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Heart Rate Variability Biofeedback (HRV-BFB) for Reducing Special Education Teachers' Work-Related Stress

Claire Gregory and Reagan Murnan
Wichita State University, Wichita, Kansas, USA

The Individuals with Disabilities Education Act (IDEA, 2004) guarantees an appropriate and individualized education program for all students with disabilities. However, an insufficient supply of fully qualified special education teachers threatens this promise. Special education teacher shortages have increased since 2012 to 6.8%, leaving approximately 23,000 positions in special education without a qualified teacher (Dewey et al., 2017). This number is expected to grow in the aftermath of the COVID-19 pandemic, which resulted in 38.4% of special education teachers meeting the criteria for generalized anxiety disorder. This is a rate 12.4 times greater than the U.S. population, and 37.6% of special education teachers meeting the criteria for major depressive disorder, a rate of 5.6 times greater than the U.S. population (Cormier et al., 2022). Special education teachers have identified that work-related stressors have an adverse effect on their overall quality of life, and this has contributed to feelings of burnout and decisions to leave the field (Hester et al., 2020). An intervention with promising results for reducing stress and anxiety is heart rate variability biofeedback (HRV-BFB), which has received increasing attention among clinicians and researchers (Chung et al., 2021; Lehrer & Gevirtz, 2014).

Therefore, our IRB-approved study will use a mixed methods approach for examining the influence of HRV-BFB for stress reduction and self-regulation utilizing both subjective and objective indicators during special education teachers' practicum semester. We will recruit the teachers before they begin their practicum semester with an ideal sample size of five. Participants will receive HRV-BFB by a trained clinician using the Neurobit Optima+ device, BioExplorer software with visual/audio feedback, and forearm sensors to record electrocardiogram data. Additionally, our study incorporates a multiple-baseline, single-case experimental design (SCED). The dependent variable (i.e., HRV) will be measured systematically after each biofeedback session by collecting HRV data averages. Participants will be asked to visit our university counseling clinic for all their sessions, including the baseline data collection of HRV (i.e., no training) and their intervention HRV-BFB sessions (i.e., biofeedback training). Participants will have from three to six baseline sessions and three to seven training sessions. The baseline sessions will include feedback but no set training protocols. Each participant's HRV session averages will be compared using percentage of nonoverlapping data (PND). Utilizing SCED allows participants to serve as their own baseline, respecting their individual changes and unique physiological functioning. At the conclusion of the HRV sessions, we will use a posttest interview to obtain qualitative data. This standardized interview protocol consists of 11 questions developed to elicit teachers' perceptions stressors encountered in the classroom, the mental and physical impact of those stressors, and perceptions regarding additional resources and support needed to reduce stress (Haydon et al., 2018).

Our study and presentation will explore the use of HRV-BFB for reducing stress and improving self-regulation alongside unveiling insights into stressors using qualitative interviews. The application of a mixed methods study offers the production of new knowledge while simultaneously testing the effectiveness of an intervention and attending to the concerns and insights of the persons involved. outcomes include increased skill without exhaustive training at asking about metabolic issues and explaining basic options to patients that may affect brain chemistry and clinical outcomes.

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Data-Driven Neurofeedback Enhances Spatial Cognition in Healthy Adults

Sinan Uslu and Claus Vögele
University of Luxembourg, Luxembourg

Background. The efficacy of neurofeedback in modulating cognitive outcomes varies between users resulting in some users not to benefit from neurofeedback (Alkoby et al., 2018). To explain this variability, most studies investigated how to learn (e.g., factors predicting changes in neurofeedback related brain activity; Alkoby et al., 2018), and only a few investigated what to learn (e.g., the targeted feature for neurofeedback; Gruzelier, 2014b). To enhance spatial cognition, most studies designed the neurofeedback training to alter alpha waves in the electrocortical activity (Gruzelier, 2014a). Recently, identifying person-specific brain networks expanded our understanding of how our brains perform complex cognitive processes (Porter et al., 2023). In this study we investigated the efficacy of personalized neurofeedback using a randomized, double-blind, sham-control design.

Methods. We recruited 40 healthy participants. After giving their written and informed consent, participants completed a socio-demographic questionnaire. Additionally, they then carried out a mental rotation task (Ganis & Kievit, 2015) and the trail making task (TMT; Bowie & Harvey, 2006) before and after a 30-min neurofeedback training session. While the experimental group received their personalized feedback, the sham group received the same prerecorded feedback from another person. We recorded the electroencephalography (EEG) signal using a BrainAmp system (Brain Products, Gilching, Germany). For the personalization, we applied a machine learning approach and individually trained a ridge regression to predict the mental rotation task performance based on task-related electrocortical activity. Prior to estimating the regression parameters, we preprocessed the EEG signal including bandpass filtering and spatial filtering via Source Power Comodulation (Dähne et al., 2014).

Results. We analyzed our data with (generalized) linear mixed models and a priori defined contrasts. In the mental rotation task, the experimental group did not reduce their reaction time in trials with correct responses more than the sham group (z = 1.28, p = .90). However, the experimental group increased their accuracy more than the sham group (z = 1.67, p < .05). Further analyses revealed that the experimental group processed more difficult trials than the sham group after neurofeedback (z = −2.78, 95% CI = [−4.19, −1.05]). Comparisons in the TMT performance did not reveal any significant difference between the groups (part A: $t(74)$ = 1.08, p = .86; part B: $t(72)$ = 0.20, p = .58).

Conclusion. Our results suggest that data-driven, individually tailored target specification for EEG neurofeedback increases mental rotation task performance more than sham feedback in healthy adults. Furthermore, the training effect was specific to spatial cognition involved in mental rotation and did not yield changes in cognitive flexibility measured with the TMT. One limitation of our study is that we cannot clearly distinguish between accuracy and reaction time due to the per trial time constraint in our implementation of the mental rotation task. Future studies should investigate if such personalized neurofeedback designs outperform classical approaches where all participants share the same target feature.

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Proficiency Modulates Effects of Embodiment Learning on Word Learning in Typical and Dyslexic Readers: Evidence From Event Related Potentials

Yiyang Wang and Yao Wang
Beijing Language and Culture University, Beijing, China

Sensorimotor experience in the form of learning to print and write letters allows the interplay between motor production and visual perception to broaden the stored representation of letters. Handwriting movement, as a manual sensorimotor skill, has direct influences on how words are recognized and acquired in the brain. Writing words with hands facilitates the acquisition and processing of the words—the handwriting effect. Previous studies have established the handwriting effect as one of the most fundamental demonstrations of language embodiment, but little is known as to how language proficiency, as in the case of bilingualism, might affect embodied learning of words in the second language (L2).

Here we report how language proficiency modulates the hand movement effects (integration of sensorimotor experience through hand movement) on word reading processing as indexed by different ERP components. Forty typical and nontypical readers participated in the behavioral and ERP experiments. They were subdivided into two groups (typical vs. nontypical) according to their Chinese L2 proficiency. We designed three learning conditions: viewing, handwriting, and drawing followed by word recognition in Chinese. We compared three conditions between two groups to unfold how effective sensorimotor experience variance across groups. Behavioral results showed reduced reaction times and error rates in both handwriting and drawing condition as compared to the viewing condition for high proficient L2 Chinese learners, but no evidence for such an embodied learning effect was found in low proficient L2 Chinese learners. However, event-related potentials (ERPs) showed modulations of N170, P200, and N400 as an effect of hand movements (i.e., handwriting and drawing) on character recognition in both groups of participants. Our results suggest a significant role of L2 proficiency in embodied language learning: high proficient L2 learners could benefit from the sensorimotor experience associated with hand movements at both behavioral and electrophysiological levels; low proficient L2 learners failed to show such an embodied learning effect behaviorally, but ERPs revealed that both handwriting and drawing facilitated early processing of visual form information of Chinese characters.

In this study, an innovative finding is that handwriting also facilitates word recognition for typical learners. The behavioral and neural correlates also suggested a strong embodiment trace leads to a strengthen word memorial trace. The results suggest a linguistic universally stratified behavioral and neuroprocessing performance in word reading for typical and nontypically developed (e.g., dyslexic) learners.

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Adolescents With Complex Childhood Trauma From Residential Homes in Romania: Searching for Neuromarkers and Neurofeedback Protocol

Gabriela Mariana Marcu[1], Ana Maria Zăgrean[1], amd Ainat Rogel[2]

[1]University of Medicine and Pharmacy "Carol Davila" Bucharest, Bucharest

[2]Boston Neurodynamics, Brookline, Massachusetts, USA

Adolescents in residential homes are one of the most disadvantaged populations. They were removed from their biological families and suffer from childhood complex trauma, which compromises the development of the frontal lobes that peaks during adolescence. The adolescents in Romanian residential homes have little chance to get adopted, as they do not receive treatment to improve their functionality, and their education level is low. All these adolescents have complex childhood trauma (also named developmental trauma) which should be considered when treating them.

Although research has shown that neurofeedback significantly reduces PTSD symptoms and improves executive functioning in adults and children (Gapen et al., 2016; Hong & Park, 2022; Rogel et al., 2020; van der Kolk et al., 2016), results show that symptoms are reduced and not eliminated. Besides, to our knowledge, there is a lack of controlled studies to investigate the efficacy of neurofeedback in adolescents in general and in those in residential homes specifically.

This study is a first step in developing a comprehensive approach for these adolescents by (1) raising awareness that their complex childhood trauma is associated with their current situation and proposing a treatment modality to directly address the neurological development, (2) proposing the most effective neurofeedback (NF) protocol as a treatment for enhancing their executive functioning and reducing their PTSD symptoms, and (3) identifying neurological objective measurements and neuromarkers to develop the most effective NF treatment and to assess the impact of NF treatment.

We propose a two-stage study:

- (S1) Stage 1: exploratory, with the aim of finding markers (EEG, qEEG, ERP, physiological, and behavioral) for adolescents with complex childhood trauma.
- (S2) Stage 2: a three-group random-control, assessor-blinded, clinical trial. Forty-eight adolescents (12–17 years old) will be randomized to either NF-S (standard T4-P4), individual NF (qEEG based) or WL (waitlist, control) group, and will complete four assessments (including follow-up).

Following the study, identified markers (neural, physiological, and behavioral) will be proposed to the research community to further testing in association with complex childhood trauma. Also, the study's results may help to guide the recommended NF protocol for adolescents who are currently in complex childhood trauma programs. In addition, follow-up assessments would inform about the stability of the significant achievements. Based on the obtained results, an intervention program will be recommended in the residential homes. Guidelines and recommendations for personnel and people preparing to adopt will be produced. Given that there are no resources allocated in Romania for the treatment of children in residential homes, there is a big need for support interventions aiming at raising their functionality and reducing their vulnerability.

The comparison of standard protocols with individual protocols (i.e., qEEG-guided) can bring valuable insights into the most beneficial NF approach to complex childhood trauma. The research will thus contribute in the long term to (1) the development of a treatment framework for adolescents with complex childhood trauma and (2) the international efforts of developing a discipline of childhood trauma.

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Development of Student Neurofeedback Learning Competencies for Counseling Programs

Ross Spears
University of Texas at San Antonio, San Antonio, Texas, USA

Advances in neuroscience continue to impact the counseling profession (Beeson & Field, 2017). It informs clinical skills and the facilitation of client development (Ivey et al., 2018). Due to increased interest in the counseling community, organizations such as the American Counseling Association (ACA) and the Association for Counselor Education and Supervision (ACES) created neuroscience interest networks (Beeson & Aideyan, 2016; Chapin, 2016). Similarly, accrediting bodies like the Council for the Accreditation of Counseling and Related Educational Programs (CACREP) include curricular standards for programs to cover biological, neurological, and physiological aspects of mental health in entry-level counseling curriculum (CACREP, 2015). The term neurocounseling was soon adopted, signifying the incorporation of the two fields.

Neurocounseling, which integrates empirical knowledge of neuroscience with the traditional wellness values of counseling, is a growing topic of discussion among the counseling profession (Crockett et al., 2017). The term serves as an avenue in exploring brain-based understanding within a counseling framework including the validation of preexisting and new therapeutic techniques and theories (Beeson & Field, 2017). As neurocounseling continues to grow, clinicians, therapists, and universities seek to add neuro-based elements into their scopes of practice (Chapin, 2016; Duenyas & Luke, 2019; Myers & Young, 2012). Neurofeedback is one such modality. As an intervention that falls under neurocounseling, neurofeedback conditions brainwave activity by monitoring and relaying real-time wave amplitude back to the client (Demos, 2019). It is tool used in treating various mental health concerns such as symptoms relating to anxiety (Gregory et al., 2020), depression (Hammond, 2005), and posttraumatic stress disorder (van der Kolk, 2016).

This poster proposal will examine what experts in both neurofeedback and professional counseling regard as required learning competencies for counseling graduate students enrolled in either a neurofeedback training course or certification program. Findings presented in this presentation may offer insight or a framework for counseling programs interested in integrating neurocounseling into their curriculum and coursework.

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Dynamics of Diffusion Indicators of the Brain White Matter Tractography After a Course of the Brain Secondary Motor Cortical Zones fMRI Neurofeedback in Stroke Patients

Denis Klebanskiy[1], Mark Shtark[1], and Estate Sokhadze[2]
[1]Novosibirsk National Research State University, Novosibirsk, Russia
[2]Duke University, Durham, North Carolina, USA

Introduction. Tractography is a method of diffusion-weighted magnetic resonance imaging (DW-MRI), which allows to reconstruct and study the structure of the conductive pathways of the brain white matter by measuring the direction of water diffusion (DH) in each voxel of the image. Neurofeedback (NFB) technology allows training aimed to control the activity of certain brain areas by fMRI signal. The purpose of the current study was to examine the effect of fMRI NFB on the dynamics of DH of the white matter of the brain in patients after stroke.

Materials and Methods. Ten patients (45 to 70 years old, 4 to 24 weeks postischemic stroke) underwent a course of standard rehabilitation. Five of them were assigned to the fMRI neurofeedback, while five served as a control group. The fMRI group additionally underwent six sessions of fMRI NFB of secondary motor cortical zones in the lesional hemisphere. Before (T1), after the course of treatment (T2) and after 6 months (T3), DW-MRI was performed; diffusion characteristics (DX) were studied in the lesional (IP) and contralateral (CP) cortices, as well as in the second and third segments of the corpus callosum (MT). Following variables were studied: fractional, kurtosis fractional, quantitative anisotropy (FA, kFA, QA), average diffusion capacity (MD), and axial and radial diffusion coefficients (AD and RD). The prognostic index of rehabilitation is the asymmetry of fractional anisotropy (aFA), calculated as the difference in FA values to the contra- and ipsilateral hemispheres.

Results. All patients had changes in the diffusion measures of both hemispheres in T1, T2, and T3. There was found a significant difference between the groups ($p < .001$) in the change of kFA indicators between T2 and T3 in the two MT segments studied: the experimental fMRI NFB group showed an increase in indicators, while the control group showed a decrease. The values of MD and AD diffusion in T1 and T3 in the second segment of MT significantly differ in two groups ($p < .001$) showing a decrease in indicators for the experimental group and their increase for the control group. The reconstruction of the tracts showed a slight increase in kFA values between T1 and T2 and their decrease between T2 and T3, a significant decrease in kFA in IP and KP between T1 and T2 ($p < .05$), T1 and T3 ($p < .05$). Similarly, MD, AD, RD in IP increased from T1 to T2 and from T2 to T3, reliably for MD between T1 and T2 ($p < .05$), T2 and T3 ($p < .001$), T1 and T3 ($p < .05$); AD between T1 and T3 ($p < .001$), T2 and T3 ($p < .05$); RD from T1 to T2 ($p < .05$), T1 to T3 ($p < .001$).

Conclusion. Stroke provokes structural changes in both hemispheres, and the reorganization of the tracts continues for more than 6 months after the stroke. To determine the contribution of the fMRI neurofeedback of affected hemisphere additional motor cortical zones to the process of such restructuring, a larger number of observations is required.

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Loreta Neurofeedback for Brain and Behavioral Dysregulation in a Stroke Patient: A Case Study

Noely Ramos-Vega[1], Ismael Castillo-Reyes[2], and Estate Sokhadze[3]
[1]Ponce Health Science University, Ponce, Puerto Rico
[2]University of Puerto Rico, San Juan, Puerto Rico
[3]Duke University, Durham, North Carolina, USA

Epidemiological data has positioned stroke as the second leading cause of death worldwide. Of 15 million people that suffer from a stroke yearly, approximately 6 million die and 5 million become chronically disabled. Stroke is the fifth leading cause of death and the first cause of long-term disability in Puerto Rico. Cognitive and motor impairments are highly prevalent and persistent in stroke survivors. Network disruptions caused by a stroke event on brain regions implicated in the different aspects of motor function and cognition can significantly impact quality of life. Targeting both focal cortical tissue damage and nonfocal global changes in brain function should be considered when developing therapeutic strategies to improve brain responses, recovery rate, and the quality of life of brain injury survivors. In this regard, using qEEG-guided low-resolution electromagnetic tomography analysis (LORETA) *Z*-Score neurofeedback (NFB) is a promising approach that has been reported to be effective for stroke and TBI rehabilitation as it targets dysregulation in networks in deep cortical locations. Being able to train these deeper structures in the brain is a major leap forward in brain mapping as connections between networks or regions can be trained, increasing the efficiency of brain networks specifically related to a patient's symptoms. The main goal of this study was to explore the effects of qEEG-guided *Z*-score LORETA NFB (LZLNB) in the optimization of behavioral performance and brain electrophysiological activity in a 57-year-old male who suffered a stroke in the central/right part of the parietal lobe (severe speech difficulties due to apraxia, left hemiparesis, and intense headaches were presented). The study used a preexperimental design with pre–post comparison. To this end, LZNFB was applied to affected brain areas for 25 sessions. Baseline and posttreatment measurements were made on qEEG metrics, event-related potentials at Pz (oddball paradigm), attention, memory, executive function, reaction time, and cognitive flexibility. Behavioral improvements were found in executive function, cognitive flexibility, processing speed, and reaction time after 25 sessions of LZNFB on computerized tasks (at the postmeasurement, the patient could complete the tasks with both hands). Significant changes were found on lower frequencies and connectivity variables across all brain areas, as observed in the qEEG *Z*-score maps. Greater discrimination and less latency for auditory stimulus were also found on P300 ERP component analysis at Pz after the intervention (prelatency= 430 ms, postlatency = 360 ms). In addition, significantly improved speech, mood, and motor function were also observed in session #6. These findings suggest the potential effectiveness of LZNFB on cognitive performance improvement among stroke sufferers. Further studies with a larger number of patients and control groups may be required to evaluate the full potential of this type of training in stroke patients.

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Language, Emotion, and Cognitive Congruence: Does Appropriated Racism Detoxify the N-Words for African American Males Using Neurophysiological Measures?

Regina Brown
Saint Mary's University of Minnesota, Rochester, Minnesota, USA

It is well documented that racial oppression, known as racism, is linked to mental (e.g., stress-related conditions such as depression, anxiety, and PTSD) and physical health challenges (e.g., stress-related illnesses such as diabetes, high blood pressure, and obesity) in African Americans (AAs). In 2020, the American Medical Association, American Psychological Association, and the American Psychiatric Association declared racism as toxic stress and therefore a public health threat. One example of racial oppression is the creation and use of the words *n*gger* and *n*gga* by whites during slavery. These words are still used to identify and classify AAs.

As part of the complex process of resistance to oppression, known as internalized racial oppression, some AAs have appropriated n*gga both as a means of desensitization and to take back the power of the word. They insist that there is a difference between n*gger and n*gga (proponents). Others are adamant that regardless of the form it takes and/or who uses it, it is injurious to the health of AAs (opponents).

To the best of our knowledge, there is a lack of empirical documentation of the neurophysiological responses of internalized racial oppression by and between in-group members. In-group use of n*gger and n*gga permeates AA culture in entertainment and daily language. The intent of the study is to provide empirical data to further discussion and inform neuropsychological, medical, liberation, social justice, and ethical studies. Therefore, the research question is "Does appropriated racial oppression emotionally detoxify n*gger/n*gga among African American males using neurophysiological measures?"

The hypotheses to investigate are (1) The relationship between affective position and emotional response to the word in either form, (2) the difference between proponents' and opponents' mean emotional response to 'n*gger', (3) the difference between proponents' and opponents' mean emotional response to 'n*gga', and (4) the difference between target and control group means based on cognitive position.

The study is investigative ex post facto with a control group. Participants are adult AA male volunteers from the Minneapolis area. For the design, both active and control groups hear an audio ERP paradigm of neutral words. In addition to the neutral words, the active group hears the target words n*gger and n*gga. All the ERP words are prerecorded in neutral prosody. The ERP paradigm consists of three trials of 10 randomized culturally-specific words, 10 times each at 3-s intervals. EEG will capture ROIs at AF3, F4, FC6, at N400 or P3 latencies. Heart rate, skin conductance, and temperature will be recorded. Pearson's R will be used to analyze the relationship hypothesis; factorial ANOVA will be run to examine differences between categorical and independent variables.

The words n*gger and n*gga are pervasive in AA culture, which is globally consumed. The results of this study can have far-reaching implications for views on entertainment, emulation, communication, cultural exchanges, and social interactions. AAs may be more likely to consider the impact of using n*gger and n*gga as innocuous forms of resistance, entertainment, and communication.

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Attention-Deficit Disorder: A Path to Diagnosis

Linda Rowan
Impact Care Management, Winnsboro, Texas, USA

Attention-deficit disorder (ADD) is often undiagnosed and misdiagnosed in children, adults, and the geriatric population. ADD is most likely a multifactorial etiology and shares symptoms with multiple other mental disorders making it challenging to diagnose.

ADD is a complex neuropsychiatric condition with a multifactorial etiological basis involving genetic and environmental determinants. The presentation emphasizes the importance of a multidisciplinary approach to the diagnosis and treatment of ADD.

The presentation highlights the significance of comorbidities and symptom similarities in making diagnosis difficult for ADD. The author stresses the importance of recognizing differences in symptoms for different age groups and obtaining an accurate diagnosis due to the overuse of prescription medications.

Method. This poster draws on recent work that is available from multiple sources, including published journal articles, systematic reviews, and clinical trials focusing on differential diagnosis, diagnostic screening tools, single photon emission computed tomography (SPECT), functional MRI (fMRI), advanced assessment, and quantitative electroencephalogram (qEEG). It highlights the effects on individuals and society when patients are misdiagnosed or undiagnosed. The author draws on expertise from years of experience as a registered nurse, and current training in psychiatric mental health nurse practitioners master's program.

Results. The specific cause of ADD remains unknown. There is growing evidence to suggest that genetics contribute to ADD, and several genes have been linked to the disorder. There is evidence of anatomical differences in the brains of children with ADD in comparison to other children without the condition (American Psychiatric Association, 2013), and changes in theta/beta brainwaves (Lee et al., 2022). A combination of tools should be used in the diagnosis of ADD.

Conclusion. Mental health practitioners need to be aware of the diagnostic tools available. Because ADD shares some of the same symptoms as depression, addiction, anxiety, autism, and other psychiatric disorders, diagnosis is imperative to develop a treatment plan. This overlap of symptoms increases the risk of false diagnoses.

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Brain Shifts Through the Triangle of Neurology

Laura Hanson
Connect My Brain, Sandy Springs, Georgia, USA

This study is designed to assess the hypothesis that stimulation of the visual, oculomotor, and vestibular systems in a novel way can promote profound, positive neuroplasticity in those suffering from general anxiety disorder.

The “Triangle of Neurology” connects the vestibular system and the eyes known as the vestibular ocular reflex, where the eyes and ears are yoked through the superior and inferior colliculus, and the ears and the vestibular system are yoked through the vestibulocochlear nerve. The Symmetron chair provides gentle elliptical movement around three axes of motion. While experiencing this gentle motion the patient is looking at a nonstimulating moving video of colors and shapes. Brain-based music is playing through bone conduction headphones.

This case study invited a female patient, 65 years of age, who presented to the office previously diagnosed with generalized anxiety disorder (GAD). The patient was given a thorough neurological examination identifying limitations in cortical function. The patient was found to have faulty eye movement patterns via RightEye Technologies (Figure 1).

Deficiencies were noted with both pursuits and saccades when matched to gender and age demographics. In addition, the patient noted sound sensitivities in her history. Many research articles have been published supporting vestibular stimulation for reducing stress and improving focus (Kumar, 2016). Pasquier et al. (2019), found a significant reduction in anxiety symptoms after 38 min of vestibular stimulation. Visual mismatch has been improved through vestibular stimulation (Wibble et al., 2020). The auditory and vestibular systems work together to process sound and movement (Oh et al., 2018). Modern work in aiding those with GAD may involve eye movement, such as with EMDR, but few have integrated focus with these three key components of the nervous system.

To monitor progress, the patient received three brain maps over a 30-day period. For this case study, the highlights of the sLORETTA summary from each qEEG map are used where the brain waves were beyond 2–3 standard deviations from typical. The Initial brain map (Figure 2): Eyes closed (EC) increased delta in the superior frontal gyrus, increased beta in the medial frontal gyrus, increased gamma in the superior frontal gyrus. Eyes open (EO) increased beta in the medial frontal gyrus.

The second brain map (Figure 3): EC increased delta in the middle occipital gyrus. EO increased delta in the anterior cingulate, increased beta in the inferior temporal gyrus, increased hi beta in the inferior temporal gyrus. The third brain map (Figure 4): EC increased hi beta inferior parietal lobe. EO increased hi beta superior parietal lobe, decreased gamma in the posterior cingulate.

Following a 10-hour treatment plan the patient displayed drastic changes in her brain maps, as well as ocular-motor function (Figure 1). Dysregulated vestibular responses coupled with GAD can propel a constellation of dysregulated autonomic symptoms which can be explained through an imbalance of the autonomic nervous system. The triangle of neurology is a path inward to promote balance to the brain, its perception and overall function of the nervous system.

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