



2 channel screens shown

# Z Score DLL Training System\* Provides Real-time Neurofeedback Training

**BRAINMASTER TECHNOLOGIES, INC. AND APPLIED NEUROSCIENCE, INC (ANI)** are pleased to announce the availability of a new tool for use in EEG neurofeedback training, assessment, and related work. The Z Score DLL training system is a joint development, that provides real-time neurofeedback training, using state-of-the-art signal processing, the NeuroGuide normative database analysis, and new computational methods.

The Z Score DLL provides, in real time, a total of 72 real-time values for 2 channels and 248 real-time values for 4 channels computed on a continuous basis, by the ANI Z DLL software. These calculations are performed more than 30 times per second, and provide data useful for training, as well as for assessing the current condition of the trainee, via their normative EEG scores on any of the 72 or 248 components.

These consist of Z scores for the following estimators:

- Absolute Power (2 or 4 channels, 8 bands)
- Relative Power (2 or 4 channels, 8 bands)
- Power Ratios (2 or 4 channels, 10 ratios)
- Amplitude Asymmetry (2 or 4 channels, 8 bands)
- Coherence (2 or 4 channels, 8 bands)
- Phase Difference (2 or 4 channels, 8 bands).

Z Scores provide an instantaneous measure of how the trainee's EEG compares with a normal population. Scores are based upon the EEG signal, the sensor locations, the age of the trainee, and whether eyes are open or closed. With this information, the Z Score system is able to provide values of 0.0 (normal), positive (above normal) and negative (below normal) scores. A Z Score of -1.0, for example, means the trainee is 1 *standard deviation* below normal for their population. So when a trainee sees an alpha level of 8.5, for example, and asks "What does it mean?" it is now possible to express this measurement (and 71 others) in terms of comparison to the normative population. This makes it possible to construct protocols that are "aware" of how the trainee fits in, and how their EEG values compare with normative. This is of considerable value in amplitude and power measurements, but is even more essential for coherence, phase, and asymmetry scores. Since it is not possible to easily tell whether a given trainee's coherence is *okay* without a normative population, this system now opens the door to more meaningful, more responsive, and more confident EEG training.

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These Z Scores provide, in real time, similar (and consistent) data as provided in a QEEG (e.g. NeuroGuide) when a QEEG is used for normative statistics. The difference is that now these Z Scores are available in real time, and are used in tandem with existing clinical neurofeedback software. It thus becomes possible to perform a mini-assessment of selected variables, during the training. Z Scores can also be used to create feedback events such as sounds, games, BrainMaster's Flash games, set inhibits or artifact detection, or control other interfaces, events, or devices. Z Scores can be processed and used in an unlimited array of possible protocols, using the fact that 0.0 means *normal*, 1.0 means *a bit high*, 2.0 means *very high*, 3.0 means *extremely high*, and so on. In other words, once a Z Score training protocol is set up for one trainee, it is automatically adapted to other trainees, by entering their age, eyes open/closed condition, and the sensor locations. The normative statistics take care of tailoring the protocol to the individual, so that thresholding and related matters are dealt with automatically.

Using these Z Scores, it is possible to design training and assessment protocols using the BrainMaster Event Wizard and Math Wizard interfaces. **These tools allow users to design protocols using a very flexible, text-oriented user interface that includes access to more than 100 built-in BrainMaster training variables (Amplitude, Frequency, Percent Energy, Percent time over threshold, Coherence, Similarity, Phase, Variability, etc.), and now the additional 72 Z Scores with 2 channels of EEG, and 248 Z Scores with 4 channels of EEG.** The Event Wizard allows users to design up to 16 complex events, each of which is a protocol on its own. These events are designed using a point and select user interface. All the design of the processing elements is preconfigured. This provides the user with access to literally thousands of possible protocols, at the click of a mouse.

Thus, by training to Z Scores instead of (or in addition to) raw scores, it is possible to normalize EEG values in real time, without the need for repeated QEEG recordings. For example, instead of training simply to a coherence metric, one could train to the Z Scores, and can train within a set of limits, rather than simply a threshold. It is also possible to combine Z Scores with any other variables during training, to provide protocols that are complex in design, yet simple to use.

It is possible, for example, to train to coherence or phase scores, and to watch the scores in relation to the normative population. This takes the guesswork out of coherence and related training, and removes the need for repeated QEEG measures, to track the trainee's progress and condition.

The Math Wizard further extends the BrainMaster 2.5SE and 3.0 software training capabilities by allowing

the use of hundreds of expressions and variables in simple equations, providing training flexibility and power. Ratios, logarithms, combinations of variables, yes/no decisions, and so on, are all available via the Math Wizard. Even Z Scores can be used in mathematical expressions, creating new training variables whose scope and power are virtually unlimited. One can, for example, create a training variable that says *go* only when all coherences are within their normal range. Or one that gives special sounds when certain coherences go above (or below) their current levels. Or, in conjunction with a MINI-Q™, one could scan the entire head for brief periods of time, normalizing coherences at each pair, for a full-head training capability. These applications are only the tip of the iceberg, considering the breadth and depth of new protocols that are now possible.

In addition, the use of NeuroGuide by ANI along with the Z Score DLL provides a variety of important capabilities, including enhanced planning of neurofeedback training as well as improved and consistent reporting of EEG results from any sessions, including training sessions as well as assessment, even MINI-Q™, sessions. NeuroGuide can be used to create reports, based on EEG analysis, that are consistent with the Z Scores used during training.

BrainMaster 2.5SE and 3.0 software can be used to provide all the existing EEG metrics (amplitude, frequency, percent energy, percent time over threshold, autothreshold values, coherence, similarity, phase, ect) while the Z Scores are being used. You can even create complex metrics which combine build in EEG values with Z Scores. Imagine, for example, a protocol which specifically rewards EEG amplitude criteria but only when all coherence values are within normal ranges.

**System Requirements:** BrainMaster EEG systems (AT1-4E-A Atlantis I & AT1-2E-A Atlantis II) with 2.5 SE or 3.0 software (April 1, 2006 or later version).

It is the policy of BrainMaster Technologies, Inc. and Applied Neuroscience, Inc. to work collaboratively, to mutually develop and validate state-of-the-art signal processing and feedback technologies, in the area of EEG feedback. We are proud to offer this latest generation of collaborative development, and to make it available to the clinical community.



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