

# LORETA Z-score Neurofeedback as a Potential Application in Epilepsy

## ABSTRACT

Prior reports of Dr. Sterman and other authors have shown effectiveness of standard 1-electrode Neurofeedback (NFB) in the treatment of medication resistant epilepsy. The tremendous progress in computer technology and introduction of Low Resolution Electromagnetic Tomography Analysis (LORETA) NFB has generated hopes for application of this technique in epilepsy therapy. LORETA localization was already shown by our group to be the cost-effective tool in detection of potential seizure origin. 10 patients from our neurology practice were subjects of LORETA Z-score NFB therapy for the purpose of seizure reduction. The presented in detail cases include primary generalized epilepsy with spike and wave discharges resistant to medications, multifocal epilepsy with grossly abnormal EEG and medications resistance, generalized epilepsy with grossly unremarkable EEG and frequent seizures, Asperger's Syndrome with epilepsy, Low functioning autism with epilepsy, focal epilepsy after surgical tumor resection with medication resistant seizures, epilepsy/seizure of unclear origin.

In addition, one case of generalized epilepsy with medication discontinuation during the NFB and case of focal epilepsy with medication reduction is presented. Patients work up included MRI of the brain, EEG, QEEG as well as LORETA electrical imaging. LORETA Z-score NFB seems to be promising tool in medically resistant epilepsy cases. Larger studies are warranted to further explore the most effective protocols for seizure reduction.

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**16 F with epilepsy, memory deficiency and "psychological" problems- LORETA showed several areas of electrical dysregulation in the left temporal lobe BA-38 and right parietal lobe BA-40**

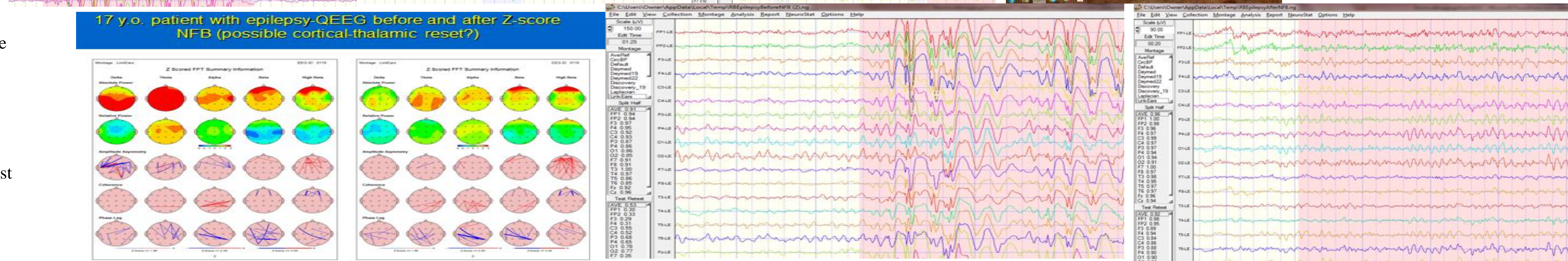
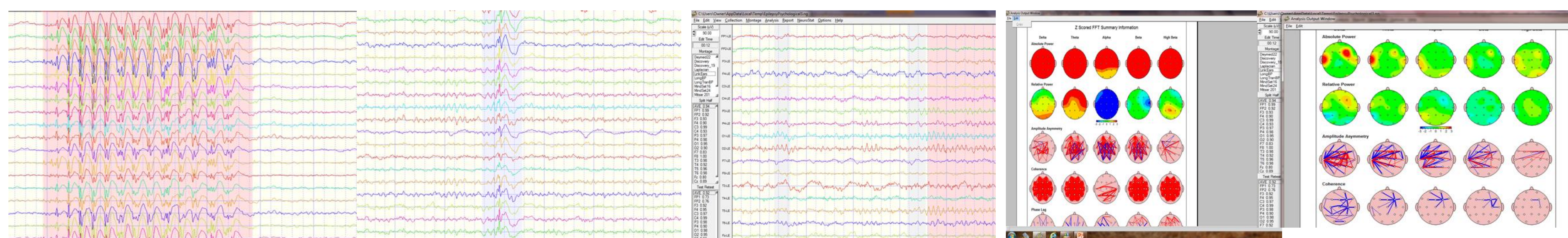


**Brodmann's Area 38:**

- Associated Functions
- Attribution of intentions/mental states to others (15079187, 1687157, 18122844, many articles)
- Self/other distinction (Left) (15299786, 16478667, 15786441)
- Moral judgments (1678876, 12169253)
- Attention
- Experiencing emotional states (12821792, 12814585, 16459394)
- Attentional orienting (10488835, 16088031, 10359073, many articles)
- Responses to threat/fearful stimulus (18307211, 17724669)
- Emotional attachment (18087352, 15257158)
- Attention
- Multimodal memory retrieval (17822649, 10694462, 10985287, many articles)
- Language
- Semantic processing (Left) (11905023, 11906222, 12121097, many articles)
- Speech comprehension (Left) (14754866, 7820563)
- Naming of items learned in early life (Left) (16987673)
- Word retrieval for specific entities (Left) (11169949)
- Lexico-semantic ambiguity processing (Left) (15884095)
- Narrative comprehension (Left) (10550887, 9579674)
- Auditory
- Selective attention to speech (Left) (15183402, 18053971)
- Response to tone stimulus (12028300)
- Response to acoustic auditory stimulation (12169258)
- Identification of familiar voices (Right) (11440737)
- Visual
- Code and structural judgments of familiar objects (15714895)

**BA-40**

- Language
- Attention to phonological relations (12457755)
- Semantic processing (more elaborate and complete) (14575838)
- Verbal creativity (15172131)
- Writing of single letters (16506011)
- Attention
- Retrieval of unpleasant experiences (18502045)
- Working memory (emotional/auditory related) (11352614)
- Conscious recollection of previously experienced events (8134341)
- Motor
- Executive control of behavior (18894118)
- Response to aversive stimuli (16128202)
- Visually guided grasping (15820644)
- Gesture imitation (15789494, 15305134)
- Visuomotor transformation/motor planning (15062860)
- Repetitive passive movements (10724112)
- Interferory sensory feedback-conflict detection (10094258)
- Somatosensory
- Compensatory spatial localization (18234508)
- Registration of tactile and proprioceptive information (17451973)
- Visual
- Responses to visual motion (7807222)



## Background and Materials and Methods

- Quantitative electroencephalography (QEEG) and LORETA has been underutilized in general neurology practice.
- Most neurologist are not familiar with QEEG therefore, QEEG has had very limited application in general neurology practice.
- Recent advances in computer technology have made QEEG testing relatively inexpensive and likely cost-effective (approximate USA insurance payment - \$ 300).
- QEEG is based on mathematical processing of 2-5 minutes of selected fragments of standard EEG recording which is able to condense the EEG data to one page color-coded summary. LORETA (Low Resolution Electromagnetic Tomography Analysis)-is a 3D mathematical transformation of QEEG data enabling relatively precise 7-10 mm localization of dysfunction (developed in the Key Institute-Zurich). This gives a neurologist unprecedented ability to look at summarized EEG information which was not previously possible with regular EEG.

This is the analysis of 10 epilepsy cases from our medical practice who underwent 19 electrode surface/LORETA Z-Score Neurofeedback for possible seizure reduction. A commercially available computerized cognitive testing (NeuroTrax Corp.) was used for cognitive evaluations and QEEG software (Neuroguide, Inc.) for EEG and LORETA analysis. TruScan (Deymed, Inc.) EEG amplifier, software and caps were used for EEG acquisition.

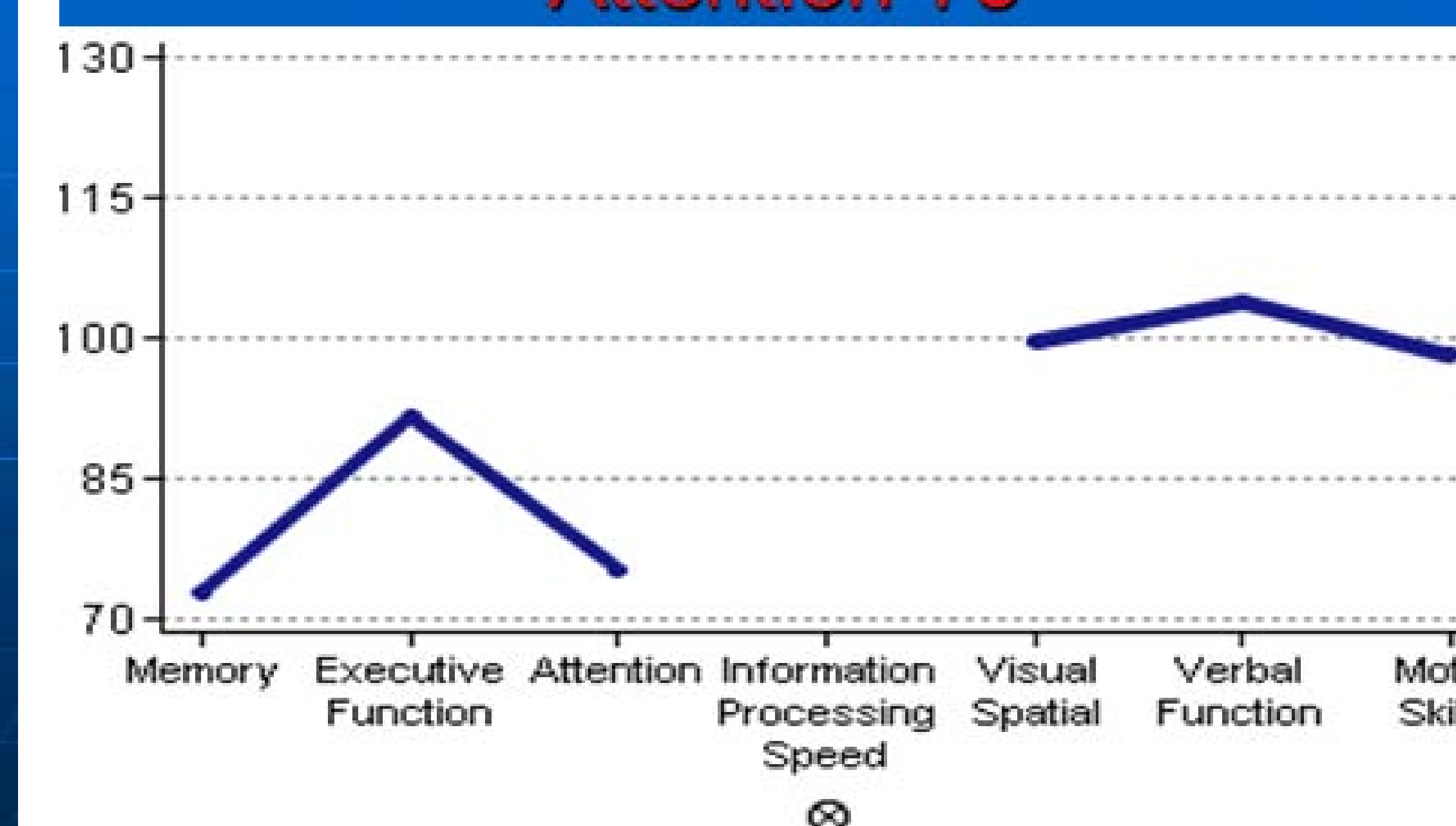
## • NFB of Epilepsy patients:

1. II-18 F with intractable epilepsy with secondary generalization.
2. BR-17 F with intractable primary idiopathic epilepsy with generalization.
3. CL-44 M with frontal epilepsy with generalization-S/P tumor resection.
4. SP-46 F with focal epilepsy and intermittent generalization and cognitive dysfunction-S/P tumor resection.
5. HL-16 F with intractable absence epilepsy with cognitive problems.
6. DW-59 M with intractable generalized epilepsy and cognitive problems (ETOH).
7. CJ-18 M with Autistic spectrum and intractable partial complex epilepsy
8. YR-23 M with Autism and frequent generalized seizures.
9. FJ-28 F pharmacist with frequent intractable generalized seizures.
10. PA-19 M with well controlled generalized epilepsy on valproate desiring discontinuation of medication.

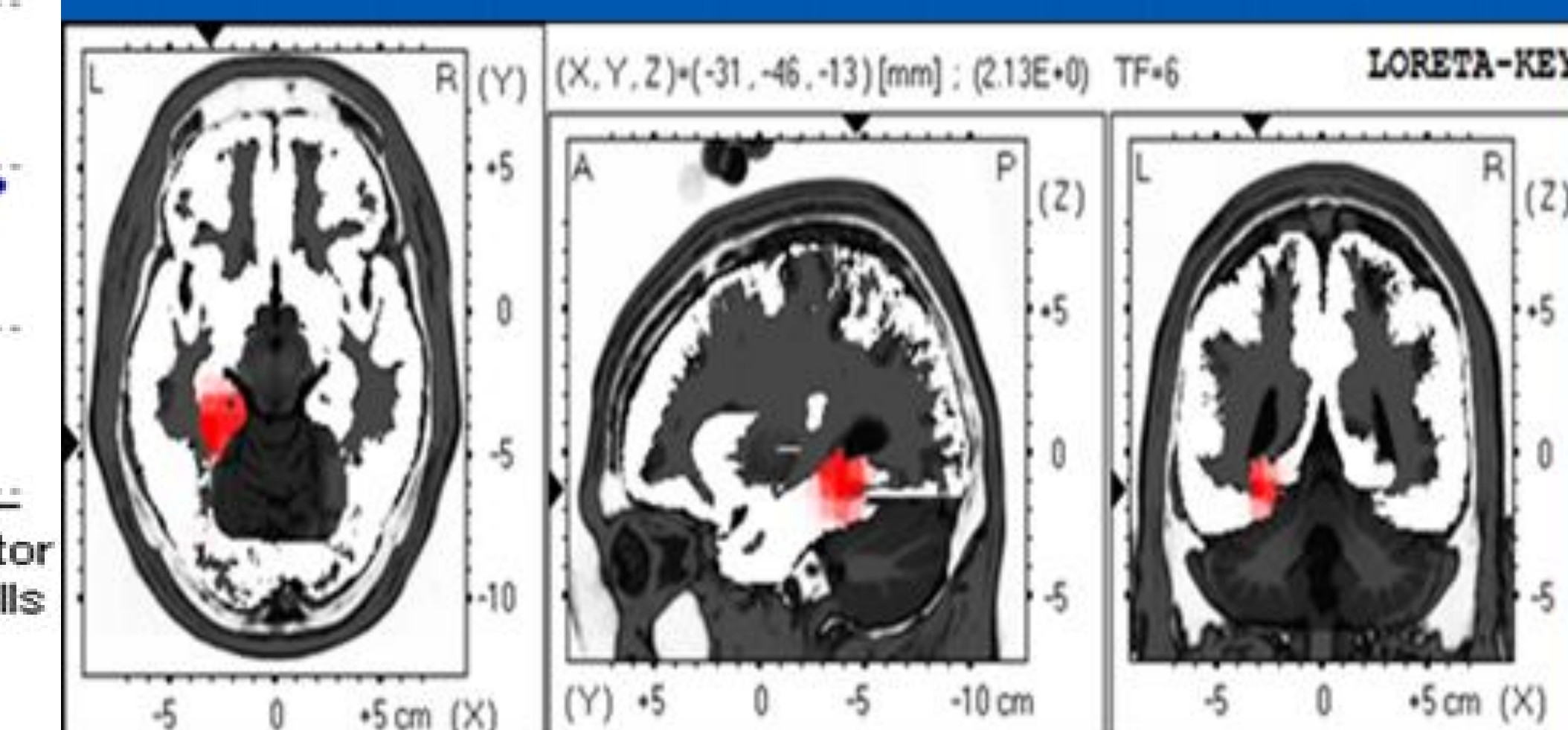
### 18 F-extensive UCLA work up

- Seizures started at age 11, sometimes preceded by eye blinking episodes.
- Current Meds: Keppra XR 1500 mg daily, Lamictal 150 mg daily.
- MRI-of the brain-nl,
- EEG-multiple sharps-P3,4 T5,6, O1,2
- Cognitive testing-low information processing speed and memory.

GCS-90.2; Memory-72.9; Attention-75



18 F from LA with medication resistant epilepsy and frequent bilateral parietal, temporal and occipital sharp discharges (evaluated in UCLA with no seizure control)



### Closing Remarks

To be Determined

- Optimal number of NFB Sessions or NFB type (surface/LORETA)? (until desired effect?)
- Optimal frequency of NFB sessions? (daily or twice a week?)
- Duration of the clinical response after NFB? - some epilepsy patients come back for "refresher" sessions many months after the completion of initial NFB therapy; others require much sooner follow up NFB therapy

### Summary

- Analysis of 10 patients from our clinic after 19-electrodes surface and/or LORETA Z-score NFB showed marked improvement of all patients including long lasting remissions or seizure frequency reduction regardless of type of epilepsy.
- Some patients reported marked improvement after only 2-5 sessions.
- Most of the patients reported also some Cognitive Enhancement related to NFB in addition to seizure reduction.
- Minimum Frequency of NFB-once per week, however more frequent NFB session seem to give more benefit.