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Each person is an individual and has a unique psychological profile, biochemistry, developmental and social history. As such, advice will not be given over the internet and recommendations and interventions within this website cannot be taken as a substitute for a thorough medical or allied health professional assessment or diagnosis.

Quantitative Electroencephalography (QEEG)

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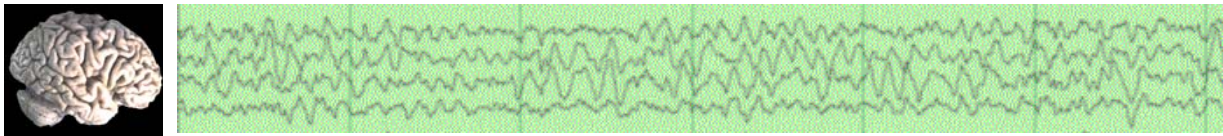
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WHAT IS A QUANTITATIVE ELECTROENCEPHALOGRAPH?

Quantitative Electroencephalography (QEEG) is the measurement, using digital technology, of electrical patterns at the surface of the scalp which primarily reflect cortical activity or "brainwaves". A multi-electrode recording of brain wave activity is recorded and converted into numbers by a computer. These numbers are then statistically analysed and are converted into a colour map of brain functioning.

Digital EEG techniques have grown rapidly in both technology and popularity since the early 1980's for recording, reviewing, and storing EEG data.

WHAT ARE THE ADVANTAGES OF QEEG IN COMPARISON TO ROUTINE EEG'S?

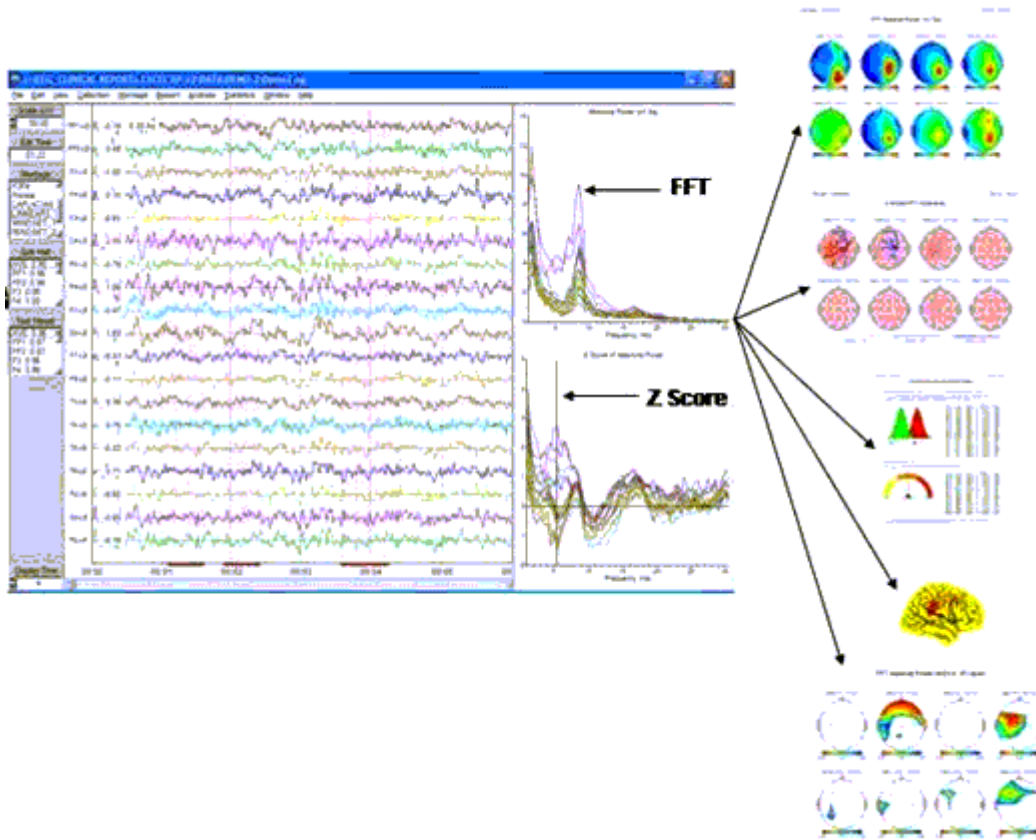
Quantitative EEG (QEEG) analysis techniques can provide additional measurements and displays of EEG in many different ways that are not possible with analogue paper EEG recordings.

Several QEEG techniques, commonly called "EEG brain mapping", include topographic displays of voltage or frequency, coherence, asymmetries and statistical comparisons to normative values ("Z" scores), as well as discriminant analysis of:

- [Learning Disabilities](#)
- [Attention Deficits](#)
- [Brain Injury](#)

Montage, filter, and gain settings can be changed retrospectively during record review.

Digital EEG recordings are extremely flexible in the way they display the EEG tracings, unlike analogue paper EEG.



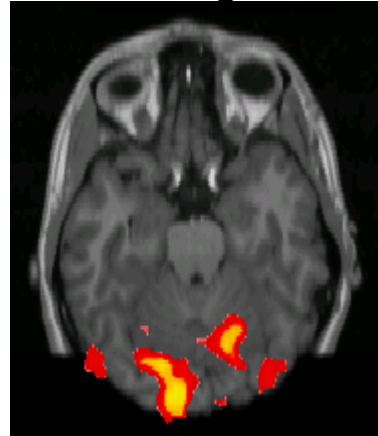
Sample from Neuroguide System

SOME EXAMPLES OF FUNCTIONAL IMAGING OF THE BRAIN INCLUDE

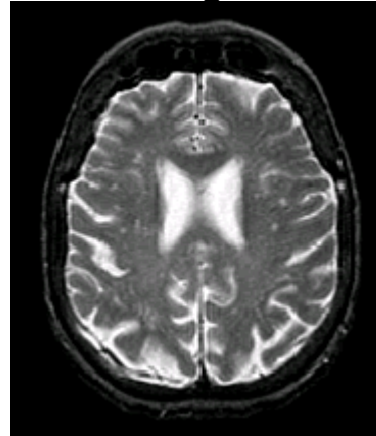
A CT Scan



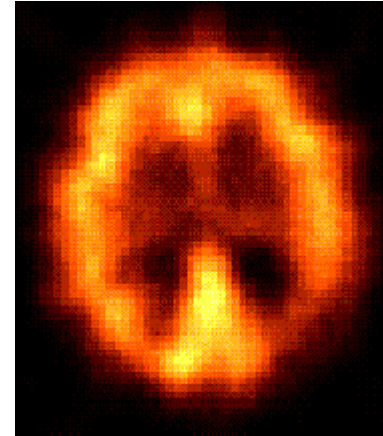
An fMR image



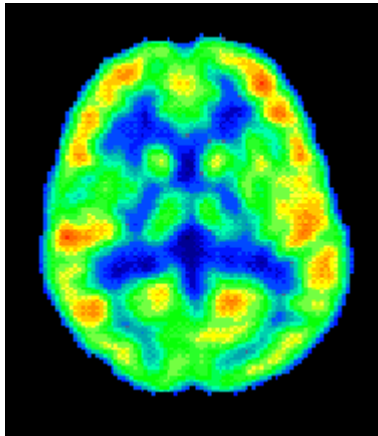
An MR image



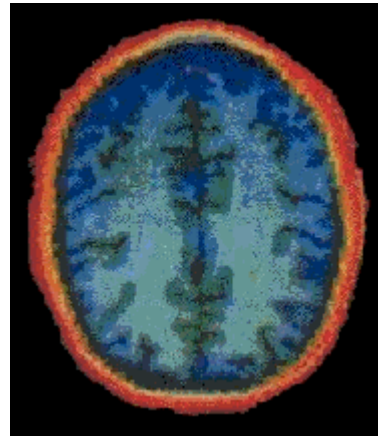
SPECT



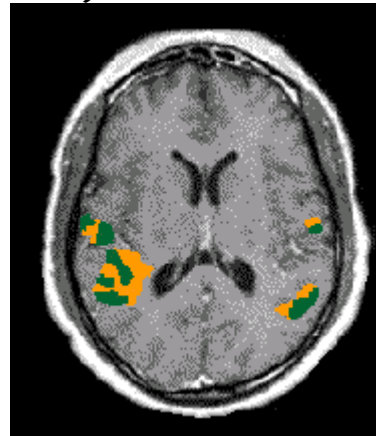
PET



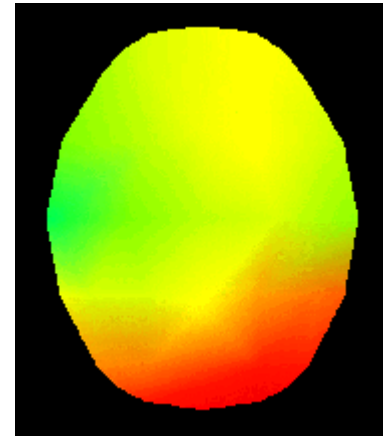
**PET/MRI
(Multi-Modal)**



**MEG
(Superimposed on
MRI)**



QEEG



Compared to other systems, QEEG is a non-invasive procedure and offers a superior temporal (time) resolution compared with fMRI, SPECT and PET imaging techniques.

MEG systems, though providing a high temporal and spatial resolution, are a relatively expensive means of monitoring the brain compared with QEEG arrangements.

Furthermore, EEG apparatus is less cumbersome than other imaging equipment (MEG, fMRI, SPECT and PET devices typically monopolise an entire room)

In terms of brain imaging techniques, QEEG looks at metabolism and function, whereas MRI's and CT scans reflect structure. Multiple-electrode recordings (19 sites) following the International 10/20 System of EEG electrode placement are converted to numbers using digital technology and these numbers are statistically analysed against normative data bases allowing subject to data base comparisons in order to show the location and extent of brain dysfunction, in specific frequency bands and under particular task conditions. (e.g. during math's, reading etc.).

Focal or generalised cerebral dysfunction is presented as coloured brain maps or graphs making QEEG an effective tool for differentiating between organic and functional brain disorders. Signature patterns discriminate between different disorders (unipolar vs. bipolar depression). Symptoms directly correlate to brain wave activity, providing a tangible & effective method of predicting and monitoring the response to medication without the need for extended trials or guesswork.

"New three-dimensional QEEG imaging methods offer an economical alternative to other functional brain imaging modalities....."

During the last decade more than 500 EEG and QEEG papers have reported well designed studies, concurring that EEG and QEEG abnormalities are found in a high proportion of psychiatric patients".

Source : Hughes, JR & Roy John, E (1999): Conventional and Quantitative Electroencephalography in Psychiatry. Journal of Neuropsychiatry and Clinical Neurosciences 11:190-208. May. American Psychiatric Press Inc.

The amount of data generated by multi-electrode recording is so enormous that it is difficult for clinicians to interpret all the data. QEEG's address this data analysis and summarisation of data in the form of coloured topographic maps of the brain, spectral analysis and graphs. Other advantages are:

DATA BASE COMPARISONS

A patient's / client's performance can be statistically compared to that of a large population data base. Such comparisons allow the clinician to determine whether or not brain functioning is abnormal, to what degree, in what locations and in which frequency bands.

PHARMACOLOGICAL ACTIVATION TEST DOSE

The QEEG provides a simple, tangible way to determine whether or not a client/patient will benefit from a psychotropic medication without the need for an extended trial. Recent research demonstrates that medication responsiveness can be improved and side effects minimised through the use of QEEG techniques aimed at guiding the physician in choice of prescription.

DISCRIMINATING FUNCTIONAL AND ORGANIC DISORDERS

QEEG's can also serve as an effective tool for differentiating between organic and functional brain disorders. This functional data provides an excellent supplement to data obtained from CT scans and MRI's.

For instance, QEEG is a useful tool for differentiating between physiological and functional causes of depression and hyperactivity. It has also been helpful in the identification of schizophrenia and dementias.

This procedure can also be employed to identify cases of cerebral atrophy associated with alcoholism or drug abuse as well as determining whether a child is presenting with neurologically based attention deficit disorder or one of psychogenic origin.

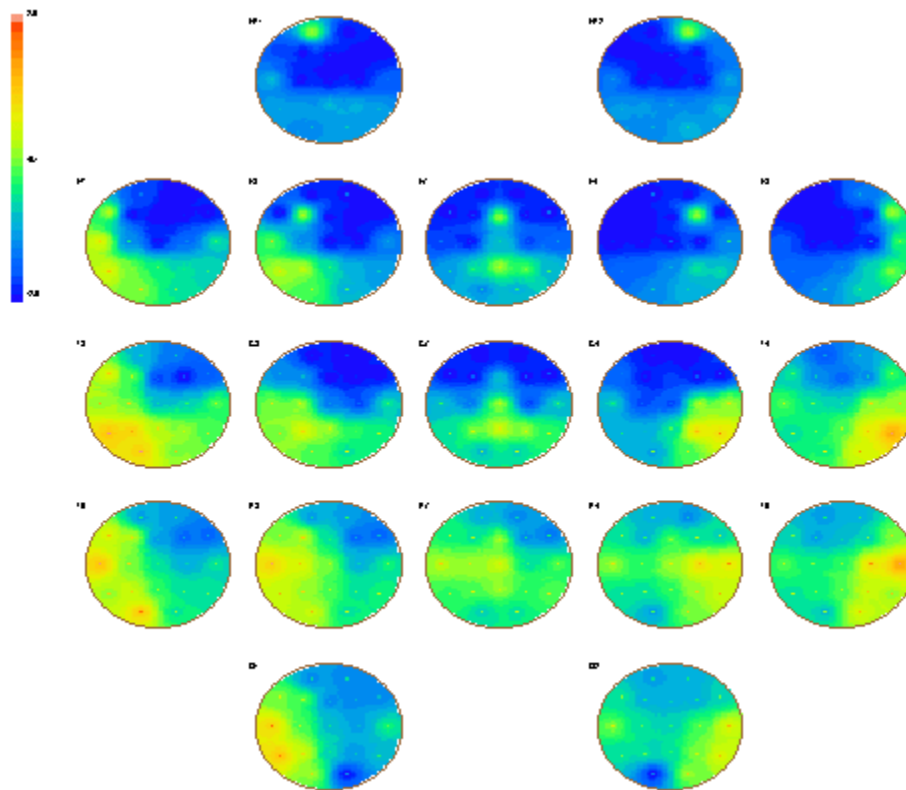
In a legal sense, the QEEG has been used (In the United States) as a tool to determine whether a person is malingering or not.

Statistical data base comparisons and specialised software allow discriminant function in such things as brain injury and learning disabilities.

SIMPLICITY OF THE PROCEDURE

The procedure has the advantage of being non-invasive safe and dynamic (temporal); quick - usually requiring no more than an hour of preparation/administration and reliable (1 minute of clean data is 94% reliable, 2 minutes is 96% reliable).

COLOURED DYNAMIC BRAIN MAP



Sample from Skil Topometric System

The coloured dynamic brain map generated by a computer makes it easy for clients / patients to visualise the problems that are being explained. Thus it facilitates communication and improves the client's (and family's) understanding of their conditions.

NEUROFEEDBACK

The sister technology to QEEG is EEG biofeedback (also known as [neurofeedback](#) or neurotherapy).

Neurotherapy is EEG biofeedback based on operant conditioning of EEG characteristics.

The QEEG provides the "targeting" information by telling us where and under what conditions (reading, listening, maths etc.) the problem is worse. This analysis allows accurate electrode placement for feedback and suggests tasks that should be used during training. The EEG feedback (both visual and auditory cues) signals the client when their brain is in fact in a more activated state, indexed by decreased delta (0.5-3Hz) and theta (4-7Hz) brain wave amplitudes and increased alpha (8-12Hz) and beta (12-18Hz) amplitudes.

Functional neuro imaging studies carried out on individuals with ADHD have shown abnormal functioning of the anterior cingulate cortex (ACC) during tasks of selective attention. QEEG findings of abnormal brainwave activity in the anterior cingulate cortex of children with ADHD are now being confirmed with neuroimaging studies. In a recent fMRI study (2006) the effect of neurofeedback training on the neural substrates of selective attention in children with ADHD was investigated. Fifteen un-medicated ADHD children who had no other comorbidities (co-existing conditions) were randomly assigned to the neurofeedback training group (experimental group) and the other five children were assigned to the control group (no neurofeedback training). The children were scanned (fMRI) while they performed the Counting Stroop test. Prior to neurofeedback training activation was evident in the left superior parietal lobule in all the children. After neurofeedback training, only those in the experimental group showed significant activation of the right anterior cingulate cortex, the key neural substrate of selective attention. (Johanne Levesque et al, Neuroscience Letters, Vol 394, Issue 3, 20 February 2006, p 216-221)

Further reading suggestion:

- [QEEG and Neurofeedback - diagnostic and training modalities for the enhancement of CNS functioning in ADHD and other disorders](#)

A brief but informative and up to date article citing case studies and statistics.

FOR WHOM WOULD A QEEG BE APPROPRIATE?

- QEEG's are initially performed to determine the presence of focal or generalised cerebral dysfunction and as a baseline guide for neurofeedback.
- Following closed head injury, stroke, heart attack, pulmonary dysfunction after hypoxia
- Where seizure disorders or tumours are suspected
- In suspected cases of ADHD, drug abuse, Learning Disabilities
- When pathological alterations in vigilance (narcolepsy, confusion, coma) or acute nervous system processes (acute headache, vomiting, aphasia) have been observed
- To investigate cerebrovascular disorders

QEEG'S CAN ALSO BE USED

- As follow-up to monitor organic brain syndromes, alcohol withdrawal, chemotherapy / radiation treatment, withdrawal from psychotropic medication or illicit drugs;
- To follow-up on infectious diseases such as encephalitis or meningitis
- To follow-up on post-operative status
- To monitor / follow up EEG biofeedback (neurofeedback)

WHAT IS THE CLIENT'S EXPERIENCE?

An ECI electrocap is placed on the head to facilitate ease of administration and consistency because it provides predetermined electrode placements. Then gel is inserted in each electrode to make a good connection. There is no pain or discomfort with this procedure. EEG recordings are then taken under four conditions: eyes closed, eyes open, a visual spatial task and a maths test.

CLINICAL TOPOGRAPHIC EEG METHODOLOGY

A fitted electrode cap with leads placed according to the International 10/20 System is applied to achieve a standardized 19 channel EEG recording. A referential montage is then obtained with linked earlobes.

Electrode impedance of less than 3 Kohms is required at all sites prior to the initiation of recording. EEG signals are fed directly to a quantitative topographic analysis system where they are digitized at a rate at or above 256 samples per second. The data is band-pass filtered between 1 and 30 Hz and stored on a hard disk for subsequent analysis.

The client is seated in a comfortable reclining chair placed approximately 3.5 meters in front of a video monitor screen and the legs rested on a small ottoman in front of the seat.

A series of standardised tests, each lasting from 3-20 minutes depending upon what the EEG is being conducted for, is administered. These tests may include:

- 1 Eyes closed;
- 2 Eyes open;
- 3 Reading for comprehension and
- 4 A mathematics test of graded difficulty.

Digitised data is subjected to a custom automatic artefact detection program that identifies and deletes eye-blink and movement artefact. This is supplemented by a visual review of the record by the clinician/EEG Technician for removal of residual undetected eye and head movement artefact, as well as muscle activity of potential consequence to the analysis. A manual cursor is used to selectively identify and delete only those brief segments affected. Atypical transients in the EEG signal are noted for subsequent analysis during this procedure.

Corrected EEG data is then analysed for frequency content using the Fast Fourier Transform.

Evaluation of these data employs various descriptive and statistical displays with a variety of frequency band formats. These can include data tables, spectral maps, individual frequency band topometric analysis (providing both within and between state evaluation), topographic maps, coherence, asymmetry and covariance analysis.

Statistical analysis compares subject data with a child to adult normative database and may be corrected for significant time-of-day variations and state transitions. Data is also evaluated for percentage change across states and compared with a normative database for state modulation. Finally, topographic maps showing covariance between all sites at relevant frequencies are compared with a normative database to evaluate the status of functional cortical interactions. A written report follows ten days to a fortnight later.

WHAT INFORMATION IS RECEIVED FROM THE QEEG?

The SKIL™ Topometric QEEG provides information on brain functioning and its impact on cognition and learning. Computerised EEG results are compared to age-related norms of the QEEG database providing information about whether the client has a deviation in qEEG functioning which varies significantly from the norm. It indicates what locations, the amplitude and frequency of waves of interest, and under what conditions the abnormality manifests itself. Advanced artefact removal, time of day correction, multiple data and statistical displays, and state comparison analysis differentiate the SKIL™ from other QEEG systems. The information is visually summarised in five graphical displays: topographic maps, spectral plots, topometric distributions, covariation maps and tables.

A hyperlink to the [SKIL™ Topometric](#) website is provided at the end of this article in the [links](#) section for more information on the capabilities of this software package.

The [Neuroguide™](#) software offers the clinician multi-functional qEEG analysis including coherence, phase and asymmetries; and 3 dimensional source localisation; a birth - 82 years of age normative data base with Traumatic Brain Injury Discriminant, Learning Disability Discriminant and a Predictive Neuropsychological Scores value based upon the EEG.

A hyperlink to the Applied Neuroscience website is provided at the end of this article in the [links](#) section for more information on the capabilities of this software package.

QEEG as a neurophysiological investigation does not substitute for neuropsychological evaluation, however as an adjunctive investigation, QEEG can be quite revealing and of course is necessary if one is to utilise neurophysiological intervention to its best advantage.

THE HISTORY OF QEEG TESTING AND NEUROFEEDBACK

Quantitative analysis of the human EEG was achieved as early as the 1930's (Berger, 1931). The 1970's and 80's were decades of exploration and experimentation with QEEG. The American Medical EEG Association (AMEEGA) Adhoc Committee on QEEG has stated "QEEG is of clinical value now and developments suggest it will be of even greater use in the future". The use of the QEEG in assisting the diagnosis of mild traumatic brain injury, ADHD, learning disabilities, stroke, and epilepsy is well documented.

Neurotherapy (a method of neurophysiological intervention) is based on the work of Professor M. Barry Sterman of the UCLA School of Medicine, Departments of Neurobiology and Behavioural Psychiatry.

Professor Sterman recognised how brain function can be altered and normalised by operant conditioning of the EEG. QEEG and neurotherapy has been endorsed by the American Psychological Association as within the venue of psychologists with appropriate training. Neurotherapy training to decrease slow wave activity and increase fast desynchronised EEG activity has been used for over 20 years to ameliorate ADHD and epilepsy and is well documented in the scientific literature. More recently EEG operant conditioning has been successfully applied to patients with mild traumatic brain injury.

IF QEEG AND NEUROTHERAPY ARE SO GOOD, WHY AREN'T MORE CLINICIANS USING IT?

As a specialist field, most psychologists and physicians simply have not been educated in the clinical applications of EEG biofeedback and are unaware of the existing research and clinical literature, in spite of the fact that the applications to anxiety, epilepsy and attentional deficits date back to the 1970's.

Furthermore, the instrumentation is expensive and requires serious study and training to use competently.

An estimated 700 clinicians are using neurotherapy and QEEG in the U.S.A. Although relatively new to Australia, a growing number of psychologists and psychiatrists are now beginning to use these tools each year to assist in client evaluation and thus in choosing appropriate treatment modalities.

QEEGs allow neurofeedback therapists to address the physiological basis of psychological, psychiatric, and neurological problems without medication. It and can also be used in conjunction with medication.

"An overview of the findings reveals numerous consistent and concordant conventional EEG and QEEG findings among studies within the same DSM (III & IV) diagnoses"

Source : Hughes, JR & Roy John, E (1999): Conventional and Quantitative Electroencephalography in Psychiatry. Journal of Neuropsychiatry and Clinical Neurosciences 11:190-208. May. American Psychiatric Press Inc.

For more information or to make an appointment please contact us on (02) 9637 9998 during business hours.

FURTHER READING SUGGESTIONS

- Learning Disabilities
- Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD)
- Post Concussive Syndrome / Head Injury
- Neurofeedback - EEG Biofeedback - a Drug-Free Strategy for ADHD, Learning Disorders and Other Conditions
- QEEG and Neurofeedback - diagnostic and training modalities for the enhancement of CNS functioning in ADHD and other disorders

LINKS

PLEASE NOTE :

Learning Discoveries offers the links below as a convenience to our clients and the users of this website. However, we do not control third party websites and we are not responsible for the websites content.

- **Deymed Diagnostic**

www.deymed.com/

Offers state of the art acquisition hardware; EEG acquisition / analysis and neurofeedback software

- **The International Society for Neurofeedback and Research**

www.isnr.org/

An international society for promotion and professionalism in QEEG and Neurofeedback

- **MindSet**

by Wayne Nolan

www.altered-states.net

Wayne Nolan's 16 and 24 channel MindSet EEG Acquisition Hardware and MindMeld EEG / QEEG acquisition and analysis software

- **Applied Neuroscience, Inc**

Neuroguide EEG and QEEG Software
by Dr. Robert Thatcher

www.appliedneuroscience.com

Many informative articles and links on QEEG

- **Nova Tech EEG**

by Leslie Sherlin

www.novatecheeg.com/

Offers QEEG analysis freeware software as well as professional "add-ons"

- **Skil™ Topometric EEG Analysis and Training**

by Dr. David Kaiser and Prof. Barry Serman

www.skiltopo.com/

Many informative articles and links on QEEG

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