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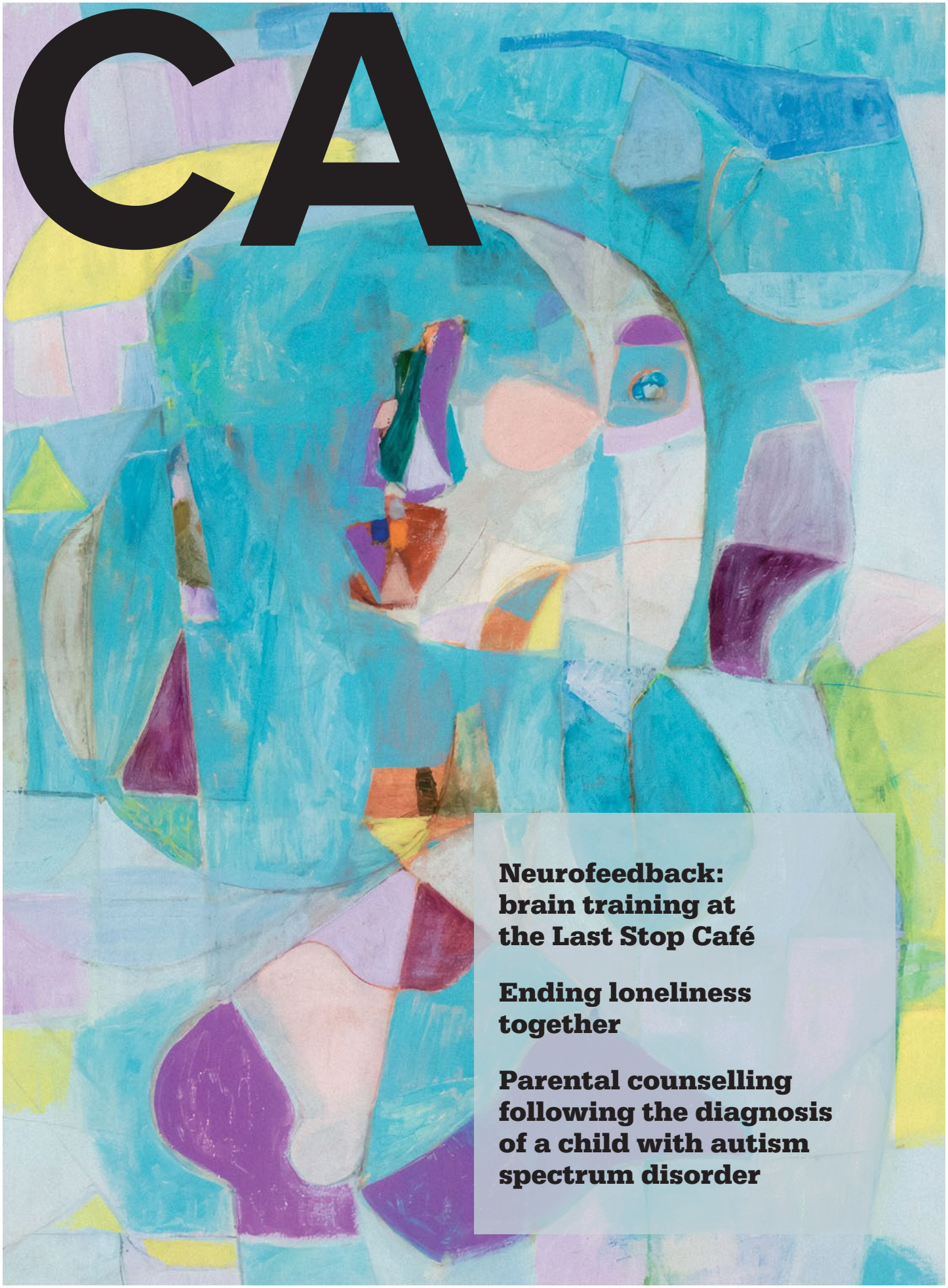

Neurofeedback: brain training at the Last Stop Café

Ending loneliness together

Parental counselling following the diagnosis of a child with autism spectrum disorder

Illustration: 123rf

NEUROFEEDBACK: BRAIN TRAINING AT THE LAST STOP CAFÉ

By **Mark Darling**
psychologist

It was 2006. The woman stood before me with tears streaming down her cheeks and the look of fire in her eyes. With an evangelical fervour in her trembling voice, she told me that she would go anywhere, do anything and talk to anyone on my behalf if I asked her to. What could she do for me? A few moments earlier I had ushered her into my office after hearing a kerfuffle in the waiting room that resulted in a call from my receptionist informing me there was someone at her desk asking to speak with me. She didn't have an appointment but only needed a few minutes she said. It wasn't my usual habit to bow to such requests, but I recognised the voice and had a window available between clients.

Sally (not her real name) was an accomplished equestrian in her late 50s who lived on a property in the hinterland about an hour's drive from my office. Like so many who came to me for neurofeedback, it quickly became obvious in our first session together that I was her last hope. All other options had been exhausted. Besides anxiety, depression and panic attacks, Sally was experiencing what she referred to as 'black spots' – epileptic seizure events that occurred in conjunction with uncontrolled outbursts of anger and migraines. Based on a quantitative mapping of her brain's electrical activity and a thorough history, I developed a brain training protocol in which Sally completed approximately

30 sessions of neurofeedback aimed at stabilising her chaotic brain. Now she stood before me to tell me that she no longer experienced anxiety, depression, panic attacks, rages of anger, migraines or the dreaded 'black spots'. She was once again able to drive her car and ride her beloved horses. So, what could she do for me? For not the first time in my career I was left marvelling at the transformative power of this unique brain training technique.

What is neurofeedback?

Neurofeedback, which is also referred to as EEG biofeedback or neurotherapy, is a means of coaching the brain to improve the way it self-regulates so that optimal states can be accessed more readily. While measuring the electroencephalogram (EEG) has traditionally been used as a diagnostic tool for the detection of epileptic seizure discharges in the brain, neurofeedback builds on that foundation by not only recording the brain's electrical signal but providing real-time feedback in order to train it towards homeostasis. While there are a variety of ways of accomplishing this, neurofeedback in its most common form involves placing sensors on the scalp for measuring the brain's electrical activity with specialised computer software providing moment-by-moment visual and auditory feedback that lets the trainee know when they are producing appropriate brainwave patterns and when they are not. As the brain notices these cues and begins to function more appropriately, improvements are often seen in a number of areas, including sleep, behaviour, attention, communication, emotional regulation, sensory integration and cognitive performance.

It should be noted that neurofeedback is not an invasive technique. There is no direct stimulation or any such active intervention via the electrodes. It simply measures the brain's electrical signal, passes the signal through an amplifier and interpretive software, then provides instantaneous visual and auditory feedback that lets the brain know when it is performing appropriately and when it is not. In the same way that behavioural psychologists use positive outcomes to reward incremental improvements in individual behaviour, neurofeedback rewards the brain for improving its performance with the reward being, for example, entertaining videos that play when the brain is performing appropriately and pause when it is not. Over time, the brain adjusts its performance so that the reward of seeing the video can be achieved and, if enough sessions have been completed, the gains made tend to be long lasting.

In essence then, neurofeedback is operant conditioning of the EEG for the purpose of teaching the brain to shift state or, more accurately, to have the flexibility needed to select the appropriate state for the situation at hand. Different states of consciousness are represented by different brainwave patterns as measured in the EEG but when we experience physical, mental, emotional or neurological stress, those patterns can become dysfunctional. Delta brainwaves, for example, are the slowest (1–4 Hertz [Hz] or cycles per second) and are usually dominant when we are in deep sleep, but when observed in a waking state may reflect the presence of a head injury. Theta brainwaves are slightly faster (4–8Hz) and are usually dominant in that spacey state when we are first dozing off to sleep at night but can often become elevated in people with attention deficit hyperactivity disorder (ADHD) when they are awake and attempting to do a task. Alpha brainwaves (8–12Hz) are generally dominant when we are in an awake but deeply relaxed state with our eyes closed such as during meditation, but can become larger and/or slower in a fully awake state when we are struggling with depression, motivation, cognition or chronic pain. Beta brainwaves are faster again (12–38Hz) and are indicative of a brain actively engaged in a task. When the brain speeds up too much and the top end of the beta range is dominant, however, we may become overfocused, often resulting in the presence of obsessive thinking, anxiety, anger, agitation, insomnia and/or trauma-based fear. Neurofeedback helps us to coax the brain out of these redundant dysfunctional stuck places.

Historically, neurofeedback has been used to help a variety of conditions in which the brain is not working as well as it might, such as epilepsy, ADHD, autism, insomnia, anxiety, depression, mild traumatic brain injury, post-traumatic stress disorder (PTSD), addictions and many other related areas. The reality, though, is that any brain can benefit from this type of training. Several players from the Italian football team used neurofeedback as a form of peak performance training prior to

them winning the FIFA World Cup in 2006 (Wilson, Peper, & Moss, 2006). Indeed, many people such as elite athletes, business executives, musicians and other performers looking to optimise their potential have used neurofeedback for peak performance and flow state training or even as a means of enhancing their contemplative practices such as meditation or yoga (see Hammond & Novian, 2023, 'Optimal functioning and peak performance' section).

An unusual history

The whole notion that it might be possible to train the brain's electrical activity first came to the fore in the 1960s when Dr M. Barry Sterman, a psychologist and sleep researcher at UCLA, discovered that cats were able to produce an 11–15Hz rhythm across the sensorimotor cortex of the brain when rewarded for doing so (Wyrwicka & Sterman, 1968). This rhythm, which Sterman dubbed the sensorimotor rhythm (SMR), is associated with a state of mental alertness coupled with physical calm. Sterman observed that whenever the cats, who were wired with EEG measuring apparatus, ceased all movement such as eating, drinking, fighting, playing or grooming while maintaining a state of mental preparedness to receive a food reward, the amplitude of their sensorimotor rhythm would increase. The cats were subsequently provided with a mixture of milk and chicken broth immediately following each SMR amplitude burst. Over several sessions the occurrence of this rhythm, along with the calm and alert behaviour, increased in this group of cats.

This might have remained an isolated experiment except for one of those accidental discoveries that science is famous for. In unrelated research sponsored by the US Air Force, Sterman was attempting to determine why astronauts on test missions sometimes suffered from hallucinations or seizures or even

Illustration: 123rf

died. Remember that this was the 1960s and the space race with the USSR was well and truly underway. NASA believed the astronauts were getting sick because of poisonous monomethyl-hydrazine fumes leaking from the rocket fuel. Sterman tested this assumption by exposing a group of 50 laboratory cats to the substance concerned. While most of the cats had seizures as expected, there was a group of 10 cats that were resistant to seizure activity. Sterman was attempting to establish a dosage curve but while all the cats showed signs of physical discomfort, there was a great divide between the two emerging groups, delineated by seizure onset. Three of the cats had no seizures at all and another seven took at least twice as long before a seizure occurred. These findings mystified Sterman until he checked back through his records and discovered that the 10 cats that were resistant to seizures had all received EEG brain training in the earlier SMR experiment involving milk and chicken broth rewards (Sterman et al., 1969). Can you hear the cogs turning? Was it possible that teaching the brain to increase the amplitude of a particular EEG rhythm could negate the effects of a toxic substance and provide robust protection again seizure activity?

Sterman had already successfully repeated the SMR training experiment with primates, but with the new discovery he moved towards trialling his novel technique with human epilepsy patients. His first candidate was a young woman in her twenties who had an uncontrolled seizure disorder. Well before the advent of the current technological age, she was to look at a box that had two lights on the front. As the measured EEG signal from the sensorimotor cortex passed through the amplifier, a green light came on when SMR activity increased, and a red light came on when the same activity decreased in amplitude. Half-hour sessions were conducted twice per week and, over time, she essentially became seizure free and was weaned off all anticonvulsant medication. She was subsequently issued with a California driver's licence (Sterman & Friar, 1972).

The publication of this case study permanently altered Sterman's professional trajectory and ultimately resulted in him assuming the mantle of the father of neurofeedback. In the immediate term it also produced a flourish of associated research activity in which the same results were consistently replicated some 20 times by 12 different research teams across the remainder of the century. Sterman (2000) subsequently conducted a meta-analysis of every published study investigating the effect of SMR brainwave enhancement on epilepsy and found that across all studies, 82% of subjects showed a clinical improvement, with an average of greater than 50% reduction in the intensity and frequency of seizure activity.

When Dr Joel Lubar from the University of Tennessee first read of Sterman's groundbreaking research in 1972, he could see immediate application of SMR enhancement for his interest group of hyperkinetic children – those who would later be identified as living with ADHD – due to the similar neurocircuitry involved. Lubar accepted a one-year appointment under Sterman's tutelage for the purpose of learning the new technique and shortly thereafter began publishing his findings. In his initial case study, he used a classic ABA design in which he trained a child out of having ADHD by rewarding an increase in SMR brainwave activity and a decrease in the slower theta waves,

with the SMR amplitude increasing threefold over the course of several neurofeedback sessions. He then reversed the protocol and trained the child to decrease SMR right back to baseline, along with a loss of all behavioural improvements, then trained him once again to increase SMR along with the restoration of all previous gains (Lubar & Shouse, 1976). The child was able to be weaned off medication and in a follow-up several years later had maintained his gains and was still medication free (Lubar, 1991).

Deliberately making someone worse would obviously be considered unethical now, but this was the 1970s and the study did provide further proof that this was no placebo since it was a blind study in which only the researcher knew of the changes in protocol. Lubar ended up developing the classic ADHD protocol of reducing the theta/beta ratio on the frontal midline – basically, bringing the underactive frontal lobes back online by decreasing the excess slow theta activity and increasing the faster beta brainwaves that are necessary for executive functions such as sustained attention, impulse control, emotional regulation, etc. (Lubar & Lubar, 1984). ADHD is now the most published topic of research in the neurofeedback field with some studies proving that, unlike stimulant medication, the long-term effects of neurofeedback are maintained following the cessation of the intervention (e.g., Arns et al., 2014; Fuchs et al., 2003; Monastra et al., 2002; Van Doren et al., 2019).

From those humble beginnings in the laboratories of Sterman and Lubar, the fledgling field of neurofeedback continued to grow organically as the novel technique was found to be helpful for other conditions, often by accident. For example, the parent of a child with ADHD doing SMR brain training might report back to the practitioner that their child was now sleeping better, performing better at academic tasks, no longer grinding their teeth, displaying less obsessive thinking or compulsive behaviour, or achieving continence at night. The possibilities were endless and, in a very real sense, particularly since the advent of the personal computer, practitioners were setting the pace with new discoveries while the researchers were scrambling to catch up.

In my first few months as a neurofeedback practitioner, I worked with a 19-year-old client with ADHD who reported rather casually that his stutter had disappeared following his previous SMR brain training session. With the later addition of beta brainwave enhancement for concentration, the stutter returned. This became a lesson in titration as I reduced the time spent training beta and increased the time spent enhancing SMR, so that the client's attentional system remained optimal while the

motor calming afforded by SMR enhancement enabled the continued absence of their stuttering.

So often in such instances we would be back on our practitioner email listservs excitedly discussing our most recent findings. It was such a fertile environment for the development of the field as we realised that neurofeedback could be helpful for conditions as diverse as learning disabilities, obsessive/compulsive disorder, autism, enuresis, encopresis, depression, anxiety, uncontrolled anger, traumatic brain injury, stroke, tinnitus, insomnia, etc. Of course, hands-on practitioners rarely have the funds or time available to conduct and publish research, and to this day there is probably a lag between what practitioners know and what appears in peer-reviewed journals.

Going deeper

While a full review of the literature is beyond the scope of this article, it is worth noting that while Sterman, Lubar and their ilk were concentrating on the developments that stemmed from eyes-open SMR brainwave training, there were others focusing on exploring the deeper, meditative states of alpha and theta in a relaxed, eyes-closed environment using auditory feedback rewards.

One of the seminal discoveries from this line of enquiry was that people with alcohol use disorder could be trained to increase relaxing alpha brainwaves to the point where they were no longer enslaved to their addiction (Peniston & Kulkosky, 1989). Alpha is generally the dominant posterior rhythm in an awake, eyes-closed state, but it was found that people with established alcohol use disorder had a profound absence of this soothing brainwave frequency. Drinking alcohol temporarily produced a surge of alpha waves, which created a euphoric sense of wellbeing, followed by a rebound to faster, anxiety-inducing beta waves as the effects wore off. No wonder they were so addicted. They were forever trying to get back into a state of peaceful relaxation that many of us take for granted.

The initial research utilising neurofeedback to enhance alpha and theta brainwaves in a group of people with alcohol use disorder demonstrated that eight of 10 participants had maintained their sobriety at the official 18-month follow-up, compared to all 10 of the control group who had relapsed in the same period. The participants were Vietnam War veterans who also had PTSD and were all identified as having a confirmed history of alcoholism extending more than 20 years and a minimum of four prior residential treatment failures. Two hardy souls from the neurofeedback group headed straight to the pub following release from the program but became so sick that they never drank again – their newly acquired intolerance to alcohol being experienced as flu-like symptoms that became so common a reaction to drinking alcohol after undergoing alpha/theta brainwave training that it was dubbed the 'Peniston Flu', after the lead researcher, Eugene Peniston (Peniston & Kulkosky, 1989).

This embryonic exploration of the subconscious realm led to the further refinement of the alpha/theta neurofeedback protocol that is still used today for alcoholism and other addictions, as well as anxiety, depression, PTSD and associated trauma conditions. The inclusion of eyes-closed theta brainwave enhancement along with the alpha training appears to enable access to deeper subconscious states where unprocessed, partially processed or inappropriately processed traumatic memories are held. And by using neurofeedback to artificially extend the time spent in the theta state, those traumatic memories can be processed and resolved. The protocol involves having the client sit back in a comfortable recliner with headphones that provide real-time feedback about the EEG in

Illustration: 123rf

the form of relaxing musical tones and nature sounds that reward an increase in alpha and theta brainwave activity while inhibiting the production of delta (sleep) and beta (mental chatter). This allows for the occurrence of a witness state in which the subconscious processes traumatic memories without fear, judgement or cognitive effort.

To give you a sense of how powerful alpha/theta training can be for someone with PTSD, I will share the story of WWII veteran, Bert (nor his real name). In our first session together, Bert described a dream in which he was alone on a jungle path in Papua New Guinea when he realised that a patrol of four Japanese soldiers was coming towards him from the opposite direction. They hadn't seen him, so he quickly hid in the bushes off to the side of the track. His plan was to let the soldiers pass by and then quietly take them from behind one at a time. He snuck up on the one at the rear of the patrol and grabbed him by the throat and started to strangle him. What he didn't realise was that he was acting the nightmare out in real time and strangling his wife in their bed. Consequently, they hadn't slept in the same room for 14 years. Following a course of alpha/theta brainwave training Bert ceased having nightmares, flashbacks, anxiety and associated chronic diarrhoea 61 years after the end of the war. Can you imagine carrying such a burden for so long? Fortunately, there is no use-by date with neurofeedback.

A personal journey

Like so many of my fellow practitioners, my introduction to the world of neurofeedback was facilitated by the pressing needs of a loved one. In my case it was my son. Nathan was born with a genetic disorder known as Angelman Syndrome that involved severely delayed development, epilepsy, absent speech, vision and motor planning difficulties, autistic behaviour, hyperactivity, stimming and a plethora of related concerns. I was desperate to find

something that might help him and, when I read of neurofeedback in early 1999 while working for Disability Services in Queensland, I did all I could to find out more about this unusual therapy. I spoke with two existing practitioners and by June of that year was attending the inaugural conference of the Pacific Rim chapter of the Society for Neuronal Regulation (now known as the International Society for Neuroregulation and Research) in Brisbane and was listening in awe to the likes of Barry Sterman describing his work with epilepsy using neurofeedback. In August of the same year, I flew to Sydney to undertake an introductory neurofeedback course for professionals, and before the year's end I was utilising the new technology at home with Nathan.

In those days, a single neurofeedback system consisted of two full-sized, DOS-based desktop computers with accompanying chunky monitors (one for the clinician and one for the client) and a single channel EEG amplifier connected by a fibreoptic cable. It was large and it was clunky, but I was able to do SMR brain training with Nathan. Despite keeping meticulous notes, it would be near impossible to condense those 250+ sessions over three years into a few short sentences. Suffice to say that Nathan became largely seizure free, was weaned off all anticonvulsant medication, had improved sleep onset, became continent, experienced improved information processing and response time (10–15 second lag down to zero lag) and had improved attention and reduced hypermotoric behaviour.

In January 2000, a couple of months after starting brain training sessions with Nathan, I commenced in private practice with a focus on neurofeedback. Being a psychologist, I have generally engaged with people who have behavioural or emotional difficulties, but I found myself consistently astounded at how apparently unrelated problems that may not have even been reported seemed to also be responding to neurofeedback when used as adjunct to counselling. I've already mentioned the teenager with ADHD and his resolved stuttering problem. Then there was the woman in her 60s who was three years post-stroke who, besides a reduction in anxiety, reported experiencing greater flexibility and movement in her left hand and leg and an 85% reduction in the numbness in her left cheek that she described as being like a dental anaesthetic gradually wearing off. She was subsequently able to drive her car again. Or the woman who was legally blind after receiving a traumatic brain injury from a motor vehicle accident, who reported that she was experiencing 20/20 vision for short periods of time some hours after each neurofeedback session. Or the teenager with ADHD and myotonic dystrophy who had marked increases in recorded blood oxygenation levels and a dramatic improvement in his personal best time over 400 metres at the Special Olympics. He went on to represent Australia, becoming a multiple gold medallist in track and field and the pool. While initially unexpected, such occurrences should not be a surprise since the brain isn't just about thinking or feeling. It literally regulates everything.

Neurofeedback in homes and schools

Unusual outcomes aside, my bread-and-butter clientele in those early days were children with neurodevelopmental disorders, particularly ADHD and autism. Parents were reporting positive improvements in their children's behaviour and emotions that led to increased enquiries from further afield. Because there were so few people offering neurofeedback, it became commonplace for families to attend my clinic on the Sunshine Coast from elsewhere in Queensland or even from interstate. This development, coupled with the fact that neurofeedback needed to be done at least twice a week over several months, meant I needed to get more creative in how I offered services. Developments in technology meant that neurofeedback systems could be taken home for parents to run sessions with their children while being supported throughout the process via phone and email. Families often came to the Sunshine Coast for a beach holiday, and across the course of a week, I conducted assessments, developed training plans, ran neurofeedback sessions and trained parents in how to connect electrodes, get a good signal and run the neurofeedback software.

As this remote neurofeedback option continued to be taken up, I became more convinced than ever that neurofeedback for children should ideally occur in a school setting and whenever speaking at public events would challenge the educators present about the possibilities. Those first to take me up on this suggestion were

a principal and his deputy from Hervey Bay Special School, who attended an ADHD and Foetal Alcohol Syndrome support group meeting that I was speaking in in Maryborough in 2003. Following a further presentation to staff and parents at the school, I then provided three days of training for the staff who were selected to be technicians. As always, my main aim was to have them know where to place electrodes, how to get a good signal and how to run the neurofeedback training sessions I designed for each child.

In the first term of 2004, we commenced a pilot project with six autistic students chosen by the school. Each of the students was ascertained as having autism spectrum disorder (ASD) Level 6, meaning they required the highest level of support offered by the Queensland education system at that time. I provided all appropriate assessments onsite at the school, and then developed individually tailored neurofeedback protocols for each student. Full support was provided remotely, and the neurofeedback sessions formed part of each child's Individual Education Profile. It felt wonderful to be normalising the process of brain training for this group of young people.

A system of independent direct observation of behaviour in the classroom for each of the students was also established. Pre-determined autistic behaviours were observed and quantified at pre-determined windows of time each day. The result was that across the first 28 neurofeedback sessions, autistic behaviour in the classroom setting reduced by an average of 64% for the students involved in the study. Improvements were reported in the areas of sleep, mood, speech, academic performance, attention, memory and social skills, and there were reductions in anger, aggression, seizures, hyperactivity and impulsivity. The two students who had epilepsy both stopped having seizures completely, one after the first session and the other after the first month (he normally had three to seven seizures per month), while two non-verbal students both began speaking a few words. The neurofeedback program at Hervey Bay Special School won a Commonwealth Award for Outstanding National Achievement in School Improvement, including funding to expand the service, and was a regional winner of the Courier Mail Showcase Award for Excellence in Innovation.

Neurofeedback and clinical practice

One favourable development for those seeking to incorporate neurofeedback into clinical practice has been the ability to map the brain using quantitative EEG technology. Rather than simply measuring the EEG for the purpose of detecting seizure activity, quantitative EEG uses computer technology to make numerous calculations from several cortical locations for the purpose of developing a more rounded snapshot of what is going on in a particular brain. Data can then be analysed in terms of comparison to group norms – with deviations from the average known as z-scores – or as a reflection of stable activation patterns that have been linked in quantitative EEG research to problem areas in a person's life. While this technology has many research applications, for the neurofeedback practitioner it provides the ability to 'look under the bonnet' rather than flying blind and basing neurofeedback protocol selection on symptoms alone. Combining a reliable map of the brain with reported symptomatology can be an extremely helpful and powerful tool in accurate protocol selection.

And while some practitioners choose to focus solely on neurofeedback in clinical practice, it is worth mentioning that this is a technique that can integrate well with other therapeutic modalities for the benefit of our clients. I'm sure we've all struggled from time to time with those counselling clients who seem 'stuck' for any number of reasons. In such instances it can be helpful to assess what is going on in their brains. Elevated beta amplitudes on the frontal midline above the anterior cingulate, for example, may reflect obsessive thought patterns that can be addressed with neurofeedback, thus allowing the client to experience more emotional or mental flexibility and therefore be better able to see options in situations. Or perhaps a client is so 'wired' or anxious that they are unable to calm down enough to focus on the counselling process. A little SMR brainwave training at the start of the session may bring a sense of calm and focus that allows them to better engage for the rest of the session. Addressing such blockages can be of tremendous benefit to the therapeutic process.

Besides counselling or psychotherapy, neurofeedback

can also be combined with other therapeutic practices. One such approach that I have found greatly beneficial has been to combine neurofeedback with Eye Movement Desensitisation and Reprocessing (EMDR) for clients with PTSD and related trauma conditions. In one recent scenario, I had a brain-injured and heavily traumatised veteran who no longer met the diagnostic criteria for PTSD following 20 sessions of neurofeedback, with his score on the PTSD Checklist for DSM-5 (PCL-5) dropping from a baseline of 53 down to 25. A score of 31 to 33 is the cut-off for a PTSD diagnosis (Weathers et al., 2013). We then did five sessions of EMDR for specific traumatic incidents, which resulted in a further drop to a score of 10 on the PCL-5. I was utterly amazed at the insights this man gained through that process as well as the restored memories. For years he had believed that his parents had abandoned him prior to him being airlifted to hospital in a helicopter. Across the course of our sessions together, however, he remembered his parents seeing him off in the chopper and then being by his hospital bedside – his tears of anguish turning to tears of joy and gratitude. What a privilege to witness this man's transformation.

Where to from here?

One of the great challenges in presenting information about my experiences with neurofeedback and the field in general is to not make it sound too miraculous. I've clearly presented some rather unusual and unexpected outcomes from neurofeedback brain training, along with some solid peer-reviewed scientific evidence – evidence that has been accumulating for more than 50 years now. And while there has certainly been those for whom neurofeedback has not been the expected panacea, in my experience the majority tend to report positive gains, and a few have a truly transformative experience. So, what does the future look like for neurofeedback? My belief is that our notions of health provision are undergoing a tectonic shift away from a traditional top-down model towards a more inclusive format where advances in science, technology and access to information allow us all, with increasing confidence, to actively participate in our own individual health journey. With neurofeedback, we're teaching people that they have the capacity to self-regulate their brainwaves rather than relying exclusively on external supports. That's a big deal and a paradigm shift worth pursuing.

The good news for those seeking to jump on board the neurofeedback train at this juncture is that much of the hard work has already been done and the future is looking radiant. A hearty band of pioneering souls has gone ahead and borne the heat of the day in order prepare the ground, put down sleepers and lay the tracks. Every initial appointment in my early days of neurofeedback was akin to another meal at the Last Stop Café for a weary traveller who had explored the other available options and found themselves at the end of the line. And the menu I served was always the same: equal portions of instruction, hope and compassion. These days people are better educated about neurofeedback. A brief glance at my calendar tells me that more than 80% of my current clients already knew what neurofeedback was and actively sought it out. That's a big shift from the early days. The Last Stop Café is now barely a whistle stop on a much grander adventure.

As Harvard medical professor and paediatric neurologist Dr Frank Duffy envisioned at the turn of the millennium, neurofeedback "should play a major therapeutic role in many difficult areas. In my opinion, if any medication had demonstrated such a wide spectrum of efficacy, it would be universally accepted and widely used" (Duffy, 2000, p. v). "It is a field to be taken seriously by all" (Duffy, 2000, p. vii). That day is now upon us. ■

This article has been necessarily selective in terms of historical content and published research. For a wonderful overview of the historical development of neurofeedback, see Robbins (2008), and to access a comprehensive bibliography of neurofeedback research, see Hammond and Novian (2023).

About the author

Mark Darling is a registered psychologist with a background in the disability field. He is recognised as the pioneer of remotely monitored home-based and school-based neurofeedback in Australia, having developed a number of remote brain-training programs for individuals and schools, including a neurofeedback pilot project at Hervey Bay Special School that resulted in a 64% reduction in autistic behaviour in the classroom in one school term. He has also trained psychologists, neuroscientists, counsellors, educators and other professionals throughout Australia in the use of neurofeedback, as well as providing online supervision for neurofeedback practitioners in Australia and overseas.

References

Arns, M., Heinrich, H., & Strehl, U. (2014). Evaluation of neurofeedback in ADHD: the long and winding road. *Biological Psychology*, 95, 108–115. https://doi.org/10.1016/j.biopsycho.2013.11.013

Duffy F. H. (2000). The state of EEG biofeedback therapy (EEG operant conditioning) in 2000: an editor's opinion. *Clinical Electroencephalography*, 31(1), v–vii.

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., & Kaiser, J. (2003). Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: a comparison with methylphenidate. *Applied Psychophysiology and Biofeedback*, 28(1), 1–12. https://doi.org/10.1023/a:1022353731579

Hammond, D. C., & Novian, D. A. (2023, May 2). *The ISNR Comprehensive Bibliography of Neurofeedback Research*. International Society for Neuroregulation & Research. https://isnr.org/isnr-comprehensive-bibliography

Lubar J. F. (1991). Discourse on the development of EEG diagnostics and biofeedback for attention-deficit/hyperactivity disorders. *Biofeedback and Self-Regulation*, 16(3), 201–225. https://doi.org/10.1007/BF01000016

Lubar, J. F., & Shouse, M. N. (1976). EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR): a preliminary report. *Biofeedback and Self-Regulation*, 1(3), 293–306. https://doi.org/10.1007/BF01001170

Lubar, J. O., & Lubar, J. F. (1984). Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting. *Biofeedback and self-regulation*, 9(1), 1–23. https://doi.org/10.1007/BF00998842

Monastra, V. J., Lynn, S., Linden, M., Lubar, J. F., Gruzelier, J., & LaVaque, T. J. (2005). Electroencephalographic biofeedback in the treatment of attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback*, 30(2), 95–114. https://doi.org/10.1007/s10484-005-4305-x

Peniston, E. G., & Kulkosky, P. J. (1989). Alpha-theta brainwave training and beta-endorphin levels in alcoholics. Alcoholism, clinical and experimental research, 13(2), 271–279. https://doi.org/10.1111/j.1530-0277.1989.tb00325.x

Robbins, J. (2008). *A Symphony in the Brain: The Evolution of the New Brain Wave Biofeedback*. Grove Press.

Shouse, M. N., & Lubar, J. F. (1979). Operant conditioning of EEG rhythms and Ritalin in the treatment of hyperkinesis. *Biofeedback and Self-Regulation*, 4(4), 299–312. https://doi.org/10.1007/BF00998960

Sterman, M. B. (2000). Basic concepts and clinical findings in the treatment of seizure disorders with EEG operant conditioning. Clinical EEG (electroence phalography), 31(1), 45–55. https://doi.org/10.1177/155005940003100111

Sterman, M. B., & Friar, L. (1972). Suppression of seizures in an epileptic following sensorimotor EEG feedback training. *Electroencephalography & Clinical Neurophysiology*, 33(1), 89–95. https://doi.org/10.1016/0013-4694(72)90028-4

Sterman, M. B., LoPresti, R. W., & Fairchild, M. D. (1969). *Electroencephalographic and Behavioral Studies of Monomethylhydrazine Toxicity in the Cat*. Aerospace Medical Research Laboratory, Aerospace Medical Division, Air Force Systems Command, United States Air Force.

Weathers, F.W., Litz, B.T., Keane, T.M., Palmieri, P.A., Marx, B.P., & Schnurr, P.P. (2013). The PTSD Checklist for DSM-5 (PCL-5). Scale available from the National Center for PTSD at www.ptsd.va.gov.

Wilson, V., Peper, E., & Moss, D. (2006). "The Mind Room" in Italian soccer training: The use of biofeedback and neurofeedback for optimum performance. *Biofeedback*, 34, 79-81.

Van Doren, J., Arns, M., Heinrich, H., Vollebregt, M. A., Strehl, U., & K Loo, S. (2019). Sustained effects of neurofeedback in ADHD: a systematic review and meta-analysis. *European Child and Adolescent Psychiatry*, 28(3), 293–305. https://doi.org/10.1007/s00787-018-1121-4

Wyrwicka, W., & Sterman, M.B. (1968). Instrumental conditioning of sensorimotor cortex EEG spindles in the waking cat. *Physiology & Behavior*, 3(2), 703-707. https://doi.org/10.1016/0031-9384(68)90139-X

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