

Z-Score LORETA Neurofeedback as a Potential Therapy in Depression and Anxiety

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Major depressive disorder (MDD) is a common mental illness affecting approximately 2.5% of the general population. MDD is one of the leading causes of disability; it is projected to have the second highest burden of disease (measured in disability-adjusted life years) by 2020 (WHO). MDD has negative social consequences in terms of reduced employment and psychosocial impairment (Anderson et al. 2011). The pathophysiology of depression involves both external social stressors and internal genetic vulnerability.

Anxiety disorders are among the most common of all mental disorders (Kessler et al. 2005). The diagnostic and statistical manual of mental disorders (DSM-IV-TR)[2] includes generalized anxiety disorder (GAD; a chronic form of anxiety characterized by excessive, uncontrollable worry), panic disorder (PD; with recurrent, unexpected paroxysms of anxiety, somatic and autonomic symptoms and fear), phobic disorders [e.g., specific phobias, agoraphobia, social phobia (SP)], post-traumatic stress disorder (PTSD; characterized by unwanted, intrusive remembrances—as daytime thoughts and night-time dreams and nightmares—and avoidance of activities and other cues associated with prior life-threatening trauma) and obsessive-compulsive disorder (OCD; with recurrent obsessions and compulsions in this category).

In addition to psychotherapy and pharmacotherapy, other noninvasive modalities including neurofeedback

(NFB), repetitive transcranial Magnetic Stimulation (rTMS) and transcranial Direct Current Stimulation (tDCS) have been found effective in the treatment of these conditions (Alonzo et al. 2013, Stevens, 2014). TMS has also been approved by the FDA for the treatment of medically resistant depression (Stevens, 2014). In addition to noninvasive modalities of the treatment of depression and anxiety, other invasive techniques were introduced as potential therapy including Vagus Nerve Stimulation (VNS) and Deep Brain Stimulation (DBS). DBS, especially with Subcallosal Cingulate (Brodmann's area 25), has been reported to be beneficial in depression cases resistant to conventional medical therapy (Riva-Posse et al. 2013 and Schlaepfer et al. 2013). Unfortunately, any invasive procedure carries a risk of potential complications and side effects including bleeding, infection and misplacement of an active electrode (Williams and Okun 2013). NFB (in contrast to the above invasive methods) is not associated with any major side effects or intrusive methodology and is relatively inexpensive. It has also been underestimated in the clinical arena as a potential therapeutic modality. Standard one- or two-electrode NFB has been reported as beneficial in relieving depression symptoms in several investigations, including a randomized controlled study (Choi et al. 2011).

In z-score NFB, a real-time comparison to an age-matched population of healthy subjects is used for data acquisition, simplifying protocol genera-

tion, and allowing clinicians to target modules and hubs that indicate dysregulation and instability in networks related to symptoms (Thatcher, 2013). Z-score NFB increases specificity in operant conditioning, providing a guide that links extreme z-score outliers to symptoms, and then reinforcing z-score shifts toward states of greater homeostasis and stability. The goal is increased efficiency of information processing in brain networks related to the patient's symptoms (Thatcher, 2013).

A recently introduced method called Low Resolution Electromagnetic Tomography (LORETA) z-score NFB is capable of targeting specific dysregulated anatomical structures, many of which are in deeper cortical locations (Koberda et al., 2013; Thatcher, 2013). For example, the Insula and Anterior Cingulate has been identified as potential NFB target sites to improve pain control in patients who display electrical dysregulation of these areas (Koberda et al. 2013).

Our neurology center conducted z-score LORETA NFB therapy of 31 patients with depression and associated anxiety. In addition to depression and anxiety, these patients frequently reported other coexisting problems like cognitive dysfunction, OCD, and/or chronic pain. Most patients were found to have qEEG abnormalities including alpha power increase, asymmetry, and/or LORETA electrical dysregulation in frontal areas (Figure 1).

Figure 2 shows LORETA images before (top image) and after (lower image)

completion of 15 sessions of z-score LORETA NFB of a 15-year-old female who suffered from extreme anxiety before and during horse riding competitions. Her symptoms included anxiety with palpitations, frequently associated with nausea and vomiting. Marked dysregulation of the Anterior Cingulate Subcallosal region-Brodmann's Area (BA) 25 was identified during the pre-NFB LORETA testing (Fig 2) manifesting as increased beta activity. Following 15 NFB sessions, this electrical dysregulation was corrected; as seen on the lower portion of the figure 2.

Detailed analysis of our patients diagnosed with depression and/or anxiety showed that out of 31 included in the study, 24 (77%) were found to have both subjective and objective (improvement of qEEG abnormalities) improvement of the symptoms within 10 sessions of LORETA z-score NFB. I would like to focus on just one of our representative patients who successfully completed z-score LORETA NFB with marked improvement in both depression and cognitive function. Cognitive function (which is often impaired in patients with depression) usually improves after NFB therapy.

The following report is a 40-year-old female who was previously treated for major depression and did not respond to pharmacological treatment. Prior to neurofeedback, she was treated with Electro-Convulsive Therapy (ECT), which was not successful in relieving her depression. Instead, the individual sustained major memory impairment and visual-spatial difficulties. Since she was not responding to conventional therapy, her psychiatrist referred her to my practice for NFB therapy. The patient's cognitive and depressive dysfunction caused inability to continue her employment as a pharmaceutical representative. Initial LORETA showed several areas of electri-

Frequent depression and anxiety QEEG abnormalities:

Frontal alpha asymmetry (increase) for depression.

- Frontal, central or occipital increase in beta power for anxiety.
- LORETA-Anterior Cingulate (BA-24), Posterior Cingulate, Subcallosal Cingulate (BA-25) Orbitofrontal cortex (BA 11), Frontal-prefrontal areas

Figure 1: Summary of frequently identified qEEG/LORETA abnormalities in patients suffering from depression and anxiety.

15 F with anxiety-LORETA-before and after 15 NFB sessions: BA 25

The figure displays two rows of three brain scans each, showing axial, sagittal, and coronal views. The top row, labeled 'LORETA-BEY', shows a red area in the Subcallosal Cingulate (BA-25) in the sagittal view. The bottom row, labeled 'LORETA-REY', shows the same views after 15 NFB sessions, with the red area resolved.

Figure 2: 15-year-old female suffering from anxiety. Upper part of the picture shows area of electrical dysregulation (area in red) in the Subcallosal Cingulate (BA-25) before NFB therapy. Lower part of the picture shows resolution of previously identified dysregulation after 15 sessions of NFB.

cal dysregulation including (Figure 3A) BA-5 (secondary sensorimotor cortex), BA-9 (prefrontal cortex), and temporal cortex (Figure 3B).

Her computerized cognitive test-

ing before NFB showed deficiency in memory, information processing speed and visual-spatial domains. After 10 sessions of z-score LORETA NFB, the patient reported major improvement

in her mood as well as mild memory improvement. Repeated computerized cognitive testing revealed marked improvement of previously deficient cognitive domains (Fig 4). Memory score increased from 85.4 to 102.8, information processing speed rose from 90.8 to 97.7 and visual-spatial domain went up from 80.8 to 100.7. Motor skills also demonstrated a one standard deviation gain in efficiency. In addition, post NFB LORETA showed an improvement of previously identified electrical dysregulation. After successful NFB therapy, the patient also was able to come back to gainful employment in the medical field (after few years of being unemployed).

This paper illustrates high effectiveness of z-score LORETA NFB therapy in complex neuropsychiatric patients, where an improvement of depression/anxiety and other associated cognitive

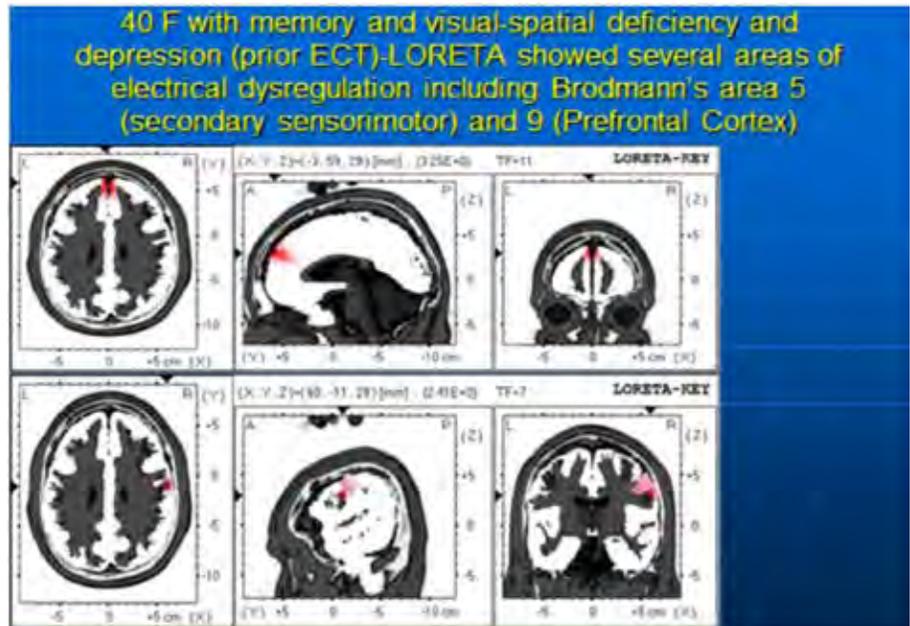


Figure 3A: Pre-NFB LORETA of 40-year-old female diagnosed with depression associated with cognitive dysfunction. Areas of cortical dysregulation are shown in red. After 10 sessions of NFB marked improvement of previously identified LORETA abnormalities was noted.

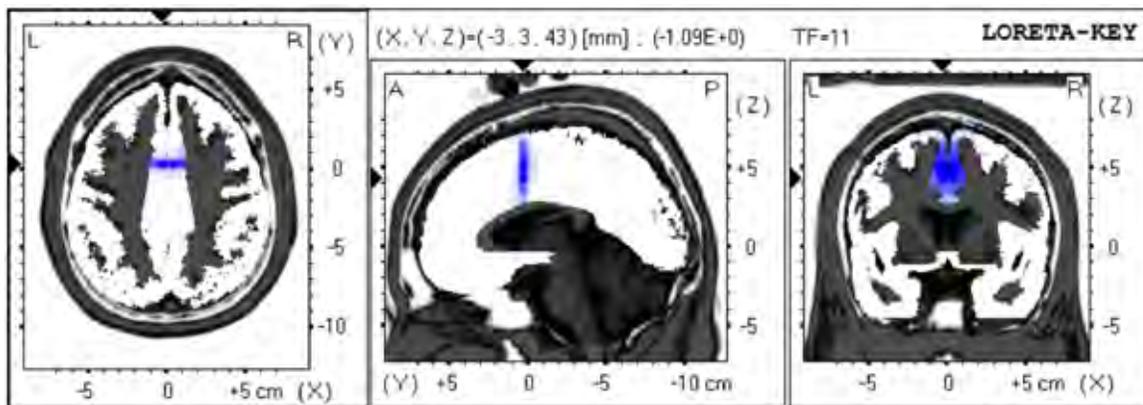
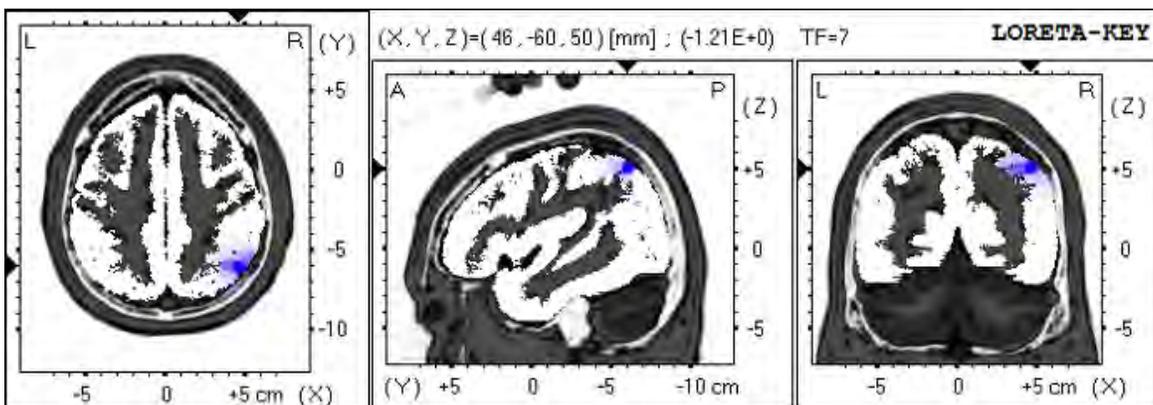


Figure 3B: 40-year-old female LORETA after NFB shows resolution of previously electrically dysregulated BA-5 and BA-9.



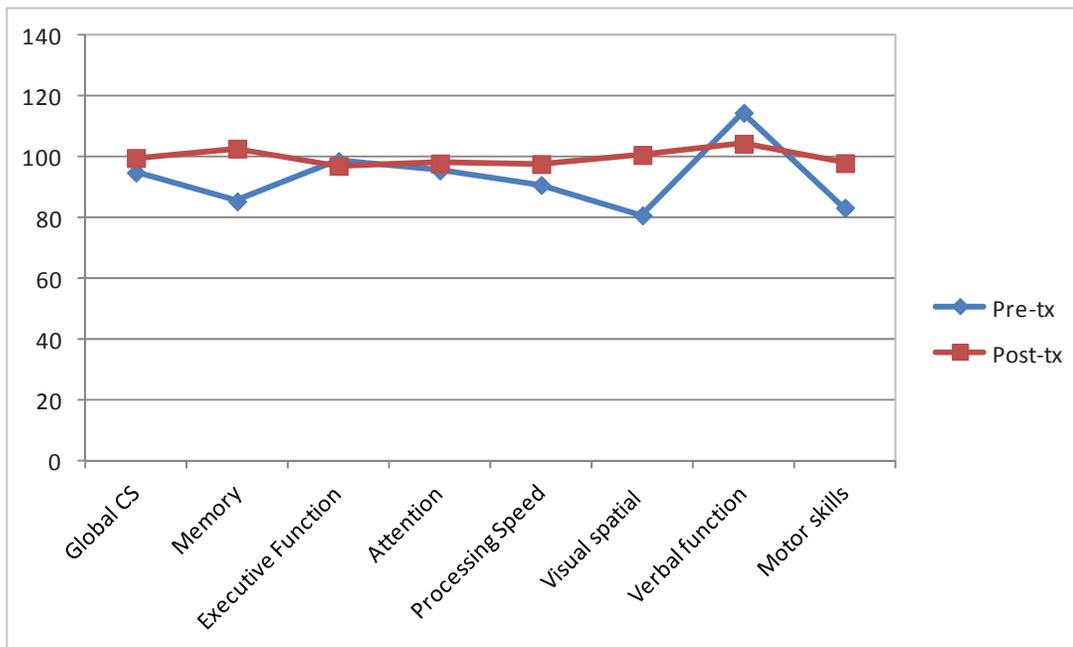


Figure 4: The blue line shows scores from computerized cognitive testing before NFB. The red line shows scores after 10 sessions of NFB. Computerized cognitive testing (Neurotrax Corp, Bellaire TX) shows data based on comparison to age and education matched controls. Expected score is 100 with one standard deviation-15.

domains can be achieved in most of the patients within just 10 treatment sessions. We also recommend implementation of qEEG/LORETA brain mapping testing in all patients suffering from depression, as well as anxiety. Since qEEG/LORETA NFB is a non-invasive technique and relatively inexpensive, it should be considered as the therapy of choice before other invasive modalities are contemplated.

About the author

Dr. J. Lucas Koberda is a board certified neurologist and an internationally trained physician who completed his residency in Neurology at the Oregon Health Sciences University in Portland, Oregon. Dr. Koberda is a director of the Tallahassee NeuroBalance Center (www.TallahasseeNeuroBalanceCenter.com) and also affiliated with The Florida State University College of Medicine. His main interest is in neuro-psychiatry and cognitive enhancement. He uses the newest technology of qEEG and LORETA Z-score Neurofeedback to successfully diagnose and treat many

medical conditions including seizures, headaches, fibromyalgia chronic pain, anxiety, depression, and prior stroke. Dr. Koberda has also effectively introduced neurofeedback protocols for a cognitive enhancement which may help students and professionals to improve their memory, concentration, verbal function, or information processing speed.

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