**BIOMARKER FUSION CLASSIFICATION**

The complexity of assessing all possible combinations of qEEG & ERP biomarker features scales up with the addition of each potential feature. Neuronetrix has implemented a flexible architecture to facilitate automated classification of qEEG/ERP data using artificial neural networks. The COGNISION™ Classifier module enables rapid testing and validation of meaningful combinations of qEEG/ERP biomarkers.

Features of the COGNISION™ Classifier module include:

- **Database**: Entire classification system is built on the COGNISION™ Patient Manager database so all clinical biomarker information can be used in the classification model.
- **Meta Modeling**: Easy and intuitive definition of classification model architecture (Class-Set, Feature Set, Training Set, Experts, Validation, etc.)
- **Data Fusion**: Can combine data from qEEG and ERP tests (spectral properties, amplitude vs. time, areas under the curve, wavelets, etc.).
- **Feature Fusion**: Automatically extracts and combines groups of features using optimized experts (Support Vector Machine, Multi-Layer Perceptron, Random Forrest, etc.).
- **Decision Fusion**: Combines decisions from multiple experts for final classification (Weighted Majority Voting, Stacked Generalization, etc.).
- **Model Validation**: Implements automatic k-fold validation.

**COGNISION™ APPLICATIONS**

- **Cognitive Research**
- **Large-scale Therapeutic Trials**
- **Clinical Investigations of Cognitive Disorders**

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**SCIENTIFIC & CLINICAL REFERENCES**

- Jackson C., Snyder P. J., Electroencephalography and event-related potentials as biomarkers of mild cognitive impairment and mild Alzheimer’s disease, Alzheimer’s & Dementia 4, S137-S143 (2008)
Recent scientific studies using complex electrophysiological measures have detected brainwave signatures for many neurological processes. NeuroNetrix has translated these scientific advances into an easy-to-use system to rapidly test and evaluate a variety of cognitive functions. The company’s COGNISION™ System automatically performs a selection of standardized qEEG/ERP tests, and then uses proprietary pattern recognition algorithms to automatically classify the subject’s brainwave signatures.

Advanced features include:

- Wireless, battery-powered system for use in an office environment
- Subject-friendly headset fits a large range of head sizes
- Calibrated insert earphones ensure consistent auditory stimuli
- Active electrodes provide high SNR and fewer artifacts
- Integrated action buttons for subject responses
- User-friendly design

COGNISION™ Test Admin

COGNISION™ tests are "ordered" in advance through the Patient Manager module and can be performed at any site which has a COGNISION™ System. The tests are administered by looking up which tests have been scheduled to be performed at a particular site and for a particular subject. The tests are then downloaded into the headset and performed.

Features of the COGNISION™ Test Admin module include:

- Notification of tests to be performed
- Specific tests identified for each subject
- Real-time display of test data, artifacts, and task responses
- Confirmation of test completion

COGNISION™ ERP Viewer

The COGNISION™ Software includes an expert application to view and analyze qEEG/ERP data. Raw, average, grand average, and group average waves can be displayed. All preprocessing functions can be stored and automatically applied to facilitate rapid qEEG/ERP interpretation. The Viewer module is fully integrated with the Patient Manager and Classifier modules.

COGNISION™ Viewer display functions include:

- Raw EEG/ERP, average, difference, grand average, and grand difference waves
- Power spectrum
- Wavelet transforms
- Automatic paradigm grouping
- Normalization: amplitude, offset, and drift
- Sinc(x) function interpolation
- Automatic peak detection

COGNISION™ Patient Manager

Management of vast amounts of personal, clinical, and biomarker data in longitudinal, multi-center studies present a formidable logistical challenge. NeuroNetrix has developed a Patient Manager module to simplify storage/sharing of such data, thereby promoting collaborative research and facilitating complex data-mining functions.

Features of the COGNISION™ Patient Manager include:

- HIPAA-compliant security
- Centralized biomarker database for all relevant neurological markers (Vitals, Family History, Medical History, Labs, Imaging, Image Findings, Psychometrics, Medications, and Patient Visits)
- Context-based SQL search functions
- De-identified data sharing
- Internet-based architecture for instant data access and visualization

COGNISION™ QEEG/ERP Protocol Editor

The COGNISION™ System uses an online library of standard ERP protocols. These protocols use auditory and/or visual stimuli which are also stored in the library. Additional protocols can be created by the user using predefined paradigm templates. These new protocols may then be shared with other users of the system.

Protocol definitions include:

- Stimulus Settings
- Sequencing
- Timing
- Epoch Grouping
- Analysis Logic

Predefined paradigms include:

- Single Stimulus
- Equal Probability
- 2-3 Deviant Oddball
- Match/mismatch
- Standard EEG

Stimuli include:

- Auditory
- Visual
- Combined

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