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Quantitative EEG Analyses

PATIENT INFORMATION

Name:
Exam#: 090494
Age: 16.18 years
Sex: Male
Handedness: Right

RECORDING

Date: November 10, 2010
Ref. By:
Test Site:
Analysis Length: 2:00 Minutes
Ave. EEG Reliability: 0.98 (SH)
Ave. EEG Reliability: 0.90 (TRT)

Medication: Concerta, Depakote, Seroquel, Abilify.

HISTORY: Severe impulsivity or explosive expression of anger, severe defiant, disruptive or destructive behavior, dangerous, self-injurious or unsafe behaviors, drug/alcohol use w/ functional impairments, severe deterioration of functioning, serious depressive symptoms, aggressiveness or assaultiveness, serious violations of societal norms, irritable or labile mood. Previous diagnosis: ADHD, Bipolar disorder. Rule-out C-P Seizure Disorder.

SUMMARY OF EEG ANALYSES:

The power spectral analysis were deviant from normal with excessive power in the left temporal and left central regions at 1 - 5 Hz, especially in the Laplacian montage. Mildly elevated power was present in right central regions at 25 – 30 Hz. LORETA 3-dimensional source analyses were consistent with the surface EEG and showed excessive current sources in the left pre-central frontal lobe and the left post-central parietal lobe with maxima at 2 Hz & 4 Hz (Brodmann areas 3, 4 & 6). EEG amplitude asymmetry, EEG coherence and EEG phase were abnormal, especially in bilateral frontal and midline central relations. Reduced coherence was present in bilateral frontal and central relations but especially in left frontal-central relations which indicates reduced functional connectivity. Elevated coherence was present in right frontal regions which indicates reduced functional differentiation. Both

conditions are often related to reduced speed and efficiency of information processing. The learning disability discriminant function detected a pattern in the EEG that is commonly present in individuals with a history of general academic problems. The traumatic brain injury discriminant function failed to detect a pattern in the EEG that is commonly present in individuals with a history of traumatic brain injury. The brain performance index (BPI) predicted a below average degree of efficiency in the allocation of neural resources with a balanced prediction for performance I.Q. and verbal I.Q. The BPI was not designed to replace neuropsychological testing but rather is a measure of the general health of the brain and the degree to which neural resources are efficiently allocated. In summary, the qEEG analyses were deviant from normal and showed de-regulation of the left frontal and parietal lobes. The left parietal lobes are involved in auditory information processing, short-term memory and receptive language skills. The frontal regions are involved in mood control, executive functioning, abstract thinking and social skills. To the extent there is deviation from normal electrical patterns in these structures, then sub-optimal functioning is expected.

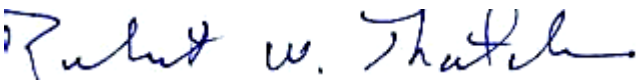
NEUROFEEDBACK RECOMMENDATIONS:

The following implications for neurotherapy are offered based upon the clinical evaluation of the patient as well as the reference data base results. These suggestions for neurotherapy should be evaluated with caution and should only be considered as possible strategies that the clinician may considered in his/her evaluation. If the patient is depressed, then the clinician should consider treating this condition first through alpha frequency enhancement or some other biofeedback protocol that may reduce depression. If depression or poor mood and/or motivation is not a problem then the clinician may consider using one or more strategies with the priority of treatment in the order presented below.

1- Suppress frequency activity 1 - 5 Hz at C3 and/or F7.

2- Suppress frequency activity 24 - 30 Hz at C4.

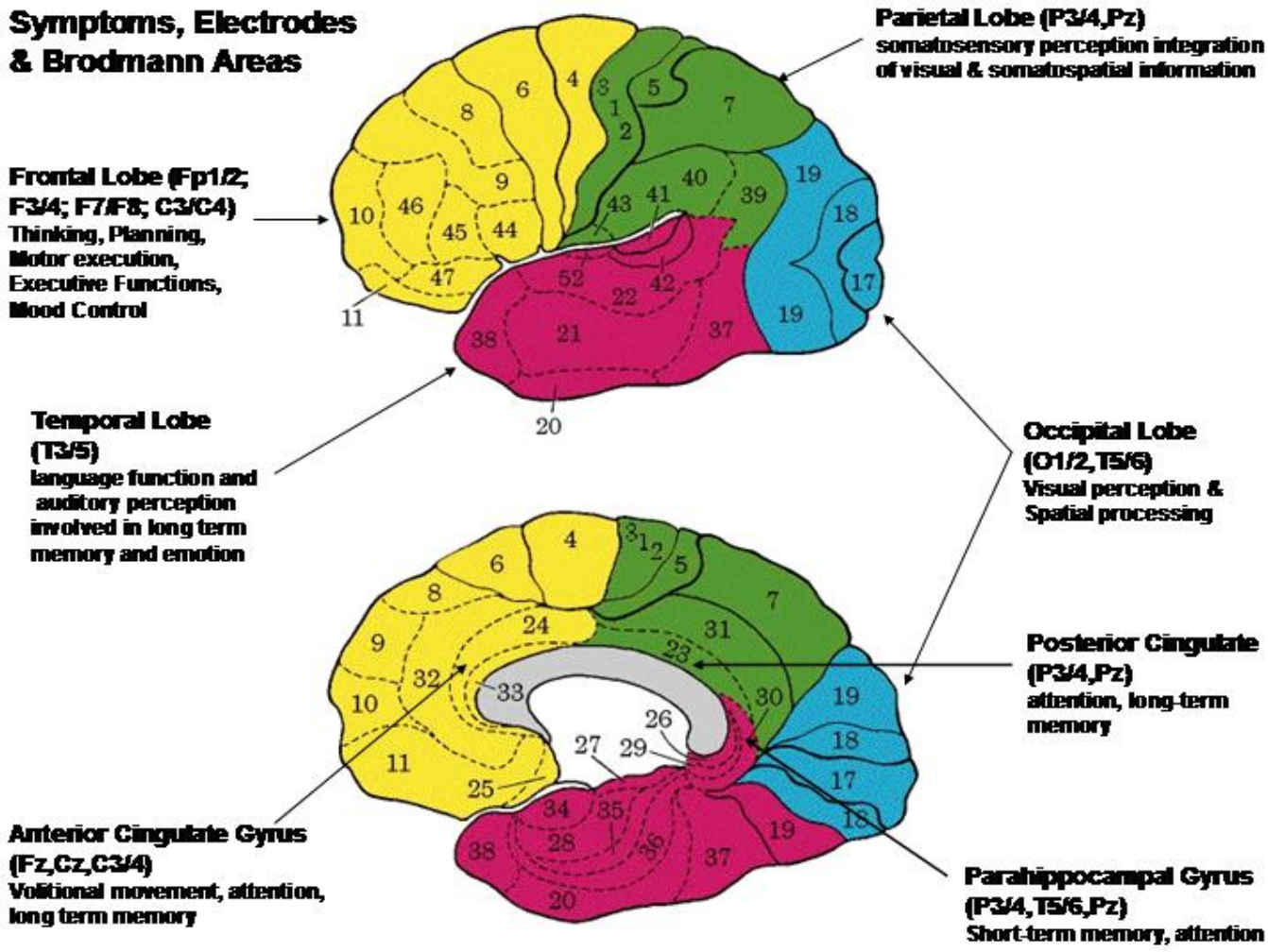
3- Reinforce EEG coherence at 1 - 7 Hz between C3 and F3.



Robert W. Thatcher, Ph.D., QEEG-T, BCIA, ECNS

Electrical NeuroImaging

Linking a patient's symptoms and complaints to functional systems in the brain is important in evaluating the health and efficiency of cognitive and perceptual functions. The electrical rhythms in the EEG arise from many sources but approximately 50% of the power arises directly beneath each recording electrode. Electrical NeuroImaging uses a mathematical method called an "Inverse Solution" to accurately estimate the sources of the scalp EEG (Pascual-Marqui et al, 1994; Pascual-Marqui, 1999). Below is a Brodmann map of anatomical brain regions that lie near to each 10/20 scalp electrode with associated functions as evidenced by fMRI, EEG/MEG and PET NeuroImaging methods.



Conventional EEG Samples and Quantitative EEG Analyses

Fig. 1 - Example of EEG and Absolute Power Z scores – Linked Ears eyes closed condition

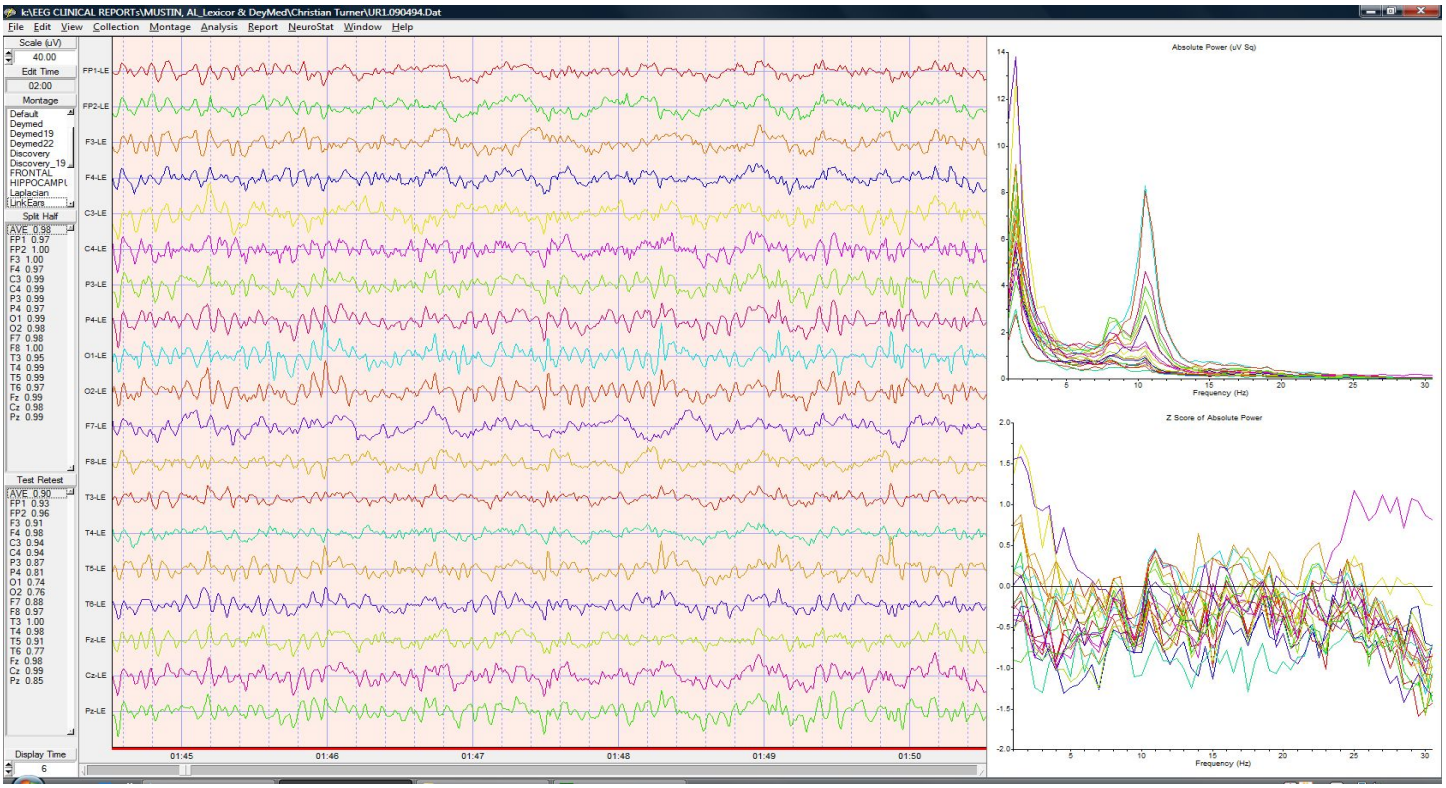


Fig. 2- Example of Laplacian Absolute Power – eyes closed condition

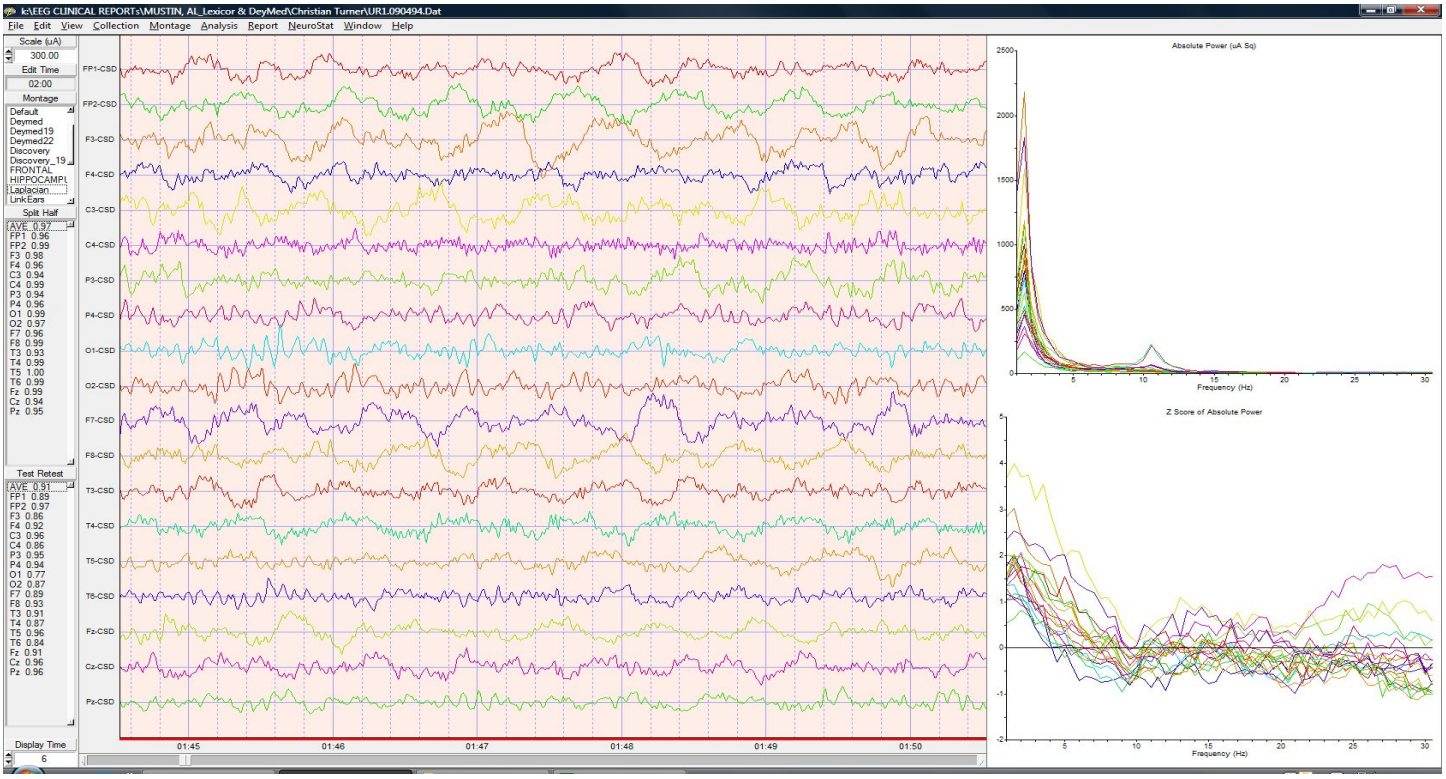


Fig. 3 – Example of LORETA Z Scores at 2 Hz. (Brodmann Area: 3, 4 & 6)

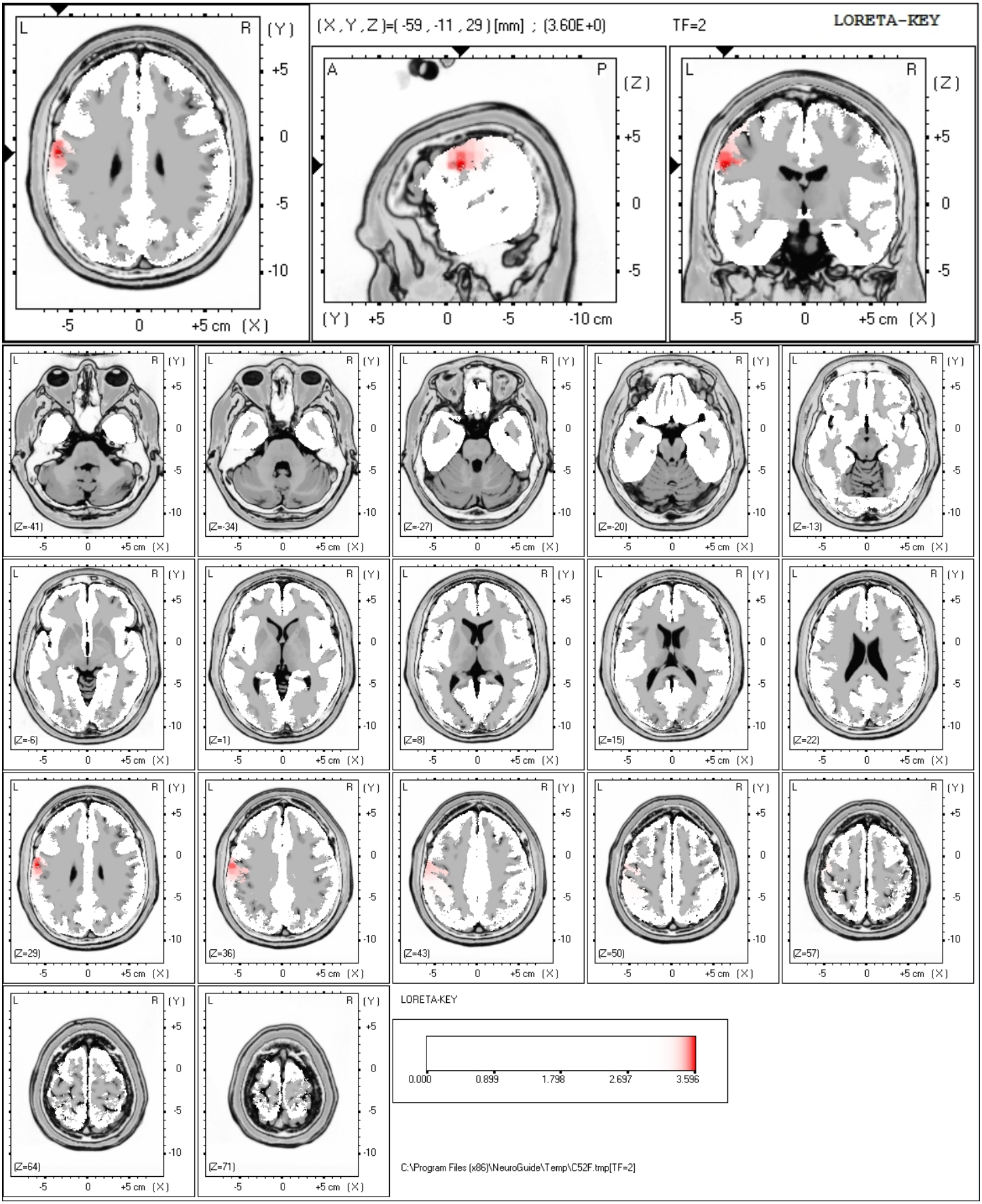
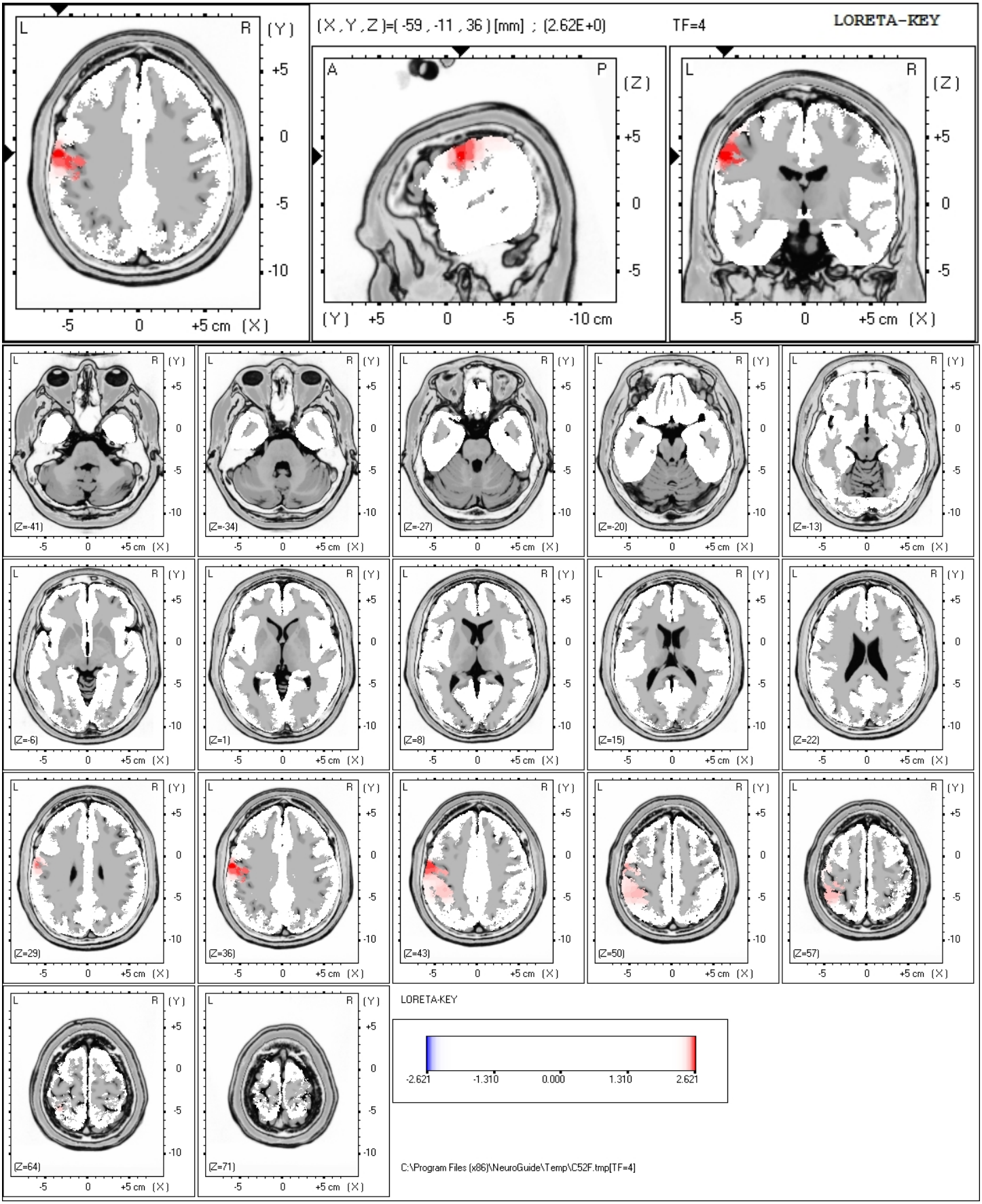


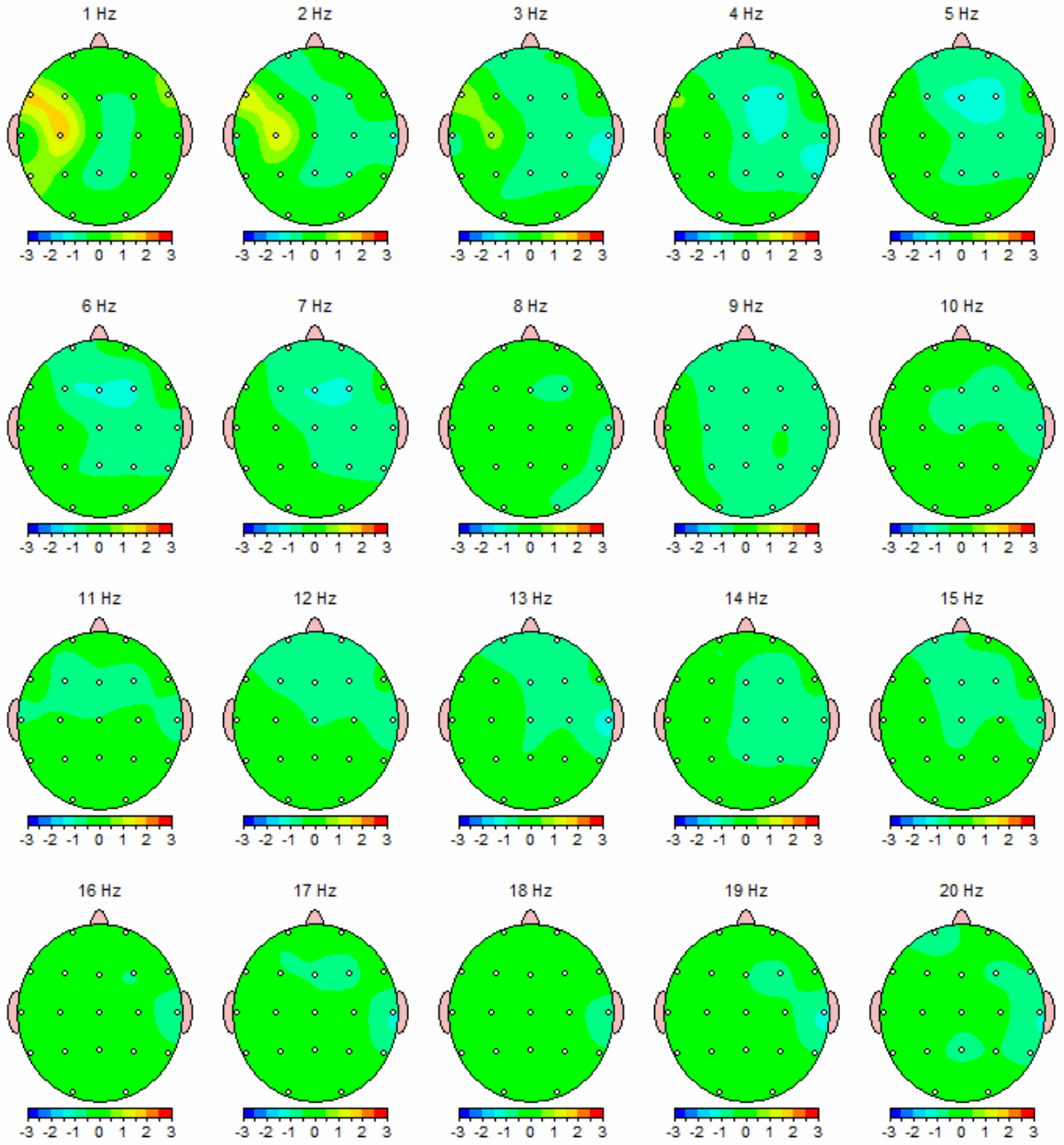
Fig. 4 – Example of LORETA Z Scores at 4 Hz. (Brodmann Area: 3, 4 & 6)



Montage: LinkEars

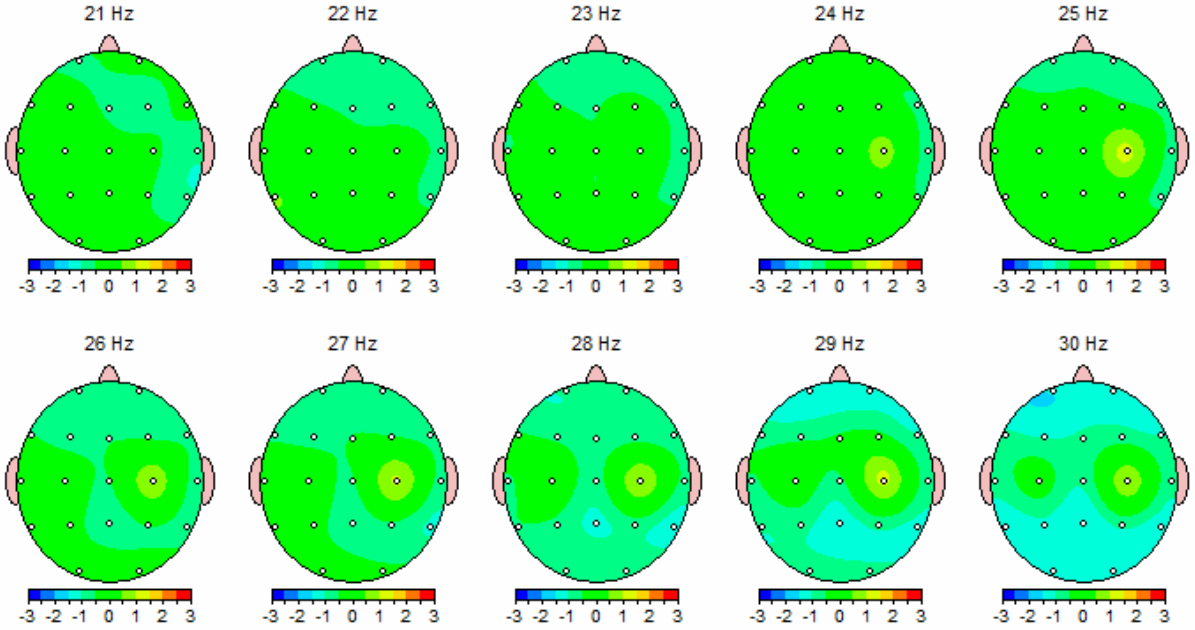
EEG ID: 090494

Z Scored FFT Absolute Power



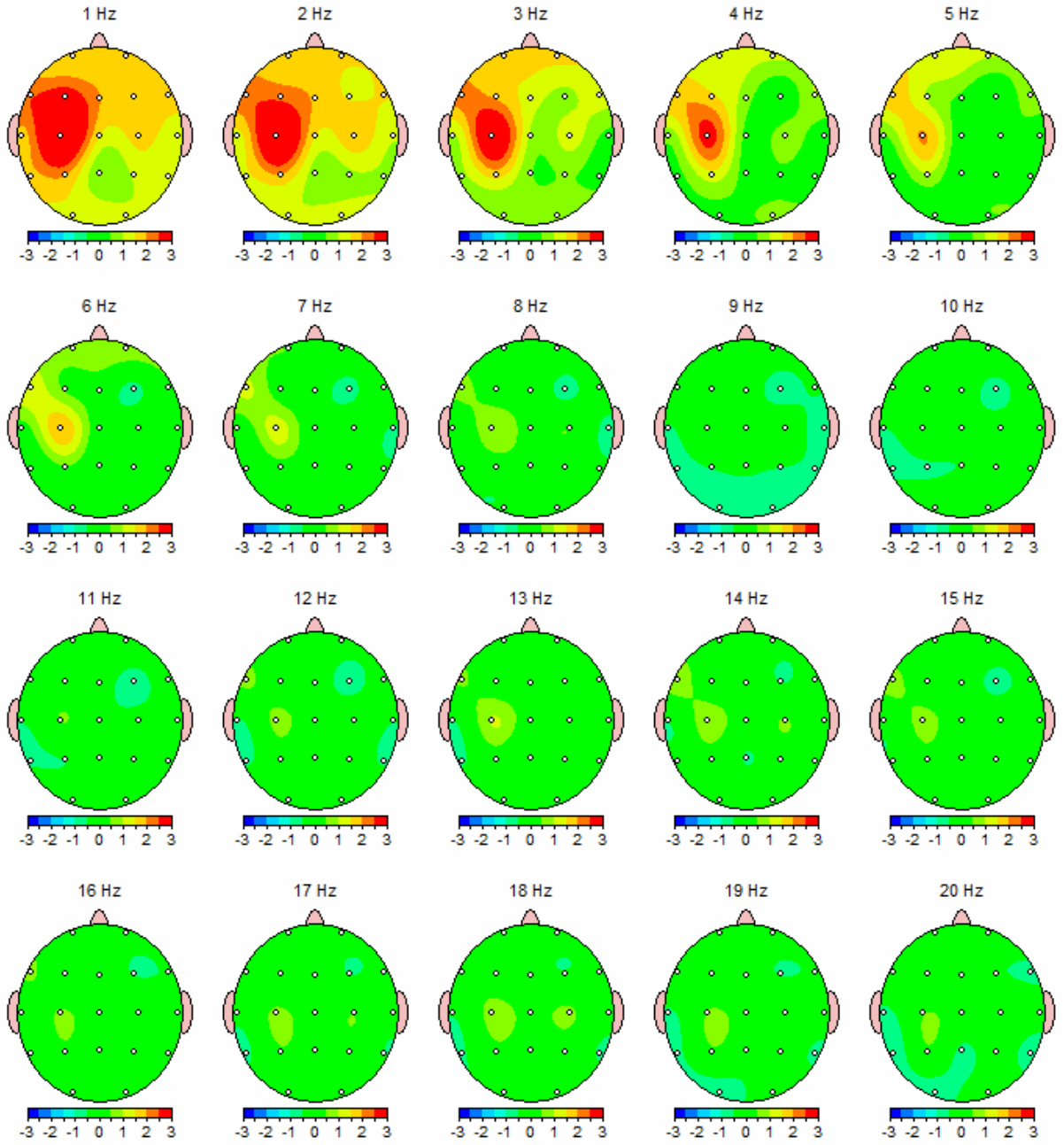
Montage: LinkEars EEG ID: 090494

Z Scored FFT Absolute Power



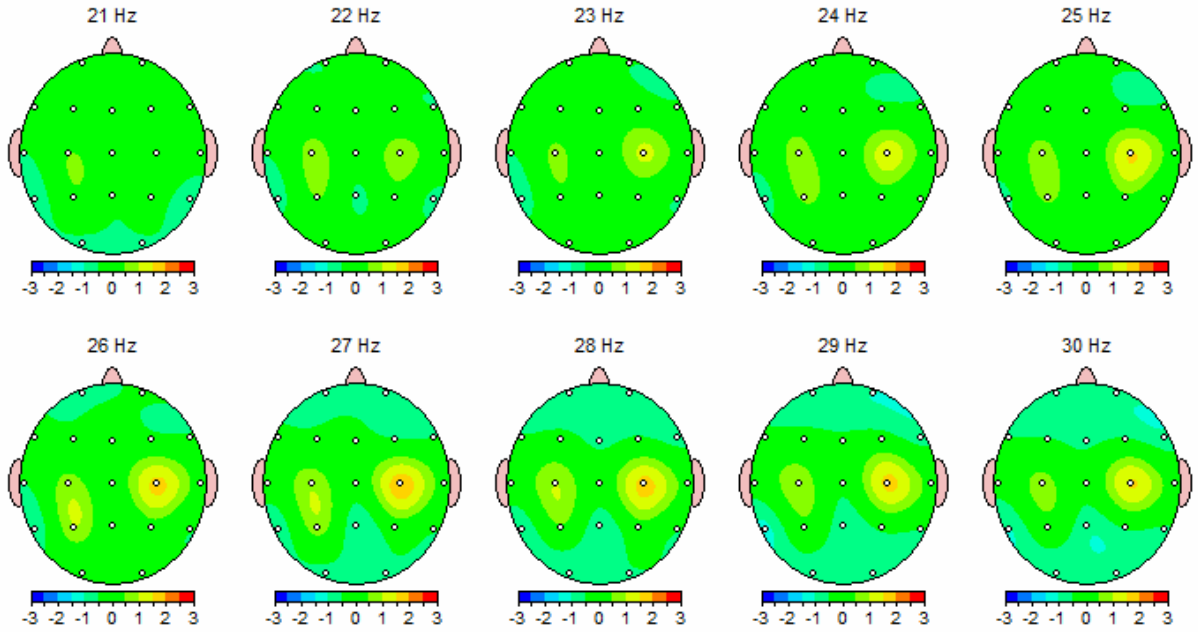
Montage: Laplacian EEG ID: 090494

Z Scored FFT Absolute Power



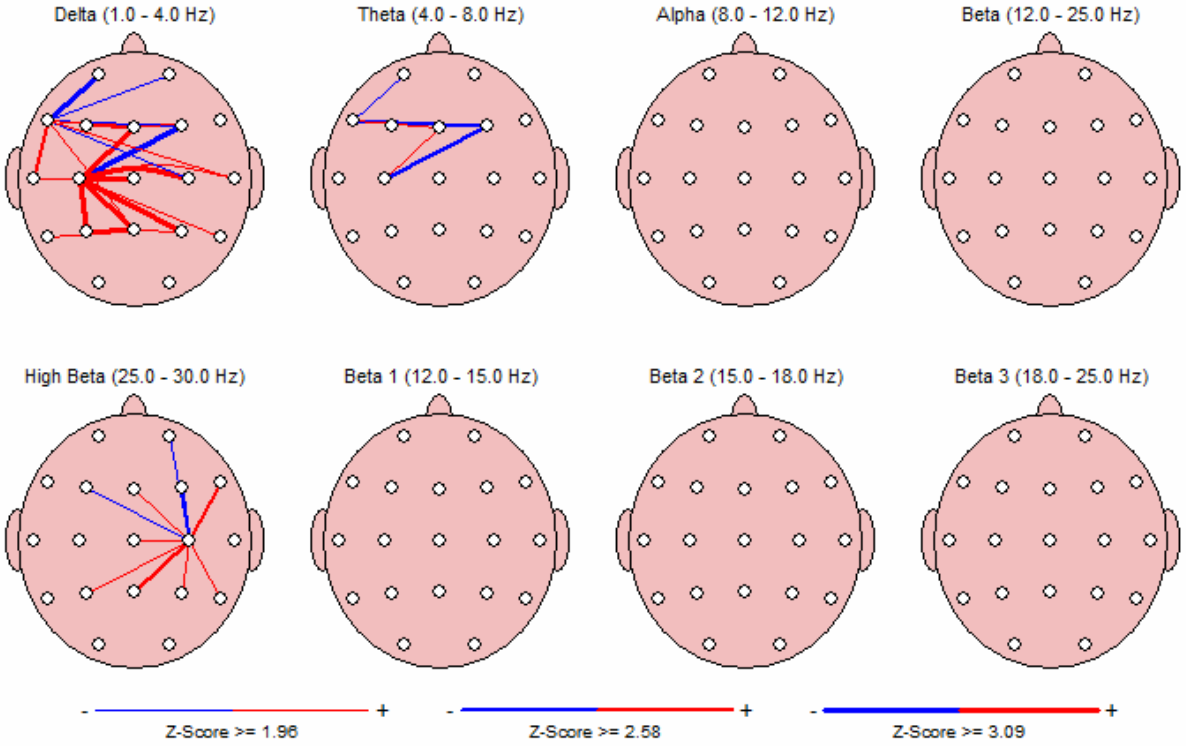
Montage: Laplacian EEG ID: 090494

Z Scored FFT Absolute Power



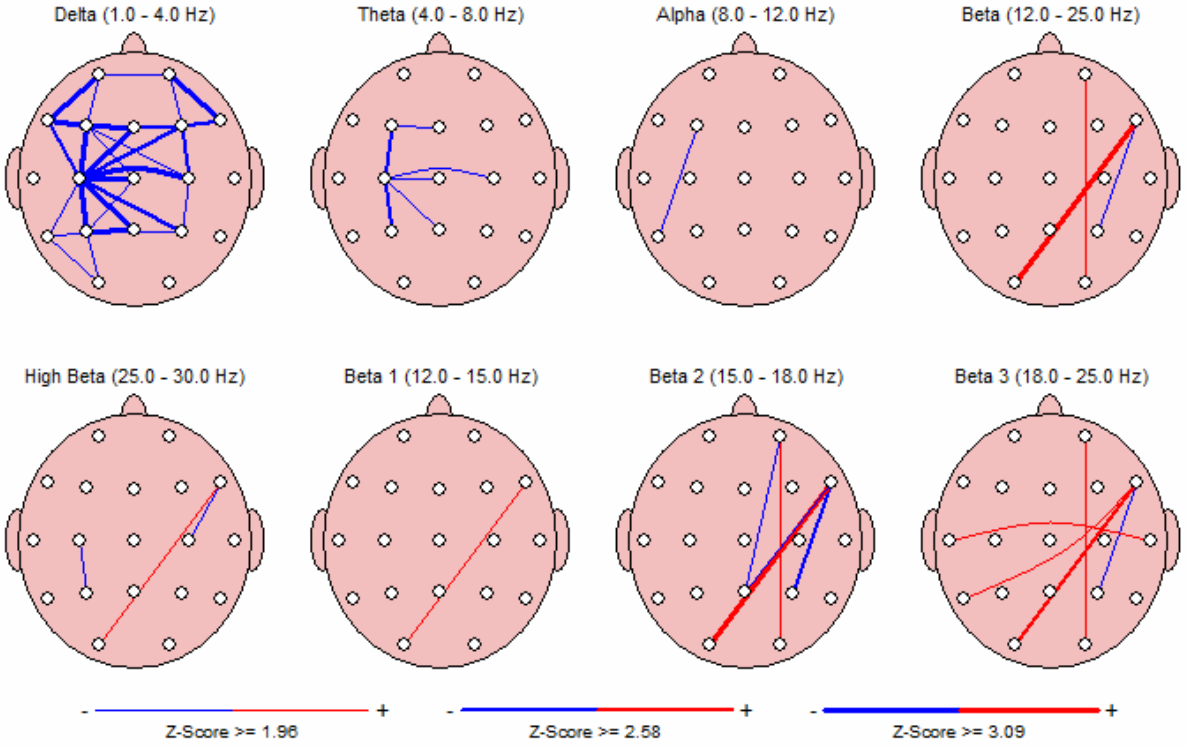
Montage: LinkEars EEG ID: 090494

Z Scored FFT Amplitude Asymmetry



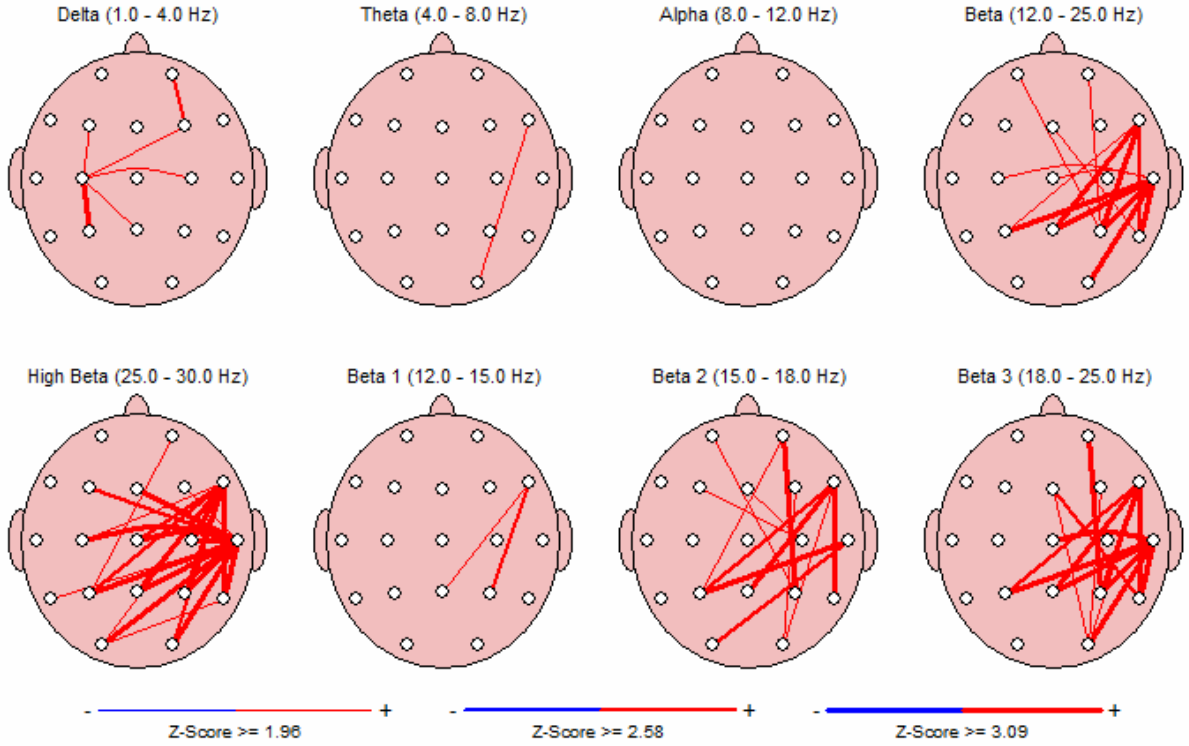
Montage: LinkEars EEG ID: 090494

Z Scored FFT Coherence



Montage: LinkEars EEG ID: 090494

Z Scored FFT Phase Lag

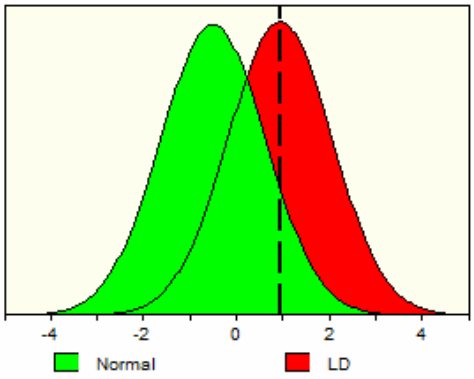


Montage: LinkEars EEG ID: 090494

Learning Disability Discriminant Analysis*

LD DISCRIMINANT SCORE = 0.91 LD PROBABILITY INDEX = 90.0%

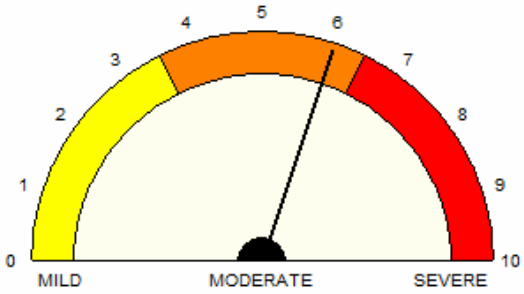
The Learning Disability Probability Index is the subject's probability of membership in the Learning Disability (LD) population.



			RAW	Z
F8	RATIO	T/B	1.52	0.24
P3	AP	Theta	10.92	-0.33
Cz-C4	AMP	Theta	34.42	-0.00
F7-T6	AMP	Alpha	-95.43	0.34
T5-O2	COH	Theta	22.75	-0.04
F3-Fz	COH	Alpha	82.04	-1.02
FP1-T5	PHA	Beta	10.35	1.30
T4-T6	PHA	Delta	4.48	-0.19
F8-T3	PHA	Delta	3.84	-0.74
T4-Pz	PHA	Theta	8.92	0.10
FP1-Pz	PHA	Delta	5.88	-0.54
F8-Pz	PHA	Beta	-89.76	7.76
C3-O2	PHA	Alpha	6.54	-1.14
FP1-F4	PHA	Alpha	1.03	-0.73

LD SEVERITY INDEX = 6.03

This severity score places the patient in the MODERATE range of severity.



The LD Severity Index is an estimate of the neurological severity of Learning Disability.

***Statement of Indications of Use:**

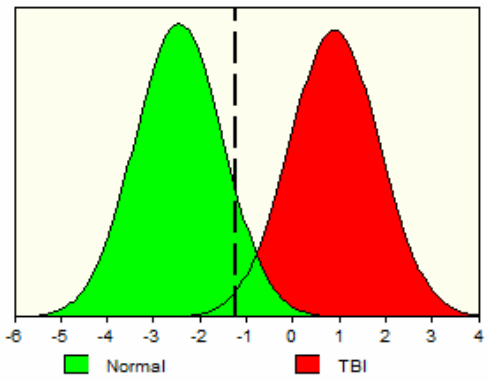
The Discriminant Analysis and Severity Index are to be used by experienced and qualified professionals for the post-hoc statistical evaluation of the human electroencephalogram (EEG). The Discriminant Analysis and Severity Index are to be viewed as an adjunct to the evaluation of the patient, and they do not serve as a primary basis for a diagnosis. Warning: Inclusion criteria of no history of traumatic brain injury and age between 6 years and adulthood must be adhered to.

Montage: LinkEars EEG ID: 090494

Traumatic Brain Injury Discriminant Analysis*

TBI DISCRIMINANT SCORE = -1.26 TBI PROBABILITY INDEX = Not Significant

The TBI Probability Index is the subject's probability of membership in the mild traumatic brain injury population. (see Thatcher et al, EEG and Clin. Neurophysiol., 73: 93-106, 1989.)



			RAW	Z
FP1-F3	COH	Theta	73.36	-0.51
T3-T5	COH	Beta	71.37	1.62
C3-P3	COH	Beta	61.50	-0.83
FP2-F4	PHA	Beta	-0.35	-0.60
F3-F4	PHA	Beta	-0.06	-1.64
F4-T6	AMP	Alpha	-65.26	-0.10
F8-T6	AMP	Alpha	-89.10	0.49
F4-T6	AMP	Beta	-24.36	-0.32
F8-T6	AMP	Beta	-41.63	0.37
F3-O1	AMP	Alpha	-128.08	-0.47
F4-O2	AMP	Alpha	-130.34	-0.46
F7-O1	AMP	Alpha	147.12	0.10
F4-O2	AMP	Beta	-93.97	-0.86
P3	RP	Alpha	39.69	-0.41
P4	RP	Alpha	46.37	0.00
O1	RP	Alpha	49.86	-0.29
O2	RP	Alpha	48.33	-0.41
T4	RP	Alpha	25.19	-0.63
T5	RP	Alpha	36.14	-0.53
T6	RP	Alpha	41.56	-0.34

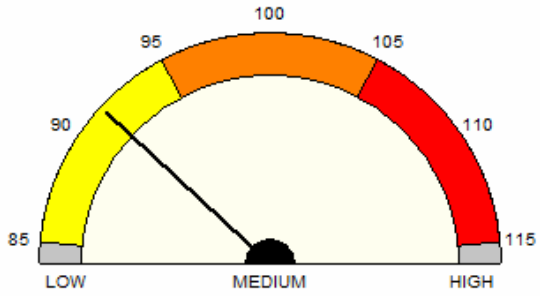
***Statement of Indications of Use:**

The Discriminant Analysis and Severity Index are to be used by experienced and qualified professionals for the post-hoc statistical evaluation of the human electroencephalogram (EEG). The Discriminant Analysis and Severity Index are to be viewed as an adjunct to the evaluation of the patient, and they do not serve as a primary basis for a diagnosis. Warning: Inclusion criteria of a history of traumatic brain injury and greater than 13 years of age must be adhered to.

Montage: LinkEars EEG ID: 090494

Predicted Neuropsychological Scores

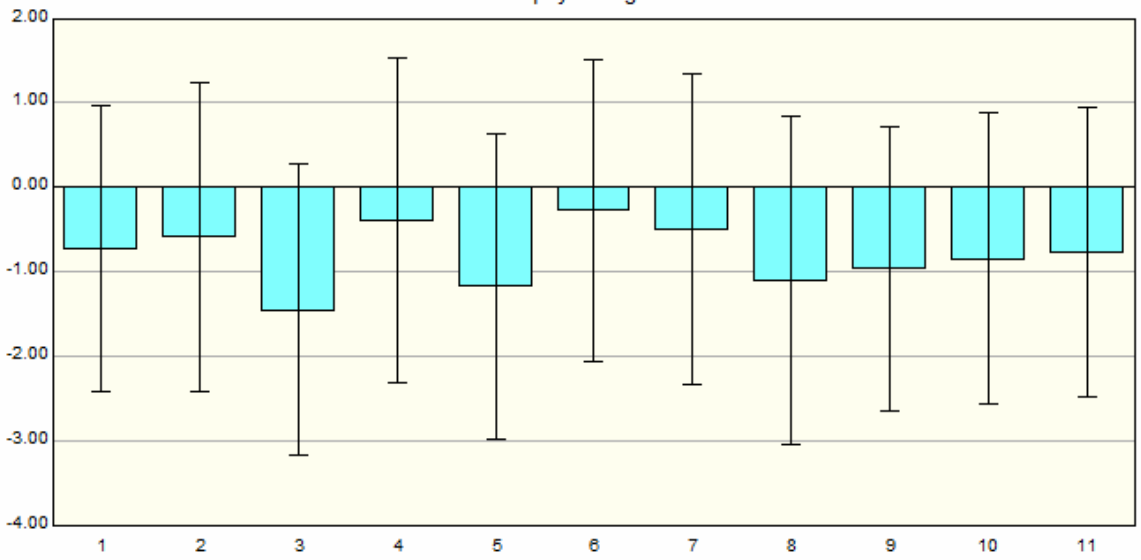
Full Scale IQ



Predicted Cognitive Performance

	Neuropsychological Tests	Scaled Score	Min SS	Max SS	Z Score	Min Z	Max Z
1	Information	8.61	3.03	14.19	-0.73	-2.43	0.97
2	Mathematics	8.85	3.09	14.61	-0.59	-2.42	1.24
3	Vocabulary	6.53	0.58	12.47	-1.45	-3.18	0.28
4	Digit Span	8.85	2.88	14.82	-0.40	-2.33	1.52
5	Picture Completion	7.67	2.40	12.94	-1.17	-2.98	0.64
6	Block Design	9.91	3.74	16.08	-0.28	-2.06	1.51
7	Coding	8.80	2.96	14.65	-0.49	-2.33	1.34
8	Mazes	7.86	1.63	14.09	-1.10	-3.04	0.83
9	Full IQ	91.60	65.00	118.21	-0.96	-2.64	0.72
10	Verbal IQ	91.45	62.41	120.50	-0.85	-2.57	0.87
11	Performance IQ	95.00	68.94	121.06	-0.77	-2.49	0.95

Predicted Z-Score Achievement and Neuropsychological Measures with 95% Confidence Intervals



Montage: LinkEars

EEG ID: 090494

Technical Information

Record Length: 15:48

Edit Length: 02:00

Reliability:

	Split Half	Test Retest
Average	0.98	0.90
FP1	0.97	0.93
FP2	1.00	0.96
F3	1.00	0.91
F4	0.97	0.98
C3	0.99	0.94
C4	0.99	0.94
P3	0.99	0.87
P4	0.97	0.81
O1	0.99	0.74
O2	0.98	0.76
F7	0.98	0.88
F8	1.00	0.97
T3	0.95	1.00
T4	0.99	0.98
T5	0.99	0.91
T6	0.97	0.77
Fz	0.99	0.98
Cz	0.98	0.99
Pz	0.99	0.85

Sampling Rate: 128

Collection Hardware: Deymed

An Addendum to Neuroguide QEEG Report

Important disclaimer - QEEG tests are ancillary tests that are not intended to provide a diagnosis by themselves, but are used to evaluate the nature and severity of deregulation in the brain such as in mild traumatic brain injury. The QEEG tests provide a quantitative assessment of areas of brain dysfunction and information on impaired conduction and connectivity between different regional neural networks in the brain. The assessment of impaired connectivity is based on abnormal measurements of Coherence and Phase.

The TBI Discriminant does not provide a diagnosis for MTBI but only information on the presence of a pattern in the EEG that is often found in patients with a history of mild traumatic brain injury. The TBI discriminant also provides information about connectivity and excitability of brain regions.

The TBI discriminant is to be used only on patients with a clinical history and symptoms of a Traumatic Brain Injury and Post Concussion syndrome.

The diagnosis of MTBI is a clinical one and is not based on any one test. A diagnosis is performed by the clinician, who integrates the medical history, clinical symptoms, neurocognitive tests with the above mentioned brain function tests as well as other information to render a diagnosis.

The information on impaired brain connectivity is derived primarily from abnormal measurements of Coherence and Phase. Assessments of regional abnormality rely also on abnormal amplitude (power) distribution across the spectrum of EEG frequencies as compared to the normative database.

Description of the Neuroguide Normative Database:

The NeuroGuide normative database in versions 1.0 to 2.4.6 included a total of 625 carefully screened individual subjects ranging in age from 2 months to 82 years. NG 2.5.1 (6/12/2008) involved the addition of 53 adult subjects ranging in age from 18.3 years to 72.6 years resulting in a normative database of 678 subjects. The inclusion/exclusion criteria, demographics, neuropsychological tests, Gaussian distribution tests and cross-validation tests are described in several peer reviewed publications (Thatcher et al, 1983; 1987; 2003). Two year means were computed using a sliding average with 6 month overlap of subjects. This produced a stable and higher age resolution normative database with a total of 21 different age groups. The 21 age groups and age ranges and number of subjects per age group is shown in the bar graph in Appendix F figure 2 in the NeuroGuide Manual (click Help > NeuroGuide Help).

The individuals used to create the normative database met specific clinical standards of no history of neurological disorders, no history of behavioral disorders, performed at grade level in school, etc. Most of the subjects in the normative database were given extensive neuropsychological tests. Details of the normative database are published at: Thatcher, R.W., Walker, R.A. and Guidice, S. Human cerebral hemispheres develop at different rates and ages. Science, 236: 1110-1113, 1987 and Thatcher R.W., Biver, C.L., North, D., Curtin, R. and Walker, R.W. Quantitative

EEG Normative Databases: Validation and Clinical Correlation. Journal of Neurotherapy, 2003, 7(3/4): 87-121. You can download a description of the normative database by going to www.appliedneuroscience,com and clicking on the webpage Articles & Links > Articles > Article #5.

Is there a normative database for different montages including bipolar montages?

Yes. The raw digital data from the same group of normal subjects is analyzed using different montages such as Average Reference, Laplacian current source density, a common reference based on all 19 channels of the 10/20 system and standard clinical bipolar montages (e.g., longitudinal, circular,

transverse). Users can create any montage that they wish and there will be a normative reference database comparison available for both eyes closed and eyes open conditions

Age range of the LORETA current density and Source Correlation normative databases

The LORETA current density and source correlation norms use the same subjects as are used for the surface EEG norms and the age range is 2 months to 82 years. The computational details of the LORETA current density norms are published at: Thatcher, R.W., North, D., Biver, C. EEG inverse solutions and parametric vs. non-parametric statistics of Low Resolution Electromagnetic Tomography (LORETA). Clin. EEG and Neuroscience, Clin. EEG and Neuroscience, 36(1), 1 – 9, 2005 and Thatcher, R.W., North, D., Biver, C. Evaluation and Validity of a LORETA normative EEG database. Clin. EEG and Neuroscience, 2005, 36(2): 116-122. Copies of these publications are available to download from www.appliedneuroscience,com by clicking Articles & Links > Articles > Numbers 11 and 12. The computational details of the LORETA source correlation norms are in the NeuroGuide manual, click Help > NeuroGuide help > Appendix-G

Implementation of LORETA measurement in Neuroguide

The Key Institute's LORETA equations and the LORETA viewer (Pacual-Marqui et al, 1994; Pascual-Marqui, 1999) can be launched by a single mouse click in the NeuroGuide window. NeuroGuide Deluxe exports frequency domain and time domain edits of 19 channel x 256 point digital EEG in microvolts (or uv^2) in the Lexicor electrode order as the standard input to the Key Institute T-Matrix. Rows are 256 microvolt time points and the columns are 19 channels at a sample rate of 128 thus producing 0.5 Hz resolution from 1 to 30 Hz. 1 Hz increments in the LORETA viewer are computed as the sum of adjacent 0.5 Hz bins and thus the 'Time Frame' control in the LORETA Viewer is frequency from 1 to 30 Hz. (see Pascual-Marqui RD, Michel CM, Lehmann D., 1994. Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. International Journal of Psychophysiology 18:49-65. For computational details see: Pascual-Marqui. R.D., 1999. Review of Methods for Solving the EEG Inverse Problem. International Journal of Bioelectromagnetism, Volume 1, Number 1, pp:75-86. Pascual-Margui, R.D., 2004. Free software and documentation from the Key Institute that was downloaded from http://www.unizh.ch/keyinst/NewLORETA/Software/Software.htm.)

There is a need to match different amplifiers to the amplifier on which the Neuroguide amplifier that acquired the original database information.

This stems from the fact that amplifiers have different frequency gain characteristics. The matching of amplifiers to the Neuroguide database amplifier was done by injecting microvolt calibration signals of different amplitudes and frequencies into the input of the respective EEG machines and then computing correction curves to exactly match the amplifier characteristics of the norms and discriminant functions. The units of comparison are in microvolts and a match within 3% is generally achieved. The Neuroguide research team double checked the amplifier match by computing FFT and digital spectral analyses on calibration signals used to acquire the norms with the calibration signals used to evaluate a given manufacturers amplifiers.

History of the Scientific Standards of QEEG Normative Databases

A review of the history of QEEG normative databases was published in Thatcher, R.W. and Lubar, J.F. History of the scientific standards of QEEG normative databases. In: Introduction to QEEG and Neurofeedback: Advanced Theory and Applications, T. Budzinsky, H. Budzinsky, J. Evans and A. Abarbanel (eds)., Academic Press, San Diego, CA, 2008. A copy of the publication can be downloaded at: http://www.appliedneuroscience.com/HistoryofQEEG%20Databases.pdf