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QEEG Evaluation Results

Client:	XXXX	Date of Birth:	00/00/1959	ID:	XXX-1
Gender:	Female	Test Date:	02/14/2011		

Referred by: Dr. X
Indications: Left sided extremity weakness and fatigue without medical explanation since 2008
Medications: None known

Methodology:

A 19-channel EEG recording was performed using the International 10-20 system of electrode placement. Linked-earlobe referential montages were recorded from this client using a Mitsar model 202 with WinEEG software. Impedance was at or below 5K Ohms at each electrode and signals were digitized at 128 samples per second using low cutoff and cutoff filters of 0.5 and 70 Hz. The client was recorded 1) eyes open at rest, 2) eyes closed at rest. Each recording was 5 minutes or longer. Records were subjected to automatic detection of ocular, muscular, and equipment-related artifact, supplemented by manual review and removal. Fast Fourier transformation was performed on selected data and spectral coefficients were displayed descriptively and statistically. Statistical analysis compared client data to age-appropriate normative databases. The QEEG analyses were based on the most artifact-free epochs available. The analysis software WinEEG Version 2.84.44 (mitsar-medical.com) and Neuroguide Version 2.6.5 (appliedneuroscience.com).

Split half and test-retest reliability are shown in Figure 19.

Eyes open findings:

During most of the recording unmanageable muscle artifact (EMG) dominated the signals at Fp1, Fp2, F7, F3, F4, F8, and less frequently at T3. Since the high cutoff was 70Hz, EMG could be reliably distinguished and appeared to be relatively absent from the vertex. This enables the probable identification of paroxysmal beta spindles at Cz and Fz in the raw EEG (Figure 1). This appears as well in the quantitative analysis of eyes open spectra (Figure 2). Both use a weighted average montage. The peak beta activity is about 22 Hz. LORETA (Low Resolution Electromagnetic Tomographic Analysis) modeling of the source of this beta activity places at Brodmann areas 10, 11 & 32 - the anterior cingulate of the limbic lobe and the medial and orbital gyri of the frontal lobe (Figure 3).

Normative comparison of absolute amplitude in Neuroguide (Figure 11) shows this beta 3 activity (18-25 Hz) to be in excess of +2 SD above normal. In figure 12, relative power, note the +3 SD significance of 19-22 Hz at the vertex.

No classical arciform mu activity was observed on the raw EEG. Nonetheless, quantitative analysis showed a distinct and persistent 12.2 Hz peak at C4 (Figure 2). C4 is the sensory and motor cortex for the left upper limb. This unusual eyes-open peak extends as well to Cz which may or may not be related to the left lower limb, as the associated cortex is deep within the central fissure. Figure 12, a Neuroguide database comparison, shows this 12 Hz activity to be +3 SD above normal.

In Figure 11, eyes open z scored absolute power, note the -3 SD reduction in low frequencies at in the C3 and C4 regions, as well as the +2 SD increase in Beta 3 at the vertex.

Figures 13-18 show Neuroguide coherence z scores for the clinical bands. Note the regularity of abnormalities concerning T6. There is apparently significant hypocoherence between C3 and C4 in the theta and alpha bands (Figures 14 & 15), as well as in beta 2 (15-18 Hz) (Figure 17).

Eyes closed findings:

The eyes closed alpha is asymmetric (Figure 8). Occipital alpha is twice as large on the left at O1 as on the right at O2. It also extends in asymmetrically into the right temporal region (T6). These observations are clearly described as abnormal by Stern and Engel [1]. There appears to be a low voltage beta peak at Cz at 19.5 Hz. (Figure 8).

Conclusions:

This congenial and astute 52 year old women complains of progressive left sided weakness since about 2008. She has undergone MRI scans of brain and spine as well as EMG and nerve conduction studies, all negative. The symptoms developed at a time when she was severally emotionally stressed, leading her to consider the possibility of a psycho-emotional component. Several years before the onset she had a head injury that has left her with an easily palpable skull depression in the vicinity of C3 (10-20 system of EEG placement), roughly 4 cm to the left of the vertex. Her MRI studies have apparently been unremarkable except for a "torturous basilar artery" possibly affecting the pons. The contribution of the basilar artery to thalamus and cortex may explain the above findings, which awaited EEG examination to be uncovered.

There is EEG evidence of abnormal thalamic and/or cortical functioning, with focal changes at C3 and C4, which correlate with her symptomatology. There are further changes, described above, indicating occipital and right posterior temporal disturbance possibly of a vascular nature. The vascular nature of

[1] Stern JM, Engel J. Atlas of EEG Patterns. Lippincott Williams & Wilkins. 2005. p 28..

such EEG changes has been described in the literature [2, 3, 4, 5]. The limbic 18-22 Hz beta may be an unrelated phenomenon whose neuropsychiatric components are unrelated to the chief complaint.

A 30 minute trial of EEG operant conditioning was performed on March 19th, 2011. The goal was to suppress the elevated mu (idling) rhythm at C4 and increase the interhemispheric phase flexibility between C3 and C4 at infra-low frequencies (those seen in BOLD fMRI studies) [6, 7, 8, 9]. There was a rapid improvement in her gait which lasted until the next day. Unfortunately, any such improvements have been temporary in the past, again raising the question of psycho-emotional factors. But in this case the therapy was targeted directly to a reproducible abnormality detected in the EEG. There is currently discussion of therapeutic trials of both transcranial direct current stimulation (tDCs) [10] and neurofeedback.

Interpretation of these findings requires further clinical correlation.

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[2] Mintschev D, et al. [Electroencephalographic findings in vertebro-basilar circulation disorders]. Psychiatr Neurol Med Psychol (Leipz). 1975 Aug;27(8):470-6.

[3] Pfurtscheller G, et al. Correlations between CT scan and sensorimotor EEG rhythms in patients with cerebrovascular disorders. Electroencephalogr Clin Neurophysiol. 1981 Nov;52(5):473-85

[4] Pfurtscheller G, et al . Foot and hand area mu rhythms. Int J Psychophysiol. 1997 Jun;26(1-3):121-35.

[5] Pfurtscheller G. Event-related synchronization (ERS) in the alpha band--an electrophysiological correlate of cortical idling: a review. Int J Psychophysiol. 1996 Nov;24(1-2):39-46.

[6] Mantini D, et al (2007) - Electrophysiological signature of resting state networks in the human brain. PNAS August 7, 2007 Vol 104 No 32.

[7] Cordes D, et al (2001) - Frequencies contributing to functional connectivity in the cerebral cortex in 'resting-state' data. Am J Neuroradiol 22:1326–1333, August 2001.

[8] Monto S, et al (2008) - Very slow EEG fluctuations predict the dynamics of stimulus detection and oscillation amplitudes in humans. The Journal of Neuroscience, August 13, 2008 28(33):8268–8272.

[9] Raichle ME (2010) - Two views of brain function (Review). Trends in Cognitive Sciences Vol.14 No.4.

[10] Matsumoto J, et al (2010) - Modulation of mu rhythm desynchronization during motor imagery by transcranial direct current stimulation. Journal of NeuroEngineering and Rehabilitation 2010, 7:27.

Figure 1 - Eyes open EEG fragment (Weighted average montage)

Figure 2 - Eyes open EEG spectra (Weighted average montage)

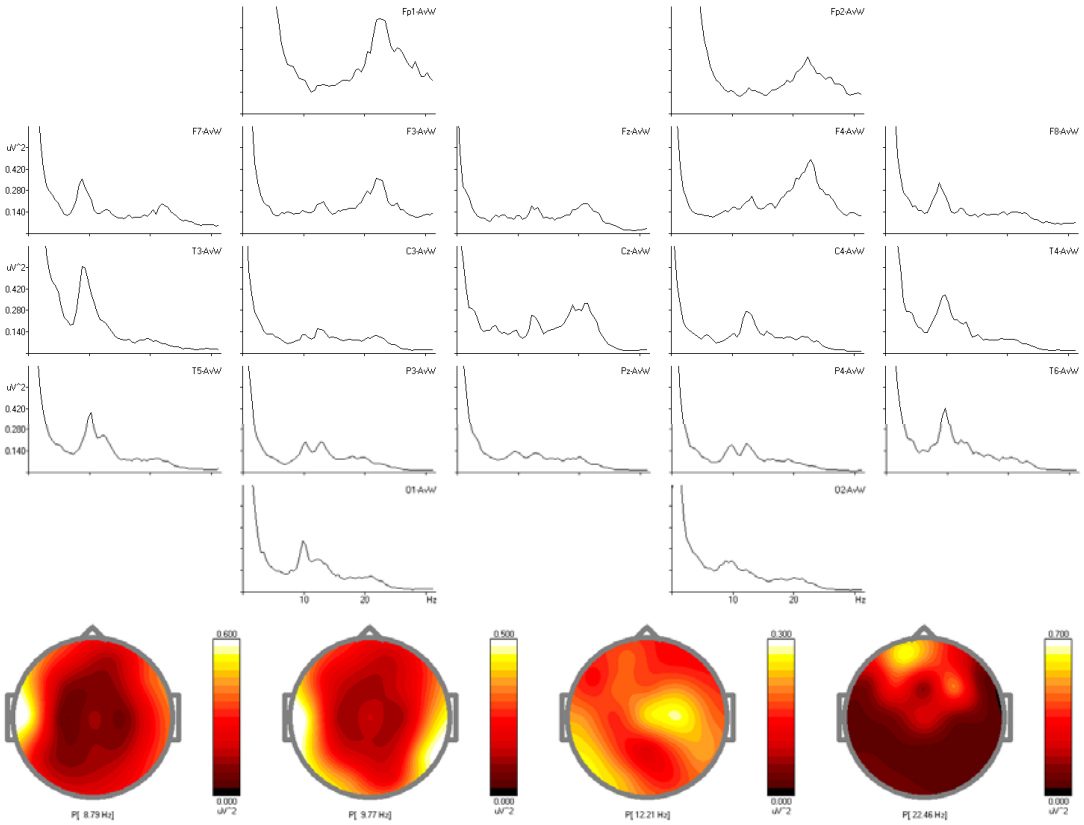

Figure 3 - LORETA localization of the 20-24 Hz beta activity seen in the raw eyes open EEG

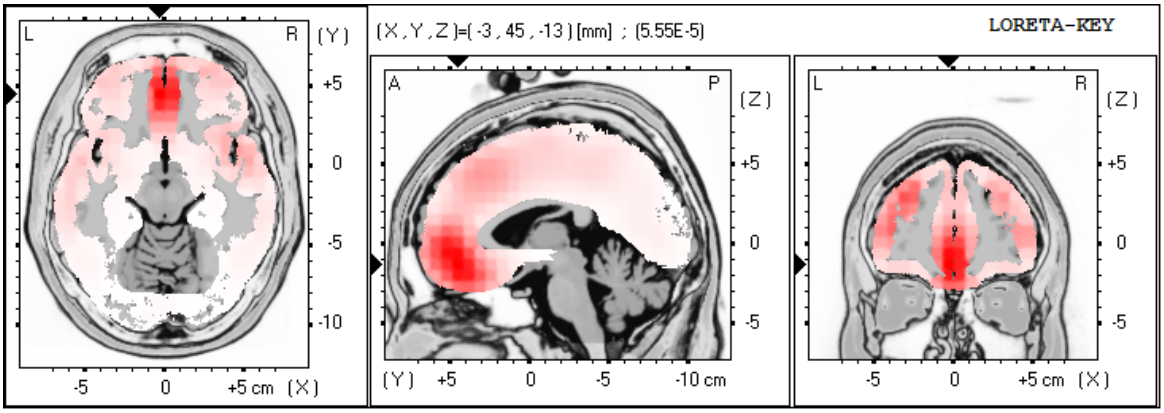

Figure 4 - Quantitative evaluation of network coherence in the eyes open recording

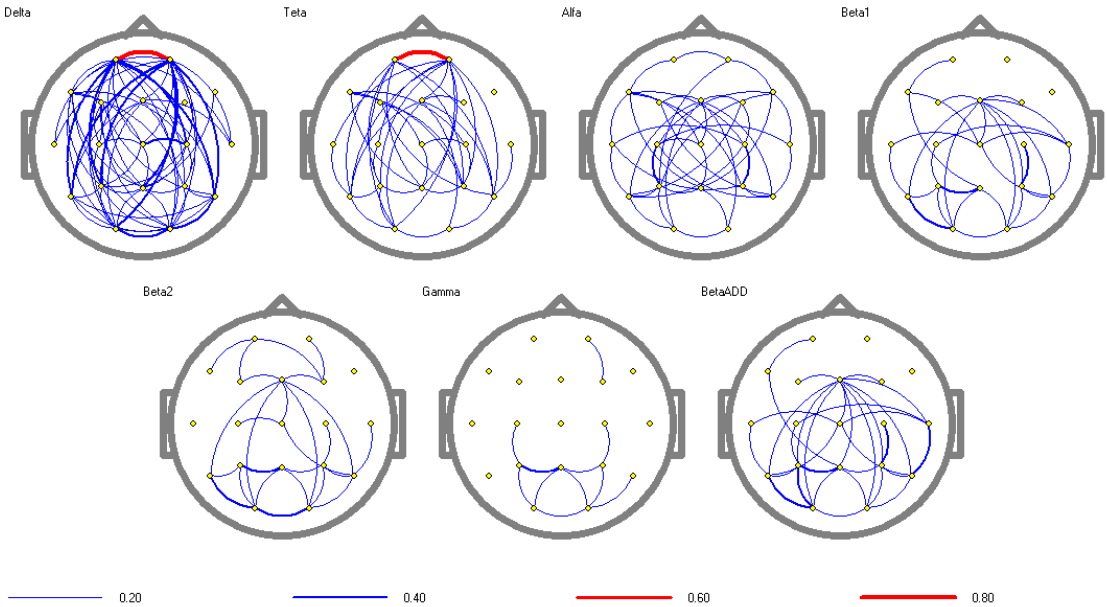

Figure 5 - Maps of absolute power for the eyes open recording

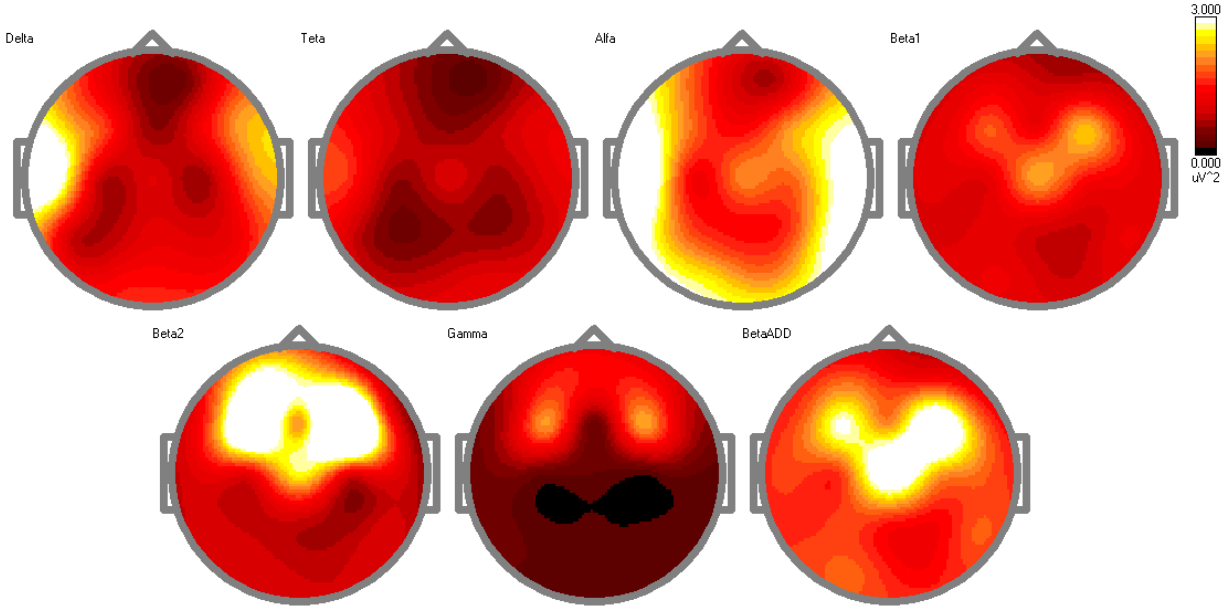

Figure 6 - Bispectral calculations for the eyes open recording

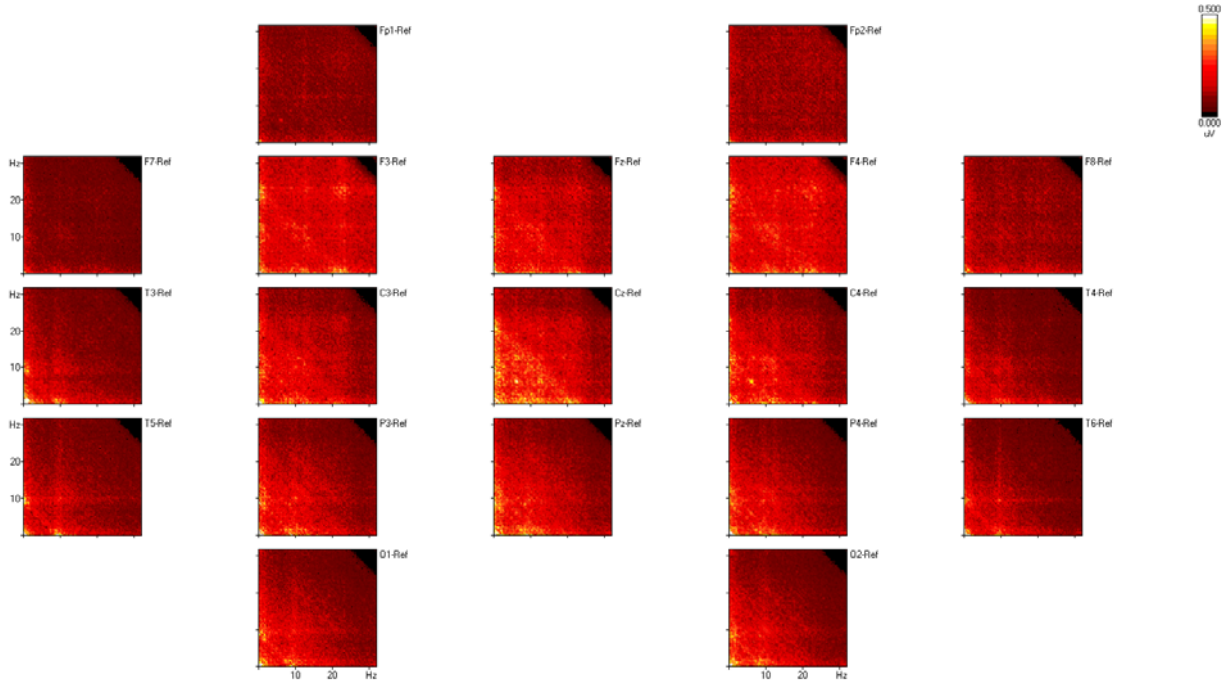

Figure 7 - Eyes closed EEG fragment (Weighted average montage)

Figure 8 - Eyes closed EEG spectra (Weighted average montage)

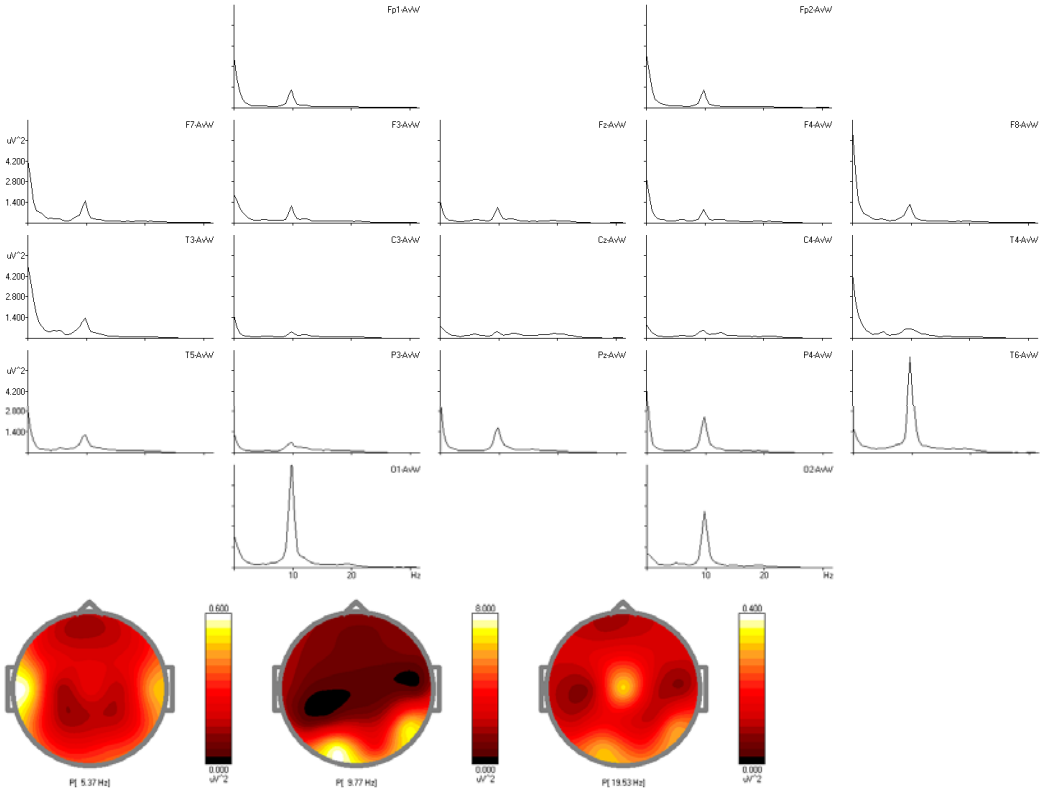

Figure 9 - Quantitative evaluation of network coherence in the eyes closed recording

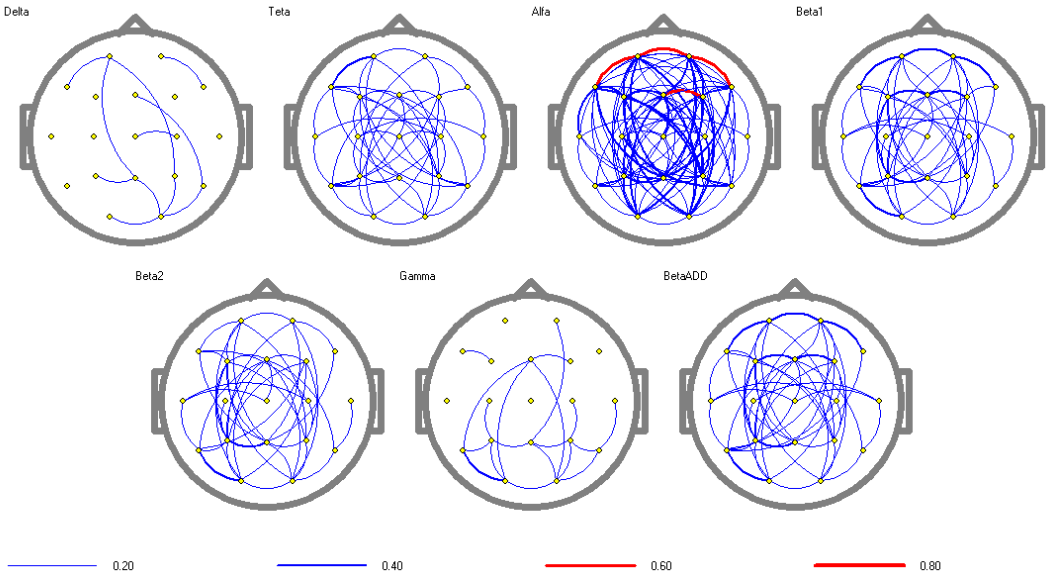

Figure 10 - Bispectral calculations for the eyes closed recording

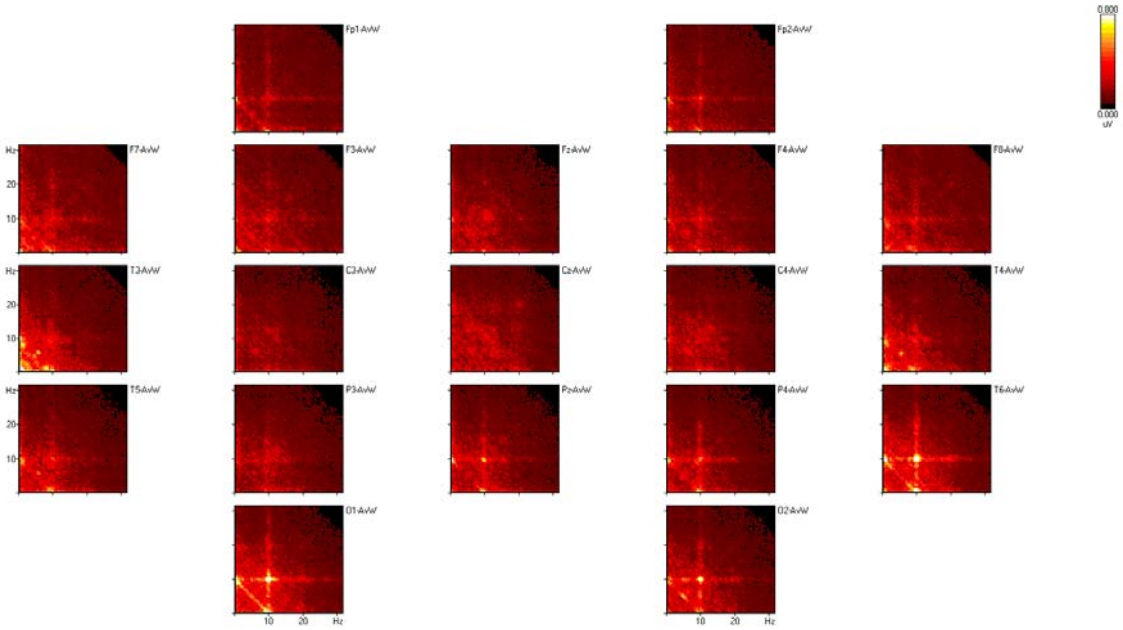

Figure 11 - Eyes open absolute power z scores (linked ears montage)

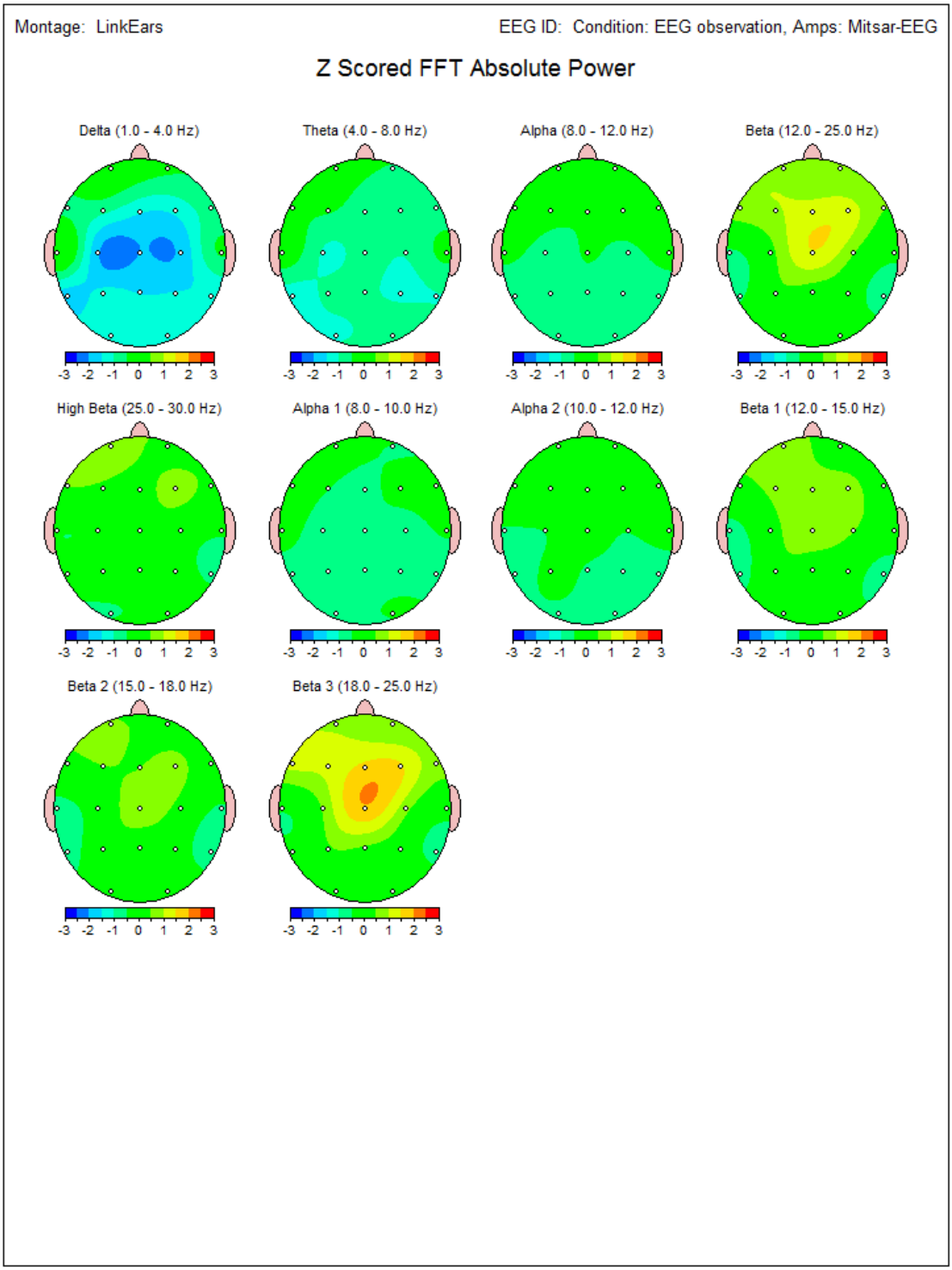

Figure 12 - Eyes open relative power z scores (linked ears montage)

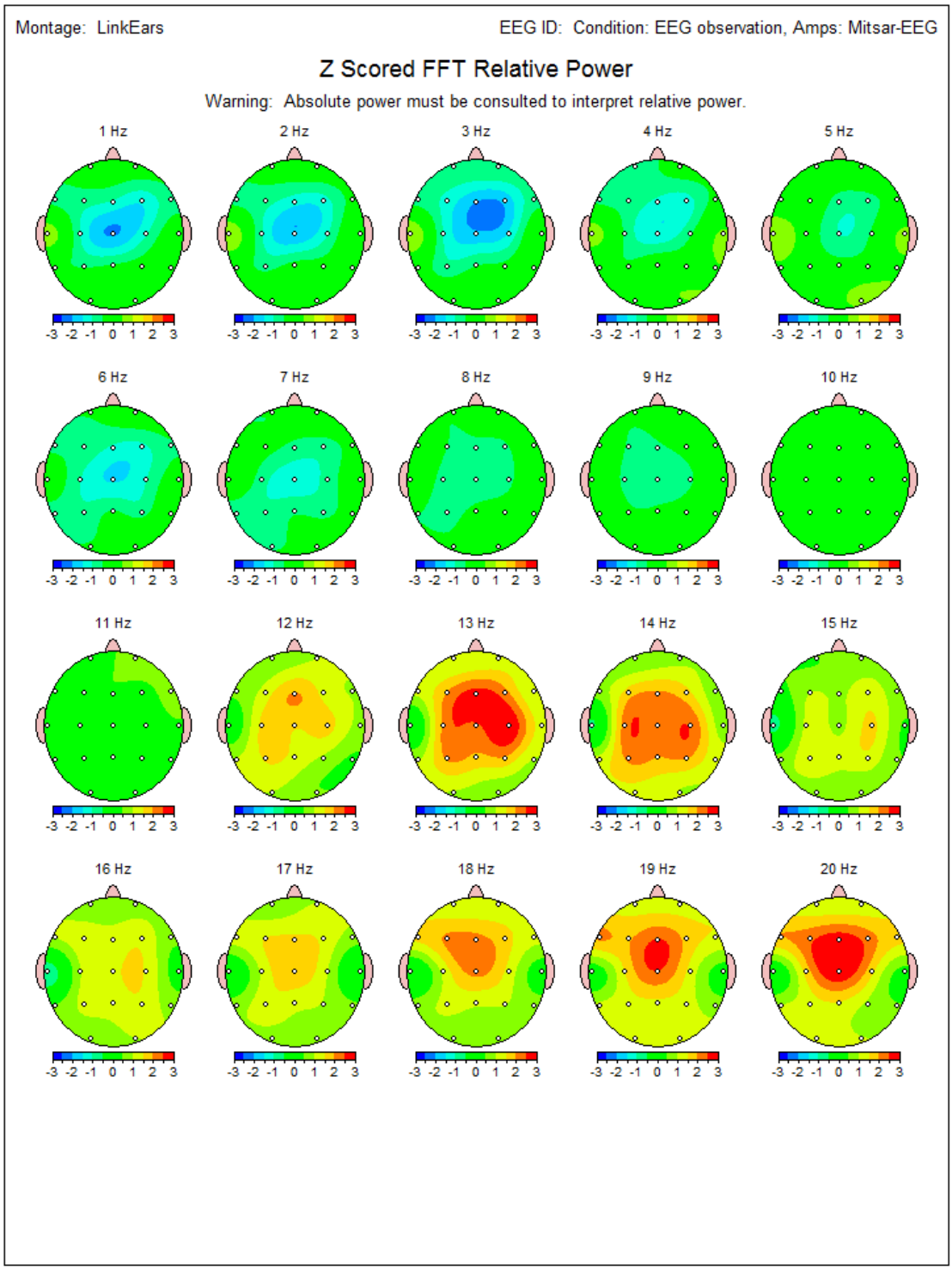

Figure 12 (Continued) - Eyes open relative power z scores (linked ears montage)

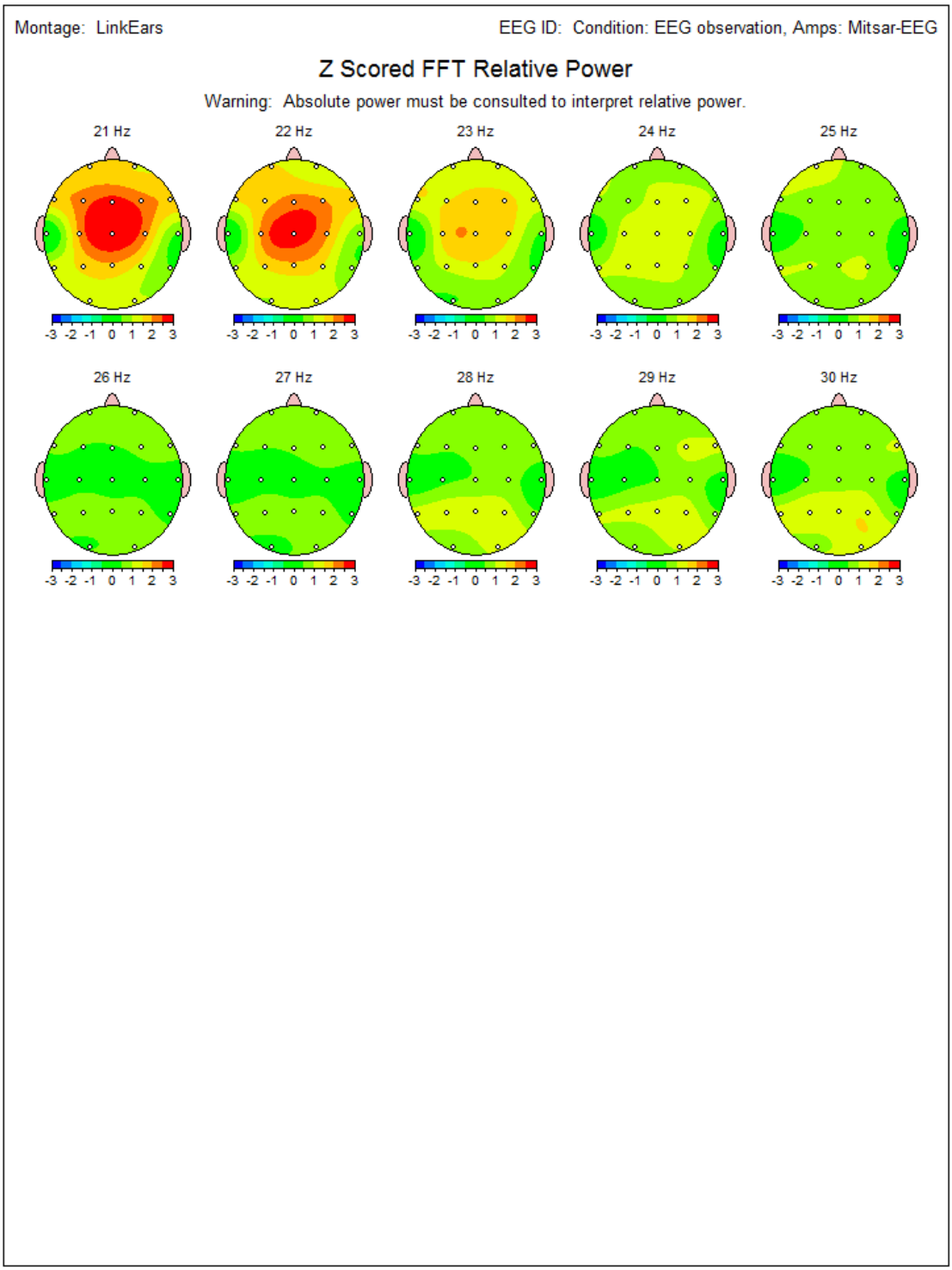

Figure 13 - Eyes opened coherence z scores - Delta

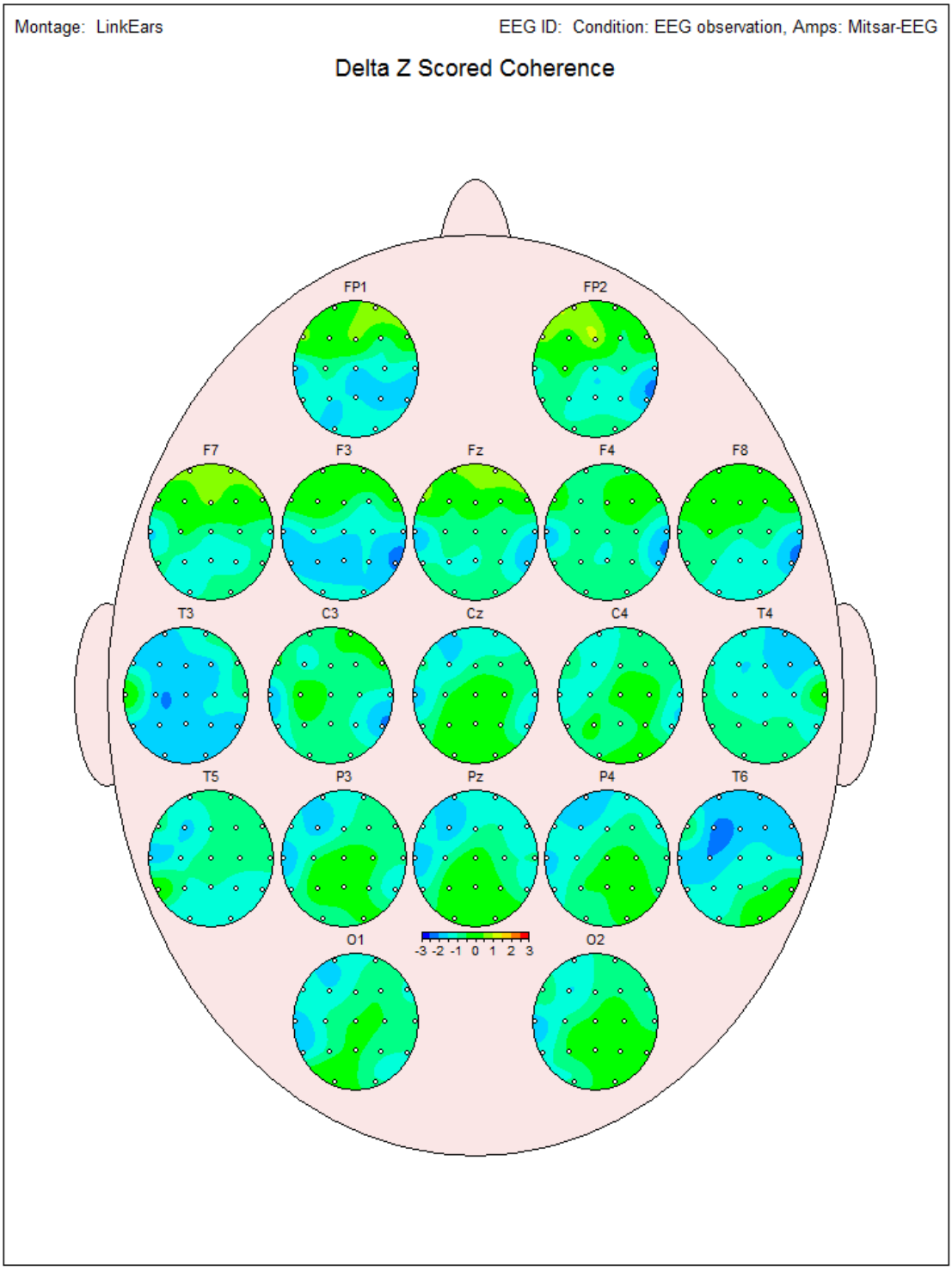

Figure 14 - Eyes opened coherence z scores - Theta

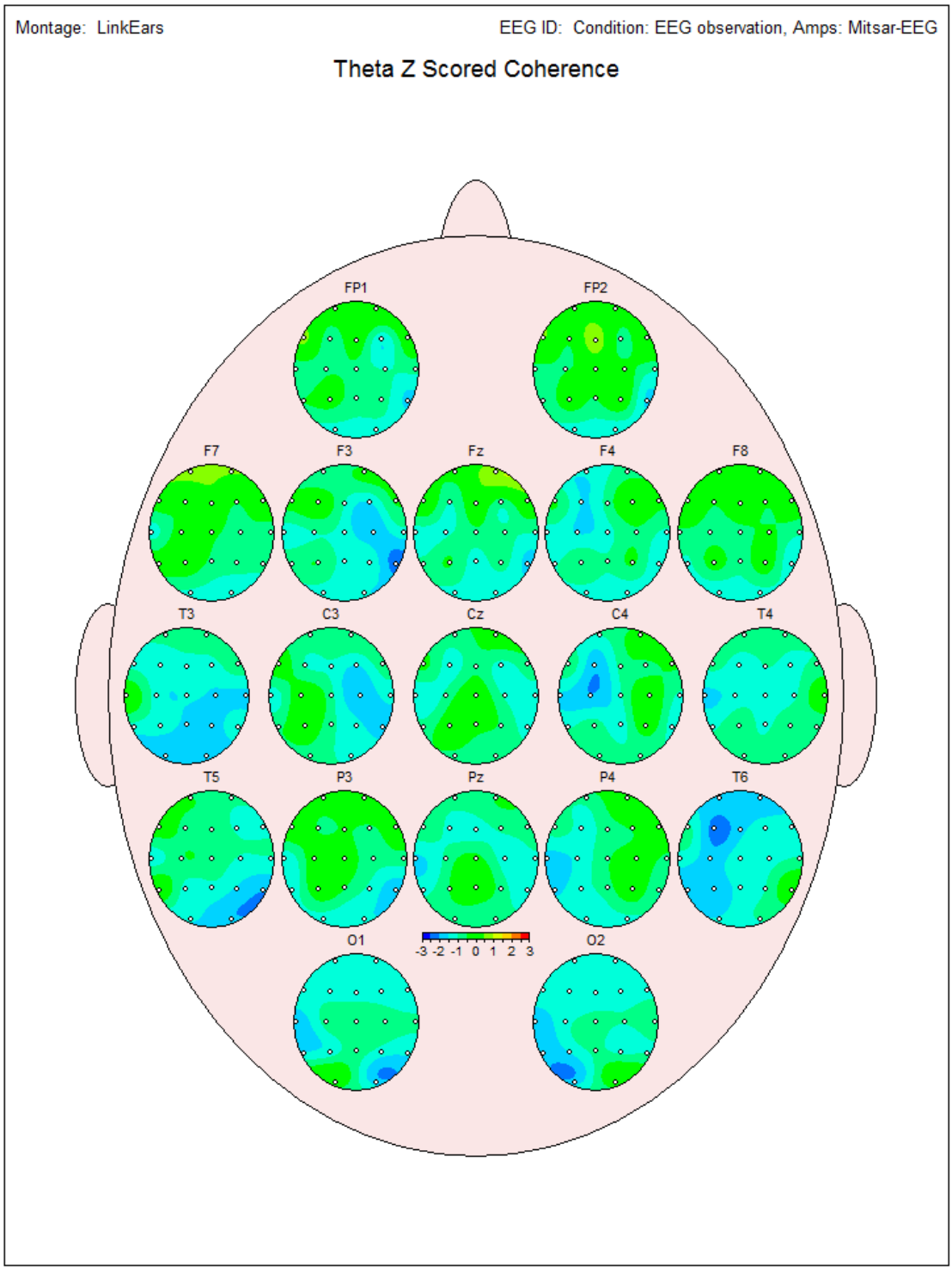

Figure 15 - Eyes opened coherence z scores - Alpha

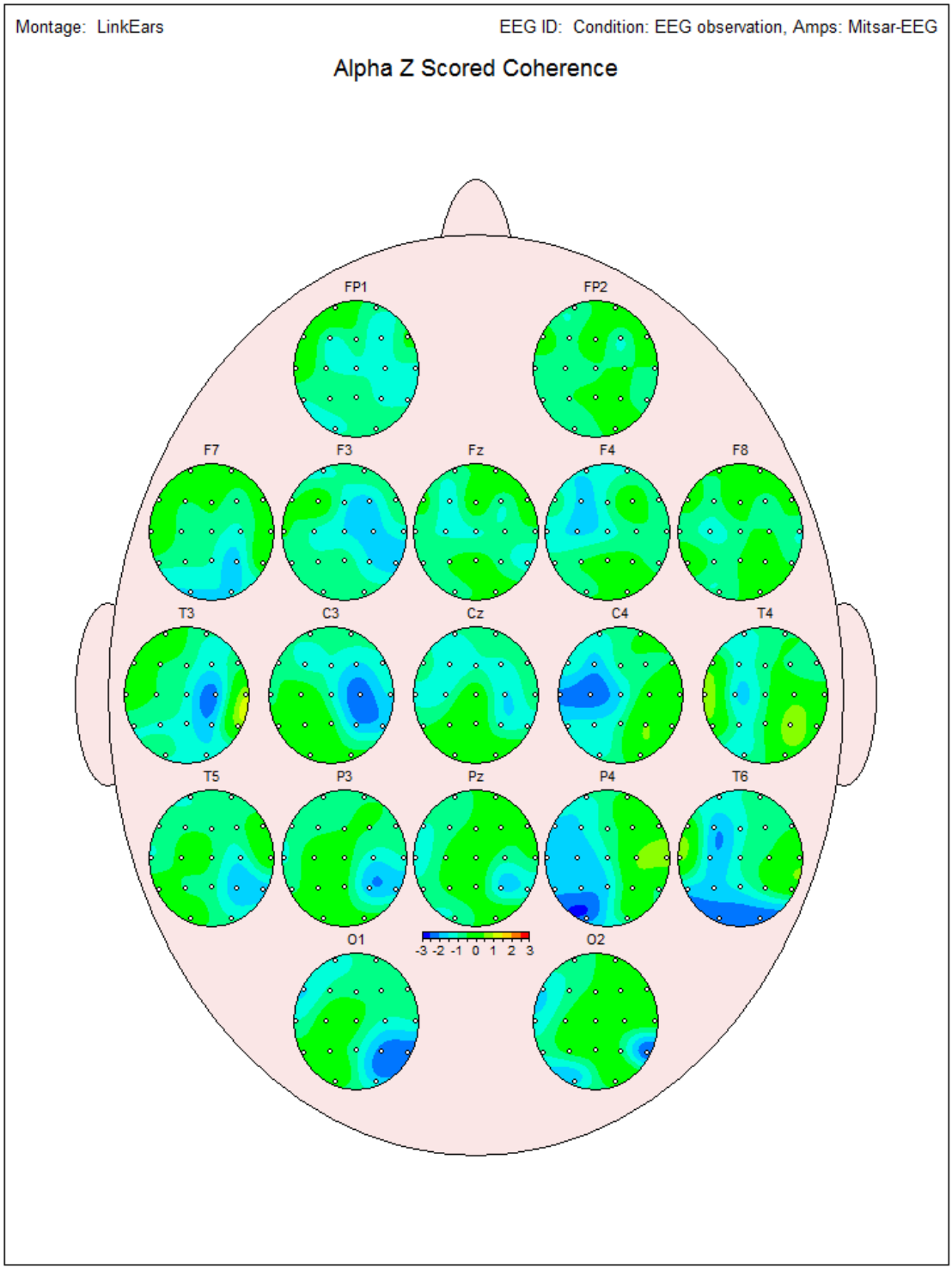

Figure 16 - Eyes opened coherence z scores - Beta 1

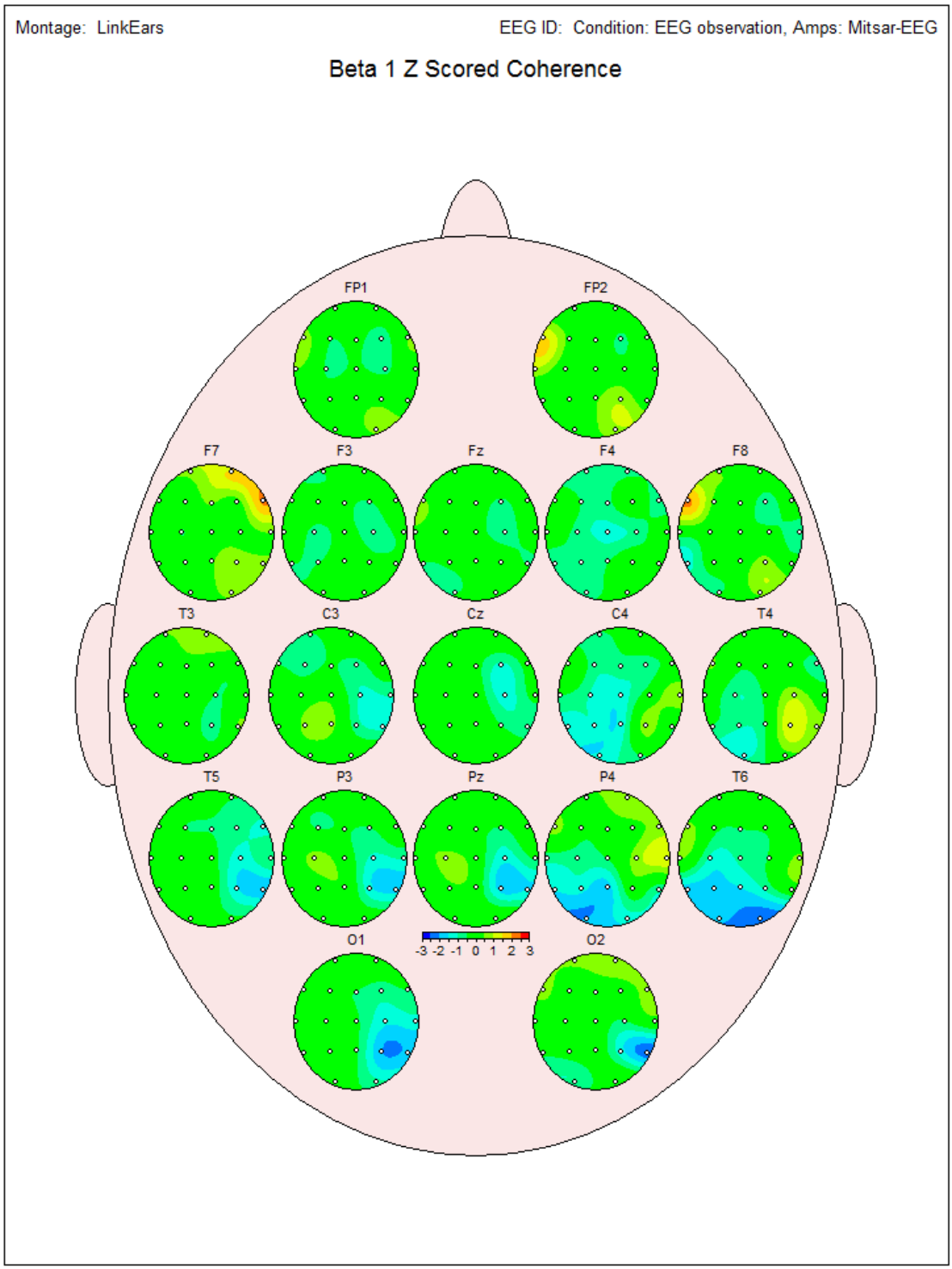

Figure 17 - Eyes opened coherence z scores - Beta 2

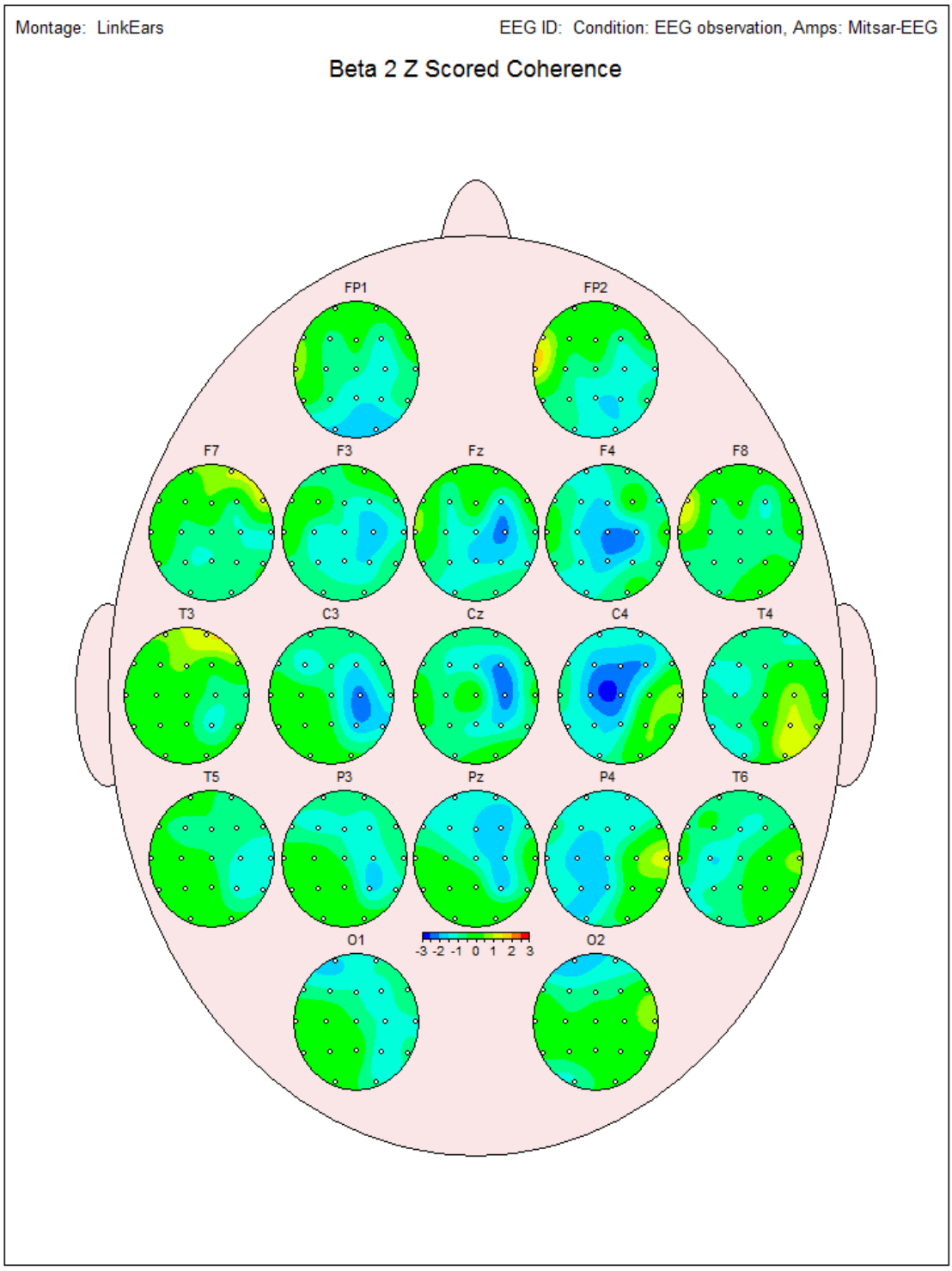

Figure 18 - Eyes opened coherence z scores - Beta 3

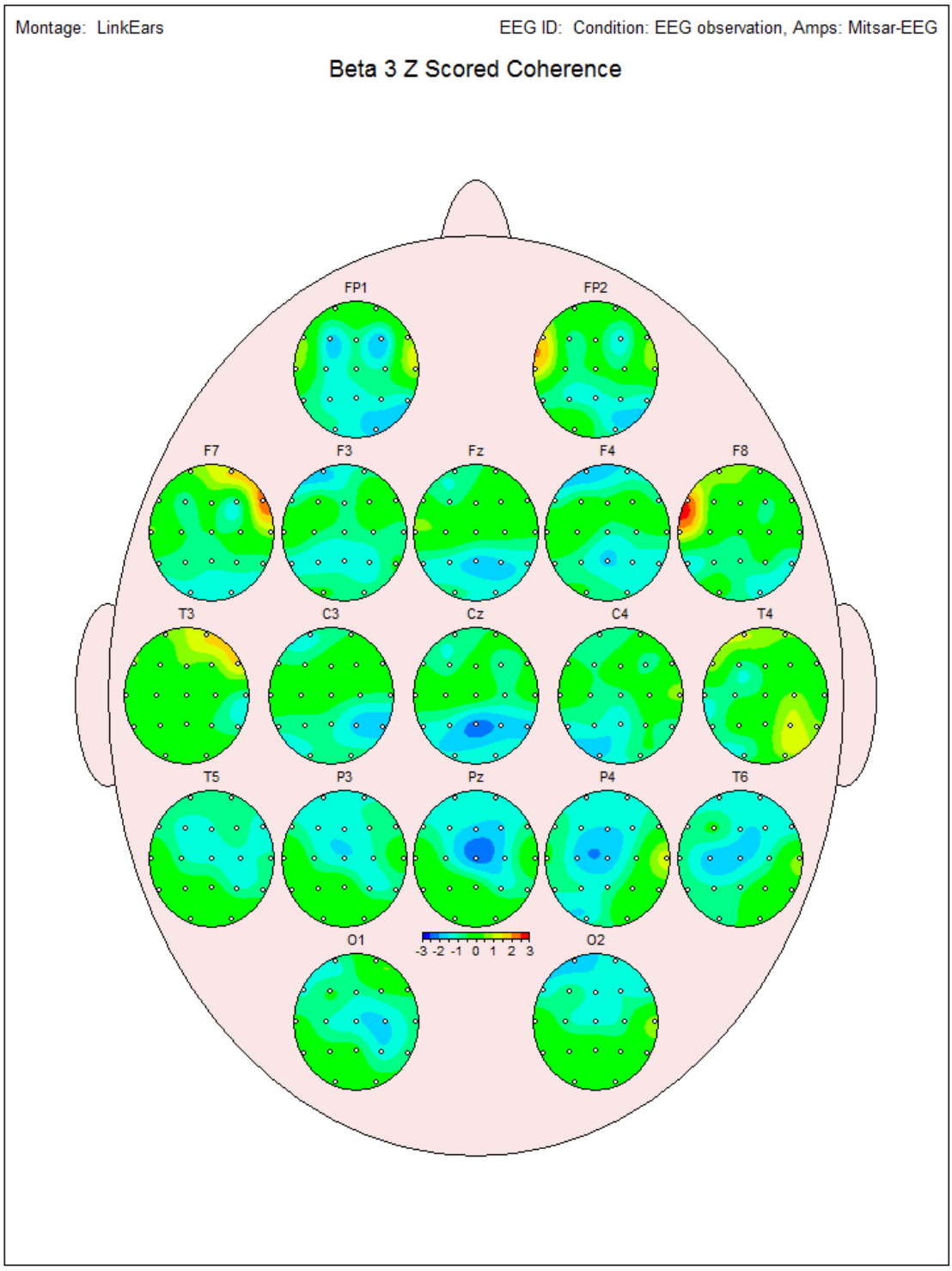

Figure 19 - Split half and Test-Retest Reliability

Montage: LinkEars

EEG ID: Condition: EEG observation, Amps: Mitsar-EEG

Technical Information

Record Length: 07:25

Edit Length: 02:14

Reliability:

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

Sampling Rate: 250

Collection Hardware: Mitsar