Five Case Studies Using Live Z-Score Training Percent-Z OK on Individuals Diagnosed with PTSD

Penijean Rutter, LMHC, BCN

Introduction

Recent advances in technology are changing the field of neurotherapy by offering clinicians information-gathering and feedback-producing paradigms that are more sophisticated than anything previously available. Using neurofeedback as an adjunctive therapy to promote relaxation and rebalance poorly regulated EEG mechanisms is growing in popularity, with the increasing ability of practitioners to scientifically demonstrate changes in EEG activational patterns that appear to correlate with clinical improvements. Emerging tools such as live 19 channel EEG recordings now equip clinicians with the ability to create not only measurements of brain activity before and after neurofeedback interventions (Thatcher 1999), but can also be the basis for complex and intelligent feedback that takes into account how individual regions function within the global context of the entire brain.

The therapeutic relationship between posttraumatic stress disorder (PTSD) and neurofeedback can be traced back over forty years due to the efforts of researchers such as Kamiya (Kamiya, 1970), Peniston and Kulkosky (Peniston, 1991), to name a few, and has often been comprised of giving the brain feedback designed to increase deficient alpha and theta rhythms, and decrease excess fast beta activity at a few selected 10-20 sites at a time. These interventions were devised using the knowledge base and technology previously available, and in many cases, were found to be effective in reducing symptoms associated with post-traumatic stress disorder (Raymond, 2005).

In 2007, Collura and colleagues released an innovative software program that introduced an entirely new paradigm into the field of neurofeedback (Collura, 2009), and named it live Z-score training (LZT). Not only did LZT track the power and amplitude measures of the EEG at each site being recorded, but it also tracked connectivity parameters, such as amplitude asymmetry, coherence and phase. This allowed practitioners to provide feedback to clients based on not only what was happening *at* each individual site being observed, but also the dynamic relationships *between* the recorded sites (Collura, 2010). Initially, this was only possible between four sites at a time, but as the capabilities of the software have continued to evolve, it is currently possible to provide feedback to a brain system based on 19 channels of live EEG. This means that a practitioner can now create training protocols based on global brain activity, and even if they choose to focus on specific brain regions, the feedback given to the client can still be delivered in the context of how other areas in the brain are functioning and responding to the changes in one particular location.

Implications for PTSD Treatment

The revolutionary neural integration capabilities of LZT are particularly relevant to a population suffering from PTSD symptoms, not the least of which are difficulties with cognitive processing, integration of memories and associations, and regulating arousal responses to situational stressors. One of the current standards of treatment for PTSD is Eye Movement Desensitization and Reprocessing (EMDR). While research on EMDR has resulted in mixed reviews (Davidson, 2001), one of the theories held by some EMDR providers is that the physiological tasks often involved in EMDR sessions, such as lateral eye movements, alternate hand tapping, and bi-lateral auditory tones, create an interhemispheric activation in which the brain assists the individual to process and integrate experiences (Levin, 1999).

The *hippocampi*, areas in the brain associated with storing and retrieving memories, and regulating fear responses, are often implicated as key regions affected by PTSD (Gilbertson 2002), while the *frontal cortex*, the *basal ganglia* and the *parietal lobes* are all involved in cognitive processing, attribution of meaning, and an individual's sense of time (Kolassa, 2007). Functional neuroimaging studies support the hypothesis that poor communication between these brain regions play a role in exacerbating symptoms of PTSD, such as flashbacks, intrusive thoughts and sensations, recurring dreams and panic attacks (Stein & McAllister, 2009).

Case Histories

The following five cases are individuals who were diagnosed by medical professionals as meeting the DSM-IV criteria for PTSD. A qEEG brain map was performed on each person before neurofeedback was introduced, and additional qEEG brain maps were acquired after a number of sessions of neurofeedback were completed.

In Figure 1, the subject is a 44 year-old female with a history of early childhood abuse and trauma. The map on the left was taken before any neurofeedback was done. The map on the right was taken after 40 sessions of LZT using a Percent-Z OK protocol unique to BrainMaster software. All sessions were performed using four channels of feedback, placed at F3, F4, P3, and P4. The placements were chosen to optimize integration and increased communication between brain areas commonly found to be affected in individuals exhibiting symptoms of PTSD, as previously discussed in this article.

Before neurofeedback, she reported difficulty functioning socially and professionally, and described an inability to form healthy romantic relationships. After completing 40 sessions, she said that she felt "100% better" and "like a different person", reporting a significant decrease in her symptoms, particularly the avoidance and numbing behaviors that drove her interpersonal frustrations.

Figure 2 contains the brain maps of a 19-year-old male from a broken family who had severe PTSD symptoms, a history of chronic substance abuse and traumatic brain injury. He had dropped out of high school, could not maintain consistent employment, and attempted suicide by slitting open his own throat with a kitchen knife. He spent six months in an inpatient facility before he started neurofeedback. The map on the left is pre-intervention, and the map on the right is after 30 sessions of four-channel LZT neurofeedback, site placements at F3, F4, P3, and P4, using the Percent-Z OK protocol. In the five years since these sessions, he has held a steady job for the first time in his life, enrolled in school and married a lovely girl. He credits the neurofeedback with having "saved his life".

These first two cases were individuals who received LZT neurofeedback in 2008 when only four channels of training, using up to 248 variables, were available. The observable changes in the EEG and the reports of clinical improvements were welcome, however the idea of being able to achieve positive clinical results with fewer sessions was appealing. When BrainMaster Technologies released an additional software option that allowed practitioners to record and provide feedback using up to 19 channels of EEG, with 5700 training variables to choose from,

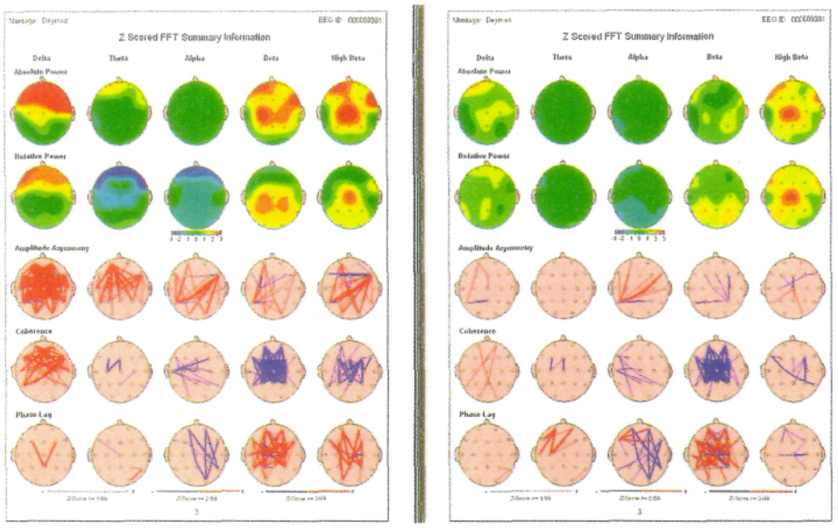

Figure 1

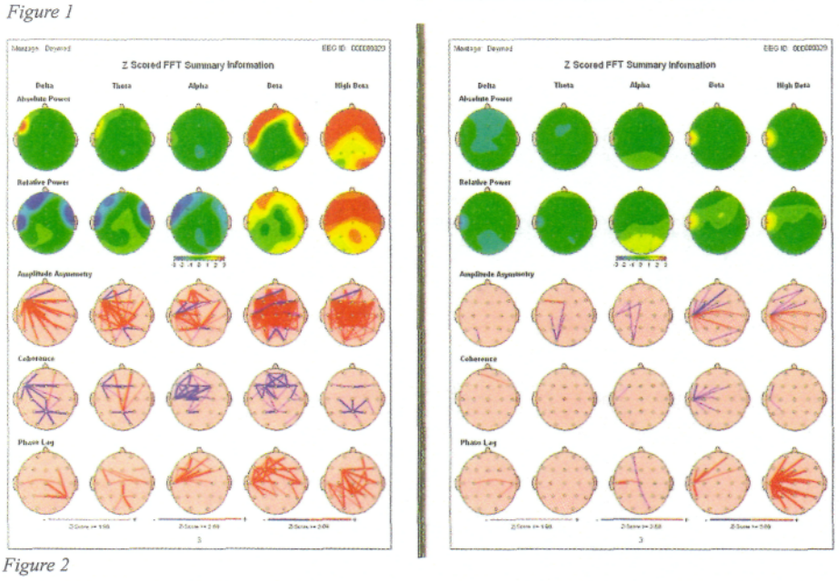

Figure 2

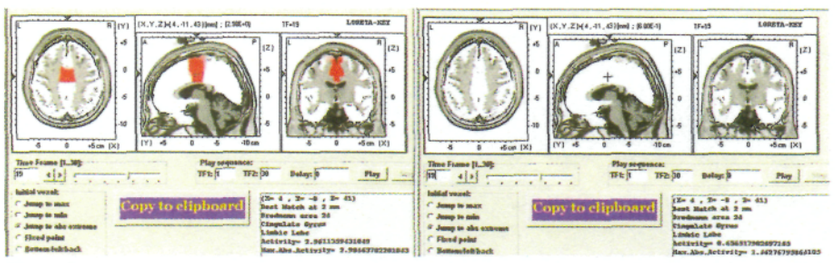

Figure 3

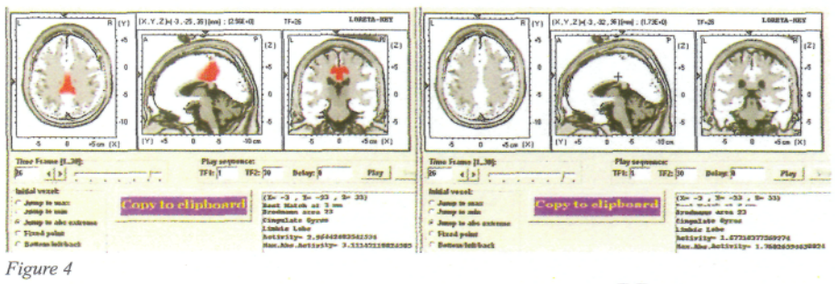

Figure 4

the next step was to incorporate additional training channels to see if there were discernible clinical improvements in fewer sessions using more training sites.

While early forays into training individuals using the full 19 sites yielded promising data, the idea of connecting 19 leads to a client every session was proving daunting to the everyday practitioner. In an effort to create an interim option, the idea of attaching nine training leads was explored, and the following two cases (Figures 3 and 4) are images of pre- and post-EEG recordings that use the LORETA algorithm to project activity in deeper brain structures and assess how feedback from scalp EEG recordings can affect limbic regulation. The images were generated from 19 channel EEG recordings, and analyzed using norms from the NeuroGuide 2.6.9 database.

In Figure 3, the subject is a 24 year-old male diagnosed with PTSD who presented with specific triggers related to social interactions. He reported hyper reactivity and irritability, outbursts of anger and volatility, and general difficulty behaving appropriately within his environmental context. The image on the left is prior to neurotherapy, and shows activity 2.98 standard deviations above the norm at 19 Hz in the cingulate gyrus, most notably Brodmann area 24, a region in the anterior part of the cingulate gyrus which is involved with emotional and cognitive processing (Critchley, 2005).

The image on the right of Figure 3 is after five sessions of LZT Percent-Z OK feedback using nine training sites: F3, Fz, F4, C3, Cz, C4, P3, Pz, and P4. The design was intended to address integration of frontal, central and parietal areas. The subject verbalized that he noticed after the first couple sessions he felt "calmer and clearer", and after five sessions he found it easier to interact socially, saying that he "didn't get as angry and impatient, and thought less about violent acts while talking to people". The 19 Hz activity in the cingulate gyrus reduced from 2.98 standard deviations above the norm to 0.6, as can be observed in the panel on the right hand side of Figure 3.

The fourth case underwent an identical regimen as case number three, which consisted of LZT Percent-Z OK feedback at the same nine central 10-20 sites for five sessions. Case number four is a 29 year-old female who presented with a history of chronically abusive relationships that resulted in her experiencing hypersomnia, generalized anxiety and avoidance, motoric apathy and indifference to daily activities of living, including showering, eating, or even getting out of bed. In her pre-intervention LORETA image, she exhibits activity 2.96 standard deviations above norm at 26 Hz in the cingulate gyrus in the region of Brodmann area 23, a location which is correlated with limbic associational integration (Lane, 1998).

She reported feeling more relaxed and energetic after her first session, and over the course of the five sessions said that she was in a "happier state, and was finding it easier to wake up in the morning and get moving. She also verbalized that she was thinking more clearly and was less overwhelmed with day-to-day activities. In her post-intervention LORETA image, seen in the right panel of Figure 4, the observed cingulate activation that was previously at 2.96 standard deviations above the norm was reduced to 1.6.

The final case subject, a 27 year-old female, came from a severely abusive family of origin, exhibiting the most extreme symptoms of PTSD out of all five cases discussed in this article. She had a history of insomnia, chronic nightmares and flashbacks, emotional rigidity, physiological reactivity and startle response, multiple panic attacks a week, hyperventilation and self-mutilating behaviors. She was also given LZT Percent-Z OK feedback for five sessions at the same sites as subjects three and four: F3, Fz, F4, C3, Cz, C4, P3, Pz, and P4.

She reported she felt relaxed halfway through the first training session, after which she slept through the night for first time in 16 months, described reduced symptoms of anxiety, a cessation in self-mutilating behaviors after third session, a noticeable reduction in number of panic attacks and flash backs, and more emotional and social flexibility by the fifth session. Her before and after qEEG maps can be seen in Figure 5.

Discussion

A review of the data presented in this article indicates a positive outlook regarding the use of live Z-score training as an adjunctive method to assist individuals recovering from traumatic experiences. Reports of symptomatic reduction after LZT neurofeedback sessions point toward the potential benefits of further investigation into the clinical utility of a training approach that includes both connectivity measures and external referential parameters in the informational paradigm presented to the brain during feedback.

The first two cases used four channels of EEG to inform the training paradigm and the brain, and required 40 and 30 sessions respectively, to make the observed changes in brain activity seen in the before and after qEEG maps in Figures 1 and 2. The last three cases used nine channels of EEG and clients were beginning to notice results within the first two sessions, in contrast to the first few cases, in which clients reported beginning to notice results between 12 and 20 sessions. Preliminary case studies using the full 19 channels simultaneously to inform the feedback paradigm have also yielded rapid changes in symptomatic presentation within a few sessions.

A limitation of this study is potential reproducibility using Z-score training approaches created by other software developers. The Percent-Z OK protocol used in these cases utilizes an algorithm that regulates feedback by allowing the brain to meet a percentage of the required criterion by interacting organically with the variables being tracked and designing an individualized protocol that is updated in real time using continuous proportional feedback. This combination of features is currently not available in other software packages offering Z-score training options, and additional studies will be needed to make a valid comparison of results between the differing approaches.

As with any powerful intervention, clinicians using LZT neurofeedback need to exercise caution when working with a population that suffers from post-traumatic stress disorder. Individuals under the care of a neurofeedback provider will also potentially need additional emotional and cognitive support to help process experiences and memories as neural integration takes place. Clients described in the present paper received appropriate amounts of cognitive behavioral therapy embedded in the neurofeedback sessions provided by this clinician. If not trained in such strategies, it is the responsibility of the neurofeedback provider to assist the individuals receiving neurofeedback in finding resources that can offer the necessary support.

It is an incredible time to be working in neurofeedback, with many brilliant and talented individuals making contributions to the field that are changing the face of healthcare forever. Using a solid scientific approach, supported by data and quality standards of care, neurofeedback providers will continue to assist many individuals suffering from not only PTSD, but also a variety of other conditions that can be positively affected with improved neural connectivity, systemic relaxation and self-regulation.

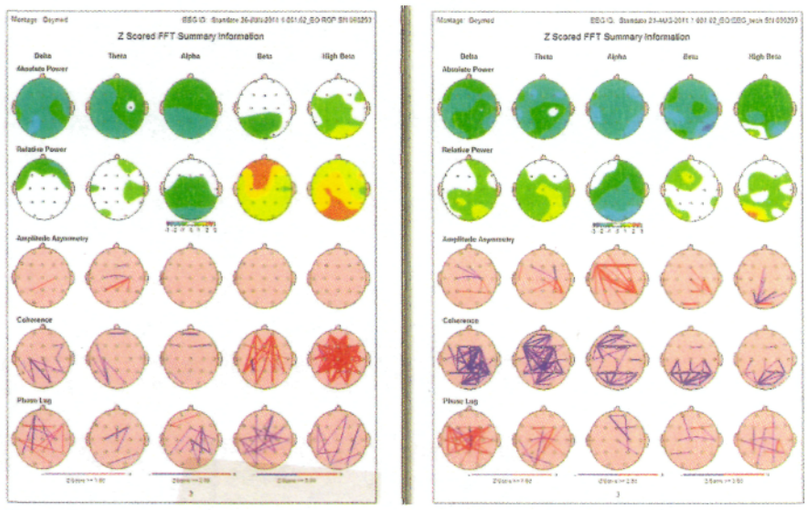

Figure 5

References

Bremner, J.D., et al. (1995). MRI-based measurements of hippocampal volume in combat-related post-traumatic stress disorder. American Journal of Psychiatry, 152, 973-978.

Collura, T. F. Guan, J., Tarrant, Bailey, J., & Srarr, F. (2010) EEG biofeedback case studies using live Z-score training and a normative database. Journal of Neurotherapy, 14(1), 22-46.

Collura, T. F. (2009) Neuronal dynamics in relation to normative electroencephalography assessment and training. Biofeedback, 36, 134-139.

Critchley HD (December 2005). "Neural mechanisms of autonomic, affective, and cognitive integration". J Comp Neurol. 493 (1): 154–66.

Davidson, PR; Parker, KC (2001). "Eye movement desensitization and reprocessing (EMDR): a meta-analysis" .Journal of consulting and clinical psychology 69 (2): 305–16.

Gilbertson, M.W., Shenton, M.E., Ciszewski, A., Kasai, K., Lasko, N.B., Orr, S.P., & Pitman, R.K. (2002). Smaller hippcampal volume predicts pathologic vulnerability to psychological trauma. Nature Neuroscience, 5, 1242-1247.

Kamiya, J. & Noles, D. (1970). The control of electroencephalographic alpha rhythms through auditory feedback and associated mental activity. Psychophysiology, 6, 76.

Kolassa, I.T., & Elbert, T. (2007). Structural and functional neuroplasticity in relation to traumatic stress. Current Directions in Psychological Science, 16, 321-325.

Lane RD, Reiman EM, Axelrod B, Yun LS, Holmes A, Schwartz GE (July 1998). "Neural correlates of levels of emotional awareness. Evidence of an interaction between emotion and attention in the anterior cingulate cortex". J Cogn Neurosci 10 (4): 525–35.

Levin, P., Lazrove, S. & van der Kolk, B. (1999). What psychological testing and neuroimaging tell us about the treatment of posttraumatic stress disorder by eye movement and desensitization and reprocessing. Journal of Anxiety Disorders, 13, 159-172.

Peniston, E. G., & Kulkosky, P. J. (1991). Alpha-theta brainwave neuro-feedback therapy for Vietnam veterans with combat-related post-traumatic stress disorder. Medical Psychotherapy, 4, 47-60.

Raymond, J., Varney, C., Parkinson, L.A., & Gruzelier, J.H. (2005) The effects of alpha/theta neurofeedback on personality and mood. Brain Research and Cognitive Brain Research, 23(2-3), 287-292.

Stein, M. B., & McAllister, T. W. (2009). Exploring the convergence of posttraumatic stress disorder and mild traumatic brain injury. Am J Psychiatry, 166(7), 768-776.

Thatcher, R.W. EEG database guided neurotherapy (1999). In: J.R. Evans and A. Abarbanel Editors, Introduction to Quantitative EEG and Neurofeedback, Academic Press, San Diego.