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In 5 seconds

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By Jeff Heinrich • Oct 29th, 2026

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Just in time for the 21st anniversary of its founding at Université de Montréal, the International Laboratory for Brain, Music and Sound Research (BRAMS, for short) has a new laboratory, an unusual one where immersive technology meets the science of music, movement and the brain.

It's called MUMI – the Music & Movement Immersive Lab. Built at a cost of $3 million, part of $9.1 million BRAMS has been funded by the Canada Foundation for Innovation, it promises to advance research into how the human brain responds to visual and audio cues.

How does a pianist deal with stage fright, playing before a tough audience, and can a way be found to rise above it? How can it be made easier for a Parkinson's patient to walk along a crowded city street? How can the crushing anxiety be taken out of public speaking?

Those are just a few examples of what cognitive neuroscientists will explore at the MUMI, led by BRAMS co-director Simone Dalla Bella, an UdeM psychology professor and holder of a Canada Research Chair in Music Auditory-Motor Skill Learning and New Technologies.



Located in UdeM's Marie-Victorin pavillion, the 35-square-metre lab is a windowless room where neuroscientists recreate real-life situations under controlled conditions and measure participants' movements, behaviour, brain activity and physiology.

"We'll be immersing people in soundscapes and dynamic visual environments, making them move and interact with their surroundings, while capturing their responses for research purposes," said Dalla Bella.

"As a lab, there's really nothing quite like it in North America. We bring together immersive sound and visuals with cutting-edge technologies to study how music affects the brain and body."

The MUMI boasts an immersive visual environment, 3D spatialized sound, two self-paced treadmills, and motion-capture cameras, making it possible, for example, to simulate strolling in a park, on a busy street, or in other complex settings.

The audiovisual environment can be altered in real time as participants move within the space, enabling brain scientists to precisely study how people get about, how they coordinate with each other, and how their hearing, vision and movement interact.

Lots of technology

The lab is tech-heavy – impressively so, as visitors at an inaugural open-house event Oct. 26 will get a chance to see. (The event continues Oct. 27 at UdeM's Roger-Gaudry Pavilion before moving to McGill for a third day of presentations Oct. 28.)

For a variety of uses – initially, for piano performance and Parkinson's research – the MUMI room has a sensor-equipped Bösendorfer Imperial grand piano (see sidebar below), the two in-ground treadmills, two overhead projectors running CANVAS immersive software, a curved projection screen that takes up the whole back wall, 16 Geneclec loudspeakers and Qualisys 'Miqus' motion-capture cameras, and several computers running specialized software including REAPER (Rapid Environment for Audio Production, Engineering, and Recording) to process digital audio.

Launched in 2005 as a joint project of UdeM and McGill University, BRAMS was initially co-run by its founders, UdeM psychology professor Isabelle Peretz (Dalla Bella's PhD thesis supervisor in the late 1990s) and Montreal Neurological Institute professor Robert Zatorre. Boosted by CFI funding that began flowing in in 2007, the centre quickly gained world renown for its study of the biological foundations of music. Dalla Bella, a classically trained Italian pianist recruited from the University of Montpellier, in France, took over from Peretz as co-director in 2018.

BRAMS' sophisticated technological platforms – among the most comprehensive in the world – are almost entirely located at UdeM and include five soundproof testing rooms, three fNIRS (functional near-infrared spectroscopy) systems, a TMS (transcranial magnetic stimulation) system, seven EEG (electroencephalography) systems, six BIOPAC systems (recording physiological responses) a hemi-anechoic room with a dome of 80 speakers, and a motion-capture video lab.

McGill, for its part, takes care of brain imaging and stimulation at the Neuro.



Demonstration of a research project at MUMI

A piano project already underway

Between 100 and 150 student trainees a year have access to the BRAMS technology to do research. And now, they have the MUMI.

"It's a great opportunity for me," said Emmanuel Adam-Marsolais, 25, a second-year master's student in neuroscience at UdeM who's leading the MUMI's first research project, supervised by Dalla Bella: a study centred on playing the Bösendorfer.

"We're looking at the effects of feedback on a performer's anxiety and performance," said Adam-Marsolais, who in July began recruiting his subjects, 24 to 30 young pianists between the ages of 18 and 35 who have at least five years experience at the keyboard.

“They come into this immersive environment, we hook them up with electrodes, and while they play we measure their heart rate, breathing and sweating, and before and after we take saliva samples for cortisol, the stress hormone. They also fill out questionnaires before and after.”

Demonstrating at the piano on a recent afternoon, Adam-Marsolais played some Bach, deliberately hitting some wrong notes. Out of sight at his computer, Dalla Bella tapped in a series of Krotos Studio audio cues for the pianist to hear from the speakers: things like gasps from the audience.

For his research, Adam-Marsolais will collect information from such simulations to build an extensive database on the physiological changes a performer goes through when playing to a live audience.

Previous studies have simulated audiences by having them appear on screens or in virtual-reality headsets, but these approaches can limit how naturally musicians perform.

The novelty of Adam-Marsolais' study is its immersiveness, which allows pianists to perform naturally without wearing a headset: the experience is multisensorial. And the researchers control everything about it, from set-up to completion, all the while taking objective measures of a player's stress during performance, capturing it in data.

Besides cueing negative reactions from the phantom audience, to induce errors the researchers give participants only 15 minutes to learn a new piece, speed up the metronome they play to. They then measure how these challenges affect their performance, how they perceive anxiety, and what changes appear in their body's physiological responses.

"What do the participants get out of it?" said Adam-Marsolais. “Well, a better idea of how they perform, for one, and a better understanding of what goes on in themselves during a performance so that they can better adjust in the future.”

Ultimately, the technology can also be used for other types of performance: in sports, for example, or in the workplace, where staff have to give verbal presentations. "Musical performance is just one model among many," Adam-Marsolais said. "But it's a good model."



A Parkinson's study, too

When it's not being used for the piano project, the MUMI – and more precisely, its treadmills – is turned over to a parallel project: simulating through virtual reality a typical outdoor setting that someone with Parkinson's disease might to pass through in daily life.

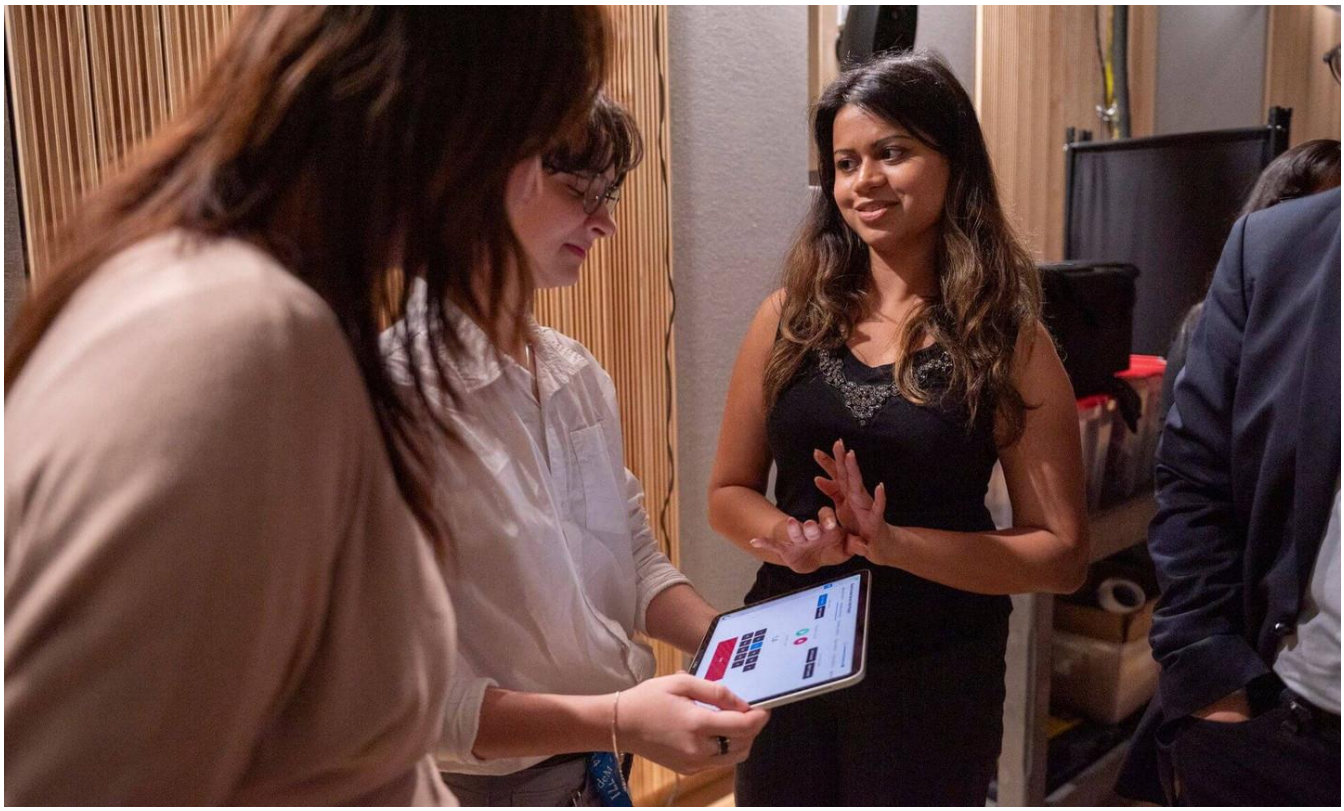
"We'd like to integrate a conventional rehabilitation technique for Parkinson's patients into the immersive environment," said Emilie You, 23, a PhD student in clinical neuropsychology beginning the research this fall under Dalla Bella's supervision. “It's called rhythmic auditory cueing: making patients walk to music

that has a specific beat. By increasing the tempo – say, by 10 per cent – we help them take longer steps and ultimately walk a little faster.”

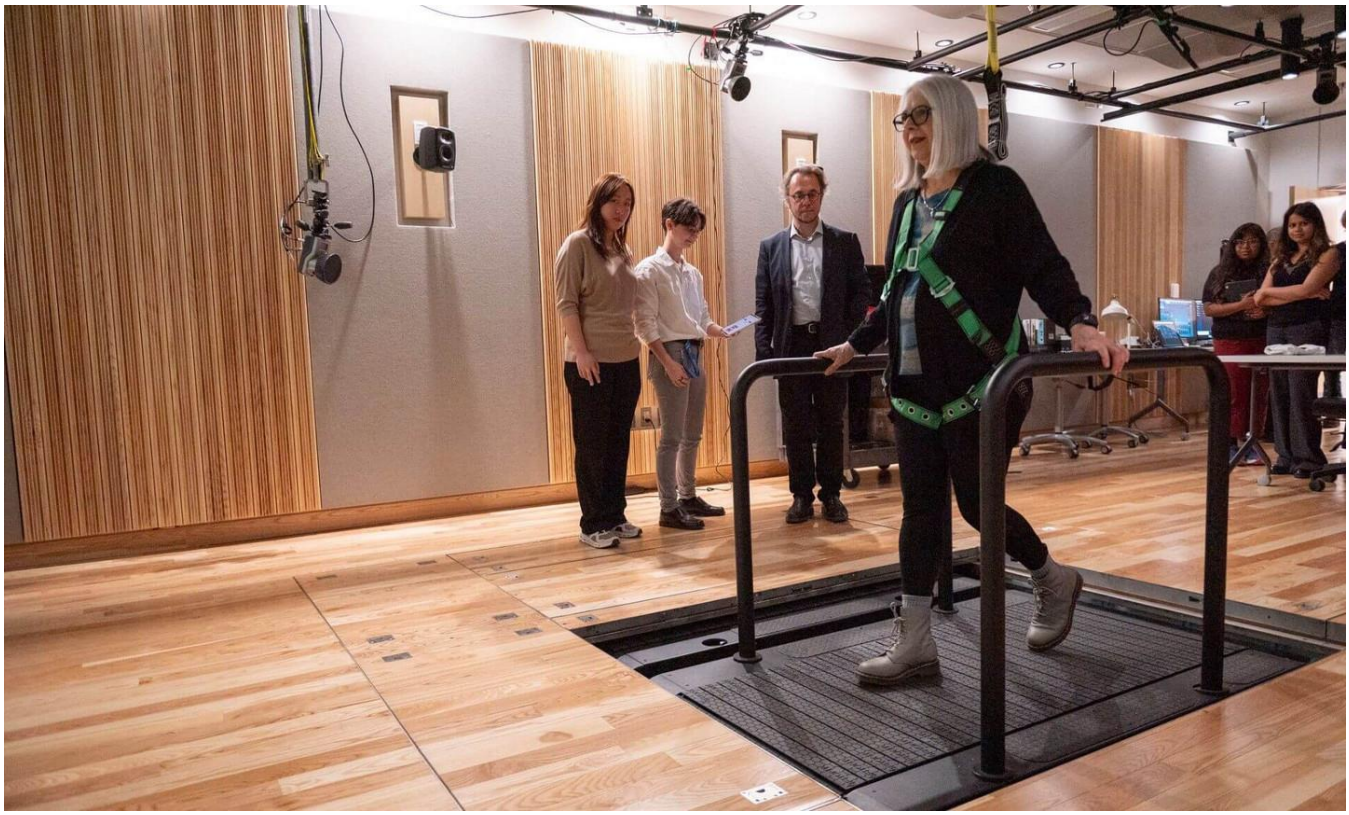
Normally, that technique has its limits: rather than multisensory, it's confined to one thing or another, such as simply listening to audio. But because the MUMI is equipped to provide both visual and auditory cues, patients get a fuller, more realistic experience. Added to that are tactile cues: haptic sensors, placed for example in a backpack or around the ankles, are made to vibrate to tell them when to start walking and when to stop.

"It's like when you dance," said Dalla Bella. “You have a lot of cues as you move around the floor: your body is synchronized to the music you hear, it's synchronized to the partner you see, you may feel a hand on your back guiding you, so that's tactile, too. We can accomplish all those things in our immersive lab, doing things that conventional techniques cannot.”

The treadmills retract into the floor of the lab. When in use, patients will wear EEG caps to capture their brain activity during closely monitored experiments. The treadmills also run on artificial intelligence, making them active: cameras to each side detect the steps the patient is taking and the treadmill speeds up or slows down whenever he or she does.







40 participants sought

The researchers aim to enroll 40 participants recruited through various channels, including organizations such as the those that work directly with Parkinson's patients. On the MUMI's big screen, they'll be presented with a variety of scenes: a path winding through a park, a side street in a quiet rural town, a busy city street, and so on.

"We'll be manipulating the cognitive load of the scene," said Dalla Bella, “adding stimuli to make the participants' walk more challenging, and measure their movements and brain response.”

The stimuli can be as simple as upping the number of bird calls in the audio mix, or as complex as running words on the screen and getting participants to identify them, or having them do other cognitive tasks such as naming shapes or memorizing information – all while they walk.

Over time, the MUMI will lend itself to work in other domains.

"We're not a clinical medical lab," Dalla Bella noted. “We're focused on fundamental research on rhythm, whether that's pertinent to Parkinson's or any other condition, including the risk of falls that comes with ageing.”

He added: "Multi-sensory cueing can be preventive, it can be instructive, and it also provides the material we need to keep pushing the research forward. Ultimately, that's our goal: to do more research that matters."

The BRAMS' Bösendorfer: more than just a great piano

BRAMS owns a truly exceptional instrument: a Bösendorfer Imperial 290, a 2.90-meter concert grand piano with 97 keys—eight full octaves—rather than the 88 keys of a conventional piano.

But what makes the piano particularly valuable for research is that it is equipped with the CEUS system, developed by Bösendorfer to record the pianist’s performance with extremely high precision.

Optical sensors measure the movements of the keys, hammers, and pedals at very high resolution—up to 500 measurements per second. This allows for an extremely detailed analysis of timing, dynamics, articulation, pedal use, and, more generally, the way the pianist controls the instrument.





The system also allows for the mechanical reproduction of a recorded performance: the piano can replay, using its own keys and pedals, the parameters of a previously captured performance. This makes it both a true concert piano and a scientific instrument for studying motor control, pianistic touch, expressiveness, and the biomechanics of performance.

It also has a rather remarkable history. When UdeM acquired it in 2005 it was the first piano equipped with the new CEUS system delivered by Bösendorfer. At that time, it was indeed the only one of its kind in North America, and likely the first production model of this system to be put into service in a research laboratory.

Other Bösendorfer CEUS pianos subsequently arrived in North America: as early as 2009, there were at least five, including three Imperial 290s. Today, though the one at BRAMS is by no means the only one, it remains one of the very few Bösendorfer Imperial 290s equipped with the CEUS system in North America—and, above all, one of the very first in history.

For more on the connections between piano performance, music and the brain, with recordings made at BRAMS's Music & Movement Immersive lab, check out Simone Dalla Bella's YouTube channel: https://www.youtube.com/@SimoneDallaBella

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