

BCIA-Australia Clinical Interchange

for Neurofeedback Practitioners *presents*

LORETA NEUROFEEDBACK

Date 9/02/2019



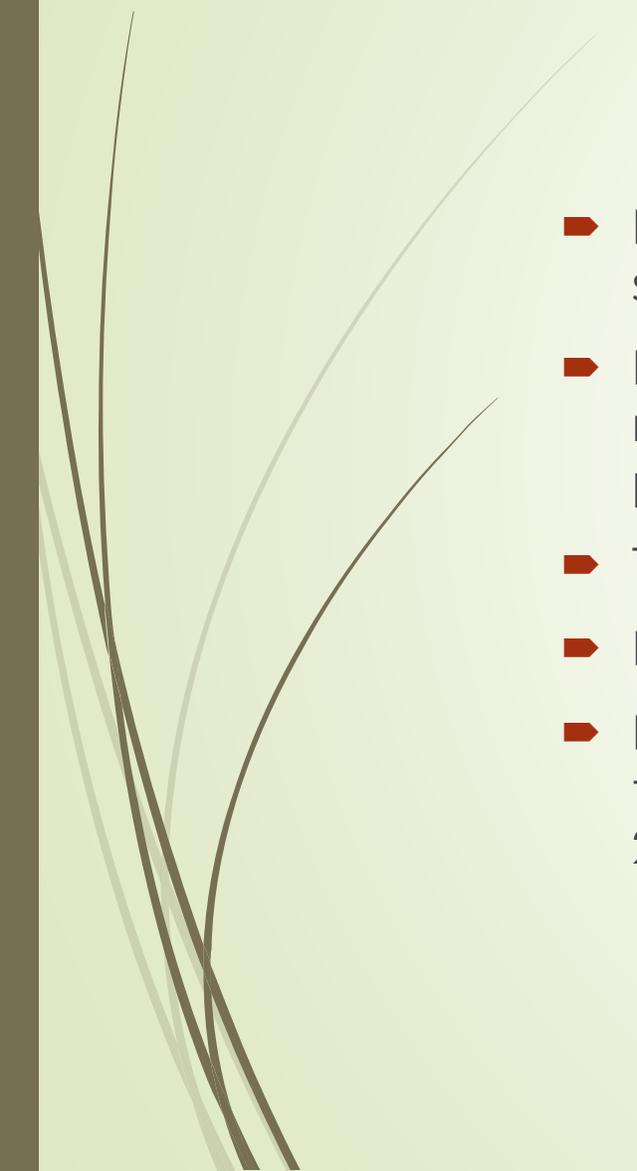
by Dr Natalie Challis

Kids Development Centre

Email: Natalie@kidsdc.com.au



What is LORETA?

- ▶ Low Resolution Brain Electromagnetic tomography (LORETA) a specific solution to an inverse problem.
 - ▶ Developed by Pascual-Marqui, Michel and Lehman in 1994 as a new method for localising electrical activity in the brain based on scalp potentials from multiple channel EEG recordings.
 - ▶ The EEG is a measure of electrical potential differences
 - ▶ LORETA estimates current densities at a deeper level
 - ▶ Differs from other quantitative EEG analysis as it is capable of determining the relative activity of regions in the brain using surface electrodes. (Sherlin, 2009, pg 84)
- 



The LORETA family

- ▶ **sLORETA**: standardized low resolution brain electromagnetic tomography (Pascual-Marqui, 2002). It has no localization bias in the presence of measurement and biological noise.
- ▶ **eLORETA**: exact low resolution brain electromagnetic tomography (Pascual-Marqui 2005). The first ever 3D, discrete, distributed, linear solution to the inverse problem of EEG/MEG with exact localization (zero localization error).
- ▶ The LORETA KEY software package has always been a free academic software package. sLORETA and eLORETA are for research purposes only.



LORETA and Frequency bands



- ▶ EEG frequency bands have been noted to have certain biological significance and can be associated to different states of brain functioning. There are still uncertainties about exactly where various frequencies are generated but there is strong knowledge about the activated areas within the brain that generate certain spectral activity along the scalp.
- ▶ Loreta analysis of limited frequency bands can be used to determine which regions of the brain are activated during different states or mental tasks, helping to determine if the brain is operating in an electrical optimal way or is dysregulated.
- ▶ The possibility of studying the voltage measured at the scalp surface and the 3D distribution of the generating electric neuronal activity is definitely a very powerful analysis tool.

Frequency Band originators

Frequency Band Name	Localisation	Description
Delta up to 4Hz	Two types: 1. Generated in the cortex 2. Originating from the thalamus	Associated with sleep
Theta from 4 to 8Hz	Controlled by the septohippocampal cholinergic system. Hippocampus	Rhythmic slow activity
Alpha 1 from 8 to 10Hz	Theorised to be primarily cortically driven. Argued there may be some corticothalamic involvement	“idle” rhythm
Alpha 2 From 10 to 12Hz	As above	Awake and alert
Low Beta 13 to 21Hz	Generated primarily by corticocortical systems	Activation of the cortex
High Beta 22 to 35Hz		Higher levels of concentration



LORETA NEUROFEEDBACK

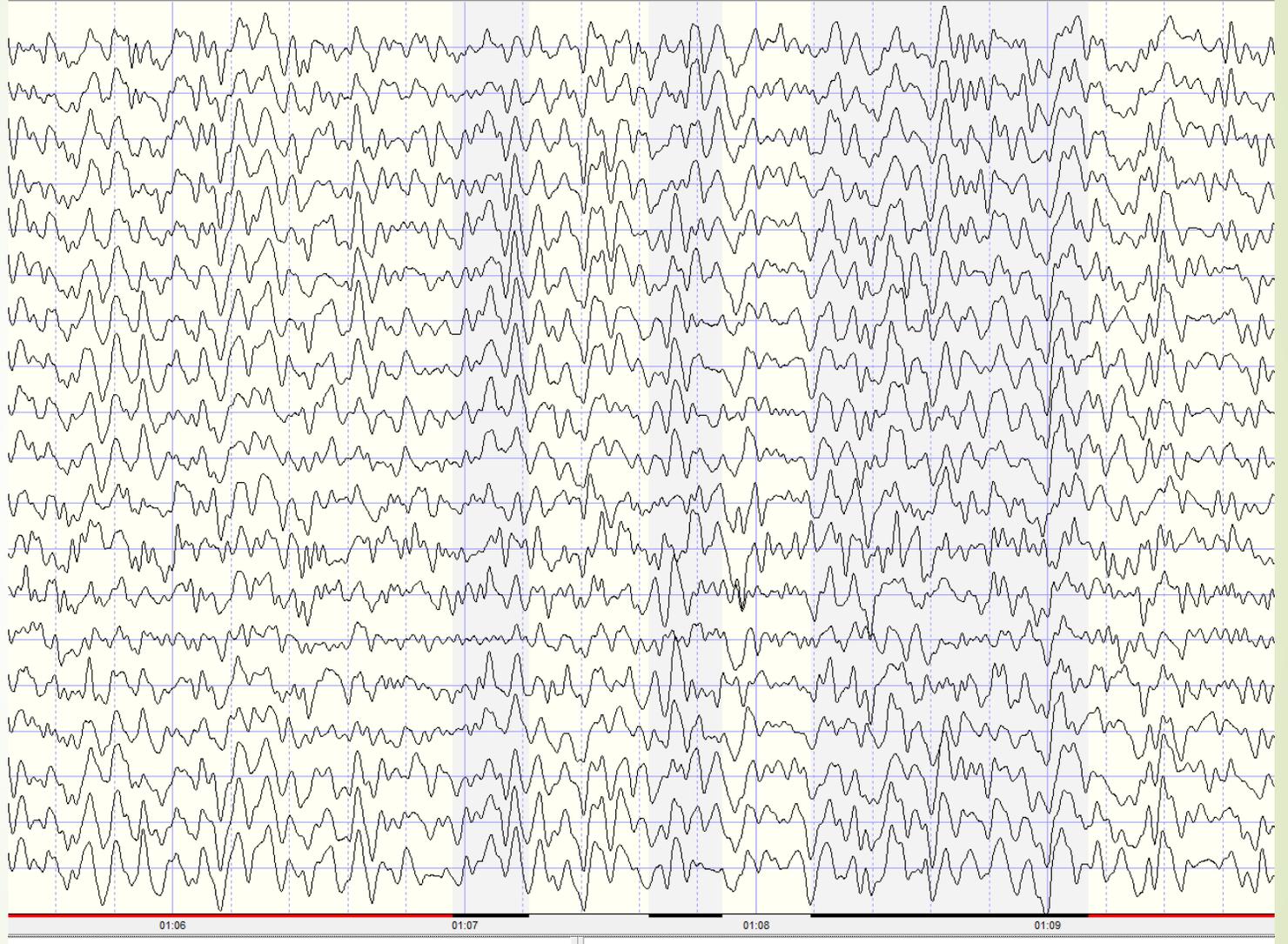
- ▶ We use this information to guide our neurofeedback protocols aiming for more accuracy which should lead to better, and quicker, results.
- ▶ We are therefore able to provide feedback related to the activity of a particular region, or regions, of the brain, rather than basing training on scalp activity. (Collura, 2014)
- ▶ LORETA based techniques can be combined with z score concepts to provide assessment and training of voxels based on normative or other references.
- ▶ There isn't a great deal of academic research into the efficacy of LORETA NF. I've included some in my bibliography

Case Study

- ▶ 45 year old female diagnosed with ADHD
- ▶ Presenting with symptoms of:
 - ▶ Inattention
 - ▶ Memory problems
 - ▶ Anxiety
 - ▶ Fatigue
 - ▶ Insomnia

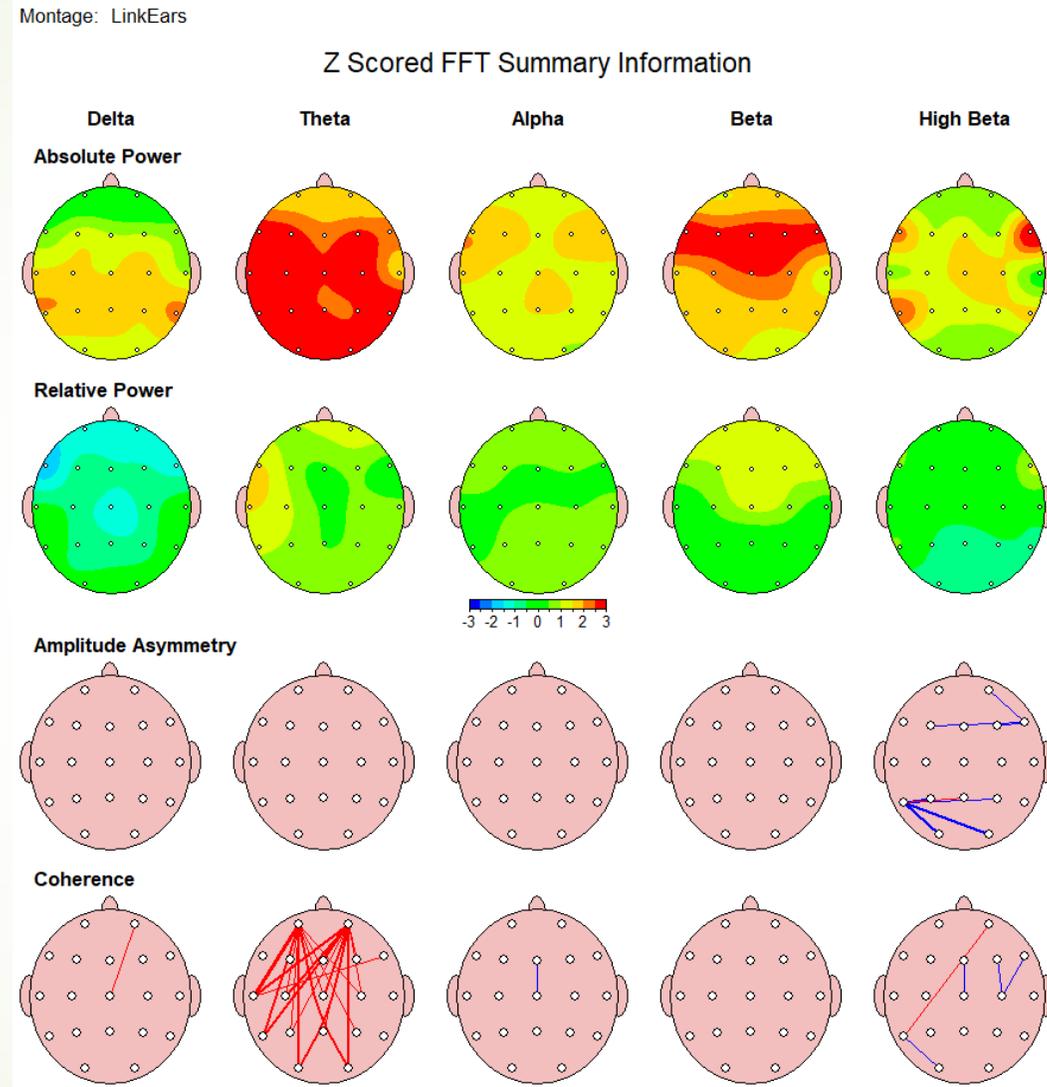
EEG

- Eyes Open EEG showing marked slowing generally



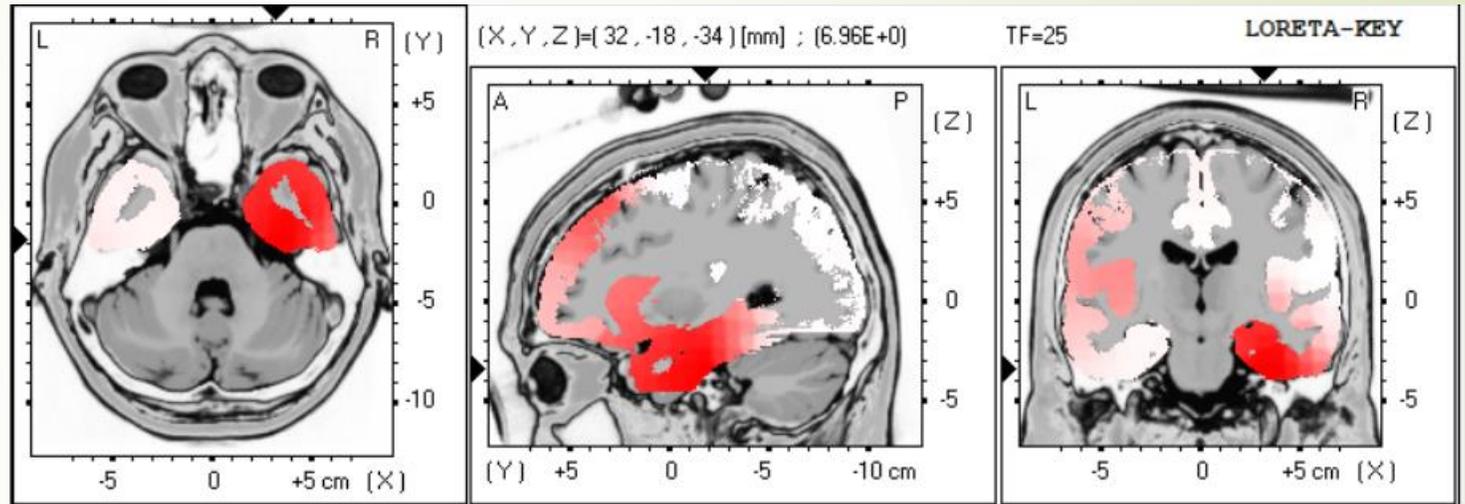
QEEG

- Eyes open
- Excessive theta explains attention deficit symptoms
- Excessive beta explains symptoms of anxiety and fatigue



LORETA

- ▶ Another advantage of LORETA Z score biofeedback is the issue of comorbidities that are often present in patients, for example, attention deficit disorder and anxiety. The advantage of linking symptoms to functional specialization in the brain produces hypotheses with common brain regions involved in both an attention disorder and anxiety. For example, attention is mediated by the hippocampus for the creation of memories; the insula and anterior cingulate for attention shift and the bilateral frontal lobes for executive control. Failure of this system may in part be due to insular cortex deregulation which is also involved in anxiety disorders and/or obsessive compulsive disorders. (Thatcher, 2010)



LORETA showing dysregulation over hippocampus and insula

Symptom Check List

- ➔ A symptom check list linked to neuroanatomy that can be used for purposes of biofeedback using the QEEG

Symptom Check List

Symptoms ICN Networks Neur...gical DoD/VA NeuroLink

Z Score: 2.00

- Power
- Coherence
- Phase
- Phase Shift
- Phase Lock

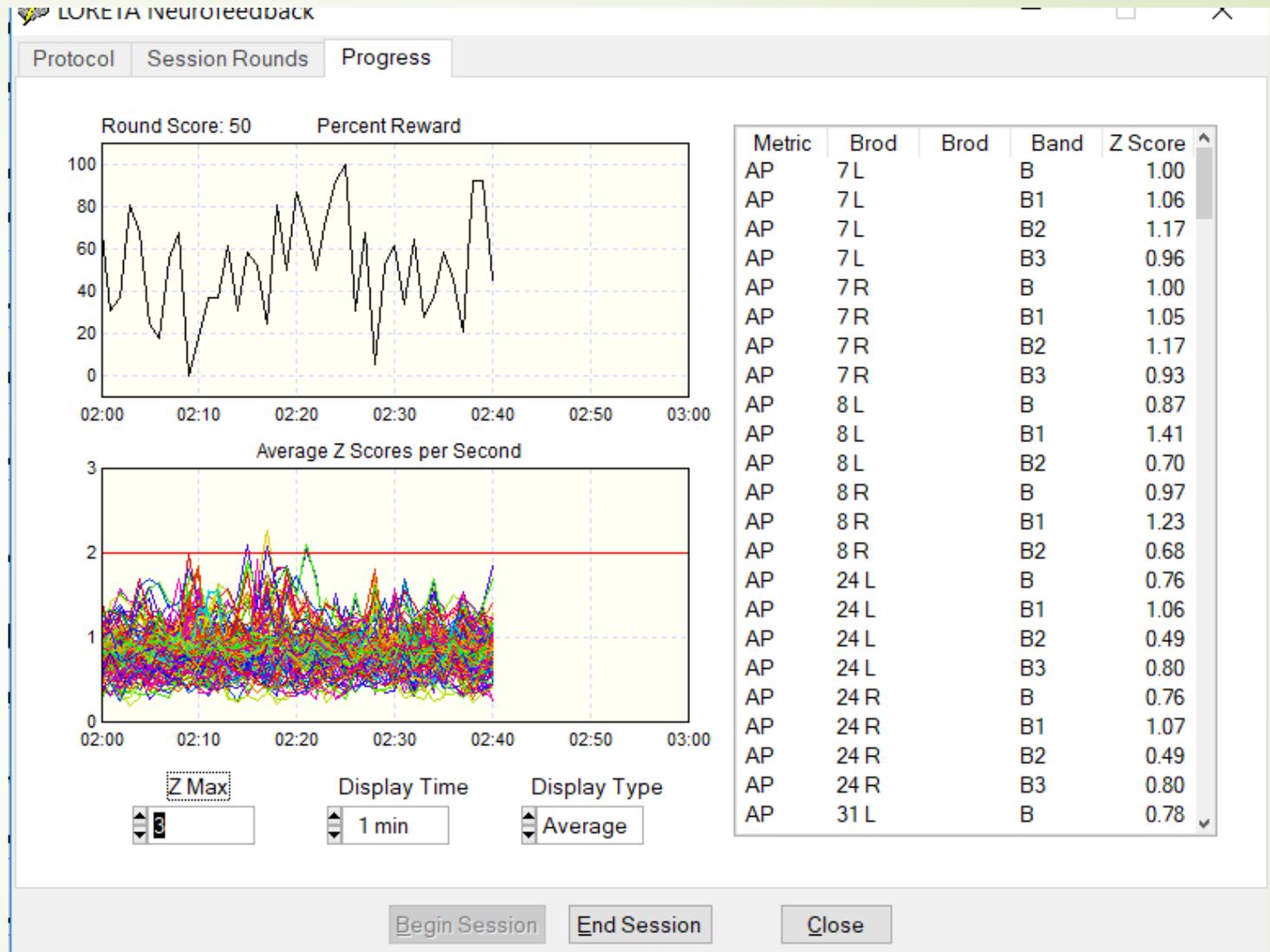
Symptom / Complaint	Severity
Anosognosia - Denial of a Problem	0
Anxiety	0
Attention Deficits - Easily Distractible	10
Auditory Sequencing Problems	0
Autism Spectrum Disorder	0
Balance Problems	0
Blurred Vision	0
Chronic Pain	0
Compulsive Behaviors and/or Thoughts	0

Hypothesis		Match		Mismatch	
Brodmann	Hem	Brodmann	Hem	Brodmann	Hem
7	Left	7	Left	1	Left
7	Right	7	Right	1	Right
8	Left	8	Left	2	Left
8	Right	8	Right	2	Right
9	Left	9	Left	3	Left
9	Right	9	Right	3	Right
24	Left	24	Left	4	Left
24	Right	24	Right	4	Right
30	Left	31	Left	5	Left

OK Cancel

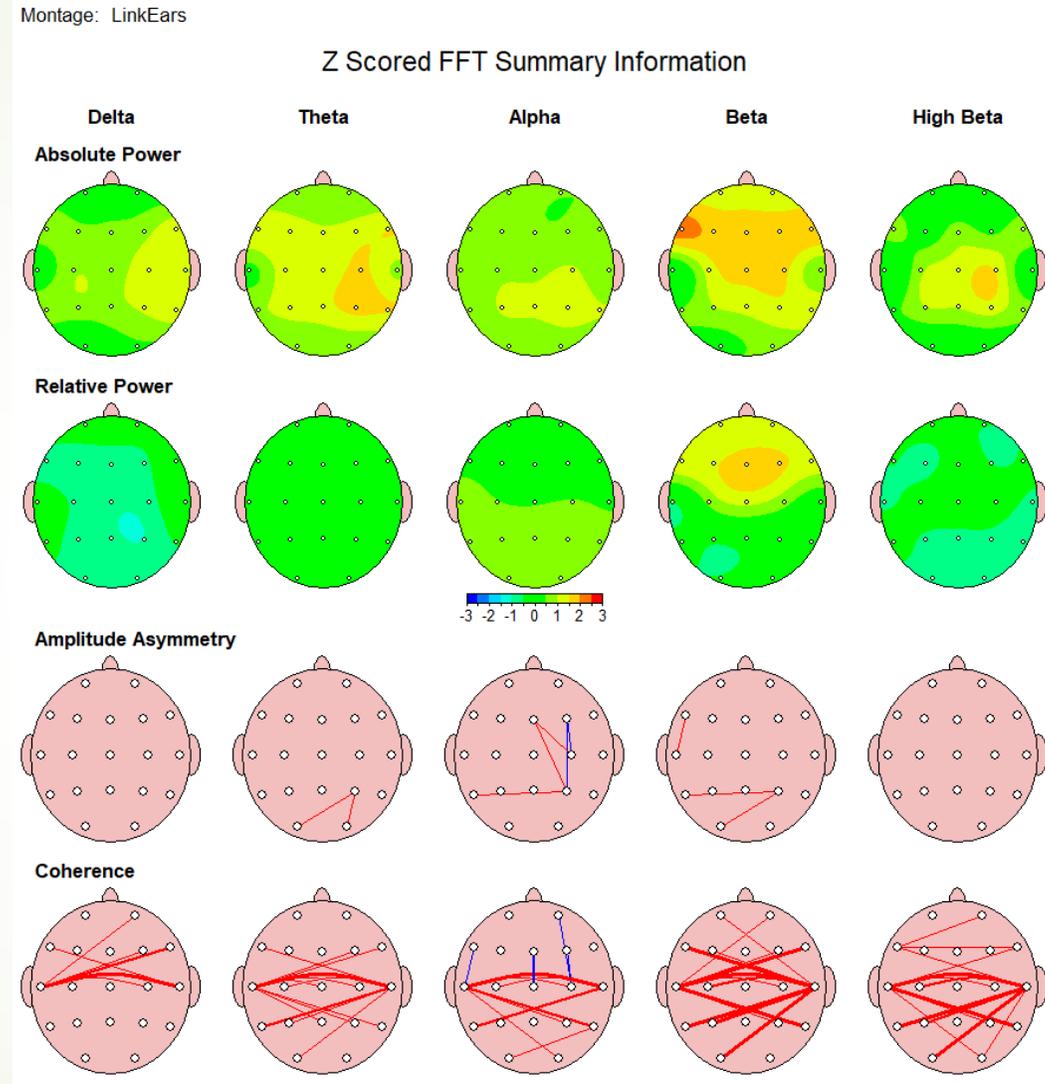
Loreta NF

- Chose Attention Network for training based on EEG presentation, symptom presentation, QEEG presentation and LORETA confirmation.
- Did 4, 20 minute sessions on this area

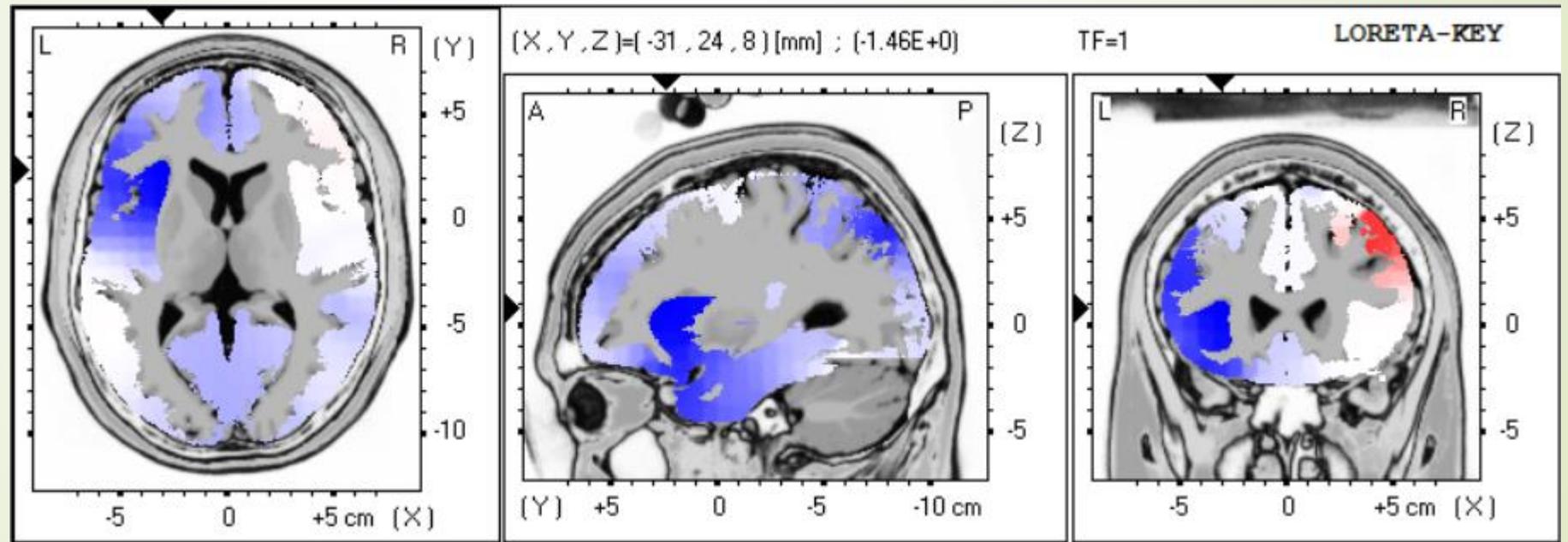


After 4 sessions

- Near normalization of Theta
- Still some overactivity across the prefrontal cortex especially around the Broca area.
- Client reports symptoms of overthinking, anxiety and anger have gone. "My mind feels quiet"
- Client complained of having trouble finding her words so we did 2 more sessions on word finding symptom.
- Still very fatigued



LORETA analysis post NF



Bibliography

- ▶ Leslie Sherlin, Diagnosing and treating brain function with the use of LORETA, chapter 4 of Introduction to Quantitative EEG and Neurofeedback, advanced theory and applications, second edition.
- ▶ Collura, T., 2014. *Technical Foundations of Neurofeedback*. 1st ed. New York: Routledge.
- ▶ Link to Bob Thatcher's LORETA Z Score Biofeedback
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- ▶ Thatcher, R., 2012. *Handbook of Quantitative Electroencepalography and EEG biofeedback*. 1st ed. St Petersburg: Anipublishing.
- ▶ Rex Cannon, Marco Congedo, Joel Lubar & Teresa Hutchens (2009) Differentiating a Network of Executive Attention: Loreta Neurofeedback in Anterior Cingulate and Dorsolateral Prefrontal Cortices, International Journal of Neuroscience, 119:3, 404-441, DOI: [10.1080/00207450802480325](https://doi.org/10.1080/00207450802480325)
- ▶ J. Lucas Koberda, Paula Koberda, Andrew A. Bienkiewicz, Andrew Moses & Laura Koberda (2013) Pain Management Using 19-Electrode Z-Score LORETA Neurofeedback, Journal of Neurotherapy, 17:3, 179-190, DOI: [10.1080/10874208.2013.813204](https://doi.org/10.1080/10874208.2013.813204)