NeuroRegulation

Proceedings of the 2025 ISNR Annual Conference: Keynote and Plenary Presentations

Selected Abstracts of Conference Keynote and Plenary Presentations at the 2025 International Society for Neuroregulation and Research (ISNR) 33rd Annual Conference, Niagara Falls, New York, USA

Citation: International Society for Neuroregulation and Research. (2025). Proceedings of the 2025 ISNR Annual Conference: Keynote and Plenary Presentations. *NeuroRegulation, 12*(4), 286–294. https://doi.org/10.15540/nr.12.4.286

KEYNOTE PRESENTATIONS

The Neuroscience of Deep Brain Reorienting (DBR): Healing of the Shock at the Core

Frank Corrigan
National Health Service, London, United Kingdom

Deep brain reorienting (DBR) is a trauma psychotherapy based in an understanding of the brainstem mechanisms for orienting and defense. It introduces the idea of preaffective shock, an activation arising in the brainstem that can produce arousal of the cortical EEG, with many attendant subjective phenomena; intensification of subsequent affective responses; disruption of sleep; enhanced vigilance; and disruption of memory processing. DBR aims to treat traumatic shock and its sequelae in a way which is not overwhelming and does not precipitate dissociative responses.

References

Corrigan, F. M., & Christie-Sands, J. (2020). An innate brainstem self-other system involving orienting, affective responding, and polyvalent relational seeking: Some clinical implications for a “Deep Brain Reorienting” trauma psychotherapy approach. *Medical Hypotheses, 136*, Article 109502. https://doi.org/10.1016/j.mehy.2019.109502

Corrigan, F. M., Young, H., & Christie-Sands, J. (2025). *Deep brain reorienting: understanding the neuroscience of trauma, attachment wounding, and DBR psychotherapy*. Routledge, London.

Kearney, B. E., Corrigan, F. M., Frewen, P. A., Nevill, S., Harricharan, S., Andrews, K., Jetly, R., McKinnon, M. C., & Lanius, R. A. (2023). A randomized controlled trial of Deep Brain Reorienting: A neuroscientifically guided treatment for post-traumatic stress disorder. *European Journal of Psychotraumatology, 14*(2), Article 2240691. https://doi.org/10.1080/20008066.2023.2240691

Endogenous Neuromodulation at Infra-Low Frequencies

Siegfried Othmer
The EEG Institute, Woodland Hills, California, USA

Even as we were engaged with the classic operant conditioning paradigm early in our neurofeedback work, results were better and faster to manifest than could be accounted for within that model. The brain was benefiting from the EEG dynamics to which it was exposed. This nonprescriptive aspect is appropriately termed endogenous neuromodulation. The brain was benefiting from a richer information stream and thus responding more globally. Clinically relevant change could be effected quite rapidly, calling for vigilance on the part of the clinician. This shifted the role of the clinician to a more observational mode. Attending to the subtleties of brain response led to the discovery in the late 90s that we respond best to very specific frequencies, referred to as optimal response frequencies. Identifying such frequencies for each client led to a net migration to ever lower frequencies. In 2006, that led us to enter the infra-low frequency range, the domain of state regulation that sets the context for the EEG regime.

With entry into the low-frequency domain, the discrete rewards were no longer meaningful and were abandoned. The modality had become pure endogenous neuromodulation in pursuit of improved state regulation. Going forward, we were now guided by control system theory, which governs the regulatory hierarchy, as well as by the developmental hierarchy and the frequency hierarchy. In control system theory the foundational requirement is for unconditional stability. Instabilities are characterized by sudden shifts into dysfunctional states. This category includes migraine, epilepsy, panic, vertigo, asthmatic episodes, bipolar mood swings, schizophrenia, narcolepsy, episodic suicidality, tinnitus, nystagmus, fibromyalgia, irritable bowel syndrome, hallucinations, dissociation, and dysautonomia. Also, it includes paroxysmal sleep disorders such as sleep apnea, nocturnal myoclonus, restless leg syndrome, nightmares, night terrors, sleepwalking, sleep-talking, and sleep paralysis.

It was found that the entire class of instabilities is responsive to training interhemispherically at homotopic sites, provided that the training is done at the client's optimal response frequency. Frequency rules were found by which the placements differed in terms of optimal response frequency.

Going ever lower in frequency took us to the foundations of the developmental hierarchy, which gave us access even to early childhood trauma that is necessarily physiologically encoded. With respect to protocols, we were guided by functional neuroanatomy. The focus on core state regulation in all of its aspects (e.g., tonic arousal, interoception, affect regulation, autonomic regulation, and executive function) can be seen as a generalization of the agenda of the traditional biofeedback modalities where the focus is on autonomic regulation.

The broad and inclusive clinical footprint that we are demonstrating with infra-low frequency neuromodulation makes the case for state regulation as the foundational focus in clinical work. It follows that the traditional biofeedback modalities should be recruited into our neurofeedback work, as these reveal state shifts in real time, thus aiding the clinician in the optimization procedure. Rendering the state shifts visible also promotes a sense of participation and of ownership of the process on the part of the client.

References

Bazzana, F., Finzi, S., Di Fini, G., & Veglia, F. (2022). Infra-Low Frequency neurofeedback: A systematic mixed studies review. *Frontiers in Human Neuroscience, 16*, Article 920659. https://doi.org/10.3389/fnhum.2022.920659

Carlson, J., Ross, G. W., Tyrrell, C., Fiame, B., Nunokawa, C., Siriwardhana, C., & Schaper, K. (2025). Infra-low frequency neurofeedback impact on post-concussive symptoms of headache, insomnia and attention disorder: Results of a randomized control trial. *Explore (New York, N.Y.), 21*(2), Article 103137. https://doi.org/10.1016/j.explore.2025.103137

Dobrushina, O. R., Vlasova, R. M., Rumshiskaya, A. D., Litvinova, L. D., Mershina, E. A., Sinitsyn, V. E., & Pechenkova, E. V. (2020). Modulation of intrinsic brain connectivity by implicit electroencephalographic. *Frontiers in Human Neuroscience, 14*, Article 192. https://doi.org/10.3389/fnhum.2020.00192

Gerge, A. (2020). A multifaceted case-vignette integrating neurofeedback and EMDR in the treatment of complex PTSD. *European Journal of Trauma & Dissociation, 4*(3), Article 100157. https://doi.org/10.1016/j.ejtd.2020.100157

Grin-Yatsenko, V. A., Kara, O., Evdokimov, S. A., Gregory, M., Othmer, S., & Kropotov, J. D. (2020). Infra-low frequency neurofeedback modulates infra-slow oscillations of brain potentials: A controlled study. *Journal of Biomedical Engineering Research, 4*(104), 1–11. https://doi.org/10.17303/jber.2020.4.104

Grin-Yatsenko, V. A., Othmer, S., Ponomarev, V. A., Evdokimov, S., Konoplev, Y., & Kropotov, J. D. (2018). Infra-low frequency neurofeedback in depression: Three case studies. *NeuroRegulation, 5*(1), 30–42. https://doi.org/10.15540/nr.5.1.30

Grin-Yatsenko, V. A., Ponomarev, V. A., & Kropotov, J. D. (2023). The changes of the infra-slow EEG fluctuations of the brain potentials under influence of infra-low frequency neurofeedback. *Journal of Evolutionary Biochemistry and Physiology, 59*, 831–840. https://doi.org/10.1134/S002209302303016X

Kirk, H. W., & Dahl, M. G. (2022). Infra low frequency neurofeedback training for trauma recovery: A case report. *Frontiers in Human Neuroscience, 16*, Article 905823. https://doi.org/10.3389/fnhum.2022.905823

Schmidt, C., Laugesen, H. (2023). Infra-low frequency neurofeedback training in Dravet Syndrome: A case study. *Epilepsy & Behavior Reports, 22*, Article 100606 https://doi.org/10.1016/j.ebr.2023.100606

Spreyermann, R. (2022). Infra-low frequency neurofeedback for PTSD: A therapist's perspective. *Frontiers in Human Neuroscience, 16*, Article 893830. https://doi.org/10.3389/fnhum.2022.893830

A Multidisciplinary Approach to Neurodevelopmental Delay

Laura Hanson
Connect My Brain, Atlanta, Georgia, USA

Neurodevelopmental delay (NDD) is the persistence of primal reflexes impacting the central nervous system and further delay of the maturing nervous system. Prenatal brain development is influenced by many factors, such as maternal and paternal health history, in-uterine movement, and pregnancy events which only identify a few. Reflexes provide the unborn child with the ability to move and protect its own life when stressed. Primitive reflexes are automatic, stereotyped movements controlled by the brain stem and driven without cortical involvement. Primitive reflexes precede the development of sensory motor development. At birth the child is met with a bombardment of sensory stimuli. Due to many events reflexes may persist which interrupts the typical developmental progression. Interruptions result in neurodevelopmental delay. The developmental history and a neurodevelopment assessment at any age identifies the timeline of potential interruptions. Early intervention is key in order to compliment the developmental windows. For example, crawling between 6–8 months for a period of 6 months exercises the brain to allow both sides of the brain to communicate. The management plan should address the earliest interruptions and provide steps that allow the lower brain to surrender, pushing the higher brain to take its rightful place directing the child's abilities in motor function, social, communication, adapting, and learning. Interventions should be well-rounded, including movement, neuroimmune function, and the identification of network development and dysfunction through quantitative electroencephalography (qEEG) analysis, while further research is needed to consider a multidisciplinary approach to NDD. In addition, expanding pediatric qEEG databases will assist the provider in understanding the varying brain patterns illustrated during childhood. A child's brain is an open window of development.

References

Aldharman, S. S., Al-Jabr, K. H., Alharbi, Y. S., Alnajar, N. K., Alkhanani, J. J., Alghamdi, A., Abdellatif, R. A., Allouzi, A., Almallah, A. M., & Jamil, S. F. (2023). Implications of early diagnosis and intervention in the management of neurodevelopmental delay (NDD) in children: A systematic review and meta-analysis. *Cureus, 15*(5), Article e38745. https://doi.org/10.7759/cureus.38745

Arns, M. (2012). EEG-based personalized medicine in ADHD: Individual alpha peak frequency as an endophenotype associated with nonresponse. *Journal of Neurotherapy, 16*(2), 123–141. https://doi.org/10.1080/10874208.2012.677664

Bailey, T. (2014). Diagnosing and treating developmental disorders with qEEG and neurotherapy. In D. S. Cantor & J. R. Evans (Eds.), *Clinical neurotherapy* (pp. 321–355). https://doi.org/10.1016/b978-0-12-396988-0.00013-1

Cantor, D. S., & Chabot, R. (2009b). QEEG studies in the assessment and treatment of childhood disorders. *Clinical EEG and Neuroscience, 40*(2), 113–121. https://doi.org/10.1177/155005940904000209

Filippi, C. G., Uluğ, A. M., Deck, M. D. F., Zimmerman, R. D., & Heier, L. A. (2002, May 1). Developmental delay in children: Assessment with proton MR spectroscopy. *American Journal of Neuroradiology, 23*(5), 882–888.

Johnstone, J., Gunkelman, J., & Lunt, J. (2005). Clinical database development: Characterization of EEG phenotypes. *Clinical EEG and Neuroscience, 36*(2), 99–107. https://doi.org/10.1177/155005940503600209

Martello, J. M. (2023). Persistent primitive reflex and developmental delay in the school-aged child. *The Journal for Nurse Practitioners, 19*(10), Article 104767. https://doi.org/10.1016/j.nurpra.2023.104767

Melillo, R., Leisman, G., Mualem, R., Ornai, A., & Carmeli, E. (2020). Persistent childhood primitive reflex reduction effects on cognitive, sensorimotor, and academic performance in ADHD. *Frontiers in Public Health, 8*, Article 431835. https://doi.org/10.3389/fpubh.2020.431835

PLENARY SESSION PRESENTATIONS

Virtual Neurofeedback: Implementation and Examination of Effectiveness

Andrea Reid-Chung and Zifeng Meng
ADD Centre, Mississauga, Ontario, Canada

In March 2020, as the ADD Centre shut down our in-person services due to the pandemic, we decided to provide a remote solution for our neurofeedback and biofeedback clients. As our senior staff had experience using GoTo Meeting virtual meeting software to run mentoring sessions for professionals learning neurofeedback, we decided to try rolling out a completely remote single-channel neurofeedback and biofeedback training program using procomp2 devices and peripherals manufactured by Thought Technology. The aim was to make the virtual program as similar as possible to our in-person CZ training program (Thompson, 1998; Thompson et al., 2010). Training included heart rate variability training and training in metacognitive strategies (Economides, 2020).

In 2022, we decided to analyze the data from our progress assessments to determine if virtual neurofeedback training was as effective as in-person training sessions. It would be essential to compare to a control group, as this had not yet been done in the literature (Philippe, 2022). We applied and received a grant from the Foundation for Neurofeedback and Neuromodulation Research (FNNR) for the analysis. This presentation will discuss how we integrated virtual neurofeedback and biofeedback training into our practice and will also review the first 22 cases of remote neurofeedback training who completed a course of 40 sessions. We will compare this to 23 clients who completed 40 in-person training sessions during the same period. The following pre- and postmeasures will be reviewed: CNS vital signs neurocognitive test battery, self-rating questionnaires, diagnostic information, and single-channel EEG data taken at CZ.

As expected, the results of our analysis showed there was no significant difference between the two groups. With all clients included in the study (n = 45), we found significant improvement on measures related to cognition and anxiety ($p < .05$) after being Bonferroni corrected. The results also indicate clinical significance because the Cohen's d effect size was larger than .8 for most of the results. As our sample size was very small, further research with larger sample sizes should be done before drawing broader conclusions.

Now that we have entered 2025, clients have grown accustomed to the flexibility of working and accessing services from the comfort of their homes. We expect to continue to offer hybrid services well into the future and look forward to analyzing the effectiveness of all our programs and sharing this knowledge with our neurofeedback community.

References

Economides, M., Lehrer, P., Ranta, K., Nazander, A., Hilgert, O., Raevanuori, A., Gevirtz, R., Khazan, I., & Forman-Hoffman, V. L. (2020). Feasibility and efficacy of the addition of heart rate variability biofeedback to a remote digital health intervention for depression. *Applied Psychophysiology and Biofeedback, 45*(2), 75–86. https://doi.org/10.1007/s10484-020-09458-z

Philippe, T. J., Sikder, N., Jackson, A., Koblanski, M. E., Liow, E., Pilarinos, A., & Vasarhelyi, K. (2022). Digital health interventions for delivery of mental health care: Systematic and comprehensive meta-review. *JMIR Mental Health, 9*(5), Article e35159. https://doi.org/10.2196/35159

Sarkheil, P., Chechko, N., Veselinović, T., Marx, G., & Neuner, I. (2021). Telepsychiatry: The remote care that unifies. *The European Journal of Psychiatry, 35*(1), 64–65. https://doi.org/10.1016/j.ejpsy.2020.08.004

Schaefer, M., Iskander, J., Tams, S., & Butz, C. (2021). Offering biofeedback assisted relaxation training in a virtual world: Considerations and future directions. *Clinical Practice in Pediatric Psychology, 9*(4), 405–411. https://doi.org/10.1037/cpp0000391

Thompson, L., & Thompson, M. (1998). Neurofeedback combined with training in metacognitive strategies: Effectiveness in students with ADD. *Applied Psychophysiology and Biofeedback, 23*(4), 243–263. https://doi.org/10.1023/a:1022213731956

Thompson, L., Thompson, M., & Reid, A. (2010). Neurofeedback outcomes in clients with Asperger's syndrome. *Applied Psychophysiology and Biofeedback, 35*(1), 63–81. https://doi.org/10.1007/s10484-009-9120-3

The Stress Phenotyping Framework: A Multidisciplinary Biobehavioral Approach for Assessing and Therapeutically Targeting Maladaptive Stress Physiology

Rachel Gilgoff

Stanford University, San Francisco, California, USA

We are facing concerning increases in mental and physical illnesses such as depression, anxiety, suicide, addictions, obesity, diabetes, asthma, and cardiovascular disease. A growing body of research is finding that adverse childhood experiences (ACE) are critical contributing factors. Indeed, the prolonged, excessive, or repeated activation of the stress response from ACEs and other stressors including racism, discrimination, and poverty, especially during childhood when the brain is still developing, has been termed toxic stress. Without support, coping strategies, and healing interventions, toxic stress is associated with long-term neurologic, endocrine, immune, metabolic, and genetic regulatory disruptions that can lead to poor health outcomes. More specifically, toxic stress can lead to dysregulation across numerous biological systems including somatosensory processing, arousal, energy and attention, reward processing, autonomic nervous system, hypothalamic pituitary adrenal (HPA) axis and endocrine, immune, and cognitive function, as well as relational health. These biological changes can set patterns that persist into adulthood, increasing the risk for chronic health conditions across the lifespan such as asthma, heart disease, diabetes, and mental health disorders.

Biomarkers hold the promise to provide a mechanism for diagnosing toxic stress, an opportunity to direct treatment, and the ability to monitor intervention effectiveness over time. Biomarkers such as inflammatory markers, cortisol levels, and epigenetic modifications provide objective measures of physiological dysregulation associated with toxic stress. These biomarkers not only confirm the biological basis of toxic stress but also offer valuable tools for early diagnosis, monitoring, and the potential for targeted interventions. The ability to measure the impact of toxic stress at a molecular and physiological level enables clinicians to move beyond psychological or behavioral assessments to a more comprehensive, multidisciplinary, biologically-informed approach to care. While much research still needs to be done, there is a vast amount of scientific research detailing mechanistic pathways, emerging biomarkers, and health consequences that are ready for translation into improved assessment and treatment of toxic stress.

However, although dysregulated stress biology is becoming increasingly recognized as a key driver of lifelong disparities in chronic disease, we presently have no validated biomarkers of toxic stress physiology; no biological, behavioral, or cognitive treatments specifically focused on normalizing toxic stress processes; and no agreed-upon guidelines for treating stress in the clinic or evaluating the efficacy of interventions that seek to reduce toxic stress and improve human functioning. We address these critical issues by (a) systematically describing key systems and mechanisms that are dysregulated by stress; (b) summarizing indicators, biomarkers, and instruments for assessing stress response systems; and (c) highlighting therapeutic approaches that can be used to normalize stress-related biopsychosocial functioning. We also present a novel multidisciplinary stress phenotyping framework that can bring stress researchers and clinicians one step closer to realizing the goal of using precision medicine-based approaches to prevent and treat stress-associated health problems.

References

Fisher, J. (2019). Sensorimotor psychotherapy in the treatment of trauma. *Practice Innovations, 4*(3), 156–165. https://doi.org/10.1037/pri0000096

Gilgoff, R., Mengelkoch, S., Elbers, J., Kotz, K., Radin, A., Pasumarthi, I., Murthy, R., Sindher, S., Burke Harris, N., & Slavich, G. M. (2024). The stress phenotyping framework: A multidisciplinary biobehavioral approach for assessing and therapeutically targeting maladaptive stress physiology. *Stress, 27*(1), Article 2327333. https://doi.org/10.1080/10253890.2024.2327333

Gilgoff, R., Schwartz, T., Owen, M., Bhushan, D., & Burke Harris, N. (2022). Opportunities to treat toxic stress. *Pediatrics, 151*(1), Article e2021055591. https://doi.org/10.1542/peds.2021-055591

Kearney, B. E., & Lanius, R. A. (2022). The brain-body disconnect: A somatic sensory basis for trauma-related disorders. *Frontiers in Neuroscience, 16*, Article 1015749. https://doi.org/10.3389/fnins.2022.1015749

Lanius, R. A., Frewen, P. A., Tursich, M., Jetly, R., & McKinnon, M. C. (2015). Restoring large-scale brain networks in PTSD and related disorders: A proposal for neuroscientifically-informed treatment interventions. *European Journal of Psychotraumatology, 6*(1), Article 27313. https://doi.org/10.3402/ejpt.v6.27313

Teicher, M. H., & Samson, J. A. (2016). Annual research review: Enduring neurobiological effects of childhood abuse and neglect. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 57*(3), 241–266. https://doi.org/10.1111/jcpp.12507

Clinical Impact of Infra-Low Frequency Neurofeedback on Combat Veterans With Concussion

Judy Carlson
VA Pacific Islands Health Care System, Honolulu, Hawaii, USA

Introduction. Given that 20–40% of combat veterans who experienced concussions during recent military operations suffer chronically from headaches, insomnia, and attention dysfunction (Agimi et al., 2024), this study's purpose is to determine impact of infra-low frequency neurofeedback (ILFNFB) on chronic postconcussive symptoms. The literature review revealed two studies which had investigated ILFNFB and postconcussive symptoms that resulted in a statistical and clinical significant change in symptoms (Carlson & Ross, 2021; Legarda et al., 2022). Two studies focused on headache, one that resulted in a decrease in migraine frequency and a stabilization of the psychological state (Dobrushina et al., 2017) and the second on tension-type headache that resulted in a reduction in headache frequency (Arina et al., 2022). Given its relationship with mild traumatic brain injury (mTBI), there was an ILFNFB study demonstrating its effectiveness with depression (Grin-Yatsenko et al., 2018). There are also several publications on the efficacy of ILFNFB in clinical settings related to these symptoms (Grin-Yatsenko & Kropotov, 2020; Kirk & Dahl, 2022; McMahon, 2020; Shapero & Prager, 2020). This study will provide additional research evidence as to whether ILFNFB might be an effective treatment option for chronic postconcussive symptoms.

Methods. Eighty-seven participants were enrolled in this randomized controlled trial, with 36 completing the intervention (20 1-hr sessions of ILFNFB and four assessment sessions) and 38 completing the control procedures (8 weekly 15-min health-related discussions and four assessment sessions). Both groups continued treatment as usual throughout participation in study. Data were analyzed on intention-to-treat principle.

Results. The participants were 86% male and 14% female; mean age was 45 for both groups. When comparing baseline to end of treatment measures, findings were clinically and statistically significant for headache (<.001, Cohen's *d* 1.29), sleep (<.001, Cohen's *d* 1.58), and attention (.002, Cohen's *d* 0.68). Additional variables of interest, including quality of life, depression, and posttraumatic stress disorder, were also significantly improved following ILFNFB at end of treatment.

Discussion. These findings demonstrated the consistent efficacy of the ILFNFB intervention across multiple outcome measures, with statistically significant differences indicating improvements in postconcussive symptom physiological measures as well as psychological and quality-of-life metrics. This may be an effective intervention for combat veterans with concussion for whom effective treatments have been difficult to identify (Agimi et al., 2024). In conclusion, ILFNFB holds promise to be a safe and effective intervention for those who suffer with postconcussive symptoms of chronic headache, sleep, and attention disorders and other relevant symptoms. This noninvasive, low risk intervention should be made available to all veterans to enhance their recovery from chronic postconcussive symptoms.

References

Agimi, Y., Hai, T., Gano, A., Stuessi, K., Gold, J., Kaufman, R., & McKinney, G. (2024). Clinical trajectories of comorbidity associated with military-sustained mild traumatic brain injury: Pre- and post-injury. *The Journal of Head Trauma*

Rehabilitation, 39(6), E564–E575. https://doi.org/10.1097/HTR.0000000000000934

Arina, G. A., Dobrushina, O. R., Shvetsova, E. T., Osina, E. D., Meshkov, G. A., Aziatskaya, G. A., Trofimova, A. K., Efremova, I. N., Martunov, S. E., & Nikolaeva, V. V. (2022). Infra-low frequency neurofeedback in tension-type headache: A cross-over sham-controlled study. *Frontiers in Human Neuroscience, 16*, Article 891323. https://doi.org/10.3389/fnhum.2022.891323

Carlson, J., & Ross, G. W. (2021). Neurofeedback impact on chronic headache, sleep, and attention disorders experienced by veterans with mild traumatic brain injury: A pilot study. *Applied Psychophysiology & Biofeedback, 49*(1), 2–9. https://doi.org/10.5298/1081-5937-49.01.01

Carlson, J., Ross, G. W., Tyrrell, C., Fiame, B., Nunokawa, C., Siriwardhana, C., and Schaper, K. (2025). Infra-low frequency neurofeedback impact on post-concussive symptoms of headache, insomnia and attention disorder: Results of a randomized control trial. *Explore, 21*(2), Article 103137, https://doi.org/10.1016/j.explore.2025.103137

Dobrushina, O., Arina, G., Osina, E., & Aziatskaya, G. (2017). Clinical and psychological confirmation of stabilizing effect of neurofeedback in migraine. *European Psychiatry, 41*(S1), S253–S253. https://doi.org/10.1016/j.eurpsy.2017.02.045

Grin-Yatsenko, V. A., & Kropotov, J. (2020). Effect of infra-low frequency (ILF) neurofeedback on the functional state of the brain in healthy and depressed individuals. In H. W. Kirk (Ed.), *Restoring the brain* (2nd ed.). Routledge.

Grin-Yatsenko, V. A., Othmer, S., Ponomarev, V., Evdokimov, S., Konoplev, Y., & Kropotov, J. (2018). Infra-low frequency neurofeedback in depression: Three case studies. *NeuroRegulation, 5*(1), 30–42. https://doi.org/10.15540/nr.5.1.30

Kirk, H. W., & Dahl, M. G. (2022). Infra low frequency neurofeedback training for trauma recovery: A case report. *Frontiers in Human Neuroscience, 16*, Article 905823. https://doi.org/10.3389/fnhum.2022.905823

Legarda, S. B., Lahti, C. E., McDermott, D., & Michas-Martin, A. (2022). Use of novel concussion protocol with infralow frequency neuromodulation demonstrates significant treatment response in patients with persistent postconcussion symptoms, a retrospective study. *Frontiers in Human Neuroscience, 16*, Article 894758. https://doi.org/10.3389/fnhum.2022.894758

McMahon, D. (2020). Neurofeedback in an integrative medical practice. In H. W. Kirk, *Restoring the brain* (2nd ed., pp. 112–133). Routledge.

Shapero, E. J., & Prager, J. P. (2020). ILF neurofeedback and alpha-theta training in a multidisciplinary chronic pain program. In H. W. Kirk (Ed.), *Restoring the brain* (2nd ed., chapter 11). Routlege. https://doi.org/10.4324/9780429275760

Using Machine Learning to Enhance the EEG Screening Review by Prescreening the EEG

Thomas Collura[1], Harry Brubaker[1], David Ims[2], and Robert Turner[3]

[1]Brainmaster Technologies, Bedford, Ohio, USA
[2]Network Neurology Health, Owings, Maryland, USA
[3]Integrative NeuroTherapy LLC, Charleston, South Carolina, USA

One cannot view a news cycle lately without hearing a story of how artificial intelligence (AI) is beginning to dominate the medical field in assisting medical professionals with patient care, diagnosis, and treatment. This ability to assist physicians and improve communication between doctors and their patients is becoming an important part of the patient care process.

The purpose of this paper is to show how a subset of AI, machine learning (ML), is being used to prescreen raw EEGs to determine how “typical” the raw EEG is and to identify certain phenotypes that may be evident. The authors are using ML to improve the quality review screening report by introducing a new analysis panel that mimics similar panels found in a physician’s report, which we call the “brain panel.”

The brain panel will be viewed by the screening team prior to any visual inspection of the EEG or any qEEG analysis that may be made. The brain panel may provide an indication as to whether the EEG should be sent out for clinical review. Our approach is to interpret raw EEG that has been minimally processed using independent component analysis (ICA). We incorporate *z*-scores in our analysis, but we do not compare a person’s EEG to a “normative” database; rather, we use *z*-scores to quantify the neurometrics and show whether they are within limits established by our ML set rules. Using *z*-scores in this way not only serves to enhance the quality review of the EEG but also produces a useful report that mimics a physician’s report, based on the quantitative findings derived from the metric analysis of an AI/ML-enhanced EEG quality review machine or system. The new brain panel includes more metrics for consideration when evaluating EEGs to provide, what we believe to be a more thorough approach to the EEG screening process.

References

Cavallo, F., Brubaker, H., & Brown, T. (2021). Utilizing individual z-scores to measure efficacy of the World’s first augmented reality glasses for autism: A single case study. *Journal of Social Sciences Research,* 54–71.

Collura, T., Cantor, D., Chartier, D., Crago, R., Hartzoge, A., Hurd, M., Kerson, C., Lubar, J., Nash, J., Prichep, L. S., Surmeli, T., Thompson, T., Tracy, M., & Turner, R. (2025) International QEEG certification board guideline minimum technical requirements for performing clinical quantitative electroencephalography. *Clinical EEG Neuroscience, 56*(5), 391–399. https://doi.org/10.1177/15500594241308654

Collura, T., & Tarrant, J. (2020). Principles and statistics of individualized live and static z-scores. *NeuroRegulation, 7*(1), 45–56. https://doi.org/10.15540/nr.7.1.45

Keizer, A. W. (2021). Standardization and personalized medicine using quantitative EEG in clinical settings. *Clinical EEG Neuroscience, 52*(2), 82–89. https://doi.org/10.1177/1550059419874945

Livint Popa, L., Dragos, H., Pantelemon, C., Verisezan-Rosu, O., & Strilciuc, S. (2020). The role of quantitative EEG in the diagnosis of neuropsychiatric disorders. *Journal of Medicine and Life, 13*(1), 8–15. https://doi.org/10.25122/jml-2019-0085

Mahajan, R., & Morshed, B. I. (2014). Unsupervised eye blink artifact denoising of EEG data with modified multiscale sample entropy, kurtosis, and wavelet-ICA. *IEEE Journal of Biomedical and Health Informatics, 19*(1), 158–165. https://doi.org/10.1109/JBHI.2014.2333010
Mateos, D. M., Guevara Erra, R., Wennberg, R., & Perez-Velazquez, J. L. (2018). Measures of entropy and complexity in altered states of consciousness. *Cognitive Neurodynamics, 12*(1), 73–84. https://doi.org/10.1007/s11571-017-9459-8
Piloto, C. (2022). *Machine learning vs artificial intelligence: What's the difference? | MIT Professional Education*. MIT Professional Education. https://professionalprograms.mit.edu/blog/technology/machine-learning-vs-artificial-intelligence/
Rejer, I., & Górski, P. (2015) Benefits of ICA in the case of a few channel EEG. *2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, (pp. 7434–7437). Milan, Italy. https://doi.org/10.1109/EMBC.2015.7320110
Wallace, B., & Collura, T. F. (1993). Imaging ability and visual processing of EEG waveforms. *Bulletin of Psychometric Society, 31*, 4–6. https://doi.org/10.3758/BF03334123

Individualized *Z*-Scores for Assessment and Training

Richard McAlister[1], Harry Brubaker[2], and Thomas Collura[2]
[1]Integrative NeuroTherapy LLC, East Brunswick, New Jersey, USA
[2]Brainmaster Technologies, Bedford, Ohio, USA

Learn from master practitioners on how to use the power of sLORETA and individualized *z*-scores for clinical outcomes and how to use individualized *z*-scores to provide a more informed analysis than a normative database can provide.

This interactive workshop will provide the science behind how individualized *z*-scores are created, how they are different than a normative database, and how they can be used to show individual improvement from therapeutic approaches when little may be seen when using a normative database comparison. The workshop will show how sLORETA can work in tandem with individualized *z*-scores to provide a more thorough analysis of a person's underlying dysregulation of their EEG. The presenters will provide case studies of how powerful these tools are for quality assessments.

Live demonstrations will be performed to show real-time analysis of current therapies such as photobiomodulation (PBM) and pulsed electromagnetic fields (PEMF) and how these analysis tools can show even subtle changes in a person's EEG when little change can be observed using normative tools. Demonstrations will be given showing how one can pinpoint dysfunctional EEG activity to specific ROI's and even individual voxels.
The presenters will show how these tools can be used to show how meditation practices can affect a person's brainwaves, how pain is suppressed, and many more applications where one may not think it would be possible to observe any changes. These tools can be used to support clinical practices in mental, medicine, peak performance training, and wellness clinics.

The presenters are all experienced practitioners and have done research using individualized *z*-scores and sLORETA. This interactive workshop will be providing ample opportunity for everyone to witness the power of this type of analysis, to see in real time how to zero in where dysregulation is occurring and provide for a stimulating and fun question and answer session throughout the workshop.

References

Collura, T. F. (1990). Real-time filtering for the estimation of steadystate visual evoked potentials. *IEEE Transactions on Biomedical Engineering, 37*(6), 650–652. https://doi.org/10.1109/10.55670
Collura, T. F. (2014). *Technical foundations of neurofeedback*. Routledge.
Collura, T. F. (2014, Spring). Specifying and developing references for live z-score neurofeedback. *NeuroConnections, 9*(1), 26–39. Retrieved from https://docs.wixstatic.com/ugd/cba323_b824c922625941808b2d633bc63f3df7.pdf
Collura, T. F., Thatcher, R. W., Smith, M. L., Lambos, W. A., & Stark, C. R. (2009). EEG biofeedback training using live z-scores and a normative database. In J. R. Evans, T. H. Budzynski, H. K. Budzynski., & A. Arbanal (Eds.), *Introduction to quantitative EEG and neurofeedback: Advanced theory and applications* (2nd ed., pp. 103–142). Elsevier.
Host-Mandel, A., & Handel, P. (2000). Effects of sampling and quantization on single-tone frequency estimation. *IEEE Transactions on Signal Processing, 48*(3), 650–662. https://doi.org/10.1109/78.824661
Kerson, C., deBeus, R., Lightstone, H., Arnold, L. E., Barterian, J., Pan, X., & Monastra, V. J. (2020). EEG theta/beta ratio calculations differ between various EEG neurofeedback and assessment software packages: Clinical interpretation. *Clinical EEG and Neuroscience, 51*(2), 114–120. https://doi.org/10.1177/1550059419888320
Messick, S. (1998). Test validity: A matter of consequence. *Social Indicators Research, 45*(1–3), 35–44. https://doi.org/10.1023/A:1006964925094
Siever, D., & Collura, T. (2017). Audio-visual entrainment: Physiological mechanisms and clinical outcomes. In J. R. Evans & R. P. Turner (Eds.), *Rhythmic stimulation in neuromodulation* (pp. 51–95). Elsevier.
Social Science Statistics (2019). T test calculator for 2 dependent means. https://www.socscistatistics.com/tests/ttestdependent/default.aspx
Thatcher, R. W. (2008, April). Z-score EEG biofeedback: Conceptual foundations. *NeuroConnections,* 9–11. Retrieved from https://docs.wixstatic.com/ugd/cba323_426c6449511f48968c49c4ee94fa0c7e.pdf

Applying Progressive Return to Activity for Concussions to Neurotherapies

Danielle Fuerst[1] and Katie Gregg[2]
[1]KBR Contractor for Special Operations, Sneads Ferry, North Carolina, USA
[2]OPTML, San Antonio, Texas, USA

The science of managing concussions continues to evolve, but expert consensus for client care currently consistently directs the use of a progressive return to activity (PRA) protocol such as return to learn or return to play. These protocols dictate a graded increase in activities overtime in the absence of symptom provocation. Though these recommendations have existed for nearly a decade, the balance of postconcussion rest and activity has not yet been widely adopted in a unified manner. Additionally, though neurotherapists have direct interest in brain injury care, current literature appears to neglect discussion of best practices for applying progressive return to activity to relevant postconcussive interventions. Though many clinicians seem to loosely apply this model through clinical intuition, the lack of explicit education for clinicians in progressive return to active has been demonstrated to significantly impact patient recovery outcomes. For example, patients treated for an acute concussion after providers received PRA training had greater overall symptom reduction at 1 week, 1 month, and 3 months after injury. Patients treated by physicians trained in a PRA model had a majority (82%) of their symptoms normalized at 1 month, while those very same clinicians prior to PRA training only 36% of patient's symptoms normalized at 1 month. With the growing public interest and increased client accessibility of neurotherapy, it's important that practitioners are educated in effective concussive recovery protocols both to aid in client and patient education and to direct their clinical care to support the best outcomes for clients. This training will apply the stages of PRA model to acute and persistent postconcussive care, and then analyze potential application of different neurotherapy interventions for stages of concussion recovery. Lastly, presenters will discuss the use of a PRA lens for the application of neurofeedback, photo biomodulation, and transcranial stimulation through the use of clinical case studies.

References

Bailie, J. M., Remigio-Baker, R. A., Cole, W. R., McCulloch, K. L., Ettenhofer, M. L., West, T., Ahrens, A., Sargent, P., Cecchini, A., Malik, S., Mullins, L., Stuessi, K., Qashu, F. M., & Gregory, E. (2019). Use of the progressive return to activity guidelines may expedite symptom resolution after concussion for active duty military. *The American Journal of Sports Medicine, 47*(14), 3505–3513. https://doi.org/10.1177/0363546519883259

Losoi, H., Silverberg, N. D., Wäljas, M., Turunen, S., Rosti-Otajärvi, E., Helminen, M., Luoto, T. M., Julkunen, J., Öhman, J., & Iverson, G. L. (2016). Recovery from mild traumatic brain injury in previously healthy adults. *Journal of Neurotrauma, 33*(8), 766–776. https://doi.org/10.1089/neu.2015.4070

Patricios, J. S., Schneider, K. J., Dvorak, J., Ahmed, O. H., Blauwet, C., Cantu, R. C., Davis, G. A., Echemendia, R. J., Makdissi, M., McNamee, M., Broglio, S., Emery, C. A., Feddermann-Demont, N., Fuller, G. W., Giza, C. C., Guskiewicz, K. M., Hainline, B., Iverson, G. L., Kutcher, J. S., … Meeuwisse, W. (2023). Consensus statement on concussion in sport: The 6th International Conference on Concussion in Sport-Amsterdam, October 2022. *British Journal of Sports Medicine, 57*(11), 695–711. https://doi.org/10.1136/bjsports-2023-106898

Psychopathology: Through the Triple Network Lens

Mark Smith
Neurofeedback Services of New York, New York, New York, USA

Recently, the brain has been conceived by neuroscientists as a prediction machine involved in reducing uncertainty in a changing environment. The successful navigation of surprising events in our environment requires healthy interactions between three cardinal networks: the default mode network (DMN), the salience network (SN), and the central executive network. Any insult to the dynamic coordination of these domain-specific control networks interferes with predictive processes, leading to distortions of reality that interfere with our ability to meet diverse cognitive, emotional, and environmental demands. When no new information can be attained by the senses due to the poor function of triple network processes, the brain can no longer accurately predict current reality. It resorts to memory to resolve uncertainty, limiting the individual to past, less than optimal strategies. Poor predictive capacity is the root of many psychopathologies including anxiety, depression, PTSD, and developmental trauma

Applied neuroscience in the form of three-dimensional analysis of deeper structures in cortex is central to this new understanding of brain function. The network-centered approach guides analysis to address the distortions produced by a poor functioning triple network model. The framework unites older neuroscience findings with newer results that reduce the siloed diagnostic categories of traditional mental health. It augurs for a spectrum of dysfunctions in the triple network model that explains the comorbidity of symptoms across diagnostic categories. The restoration of aberrant activity in large scale behavioral networks may be accomplished through many different modalities. However, they should address specific regions within the networks that influence autonomic behavior. Additionally, technology should provide strategies related to activation and that address the relationships between the three cardinal networks in psychopathology.

Among the most important relationships between large scale behavioral networks involve the DMN and the SN. The DMN underlies a sense of self, while the SN determines what is important. This relationship is central to healthy functioning that includes effective predictive mechanisms. A dysfunctional relationship between these two networks is central to distortions of reality that involve self-identity. In psychopathology, a dysfunctional relationship between SN and DMN amplifies memory over sensory data dooming individuals to reflexive, historical behavior rather than optimal behavior driven by current circumstances.

References

Das, A., & Menon, V. (2024). Electrophysiological dynamics of salience, default mode, and frontoparietal networks during episodic memory formation and recall: A multi-experiment iEEG replication. *bioRxiv*. https://doi.org/10.1101/2024.02.28.582593

De Ridder, D., Smith, M. L., & Adhia, D. (2023). Autonomic nervous system and the triple network: An evolutionary perspective with clinical implications. In D. R. Chartier, M. B. Dellinger, J. R. Evans, & H. K. Budzynski (Eds.), *Introduction to quantitative EEG and neurofeedback* (3rd ed., pp. 63–77). Academic Press.

De Ridder, D., Vanneste, S., Smith, M., & Adhia, D. (2022). Pain and the triple network model. *Frontiers in Neurology, 13*, Article 757241. https://doi.org/10.3389/fneur.2022.757241

Hutchinson-Wong, N., Glue, P., Adhia, D., & de Ridder, D. (2025). How does depressive cognition develop? A state-dependent network model of predictive processing. *Psychological Review, 132*(2), 442–469. https://doi.org/10.1037/rev0000512

Menon, B. (2019). Towards a new model of — The triple network, psychopathology and the structure of the mind. *Medical Hypotheses, 133*, Article 109385. https://doi.org/10.1016/j.mehy.2019.109385

Menon, V. (2011). Large-scale brain networks and psychopathology: A unifying triple network model. *Trends in Cognitive Sciences, 15*(10), 483–506. https://doi.org/10.1016/j.tics.2011.08.003

Sha, Z., Wager, T. D., Mechelli, A., & He, Y. (2019). Common dysfunction of large-scale neurocognitive networks across psychiatric disorders. *Biological Psychiatry, 85*(5), 379–388. https://doi.org/10.1016/j.biopsych.2018.11.011

Zhang, W., Kaldewaij, R., Hashemi, M. M., Koch, S. B. J., Smit, A., van Ast, V. A., Beckmann, C. F. Klumpers, F., & Roelofs, K. (2022). Acute-stress-induced change in salience network coupling prospectively predicts post-trauma symptom development. *Translational Psychiatry, 12*(1), Article 63. https://doi.org/10.1038/s41398-022-01798-0

Zhu, X., Suarez-Jimenez, B., Lazarov, A., Such, S., Marohasy, C., Small, S. S., Wager, T. D., Lindquist, M. A., Lissek, S., & Neria, Y. (2022). Sequential fear generalization and network connectivity in trauma exposed humans with and without psychopathology. *Communications Biology, 5*(1), Article 1275. https://doi.org/10.1038/s42003-022-04228-5

Received: November 15, 2025
Accepted: November 15, 2025
Published: December 19, 2025