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#001: Introducing a new podcast: In Pursuit -- Episode 1, Thought Controlled Futures

Eric van Bemmel

Hello listeners. Up Close senior producer Eric van Bemmel here. In this podcast episode, we take a break from the usual Up Close interviews; instead, we've got for you the very first episode of a new podcast put together by regular Up Close host Dr Andi Horvath. It's called "In Pursuit", and it's takes a kind of documentary approach to cutting edge research in the areas of science and health. The episode you're about to hear looks at fast developing technologies that will allow us to control our physical environment with our thoughts alone. So have a listen to Episode 1 of In Pursuit, entitled "Thought Controlled Futures". It's created and presented by Andi Horvath.

Andi Horvath

You are listening to In Pursuit, a University of Melbourne podcast. I?m Dr Andi Horvath. Imagine you could manipulate and control the movement of a robot or any technology just by the use of your thoughts alone. Whilst it sounds like science fiction, it already exists in various experimental prototypes, because this sort of technology it has enormous potential for paralysed patients to use thought control to activate say a wheelchair, prosthesis or some sort of exoskeleton. At the 2014 soccer World Cup between Brazil and Croatia, a young paraplegic Brazilian who is usually wheelchair-bound was up and standing wearing a new mind-controlled robotic exoskeleton. He then kicked off the world cup game. On his head he had a cap that pick up electrical signals from the brain via his surgical brain implants. These signals were then converted by a computer into commands tor the ?first-generation full-body skeleton? to follow through. It was the first public demonstration of thought-controlled technology. Another group of research scientists and engineers have just made a new milestone innovation into this thought-controlled technology brain computer interface a whole lots easier, safer and more effective -- paving the way now for mainstream therapeutic use. Dr Tom Oxley is a neurologist from the

University of Melbourne and Royal Melbourne Hospital. He is currently based at Mount Sinai Hospital in New York and is the founder of Smart Stent. Tom, how do you sum up this new innovation?

Tom Oxley

We have been developing a brain machine interface to be able manipulate control and movement of physical robots by use of their thought alone. What we are trying to achieve is the recording of brain activity without the requirement of cutting open the skull in a procedure, which is called a craniotomy. To do that we have developed technology which incorporates recording electrodes onto a stent. A stent is a metal scaffold, which is implanted on the inside of an artery or a vein, or any blood vessel inside the brain, via a procedure called an angiography. We?ve built on stent technology and turned it into an electrode-recording array, so we are essentially implanting that in the brain to listen or record activity from the brain. And the reason we want to do that is the same reason other groups have been implanting this type of technology.

Andi Horvath

Let?s visit the people making this stent and venture into the Vascular Bionic Laboratory. It?s part of the Department of Medicine at the University Melbourne. There we?ll meet Dr Nick Opie, who is the chief biomedical engineer, and a director of Smart Stent.

Nick Opie

So we?re developing a minimally invasive brain machine interface. Now this technology has the capacity to record neural information and convert this information into commands that can be used by exoskeletons or prostheses or computers. And our aim is to enable people with limited mobility or paralysis to have access to this technology to improve the quality of their life. The beauty of the technology we?ve developed as that unlike systems, we can access the brain without requiring open brain surgery, so our procedure is a lot safer than existing technologies and from some of the data collective recently it looks like it functions a lot better as well. One of the difficulties has been how do make something flexible enough it can take all the pathways of the vessels but also stiff enough that you can push it through and deliver it position and that?s been one of the biggest challenges which we have overcome a number of times through successive iterations, and every time it?s getting a lot better and it?s working a lot...

Andi Horvath

Nick, what is the stent actually made of?

Nick Opie

So the stent we are using is nickel titanium, called nitonol. It?s a self-expanding material that enables this metal to be compressed and expanded many more times than common materials without fatigue. And by using this metal we can deliver the device through a very small 1mm catheter and when in the desired position over the brain we can expand this device to 5- 6 mm.

Andi Horvath

So you are working a stent. Can I talk to some of your engineers here in the lab? Gee, the stent is actually like a 2 cm fishnet stocking. How do you actually attach the electrodes?

Steve Ronayne

So we have a bunch of very small and fine ophthalmic tools that we use to place these electrodes in place. We use some UV-curable glue. So this is bonded to the stent under very awkward circumstances that need to be very finely controlled by us. It?s not easy to do and requires a lot of practice but we are getting the hang of it I think.

Andi Horvath

That was engineer Steve Ronayne. In this lab, I see a diagram which shows this stent in place in a blood vessel in the brain and a wire sending those brain signals to a device kind of like a pacemaker device that is implanted into your shoulder region. Now that device translates the electrical signal to computer commands. And via Bluetooth it then activates another device like a prosthesis or exoskeleton. So let?s chat to Sam John, another engineer in this lab.

Sam John

Everything we think gets coded in the brain as electrical signal. And so we are trying to understand what that code is between how we think and what the electrical signals look like. And then once we get that, we do some analysis on it, try to decipher what is the brain trying to say when thinking about moving my left hand or moving my right hand, and then using that information to then control an external device based on that electrical signal.

Andi Horvath

Next up we chat to Terry O? Brien, a clinical neurologist, who is going to be conducting some the clinical trials. He is Professor of Medicine at University of Melbourne, and he?s based at the Royal Melbourne Hospital.

Terry O?Brien

Initially, clinical trials, which we plan to start in 2017, will be aimed to demonstrating safety and the fidelity of the recordings over time. Almost certainly initially with patients who have been paralysed, probably from a spinal cord injury so they don?t have movement of the limbs now, and is wanting to contribute to advances in science so people like themselves will eventually be able to have movement again. They would have to recognise, of course, initially there wouldn?t be any guarantees that it will benefit them, though, of course, we hope that it would. So it would be someone who would be altruistic in their motivations for being involved.

Andi Horvath

Tom Oxley, can you tell us how the patients learn to use the device?

Tom Oxley

So in a corollary example it as though the brain is learning how to do a new task, much in the same way the brain can learn how to do any new task, whether it?s learning to play the piano, improving your typing on keyboard, or learning how to play a new computer game or video game. You have to understand what it takes for the brain to manipulate its fingers to conduct that activity. And it?s the same process with what we are doing, it?s just that there is no arm or fingers. We complete the circuit, show the patient what it takes to manipulate the signal, and then they learn how to do that and improve over time.

Terry O?Brien

I think being able to enable people to walk again for the first time who have been paralysed is something Chris Reeve dreamed of. I think that?s the really most exciting thing, and if this?ll contribute to that it?ll be a tremendous achievement.

Andi Horvath

This stent technology currently records brain electrical activity but can we send electrical signals back into the brain. Tom Oxley and Nick Opie can we hear from you?

Tom Oxley

Well, what you are describing is the basis of deep brain stimulation, or DBS, which you might have seen requires an electrode, implanted into the brain via craniotomy that is removal of a small piece of skull, for the treatment of Parkinson?s disease. The reason it works in Parkinson?s disease is because it interrupts an abnormal signal in the brain by delivering a strong signal that interrupts that circuit. So it?s feasible that our technology can do that.

Nick Opie

Because there are so many blood vessel in the brain we have the ability to access any brain region. So, almost all neurological conditions may be able to be treated with this technology whether it be epilepsy, Parkinson?s, depression, Alzheimer?s, you know the list goes on of what could be accessed by this by us.

Andi Horvath

Terry O?Brien.

Terry O?Brien

So another obvious and relatively early application would be in epilepsy. And that is at the moment we have patients with epilepsy about a third of them don?t have their seizures adequately controlled with current treatments. And we don?t have very good ways of mapping when someone?s going to have a seizure, and the fact they could have a seizure at any time and any place is a really disabling thing. It means they can?t drive a car. It means they?re at risk when they go swimming or even when they are shopping in the supermarket. So the ability to chronically record neural activity and understand when someone is going to have a seizure and give them alerts will potentially allow drugs to be delivered at the time, or stimulation studies [and] would be a major therapeutic advance. So that?s another obvious application.

Tom Oxley

Epilepsy we think is going to definitely be a potential application. The electrodes are recording activity 24 hours a day and they are able to provide an alert system for when the seizure is coming. When that seizure comes, it delivers a signal back into the brain which attempts to interrupt the epileptic seizure and stop the seizure. And we think that our technology could achieve that also one day. The other applications that are exciting in deep brain stimulation are around refractory psychiatric disorders, particularly obsessive-compulsive disorder -- the idea being that interruption of an abnormal circuit using an electrical signal enables the patient to breakthrough what is otherwise a disabling recurrent thought circuit. And we know that some the blood vessels in the brain run near parts of the brain that are important in obsessive-compulsive disorder. It?s a long time before we could do that in the brain, and we think it a very exciting time for neurology to be able to moving into applications for treatment of a whole range of conditions we haven?t otherwise previously been able to treat.

Andi Horvath

Tom Oxley, could we have stents in multiple parts of the brain?

Tom Oxley

We?re starting off with the motor system, and that?s enabling us to target the part of the brain that controls movement. What?s right next to the motor system is the sensory system, and there are many blood vessels around that sensory system. So one other application we think might be possible is delivering signals back into the brain, into the sensory system to, in a sense, to provide patients a capacity to feel again. And in patients who have severe spinal injuries that is a lack of sensation in their body and this would be one mechanism of providing input into their body to give them back one of their sensory functions.

Andi Horvath

Gil Rind from the vascular bionics lab.

Gil Rind

Stimulating the brain could be a way to allow you to actually get feedback from what you?re touching with your arm or your leg and be able to know whether you are touching a smooth surface or whether you?re about to crush that can of Coke you are holding. So there could be sensors on the prosthetic that stimulate the sensory cortex and allow you to feel what the prosthetic feels.

Tom Oxley

The other sensory functions that jump out a disabled human are the visual system, and we have been brainstorming around whether we can potential look toward using this as a visual prosthesis as well.

Nick Opie

I think there?s a lot of technology coming out of Melbourne in particular, with cochlear implants and bionic eyes that are taking information from the surroundings, whether it be in auditory or visual, and putting back into the brain so the person can see or hear, and this is another device that has the capability to do these sort of returning of signal.

Andi Horvath

This stent research project is funded and supported by a consortium of groups, including the US Defence department. Their goal is to repatriate soldiers but this technology has applications beyond its therapeutic use. Dr Regina Crameri is associate director of the Defence Science Institute in Melbourne.

Regina Crameri

So there?s a number of different technologies and different platforms where you could use this type of technology. For example, pilots who are in a very complex environment when they?re flying planes. Having this device could for example reduce their cognitive load while they are flying and therefore make it simpler for them and less stressful.

Andi Horvath

This got me thinking the uses for this technology for human enhancement in the fields of, say, sport, communications, and even entertainment. I started a conversation with Terry, Tom and Nick and the engineers. Let?s dare to dream with this technology. I kind of like the idea of having an exoskeleton. I might ditch my bike, and get a stent in and that?s the way I would like to arrive at work. Is that ridiculous and preposterous thinking?

Terry O?Brien

So you can be like Robert Downey Junior in Iron Man. Why not? (Laughs.) I don?t think there will any time in the foreseeable future where someone will want to have something like this implanted unless they need it, but you never know where technology could take us.

Tom Oxley

I think it?s, well it?s not preposterous; it?s science fiction still. But it is an interesting new world of possibilities that?re beginning to emerge. And I think we?re beginning to move into a phase in medicine where we?re moving away only from the treatment of disease but back into the recovery of function and sometimes augmentation of function. It struck me watching the Paralympics recently that, particularly with the 100-metre sprinters, that there should come a time, probably not in the far too distant future, where the athletes in the Paralympics begin to break records that we are achieving. I think that will be a very confronting time in human history when we have come to a point where we can engineer beyond normal capacity into augmented capacity.

Nick Opie

They are starting up a series of games called the ?cyb-athalon?, where paralysed patients and patient with other disabilities to use devices similar to this to run obstacle courses or to control computer cursors and play games. And so there is clinical need for this technology, but I can?t see why in future generation this can?t be used for more broad application.

Andi Horvath

Also joining us in this conversation is Dr Rain Liivoja from the law school of the University of Melbourne.

Rain Liivoja

So, in some circumstances where this technology is not used for medicinal or therapeutic purposes, that might actually help to lower the cost of that technology if it being used on a more wider scale which will then actually make it more affordable to people who will need that technology to overcome a certain disability, to manage a particular injury.

Andi Horvath

If allowed to dream as engineers, where would you like to see this technology go? Steve Ronayne.

Steve Ronayne

I guess the obvious go-to is something a kin to a universal remote control. So say you have your home environment, your house, and you have every machine and device or whatever exists within the house and you just think about controlling that as opposed to going to the interface pressing the button and it happens.

Rain Liivoja

Yeah it?s probably not out of the question, but on a day day-to-day basis I can?t imagine someone realistically agreeing to brain surgery in order to have their TV remote implanted effectively in their head.

Andi Horvath

At least not this year.

Rain Liivoja

Not this year.

Tom Oxley

I think you look at the way we use smart phone now it?s pretty incredible to think how we communicate silently to one another without having to speak at all, just looking down at a little black device. But if that black device was inside your brain and you didn?t need to use your hands to manipulate the keys to send a text message suddenly your achieving telepathy. And I think it doesn?t seem to be too crazy that, in the future at some point, a lot of these devices are going to be enabling us to be achieving electronic capabilities that we could never really imagine now. In the same way that we could have never imagined that smart phones would be giving us what they are giving us 100 years ago.

Andi Horvath

Tom I?m worried that dreaming might activate my domestic devices but what I am more worried about is someone hacking into my thought-controlled technology.

Tom Oxley

Well, it does then make you worry about who can hack into your phone and whether you can hack into your brain, and I get that comment a lot too. That if we begin to connect our brains up to electronic devices that cyber security directly to our brain becomes an issue. Yes, I don?t want my brain hacked. It?s certainly interesting to imagine where this technology can go and whether that is the world we want to be living in or not.

Andi Horvath

Any new commercial technology in society requires input from ethicist and lawyers. Dr Rain Liivoja and Dr Regina Crameri give us some insights and things to think about.

Rain Liivoja

Perhaps the first issue with regard to any type of medical technology is the safety to the user. This technology would also raise the question about safety to the society at large. So for instance should we allow a person who has two thought-controlled prosthetic arms to drive a car or to drive an aircraft? And the questions about safety to the person and safety of the person to society don?t necessarily have the same answer in any given point in time. There are potential novel problems of accountability that arise from the use of brain machine interfaces and that will result in the consequences in the physical world. It?s not clear how the law will address that problem.

Regina Crameri

If we could maintain the ethical debate around what is good for society and the uses therefore of that in society, then I think we can really advance this technology. But unfortunately with every technology there is always an adverse effect of that, and there will be people who use it for nefarious effects. And we just need to make sure that?s as a society we realise that we can?t stop this technology we got to enhance it and adapt to it what we want to look like.

Andi Horvath

Thank you to Dr Tom Oxley, Dr Nick Opie and his engineers Gil Rind, Steve Ronayne and Sam John. Thank you also to Professor Terry O?Brien, Dr Rain Liivoja and Dr Regina Crameri. This has been ?In Pursuit?, a University of Melbourne podcast.

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