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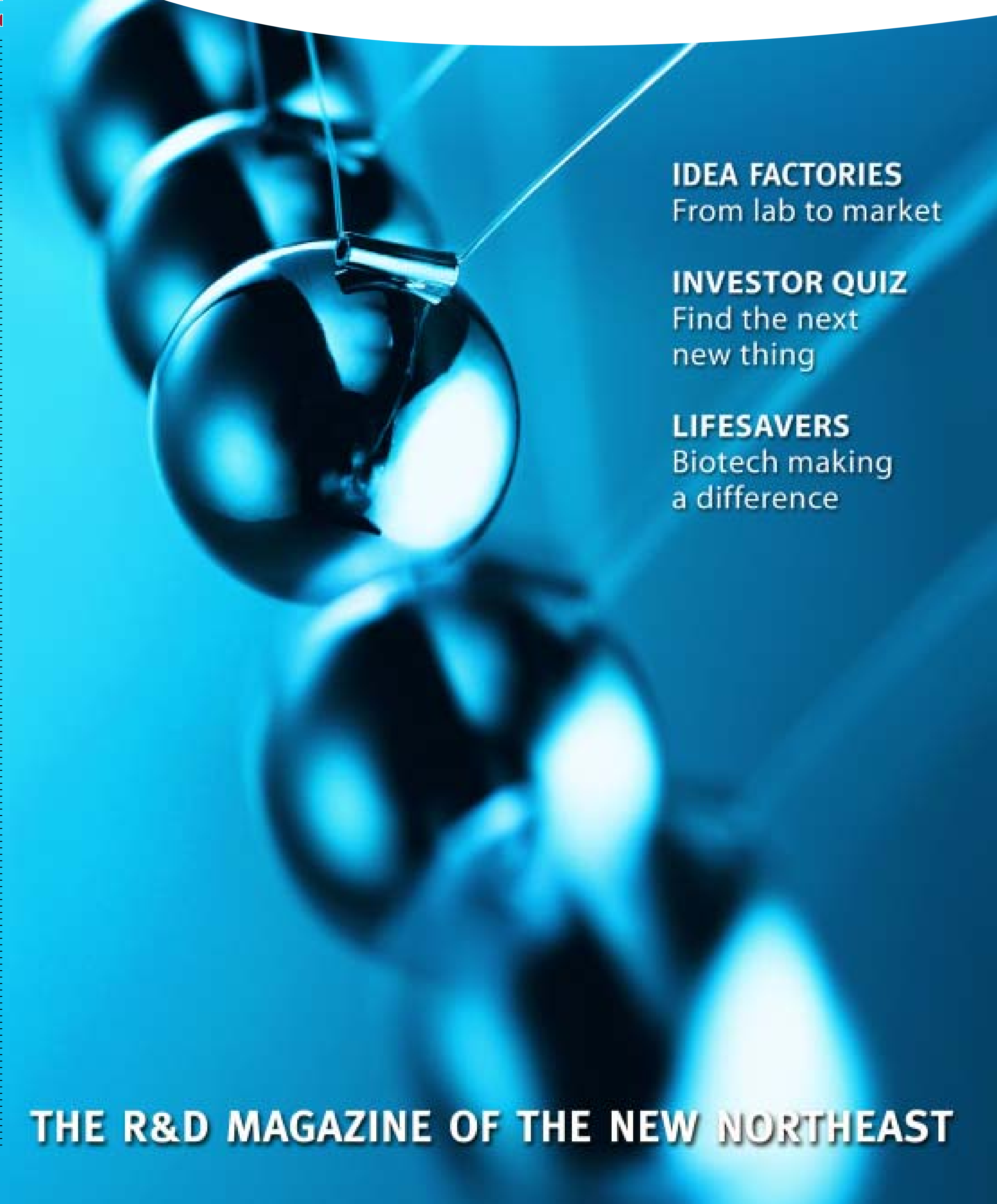

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BRAIN POTENTIALS

***John Connolly's** brain-response testing technique enables communication with patients unable to speak*

COURTESY JOHN CONNOLLY

Connolly developed the technique by studying the brain responses of healthy graduate students.

Using an electroencephalograph (EEG) machine, doctors can obtain what are called event-related brain potentials, which are the brain's responses to events in the environment. A computer connected to the EEG both controls the stimulations and measures the brain responses

The clock starts ticking a millisecond after a tiny blood vessel bursts in the brain. By the time a stroke victim reaches a hospital, doctors are working to prevent vital neurons from being destroyed. The next several hours are critical. With the right drugs and therapy, the patient's odds of avoiding permanent disability or death are vastly improved. Communication between doctor and patient is vital; the trouble is that stroke victims are often unable to speak for at least a week, making some therapeutic decisions difficult or impossible.

Those odds could be improving soon, thanks to a Halifax scientist. John Connolly is a researcher with Dalhousie University's Faculty of Medicine and Dalhousie's Neuroscience Institute. He has developed a revolutionary new technique that allows doctors to peer into the brains of people who are unable to communicate. The technique involves stimulating a patient's brain in predictable ways and then monitoring the responses. Using an electroencephalograph (EEG) machine, doctors can obtain what are called event-related brain potentials, which are the brain's responses to events in the environment. A computer connected to the EEG both controls the stimulations and measures the brain responses. If the patient understands and responds properly, doctors can administer crucial therapy.

John Connolly

It sounds a little like science fiction, but Connolly says it's actually quite simple. "Ironically, we use some of the oldest technology available," he says. It works because the event-related potentials occur at highly predictable and precise moments. "For example, if you show a patient a picture of a ball, and you say the word 'car,' the graph will indicate whether the patient recognizes the mistake," he explains.

Connolly developed the technique by studying the brain responses of healthy graduate students, but his first clinical test was dramatic. A patient at a Halifax hospital had been the victim of a violent attack; a large knife was plunged deep into his skull, causing extensive brain damage. The man was unable to communicate, respond, or move.

Connolly's test revealed that the patient had a conscious and functioning brain; he was aware of his surroundings and fully understood people when they spoke to him. "Knowing that meant that he might respond to therapy," says Connolly. "That information was crucial." Several months later, after intensive rehabilitation that had been withheld initially because the patient was judged to be mentally incapacitated, he walked out of the Nova Scotia Rehabilitation Centre.

The potential applications are broad. Connolly has used these techniques to investigate reading problems in children and adults by watching their brain function change during a reading remediation process. Children with spastic quadriplegic cerebral palsy often are labelled as mentally challenged, even though many have normal mental abilities. Knowing their level of intelligence means they can get the education and therapy they need. Connolly and his colleagues also are working with coma patients to determine whether these measures can be used to check for signs of awareness.

Today the scientist divides his time between his Halifax laboratory and the University of Western Ontario in London, where he is conducting clinical trials. He also is working closely with the National Research Council of Canada to develop commercial applications—in particular, a portable device that accomplishes his technique or a "software patch" that could be added to already existing EEG machines. After a couple of false starts, he has patents pending in both the U.S. and Canada and hopes for the day when every hospital in North America will use the technology.

Connolly's research is supported by the Canadian Institutes of Health Research and the Natural Sciences and Engineering Research Council of Canada, as well as the Dalhousie Medical Research Foundation (DMRF). "DMRF encourages scientific innovation with the intention of improving medical care and treatment," says Jean Sloan, the organization's executive director.

After 10 years of development, Connolly admits that he still has a way to go before his idea turns a profit. "What fool came up with the expression, 'Build a better mousetrap and the world will beat a path to your door?' It's not true," he says. "It takes a lot of hard work to develop something like this. And luck." — **TOM MASON**

For more information, please visit www.dal.ca/~connol/people.html

NEURAL NETWORKS

*The **Brain Repair Centre** takes a multidisciplinary approach to its R&D, involving a network of researchers from Nova Scotia's Capital Health District, Dalhousie University, the IWK Health Centre, and the National Research Council*

In just three years, the Brain Repair Centre (BRC) in Halifax has emerged into the international front lines of neurological research, with innovations as futuristic as robotic telementoring for neurosurgery and neurotransplants for Parkinson's patients.

"We have the only working robotic telementoring program in Canada," says Dr. Ivar Mendez, an internationally renowned neurosurgeon. The BRC chair, who doubles as professor and head of the Neurosurgery Division at Dalhousie University's medical school and the QEII Health Sciences Centre, made medical history two years ago by controlling a robotic arm in Halifax to guide two surgeons in removing a patient's brain tumour in Saint John, N.B.

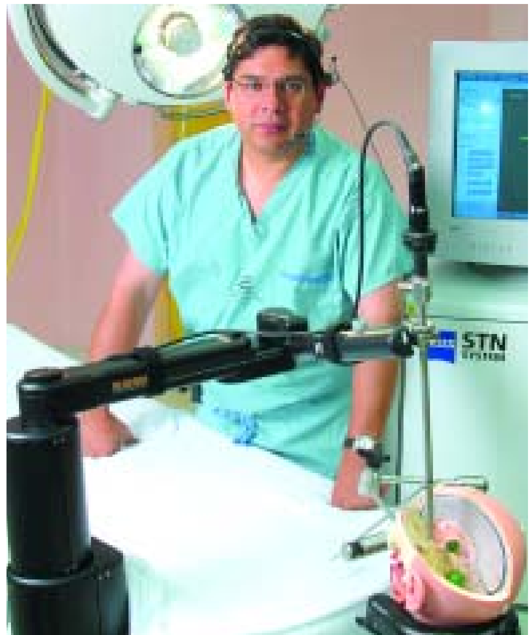
Today the BRC, in conjunction with the Neurosurgery Division, can direct long-distance neurosurgery anywhere on the planet through a new and privately funded telerobotic and telemedicine surgical facility at the QEII. "We have the clinical transplantation program, which

COURTESY BRC

A rare 4 T MRI being delivered to the Halifax Infirmary.

is unique in the country," says Mendez. At the QEII, where the BRC is located, Mendez implants dopamine-producing cells deep into the brains of selected Parkinson's patients to alleviate the tremors and involuntary movement associated with the degenerative disease. Students have come from as far away as Australia and Japan to learn from Mendez and his talented team.

Thanks to its innovative work, the BRC has attracted more than $20 million from government and other sources. The investors see the potential not only for medical breakthroughs but also for commercial spinoffs. The possibilities include new drugs; surgical instruments; medical devices; cell lines; computerized equipment and software; chemical agents called trophic factors, which help nerve cells in transplanted tissue survive in the brain; and protocols for transplanting cells, tissue, or new protective compounds to improve transplantation outcomes. These are the projected offshoots of the BRC's current work in neural transplantation, neuroimaging and neuroprotection, and drug development.



COURTESY BRC

Dr. Ivar Mendez: making medical history with a robotic arm in the operating room.

The BRC was created in 2001 to find treatments and cures for such incurable disorders as Alzheimer's, Parkinson's, Huntington's, amyotrophic lateral sclerosis (ALS), multiple sclerosis, serious mental illness, stroke, traumatic brain injury, and spinal cord injuries, among others. The Centre's goals: restoring function to brains and spinal cords damaged by disease or trauma, promoting recovery, and preventing disease. The approach is multidisciplinary, involving a network of about 100 science researchers, clinicians, students, and technicians from Nova Scotia's Capital Health District, Dalhousie, the IWK Health Centre, and the National Research Council (NRC). The BRC also participates in a broader partnership with governments, research institutes, and the life sciences community.

Determined to maintain its edge, the BRC, in partnership with the NRC, is calibrating a new 4 Tesla magnetic resonance imaging (MRI) system, one of only a handful worldwide. Expected to be ready as early as January of 2005, it will allow researchers to peer at brain functions. The Neuroimaging Research Laboratory at the QEII that houses the MRI can even handle anaesthetized patients from the operating room to be imaged.

Meanwhile, in the Tupper Building at the Dalhousie medical school, and with the support of the Atlantic Canada Opportunities Agency's Atlantic Innovation Fund, the QEII Foundation, the Dalhousie Medical Research Foundation, and various individual research grants, the BRC's new Cell Restoration Laboratory is investigating how stem cells can be used for brain and spinal cord repair. Novel cell lines, new protocols in transplantation, and new instruments and methods to implant cells are expected to be the result. Assisting with the work is a Multi-Photon microscope worth more than $1 million that allows researchers to look at live cells. Unrivalled in Canada, the program is one of four worldwide.

"To be able to offer to Atlantic Canadians world-class service," says Mendez, "you need to be on the leading edge of innovation." The success of the BRC means that new therapies, products, and services tested and developed at the centre will help Atlantic Canadians first. The BRC's planned expansion in the Life Sciences Research Institute Facility will be a quantum leap toward growing the local medical research base, generating new products with commercial potential, attracting multimillion-dollar investment from public and private sources, and helping make Halifax a world-class centre of discovery.

Even the Chinese have taken notice. Mendez has confirmed that China is seeking the BRC's expertise to start its own brain repair program. If you put all of those benefits together, he says, it adds up to "real value." — STAFF

For more information, please visit www.brain-repair.ca