically, music can play a key role in recovery after a brain injury, such as a stroke. Neuroplasticity refers to changes in the brain and can occur as a function of development during growth, or through skill training in sport or music. Similarly, rehab uses intentional training to reorganize brain function after a brain injury. Using music in rehabilitation can be helpful as an enriching stimulus, requiring the injured individual to try to engage memory, cognition and movement systems at the same time. This approach has been demonstrated to have positive effects in many patients.

Whether you're an athlete, artist, musician, or widget-maker, movement is integral to our lives. Human movement may be a lot more complex than it seems, but understanding it better can help us not only move better, but keep moving after injury or disease. Ⓡ

KOSMIC CLOCK

RCIScience has a small collection of artifacts. Among the more curious members of this collection is a clock that displays time in a 24-hour format. In these days of cellphones and digital watches, you might wonder why this is special. That's because ours is an analogue clock. It uses a clever mechanism to flip 12 blocks on which the hours appear around the dial so that morning hours display in Roman numerals and post-noon hours in Arabic numerals. The clock also displays Greenwich Time by means of a second, dedicated hour hand.

Our Kosmic Clock was given to the Institute by Henry E. Waite of Boston in 1888. Made by the E. Howard Clock Co. of Boston, it is one of only 6 known to exist. Waite likely sent the clock in hopes that Sir Sandford Fleming, globally-known as the inventor of standard time, would endorse it.



Kosmic clock movement

After 130 years, the clock was in desperate need of repair. The Ottawa Valley Watch and Clock Collectors Club (OVWCC) offered to help. Daniel Hudon, the Club's Master Clock Restorer and his assistant Andrea Gilpin disassembled the clock movement and its patented mechanism, performed all necessary cleaning, oiling and adjustments, then machined and replaced missing parts. Further, they documented the clock specifications for future reference. This may be the only set of documentation on this clock in existence.

The restoration is now complete and the Kosmic Clock is ready to tick for another 130 years, hopefully on display to the public. To see further details of the restoration please go to the OVWCC website (**www.ottawaclocksandwatches.ca**) and look for the Bytown Times edition of November, 2017.

RCIScience thanks Ray Springer, Daniel Hudon, Andrea Gilpin and the rest of the OVWCC for it's great help in documenting this fascinating artifact!

Captain John Henry Lefroy
a portrait

Henry Lefroy was a British Empire adventurer, knowledge seeker and soldier-scientist. Son of a clergyman and descended from Huguenot refugees, Lefroy was born and spent the early years of his life in Ashe, Hampshire. He lived in the same house where, years earlier, his grandmother encouraged Jane Austen with her early writing and where his uncle shared a brief flirtation with the soon-to-be-famous novelist.

Lefroy attended the Royal Military Academy at Woolwich and joined the Royal Artillery in 1831. Demonstrating an aptitude for science, he studied practical astronomy with the Royal Engineers. At the time, there was a global interest in terrestrial magnetism as a tool for navigation. Governments and scientific societies around the world mounted expeditions and established fixed observatories in a global effort that became known as the "Magnetic Crusades." As part of this international effort, Britain established observatories in Toronto, St. Helena, the Cape of Good Hope and Van Diemen's Land (Tasmania).

In 1839, Lefroy set sail for St. Helena. He travelled aboard the HMS Erebus and Terror, fabled ships that later carried the Franklin Expedition on its doomed journey to navigate the Northwest Passage. This particular voyage was one of scientific discovery under the command of famed polar explorers, James Clark Ross and Francis Crozier. After a 126-day journey criss-crossing the Atlantic, Lefroy disembarked and took up his post as Director of the St. Helena Observatory, while Ross and Crozier continued on to the Antarctic. The Observatory occupied the same remote corner of St. Helena where Napoleon Bonaparte spent his second exile. Lefroy witnessed the disinterment of Napoleon's body prior to it being repatriated to France.

After three years in St. Helena, Lefroy was reposted to Toronto as Director of the Magnetic and Meteorological Observatory, a position he held until 1853. Part of this posting included an 18-month survey of British North America, during which time he traveled 5500 miles by canoe, dogsled and on horseback with the Hudson's Bay Company between Montreal and Fort Good Hope, on the Mackenzie River in the Northwest Territories. Over the course of the survey, Lefroy took magnetic and meteorological readings at more than 300 stations, on occasion as frequently as every five minutes. The rigour that Lefroy demonstrated during his travels earned him the respect of John MacLean, a Hudson's Bay Company Chief Factor, who described him as, "equal to all the hardships and privations of a voyageur's life…and the ablest mangeur de lard we have had in the country for years."

Following his journey, Lefroy returned to Toronto where he helped pioneer the use of photography to record terrestrial magnetism and created some of Canada's earliest meteorological reports. Observations of magnetic variation made in Toronto confirmed the connection between solar disturbances and Earth's magnetic field, causing, among other things, the aurora. In associated work, Lefroy collaborated with John Henry, founder of the Smithsonian Institute in Washington on a North American survey of the Aurora Borealis.

Wayne Reeves, City of Toronto and David O'Hara, Fort York unveil a portrait of Captain Lefroy.

A dedicated scientist and polymath, Henry Lefroy recognized the value of gathering like-minded people together and was instrumental in the early days of the Royal Canadian Institute, serving as President in 1852-3. Toronto had only 30,000 citizens at the time and struggled to create the type of institutions for professional, scientific and cultural advancement that existed in Montreal.

In the Canadian Institute's 1949 Centennial Volume, W. Stewart Wallace noted that the Institute was initially intended as a professional society for architects, engineers and surveyors, but membership and attendance at early meetings was chronically poor, reaching a low point in February, 1850 when only two people showed up. One was Sandford Fleming and the other was a surveyor by the name of F. Passmore. "This looks bad," the two men solemnly agreed. Dispelling the need for a quorum, they approved a flurry of resolutions, the most important of which was to open the membership to, "all those whose pursuits or studies were of a kindred spirit."

When Henry Lefroy took the helm, he built on Fleming's philosophy of openness. He saw an opportunity to support the scientific community, but also to have an impact on the intellectual and cultural development of the United Province of Canada. He believed that the Institute could fulfil functions similar to those of the Societies of Art, Academies of Science and Literary and Historical societies present in older, more populated cities. Under his direction, membership grew significantly to include an influential cross-section of Toronto society with doctors, newspaper publishers, lawyers, artists, businessmen, academics and members of the clergy.

Markham's town crier at the Science at Fort York event.

The Institute's 1851 Royal Charter encouraged the advancement of the Physical Sciences, the Arts and the Manufactures. Its lofty goals were to "open up the wilderness…smooth the path of civilization…and direct the great sources of Power in Nature for the use and convenience of man." The Institute displayed collections of art in the legislative buildings, opened the first public museum in Toronto and introduced a scientific journal that was distributed internationally.

When the British Artillery withdrew from Toronto in 1853, the Institute campaigned for the continuation of the Toronto Observatory which ultimately evolved into the Canadian Meteorological Services. A rebuilt observatory is still located on the grounds of the University of Toronto's St. George Campus, while remnants of the original observatory can be visited near the University's Convocation Hall. Then, as now, the Institute played an important role in public education that continues to this day.

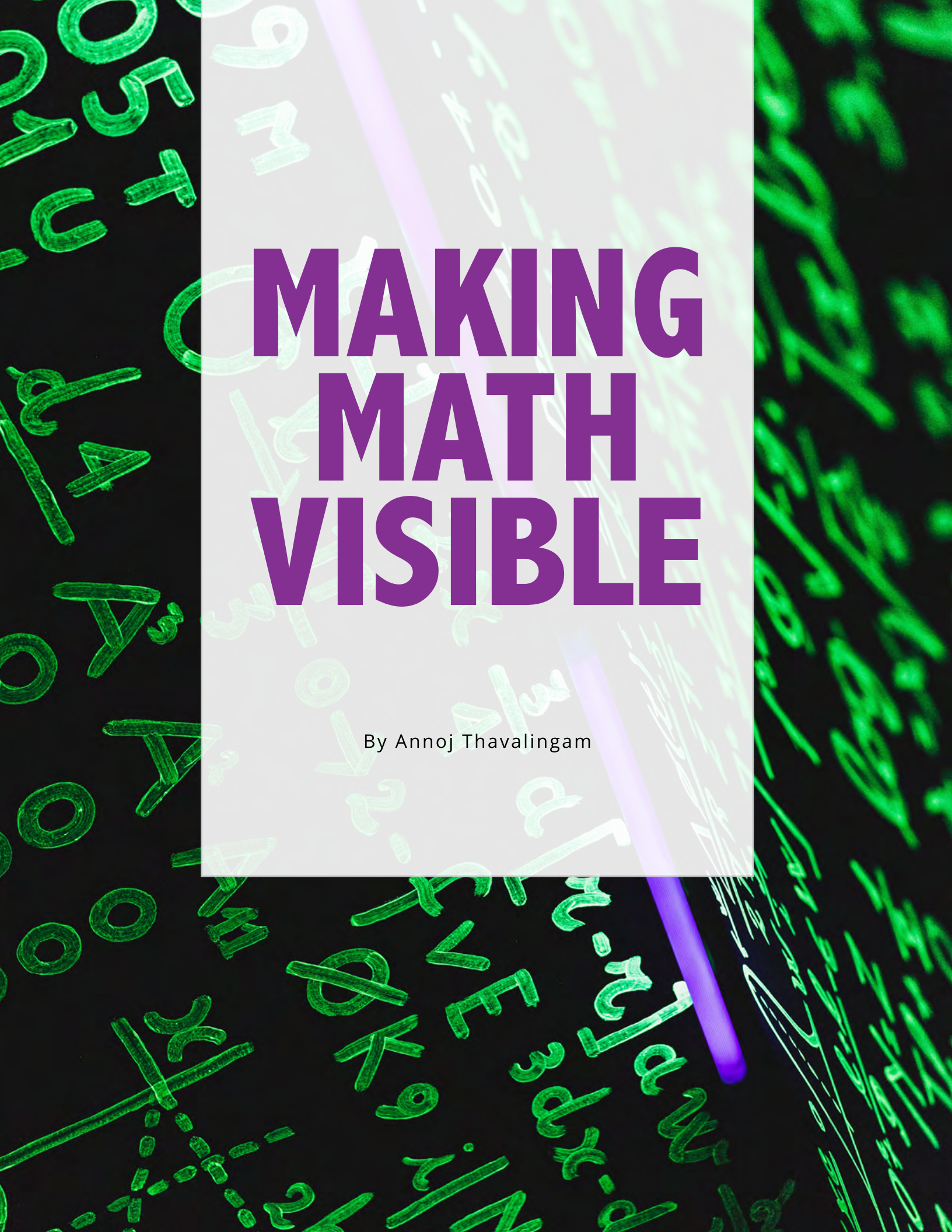
The great institutions of which Sanford Fleming, Henry Lefroy and the other gentlemen of the early Royal Canadian Institute dreamed took another 50 years to emerge. The valiant efforts of a few visionaries, however, demonstrated that the paucity of resources and even interest in the quest for a better future can be overcome with persistence and the use of creative minds.

Later in life, Lefroy's role as a soldier-scientist found application in other areas of the burgeoning British Empire including the creation of the Royal Artillery Institute in Woolwich, supporting Florence Nightingale in the Crimea, and as a scientific advisor for the War Office in London. As Governor of Bermuda and administrator of Tasmania, Lefroy's scientific skills were called into play as he set forth to better the economic, health and social well-being of the populace. He was knighted and rose to the rank of General. A town near Barrie, Ontario and Mount Lefroy in Banff, Alberta were named in his honour. In 2002, a portrait of Henry Lefroy, *Scene in the North-west: Portrait of John Henry Lefroy* was sold at an auction in Toronto for C$5.1 million, the highest price for a painting ever sold in Canada at the time.

Although his accomplishments extend beyond Canada, the magnetic energy of Henry Lefroy is indelibly manifested in Canadian history and its scientific communities.

Sharon Lefroy is the great-great grand-daughter of John Henry Lefroy and is currently writing his biography.

On February 5th, 2019 a portrait of Captain Henry Lefroy of the British Royal Artillery, was unveiled by Wayne Reeves, Chief Curator of the City of Toronto Museums and Heritage Services at an event of the Royal Canadian Institute for Science (RCIScience) held at the Fort York Visitor's Centre. The portrait was painted by Georges Berthon in 1853 on the occasion of Lefroy's return to England after serving as the Vice-President and President of the Institute between 1851 and 1853. It has recently been donated to the City of Toronto by RCIScience.



MAKING MATH VISIBLE

By Annoj Thavalingam

George Hart and Elisabeth Heathfield are educators with a mission to popularize math among children and the general public. "There's a long cultural history of how math has been approached and how it's described that needs fixing," says Hart, a retired math professor from Stony Brook University on Long Island in New York State. He refers to the traditional pedantic method of teaching math in classrooms, where worksheets and rote learning hold sway.

The project that Hart and Heathfield have started in response is *Making Math Visible*, a mobile workshop that tours schools across the globe, allowing students to engage with math first-hand via math-inspired sculptures. As an elementary school teacher, Heathfield incorporates sculpture building as an opportunity to foster a love of mathematics. "My class is like a lab for math education," says Heathfield. "By showing students things that are beyond what's in the curriculum, they can ask questions and look forward to things they'll encounter later on."

George Hart and Elisabeth Heathfield display the cardboard sculpture Spring, based on an elaborate solid known as a rhombic tricontahedron. This shape could be described as a polyhedron of 30 faces, 60 edges and 32 vertices, or represented as a collection of equations, but neither inspire the mind quite like a tangible, artistic representation.

Making Math Visible came to RCIScience and the Fields Institute, where children and adults, math lovers and math phobes had the opportunity to collectively create reflexible (objects that are mirror images of one another, eg. our left hand and right hand), floral cardboard structures.

The sculpture *Spring*, as well as many of the other sculptures designed by the duo, can be discussed at a variety of levels depending on the target audience. For our crowd of families and seniors, Hart broke down *Spring*'s complex architecture into a story of symmetry. Gently rotating the sculpture, Hart demonstrated how the structure looks identical in two, three or five instances, depending on which view is taken as the point of reference. Being able to visualize the harmony underlying such a detailed architecture was eye-opening.

Heathfield and Hart craft sculptures in the hope that they will serve as focal points for discussions on the relevance of math in art, nature and our daily lives. From the swirls of seashells to the gentle arches of spider webs, mathematics is nature's greatest tool for creation and innovation. Even in our man-made, urban landscape, the unique alignment of floor tiles in a lobby, or the resemblance of skyscrapers to stalagmites, may slip our eye's notice.

All hands on deck as audience members build the sculpture!

Hart asserts that exposure to math's ubiquity and potential at a young age will help usher a cultural shift towards mathematics. "One of the things you see when you walk around schools," explains Hart, "is lots and lots of language on the walls… We have all these institutions devoted to getting language to the public, whether it's giant public libraries or language in the arts. We need more of that in mathematics, so by making giant mathematical structures, it shows that you think that math is as worthy as other monuments in our culture."

Heathfield adds that novice students of music are exposed to the works of renowned composers as samples of the depth of successful performances or compositions. "But with math, we don't do that. We only expose them to what we think they can do, and we don't show them there's all this other stuff that one day they could do if they keep with it."

For more information about Hart and Heathfield's initiative, please visit www.makingmathvisible.com.

VENTURING FROM THE LAB

"I would like to congratulate RCIScience on the 170th anniversary of its founding. I am grateful for your organisation's ongoing commitment to engaging the public on scientific issues. Scientifically literate citizens are able to make informed decisions on complex issues, while serving as role models for young people who may wish to pursue a career in the sciences, technology, engineering or mathematics."

The Honorable Kirsty Duncan,
Minister of Science and Sport

At RCIScience, we believe in thinking scientifically.

Over the last few years, we conducted many experiments with programming, to try and make what we do more relevant to more people.

In **2018-2019**, we ventured out from our lab, and really put our findings into practice!

NEW PROGRAMS

- Number of events per year **increased by 60%**
- Bringing multiple scientific perspectives to an issue
- Hosting top researchers and cutting edge ideas
- Playing at the intersection of art and science
- Working with new partners

- Bringing early career scientists and cutting-edge ideas out of the lab
- Supporting new ideas in science communication—hosted **Science Everywhere**'s 'Freestyle Social' at the **Canadian Science Policy Conference**, Fort York and at a supplementary **Living with Pot** event
- Providing a platform for science communicators to hone their skills

FOSTERING INNOVATIVE IDEAS

- Awards named for our founders—**William Edmond Logan Award** to the Science Communication Program at **Laurentian University** offered in partnership with **Science North**. **Fleming Medal** to Dr. John Smol
- Creating programs that explore our history and the history of science in Canada

BRINGING OUR PROGRAMS TO NEW MARKETS

- Active programs in **Mississauga, Waterloo and Ottawa**
- Planning programs in **Halifax and Vancouver** 2019-20
- Bringing scientists off university campuses to pubs, coffee shops and the street!

REACHING NEW AUDIENCES

- Audience **increased by 62%** over 2017-18, **94% increase** over 2016-17
- Taking science into new spaces
- Speakers that reflect the **diversity of Canada**
- Increasing online audience. **30% increase** in YouTube impressions, Twitter impressions **up 60%**, **57% increase** in Facebook page followers. And we're now on Instagram!

USING OUR UNIQUE STORY

CONNECTING CANADIANS WITH SCIENCE

- Telling the stories of science in Canada
- Creating a community of science supporters
- Building a science culture in Canada

Music & the Injured Brain

By Swapna Mylabathula

What's the last song you listened to? Were you singing along in your car, getting pumped up at the gym, or dancing at a party? Music is not just a part of our everyday lives, it has been woven into the fabric of humanity for many, many thousands of years. The oldest instruments known are bone flutes found in Germany made 45,000 years ago. The influence of music is universal, and appears in cultures all around the world. It can calm us down, hype us up and make us feel nostalgic. But music also plays a role in modern medicine. It is the cornerstone of the dynamic field of music therapy for the injured brain.

When you listen to a melody it is processed in your brain through neural networks that interface with the areas responsible for functions including motor control, cognition, and speech and language. With such a large neural reach, music can be instrumental in brain injury rehabilitation.

Traditionally, music therapy was firmly rooted in social science and used for improving social relationships, well-being and emotional support. But recent developments have led to a paradigm shift in which music therapy encompasses neuroscience to help improve general quality of life and specific functions such as speech and language.

Human brains share common processes for music and language. The frontal lobe, for example, handles language syntax and structure as well as harmonies. The temporal lobe deals with memorization of vocabulary and melodies. This sheds light on why we can often recall song lyrics from childhood without difficulty, but struggle to remember what we ate for breakfast.

Music therapy has moved beyond its social science roots. Neurologic Music Therapy (NMT) is currently practiced through a standardized model across 30 countries and is recognized by the World Federation of Neurologic Rehabilitation. Dr. Michael Thaut, Canada Research Chair in Music and Health Sciences, and his team recently showed that "auditory priming", or listening to a beat prior to an action like tapping a finger, can improve the ability to synchronize movement. This, in turn, helps to regulate that movement. Following a brain injury, movements like walking can be significantly affected, but auditory priming can help regain this function.

Rhythmic Auditory Stimulation (RAS) is one of three NMT techniques that focuses on motor control to regulate abnormal gait, or pattern of walking. The six steps of RAS allow patients to gradually move from an assessment of their baseline gait, to using rhythms to change their gait pattern by moving in synchrony with a beat, to walking with an improved gait without music. The process helps to regulate gait and improve mobility even when there is no audible beat. Though Dr. Thaut cautions that, as with any brain-related process, "if you don't use it, you lose it." Ongoing training is required to sustain the positive change to gait beyond about a month. Dr. Thaut's team was the first to discover this effect on gait with stroke and Parkinson's Disease patients.

In addition to using NMT to improve motor function, there are 9 different techniques to improve cognitive function, including attention, memory

Neurologic music therapists translate research into practice. **Dr. Corene Thaut**, Assistant Professor in Music and Health Sciences at the University of Toronto, guides her patients through Melodic Intonation Therapy. This is one of eight NMT techniques used for improving speech and language in patients who have lost the ability to speak fluently but can still access their spoken language via music.

There are six steps in this process. First, the music therapist hums a melody that includes a phrase to be spoken, while also tapping a finger. Then the therapist sings the phrase while tapping the patient's hand. The patient then joins in singing with the therapist. The therapist sings more quietly while the patient continues. The therapist sings the phrase while the patient echoes it. And finally, the patient recalls the phrase when prompted.

During a special RCIScience presentation, Dr. Corene Thaut invited a patient experiencing Broca's Aphasia (an inability to speak fluently) following a stroke to demonstrate the impact of music therapy on speech. Although his comprehension is intact, he has great difficulty speaking organized and meaningful sentences. Together, they delivered a moving and inspiring performance that was the culmination of many hours of hard work and determination, facilitated by music therapy.

Seeing and hearing the real-life applications of music therapy brought the audience to their feet in a standing ovation—certainly another high note of the **2018-2019 RCITalks**.

NO SUGAR COATING

If you grew up in Guyana and loved science, you became a doctor. Even if, early on, you were so fascinated with planets and black holes that you hid the books about them in the library so no one else could borrow them! When **Krishana Sankar** immigrated to Canada to begin her studies at the University of Toronto, she thought she would start on a track towards a career in medicine. Flash forward a few years and some encounters with lab work enticed Krishana to pursue a PhD in diabetes research, combining engineering with biology to improve islet transplantation as a treatment for type 1 diabetes.

Combining her love of science with a life-long passion for dancing, Krishana successfully launched the *#150mins* campaign during Diabetes Awareness Month. This campaign increases diabetes awareness through interactive posts and quizzes, and challenges the public to complete 150 minutes of moderate exercise each week to combat type 2 diabetes and ultimately live healthier lifestyles.

An avid science communicator, Krishana feels a responsibility not only to share her research with tax payers, but to show the public how to spot fake science news and actively dispel the spread of misinformation, particularly rife on social media.

As an immigrant and a woman of colour, Krishana noticed that neither of these two groups are well-represented in administrative and executive positions, particularly within academia. She has since become an advocate for women of colour in Science, Technology, Engineering, Art, Medicine and Math (STEAMM). Noting that new immigrants have to face a new culture, a new language, new systems of work and build new networks, coupled with the fact that women of colour are an underrepresented group in STEAMM, Krishana co-founded WOCScan (Women of Colour in STEAMM Canada - @WoCScan on Twitter) to help address these and other barriers.

More recently, Krishana has partnered with fellow scientists to launch a fundraising campaign aimed at bringing the book *Inferior* to publicly-funded high schools across Canada. The aim? To inspire a generation of students to understand their potential is not limited by their sex or gender.

You can follow Krishana on Instagram @beyond.the.ivory.tower and Twitter @krishanasankar.

and planning. Dr. Nathan Churchill, a research associate in the Neuroscience Research Program at St. Michael's Hospital in Toronto, is investigating whether long-term musical memories can provide a cognitive boost to people diagnosed with Alzheimer's Disease.

Alzheimer's is the most common type of dementia, characterized by progressive cognitive impairment. Aging affects the brain by decreasing the volume in the frontal and temporal lobes. In Alzheimer's patients, the decrease in the temporal lobe is more pronounced in the early stages of the disease, impacting memory. However, music-related memory appears to be less affected than other types of memory. Using music, especially music chosen by the patient, has been shown to help the patient remember more of their own life experience.

While this is a relatively new area of inquiry, Dr. Churchill notes that using individualized music playlists creates positive changes in symptoms like anxiety and cognition in Alzheimer's patients. Further research should reveal how music does this, as well as whether musicians themselves maintain memory longer because of their training. Initially slow to develop, NMT for improving cognitive function is now the fastest growing area of research in the field, with a lot of work still needed to understand how it works.

Where does NMT go from here? Dr. Corene Thaut is looking forward to seeing NMT expanded into more patient populations, including those living with autism. Dr. Michael Thaut is excited for widespread acceptance and recognition of NMT around the world as a state of art therapy.

The next time you listen to music or play an instrument, you might be guarding against future neurologic injuries. So turn up the volume (while respecting your auditory function, of course) and tune-up your brain!

Living WITH POT

Medicine & Public Health in an Age of Legalization

By Dr. Chinmaya Sadangi

From its origins in Asia, cannabis has dispersed all around the world. "Though," botanist Dr. Lesley Campbell notes, "I have not heard of any population in Antarctica." As an agricultural crop, cannabis plants produce fibre, used for rope and clothing, omega 3-rich seeds and oil, and, of course, the CBD and THC compounds.

On October 17th 2018, Canadians could legally indulge in recreational cannabis for the first time since 1923. After nearly 100 years of restriction, many are concerned about the impact of legalization on medicine and public health. Three researchers in Toronto shared their perspectives of how Canadians will navigate living with pot.

Dr. Lesley Campbell is a botanist at Ryerson University who grows pot in her lab. For a long time, she was one of only a handful of researchers in Canada with a license to do so and what she's learned about the plant is now in high demand. Dr. Campbell explained that the *Cannabis sativa* and *Cannabis indica* plants, often referred to as hemp, are two species in the *Cannabaceae* family. Both species produce chemicals known as cannabinoids. Mammals of all stripes, including humans, have receptors for cannabinoids throughout their bodies, and even produce their own variants, called endocannabinoids. Of the more than 100 cannabinoids in the *Cannabis sativa* and *Cannabis indica* plants, Tetrahydrocannabinol (THC) and Cannabidiol (CBD) are the two most well-known. THC is associated with the plant's famed psychoactive effects, while CBD is thought by many to have therapeutic properties.

Dr. Campbell explains that there are male and female cannabis plants, but the males are very small. With more biomass, the female plants produce more of the desired compounds. "The males, if they pollinate the females, would radically drop down the production of the medicinal compounds – THC and CBD in the females," says Dr. Campbell. "Therefore, it is important to keep the males away from the population." That is why cannabis is most often propagated by cloning. This not only allows for female-only plants, but also helps with their consistency.

In nature, cannabis propagates by pollination. In case you were wondering, insects do not have cannabinoid receptors, so no bees get high by pollinating it, and the hookah-smoking caterpillar that Alice meets in Alice in Wonderland is truly a work of fiction. Humans, however, do have these receptors. Lots of them. Dr. Ruth Ross, Chair of the Department of Pharmacology and Toxicology at the University of Toronto studies the effect of cannabinoids on humans. Dr. Ross explained that cannabinoid receptors are part of a system in our bodies that helps regulate various physiological processes. This so-called endocannabinoid system is involved in such things as appetite, pain, learning and memory, stress and fear response.

Cannabinoids like THC work with the endocannabinoid system through cannabinoid receptors and help with things like pain management and appetite stimulation. But, as Dr. Ross notes, along with the good effects of THC, come bad and even ugly ones. The bad include short-term memory loss, impaired driving and severe vomiting. The ugly could include psychosis and schizophrenia.

"The males, if they pollinate the females, would radically drop down the production of the medicinal compounds - THC and CBD in the females," says Dr. Campbell. "Therefore, it is important to keep the males away from the population." That is why cannabis is most often propagated by cloning.

In the brain's hypothalamus, endocannabinoids (the body's own cannabinoids) are involved in appetite stimulation. Adding THC can stimulate appetite. In the cortex, however, endocannabinoids are involved in cognition, attention and motivation - all things which THC tends to impair. In the amygdala, endocannabinoids are involved in fear and anxiety. It is not yet well understood how THC will affect these.

In weighing the benefits and risks, there are many variables, such as the dose, how it is delivered, the type of cannabis, a person's genetics, age and pre-existing conditions. Dr. Ross says she's often asked by people what will happen if they smoke cannabis. "I can't say because of the variables in the cannabis and the variables in you."

So, while there may be health benefits to using cannabis and some therapeutic relevance, one big question is whether humans can develop a dependency on cannabinoids. This is the subject of a lot of debate. After all, alcohol and tobacco are both addictive. In fact, as Dr. Tony George at the Centre for Addiction and Mental Health explained, tobacco is the single most addictive substance that humans elect to put in their bodies.

As an emergency room physician at CAMH, Dr. George sees the effects of addiction first hand. He explains how the addictive properties of a substance are measured. Researchers look at the cumulative occurrence of dependence on a drug and divide that by the number of people who take it. It turns out that one-third of people who try tobacco develop a dependence on it. That is followed by cocaine and heroin, which are slightly less addictive. Alcohol is up there as well. Dr. George also outlines that these drugs can become a burden if they create lasting effects on health. We all know the effects of tobacco, but alcohol is another prevalent drug with a high burden on health.

"I tell people who ask me what will happen to them if they smoke cannabis that I can't say because of the variables in the cannabis and the variables in you."- DR. RUTH ROSS

According to Dr. George, cannabis users can develop dependence on the substance. One in ten adults (10%) do so, but more worryingly, the rate of dependence among youth is higher at 17%. The difficulty is that ages 15-25 is a time when people often experiment with drugs. It is also when some mental illnesses develop.

Further, the strains of cannabis now available are very different from those that previous generations may have indulged in. “Back in the day of bell bottoms, disco and Cheech & Chong, the THC and CBD was about equal, at 3%. Now, the plants produce up to 25% THC.” That said, Dr. George is not opposed to legalization, as long as Canada creates more capacity to study, treat and educate people about cannabis and its potential harms, enforces evidence-based age restrictions and imposes limits on THC content.

What came through loud and clear is that the science on pot use is not settled. Due to the strong restrictions on the substance for the past century, science hasn’t been able to do much study on the effects of cannabis. “If there is going to be money generated, hopefully some will be put back into research and education,” says Dr. George.

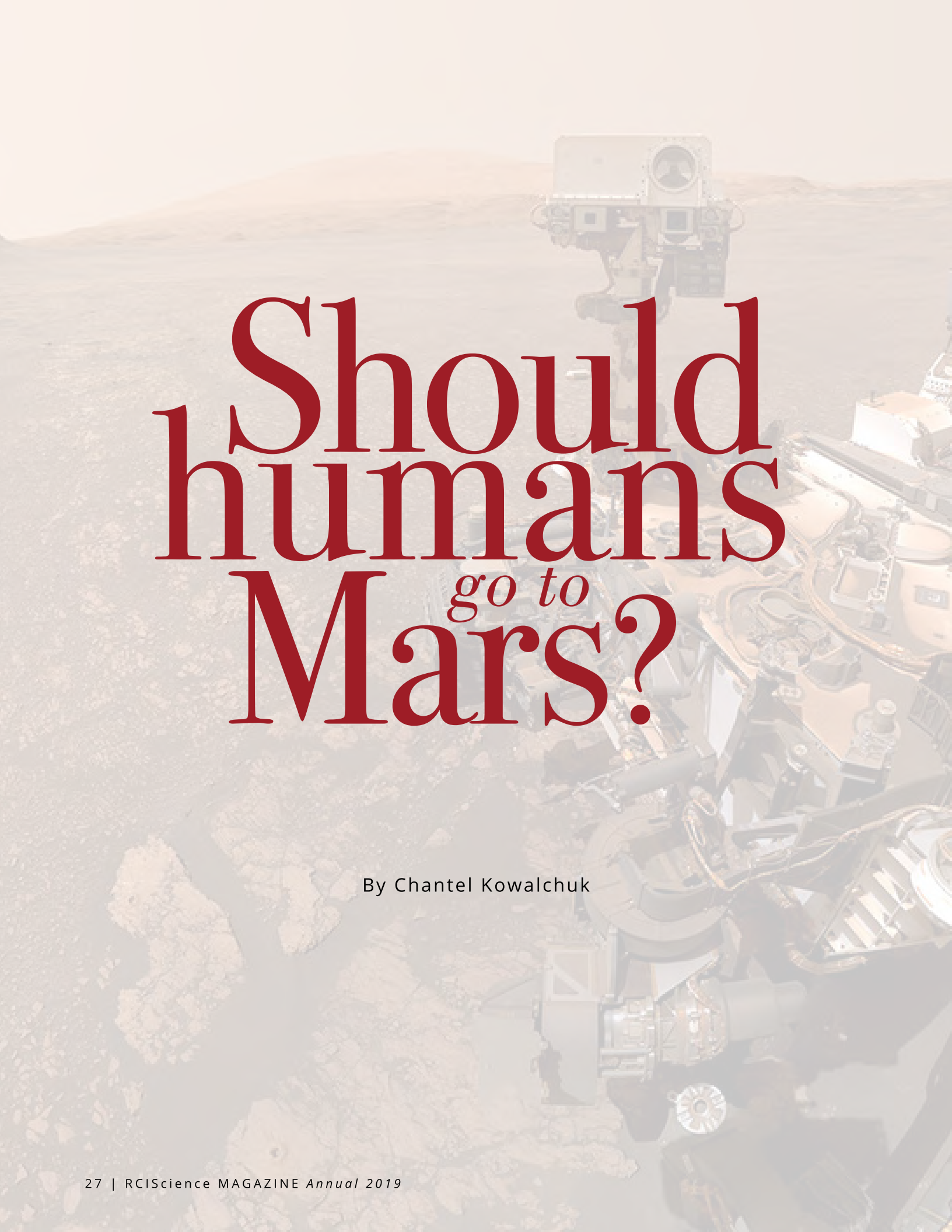
"Back in the day of bell bottoms, disco and Cheech & Chong, the THC and CBD was about equal, at 3%. Now, the plants produce up to 25% THC." - DR. TONY GEORGE

With pot companies raking in the profits and governments collecting their sin taxes, perhaps it’s time to plough some of that money back into research to make sure science can inform our decision on whether or not to live with pot.

DR. TONY GEORGE'S CAVEAT "H-EMPTOR"

6 Recommendations for Legalization

1. National strategy for public education on cannabis and its harms.
2. Limits on THC potency and clear product labeling.
3. Evidence-based age limit for recreational cannabis use.
4. National surveillance strategy post-legalization.
5. Developing treatment capacity for problematic cannabis use with special emphasis on youth and people with mental illness.
6. Education and training for physicians and other healthcare providers on the benefits and harms of cannabis.



Should humans go to Mars?

By Chantel Kowalchuk

Is it the noblest mission, or is our energy better spent elsewhere?

Space exploration fascinates across generations, demographics and countries, and Canada is no exception. Recently, we joined the Lunar Gtateway project, which will create a spaceport to allow for Moon exploration. But why not aim further? Mars, the mysterious red planet, has spawned countless books, movies and fantasies. Excitingly, we are now entering an age where seeing the footsteps of a human on Mars is no longer a fantasy, but a realistic possibility. Human exploration of Mars would certainly be an amazing achievement, but is it an adventure with a deeper purpose?

MARS: THE PLANET

Dr. Isaac Smith, planetary scientist at York University, says yes, but not for the reasons you might see in science fiction. Instead of exploring to find alien life or working towards a replacement Earth, Dr. Isaac Smith is excited at the opportunity Mars presents as a tool to discover more about our own planet. "Mars is a simplified version of Earth...we can use it to understand how Earth evolved," says Dr. Smith. Mars has two polar ice caps, like Earth, and these ice caps have thousands of layers. These layers contain data that can be used to study climate patterns dating back millions of years, meaning the potential for discovery is endless.

PSYCHOLOGY OF SPACE TRAVEL

Dr. Martha Lenio stresses that the potential discoveries from Mars extend beyond the physical and into better understanding of humankind. Dr. Lenio was an astronaut candidate and participated in NASA's HI-SEAS program, an intensive, eight-month Mars simulation held on an active volcano in Hawaii. The purpose of the program was to learn how to select and support the best team of astronauts possible. "The human factor is just as important as the mechanical in a successful Mars mission," Lenio emphasizes. In other words, being stuck with the same handful of people in a confined space for eight months (or in the case of an actual Mars mission, three years) could be just as detrimental to the mission as, for example, radiation exposure.

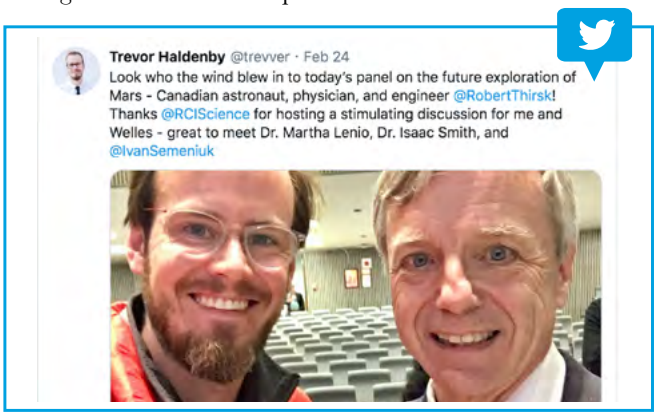
The HI-SEAS program studied changes in psychological factors such as cognition, stress and social interaction over the eight-month span. Perhaps unsurprisingly, people's mental outlook did not fare well. "At the start, everything is new and shiny. Towards the middle, everything cuts into a funk, as you're doing the same thing over and over, in the same place with the same people. And towards the end, people are either happy to go in, or you're wrapping up your research and there is a lot of work to do, so it can become quote volatile," explained Dr. Lenio. This kind of investigation is vital to help NASA learn how to best pick a team and support that team, particularly as a voyage to Mars has no opportunities to swap out personnel.

SPACE AS A TOOL FOR PEACE

Dr. Robert (Bob) Thirsk, a Canadiant astronaut who visited space in 1996 and in 2009, has a unique perspective on the benefits of space exploration. Though the curiosity and discovery aspect of a Mars mission is frequently touted as the primary goal for exploration, Thirsk takes a different approach. "In Canada, if we do deep space exploration, it must be for social benefit, it can't just be for discovery." Thirsk sees a mission to Mars as an opportunity to unite international enemies as countries work together towards a common goal. He also sees the mission as a way to inspire the public perception of science, and to inspire children to pursue studies and careers in science, technology, engineering and mathematics.

Yet with great potential comes great risk, and an adventure to Mars comes with a multitude of each. To Dr. Smith, the largest risk is the potential for radiation damage. On Earth, humans are exposed to an average of 0.005 mSv (micro sieverts, a unit

representing the dosage of ionizing radiation) in their lifetime. On Mars, explorers would be exposed to 900 mSv total. Another major issue is finding a power source. Solar power is a possibility, but is problematic as Mars receives 43% less sunlight than Earth due to its greater distance from the Sun, and because the vast amount of dust on its surface can block out sunlight and coat solar panels.



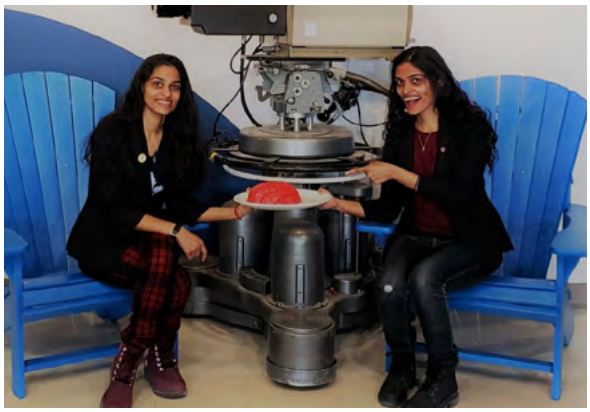
Dr. Thirsk also emphasizes the challenges; but instead of seeing them as hindrances, he views them as vehicles for technical innovation. Healthcare of astronauts, for example, is a major concern. Currently, medical samples from space are sent down to Earth for analysis, which would not be possible during the 300 million km journey to Mars. Thirsk foresees this challenge as inspiring innovative artificial intelligence to undertake health analysis and *in situ* processing of samples. He also predicts that sensors will be developed to constantly monitor the health status of all crew members.

Developed to support a Mars-bound crew, for Thirsk, the crux is that these healthcare advancements will also be useful on Earth. Many of our most creative technologies were born out of a need to answer a space-related issue – LASIK, solar cells, artificial limbs, even memory foam. Thirsk believes that space-driven innovation will continue to produce technologies to improve the life of citizens of Earth.

Astronaut Charlie Duke is often quoted for his view on space travel, "I went for the thrill of adventure and desire to explore." But the underlying idea from Drs. Smith, Lenio, and Thirsk is that the purpose of a Mars mission is not adventure, it is not human curiosity, and it is not discovery of our solar system. The purpose of a mission to Mars, is to improve human life on Earth. It can achieve this by providing information about our own planet's geologic history, enhancing our understanding of human psychology and sociology, and propelling our motivation for technological innovation. All with a global side effect of uniting nations and inspiring our citizens.

So, are we really going to leave footprints on Mars? And should we? As of now, it seems less a question of *whether* and more a question of *when* will we be able to. Currently, we simply do not have the technology to get us there safely. We are limited by funding, power options and radiation. We do not know how the human body will cope on Mars, or post-Mars. With prioritization of the Moon with the recent Lunar Gateway project, Mars has been put on the backburner. But Mars, the ultimate land of human exploration and imagination, has not, and will not, be forgotten.

VOLUNTEER PROFILE



You might have noticed them pop up on our social media, or even at some of our events, cornering audience members with questions or taking pictures. Often a pair, but each one of a kind, these two are hard to miss! But who are the STEAM Sisters?

Swapna Mylabathula is an MD/PhD Candidate and McLaughlin Scholar, working to become a clinical scientist with a focus in sports medicine. Her twin sister Sandhya is a PhD Candidate, returning CIHR Fellow in Public Health Policy and Junior Fellow at Massey College at the University of Toronto.

Both big hockey fans, they've spent the past decade involved in concussion research and advocacy work. Together, they co-developed a Pan-Canadian Concussion Strategy, recently presenting their recommendations to Parliament and informing new concussion legislation in Ontario (Rowan's Law).

They've co-delivered a TEDx Talk, feature on a number of podcasts including *Medicine in Motion* and *Raw Talk*, volunteer for a large number of organizations including Let's Talk Science, and are currently preparing to film television and digital content aimed at youth.

Huge advocates for science and science communication, they created one of our favourite initiatives, Scientists on the Street™, where they engage directly with the public across Canada to explore scientific topics related to #RCITalks. When asked why they support RCIScience, they replied, "They are a great representation of the science community - intelligent, funny, welcoming, and always curious!"

Recognized as two of the top 50 most influential Torontonians (Grid TO Magazine) and as Urban Heroes (Toronto Community News), these two show no signs of slowing down anytime soon! You can follow their adventures in STEAM (science, technology, engineering, art and math) on Instagram @steam.sisters.

what would you do if you ran the zoo?

Dr. Gabriela Mastromonaco is committed to finding ways to preserve domestic species such as wood bison.

By Aren Mnatzakanian

Modern zoos are animal-centric, placing the well-being of wildlife above all else.

Do you remember your first time visiting a zoo? It was likely a memorable experience, full of excitement at getting to see a variety of likely exotic animals up close. Professor of psychology and RCIScience Vice-Chair Dr. Suzanne MacDonald's first visit to the London Zoo as a 9-year-old girl, however, was memorable for a different reason. Her excitement to see the famous chimpanzee exhibit was quickly dampened when she noticed an obvious expression of sadness on the primates' faces. She asked what zoo management could do to make these sad apes happier. Unsatisfied with their answer, Dr. MacDonald got to work, obtained her PhD and dedicated her career to improving the quality of life of animals living in zoos.

The subject of zoos can sometimes be viewed as controversial. "Whether you love them or you hate them, zoos exist," says Dr. MacDonald. But what roles do zoos play in modern society? What constitutes a good zoo and who regulates them?

The practice of keeping animals under human care has a long and varied history. In ancient Rome, exotic species were imported from conquered lands and pitted against each other in a fight to the death, as a macabre form of entertainment. Fast forward to 1828 and Regent's Park Zoo was established for the scientific study of animals. Not long after, due to popular demand, this precursor to the London Zoo opened its doors to the public as a place of amusement, with elephant rides, bear feedings and chimpanzee tea parties.

"A visit to the Toronto Zoo is expected to be the beginning of a visitor's long-term relationship with the natural world, and the origin of their conservation-minded thinking."

Modern zoos have come a long way. An example of a good modern zoo is the world-class Toronto Zoo. One of the things that makes this zoo so successful is its clarity of vision: *To be Canada's national leader in saving wildlife to ensure the rich diversity of nature for future generations*. In addition to breeding, rearing and releasing endangered animals back into their natural habitats, the Toronto Zoo invites visitors to think critically about important, real-world issues, like habitat loss and species endangerment.

For Toronto Zoo CEO, Dolf De Jong, what matters most is, "Looking at the things people aren't paying attention to and finding ways to highlight them." To this end, their zoo programming is designed to promote a science-literate and conservation-minded community. A visit to the Toronto Zoo is expected to be the beginning of a visitor's long-term relationship with the natural world, and the origin of their conservation-minded thinking.

A visit to the zoo may trigger lifestyle changes such as refusing a plastic straw at a fast food restaurant or even switching to an electric car. Such influences on lifestyle choice, though optimistic, are not unrealistic. With over 1 million annual guests spending an average time of 4 hours at the Toronto Zoo, there is a huge window of opportunity to challenge the perspectives of visitors, to deliver new information and ultimately foster broader dialogues about habitat and species conservation. According to De Jong, "the Toronto Zoo is a key player in the conservation field and its role in getting people more connected to nature is becoming increasingly important."

Modern zoos can also function as research labs outside of the traditional academic setting. One research program that is currently being pursued at the Toronto Zoo involves developing technologies to overcome barriers to reproduction and allowing endangered species to repopulate. Dr. Gabriela Mastromonaco, Curator of Reproductive Programs and Research at the Toronto Zoo, believes that, "Zoos are the only groups at the forefront of this research that look to overcome the challenges to reproductive success in wildlife."

Her personal experience with Canadian Wood Bison illustrates the impact that such research can have. Canadian Wood Bison are a genetically distinct subspecies of bison. Their populations are threatened in Canada, with only 3,500 individuals remaining in the wild. The numbers declined as a result of an infection spread from imported European cattle, and from population culling by the domestic cattle industry.

To help preserve the species, Parks Canada assembled a team that included Dr. Mastromonaco's lab, to try to enhance the reproductive success of bison and, ultimately, conserve the subspecies. The result? Pioneering efforts in sperm and embryo banking, artificial insemination and in vitro fertilization (IVF). These breakthroughs enabled the preservation of genetic diversity and the restoration of genetic material that would have been lost if the endangered bison had vanished. The team's accomplishments included the live birth of a calf from sperm that had been frozen for 30 years. Soon after, they succeeded with the world's first frozen-thawed IVF embryo transfer of a wild animal.

The success of this research means that future species conservation efforts will not require relocating animals to different habitats. Instead, frozen cells can be transferred from one research lab to another. "Think about 2070, when only sperm and embryos are moving around the world," says Dr. Mastromonaco. These advances in reproductive technology have the potential to enable global population manage-

ment regardless of where species originate from, what borders prevent their migration and what barriers to reproductive success they experience.

The concept of a zoo has changed significantly over the years. Today, there are over 10,000 recognized zoos around the world. Modern zoos exhibiting good practice are no longer considered places where animals live in captivity, but are places where animals live under human care. They are set up primarily for the conservation of endangered species, for educational purposes and for scientific research. Modern zoos strive to provide naturalistic habitats with enriched environments so animals receive sufficient cognitive stimulation. Animals are given control over their environments in order to exhibit species-typical behaviours. Not, as in the old days, hosting tea parties. In short, modern zoos are animal-centric, placing the well-being of wildlife above all else. Hopefully now, Dr MacDonald's inner 9-year-old can feel proud of her role in continuing efforts to shape the modern zoo.

VOLUNTEER PROFILE

Asad Siddiqui is a regular volunteer for RCIScience, often lending a hand during registration at our Science Sunday events in downtown Toronto.

After completing a B.Eng in nuclear engineering, Asad wanted to continue learning so attended a few #RCITalks.

Wanting to bridge the gap between science and the public, he quickly became a volunteer, hoping one day to host his own science-themed events for under-served communities.

His most memorable moment volunteering for RCIScience was meeting Dr. Robert Thirsk, thinking "Woah, this is somebody who's been to space... and I'm getting to meet him in person?"

Asad is currently working to become a full stack developer and in his free time can often be found reading in coffee shops, spending time with family and friends or photographing the moon during its waning periods!

CAZA AZAC
CANADA'S ACCREDITED ZOOS AND AQUARIUMS
AQUARIUMS ET ZOOS ACCRÉDITÉS DU CANADA

ZOO ACCREDITATION

Unfortunately, not all Canadian zoos are as exceptional as the Toronto Zoo.

In fact, only 29 out of a total of 160 zoos are accredited in Canada. With thousands of zoos across the globe, what measures can be taken to ensure the wellbeing of the animals living in them?

Dr. Susan Shafer is the Executive Director of Canada's Accredited Zoos and Aquariums (CAZA).

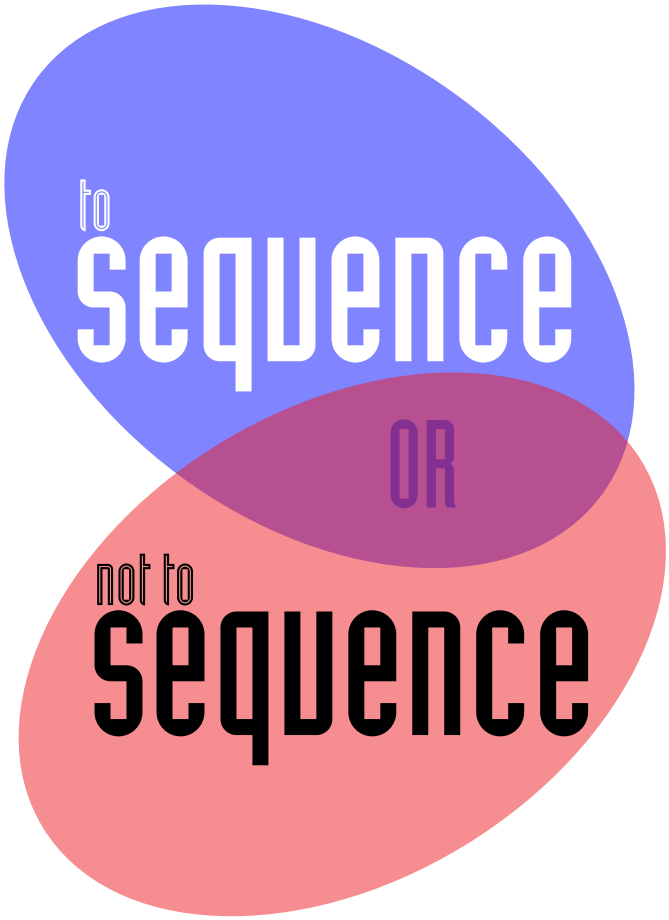
This is a professional organization concerned with animal welfare and human safety in zoos and aquariums.

Dr. Shafer suggests **three measures** to ensure good zoos:

1. Zoos must have a clearly-stated mission. A zoo must make it clear whether it will focus its efforts on animal rescue, conservational research, education, or something else.

2. Running a zoo requires a massive workforce of employees, volunteers and community members. It is crucial for these individuals to have an understanding of the science that underlies how to best care for the various species living in captivity.

3. All zoos can benefit from becoming accredited and following the best practice standards put forth by organizations such as CAZA.



That is the question.

By Annoj Thavalingam

Moving from frontier-smashing innovation to a commonplace, commercial service.

"How many people here have sequenced their genome?"

This was the question posed by eminent Harvard geneticist, Dr. George Church, to hundreds attending his public lecture, presented by RCIScience, Ontario Genomics and the Gairdner Foundation. Only three hands went up.

Since the first successful sequencing of the human genome in 2001, the cost of whole genome sequencing has plummeted from hundreds of millions of dollars to about one hundred per sample. It has also moved from frontier-smashing innovation to a commonplace, commercial service.

The information gleaned from DNA sequencing technologies spans your past, present and future. From insights into the patchwork of your ancestry to the likelihood of developing certain diseases, there are tales and prophecies encrypted within your DNA, just waiting to be told.

So what's holding people back? Dr. Church believes that our perception of DNA sequencing is a key factor. Specifically, how we perceive its cost, utility and impact on our privacy. With the cost dropping precipitously over the past two decades, the value to individuals cannot be denied. But that value also extends to third parties, including employers and insurers.

Simply put, neither employers nor insurers want to invest in individuals with reduced lifespans. Since your DNA sequence can offer a glimpse into future health issues, the denial of opportunities based on your genes would constitute genetic discrimination.

Fortunately, the Canadian government passed the Genetic Non-Discrimination Act (GNDA) in 2017, which prohibits the solicitation of genetic test results by third parties. However, as Dr. Church notes, "Nobody can pry [your genome] loose from you, but they can just go and collect the DNA off [your] chair, so be wary of that particular loophole."

Most diseases emerge through a combination of genetic and environmental factors. However, a small number of diseases are caused solely by genetic mutations, such as cystic fibrosis, Tay-Sachs disease and Duchenne muscular dystrophy. While DNA sequencing can detail the genetic abnormality driving the disorder, the question remains if there is a possibility of correcting the mutation and eliminating a disease.

One emerging solution is gene editing - the modification of specific sites of DNA. The premise seems simple. Identify the faulty strand of DNA and, by insertion or deletion of relevant nucleotides (the building blocks of DNA and RNA), fix the code. The technology at the forefront of this field uses CRISPR-Cas9. This two-component system consists of RNA, which binds to complementary DNA, and the Cas9 protein, which cleaves the DNA at a precise location to facilitate repair.

Dr. George Church in conversation with Dr. Steven Scherer and Dr. Reinhart Reithmeier

In laboratories, CRISPR-Cas9 has successfully edited the genomes of many varieties of cells. Its use in humans to treat disease, however, has been hindered by safety and ethical concerns. The reality is that many genes are pleiotropic, that is, they can influence multiple characteristics of an organism. Since we don't yet have a complete understanding of how a pleiotropic gene affects the phenotypes it regulates, there is the potential for unintended consequences when that gene is edited. Indeed, the use of CRISPR-Cas9 in mice models has lead to unexpected deletions in targeted genes. Additionally, the system can target DNA non-specifically at times, resulting in undesirable mutations elsewhere in the genome.

Despite these dangers, biophysicist Dr. He Jiankui reportedly edited the germline (inheritable) cells of an embryo to enhance its resistance to HIV infection in 2018. Following the procedure, twin girls were born in late 2018, and while genetic anomalies have not been reported by Jiankui's team, the infants' future health remains uncertain.

The experiment's disregard for caution and ethics made headlines around the world. But with the gene editing field rapidly evolving, Dr. Church remains optimistic that, one day, it will provide a safe and effective treatment for genetic disorders.

DNA sequencing, it turns out, could play an important role in providing a more complete picture of gene networks and interactions. The genomic sequence of any one individual is an indecipherable jumble of nucleotides, but when thousands upon thousands of whole genomes are analyzed side-by-side, along with matching medical histories, the effects that specific genes have on health can be better discerned.

Dr. Church is the architect behind a project with exactly this goal. The Personal Genome Project (PGP) is an open-access database where the environmental, genomic and trait data of participants are uploaded for analysis by researchers. Since its inception in 2005, many countries have established their own PGP chapters, including Canada's own PGP-C, launched by the University of Toronto's Dr. Stephen Scherer. "Many of us believe that the genome is going to be like a Global Positioning-type System," explains Dr. Scherer, "where once we get more and more data to compare against, it'll start to make more and more sense."

With the sharp decline in costs for DNA sequencing, the possibility of annotating the human genome in all its richness is a step closer to reality. To achieve this goal, human genome databases rely on the accumulation of DNA sequences from the public. While these databases maintain confidentiality, your genome is also no longer in your hands. So then to sequence, or not to sequence? That is the question.

"A conversation with George Church" was delivered in partnership with Ontario Genomics and the Gairdner Foundation.

CLIMATE CHANGE

By Nicholas Demers

CLIMATE CHANGE is one of the most prevalent public issues of our time and research has a lot to say about it. RCIScience hosted several researchers and people who work in the field of climate change at each of our main locations: Toronto, Ottawa and Waterloo in 2018-19. We explored various facets of climate change, from forecasting extreme weather events at a local level using global climate models, to the health and economic effects of these events on Canadians.

Extreme weather is a meteorological event that far exceeds normal weather conditions and variations. Extreme weather has always existed, but recent years have seen an increase in these events. 2018 saw catastrophic flooding in southern France, destructive forest fires in British Columbia and a devastating water shortage in Capetown, South Africa. Municipalities in eastern Canada are overwhelmed by heavy rain events in summer, while the north and west experience drought.

Dr. Maya Papineau, an environmental economist from Carleton University uses insurance data to show the economic impact of severe weather. Insurance payouts have doubled every 5-10 years since the 1980s. She notes that nearly one fifth of Canadians live in flood-prone regions already, and extreme weather in the form of large storms is likely to increase flooding in urban areas. Insurance companies may find it impossible to insure certain homes, which could lead to mortgage defaults. Dr. Papineau describes climate change as a market failure. That is, a situation in which the outcome of market activity is not optimal for society.

Dr. Peter Berry of the University of Ottawa studies how extreme weather events, and climate change in general, directly affects our health. He gives as example in the slow, northward march of Lyme Disease as temperatures in southern Canada expand the habitat for the infected ticks. Heat-related deaths are also on the rise. In 2018, 93 people in Quebec died due to heat-related causes. Some might have died in a normal summer heat, but with 9 of the 10 hottest years on record occurring since 2005, and the global average temperature consistently above that measured between 1951 and 1980, the link between these deaths

and extreme heat events due to climate change is solidifying.

Our mental health can suffer too. Interviews with people who have lost everything to flood, fire or tornadoes are becoming all too common on the nightly news. Longer lasting mental health effects are starting to surface, such as the measurable increase in PTSD observed in people who had lived through the firestorms of Fort McMurray in 2016.

All of this exerts a toll on our public systems and infrastructure. The lack of coordinated planning for climate change is a disturbing trend in Canada. Dr. Warren Mabee of Queen's University notes that 170 or more municipalities across Canada, home to about 50% of our country's population, have climate change action plans to help inform their specific urban planning. Unfortunately, most of these plans include elements outside of the municipality's authority. Consequently, though Canadian cities attacked these plans with enthusiasm in the mid-2000s, more than 100 of them have realised little to no outcomes. Further, a lack of coordinated data collection on activities such as how we use energy or get to work, means that many of these plans are based on guesses rather than real evidence. And of course, a lack of intergovernmental cooperation almost guarantees that these plans will fail.

Dana Decent was, until recently, Manager of the Intact Centre on Climate Adaptation. This is a partnership between Intact Financial and the University of Waterloo to prepare Canadians for the impacts of climate change. Ms. Decent outlined some specifics of a community climate action plan enacted in the City of Waterloo that included improving community resiliency through design standards to mitigate the effects of flooding, and to reduce the risk to homeowners through a Home Flood Protection Program, coupled with training home inspectors on flood risks.

Ms. Decent's work points to some of the opportunities that are emerging from the gloomy forecasts of climate change. Urban plans that encourage active transportation in favour of the car both reduce emissions and can lead to positive health outcomes. Participatory democracy has a chance to get stronger. Polls show that most Canadians support action to limit climate change, forcing politicians to engage with them on the issue. To create effective climate change action plans, better coordination needs to happen between the various levels of government, which should have a knock-on effect in wider society. And there's plenty of work for new researchers to do collecting data to inform climate action plans and about the impacts of climate change.

Canada is feeling the effects of climate change more keenly than some countries, particularly in the far north. There, no matter what actions the world takes now to reduce greenhouse gas emissions, temperatures will continue to rise into the middle of this century. This points to an urgency in Canada to prepare for this change and to do as much as possible to understand how this global phenomenon exerts very local, even personal, consequences.

Scaling global climate change down to investigate its effects at the local level is how Dr. Richard Peltier, a geophysicist at the University of Toronto, turned his interest in thermal convection on Earth into an internationally-recognized method of generating computational models of climate. Dr. Peltier's work scales global climate models down to the local level to help uncover the connection between climate change and extreme weather.

"It is an unassailable truth that atmospheric carbon dioxide is caused by human-induced fossil fuel burning and that the CO2 increase is the unambiguous cause of the continuing rise of mean surface temperature over the past 50 years. There is no alternative to this truth." DR. RICHARD PELTIER

His work makes it very clear that we are experiencing more extreme weather because of climate change. That said, predicting the specific effects of climate change is not easy. Computerised models of planet Earth use the fundamental physics of energy absorption and convection to predict what will happen over time. The Community Earth System Model (CESM), features three-dimensional oceans, three-dimensional atmospheres and the circulation within each, as well as sea ice cover, and small scale processes like rain. CESM can make predictions to a resolution of about 100km.

To turn these predictions to something useful on a local scale, Dr. Peltier uses a technique called dynamic downscaling, in which all of the data within

a global model is scaled down to a small area with higher resolution. He first scales it to the size of a continent, then again to the size of a domain like the Great Lakes basin. By incorporating the large amount of data, extremely accurate predictions can be made about the local effects of climate change.

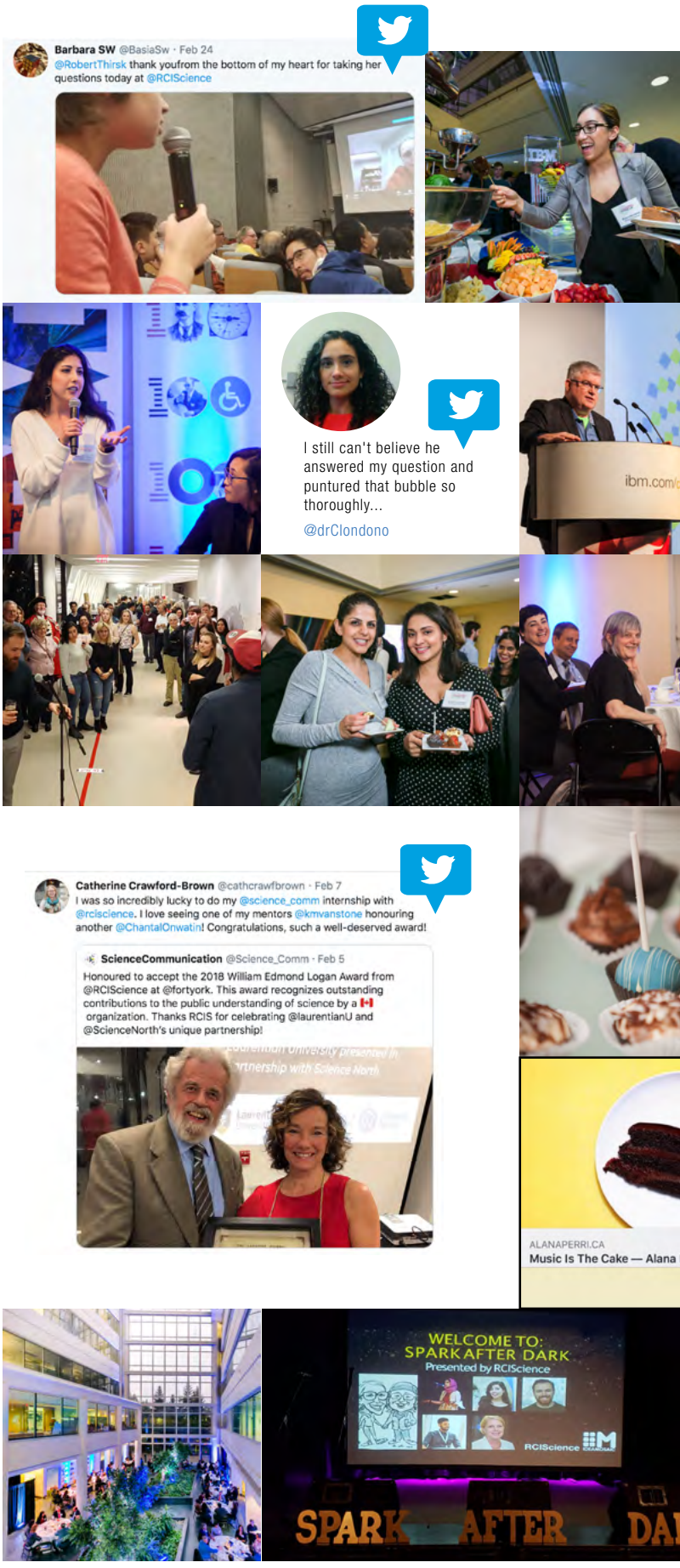
The news is, sadly, not good. Global models predict that by 2100, the average temperature will increase by 2.5-3.5 degrees in the Great Lakes region. Dr. Peltier's higher resolution model suggests that the average surface temperature will, in fact, increase by 3.5-4 degrees by 2050.

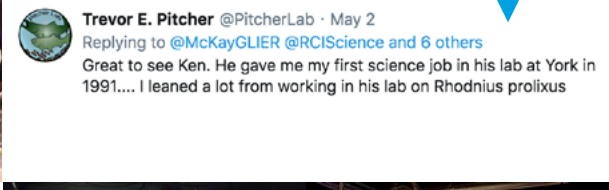
Dynamic downscaling can also be used to predict extreme weather events. Dr. Peltier's team tested this by using the model to generate predictions for the past, then comparing the predictions to the actual weather observed at Pearson International Airport in Toronto. From 1989-90, the model predicted that, during an extreme weather event, an average of 102 mm of rain or snow would fall per day. The observed number was 100 mm. Turning an eye to the future, the models forecast that, by 2050, 150mm of rain or snow will fall during extreme events, an increase of 50mm, or 30% over 1990 levels.

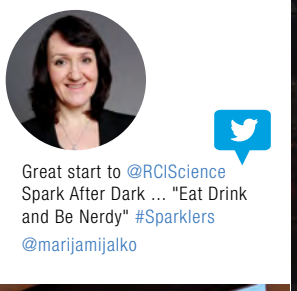
The power of these models can be applied to other regions as well. Peltier's model predicts that British Columbia, traditionally a wet place, will have far less precipitation by 2100. By contrast, Alberta, which has been traditionally dry, will become much wetter.

Although these computational modeling techniques are extremely complex, the bottom line is simple. If significant changes aren't made in fossil fuel consumption immediately then global warming will continue. As a result of this global warming we can expect extreme weather events to increase in severity and frequency. As Dr. Peltier phrases it—it's simple thermodynamics.

Dr. Peter Berry, Climate Change is Real, Now What? (Ottawa, 2019)

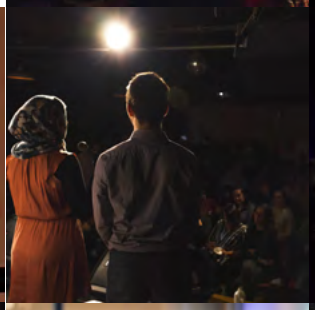



Trevor E. Pitcher @PitcherLab · May 2
Replying to @McKayGLIER @RCIScience and 6 others
Great to see Ken. He gave me my first science job in his lab at York in 1991.... I leaned a lot from working in his lab on Rhodnius prolixus


Great start to @RCIScience Spark After Dark ... "Eat Drink and Be Nerdy" #Sparklers @marijamijalko


WELCOME TO:
SPARK AFTER DARK

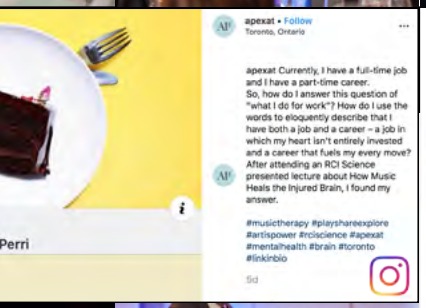

Entanglement
CAN'T HACK MARRIAGE? TRY QUANTUM ENTANGLEMENT INSTEAD
Only Lovers Left Alive
UNIVERSITY OF WATERLOO | IQC




Meet the presenters:
Aidan Dahlin Nolan &
Leigh Paulseth
@SciXchangeRU

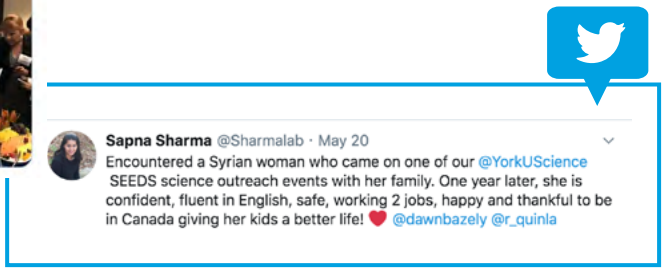

Ive Velikova (she/her) @ScienceWithIve · May 22
So... here's me explaining to an entire bar what a hot flash feels like
Thank you thank you THANK YOU to @IdeaMosaic @RCIScience for giving me an opportunity to share my tragic story at a comedy variety show
It's scary to be vulnerable, yet important to do it anyway
A 22-Year-Old's Guide to Menopaus


Meet the presenter:
Selvyn Simoes


apexat • Follow
Toronto, Ontario
apexat Currently, I have a full-time job and I have a part-time career. So, how do I answer this question of "what I do for work"? How do I use the words to eloquently describe that I have both a job and a career – a job in which my heart isn't entirely invested and a career that fuels my every move? After attending an RCI Science presented lecture about How Music Heals the Injured Brain, I found my answer.
#musictherapy #playshareexplore #artispower #rciscience #apexat #mentalhealth #brain #toronto #linkinbio
5d
Perri


Raphie (りん) @xsakuraphie · May 1
Had such a blast at the @RCIScience dinner tonight!!!
Thanks for hosting us, and thanks #UofTBiochem for the invite :D
I probably learned more science tonight than I did these two years in lab... (shhhhhhhh


Celebrating
Toronto's
Scientific He


Sapna Sharma @Sharmalab · May 20
Encountered a Syrian woman who came on one of our @YorkUScience SEEDS science outreach events with her family. One year later, she is confident, fluent in English, safe, working 2 jobs, happy and thankful to be in Canada giving her kids a better life! @dawnbazely @r_quinla

RCIScience
Royal Canadian Institute for Science

ROYAL CANADIAN INSTITUTE

Statement of Financial Position *As at June 30*		
	2019	2018
ASSETS		
Cash, receivables & prepaid expenses	**$11,619**	$21,986
Investments	**$1,353,812**	$1,505,457
Portraits & archive items	**$3,200**	$3,200
	$1,368,631	**$1,530,643**
LIABILITIES		
Current		
Accounts payable and accrued liabilities	**$32,811**	$47,897
Deferred grant revenue	**$16,651**	$23,050
	$49,462	$70,947
NET ASSETS	**$1,319,169**	**$1,459,696**

Statement of Operations and Changes in Net Assets		
	Year end June 30, 2019	March 1, 2017 to June 30, 2018
REVENUE		
Investment income	**$37,787**	$62,791
Fundraising events	**$33,358**	$94,950
Grant Revenue	**$30,449**	$8,550
Donations & Membership Fees	**$27,217**	$48,080
	$128,811	$214,371
EXPENSES		
Staffing	**$145,248**	$136,478
Program Costs	**$50,337**	$61,641
Fundraising	**$14,527**	$77,165
Investment Management	**$10,273**	$14,129
Professional fees	**$9,438**	$9,355
Office expense & Insurance	**$9,193**	$19,300
Science Scholarship	**$5,000**	$1,000
Governance & Board	**$2,872**	$4,575
	$246,888	$323,643
Unrealized gain (loss) on investments	**-$22,450**	$27,668
Net assets, beginning of year	**$1,459,696**	$1,541,300
Net assets, end of year	**$1,319,169**	$1,459,696

"I really enjoy attending your lectures."

"Seeing theory turned into practice made it real."

"Keep up the excellent level of topics!"

"You people make science fun!"

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