

Incorporating quantitative EEG analysis into the MNI Open Science neuro-informatics ecosystem

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SUMMARY

This poster presents the integration of the Tomographic Quantitative EEG Analysis toolbox (**qEEGt**), as a plugin in **CBRAIN**.

CBRAIN is an open neuro-informatics platform, developed at the Montreal Neurological Institute (MNI), connected to a database system named LORIS. CBRAIN and LORIS are the pioneer efforts developed by the MNI for the purpose of open science.

qEEGt deploys the toolbox developed at the Cuban Neuroscience Center (CNEURO). It includes age regression equations and calculation of z- spectra based on a Normative Database collected by the Cuban Human Brain Mapping.



Introduction

Revived interest in electrophysiology, driven by the maturity of EEG source imaging, has led to new informatics challenges (7). Integrating sophisticated EEG analysis with high-performance computing is pivotal to promulgating standardized methods across research and clinical settings (1).

In response, a joint collaboration from the Cuban Neuroscience Center (CNEURO), the University of Electronic Science and Technology of China (UESTC) and the Montreal Neurological Institute (MNI) is incorporating CNEURO's quantitative EEG methods into the MNI Open Neuroscience ecosystem, based on the LORIS and CBRAIN data- and tool-sharing platforms (3).

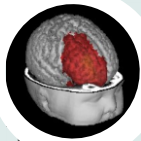
CNEURO's Quantitative EEG toolbox (qEEGt) offers VARETA source imaging method (2), age regression equations and calculation of z- spectra to produce age-corrected normative SPM maps of EEG log source spectra.





qEEGt Features

- **qEEGt** is mainly (but not only) for the analysis of the EEG resting state activity.
- It uses artifact free EEG epochs of quasi-stationery signals.
- Measurements are calculated for both EEG at the scalp as well as for the primary current at the sources by means of estimating the VARETA solution.



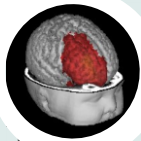
qEEGt Features



- Signal are transformed to the frequency domain by means of FFT to produce:
 - Cross-spectral matrices for the leads, for the whole frequency narrow band range (defined by the user)
 - Raw Log scalp/source spectra for Narrow/Broad-Band models.
 - Z-probabilistic measurements for the scalp/source spectra, using the norms of the Cuban population, in a range from 5 to 87 years.
 - Coherence matrices (*)

(*) coherence matrices have been widely used to assess EEG symmetry among homologous leads and hemispheres. It is not considered here as a measurement of connectivity.

Brain connectivity at the scalp makes no sense.



qEEGt Features

- Normative data are provided for:
 - Eyes Close and Eyes Open brain states
 - Average Reference, Linked-Ears and Laplacian montages
 - Traditional Broad Model (Hz): δ (1.5-3.5); θ (3.5-7.5), α (7.5-12.5), β (12.5-19.15)
 - Narrow Band Frequency range: from 0.39, step: 0.39, to: 19.15 Hz
 - With or without correction by the Global Scale Factor



qEEGt Features

- For the Raw spectra:
 - Broad-Band model is defined at user's convenience
 - Narrow Band Frequency range and resolution defined by user
 - Average Reference, Laplacian and Linked-Ears montages available, as well as re-referencing to any of the leads
 - Global Scale Factor correction at user selection (GSF*)

(*) GSF is a factor defined by (11) to account for the percent of EEG variability not related neurophysiological activity, thus, this factor makes the recordings from different devices and different persons more comparable.




qEEGt Features

- For both Z and Raw spectra the Broad-Band model includes:
 - Absolute Power
 - Relative Power
 - Mean Frequency: the frequency which divides the area under the spectra at each band in two equal parts.

qEEGt-CBRAIN Interface

1. The first step is to register as a CBRAIN user (if not yet done) and to login at the CBRAIN portal.
2. Then select the qEEG plugin and Launch the task.



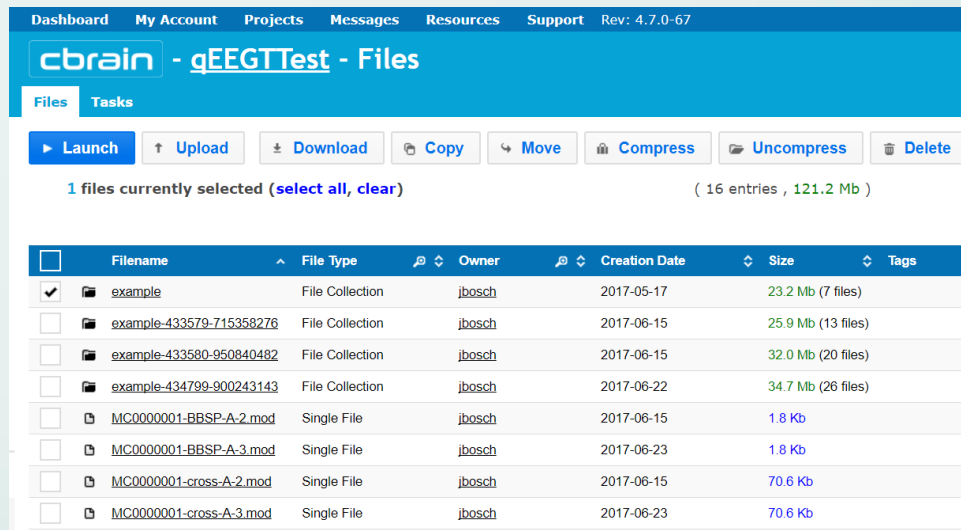
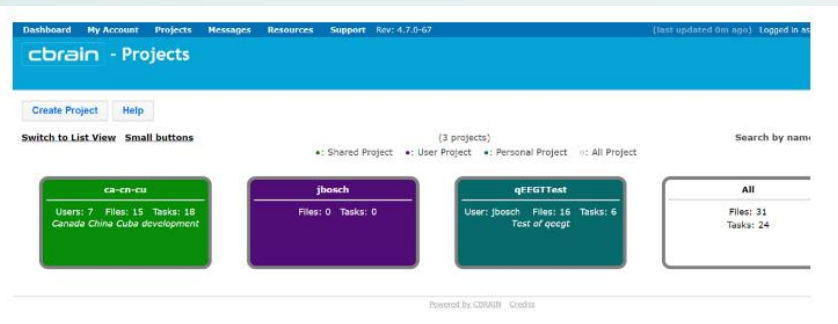
The screenshot displays the CBRAIN web interface for managing projects. The top navigation bar includes links for Dashboard, My Account, Projects, Messages, Resources, and Support, along with the version number (Rev: 4.7.0-67) and a login status (Logged in as...). The main heading is "cbrain - Projects". Below this, there are buttons for "Create Project" and "Help". A section titled "Switch to List View" and "Small buttons" is visible. The projects are listed in a grid, with filters for "Shared Project", "User Project", "Personal Project", and "All Project". The "All Project" filter is selected, showing a list of projects with their respective statistics (Users, Files, Tasks) and descriptions.

Project Name	Users	Files	Tasks	Description
ca-cn-cu	7	15	18	Canada China Cuba development
jbosch	0	0	0	
qEEGtTest	User: jbosch	Files: 16	Tasks: 6	Test of qeegt
All		Files: 31	Tasks: 24	

Powered by CBRAIN Credits

qEEGt-CBRAIN Interface

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qEEGt-CBRAIN Interface

Set the parameters at the menu and start the task

DashboardMy AccountProjectsMessagesResourcesSupportRev: 4.7.0-57

cbrain - qEEGTest - Launch Qeeg

FilesTasks

(last updated 2m ago) Logged in asSign out

Search for anything

Launch qeeg Task

Task Control: (show/hide)

Server & Version:
undefined

Save results to:
Data provider of input files (info)

Description:

Owner:
Jösch (Jorge Bosch-Bayard)

Project:
qEEGTest

(This first line should be a short summary, and the rest are your notes)

Preset Management: (show/hide)

Task Parameters (Help):

Input directory *

example

Directory containing the files to process.

Baseline *

Baseline of the file to process in the input directory.

State *

A

Example: "A", EEG state to be analyzed. The program will look for existing analysis windows labelled as state 'A' (Eyes Closed).

Window length *

2.56

Length of the analysis window in seconds.

fmin *

0.390625

Low cut frequency for analysis. Example: "0.390625".

freqres *

0.390625

Frequency resolution for analysis. Example: "0.390625". The analysis will use a frequency band like this: fmin:freqres:fmax. The program will compare this interval with the interval that is obtained for the real frequency parameters of the signal and will match both of them.

fmax *

19.11

High cut frequency for analysis. Example: "19.11".

wbands *

1.56 3.51; 3.9 7.41; 7.8 12.48; 12.87 19.11; 1.56 19.11

Broad Bands definition. A string representing a 5x2 matrix of real numbers, where rows are separated by ';' and columns by spaces. Example: "1.56 3.51; 3.9 7.41; 7.8 12.48; 12.87 19.11; 1.56 19.11".

Brain (--brain)

Restricts the inverse solution to only gray matter. Otherwise, deep structure (basal ganglia) will be included in the grid.

PG Apply (--pg_apply)

Subtracts the Global Scale Factor (Geometric Power) from the EEG signal.

Broad Band Spectral Model (--bbsm)

Calculates the Broad Band Spectral Model.

Narrow Band Spectral Model (--nbsm)

Calculates the Narrow Band Spectral Model.

Spectra (--spectra)

Calculates the Spectra at the EEG sources.

Broad Band Spectral Model Z values (--bbsmz)

Calculates the Broad Band Spectral Model Z values.

Narrow Band Spectral Model Z values (--nbsmz)

Calculates the Narrow Band Spectral Model Z values.

Source Spectra Z (--ssz)

Calculates the Sources Spectra Z values.

Source Spectra Z (--ssz)

Calculates the Sources Spectra Z values.

Correlations matrix (--corr)

Calculates the correlations matrix between all pairs of channels for each epoch.

Coherence matrix (--cohe)

Calculates the coherence matrix between all pairs of channels for each frequency.

Phase difference matrix (--phdiff)

Calculates the phase difference matrix between all pairs of channels for each frequency.

Frequency domain correlations (--fcorr)

Calculates the frequency domain correlations between all pairs of channels for each frequency and each epoch.

XYZ components (--storexyz)

Stores the XYZ components of the solutions at the sources.

Output Directory (--output)

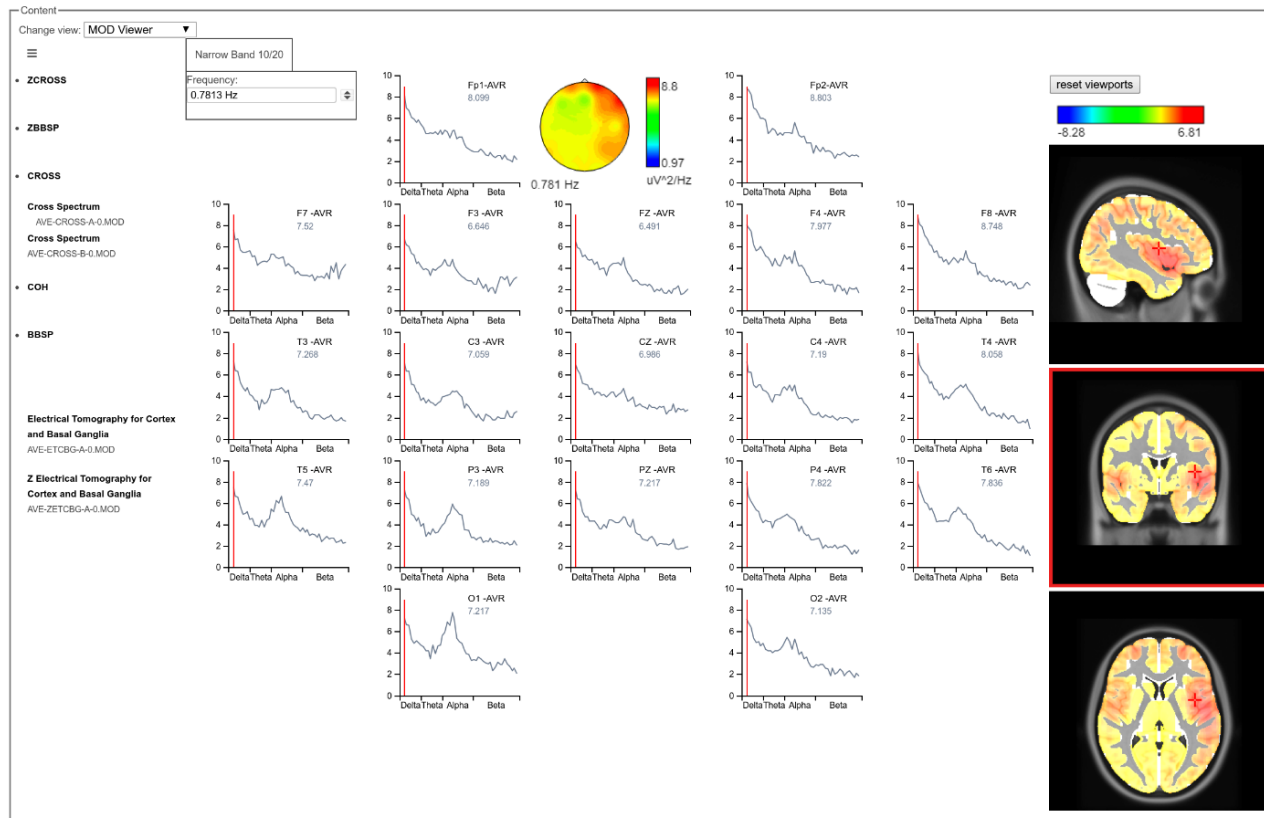
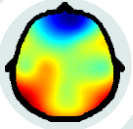
results

Place to store outputs

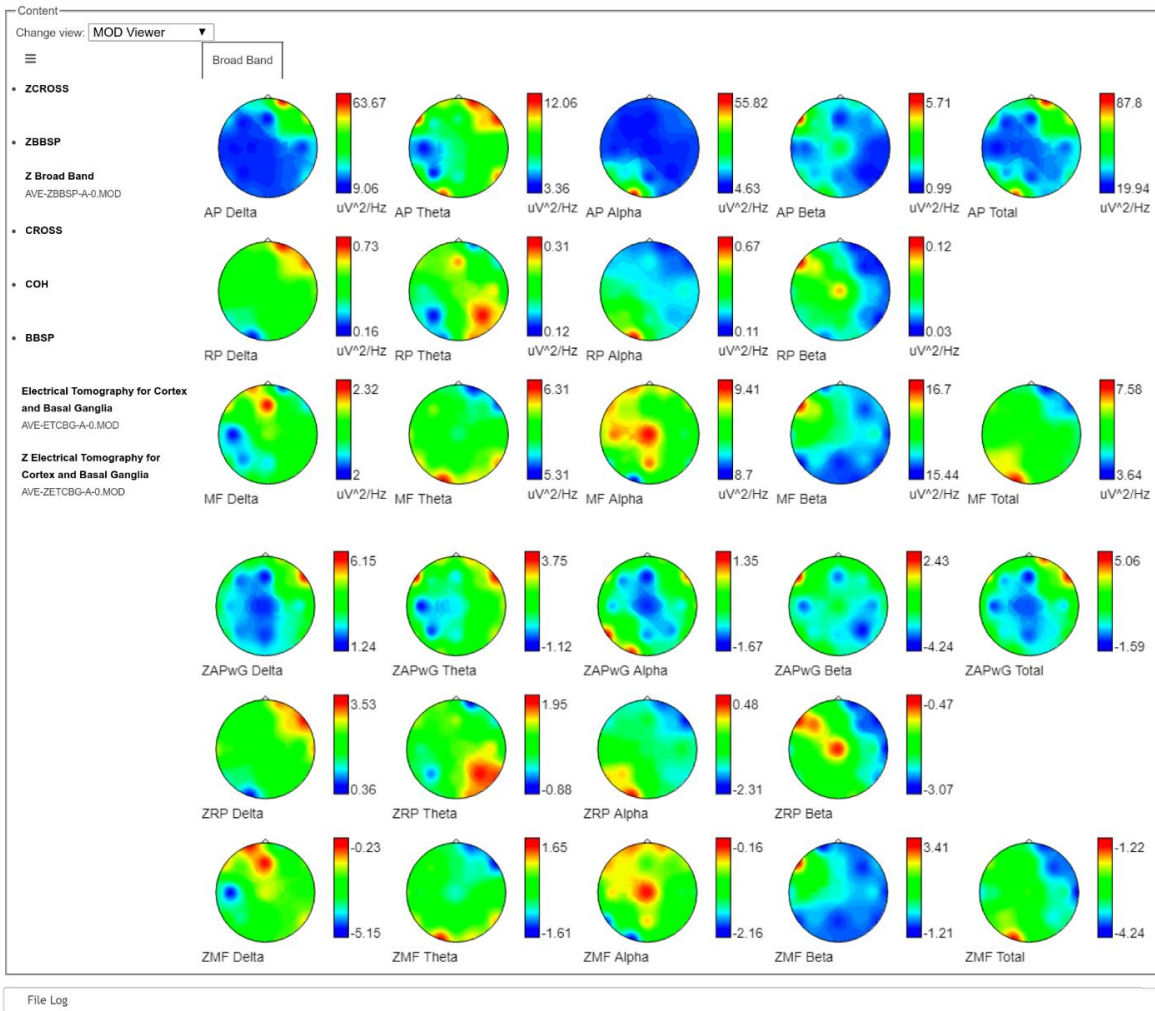
Preview

Start qeeg

Results



CBRAIN qEEGt visualization tool. Log raw EEG spectra at the scalp for the leads. The topographic and 3D tomographic maps are drawn at frequency 0.78 Hz, where the cursor is located. The red color at the maps show increased frontal activity, that extends to the temporal in the right hemisphere. The 3D tomographic maps show that the maximum of the activity is in the temporal pole. Similar graphs can be obtained for the Z values, both at the sensors as well as at the sources.



Results



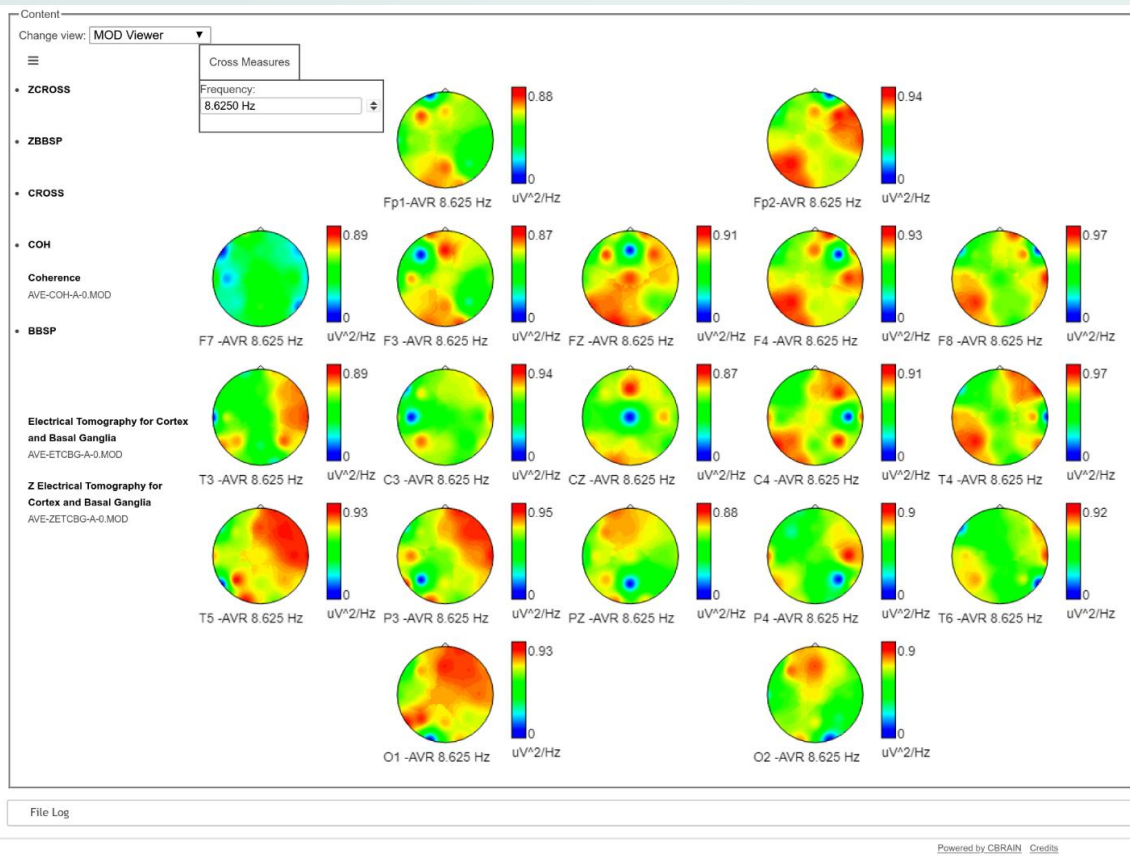
CBRAIN qEEGt visualization tool.
Broad-Band model at the scalp.

Z-values and Log-raw EEG spectra are shown at the same screen. Above the Log-raw values for the 4 frequency bands at every Lead. Below, the same results for the Z-spectra.

The red color in the raw Absolute Power maps (first row) show the same frontal and temporal higher slow activity (Delta and Theta) that was observed in the previous Figure in the right hemisphere.

The Alpha activity is concentrated in the contrary hemisphere (O1).

Results



CBRAIN qEEGt visualization tool.

Topographical maps of the coherences of one electrode against the rest, at a specific frequency (8.6 Hz in the example). In each map, the blue dot refers to the position of the target electrode, showing its coherence regarding the rest of the head. Values in these maps go from 0 (blue) to red (1). For example, the maps of T5, P3 and O1 show a very high coherence between the parieto-occipital leads of the left hemisphere with the frontal and temporal leads of the contrary hemisphere.

References

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The present qEEGt plugin is the first step to introduce quantitative EEG functionalities in CBRAIN, one of the most widely used ecosystems for brain imaging analysis.

The “normative SPM of EEG source spectra” based on the use of EEG normative databases are released in an open source toolbox for the first time.

The introduction of the Global Scale Factor is a key feature to make EEG recordings from different sites, EEG devices and persons more comparable for statistical purposes.

The EEG features obtained from the qEEGt are widely used in many of the new novel procedures of variable classification: biomarkers, early brain illnesses detection, alone or in combination with other kinds of neuroimages.

CONCLUSIONS



THANK YOU!