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Memphis wired for advanced exploration of trauma on young brains

SPECIAL REPORT: Researchers believe neurofeedback impacts learning, communication, behavior, coping

By [David Waters](#)

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Dr. Eraina Schauss fills a syringe with electro gel which is then inserted into small holes in the qEEG cap. (Patrick Lantrip/Daily Memphian)

The process begins with a teenage boy or girl sitting in front of a computer screen wearing a red or blue nylon cap.

The cap isn't a fashion statement. It's embedded with 19 button-size sensors, each attached by wire to a brainwave amplifier.

Dr. Eraina Schauss or another mental health counselor injects a pasty conductive gel into a tiny hole in each sensor.

"We tell them they get some free hair gel with every treatment," joked Schauss, who is on the faculty at the University of Memphis and the University of Tennessee Health Science Center.

Since January, Schauss and her colleagues from the U of M's [BRAIN CENTER](#) have been measuring, recording and training the brain waves of nearly three dozen adolescents at [Compass Intervention Center](#).

It's called neurofeedback training. Schauss believes neurofeedback can be used to treat developmental trauma, a sort of childhood version of PTSD.

"Chronic trauma reorganizes the brain," Schauss said. "With neurofeedback, we can help the brain regain its balance, teach the brain to self-regulate and become more resilient to trauma."

Compass is a secure facility on a quiet suburban street not far from TPC Southwind golf club.

Counselors there provide various forms of therapy, including trauma-focused cognitive behavioral therapy, to adolescents who have been admitted by their parents, referred by children's services, or assigned by a judge, after being hospitalized.

IN THIS SERIES

PART 1: [Memphis brainpower counters attacks of trauma, distress on a generation of young victims.](#)

COMING SATURDAY, PART 3: [Audiologists at the U of M are pioneering new methods of diagnosing and treating school children with hidden, brain-based auditory deficits that disrupt learning and behavior.](#)

The neurofeedback training, being conducted with the consent of the teenagers and their caregivers, is new.

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"We're definitely seeing positive results," said Lisa Smith, Compass CEO. "The kids are sleeping better, they have better self-control, less aggression and impulsivity. And they're more able to talk about their trauma."

The neurofeedback training is one example of the cutting-edge brain science research being done in Memphis.

Schauss and other brain scientists at work here believe the research will have a profound impact on children and adolescents who struggle to learn, communicate, behave and cope.

They hope it will have a lasting impact on a community struggling with the high cost of poverty, violence, addiction, obesity, and mental and physical illness.

But brain researchers like Schauss face medical, political and financial obstacles that could prevent their work from being widely accepted and applied.

LOOKING INSIDE THE BRAIN

Neurofeedback training isn't as futuristic as it might seem.

The first recording of the brain's electrical activity was made in 1924, a development that helped physicians study epilepsy, dementia and brain tumors.

Since the neurotechnology revolution began in the 1990s, neurofeedback has been used successfully to treat everything from sleep disorders and seizures to traumatic brain injury and post-traumatic stress disorder, or PTSD.

"Neurofeedback has made a big difference for a good number of people," said Dr. Katherine Veazey Morris, a polytrauma psychologist for the Memphis Veterans Medical Center.

"We don't know where PTSD ends and traumatic brain injury begins. Neurofeedback is not a panacea, but I can't imagine treating either without it."

Eight in 10 children who have suffered trauma don't meet the diagnostic criteria for PTSD. So children of trauma often are diagnosed with — and medicated for — one or more other behavior disorders such as attention deficit/hyperactivity, oppositional defiance, generalized anxiety, or conduct disorder.

"Neurofeedback has made a big difference for a good number of people. We don't know where PTSD ends and traumatic brain injury begins. Neurofeedback is not a panacea, but I can't imagine treating either without it."

Dr. Katherine Veazey Morris, polytrauma psychologist

The National Institute of Mental Health says such diagnostic categories are dated and imprecise.

"Currently, the diagnosis of mental disorders is based on clinical observation," NIMH declared in 2013. "The present diagnostic system does not incorporate current information from integrative neuroscience research, and thus is not optimal for making scientific gains through neuroscience approaches."

In recent years, NIMH has encouraged new research that integrates neuroscience, genetics and brain imaging studies into behavioral and clinical approaches to mental health.

They want researchers to do more than observe behavior. They want researchers to study the brain and its genes, cells, neural circuits and brainwave patterns.

"Mapping the cognitive, circuit, and genetic aspects of mental disorders will yield new and better targets for treatment," NIMH said.

That's what Schauss and her colleagues are trying to do with their neurofeedback study.

TRAUMATIZED BRAINS

More than half of the kids at Compass have become involved with the juvenile justice system. Two-thirds have substance abuse problems.

All are struggling to overcome the destructive effects of early and chronic trauma — significant abuse, neglect, loss, or exposure to violence. Such adverse childhood experiences, or ACEs, can have a profound and lasting impact on developing bodies and brains.

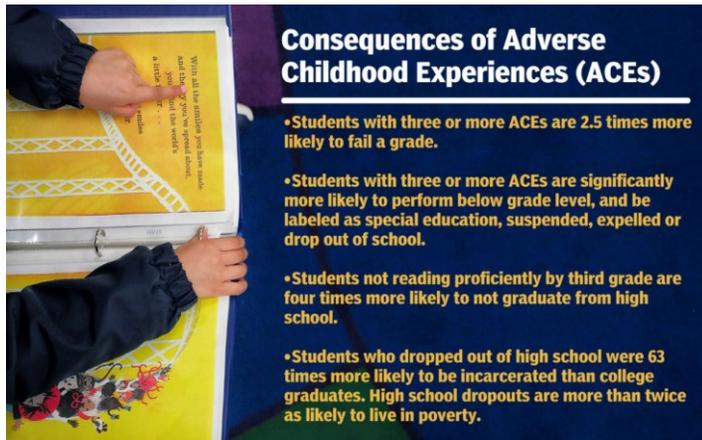
Brain imaging technologies have shown that chronic stress and trauma can rewire or dysregulate a child's brain.

Good stress rapidly increases glucose levels, speeding the heart rate, and increasing blood flow to the body and the brain. That allows young minds to respond to threats. When the threat passes, the brain and body calm down.

But when stress becomes chronic, it becomes toxic. The system is amped up all the time. Young brains and central nervous systems get locked into a constant state of high alert (fight, flight or freeze mode).

Prolonged stress can strengthen neural connections to the brain's "fight or flight" center and weaken those to the brain's "self-control" center.

And it can shrink areas of the brain associated with the regulation of emotions, metabolism, memory, and learning. Children of chronic stress and trauma often become more anxious, impulsive, aggressive, hyperactive. They often exhibit lack of empathy and poor problem-solving skills.



(Jim Weber/Daily Memphian)

They become more prone to violence, aggression, depression, substance addiction, suicide, illness and disease, not to mention academic failure. The problem is especially acute in high-poverty urban areas such as Memphis.

Adults in Shelby County are much more likely than those elsewhere to have experienced adverse childhood experiences, according to a survey conducted five years ago by the ACE Awareness Foundation.

The survey found that 20 percent of adults here had been sexually abused as children, 22 percent said they were regularly exposed to violence between adults, and a mind-boggling 37 percent said they had witnessed a stabbing or shooting.

"These kids are here for different reasons — addiction problems, behavior problems, psychiatric problems," said Kimberly Jones, clinical program director and supervisor of trauma-focused cognitive behavior therapy at Compass.

"But what they all have in common, every child here has experienced some form of chronic trauma. Trauma not only hurts, it affects a child's ability to heal."

FLEXING YOUR BRAIN

The teenagers in the nylon caps sit quietly and still, but often their brains and body are racing.

Their metabolic scores — assessments of their physiological health measured by the software — are often two or more times higher than normal.

One teenage girl, for example, had a metabolic score of 42, double what it should have been for a girl her age.

She was suffering from anxiety and depression. She had trouble controlling her impulses and emotions. She became aggressive and she self-medicated with alcohol and marijuana, which got her into trouble. The sexual abuse and other forms of chronic stress and trauma she'd endured had taken their toll, Schauss said.

Chronic stress and trauma can be especially hard on a young, developing brain.

The brain makes up about 2 percent of the body's weight but requires about 15 percent of its cardiac output, 20 percent of its oxygen, and 25 percent of its glucose to power billions of neurons and trillions of synapses.

A traumatized brain often produces an overabundance of higher frequency brainwaves, or beta waves, which require even more energy.

"Kids with trauma have overactive brains," Schauss explained. "Their brains are on hyperalert, even when they're no longer in real danger."

The purpose of neurofeedback is to help the brain calm and stabilize itself, and to repair the dysregulated brain patterns created by trauma.

"When the fear patterns relax, the brain becomes less susceptible to automatic stress reactions and better able to focus on ordinary events," Dr. Bessel Van Der Kolk, one of the world's leading experts on trauma, wrote in "[The Body Keeps the Score](#)."

"Neurofeedback simply stabilizes the brain and increases resiliency, allowing us to develop more choices in how we respond to stress and trauma."

Neurofeedback training assumes that the brain wants to work more efficiently and effectively, to be more balanced and healthier.

"When the fear patterns relax, the brain becomes less susceptible to automatic stress reactions and better able to focus on ordinary events. Neurofeedback simply stabilizes the brain and increases resiliency, allowing us to develop more choices in how we respond to stress and trauma."

Dr. Bessel Van Der Kolk, trauma expert

It also assumes the brain's neuroplasticity — that the brain can and will auto-correct itself, given enough positive reinforcement.

"It's sort of like flexing a muscle," Schauss explained. "Neurofeedback flexes certain brainwaves to make them stronger. That allows certain other brainwaves to become weaker."

A BILLION MINI-COMPUTERS

Before neurofeedback training can begin, the teenagers in the nylon caps must complete several physical, social, emotional, behavioral and cognitive assessments.

Among the hundreds of issues:

- I have trouble filtering out background noises.
- People tell me I do or say things that I don't remember doing or saying.
- I feel like my past is a puzzle and some of the pieces are missing.
- I find myself doing something I know is wrong, even when I really don't want to do it.
- Sometimes I will take a risk just for the fun of it.

Their responses helped researchers assess their states of mind as they develop treatment plans.

But the questionnaires and other records only give them a general sense of the direction of treatment. To develop a neurofeedback treatment plan specifically designed for each teenager, they need a map — a brain map.



Dr. Eraina Schauss is the director and founder of the Brain Center at the University of Memphis. (Patrick Lantrip/Daily Memphian)

"If you're going to treat someone for a headache, you need to know whether it's being caused by the weather or a tumor," Schauss said. "New technologies now allow us to actually study the organ we are treating."

Those new technologies include quantitative electroencephalography (qEEG), a quick, safe and non-intrusive way to measure and record the electrical activity of your brain.

It's similar to an electrocardiogram, or ECG, which measures and records the electrical activity of your heart through small electrode patches attached to your chest, arms and legs.

A qEEG traces and analyzes brain waves millisecond by millisecond through 19 button-size electrodes embedded in nylon caps.

A brain cell, also called a nerve cell or neuron, is like a mini-computer. It receives, analyzes, coordinates and transmits information that generates thoughts, emotions and behaviors.

Each brain has billions of mini-computers. They communicate with each other by firing electrical impulses. Those impulses can be measured as waves.

Billions of brain cells fire trillions of impulses every second, generating a lot electrical activity. A qEEG measures changes in that activity.

Too much electrical activity in certain brain areas is linked with anxiety disorders, sleep problems, hyper-vigilance, impulsive behavior, anger/aggression, agitated depression and chronic nerve pain.

Too little activity in certain brain areas is linked to depression, attention deficit, chronic pain and insomnia.

"Chronic trauma reorganizes the brain. With neurofeedback, we can help the brain regain its balance, teach the brain to self-regulate and become more resilient to trauma."

Dr. Eraina Schauss, BRAIN CENTER founder

Combinations of too much and too little are linked to anxiety, depression and ADHD.

Neurofeedback software produces a color map that shows which brain waves are highest and lowest in key parts of the brain. The map also shows which brain waves are working together and which are not.

Children with long histories of traumatic stress show some common brain wave patterns: For example, too much wave activity in the brain's "fear center" (right temporal lobe), and not enough alpha wave activity in the decision-making "self-control" center (left frontal lobe).

"Our research showed that calming the fear center decreases trauma-based problems and improves executive functioning," Van Der Kolk wrote. "Neurofeedback changes brain connectivity patterns. The mind follows by creating new patterns of engagement."

RELAX AND WATCH

Neurofeedback training is a lot like watching TV.

Each participant chooses an age- and content-appropriate TV show or movie from Netflix. Disney movies and cooking shows are the favorites.

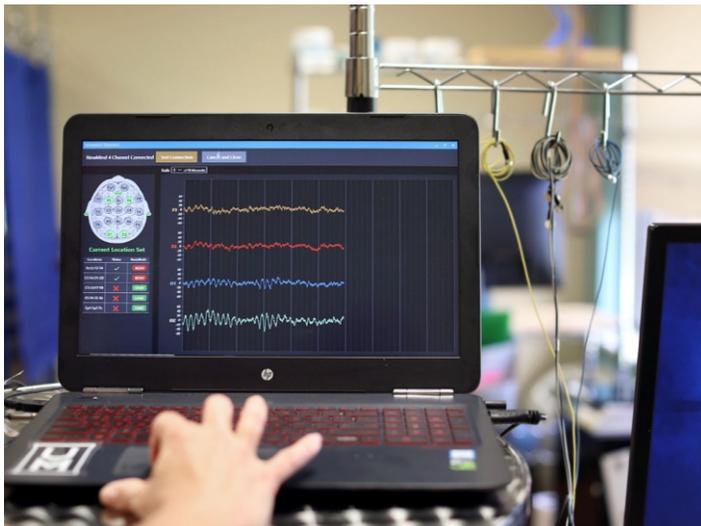
"We tell them to just relax and watch," Schauss said. "Your brain will do the rest."

Each neurofeedback training focuses on two areas of the brain. So instead of the nylon cap with 19 sensors, the teens have two or three sensors pasted directly on her heads.

Every now and then, as they watch the movie or TV show, the screen fades. They can still see the show, but the picture isn't as clear and bright.

In a matter of seconds, the screen brightens again. A few minutes later, it fades again. Then it brightens again. The longer they watch the show, the less frequently the screen fades.

They aren't touching the laptop. Neither is Schauss or her counselors. The screen is being controlled by the teenagers' brain waves, via the sensors connected to neurofeedback software.



Once hooked up, doctors can map and monitor an individual's brain activity. Although this technology has been around for a while, it's only beginning to gain popularity. (Patrick Lantrip/Daily Memphian)

"Their brains are learning to control themselves," Schauss explained.

It's a form of operant conditioning — rewarding desirable behavior and punishing undesirable behavior. In this case, it's the behavior of certain brainwaves.

The qEEG identifies dysfunctional brainwave patterns and locations in each patient — which waves are too high and need to be reduced or trained down, which are too low and need to be increased or trained up.

When the neurofeedback software detects dysfunctional and undesired wave patterns — say alphas that are too low or betas that are too high — the movie screen fades.

When the software detects healthy and desired patterns — say alphas or betas that are within normal range — the screen brightens.

"Neurofeedback nudges the brain to make more of some frequencies and less of others, creating new patterns that enhance its natural complexity and its bias toward self-regulation," Van Der Kolk wrote in "The Body Keeps the score."

"Every brain is resilient and beautiful in its own way. The more individualized we can be with our diagnosis and treatment, the more effective it will be."

Dr. Eraina Schauss, BRAIN CENTER founder

Those gentle, non-intrusive, un-medicated nudges, over the course of 21 neurofeedback sessions — three per week for seven weeks — are generally enough to stabilize and re-regulate the brain's wave patterns.

So far, the neurofeedback trainings have gone well, Schauss said.

For example, after 21 sessions, the teenage girl with the metabolic score of 42 saw it drop to 9. Her impulsivity scores dropped from 4 to 1, her depression from 4 to 0, and her anxiety from 7 to 4.

"Each of us is a unique combination of our genes, environment, experiences and responses," Schauss said.

"Every brain is resilient and beautiful in its own way. The more individualized we can be with our diagnosis and treatment, the more effective it will be."

FUNDING THE FUTURE

Last year, the Memphis Research Consortium provided a three-year, \$1 million grant for the BRAIN CENTER.

It's an acronym for Building Resilience across Ages through Integrative Neuroscience, a Consortium of Education Neurofeedback Therapy, Epigenetics and Research.

Basically, it's a collaboration among some of the biggest brains in Memphis — researchers from several departments at the U of M (clinical mental health counseling, public health, and criminology/criminal justice) and at UTHSC (genetics, genomics and informatics, and preventive medicine).

The neurofeedback training at Compass is the BRAIN CENTER's primary focus, but it's providing related research opportunities.

Dr. [Rob Williams](#), chair of genetics, genomics and informatics at UTHSC, is analyzing before- and after-treatment blood and saliva samples from the participants.

Williams is looking to see if trauma leaves a mark on a child's genes — a mark that can be passed down epigenetically from parents to their children.

"We want to look at the DNA and see what, if anything, changes," Williams said. "Have these adverse experiences interfered with how genes get turned on and turned off. This study is a unique opportunity and a first step toward more precise treatment of trauma."

Meanwhile, Dr. [Byron Jones](#) of UTHSC is analyzing each participant's toenail clippings for evidence of neurotoxins such as lead, iron, copper and zinc.

"Too much or too little of these elements have deleterious effects on brain function," Jones said.

Schauss and her colleagues hope to complete testing and treatment of 100 adolescents at Compass by next May. And they'd like to expand their study beyond the friendly confines of Compass.

"This study is a unique opportunity and a first step toward more precise treatment of trauma."

Dr. Robb Williams, UTHSC

"This is not the 'Ivory Tower' research of old; what she is trying to do is develop practical, evidence-based models of care," said Dr. Steven West, chair of the counseling, educational psychology and research at the U of M.

"But mental health care is operated on a shoe-string budget when compared to medical care ... Despite the nature and extent of these problems, funding for both the development of evidenced-based care and for care itself is limited."

Earlier this year, the legislature eliminated funding for the second and third years of the study.

"Politics," said Ted Townsend, the U of M's chief economic development and government relations officer and an MRC board member.

"And it's a shame. This project was an example of the great potential of the consortium and its mission to drive innovation through collaboration among this city's leading medical and research institutions. We're not giving up."

Townsend and UT officials are discussing the idea of making the BRAIN CENTER the first U of M/UTHSC joint institute. They hope to involve the trauma-related research at LeBonheur's Family Resilience Initiative and Dr. Altha Stewart's Youth Advocacy Center.

"It would be amazing for all of us to be in one place working together as a team for the city," Schauss said.

IMAGINE THE POSSIBILITIES

Next month, Schauss plans to travel to Nashville to present her findings to Gov. Bill Lee and member of his cabinet.

In late July, two members of Lee's cabinet came to Compass to learn more about the neurofeedback study: Marie Williams, who has been commissioner of the Tennessee Department of Mental Health and Substance Abuse since 2016; and Jennifer Nichols, commissioner of the Department of Children's Services since January, and a former assistant district attorney and criminal court judge here in Shelby County.

Schauss explained how the project worked, the positive results so far, and the potential.

She also noted that qEEG neurofeedback has shown significant results in treating anxiety, depression, mood disorders, post-traumatic stress disorder, traumatic brain injury, attention-deficit/hyperactivity disorder and addiction.

"Not only does the treatment work, but it lasts even when the patient goes back to a stressful or toxic environment," Schauss said. "It helps the brain become more resilient."

"That makes sense to me," Williams said.

"So how does it work?" asked Nichols.

"Why don't we show you," Schauss said.

The two state officials followed Schauss to a room that has been turned into a neurofeedback training center.

Williams sat at one station, Nichols at the other. Schauss placed a blue nylon cap over Williams's scalp and injected a pasty conductive gel into tiny holes in the cap's 19 sensors.

"This might explain a lot of things to the people in Nashville," Williams joked as the software began mapping her brain waves.

Next, Schauss prepared Nichols for a less-involved form of neurofeedback training called SMR, or sensorimotor rhythm. As SMR increases, the body feels more relaxed.

"I'm going to leave here a better person, but Marie's going to leave here with gunk in her hair," Nichols joked as Schauss placed a few sensors along the top of her capless head.

They both left with a bit of gel in their hair. They also left impressed.

"This could really revolutionize what we do and what we fund," Williams said.

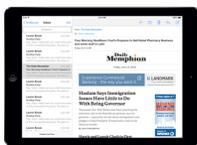
"Can you imagine the possibilities?" Nichols said.

"Yes, we can," Schauss replied.

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