Acoustical neuro-modulation normalizes EEG current density and EEG coherence in functional neural networks of Autistic children through unique auditory disentrainment

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ABSTRACT

This study investigated the EEG topographic and 3D tomographic effects of audio stimulation generated by unique algorithms designed **by Biosensor, Inc.** to disentrain or dehabituate abnormal and deregulated neural network activity. Disentrainment stimulation techniques can be used to normalize neural function, relieve symptoms and improve system adaptivity. Audio disentrainment techniques, as opposed to pulsed electrical or magnetic techniques, are less invasive, more available and potentially more powerful. A case series of 5 children diagnosed with Autism is reported on in this study. Subjects received audio stimulation consisting of a carrier wave modulated by signals based on standard EEG frequency bands. Comparisons of pre and post stimulation LORETA and topographic qEEG neuroimages revealed normalization of both current source density and coherence with very large effect sizes. Dynamic analyses of specific frequency bands during stimulation reveal frequency-band specific disentrainment effects. The ability of this technique to rapidly and profoundly normalize neural network function is justification for further research, development and application.

BACKGROUND

Auditory stimulation affects neural network activity through the auditory brainstem and midbrain and affects the EEG through frequency following responses.

- The human auditory system has a frequency range of 20-20,000 Hz
- Most of the power in the human EEG is below 20 Hz
- Frequency-following responses occur when sensory or other forms of stimulation induce resonance in the EEG
- Auditory Frequency-following responses below 20 Hz can be achieved by carrier waves that produce beat frequencies
- Acoustical stimulation that decreases phase lock in the EEG and increases phase shift is called **disentrainment** stimulation
- Higher IQ has been correlated with decreased phase lock and increased phase shift in the human EEG
- A technique that normalizes phase shift and phase lock in an individual's EEG has potential to improve neural network activity and increase function in that individual
- Quantitative EEG is an effective means of discovering abnormal functional neural network activity and evaluating the a technique's ability to normalize neural function

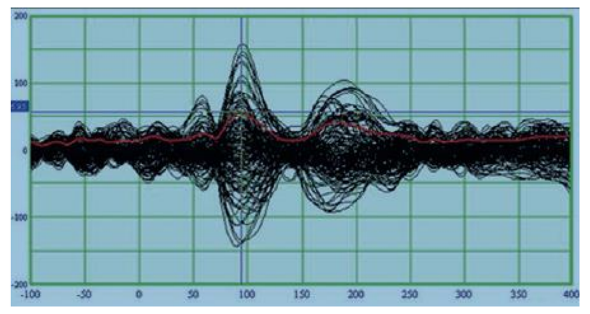
OBJECTIVES

- Test the effects of Acoustical Neuro-Modulation on functional neural network activity in children diagnosed with Autism
- Discover the mechanisms of action by which Acoustical Neuro-Modulation affects neural network activity
- Discover whether Acoustical Neuro-Modulation can serve as a safe and effective method to improve brain function and quality of life for children with autism
- Begin development of methods by which Acoustical Neuro-Modulation may be provided to children diagnosed with autism in large-scale cost effective ways

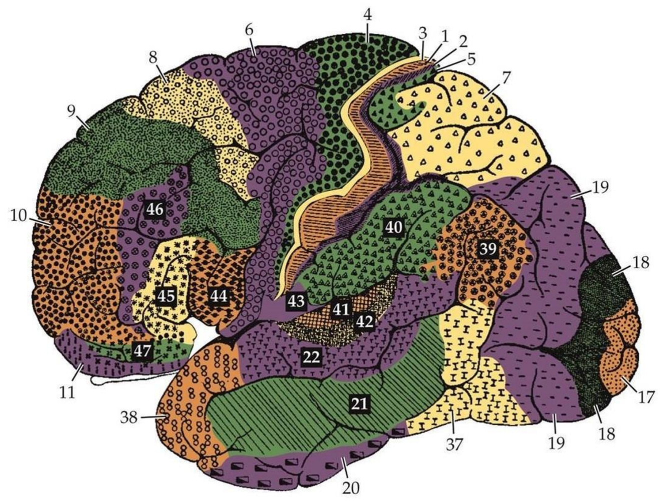
METHODS

- Pre Training Baseline 19 Channel EEG Recorded
- Quantitative Topographic & LORETA Tomographic Analyses and Normative Database Comparisons
- ANM Sound Set Chosen Based on Most Deviant EEG Frequency Band and Most Deviant Z Score LORETA Voxel
- ANM Sounds Delivered Through High Quality Noise-cancelling Headphones for approximately 10 minutes
- Post Training Baseline data recorded
- Pre-Post Comparisons: Paired t-tests, Cohen's d for effect size

	Most Deviant Brodmann Area	Most Deviant EEG Frequency Band	Baseline Z Score
Case 1	10 Right	Delta	+4.74
Case 2	2 Left	Theta	+6.12
Case 3	24 Left	High Beta	+4.33
Case 4	47 Right	Delta	+4.05
Case 5	23 Left	Delta	+5.77



Complex interactions of auditory signals



Brodmann Areas identify functional neural network hubs

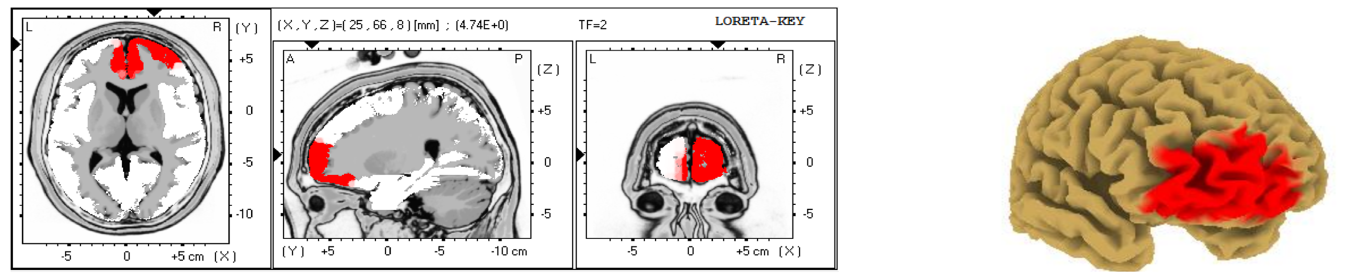
RESULTS

	Z Score Change Toward Normal	P Value	Effect Size
Case 1	2.62	P<0.00001	Very Large
Case 2	1.88	P<0.00001	Very Large
Case 3	1.59	P<0.00001	Very Large
Case 4	1.9	P<0.00001	Very Large
Case 5	2.14	P<0.00001	Very Large

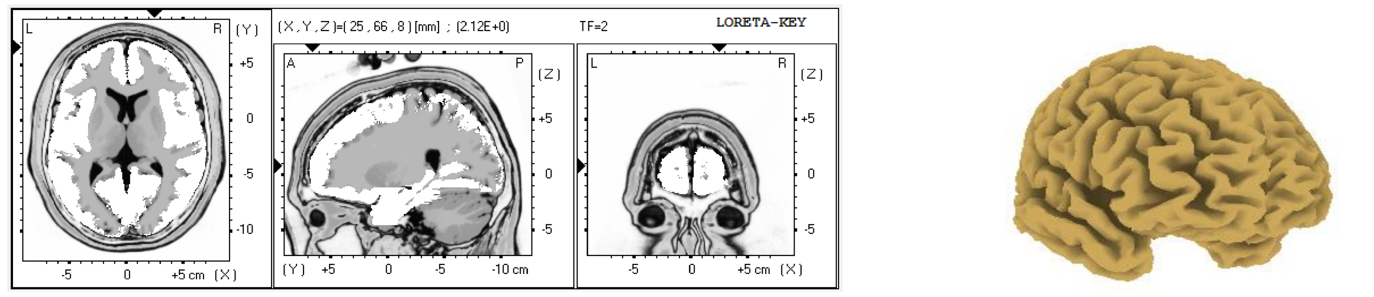
RESULTS

Case 1 LORETA tEEG:

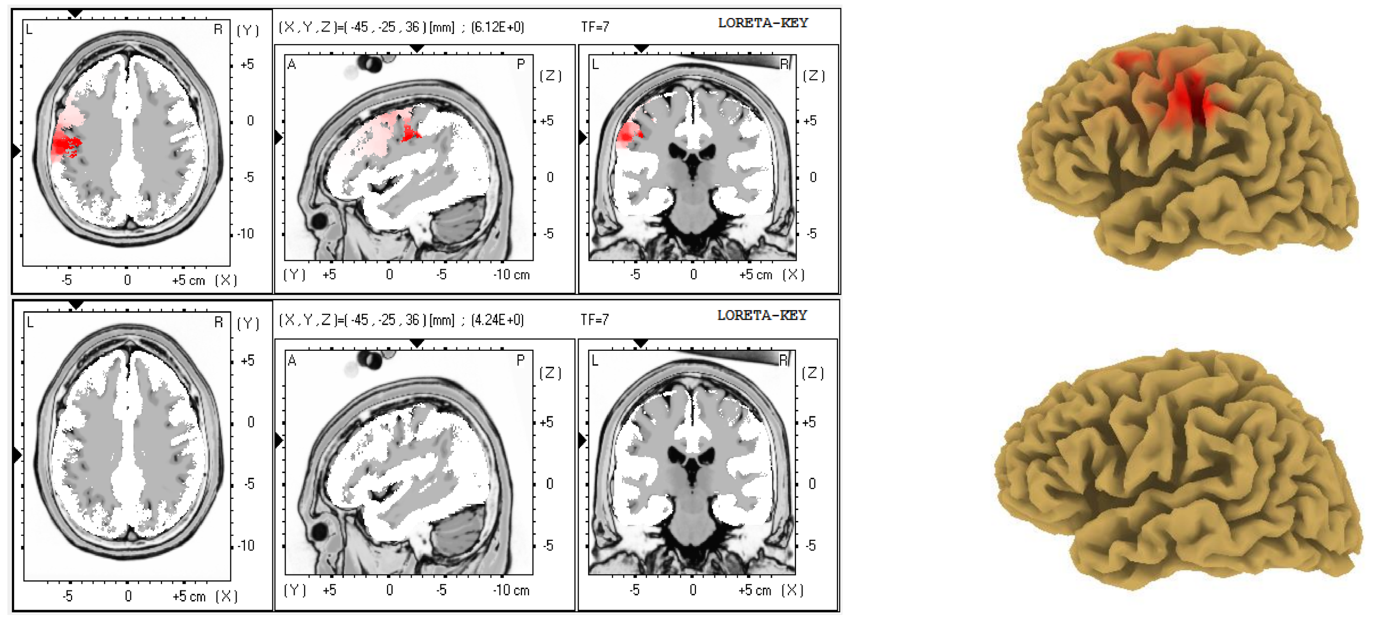
Pre Training Baseline



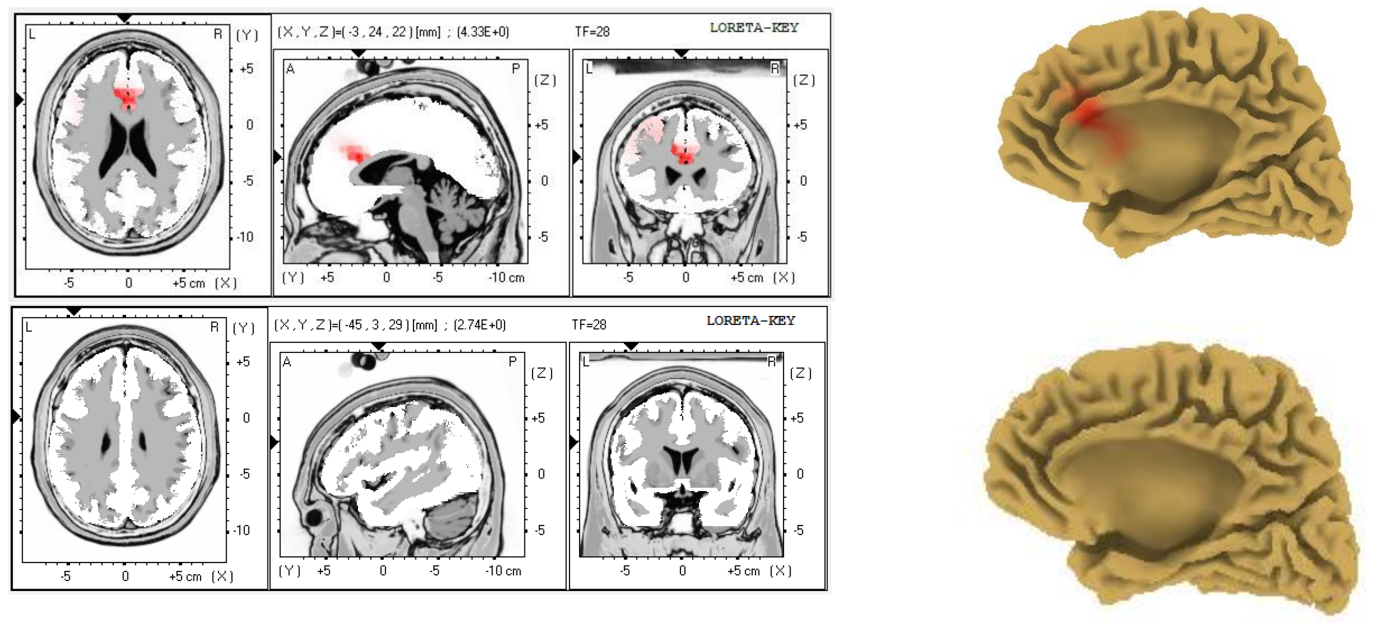
Post Training Baseline



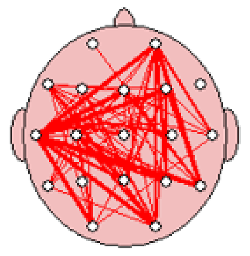
Case 2 LORETA tEEG Pre and Post:



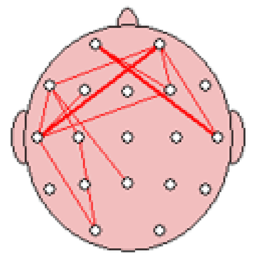
Case 3 LORETA tEEG Pre and Post:



Typical pre training topographic map showing hyper-coherence



Typical post-training topographic map showing resolution of hyper-coherence



CONCLUSIONS

- Acoustical neuro-modulation had a normalizing effect on current density, probably mediated through normalized phase, coherence and synchrony among the functional neural networks