THE AUSTRALIAN

Guy Ben-Ary's CellF: playing with neurons

PENNY DURHAM THE AUSTRALIAN 12:00AM August 4, 2016

"Every man can, if he so desires, be the sculptor of his own brain." So said Santiago Ramon y Cajal (1852-1934), the Spanish father of neuroscience, who had set out to be an artist.

A rebellious youth, he was apprenticed first to a shoemaker, then a barber, before being finally convinced to study medicine. Ramon y Cajal's meticulous pen drawings of neurons under the microscope still appear in textbooks, and his insights — that neurons are separate and polarised entities, receiving information through their dendrites and passing it on through their axons — form the foundation of what is one of the hottest fields in science.

The work of Guy Ben-Ary, an Israeli artist and researcher based in Perth, is a modern echo of this meeting of art and neuroscience — and also a curious instance of a man sculpting his own brain.

Ben-Ary has worked for more than 15 years in bioengineered brains, based at the SymbioticA laboratory at the University of Western Australia — the first and so far only collaborative facility, he says, where artists have equal status with scientists.

CellF, a highly ambitious and original self-portrait that represents the culmination of all this work, premiered in Perth last year and appeared in Sydney in June. Ben-Ary is negotiating more performances in several museums and festivals in Australia and internationally.

It consists of a neural network grown on a multi-electrode array connected to a modular analog synthesiser; the tiny "brain" receives electrical stimulation from live musicians and responds with electrical impulses, creating sounds through the synthesiser in a kind of cybernetic jam session.

The 100,000-odd brain cells in the network started as skin cells on Ben-Ary's arm; they were converted into pluripotent stem cells, then differentiated into neurons in an immensely difficult technical process requiring collaboration with many partners.

You can watch videos of this process on his website (guybenary.com), the multitude of spindly axons and dendritic trees wriggling towards each other to form connections.

This is beautiful in its own right — it's no wonder Ramon y Cajal called neurons "the

This is beautiful in its own right — it's no wonder Ramon y Cajal called neurons "the butterflies of the soul".

But Ben-Ary had a lot further to go before it became art.

"When we talk about art and science, there's a lot of people who think this is it," Ben-Ary says, pointing at the video. " 'Put it in a gallery because it's beautiful.'

"But the work we're doing is not about beauty. It's part of it, but for me this beautiful movie is just part of the process."

He took it further, creating a "rock star in a Petri dish" — a portrait of the artist as the musician he always wanted to be.

"When I was 12 years old I wanted to be a rock ' n' roll star — I wanted to be David Bowie," Ben-Ary says. "I'm a music lover but I don't play." When it's suggested that Bowie would have loved this work, he says: "I know."

Ben-Ary's work with neural networks grown on multi-electrode arrays was inspired by neuroscientist Steve Potter, then a professor at the Georgia Institute of Technology in Atlanta. Is it possible, Ben-Ary wondered, to build a mini-brain that responds to stimuli, that — in the simplest sense — learns? Could it demonstrate plasticity, the ability of the brain to reshape itself and its function by forming new neural pathways (something that Ramon y Cajal foreshadowed)?

Neurons on their own will form a network, he discovered, but a chaotic one. "What I was interested in was: if you give it a body and start stimulating it, would it start organising itself?"

The first attempt to give the symbolic mini-brain a body was a cyber-artist called MEART with a robotic drawing arm. It was installed in a shopping centre, digital images of passers-by were fed to the network and the arm responded by drawing portraits that didn't resemble the subjects at all.

The second project, called *Silent Barrage*, played on Potter's observation that the network's responses bore a strong resemblance to the barrages of neural activity that occur in an epileptic fit. The "body" this time was an array of tall, articulated columns with drawing arms that people could walk among, with cameras that relayed their movements back to the network; these stimuli, it turned out, quieted the barrages, "cured" the seizures. The performance in Moscow drew unexpected reactions from the crowd.

"People got really emotional, they didn't want to leave this space," Ben-Ary says.

"They started to walk and dance and wave their hands to the cameras to tell the neurons 'We're here to help you!' "

It was then that he discovered induced pluripotent stem cell technology, whereby an adult cell can revert to a stem cell with the ability to become many different types of cell. This meant Ben-Ary could theoretically make his next brain out of his own flesh. This simultaneously solved an ethical question for him — he hadn't been entirely comfortable using animal cells — and allowed him to pose ethical questions of his own.

"Part of our work is to be playful but be critical about new trends in biotechnology," he says. "One of the strategies is to problematise the technology by suggesting contestable futures or, in my case, absurd scenarios. You generate humour, make it absurd, and that allows viewers to engage with the technology in a critical way."

To get a feel for the technology, he began a work that would be called *In-Potentia*, though it was Project Dickhead until funding was made conditional on a name change. This involved making a neural network out of foreskin cells, which are easily and commonly bought online for research purposes. The result was exhibited in Sydney in 2013.

"We put the brain on a pedestal, packed like a piece of jewellery, this beautiful object that references the Enlightenment and the 18th-century ideal of the brain as the centre of us — Descartes' 'I think, therefore I am'.

"This object was a fully functional, automated, life-sustaining biological lab. An incubator heated to 37C, the right humidity, a fridge and a heating device, pumps, all packed inside.

"According to the law today, you're alive if your brain works. This highlights how these technologies allow us to grow these living entities, but we are not equipped to deal with them. Language and taxonomies are not equipped to deal with that. We don't even have the words to describe them. We have just one word to describe life. So we asked people to think about what 'life' is."

Then came *CellF*, which he calls "a long and painful process". Ben-Ary took a sample of his own flesh, cultured the cells and took them to a friend at the Pluripotency Laboratory at the University of Barcelona, where — working very near Ramon y Cajal's lab — they were rewound into stem cells. Then he shipped them back to Perth

and began differentiating them into brain cells. This took 18 months, 15 protocols and hundreds of trials of cultures.

"I was doing it in such a chaotic way, throwing growth hormones here and mixing materials there and trying to get them to grow," he says. "It was easy to grow them on plastic but very hard on this (electrode) interface. That's biology: you move from plastic to glass and you need another two years of experimenting." Then he had to coax them to show signs of life, to respond in some way to stimuli.

"Those cells are not even neurons, they are skin cells that were forced to be neurons, and now you expect them to perform? A scientist who's doing similar work said, it's like taking butter, sugar, flour, vanilla, throwing them on a table and saying, 'Well, can you become a cake now?' "

With funding from the Australia Council and many collaborators invested in the work, he pushed through the self-doubt, and eventually had what he wanted. Then what?

"I was left with my brains in a dish. What would I do for a body? I'd been looking at my cells for two years, bits of myself in incubators, 40 dishes with my bits growing in Barcelona, in Perth, and I kept on looking at them and loving and hating them every day. I really didn't want to portray myself so I decided to portray one of my dreams." The rock star, in the form of a modular analog synthesiser, was suggested by his friend, Tokyo-based drummer Darren Moore, and built by Perth synth-maker Andrew Fitch.

The whole "artist" is housed in a trumpet-shaped mini-lab designed by Nathan Thompson, its form inspired by the noise machines of the futurists, the pioneers of electronic music.

So how does it sound? The Sydney Symphony Orchestra it isn't, but as a very experimental "post-human improvised sound piece", it works — a neural noise concert that invites the audience to consider the possibilities and the ethics of manufactured sentience.

Ben-Ary's symbolic brain, he says, "allows me to bring the question of emergence to the table and the ethical implications of working with brains that may have in the future the capacity to be intelligent and sentient and conscious — it's a can of worms, really. There are companies now saying 'We can do it, give us money' … A lot of

what I'm doing is looking at those technologies and saying, 'Hang on, this is f..king crazy!'

crazy?

"I think this is where art can play an important role, bringing those ethical and philosophical questions to the wider public to initiate this dialogue — as well as having fun." As to the relationship between the art and the science, Ben-Ary sees them as having distinct ends, but cross-fertilising.

"I use tools that were developed initially for scientific research, but I'm using them for my own research, which involves biological work but it is artistic biological work. The networks I create are artistic neural networks, and the data that I collect is artistic data. Interestingly enough, in parallel with my work there are scientists collecting their own datasets that are scientific.

"I'm sucked into the science and the scientists are sucked into the art, and there's an interesting contamination between us."

Read more about the meeting of art and science in Rewire magazine in The Weekend Australian on Saturday.