SHORT SCIENCE

HKUST robot judged world's most elegant

A team of engineering students from the Hong Kong University of Science and Technology beat 25 others last month to the Design Elegance Award in a major robotics contest – the 2011 International Student Remotely Operated Vehicle Competition, held at Nasa's Neutral Buoyancy Laboratory in Houston, Texas. In the contest, the robots had to carry out such tasks as collecting water samples, capping a wellhead and rescuing animals, 10 metres under water. The GEAR team of HKUST, making its first appearance in the competition, had 13 engineering students from various disciplines – mechanical engineering, electronic and computer engineering, and computer science. With a design inspired by toy model building bricks, the bodies of the mini-figures can be connected with tools to meet the needs of a real-world ocean workplace. The device can rotate 360 degrees, whereas conventional robots can only rotate up to 180 degrees. Adrian Wan

Air pollution affects learning and memory

Long-term exposure to air pollution can lead to physical changes in the brain – as well as learning and memory problems and even depression – new research in mice suggests. While other studies have shown the damaging effects of polluted air on the heart and lungs, this is one of the first long-term studies to show the negative impact on the brain, said Laura Fonken, lead author of the study and a doctoral student in neuroscience at Ohio State University. In the study, mice were exposed to either filtered air or polluted air for six hours a day, five days a week for nearly half their lifespan. Results showed clear physical differences in the hippocampus – a big part of the brain which deals with learning, memory and depression – of mice exposed to polluted air compared with those who weren't. Adrian Wan

Now we know: smog gives us that sinking feeling. Photo: Bloomberg

Light shimmers off flowers, researchers find

Scientists are showing off a little-known property of some common garden flowers: they're iridescent, meaning that light shimmers off them like the back of a CD. University of Cambridge researchers believe this is intended to catch the eye of busy pollinators – bees find the blooms easier to spot and may prefer flashy flowers over their non-iridescent counterparts. The phenomenon has been relatively little studied until now – iridescence in plants was first formally identified in hibiscus flowers in 2009 – something researcher Silvia Vignolini said might be due to an interesting piece of science hiding in plain sight. "Trivial things, sometimes nobody takes care of them," she said at the opening of the Royal Society's summer science exhibit. "It's weird that after all this time you can discover something new about flowers." AP

THE BRAIN

ILLUSTRATION: BAY LEUNG

CAUSE FOR A RETHINK ON HOW WE LEARN

Scientific progress and technology shine light on deciphering the language of the brain, research that will have immense importance for our species

William Wang

We learn a new word, or make a new friend, or taste a new dish, or undertake any of the innumerable things we do from day to day, and the experience is somehow etched into our brain and filed away in our mental world. If the experience is salient enough, it can be recalled again, even many years later, sometimes with amazing emotional vividness. It is the sum total of these personal experiences that makes each of us absolutely unique as individuals, since no one else could have had exactly the same experiences.

How does the brain do this? How does it take these bits and pieces of diverse experiences, and connect them together to build a coherent mental world?

When we recall an experience, often our language gets involved, with its nouns and verbs, syllables and intonations. But surely there isn't a miniature grammarian working away inside our brain, keeping a diary of our myriad activities, minute by minute. If there were, our inner grammarian would need another grammarian inside his brain to keep his diary, and so on ad infinitum.

When mice were kept in 'enriched' environments with companions and toys, many cortical regions of their brains thickened

So the brain must have its own distinctive language, nothing like the one you and I use. And obviously, being able to decipher the brain's language would have immense importance for our species, in particular for learning how we learn.

It is tempting to compare brains with computers, where any sound or image can be stored as long strings of ones and zeros. But that is only a very poor approximation of how the brain actually does things. The brain is vastly more complicated than any computer that has ever been built. We have only begun to study it scientifically since the start of the 20th century, when a Spanish doctor named Santiago Ramon y Cajal identified its most fundamental unit – the neuron.

According to the latest estimate, our brain has about 100 billion neurons, which communicate with each other across tiny spaces called synapses, not unlike switches in a digital circuit. Unlike digital circuits, however, the sender neuron releases tiny amounts of various chemicals into the synapses, called neurotransmitters, and these determine the behaviour of the receiver neurons.

On average, each neuron is linked to others by 1,000 synapses. So the amount of information that is constantly flowing in our brain is astronomically large. To support all this work, the brain is the most expensive part of our body, in terms of metabolic costs. Although modest in size, only 1.4kg or so, it draws about a fifth of the body's entire blood supply.

Numerous things happen when we learn a new word. Additional blood flows into the relevant regions of the brain. This raises the level of blood oxygen, which can be detected by the technology of magnetic resonance imaging, or MRI.

At the same time, the neurons chatter away with one another by sending pulses of electrical potential down their output arms, their axons. The changes in electrical potential can be monitored by electro-encephalography, or EEG. The magnetic fields generated by the flowing electrons can be measured by magneto-encephalography, or MEG.

Each of these powerful technologies of imaging the brain has its strengths and drawbacks. MRI pictures, constructed from three-dimensional scanning, are precise in locating the activity in space. EEG and MEG, on the other hand, are better in time resolution, in the order of milliseconds. These technologies were first developed for hospital use, but now they are increasingly harnessed for research on human cognition. Exciting windows are opening that allow us to view directly the source of our human uniqueness.

85%

The part of the brain's weight taken up by the cerebrum – most developed in humans, though elephant and whale brains are bigger

One early discovery, made at the University of California, Berkeley, several decades ago, was that relevant regions of the brain became enlarged with use. When mice were kept in "enriched" environments, with companions and toys to play with, many cortical regions of their brains grew thicker than in mice kept in "impoverished" environments. This lesson applies to human brains as well.

Recently, imaging studies have shown that the brain region that controls finger movement of the left hand is larger for professional violin players. More dramatically, a paper just published in the prestigious *Proceedings of the National Academy of Sciences* of the US by a group led by Lihai Tan of the University of Hong Kong showed that, with just two hours of training to learn four new words for naming colours, the visual cortex of the human subjects was significantly thickened.

Such enlargements of the brain cannot go on indefinitely, of course. At some point after the new skills have stabilised and integrated into the system, it appears that the neural circuits reorganise and the brain volume reduces. The situation is not unlike the evolution of computer technology, in which big and clumsy machines have been replaced by ever-smaller personal computers.

The brain of Albert Einstein is instructive. It has recently been studied in great detail. It turns out that, despite the scientist's extraordinary intellect, the various neuronal regions of his brain were of ordinary size. However, his brain had a much higher than average number of glia cells.

For more than a century now, ever since Cajal, it has been thought that it is the neurons that construct our mental world, with glia cells as silent partners that merely provide the metabolic infrastructure to serve the neurons. But some neuroscientists have begun to argue for a much bigger role for glia cells – that they interact with neuronal transmission in important ways, and even transmit information themselves by slow waves of chemical changes over longer distances.

An eloquent statement of their viewpoint is a book published last year by Douglas Fields of the US National Institutes of Health, titled *The Other Brain*. If they are right, then our understanding of how the brain constructs our mental world is in for some fundamental rethinking.

Therein lies the true excitement of basic research in science – we may be at the dawning of a new era of exploring the language of the brain.

William Wang, a linguist, is the Wei Lun Research Professor at the electronic engineering department of Chinese University

HEALTH

HK biochip puts disease diagnosis on the fast track

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Infectious diseases may soon be diagnosed faster in Hong Kong. A lot faster.

Hong Kong-based Hai Kang Life, the company headed by former University of Science and Technology professor Albert Yu Cheung-hoi, has unveiled a biochip that has the potential to diagnose emerging infectious diseases significantly quicker than comparable technologies.

A biochip, sometimes referred to as a "lab on a chip", is a device that combines a chip and a chip reader to test for specific genetic material in DNA samples.

Yu said his chip could identify a disease in about an hour, as opposed to the standard six hours.

"For infectious diseases, time is very important," Yu said. "This is the breakthrough."

The inspiration for this technology was partly a result of a void Yu saw during the 1997 Hong Kong avian influenza outbreak.

"We had this H5N1 [flu virus], but we didn't have something sensitive and easy to use to diagnose this."

So Yu, a neuroscientist, and Hai Kang Life set about developing his biochip and tests to analyse genetic content for disease information. Over a nearly a decade, the researchers came up with a compact chip that packs various functions into a single device.

"We use a nanoparticle method, which makes this whole thing very easy. The whole device is very small," Yu said.

Apart from disease detection, the chip will have other uses.

"We'll also use it for blood screening," Yu said.

"Later on we will probably extend into cancer diagnosis."

University of Hong Kong biochemistry professor Julian Tanner said the technology could make various contributions to the biotech field.

"Hai Kang Life's new chip technology is a major step forward, particularly in terms of speed of analysis," Tanner said.

He also noted the technology's "low cost without a need for expensive specialised equipment".

Professor Lok Si, scientific director of HKU's Genome Research Centre, said: "There have been many so-called 'lab on a chip' [devices], but few have achieved the practical balance between cost, ease of operation, speed, mobility and sensitivity."

Yu, who now teaches at Peking University, hopes his company's new biochip – which awaits testing – will help put Hong Kong on the map as a city at the cutting edge of biotech research. "We are working really hard. We are still behind," Yu said.

The chip technology is a major step forward, particularly in speed of analysis

HKU PROFESSOR JULIAN TANNER

"We do have a critical scientific community in Hong Kong."

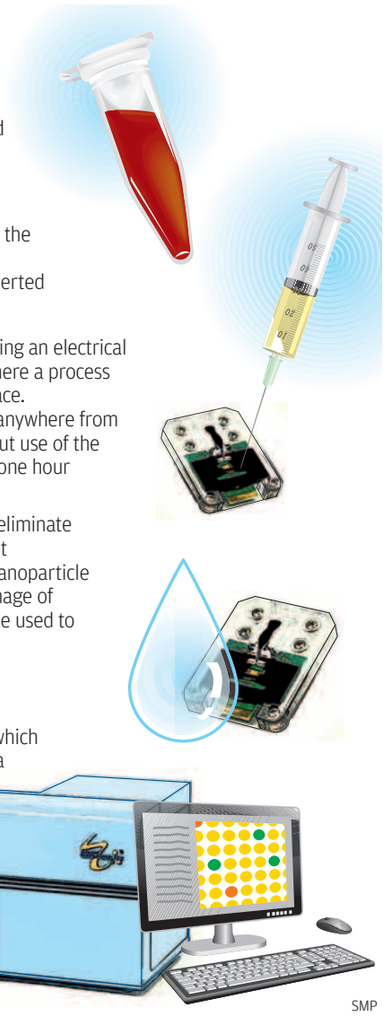
He estimated there were at least 300 Hong Kong companies working in biotechnology and related fields.

Lok is enthusiastic about the future of biotech in Hong Kong, but not all share his enthusiasm.

Professor Frederick Leung Chi-ching, of HKU's school of biological sciences, thinks Yu would have had more success outside of Hong Kong.

"I believe the technology is sound and still requires clinical and market validation. In my opinion, Yu should have moved his invention out of Hong Kong and just maybe he would have his machine in the market by now," Leung said.

How the chip works



Source: Hai Kang Life Corporation Limited SMP

SCIENCE FOCUS
WITH REINHARD RENNEBERG

Feeling aggressive? It could be your 'warrior gene' in action

A study shows that some people may be genetically predisposed to respond angrily to provocation

Do *you* have the "warrior gene"? I believe that I am a peaceful man, longing for harmony: I never shout at lazy students (yes, they do exist at Asia's No 1 university, HKUST); and I never used to beat my two boys when they were small and very naughty. As a scientist, however, I like creative solutions and am ready to take big risks.

The Swiss DNA test company Igenea has a new test for the "MAOA gene". I was tempted to try – a swab from my mouth would be sufficient. So why not?

The background: monoamine oxidase A (MAOA) is an enzyme in our body that breaks down important neurotransmitters in the brain. Neurotransmitters like dopamine, norepinephrine and serotonin help transfer the nerve impulses. The enzyme is encoded in our DNA by the MAOA gene.

Humans have various forms of the gene, resulting in different levels of enzymatic activity. People with the low-activity form (MAOA-L) produce less of the enzyme, while the high-activity form (MAOA-H) produces more of the enzyme.

Less MAOA means your neurotransmitters are less broken down. You have a higher concentration in the blood. You should be more aggressive.

Rose McDermott, a professor at Brown University, had a theory that individuals with MAOA-L display higher levels of aggression – they're not aggressive in general, just in response to provocation. She ran an experiment in which subjects were asked to cause physical pain to an opponent they believed had taken money from them. How to punish them? By administering varying amounts of hot, spicy sauce.

Only about a third of people in Western populations have the low-activity form of MAOA. By comparison, low-activity MAOA has been reported to be much more common – approaching two-thirds of the population – in some peoples with a history of warfare. This has sparked controversy, with MAOA dubbed the "warrior gene".

Seventy-eight male students from the University of California-Santa Barbara took part in the experiment over networked computers. Each subject first performed a vocabulary task in which they earned money. Then they were told that a "bad" anonymous partner, linked over the network, took some of their earnings. They could choose to punish the "bad" takers by forcing them to eat unpleasantly hot sauce – but they had to pay to do so. Don't worry: in reality, no one actually ingested hot sauce.

All 78 were tested for their genes. The results clearly demonstrated that low-activity MAOA subjects displayed higher levels of aggression. MAOA significantly predicted aggression in a high-provocation situation (when a lot of money was taken). So MAOA influences aggressive behaviour, with potentially important implications for interpersonal aggression, violence, political decision-making – and crime.

[It may have] implications for ... aggression, violence, political decision-making – and crime

This stirred a heated debate. Should murderers be excused if they have the "warrior gene"? (My answer: we are not simply the product of our genes. Culture and education form the personality.)

The "warrior gene" is located on an X chromosome. Males get it from their mothers. As men have only one X chromosome (in the pair XY) it can display its full activity. Women, however, have XX, and one X can compensate for the activity of the other. (My mother is an extremely peaceful person – women in general seem to be more peaceful.)

So, what did Igenea have to say about my DNA? Tell you a secret: I have five copies of the gene – a very good warrior! But is that good or bad? I am a pacifist and hate the military, but love to take risks. So now I want to know more. There is another gene mutation: "avoidance of errors". This might be even more important than being aggressive …

Reinhard Renneberg is a professor of bioanalytical chemistry at the University of Science and Technology