



Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

Cognitive Enhancement Using 19-Electrode Z-Score Neurofeedback

J. Lucas Koberda ^a, Andrew Moses ^a, Laura Koberda ^a & Paula Koberda ^a

^aTallahassee NeuroBalance Center, Tallahassee, Florida, USA

Published online: 21 Aug 2012.

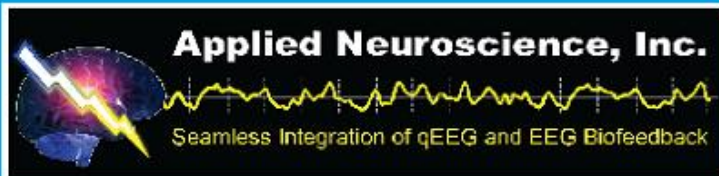
To cite this article: J. Lucas Koberda, Andrew Moses, Laura Koberda & Paula Koberda (2012) Cognitive Enhancement Using 19-Electrode Z-Score Neurofeedback, *Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience*, 16:3, 224-230, DOI: [10.1080/10874208.2012.705769](https://doi.org/10.1080/10874208.2012.705769)

To link to this article: <http://dx.doi.org/10.1080/10874208.2012.705769>

PLEASE SCROLL DOWN FOR ARTICLE

© International Society for Neurofeedback and Research (ISNR), all rights reserved. This article (the "Article") may be accessed online from ISNR at no charge. The Article may be viewed online, stored in electronic or physical form, or archived for research, teaching, and private study purposes. The Article may be archived in public libraries or university libraries at the direction of said public library or university library. Any other reproduction of the Article for redistribution, sale, resale, loan, sublicensing, systematic supply, or other distribution, including both physical and electronic reproduction for such purposes, is expressly forbidden. Preparing or reproducing derivative works of this article is expressly forbidden. ISNR makes no representation or warranty as to the accuracy or completeness of any content in the Article. From 1995 to 2013 the *Journal of Neurotherapy* was the official publication of ISNR (www.isnr.org); on April 27, 2016 ISNR acquired the journal from Taylor & Francis Group, LLC. In 2014, ISNR established its official open-access journal *NeuroRegulation* (ISSN: 2373-0587; www.neuroregulation.org).

THIS OPEN-ACCESS CONTENT MADE POSSIBLE BY THESE GENEROUS SPONSORS



COGNITIVE ENHANCEMENT USING 19-ELECTRODE Z-SCORE NEUROFEEDBACK

J. Lucas Koberda, Andrew Moses, Laura Koberda, Paula Koberda

Tallahassee NeuroBalance Center, Tallahassee, Florida, USA

A 23-year-old man presented for a neurological evaluation due to cognitive problems restricting him from college education. He graduated successfully from high school but had problems in college, which caused his subsequent withdrawal. He was interested in trying neurofeedback (NFB) for possible cognitive enhancement. His initial computerized neurocognitive testing showed global cognitive standard score (GCS) of 93.1. The information processing speed standard score was 64.5 and was the lowest of scored domains. Quantitative electroencephalography revealed right frontal and temporal increase in delta power and left frontal and temporal beta power excess. Fifteen sessions of 19-electrode Z-score NFB lead to marked improvement of the patient's subjective cognitive perception as well as GCS on computerized neurocognitive testing. His post-NFB GCS was 104.1 and information-processing speed reached 85.2. Also a reduction of the right frontal and temporal delta power expression was achieved, as well as improvement in the left fronto-temporal beta power. This case report illustrates marked increase in cognitive performance achieved by Z-score 19-electrodes NFB training and justifies the initiation of larger studies to confirm these promising findings.

INTRODUCTION

Neurofeedback (NFB) has grown increasingly popular since early 1960s, when it was initially reported as an effective treatment in epilepsy and attention deficit hyperactive disorder (Lubar & Lubar, 1984; Serman & Egner, 2006; Tan et al., 2009). NFB has become attractive to the public due to limitations in the effectiveness of medication treatment and its associated side effects. Some cognitive enhancement has been reported in a few previous reports utilizing NFB training usually at one electrode site (Angelakis et al., 2007; Gruzelier, 2009; Vernon, 2005;

Zoefel, Huster, & Herrmann, 2011). At this point the amount of time and the number of sessions necessary for major improvements in cognition to be achieved is unclear.

The recent introduction of 19-electrode Z-score and low resolution electromagnetic tomography analysis (LORETA) NFB equipment has generated some hopes for an improvement of NFB efficiency (Cannon, Congedo, Lubar, & Hutchens, 2009; Thatcher, 2010). The purpose of this case study is provide detailed information about a patient that showed improved cognitive functioning in less than 20 sessions using 19-channel Z-score NFB.

Received 3 January 2012; accepted 1 June 2012.

Address correspondence to J. Lucas Koberda, MD, PhD, PO Box 13554, Tallahassee, FL 32317, USA. E-mail: jlkoberda@yahoo.com

METHODS

This case report is based on the results of the first patient who underwent a cognitive enhancing training in our clinic using both 19-channel surface Z-score NFB and 19-channel LORETA Z-score NFB using a symptom checklist and qEEG software (Thatcher, 2010).

The symptoms of concentration, executive function, anxiety, multitask performance, compulsive behavior, dyscalculia, multitasking problems, sequential planning problems, and obsessive thoughts about self were chosen from the "symptom check list" (Thatcher, 2010) to identify training targets based on the patient's symptoms and neurocognitive profile.

The patient was a 23-year-old male who presented for an initial appointment with his parents and complained of cognitive problems affecting his academic performance. His parents were both high achievers (father a college professor, and mother a midwife). Initial testing included normal MRI of the brain and blood work. A commercially available computerized neurocognitive testing was used for the initial and post-NFB assessment (MindStreams, NeuroTrax, Bellaire, TX). NeuroTrax Corporation neurocognitive testing is a computerized neuropsychological assessment where a patient is compared to aged and education-matched healthy controls, where the mean is 100 with a standard deviation of 15. QEEG analysis was completed using commercially available NeuroGuide software (Applied Neuroscience, St. Petersburg, FL) and previously recorded 19-channels digital EEG.

Approximately 1 to 3 min of artifact-free, eyes-closed EEG segments were selected and subjected to further QEEG analysis.

NFB1 (surface Neurofeedback) and NFB2 (LORETA Neurofeedback) using the NeuroGuide system was given in approximately 25-min sessions twice a week using auditory feedback.

RESULTS

Initial computerized neurocognitive testing completed in May 2011 showed below-average results, with global cognitive score (GCS) of 93.1. Other below-average scores were found on subtests for memory (88.7), attention (93.7), information-processing speed (64.5), and visuo-spatial orientation (89.3; see Figure 1). The QEEG showed a right frontal and temporal excess in delta power as well as an excess in left frontal and temporal beta power (see Figure 2). After completion of 15 sessions of Z-score NFB (LORETA and 19-channel surface), another computerized cognitive testing was completed in December 2011 and showed a GCS of 104.1, with marked improvement in memory (104.9), attention (104), information-processing speed (85.2), visuo-spatial function (106.4), and other domains (see Figure 3). Also, a marked reduction occurred in the right fronto-temporal excess in delta power, and the left temporal beta power excess was noted on repeated QEEG testing (Figure 4). The patient also reported an improvement in his subjective perception of cognitive function, including memory, clearness of thoughts, and executive function, as well as a reduction of anxiety.

DISCUSSION

The presented case report illustrates marked improvement in cognitive functions after a relatively short course of 19-electrodes Z-score LORETA and surface NFB treatment (15 sessions). The largest increase was in the information-processing speed, where more than 1 *SD* (20 points) improvement after NFB therapy was noted. When compared to traditional 1-electrode NFB therapy, it seems that more rapid improvement may have occurred using Z-score 19-electrode NFB training. Larger studies will be needed to explore full potential of Z-score 19-electrode NFB for cognitive enhancement.

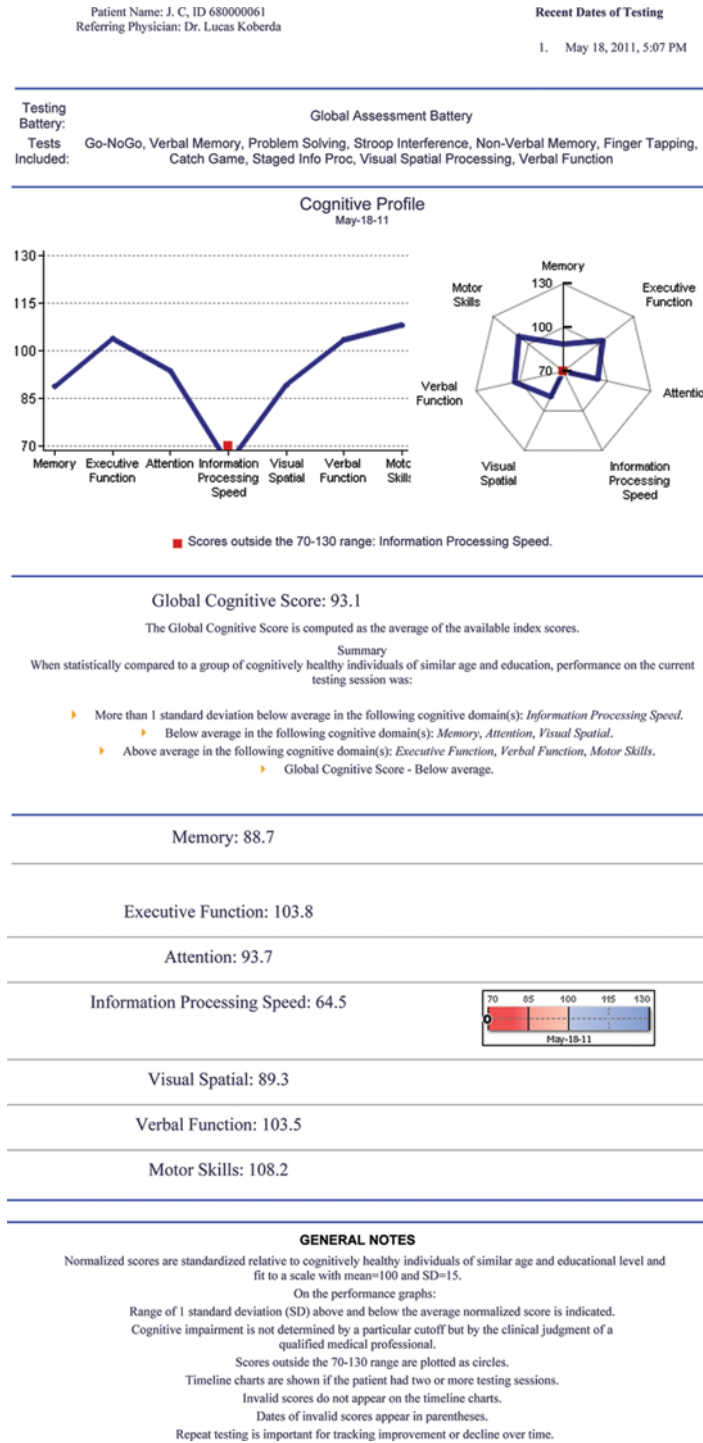


FIGURE 1. Computerized neurocognitive testing results before neurofeedback initiation. (Color figure available online.)

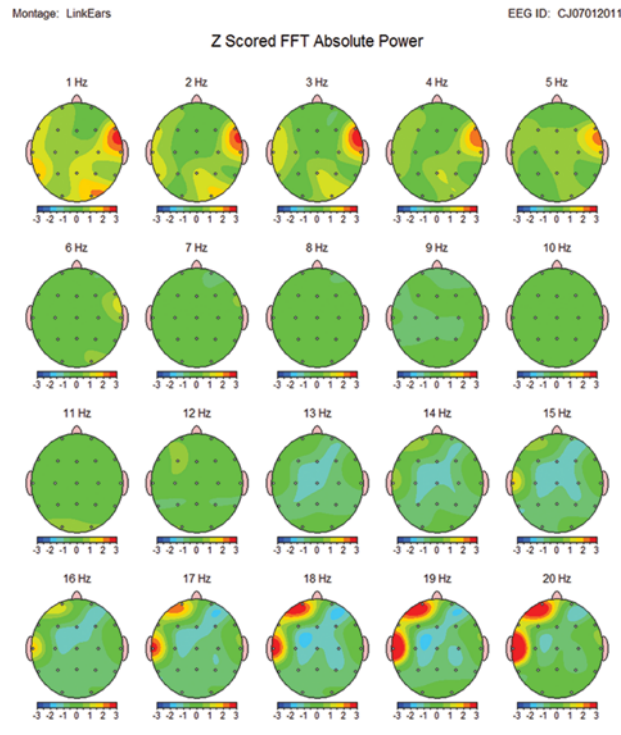
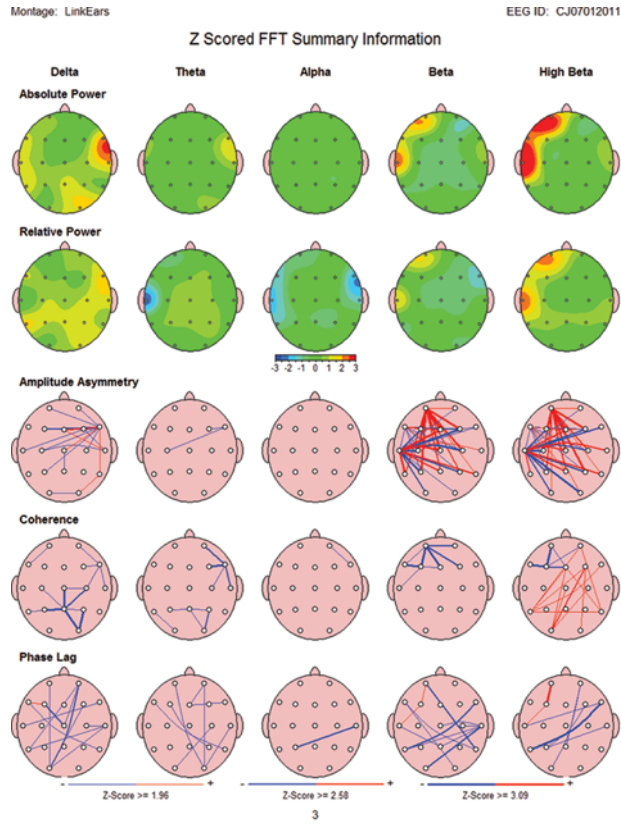


FIGURE 2. Pretreatment quantitative electroencephalography maps showing evidence of increased right frontal and temporal delta power as well as left frontal and temporal increased beta power. (Color figure available online.)

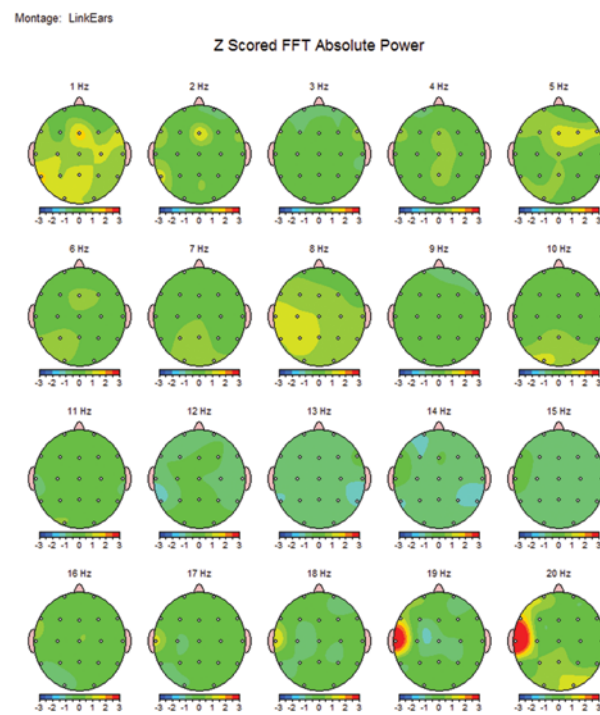
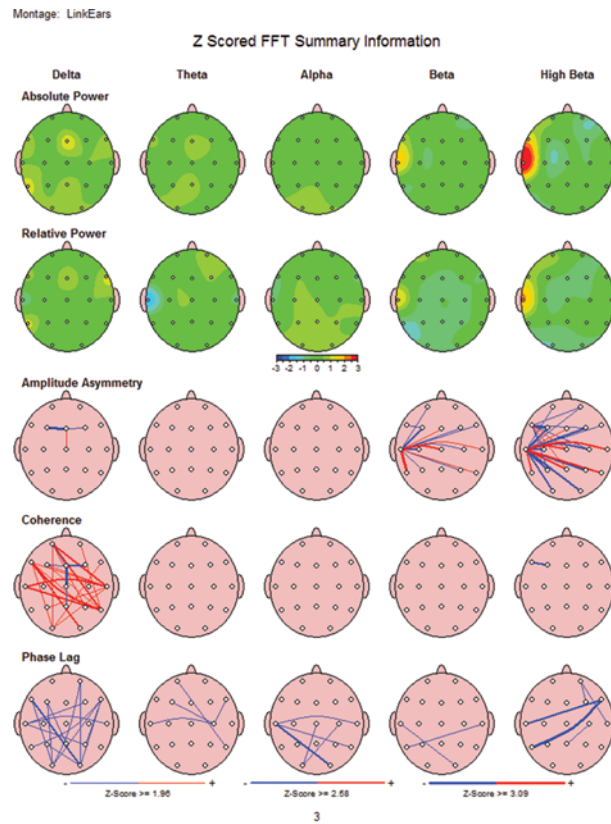


FIGURE 3. Postneurofeedback quantitative electroencephalography maps showing an improvement in right fronto-temporal delta power as well as left fronto-temporal beta power. (Color figure available online.)

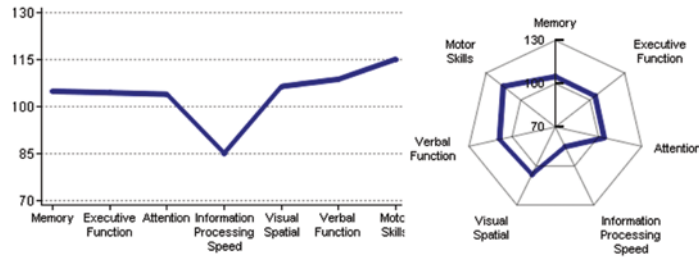
Patient Name: J.C. JD 680000130
 Referring Physician: Dr. Lucas Koberda

Recent Dates of Testing

1. December 8, 2011, 5:18 PM

Testing Battery: Global Assessment Battery
 Tests Included: Go-NoGo, Verbal Memory, Problem Solving, Stroop Interference, Non-Verbal Memory, Finger Tapping, Catch Game, Staged Info Proc, Visual Spatial Processing, Verbal Function

Cognitive Profile
 Dec-8-11



Global Cognitive Score: 104.1

The Global Cognitive Score is computed as the average of the available index scores.

Summary

When statistically compared to a group of cognitively healthy individuals of similar age and education, performance on the current testing session was:

- ▶ More than 1 standard deviation below average in the following cognitive domain(s): *None.*
- ▶ Below average in the following cognitive domain(s): *Information Processing Speed.*
- ▶ Above average in the following cognitive domain(s): *Memory, Executive Function, Attention, Visual Spatial, Verbal Function, Motor Skills.*
- ▶ Global Cognitive Score - Above average.

Memory: 104.9

Executive Function: 104.4

Attention: 104

Information Processing Speed: 85.2

Visual Spatial: 106.4

Verbal Function: 108.7

Motor Skills: 115.1

GENERAL NOTES

Normalized scores are standardized relative to cognitively healthy individuals of similar age and educational level and fit to a scale with mean=100 and SD=15.

On the performance graphs:

Range of 1 standard deviation (SD) above and below the average normalized score is indicated.

Cognitive impairment is not determined by a particular cutoff but by the clinical judgment of a qualified medical professional.

Scores outside the 70-130 range are plotted as circles.

Timeline charts are shown if the patient had two or more testing sessions.

Invalid scores do not appear on the timeline charts.

Dates of invalid scores appear in parentheses.

Repeat testing is important for tracking improvement or decline over time.

FIGURE 4. Postneurofeedback computerized neurocognitive testing shows marked improvement in cognitive scores. (Color figure available online.)

REFERENCES

- Angelakis, E., Stathopoulou, S., Frymiare, J. L., Green, D. L., Lubar, J. F., & Kounios, J. (2007). EEG neurofeedback: A brief overview and an example of peak alpha frequency training for cognitive enhancement in the elderly. *Clinical Neuropsychology, 21*, 110–129.
- Cannon, R., Congedo, M., Lubar, J., & Hutchens, T. (2009). Differentiating a network of executive attention: LORETA neurofeedback in anterior cingulate and dorsolateral prefrontal cortices. *International Journal of Neuroscience, 119*, 404–441.
- Gruzelier, J. (2009). A theory of alpha/theta neurofeedback, creative performance enhancement, long distance functional connectivity and psychological integration. *Cognitive Processing, 10*(Suppl. 1), S101–S109.
- Lubar, J. O., & Lubar, J. F. (1984). Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting. *Biofeedback and Self Regulation, 9*, 1–23.
- Serman, M. B., & Egner, T. (2006). Foundation and practice of neurofeedback for the treatment of epilepsy. *Applied Psychophysiology and Biofeedback, 31*, 21–35.
- Tan, G., Thornby, J., Hammond, D. C., Strehl, U., Canady, B., Arnemann, K., & Kaiser, D.A. (2009). Meta-analysis of EEG biofeedback in treating epilepsy. *Clinical Electroencephalography and Neuroscience, 40*(3), 173–9.
- Thatcher, R. W. (2010, December). LORETA Z score biofeedback. *Neuroconnections, 9*–13.
- Vernon, D. J. (2005). Can neurofeedback training enhance performance? An evaluation of the evidence with implications for future research. *Applied Psychophysiology and Biofeedback, 30*, 347–364.
- Zoefel, B., Huster, R. J., & Herrmann, C. S. (2011). Neurofeedback training of the upper alpha frequency band in EEG improves cognitive performance. *Neuroimage, 54*, 1427–1431.