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TAKING THE PLUNGE

A group of previously inactive people has taken to the pool with amazing results. Now they are better able to control their diabetes. P4

REWIRING THE BRAIN

The brain is our most complex and unknown organ and continues to amaze medical science. Most amazing is its ability to adapt and find new pathways around damaged areas, making it possible for it to retrain itself to continue to carry out tasks. PETA RASDIEN reports.

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Long road back, but it's possible

Regaining high-level functions has meant dealing with poor short-term memory and suffering low self-esteem

Alex Eves

Suffering a traumatic brain injury was the most frightening thing I have ever dealt with. It left me feeling desperately helpless with no idea what was happening to me or if I would get better.

But over time I have rebuilt and writing this now is another small victory.

Almost two years ago to the day, I fell over at home and cracked my head on a tile floor.

I don't know why I collapsed as all my memory from then is gone and the doctors who treated me haven't been able to shed any light either.

But the result was a fractured skull and bleeding on the brain that left a 2.5cm blood clot on the left side. To deal with the potentially fatal pressure build-up, surgeons at Sir Charles Gairdner Hospital put me into an induced coma and removed a large section of my skull.

This gave my brain room to swell and helped drain the blood.

I am lucky — I woke two weeks later and my basic cognitive functions such as memory, motor control, balance and speech started returning quickly.

After a few more weeks I was able to walk, eat, clean and relieve myself unassisted, so was transferred to Royal Perth Rehabilitation Hospital in Shenton Park.

Ongoing recovery over the next fortnight was encouraged by daily mental and physical exercise sessions with rehabilitation therapists and I was progressively being allowed more responsibility such as making my own breakfast or going on semi-supervised walks within hospital grounds.

Visits by family and friends helped immensely and once I showed enough common sense not to endanger myself, I was released from care.

After recuperating at home for a few months, I became a part-time volunteer with the Royal Life Saving Society before feeling confident enough to start a graded return-to-work program.

With awesome support from my work colleagues and guidance from the State Head Injury Unit, I was back to full-time work about a year later.

Nowadays, I continue to build confidence and competence by slowly slotting back into my old work role.

I'm still trying to regain all my high-level brain functions, which has meant dealing with very poor short-term memory, being easily confused or distracted and suffering from incredibly low self-esteem.

It has also meant bouts of severe anxiety and depression while my brain's emotional centres right themselves.

None of that is fun.

Ongoing treatment involves working with counsellors and therapists, nurturing a willingness to keep trying and allowing some self-compassion after occasional meltdowns.

Despite those setbacks, I am recovering well.

Friends, family and colleagues have noticed continual small improvements and I really enjoy the light-globe moments when mental fogs clear up or emotional hang-ups are released.

I know a full recovery will take a long time and I often get frustrated by the slow progress.

So I try to enjoy the here and now, marvelling at the benefits of modern medicine and the brain's ability to fix itself.

I also carry a lot of empathy for those who have dealt with this experience, are dealing with it now or will have to in the future.

Alex Eves. Picture: Robert Duncan

NEUROLOGY RESEARCH

Same brain, different routes

Long-held beliefs about recovering from stroke and other neurological injuries are being challenged, writes PETA RASDIEN

Research investigating ways to turbocharge the brain's natural plasticity as a way to overcome traumatic brain injury and stroke is showing promising results and offering hope to the many people affected.

Brain plasticity occurs throughout a person's lifetime, with neural connections forged and refined or weakened and severed as we learn and experience new things.

The conventional wisdom used to be that, once damaged, the brain could not be repaired or function restored but new ways of imaging brain activity, including functional MRI, has proved that mental activity can shape the brain by strengthening and forging new neural connections.

How this phenomenon plays out when it comes to the brain's ability to compensate for injury, and the mechanisms by which it does so, has been the subject of intense research in recent times.

> 'It used to be thought that the older brain was less plastic than the younger brain, but this is now being challenged. Older people do demonstrate plastic change and the older brain can adapt to experience and injury.'
> Andrea Loftus

Andrea Loftus, Curtin Neuroscience Research Laboratory director, is one of a number of researchers in WA looking to harness the potential of neuroplasticity to improve recovery from brain injury, offering patients hope of a better quality of life.

"Non-invasive brain stimulation methods such as transcranial direct current stimulation (tDCS, where low electrical current is delivered to specific areas of the brain) are being explored as potential therapeutic options," she said.

"tDCS can be used to excite affected areas of the brain and is producing some promising results for a range of disorders and injury. Coupled with other forms of therapy, such as bi-manual training (using both upper limbs at the same time, such as clapping or typing), there is huge potential for recovery for some individuals."

But Dr Loftus said what worked for one person would not necessarily work for another.

"We suspect this is because no two people are the same in terms of the injury they experience," she said.

"No one person's stroke is the same as another's in terms of location and extent, which means that some people may be more responsive to different therapies than others. With regards to non-invasive brain stimulation, the techniques associated with tDCS are still a developing science, so we are working towards understanding what works for an individual and why.

"It used to be thought that the older brain was less plastic than the younger brain but this is now being challenged. Older people do demonstrate plastic change and the older brain can adapt to experience and injury."

Neurologist David Blacker has seen some remarkable recoveries from stroke: people who might have been written off as lost causes in the emergency department after a massive brain bleed, who then walk out of rehabilitation months later.

"But I've given up thinking it is amazing to think it is something we should all be able to push for," the WA Neuroscience Research Institute medical director said.

"In everyday practice we see people improving after brain injury and after stroke all the time. I say to stroke patients that no matter how old you are there is going to be some chance of improvement."

Dr Blacker said within the brain, particularly in the frontal lobes, there were multiple circuitries which could take over from damaged areas.

How the brain rewired and adapted itself for speech and language was a prime example of plasticity in action.

For most people speech and language is controlled on the left side of the brain so when that area is damaged people can lose their ability to communicate verbally. But recovery was possible as other areas of the brain took on the job of the damaged part, not just in the left hemisphere but also in the right.

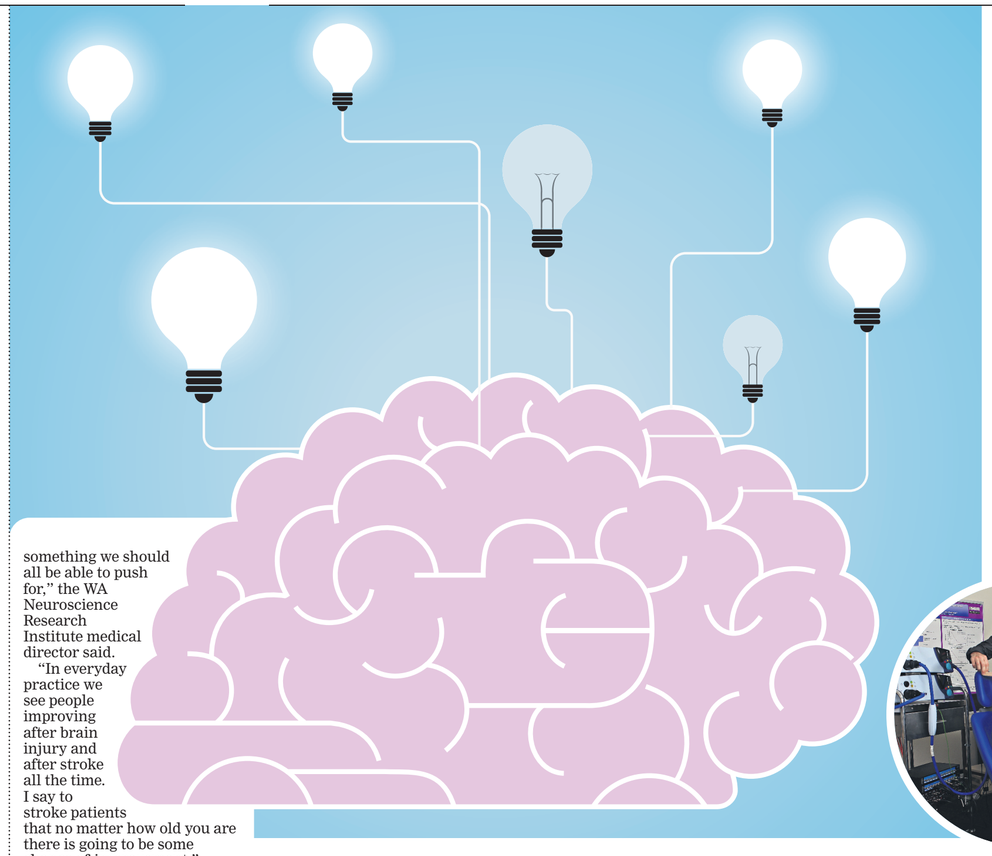
Previously it had been thought that you could only swap your language hemisphere over in infancy or early childhood.

Brain plasticity is linked to learning, according to Soumya Ghosh, director of the institute's Centre for Restorative Neurology, and it is those same techniques of learning that can be used to help the brain relearn movements or other functions after it is damaged.

"We know synaptic plasticity and some amount of synaptic reorganisation goes on all the time because we can learn new motor skills, we can remember new things," he said.

Investigation of the mechanisms behind this revealed that the brain "rewired" itself by changing the strength of some synapses and weakening others after injury.

Dr Ghosh and colleagues are studying the benefits of brain stimulation in combination with treatment and exercise regimes to see if it can enhance recovery and results so far have demonstrated modest gains.



New methods to prime pathways

Peta Rasdien

The flurry of research under way into brain plasticity has uncovered elements thought to be important in maximising the brain's ability to rewire itself after injury. Visualisation of a task can in itself activate areas of the brain crucial to actually performing the task.

"If you put someone in a functional MRI (FMRI) scanner and you get them to imagine tapping their finger and then you get them to actually tap their finger you can see that the bits of brain that light up with the imagined task versus the actual task are only a few centimetres apart or even less," David Blacker, medical director of the WA Neuroscience Research Institute, said.

"So you can actually prime your motor pathways by imagery."

Dr Blacker said it was important rehabilitation was varied and had an aspect of newness that would fire up multiple parts of the brain in order to make it valuable in forging new connections.

"Once it becomes easy that means the neurons have come together and you just keep on strengthening that circuit," he said.

"If you do an FMRI on a very easily learnt task the brain doesn't light up much at all."

People with a brain injury find it hard to multi-task, so researchers were working on ways to help patients focus on tasks to ensure they got the most out of their therapy.

Repetitive practice, similar to how we learnt times tables by rote in primary school, and already used in rehabilitation practice, helped drive chemical connections. Physical activity, in combination with physiotherapy, had also been demonstrated to aid recovery.

"Old textbooks say that after two years, you can't learn anything new, you have plateaued," Dr Blacker said.

But that was not true, numerous rehabilitation studies had shown that applying a short burst of therapy, even years after brain injury could lead to some degree of improvement.

"We are also learning that perhaps at various different phases in stroke recovery there might be better windows for improvement."

Dr Blacker and his colleagues at the institute hope to launch a dedicated neuro-rehabilitation program that would incorporate latest neuroplastic therapies in late 2016.

Stimulating research

Peta Rasdien

Brain stimulation, where a low-level electric current is delivered to a specific area of the brain, holds great promise as a tool in spurring brain plasticity.

Curtin Neuroscience Research Laboratory scientist Blake Lawrence is investigating the therapeutic effects of brain stimulation and brain training to try to improve memory and thinking skills in people who have Parkinson's disease.

"Parkinson's for a long time has been considered a movement disorder and, although it is, it wasn't until the past decade or so that we have identified memory and thinking difficulties," Mr Lawrence said.

"It was thought that once people demonstrated a decline there was no real way of addressing that but brain plasticity is showing that you can improve these skills even if you have experienced a decline."

Using transcranial direct current stimulation (tDCS) to target the left dorsolateral prefrontal cortex, the area of the brain responsible for memory and executive thinking, he is measuring whether increasing the electrical activity between neurons in the brain will reverse or slow the decline in higher-order thinking skills associated with Parkinson's.

Blake Lawrence with patient Ailsa O'Shannassy. Picture: Gerald Moscarda

Participants undergo a four-week intervention once a week for 20 minutes of stimulation. The results will be compared with a group completing in-home brain-training exercises and a group completing brain training and brain stimulation combined, to see which combination can improve memory and thinking.

Chronic pain is another target for brain-stimulation research.

PhD researcher Emily Corti is investigating whether tDCS can alter motor cortex excitability, to change the memory and thinking skills in people with chronic pain.

"Systems in the motor cortex warn us of any potential danger to our body but when they don't work correctly they become more easily activated and the pain becomes easier to trigger," Ms Corti said.

Studies had shown tDCS could restore normal functioning of these systems and reduce pain.

Ms Corti is conducting research into chronic back-pain sufferers using tDCS and targeting the dorsolateral prefrontal cortex, which is also part of the brain's pain network, activated during pain but not responsible for it.

"As anyone who has ever been in any kind of acute pain knows, pain really disrupts our thinking and our memory ability so what we also wanted to see was what impact was pain having on people with chronic lower-back pain."

Results from both studies are due next year.