



Curtin University

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# HEALTH AT CURTIN

NEUROSCIENCE AND BEHAVIOURS

Make tomorrow better.

Faculty of Health Sciences research magazine

# LATEROPULSION SITS FRONT AND CENTRE ON THE BALANCE BOARD

By Karen Green

The application of 'gaming' hardware and software in clinical settings is an interesting trend in physical rehabilitation.

Now, an Australian research collaboration is investigating whether Nintendo's Wii Balance Board can help with the diagnosis and recovery of lateropulsion in stroke patients.

Stroke is a leading cause of adult disability in Australia, with up to 40 per cent of stroke survivors suffering from a condition called lateropulsion, whereby they lean involuntarily to one side when standing and sitting.

It is a challenge, however, for therapists to correct lateropulsion, as patients instinctively push back against passive correction.

At the School of Physiotherapy and Exercise Science, Professor Keith Hill is leading a research team focused on reducing the impact of lateropulsion in both stroke patients – and on the health system.

*"People with lateropulsion have an altered perception of their posture. They can be leaning quite markedly, but believe they are standing or sitting up straight," Professor Hill says.*

"The brain's resistance to correction means patients are slow to re-gain their mobility, and their ability to complete everyday tasks, such as showering and dressing.

"These patients are therefore in hospital-based rehabilitation longer than those without lateropulsion, which impacts their motivation and, again, their recovery."

Surprisingly, there's been little research about lateropulsion in stroke patients, despite the issue being resource-intensive for the health system.

But a national research collaboration is now focusing on the issue, using a technology developed by Nintendo for its exercise and sports video games.

"The Wii Balance Board can help to track the changes in the level of lateropulsion in patients, specifically in the six months following stroke," Hill explains.

"Being portable and light, we can take the device to patients, and avoid having to transfer them to a clinical laboratory to capture posture and balance data early following stroke."

One patient noted that using the Wii Balance Board helped them understand more about their condition, prognosis and recovery.

The project – which includes Dr Kim Brock's team at St Vincent's Hospital, Melbourne, Dr Ross Clark at the University of the Sunshine Coast, and Curtin PhD student Melissa Birnbaum – builds on Curtin research led by Associate Professor Kylie Hill and Ms Stephanie Parkinson.

The team is hoping that, overall, the Wii technology will deliver more information about the postural control deficits of patients. A longitudinal study of 60 stroke rehabilitation patients is now underway, as well as a retrospective investigation of the links between lateropulsion and other clinical conditions.

"Results of this stream of research will be used to generate new approaches to treating lateropulsion," Hill says.

"The end goal is to reduce hospitalisation and improve longer term walking outcomes for stroke patients with lateropulsion."

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## Message from the Dean of Research

The complexity of the human brain lies at the frontiers of science. Wired with close to a quadrillion connections, the brain controls human emotions, reasoning, memory and motor control, inspiring myriad areas of research, with results that continue to fascinate.

In recent years, the emergence of new diseases, the increase in Australia's aging population and higher levels of sensory processing disorders such as autism, have prioritised healthcare elements of neuroscience research, with Curtin's robust and diverse research hub embracing the challenge.

Our researchers are targeting major national and global health issues such as Alzheimer's disease (p10), pain management (p16) and overcoming drug use (p2) and alcohol consumption (p22), and translating their findings into effective programs and interventions that improve people's mental and physical health and wellbeing.

It wasn't too long ago the scientific community was convinced that damage to the brain and neural pathways was permanent. We now know that targeted stimulation will prompt the human brain to re-route its wiring in stroke patients (p6) and in children who are diagnosed with cerebral palsy (p8).

In addition, the neurochemical balance in the brain is a delicate one, and statistics suggest that one in six Australians will develop an anxiety disorder in



their lifetime. Our researchers are making headway in finding treatment programs for phobias (p12) and obsessive-compulsive disorder (p20), alongside new discoveries in how a person on the autism spectrum comprehends the world around them (p4).

With much of our research supported by highly competitive funding awarded by the NHMRC, the Australian Research Council and other major funding bodies, I am extremely proud of the work our dedicated researchers are doing in the neuroscience arena and invite you to browse the remarkable and progressive projects showcased in this magazine.

**Professor Torbjorn Falkmer**  
Dean of Research  
Faculty of Health Sciences

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# WORLD-FIRST MEDICATION TRIAL FOR ICE ADDICTION

By Zoe Taylor

Researchers from the National Drug Research Institute (NDRI) are trialling the efficacy of a promising medication to treat dependence on crystalline methamphetamine, also known as 'crystal meth' or 'ice'.



Australia has one of the highest levels of ice use and dependence in the world. According to the *Medical Journal of Australia*, since 2010 the number of dependent users in Australia has risen from 72,000 to 160,000, and the number of amphetamine-related hospital admissions and arrests has more than tripled.

In light of this, the multi-institutional research team, led from Curtin by NDRI's Associate Professor Rebecca McKetin, received a \$1.55 million National Health and Medical Research Council grant to conduct a world-first out-patient trial of the medication N-acetyl-cysteine (NAC) to treat addiction to ice.

NAC is an inexpensive medication that has previously been trialled to treat addiction to substances such as cannabis and cocaine, as well as mitigate a range of compulsive behaviours, such as gambling.

"N-acetyl-cysteine has a long use in medicine for other purposes, such as paracetamol overdose and treatment of neuropsychiatric conditions," McKetin says.

*"If found to be effective, this medication has the potential to be a cost-effective treatment option for ice dependence."*

Ice is an addictive and highly pure stimulant drug. It causes a surge in the neurotransmitter dopamine, the brain's natural pleasure chemical, giving the user intense feelings of euphoria, confidence and energy. Physical effects can include an increase in heart and breathing rates, dilated pupils, a reduced appetite and an increased sex drive.

When ice is smoked or injected, its effects can occur within minutes and usually last between four to 12 hours.

"When they come down from the drug, users feel depressed, paranoid and irritable," McKetin says.

"This is because the brain's dopamine levels have been exhausted, creating a short-term deficit while the brain manufactures more. Dependence can occur when users take ice repeatedly to try and regain feelings of normalcy."

With long-term use, ice can cause changes in the functioning of dopamine and other neurotransmitters, including noradrenaline, which can trigger hallucinations and paranoia. Heavy use can also lead to neurotoxicity of the brain, where nerve terminals start to degenerate due to over-activity.

"The toxicity of the drug in high doses can affect the heart and increase the risk of stroke. It also has a terrible effect on mental health, because those chemicals in the brain that it is acting on constantly, are involved in mood regulation."

Currently, there is no effective medication to treat addiction to ice, and this is a significant barrier for users seeking treatment. The main form of non-pharmacotherapy treatment is counselling interventions and residential rehabilitation.

For this reason, trialling NAC introduces a novel approach to treating drug addiction: it targets the parts of the brain that reduce cravings, and also protects the brain against neurotoxicity.

NAC helps to reduce cravings by restoring the homeostasis of neurotransmitters in the brain, effectively managing the levels of specific chemicals that regulate the release of dopamine, making it easier for users to manage their desire for the drug. By restoring homeostasis, NAC also protects the brain from over-activity and neural degeneration.

Another key point is that NAC is also relatively inexpensive and can be delivered as a prescribed over-the-counter medication, thereby easing demand on drug treatment services.

"The beauty of NAC is that it works with a whole range of drugs," McKetin says. "It's targeting the change in the brain that happens with addiction, rather than the particular substance, so therefore the effects can be carried across different drugs. There are signs of efficacy for tobacco, cannabis, cocaine and meth."

The NAC trial will start in April this year and continue until 2019. It will enable McKetin and her research team to potentially detect a reduction in methamphetamine use and changes in a range of clinical outcomes, such as the agitation and paranoia that people experience when they use the drug heavily.

McKetin says the next steps will be to work out how to use NAC in conjunction with other treatments.

"Once we work out whether NAC can help people to reduce their ice use, the next step will be to work out how to use it in clinical practice.

"What we know from epidemiological data is that even if people don't stop using altogether, if they reduce their use significantly, we actually see a really big reduction in harms. They are much less likely to have psychotic symptoms, much less likely to get aggressive. So, for us, even a moderate reduction in use would be really good."

The trial will be conducted in collaboration with Deakin University, Monash University, the University of Wollongong, the University of Newcastle, La Trobe University and the Burnet Institute.

[curtin.edu/ndri-med](http://curtin.edu/ndri-med)

# HOW PEOPLE WITH AUTISM SEE THE WORLD

By Anita Shore

**“Too fast!” cried Susan Morris’ son as he tearfully learned to ride a bicycle. He frequently lost his balance and struggled to tell whether his bicycle was moving forward or was stationary. Later diagnosed with high-functioning autism, he continued to misinterpret visual cues in daily life, leading his mother to question whether autism and visual motion processing are intrinsically linked.**

For people on the autism spectrum, the world is a bewildering place. With oversensitive sensory systems, they battle to process the maelstrom of information flowing into their brains. Often the result is sensory overload, leading to signature behaviours such as tantrums, anxiety and social withdrawal.

“Their natural ability to pare down information appears to be missing – the ‘filters’ are not working. And so whatever their behaviours are, it is to manage those filters, and keep the world constant and predictable,” Morris explains.

As a researcher in sensorimotor control, Morris has dedicated her research to exploring links between visual motion processing and autism, determined to develop interventions that reduce the disability it causes.

She has discovered that people on the autism spectrum have increased sensitivity to visual motion in their peripheral field of vision, which affects how they perceive their environment and where they place themselves in time and space.

“Most people with autism have motor coordination problems. Sensory responses influence motor responses and they feed back on each other in a loop.”

Her team’s first study determined how people used visual processing for postural control, by inducing postural illusion using muscle stimulation.

She realised that while everyone in the study leaned forward in response to the stimulation with their eyes closed, only the ‘neurotypical’ adults corrected their posture when their eyes were open.

“The people with autism did not use their vision to stabilise themselves – and that affected their motor control and movement,” she says.

The team’s second study compared the way in which people with autism processed optic flow, using streamed images of moving stars that filled their primary and peripheral vision, creating a visual illusion of self-movement.

“When the stars flow out, it feels like you are going through space and your body will naturally lean backwards. When the stars flow the opposite way, it’s like you are driving backwards through space, and you lean forwards into it.”

She observed that while everyone leaned when exposed to the whole visual field, the results were different when motion was limited to the periphery.

In the forward direction, all the adults ignored movement on the periphery – behaviour Morris believes is learned from daily activities such as driving in a car. However, in the backward direction only the adults with autism leaned forwards.

“When only part of the visual field moved, the neurotypical adults saw peripheral optic flow as something moving, whereas the adults with autism perceived it as self-motion.”

Morris likens this experience to linearvection, where an observer feels like they have moved and the stimulus has stayed stationary.

“Imagine you are on a train and then out of the window you see the train next to you start to move. For a moment you’re unsure if you’re moving or the train outside the window is moving. Perhaps this is the experience of people with autism most of the time.”

Morris is repeating the experiment with children aged between eight and 10 years to find out at which point in life people naturally learn to filter peripheral motion.

“Children have had less exposure to peripheral optic flow and so this study may determine whether visual development in individuals with autism is due to immaturity in visual information processing, or the result of a different developmental trajectory.”

While her findings could inform intervention strategies, Morris believes an individual’s brain chemistry is another consideration – specifically the activity of inhibitory neurotransmitter, gamma-aminobutyric acid (GABA).

“GABA has been demonstrated to be lower in people with autism. If GABA is not working properly, inhibitory circuits don’t work with the same timing or in the same amount as the excitatory circuits – and as a result, excitatory circuits are not switched off.”

GABA imbalance has also been linked to other brain processing disorders such as ADHD, dyslexia, central auditory processing disorder and social anxiety disorders.

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*“Are these conditions discrete?” Morris ventures. “People with visual disorders quite often have autistic characteristics. The fundamental underlying issue may be similar, which is related to processing information. Maybe they are all spectrums of a common problem.”*

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Undoubtedly, this conjecture is a topic for wider discussion, but for now Morris is developing therapies that “reduce the overwhelm” and encourage adaptation, so people with autism can lead relatively normal lives.

Now with her son fast approaching adulthood, Morris remains resolute about making a difference. When asked where her end point is, her reply is simple:

“How we see the world impacts incredibly on where we go. This project is ongoing – for the rest of my career!”

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# STARTLING RESPONSE FROM STROKE PATIENTS

By Nicholas Brant



**Neuroscientists are helping stroke survivors regain control of their bodies by using unexpected bursts of noise to boost brain function and facilitate movement.**

The bang from a car backfiring or the crack of a starter's pistol will elicit little more than a startled response from most people. But for Curtin's neuroscientists, this type of high-intensity noise forms a key part of research into how the brain controls our movements.

Dr Welber Marinovic is currently leading research funded by the Australian Research Council into how different types of sensory stimulation such as electric shocks and loud noises can produce different responses in the brain.

The research team is ultimately trying to work out which types of sensory stimuli can help people produce more vigorous movements and when they could be applied, with a view to helping stroke patients regain control of their movements.

"What I am trying to understand are the basic brain mechanisms by which unexpected sensory stimuli leads to quicker and more vigorous movements after a go-signal, which is a phenomenon called the StartReact Effect," Dr Marinovic says.

"Past research has shown that if you deliver an acoustic stimulus during movement execution, such as contracting your index finger in conjunction with an acoustic noise like 'shhhh', then that suppresses activity in the motor cortex," he explains.

"What I have shown is an acoustic noise doesn't always inhibit the motor cortex, it can actually facilitate cortical activity if presented at the appropriate time. This is a novel finding that has helped us to further our understanding about the StartReact Effect."

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***"If we can better understand the StartReact Effect and the associated mechanisms in the brain, then we can experiment with different types of stimuli and tasks to help stroke survivors relearn movements."***

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"Right now, we are trying to figure out the basics, that is, what are the characteristics of acoustic stimuli and what are the associated brain mechanisms; otherwise using it in rehabilitation scenarios relies on guesswork.

"I have a hypothesis that the Locus Coeruleus – a small nucleus in the brainstem – is involved in the StartReact Effect and perhaps activation of this nucleus by an unexpected sensory stimulus rapidly increases neuron activity in the motor cortex.

"I suspect that might be the main mechanism that leads to movement facilitation, but further studies are required to test this hypothesis."

The research team is currently exposing test subjects to very short bursts of highly intense 100 decibel white noise – noise containing many frequencies with equal intensities – to test their ability to move on cue.

"Pure tones also work, but they are perceived as less intense and therefore, less effective. The secret to making the sound a more effective stimulus is to make the timing of the sound unpredictable," Dr Marinovic explains.

"For instance, the unexpected sound of a car backfiring or a pistol discharging are good examples of sounds that could trigger not only strong reflexes but also voluntary responses from stroke patients."

The team has tested different types of actions in association with noise stimuli including finger abduction (waving a finger back and forth) and are now testing wrist flexion and extension. They next want to try coordinated movements of two or more fingers in flexion and extension, such as touching the thumb and forefinger together.

"That is a very functional action for everyday activities like holding a coffee cup and depends greatly on corticospinal connections – connections between the motor cortex and the muscles," Dr Marinovic says.

"The StartReact Effect might depend on task functionality or the types of muscles you are trying to move, so we want to understand whether the effect is task dependent, muscle dependent or both.

"Knowing this is important because if you have a stroke patient whose limb is impaired, you can help the patient to more easily engage in rehabilitation programs if you know which muscles are more prone to the StartReact Effect and which muscles aren't."

The research team also want to investigate whether exposing stroke patients to noise stimuli over a prolonged period will eventually enable them to move more easily without the requirement of hearing any accessory stimulus at all.

"During one-hour-long sessions with patients I have observed patients with great difficulty in initiating movements by themselves, but when the white noise was played they could move far more easily and vigorously," Dr Marinovic says.

"What I want to know is, if I do this over the course of a month, is the person going to be better off even without the acoustic stimulus? And can they regain movement more quickly than people not using this type of stimulus?"

# GIANT LEAPS ON HORIZON FOR CEREBRAL PALSY

By Karen Green

A top-notch collaboration of 15 Australian and three international research organisations looks set to deliver the best progress in more than a century in diagnostics and interventions for cerebral palsy.

**Every week, 11 Australians are born with cerebral palsy, and there is no known cure.**

Cerebral palsy is not a modern disease. In fact, it's not a disease, but a physical disorder ranging in severity from a slight limp to paralysis of one side of the body (hemiplegia), to speech and mental impairments.

Ancient Egyptian, Roman and Greek civilisations all documented the symptoms of cerebral palsy, but it wasn't until the 1800s that a concerted first-world effort to pinpoint the physiological causes occurred. The conclusion was brain injury during birth, likely due to suffocation.

English surgeon William John Little was the first to medically document spasticity of the limbs in children but, in 1889, Canadian physician Sir William Osler revised the name 'Little's Disease' and referred to the condition as cerebral palsy (CP), Latin for 'brain paralysis'.

Controversially, Sigmund Freud then proposed that CP was not only a birth-related injury, but one that could occur in utero. He was correct – more than two-thirds of congenital brain injury causing CP are now thought to occur in the third trimester of pregnancy, although the causes are largely a mystery.

But two positive aspects of CP are known: the brain injury is non-degenerative, and early intervention can arrest the lifelong decline in mobility.

Professor Catherine Elliott, Chair of Allied Health at Curtin, is a researcher in the area of neurological impairment. For many years she worked as an occupational therapist, focusing on interventions for CP in babies and children. Now, her work is contributing to an international step-change in the diagnosis and treatment of CP.

Elliott is one of 10 Chief Investigators on the Australasian Cerebral Palsy Clinical Trials Network – a five-year national Centre of Research Excellence project. The centre is headed by Professor Ros Boyd, a neuroscience researcher at the University of Queensland (UQ) and former Haydn Williams research fellow at Curtin. In addition to several Australian research partners, the collaboration includes the University of Pisa, Italy, and the University of Auckland, New Zealand.

Two of the project's key aims are: to develop tools for earlier detection of CP, and to fast-track children to clinical trials of new 'neuroprotectants'.

So, just how early can CP be detected? And why is earlier detection desirable?

"Timely intervention can deliver better lifelong health outcomes for those born with CP, but these have been delayed due to the lack of early diagnosis," Elliott explains.

"Neuroplasticity is the key. If we diagnose early, we can apply interventions that exploit the young brain's immense plasticity."

Currently, clinical practice diagnoses CP at about 20 months of age. However, the project has produced a new diagnostic tool, called the General Movements Assessment (GMA), which can be conducted on babies only 12 weeks old and, according to the data, is 98 per cent accurate.

Neuroplasticity is a very exciting research area for neurologists and physical therapists. It wasn't too long ago the scientific community was convinced that damage to the brain and neural pathways was permanent. We now know that targeted stimulation will prompt the human brain to re-route its wiring – from bypassing a single damaged neuron to reorganising an entire cortex – and regain lost functions.

Next-generation technologies are another promising research angle for the centre.

"Diagnostic innovations are on the way. One of our project leaders is using neuroimaging to diagnose infants born pre-term at only 30 weeks' gestation," Elliott explains.

Using MRI scans, Professor Stephen Rose, a physicist at the CSIRO and UQ, has detected biomarkers of CP in the foetal brain, which provides the potential for a diagnosis during pregnancy.

And far from the clinical setting, a 'diagnostic app' is another innovation, where parents in remote locations can send video images of their baby, whose movements are assessed using pattern recognition technologies.

"Being consumer-driven research, this aspect of the project has excellent promise to ensure knowledge transfer into clinical practice," Elliott says.

Elliott believes the project's application of neuroimaging and machine-based learning tools could put Australia at the fore of clinical innovations in neuroscience.

*"In the near future we could see babies and young children with CP have relatively normal fine motor and cognitive development. And there's the potential for this project's outcomes to inform interventions and rehabilitation in autism and stroke, for example."*

The project will also trial several novel neuroprotectants – medications that may protect neural function and prevent gross motor impairment. The hope is that by the time the research centre disbands in 2020, one or two neuroprotectants will be implemented and the rate of CP will be in marked decline.

But for the present, Elliott's main aim is for the GMA to be embedded into clinical practice – not only in Australia, but worldwide.

"To ensure better outcomes now for those born with CP, the priority is to have the GMA inform new international guidelines and embedded into clinical practice."

# COULD GARLIC HOLD THE KEY TO CURING ALZHEIMER'S DISEASE?

By Daniel Jauk

Garlic is well known for its ability to fight the common cold, however, Curtin researchers have also discovered that an odourless aged extract of the root vegetable may reduce the risk of developing Alzheimer's disease and even reverse its effects.

Memory loss, disorientation, emotional unpredictability, weakening motor skills, loss of speech. The symptoms of Alzheimer's are well established, but despite the first case of the chronic neurodegenerative disease being documented more than 100 years ago, medical scientists have yet to determine what causes it, how to prevent it, or how to cure it.

With close to 50 million people worldwide living with the condition, a number expected to more than double by 2050, research into the disease has become increasingly important.

For the past ten years, Senior Research Fellow Associate Professor Ryu Takechi, from the Curtin Health Innovation Research Institute (CHIRI), and his team have been investigating the connection between cognitive impairment and subtypes of dementia, including Alzheimer's disease.

Takechi has focused his team's efforts around mounting evidence suggesting it is linked to breaches in the blood-brain barrier, a layer of tightly opposed cells lined with microscopic blood vessels called capillaries, that regulates the transportation of molecules in and out of the brain.

When breaches occur, harmful molecules may enter the brain – including amyloid beta, a mysterious protein that causes the death of neurons and, in doing so, is believed to contribute to the development of Alzheimer's disease.

"Our research identifies the factors that break down the brain's capillaries and that can protect or restore the function of the blood-brain barrier integrity. Restoring and reversing a patient's memory function is our ultimate goal," Takechi says.

"In the last few years, we found the damage to the blood-brain barrier is induced by inflammation and oxidative stress."

In 2010, the researchers published an important finding – that diets enriched in saturated fatty acids, such as fast food, can increase dysfunction of the blood-brain barrier, and therefore potentially increase the risk of developing Alzheimer's disease.

The researchers later found that aged garlic extract, an odourless product widely available in Australian pharmacies and some convenience stores, can completely prevent the breakdown of the blood-brain barrier.

The extract prevents dietary saturated fat-induced oxidative stress and protects the neurons in the brain that are central to memory function.

*"The major strength of garlic is in its unique cocktail mixture of a number of strong antioxidant compounds that are both water soluble and insoluble, compared to other pharmacological drugs or nutraceutical agents that contain just a single beneficial compound," Takechi says.*

Since then, the team has established the Animal Behaviour Testing Unit within Curtin's life science facility to examine how the cognitive abilities of preclinical rodent test subjects are affected after they have been fed with garlic.

These studies are now close to completion, with new studies already well underway into whether certain classes of cardiovascular drugs may prevent inflammation in the brain and breakdown of the blood-brain barrier, and how metallic content, such as iron and copper, relate to the dysfunction of the blood-brain barrier, ageing and Alzheimer's disease onset.

Dr Virginie Lam, who has led the preclinical trials in the laboratory, says the vast output of findings wouldn't be possible without strong collaboration between herself, Takechi, CHIRI Director Professor John Mamo, neuropsychologist Dr Matthew Albrecht and analytical chemist Dr Mark Hackett.

"It was great to have Dr Albrecht's help, for example, in analysing how the memory and other cognitive functions of our preclinical models were affected after we conducted dietary interventions," Dr Lam says.

Since beginning their research, the diverse team has attracted substantial funding from the WA Department of Health, Dementia Australia Research Foundation, and the National Health and Medical Research Council.

Last year, Takechi was presented with a prestigious Boosting Dementia Research Leadership Fellowship worth \$720,000 by Australian Minister for Health Greg Hunt, to begin work in associated research: investigating the connection between diabetes and dementia.

In the future, the team is planning to begin human clinical trials on the aged population or those afflicted with Alzheimer's disease to see how their research can be translated into practice.

"We definitely want to see some public health outcomes with the increased adoption of aged garlic extract and nutraceuticals," Dr Lam says.

"We also want to conduct regular public seminars around Perth as part of CHIRI to help us disseminate our findings."

[curtin.edu/hs-chiri](http://curtin.edu/hs-chiri)

# TUNING OUT THE FEAR

By Anne Griffin-Appadoo

Did you know more people fear snakes and spiders than soaring heights or tiny spaces? For some, these worries are minor concerns, easily dismissed. But for others, specific anxieties and fears can cast a debilitating shadow over daily life. It is this type of fear – and specifically its “extinction” – that interests Curtin researcher Professor Ottmar Lipp.

“Fear and anxiety is actually a positive thing, not a negative,” Lipp is quick to explain. “If you were not afraid of things that are dangerous, then most likely you wouldn’t be here! The problem is that it can get out of hand.

“The statistics suggest that one in six Australians will develop an anxiety disorder in their lifetime. So it’s a significant problem.”

Lipp has a notable record of research in the field of psychology, particularly in associative learning, psychophysiology and emotion.

He explains there are three ways in which we acquire anxiety.

“The first is by direct experience. You experience something negative in a particular situation and as a result you become afraid. For example, you go for a walk in the park and get bitten by a large dog. Consequently, you’re very likely to become afraid of dogs.”

Other ways of acquiring fears include vicarious experience, for example, hearing firsthand about somebody being bitten by a dog or witnessing the incident take place, or through third-party information, perhaps via a film or through the news.

*“A year ago we had a craze of people being afraid of clowns,” Lipp says. “This was most likely triggered by the pre-marketing of the movie IT which features a clown monster that takes children!”*

Over the past few decades, Lipp says great progress has been made in identifying and treating fears.

“As psychologists, we have developed a range of treatments which are very effective at reducing anxiety in the short term,” he explains.

“However, the bad news is that relapse rates vary between 30 to 60 per cent of successfully treated participants.”

Lipp hopes to tackle this significant relapse rate through research that could enhance the long-term effectiveness of treatments.

Currently, anxiety can be treated via “extinction” learning, Lipp says. This occurs through increasing and continued exposure to the cause of the fear. For example, using the earlier dog scenario, a patient would be gradually exposed to a dog in a safe setting and encouraged to increase interaction with the dog over time.

However, the learning acquired in this treatment is fragile and context-specific compared to the original acquisition of the fear. Should the patient encounter a different breed of dog or visit a different park, the fear can easily return.

To combat this, Lipp and his team have been trialling a new methodology, initially pioneered at New York University in 2015.

“The procedure is called novelty facilitated extinction (NFE),” Lipp says with excitement. “The big idea is that rather than presenting the stimuli that created the anxiety alone, you pair them with a novel stimulus that is surprising.”

“For example, if the person is afraid of dogs, you would not only expose them to the dog and encourage interaction, but you would pair these encounters with something unexpected – like music.”

Lipp and his team conducted the trials in the Psychology Experimental Research Laboratories at Curtin (PERL-C), which has eye-tracking instrumentation and EEG equipment for recording brain electrical activity, important resources for psychophysiological research.

“In our simple lab scenario we used [an auditory] tone to accompany an image which had previously caused anxiety,” Lipp explains.

The team has been surprised by the results so far, which confirm that NFE has a significant long-term impact on extinguishing fear.

“The question now is in what way does NFE strengthen extinction learning?” Lipp says. “One possibility is that NFE creates bigger prediction errors. The less predicted an outcome is, the more surprising an outcome is, the more you learn and this potentially results in better, stronger extinction learning.”

Alongside NFE, Lipp is investigating the physiology behind the acquisition of likes and dislikes as well as how we process emotion in facial expressions.

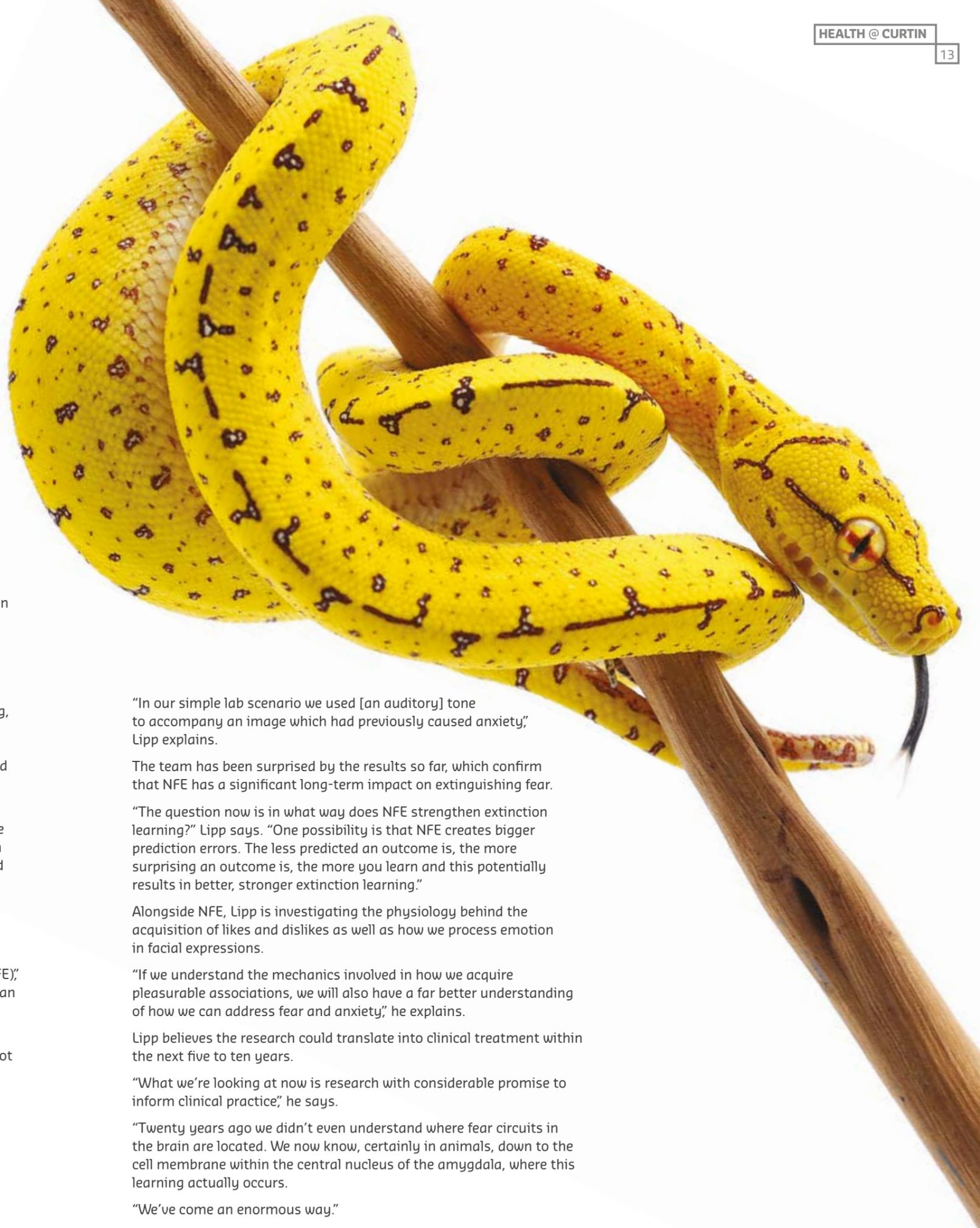
“If we understand the mechanics involved in how we acquire pleasurable associations, we will also have a far better understanding of how we can address fear and anxiety,” he explains.

Lipp believes the research could translate into clinical treatment within the next five to ten years.

“What we’re looking at now is research with considerable promise to inform clinical practice,” he says.

“Twenty years ago we didn’t even understand where fear circuits in the brain are located. We now know, certainly in animals, down to the cell membrane within the central nucleus of the amygdala, where this learning actually occurs.

“We’ve come an enormous way.”



# CAN TACKLING HARM YOUR BRAIN?

By Anita Shore

When former England striker Jeff Astle died from early onset dementia in 2002, the coroner put it down to heading footballs. Since then, several studies have linked repeated head trauma with degenerative brain disease, prompting Dr Andrew Lavender to investigate whether minor trauma from tackling could also affect a player's brain function.

**For athletes playing contact sports, head and body clashes are common. Pounding knocks, jarring collisions and swift changes in direction can cause the brain to bounce against the skull resulting in microscopic brain trauma, sometimes on both sides of the brain's outer surface.**

"Although the brain is encased in a protective skull and cushioned by fluid, a sudden change in direction can cause the nearside to impact the skull, then rock back so the other side is also impacted – a coup-contrecoup effect," Dr Lavender explains.

While concussive injuries stemming from head blows are well documented, it is lesser known that brain injuries can also occur without head contact, for example when a player's body suddenly changes direction, causing a whiplash movement to their neck.

"In a rugby tackle players cannon into each other, but if at the last split second the player tries to dodge, the impact is not at the precise moment or the precise position the player is expecting, they may move differently and that changes the impact."

Dr Lavender's current study examines the incidence of brain injuries so minute they don't appear to have an immediate effect, but could have more serious effects in the longer term.

"A player may feel just fine after a tackle but what has actually happened to their brain? Has it been jostled around enough to cause a minor injury?"

Using techniques that assess the brain's cortical neural pathways, Dr Lavender meticulously looks for evidence of microscopic brain changes following a tackle, which are not detectable by sideline tests or even the player's own perception.

"They are not classified as injuries at this point. In fact, the players themselves probably won't notice any difference. But when we run neurological tests, we can detect a difference."

To gather data, he simulates tackling events in a motion analysis laboratory, so far testing male and female rugby players.

"In each simulation we have two players, one at either end of the mats, timing gates at either end – so we can set their speed as they are coming in – and they go through a tackle."

"It's not a full tackle, like in a game. But they are hitting each other at a similar speed to what is typical in a game and the technique is there. It is sufficient to see if there is any movement of the head relative to the torso."

During the simulations, players wear markers on their shoulders and head, which are tracked by motion analysis software – the same technology used to create avatars.

"The software provides data that tells us how much the head is moving relative to the shoulders at a particular point in time. And from that we can infer how much the brain is moving inside the skull," Dr Lavender explains.

Preliminary data shows that rugby players' heads don't actually move that much in relation to their bodies, an observation Dr Lavender ascribes to their experience in the sport.

"Rugby players know how to tackle well. Their neck and shoulders are controlled. They roll their body into the right angle, use their shoulders and tense up at just the right time and brace in the right kind of way."

"What becomes a problem for them is when there is something slightly different or they get hit from an angle they are not expecting, or they lunge at an opponent's hips and get hit in the face with a knee and that causes the head to move about differently."

Following the simulations, Dr Lavender conducts tests on a player's memory and balance, as well as a cortical inhibition test, where the brain is briefly stimulated with a magnet to measure signals from the brain to the muscles.

"The study has found an increase in activity of the brain's inhibitory neural pathways – a reflection of protective mechanisms against minor injury – but unless you do an in-depth assessment, you can't tell."

*"A player can probably walk and function basically fine, but there is a change in the way their brain is operating. This change is imperceptible to the player and normalises within 24 hours."*

Dr Lavender will be gathering data for another year, but he is keen to stress his results are unlikely to warrant changing the ways in which sports are practised and played.

"A reasonable take-home message is that tackling may cause some short-term effects but the brain recovers quickly. We don't see anything that is debilitating in the long-term at this stage. This is different from players who have experienced multiple concussions across an entire career."

"Scientists have examined the brains of players who died from dementia and found severe damage to their brains as a result of a long sporting career with many concussion injuries."

"If you did the same with players who had not suffered multiple concussions when they eventually died, we expect you would see a pretty healthy brain."

# YOU'RE THE VOICE: the evolution of the PainChek app

By Nik Malane

How can someone tell you they're experiencing pain or discomfort that isn't overtly visible, if they can't communicate through speech? Professor Jeff Hughes from Curtin's School of Pharmacy and Biomedical Sciences has created an app that gives a voice to people who are living with conditions that impact upon their ability to verbally communicate with others.

One of these conditions is dementia, a neurodegenerative condition that affects the brain's cognitive ability. It's currently the second leading cause of death in Australia, and with the number of people living with dementia set to reach more than 536,000 by 2025, the demand for tools that help treat and manage the condition is sure to increase.

Professor Hughes' brainchild was the world's first smartphone app for pain assessment and monitoring, developed under the banner of Curtin start-up company ePAT (electronic Pain Assessment and Technologies Ltd) from 2014. The start-up was acquired by PainChek Ltd in 2016, and the app is now being further developed and marketed by the company as 'PainChek'.

The app provides an accurate and reliable means for healthcare professionals and family members providing care at home to assess pain, and ultimately help to improve quality of life for those they care for.

*"A significant issue among people with advanced dementia is that they no longer have the communication skills to express the level of pain they are suffering," Hughes explains.*

"The seriousness of their pain can often go unrecognised. But PainChek, a smart-device app, which utilises automation and artificial intelligence, allows for the detection and quantification of pain, based in part on a patient's facial expressions."

PainChek uses facial recognition and a 42-point pain scale to help healthcare professionals and family members decipher the level of pain being experienced by their patient or family member, allowing them to respond accordingly. A level between zero to six represents no pain, seven to 11 mild pain, 12 to 15 moderate pain and anything above 15 means severe pain.



The tailored pain scale was developed by Hughes and his team through a tireless review of existing literature and tools, including the well-known Abbey Pain Scale, an observational pain assessment tool used nationally in the assessment of pain in people with dementia.

PainChek automates pain assessment, allowing for the continual evaluation of pain, and providing the user with access to a personalised pain chart of their patient or family member, which has been mapped over an extended timeframe. The chart is designed to be used in conjunction with other information recorded on the app, which correlates with or affects pain levels, such as medication types and dosages, activity levels and behaviour. All recorded data is backed up when the device is connected to the internet.

Since its inception in 2013, Hughes and his team have been working hard to assess and monitor the performance of the app. They've conducted validation studies with a range of Perth-based aged care providers, including Mercy Care, Juniper, Bethanie and Brightwater, comparing each generation of the app with the Abbey Pain Scale. Data from these trials was used to support the registration of the app as a Class 1 medical device in Australia (Therapeutics Goods Administration registration) and Europe (CE Mark) by PainChek Ltd.

Trials in aged care facilities were successful, validating the functionality and purpose of PainChek. One of the residents

living with dementia was previously cared for at home by her husband. He says the app has been an invaluable tool for assessing his wife's constant lower back pain.

"When we tested the app on my wife, we got a score of four out of 10. It was so quick and accurate. She's in pain constantly with her lower back, and has trouble sitting down. The pain scale changes daily, and it makes me feel really comfortable that I can administer the necessary pain killers at any given time."

In addition, the research has led to the development of a partnership with Dementia Support Australia, which comprises the two entities Dementia Behaviour Management Advisory Service and Severe Behaviour Response Teams.

"Dementia Support Australia sends consultants out to assist in the care of people living with dementia who have significant behavioural problems," Professor Hughes says.

"What they had found from their own observations was that somewhere between 35 to 60 per cent of the people had undetected or undertreated pain, and they wanted the means to improve the assessment and documenting of that pain, and better demonstrate the effectiveness of their service.

"PainChek Ltd are effectively doing an implementation trial with them, starting here in Western Australia and then in South Australia. As part of the trial, we provide training and, after each roll out, we also offer clinical and technical support. In 2018, we'll roll out the app to all 150 of their consultants Australia-wide."

The development of the app hasn't stopped there, with PainChek Ltd working on adaptations that can cater for other groups unable to communicate verbally: infants and pre-verbal children.

"Twenty per cent of children have chronic pain, with common causes being headaches and gastrointestinal or musculoskeletal conditions. And that pain can produce a whole range of issues, such as behavioural problems, poor interaction with others and avoiding school. Most people think that little kids don't feel pain the way adults do, but we're learning this isn't the case," Hughes reveals.

The intended impact of the children's app is three-fold. One, to provide parents with surety about whether they're taking the appropriate action. Two, to assist healthcare professionals in deciding what level of pain a child might be in and which medication to administer if applicable, and three, to encourage the investigation of the root cause of the pain to then seek the appropriate treatment.

Much like the adult app, the children's app contains a number of items to help assess pain, however, the facial recognition element is far more in-depth due to the fact that children typically use more pain-associated facial expressions than adults. As a result, Hughes' team has been capturing videos of children who are in pain, primarily during the immunisation process, with each video contributing to a database of coded images. With a preliminary algorithm already built, PainChek Ltd plans to have the first prototype available for trialling in 2018.

[painchek.com](http://painchek.com)

# JOINING THE CULTURAL DOTS

By Nicholas Brant

Academics, mental health and drug and alcohol service providers are working with Aboriginal Elders to improve service provision for Aboriginal people as part of a project that is going from strength to strength.

**Fluttering in the breeze above the Richmond Wellbeing building, the Aboriginal flag may not attract much attention from the casual passer-by.**

But for the Aboriginal people coming to seek help from the mental health service provider, the flag makes a world of difference and represents just how far the organisation has come in creating a culturally secure place for them.

The flag, décor and work practices of Richmond staff, in addition to changes instituted by other mental health and drug and alcohol service providers around Perth, all stem from the Looking Forward Moving Forward Project, which is a National Health and Medical Research Council (NHMRC) funded project located at Curtin's Bentley Campus.

Now into its fifth year, the project led by Dr Michael Wright – a Yuat Nyoongar man from the Moora and New Norcia region – aims to improve the access and responsiveness of Perth's mental health and drug and alcohol services for Aboriginal people.

The project expanded out of Dr Wright's 2010 PhD project where he investigated experiences of caregiving within Aboriginal families living with a mental illness.

"Aboriginal people told me lots of stories about how the mental health system was failing them at all levels in regard to the lack of cultural safety and lack of attentiveness to issues," Dr Wright explains.

"The biggest issue was the system's lack of understanding of the importance of kinship systems and how family is so important in supporting the person suffering from a mental illness. The very individualistic idea of health delivery does not fit within an Aboriginal world view.

"This can cause enormous problems for the families because they are not included in the recovery process. The person who is unwell also becomes quite distressed as they are alienated from their family when the health system takes over."

Consulting with Nyoongar Elders, the project's research team found suicide, especially among young people, was the most serious issue identified by the community. The community also reported feeling frustrated that substance abuse and other serious mental health concerns remained unresolved.

"We arranged for Elders to meet with the senior management of 14 mental health and drug and alcohol service providers around Perth, such as Richmond Wellbeing, to pass on their knowledge and let that advice filter down into the organisation itself," Dr Wright says.

"Over the last five years, the Elders have demonstrated that a lack of understanding and recognition of the importance of kinship through connection of family can seriously impede the recovery journey for Aboriginal people suffering from mental health conditions.

"That means services are moving away from an individualistic model of care and are thinking about how families are very much a part of the recovery process.

"Now there is a greater acknowledgement around sense of compliance and what that looks like and how they can do that differently. We are changing work practices inside the various organisations and that is directly as a result of their work with the Elders."

Richmond Wellbeing Executive Manager of Operations Adrian Munro said that five years ago they had no Aboriginal clients and thought at the time that if Aboriginal people did not want to access services, that was their issue.

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*"The Elders helped us realise that Aboriginal people desperately wanted mental health services, but our services were not culturally safe and appropriate, and that everything we did was like putting up a sign out front saying Aboriginal people are not welcome," Munro says.*

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The Elders have been able to guide Richmond Wellbeing to make a number of changes including cultural awareness training for staff, raising an Aboriginal flag outside the building and having an Acknowledgment of Country in every room in Richmond.

"You will not find an Aboriginal person who comes into our building who doesn't immediately realise the flag is present. We have had people come in and say 'I have never accessed any service from a white man ever before but the fact you have an Aboriginal flag out there I am prepared to give you a chance'"

Richmond Wellbeing now employs 18 Aboriginal staff, and in 2017 provided support to close to 200 people, representing 15 per cent of the company's total client base.

Dr Wright and the service providers are now developing metrics to measure changes that have occurred within each organisation to determine the sustainability of the service delivery model beyond the life of the project.

# HOW CAN WE HELP ADOLESCENTS CLIMB 'OCD MOUNTAIN'?

By Daniel Jauk

Obsessive-compulsive disorder (OCD) is a debilitating mental health condition that's believed to affect at least 500,000 Australians, with adolescents representing a significant portion of those affected. Generally misunderstood in the community, people who have OCD don't simply have a penchant for tidiness – they have a variety of unwanted obsessions that can cause significant stress and anxiety unless there is some intervention.

**OCD? Not Me! is a free, online treatment program developed by Curtin University researchers that seeks to help young people aged 12–18 years with OCD.**

Based on Exposure and Response Prevention – the gold-standard treatment for OCD – the program challenges participants to climb the metaphoric 'OCD Mountain' and gradually reduce the use of compulsive rituals to reduce their anxiety.

"People with OCD experience obsessions that are hard to dismiss and cause significant anxiety and distress. These include thoughts they are contaminated with germs, vivid images of something terrible happening to a loved one or thoughts they are a bad person. It is important to note these thoughts are unwanted," explains lead researcher Professor Clare Rees.

"In response, the individual usually completes repetitive behaviours – compulsions – to reduce their distress. For example, if the intrusive thought is their mum getting sick, the young person might complete mental rituals, such as repetitively thinking 'I love you, mum'.

"Schoolwork can also be affected; a young person might be caught up in writing perfect sentences because they have the fear that if they don't something terrible may happen to a loved one.

"Unfortunately, what happens is that the person then falsely believes they must do a checking ritual to prevent the feared outcome."

The OCD? Not Me! program tackles these compulsive rituals in eight stages, based on Exposure and Response Prevention treatment modules, from 'Getting Ready' to 'Base Camp' and all the way to 'Reaching the Summit'.

As each stage is completed, parents are simultaneously given supplementary resources to ensure they understand their child's symptoms.

The Curtin-led program is unique because it is fully automated, meaning participants do not have to interact with a therapist. Rees says this automation, along with the program's interactive elements, have been key to its success.

"There are a number of significant obstacles to accessing evidence-based treatment for OCD. These include a lack of clinicians with expertise in treating the disorder, long waiting lists, cost of treatment and, in many cases, the practical difficulty and the fear participants have of attending face-to-face sessions," Rees explains.

"We are aiming to make effective treatment more easily available to greater numbers of young people, before the problem becomes more entrenched and difficult to shift. Exposure with Response Prevention means we start by asking somebody with OCD to wash their hands for eight minutes, instead of 10 minutes, and so on.

"We want young people to see OCD as a challenge they can overcome as opposed to a medical condition they are stuck with, so that's why we structured the program to feel like an adventure.

*"We also renamed some common therapeutic strategies to fit in with the metaphor of a mountain climbing expedition; for example, controlled breathing became the 'Breathing Control Regulator' and psychoeducation became 'Mountain Guidebook'."*

The research project began in 2013 after Rees and her team – fellow Curtin researchers Dr Rebecca Anderson and Dr Amy Finlay-Jones – were awarded more than \$460,000 from the Commonwealth Department of Health. This number later increased to \$640,000 as the department chose to extend the funding.

The team decided on an open trial design, as opposed to a controlled trial design, to directly compare the symptoms experienced by the young people from before they participated in the program to when they finished it.

Overall, more than 50 young people completed the majority of the program, with the research team observing that the participants' OCD symptoms decreased in intensity over the duration of the program.

"We found the program resulted in statistically and clinically significant reductions in the severity of symptoms, as well as reductions in the amount of interference the symptoms cause in daily life, such as getting to school on time or the amount of time needed to take a shower," Rees says.

Rees' team are now planning the next phase of the research, where they are hoping to create two apps based on the OCD? Not Me! program: one for clinicians working with young people and one for the young people themselves.

[curtin.edu/bbmh-research](http://curtin.edu/bbmh-research)

# RETHINK THE DRINK: teenagers and alcohol

By Zoe Taylor

There is a trend in Australia that suggests more young people are choosing to abstain from drinking alcohol, but a project led by Curtin's National Drug and Research Institute (NDRI) reveals that the subset who continue to drink may be doing so at riskier levels.

Coordinated by Dr Tina Lam, the Young Australians Alcohol Reporting System (YAARS) is a collaborative national project that provides detailed insight into the risky drinking habits and associated harms experienced by 14–19 year olds.

In 2016 and 2017, YAARS surveyed 3,500 Australians aged 14–19 who represented the heaviest drinking 20–25 per cent of their age bracket.

With alcohol being one of the leading causes of death and hospitalisations among young people in Australia, the findings of the YAARS project can help inform policy, prevention and treatment initiatives, as well as parental responses to teenage drinking, to make drinking a safer experience for young people and the wider community.

But what is risky drinking? For adults, the National Health and Medical Research Council recommends that the consumption of no more than four standard drinks on a single occasion reduces the risk of alcohol-related injury from that occasion.

Half the YAARS participants were found to be consuming 11 or more standard drinks per session at least once a month.

"Exceeding four standard drinks per sitting per month increases the risk of ending up in the emergency department with an injury to above one in 100," Dr Lam says.

"As the quantity consumed increases, the risk of injury or even alcohol-related death or disease also rapidly increases. These risk levels are for adults, so the risk is likely to be even higher for young people."

More than three-quarters of survey participants experienced at least one negative consequence as a result of their most recent risky drinking session; 34 per cent said or did embarrassing things; 20 per cent felt sick or vomited; 16 per cent did impulsive things; 19 per cent could not remember large stretches of time; seven per cent passed out; and seven per cent got into sexual situations they later regretted.

"While some of these outcomes, such as vomiting and hangovers, can seem less serious, when they are frequently experienced they can point toward a more problematic pattern of harms," Dr Lam says.

A teenager's brain, which continues to develop until around the age of 25, can be particularly vulnerable to the effects of alcohol.

"When heavy alcohol consumption becomes chronic, changes to the brain's mesolimbic 'reward' pathway occur. Regular exposure to alcohol reduces the brain's baseline sensitivity to pleasure, and drinkers may compensate for this by consuming higher quantities over time to get the same feeling. This gradual escalation of use can contribute to the development of dependence and other alcohol-related problems."

Alarming, a fifth of the YAARS survey participants reported signs that were also suggestive of alcohol dependence. Dr Lam says that changes to individual behaviour can dramatically reduce the risks associated with heavy drinking.

"The primary thing would be some sort of reduction in the quantity of alcohol consumed. Kids get really disappointed when they hear that, but even a small reduction, on a population level, is going to have a significant impact on the number of young people ending up in the emergency department."

Contrary to popular belief, parents also play a significant role in how young people use alcohol.

*"One of the consistent findings is that if a parent doesn't approve of a young person engaging in risky alcohol use, that person is less likely to engage in that use,"*  
Dr Lam says.

"It is important parents are positive role models – they have to walk the walk, not only talk the talk. That seems really obvious, but it's important to support parents, to say that you might think your teenager isn't listening to you anymore, but be assured that evidence suggests you can have a huge impact throughout their childhood and late adolescence in delaying or reducing their drinking."

The WA Minister for Health is currently investigating placing a minimum floor price on alcohol in an effort to reduce the state's alcohol-related harms.

"The evidence tells us that strategies that influence the availability of alcohol have the greatest impact in reducing harms such as hospitalisations, traffic accidents and alcohol-related violence. This suggests that we need to look at price mechanisms," Dr Lam says.

"Such legislation needs community support to be realised and can't stand in isolation. That means thinking about how we treat alcohol in our homes and as part of our social circles, and how we learn about it in schools. We need small changes in a variety of areas to deliver the message that we care about and want to prioritise youth safety and health."

[curtin.edu/ndri-alc](http://curtin.edu/ndri-alc)

Half the YAARS participants consumed 11 or more standard drinks per session, more than double the amount recommended by the National Health and Medical Research Council.



# GETTING BACK ON TRACK: technology changing the treatment of low back pain

By Nik Malane

The body's relationship with pain is a complicated one. For example, 'learned behaviour' within our nervous system can cause pain to persist long after an injury has healed, which can have detrimental effects on people's mental and emotional health, as well as the state of our national healthcare system.

Curtin biomechanics researchers Dr Amity Campbell and Associate Professor Peter Kent are undertaking ground-breaking research using technology that aims to change learned behaviours and improve the lives of those living with low back pain, which is the most prevalent and costly musculoskeletal condition there is, and the leading cause of 'years lived with disability' globally.

The project is a randomised, controlled trial examining and comparing methods of treating low back pain experienced by people over the age of 18 who have received treatment from a healthcare professional for more than six weeks.

Set to commence in July 2018 for a four-year period, it will investigate a patient-centred treatment called cognitive functional therapy, which targets the beliefs, fears and associated behaviours (both movement and lifestyle) of each individual with back pain.

Two forms of this method, each emphasising some elements of the treatment more than the other, will be compared to 'usual care', which encompasses a range of interventions from exercise therapy and manual therapy, to painkillers and anti-inflammatory medications.

In addition, participants in the cognitive functional therapy groups will be asked to periodically wear small wireless sensors to track their movement, which will help the researchers ascertain how changing movement behaviours can improve back pain.

"We know that cognitive functional therapy seems effective for treating low back pain, and so what we're really interested in is what the most effective components of that treatment are, and whether the wearable sensors can help us understand that," Dr Campbell says.

The sensors are similar to USB sticks, and contain three pieces of hardware and two chips developed by an Australian company, each of them indirectly measuring movement. Once placed on the wearer, information is recorded and delivered to the researchers for analysis.

"The sensors have really sophisticated, powerful algorithms that combine the information to make this indirect measure of movement as accurate as possible.

"The hardware's been available for some time, but the technology has really come a long way in terms of the algorithms. We can do a study like this using wearable sensors, whereas in the past we would have been restricted to a laboratory environment to try and get as accurate a measure as we can now with these wearable sensors," Dr Campbell explains.

Dr Campbell and Professor Kent are working in close collaboration with a range of Australian and international institutions, including the University of Western Australia, Macquarie University, Monash University, the University of Southern Denmark, Imperial College and Aspetar Sports Medicine and Orthopaedic Hospital in Qatar. Each plays a very specific role, from data collection and investigation to economic analysis.

Aside from enhancing knowledge in this space, the findings of the research could have a significant economic impact.

"Monash is doing the economic analysis in relation to its impact on the healthcare system, assessing the cost-effectiveness of this treatment when compared to usual care.

*"We want to lessen the current and future burden on the healthcare system, so that the money can be used for other things", Kent explains.*

[curtin.edu/pain-research](http://curtin.edu/pain-research)

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