

NeuroCognitive

Brain Center

A Crossroads Institute Affiliate

QEEG Brain Mapping

An Innovative Diagnostic Tool for
Neurological and Behavioral Disorders



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INSTITUTE

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Analyzing Brain Activity

Quantitative Electroencephalogram (QEEG) Brain Mapping is a procedure that records electrical activity within the brain from 24 channels. This tool gives us the ability to view the dynamic changes taking place throughout the brain during processing tasks and assists us in determining which areas of the brain are fully engaged and processing efficiently. Over the past 30 years, a method of QEEG analysis called Neurometrics has been developed at the Brain Research Laboratory of New York University's Medical Center under a grant from the National Institute of Health.

Neurometric analysis aids in a more precise diagnosis of subtle brain dysfunction. It provides information about the functional organization and disorganization of the brain and its normal development. It serves as a basis for identifying variations in brain function that are associated with different types of neurological disorders including Attention Deficit Disorder, Learning Disabilities, Depression, Dementia, Mild Head Injury and Obsessive/Compulsive Disorder, as well as assuring that the true underlying cause of the problem is addressed.

Neurometric analysis received FDA approval [510(k) 974748] as a diagnostic tool and presently is the only objective measure for many of these neurologically based disorders. This process is used in select hospitals, clinics and research centers around the world.

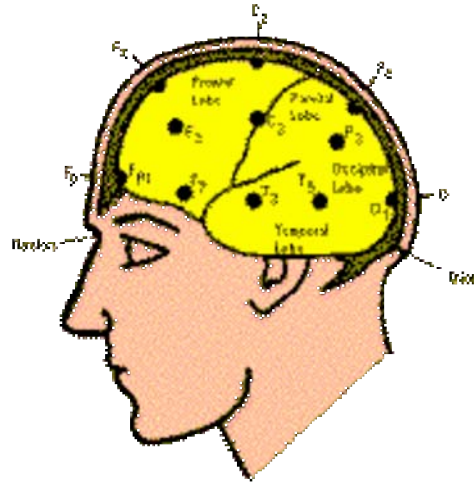
At Crossroads Centers we use this objective, accurate and detailed information to create more effective neurodevelopmental training protocols. The brain map provides us a baseline to work from while we retrain the brain and correct metabolic and physiological problems in the body.

Electrical Activity

The brain behaves like any other electrical system. Changes in membrane polarization, inhibitory and excitatory post-synaptic potentials, action potentials etc. create voltages that are conducted through the brain tissues. These electrical voltages enter the membranes surrounding the brain and continue up through the skull and appear at the scalp where they are measured as microVolts. This electrical activity occurs at several different frequencies.

These potentials are recorded by an electrode that is attached to the scalp with non-toxic conductive gel. The electrodes are fed into a sensitive amplifier. At Crossroads, the EEG is recorded from many electrodes arranged in a particular pattern. The pattern we use is the international 10/20 standard for describing these positions.

The 10-20 system is based on the relationship between the location of an electrode and the underlying area of cerebral cortex.



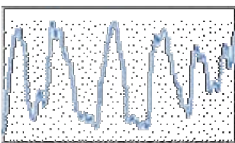
The "10-20 System" of Electrode Placement

Each point on this figure above indicates a possible electrode position. Each site has a letter (to identify the lobe) and a number or another letter to identify the hemisphere location. The letters F, T, C, P, and O stand for Frontal, Temporal, Central, Parietal and Occipital. (Note that there is no "central lobe", but this is just used for identification purposes.) Even numbers (2,4,6,8) refer to the right hemisphere and odd numbers (1,3,5,7) refer to the left hemisphere. The z refers to an electrode placed on the midline.

Electrical activity is described by three characteristics; frequency, amplitude and intensity. Frequency, measured in Hertz (Hz), is the number of times a wave repeats itself within a second. It can be compared to the frequencies that you tune into on your radio. If any of these frequencies are deficient, excessive, or difficult to access, our mental performance can suffer. Amplitude represents the power of electrical impulses generated by brain. Intensity, which is like the volume of brain wave activity, is measured in microvolts.

The raw EEG is usually described in terms of five frequency bands described below. Each of these has its distinct function and can be used to detect brain dysfunction.

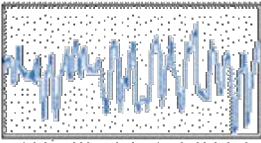
Delta (0.1 to 3 Hz)



The lowest brain frequencies are Delta waves. These occur in deep sleep and in some abnormal processes. They also are produced during experiences of "empathy states". Delta waves are involved with our ability to integrate and let go. Delta activity reflects our unconscious mind. It is the dominant rhythm in infants up to one year of age and it is present in stages 3 and 4 of sleep. It tends to be the highest in amplitude and the slowest waves. We increase Delta waves in order to decrease our awareness of the physical world. We also access information in our unconscious mind through Delta. Peak performers decrease Delta waves when high focus and increased performance are required. However, most individuals diagnosed with Attention Deficit Disorder, naturally increase rather than decrease Delta activity when trying to focus. The inappropriate Delta response

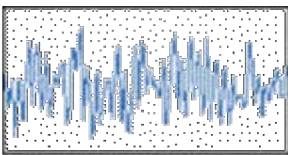
often severely restricts their ability to focus and maintain attention. It is as if the brain is locked into a perpetual drowsy state. The effect of increasing Delta by training is to induce drowsiness, trance and deeply relaxed states. Another way to look at Delta is to imagine you are driving in a car and you shift into 1st gear – you are moving but not going to get anywhere very fast. Delta represents 1st gear.

Theta (4-8 Hz)



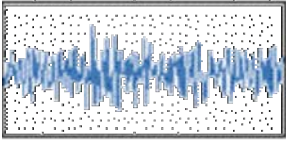
Theta activity is classed as "slow" activity. It is seen in connection with creativity, intuition, daydreaming, and fantasizing and is a repository for memories, emotions and sensations. Theta waves are strong during internal focus, meditation, prayer, and spiritual awareness. It reflects the state between wakefulness and sleep and relates to the subconscious. It is abnormal in adults when awake but is perfectly normal in children up to 13 years old. It is also normal during sleep. Theta is believed to reflect activity from the limbic system and hippocampal regions. Theta is observed in anxiety, behavioral activation and behavioral inhibition. When the theta rhythm appears to function normally, it mediates and/or promotes adaptive, complex behaviors such as learning and memory. If Theta is enhanced by training, it can induce a drifting, trance-like state. If suppressed, it can improve concentration and our ability to focus attention. In our car example, Theta would be considered 2nd gear. Not as slow as 1st gear (Delta) but still not very fast.

Alpha (8-12 Hz)



Alpha waves usually will peak around 10Hz. Good healthy Alpha production promotes mental resourcefulness, aids in the ability to mentally coordinate and enhances an overall sense of relaxation. In this state you can move quickly and efficiently to accomplish whatever task is at hand. When Alpha predominates, most people feel at ease and calm. Alpha appears to bridge the conscious to the subconscious. It is the major rhythm seen in normal relaxed adults. It is present during most of life especially beyond the thirteenth year when it dominates. We think that Alpha rhythms are derived from the white matter of the brain. The white matter can be considered the part of the brain that connects all parts with each other. Alpha occurs whenever a person is alert but not actively processing information. They are strongest over the occipital (back of the head) cortex and also over frontal cortex. Alpha has been linked to extroversion (introverts show less), creativity (creative subjects show Alpha when listening and coming to a solution for creative problems), and mental work. When our Alpha is within normal ranges we tend to also experience good moods, see the world truthfully, and have a sense of calmness. Alpha is one of the brain's most important frequencies enabling us to learn and use information taught in the classroom and on the job. You can increase alpha by closing your eyes or breathing deeply. You can decrease alpha by thinking or calculating. Alpha training can produce relaxation and in conjunction with Theta training can create an increase in sensation, abstract thinking and self-control. In our car scenario, Alpha would represent neutral or idle. Alpha allows us to shift easily from one task to another.

Beta (above 12 Hz)



Beta activity is 'fast' activity and it reflects desynchronized active brain tissue. It is usually seen on both sides of the brain in symmetrical distribution and is most evident frontally. It may be absent or reduced in areas of cortical damage. It is generally regarded as a normal rhythm and is the dominant rhythm in those who are alert or anxious or who have their eyes open. It is the state that most of brain is in when we have our eyes open and are listening and thinking. Beta is activated when we are problem solving, making judgments or decisions or processing information about the world around us.. The Beta band has a relatively large range and has been divided into sub ranges. Low Beta (12-15 Hz), formerly called "SMR " makes us feel relaxed yet focused and integrated. Deficient low Beta can reflect "ADD" and a lack of focused attention. Conversely, increasing low Beta can produce relaxed focus and improved attentive abilities, Midrange Beta (15-18 Hz) is produced by thinking and awareness of self and our surroundings. It occurs with alertness but not agitation. Training can increase mental ability, focus, alertness and IQ. High Beta (above 18 Hz) is also related to alertness and mental activity, e.g. math, planning, but is also associated with agitation. Training in this frequency can induce alertness, but may also produce agitation. Beta represents overdrive or hyperdrive in our car scenario

Gamma (above 36 Hz)

Gamma is the only frequency group found in every part of the brain. It is hypothesized that the 40Hz Gamma brain activity consolidates various brain areas for simultaneous processing. A good memory and well-integrated thoughts are associated with well-regulated and efficient 40Hz activity, whereas a 40Hz deficiency creates learning disabilities. The effects of Gamma training are unknown.

What Does the Map Look Like?

Below are two typical Brain Maps showing, in a graphical way, many important aspects of brain function. The map on the left shows baseline brain map of six-year old child with a learning disability. The map on the right indicates improvements made one year later.



The colors in these maps indicate levels of activity. They allow us to see in a graphical way how the brain receives and processes information and then executes responses.

How to Read the Brain Map

At Crossroads Institute, we use an analysis technique called Neurometrics in order to get a better view of how the brain is processing and to determine if it is performing within normal limits. Neurometrics is a mathematical technique that compares the EEGs of normal brain functioning individuals with your brain waves. Using Neurometrics as an analysis tool, the neurotherapist has at their disposal a sound, objective measure to help determine the possible source of symptoms.

Each Brain Map report includes extensive statistical tables of univariate and multivariate measures of absolute power and relative power, power asymmetry and synchronization (coherence), and color-coded topographic brain maps. This data is used to help identify normal and abnormal brain electrical activity. Selected EEG features from different brain regions quantify the organization within the brain to identify disturbances in brain processing. Brain processing problems often reveal themselves in the QEEG in one or more of the following brain wave categories:

Absolute Power - How much Brainpower is Available? Absolute Power measurement aids the Neurotherapist in determining whether enough brainpower within a particular frequency range is present at each recording site.

Relative Power - Who's In Charge Here? The Relative Power measurement aids the Neurotherapist in determining whether a particular frequency is overpowering other vital brain frequencies.

Mean Frequency – Are they within Spec? Each frequency band is measured between specific ranges. The average frequency tells us whether or not that specific bandwidth is operating within normal ranges. For example, the alpha frequency is measured between 8hz and 13hz. It should peak around 10 hz. Often when we observe it peaking at 9.5hz and below, we observe individuals being tired, error prone or simply misunderstanding vital input information.

Ratios - Relationships are extremely important! Relationships between the various brain frequencies are compared to those individuals with normal brain functioning. Ratios lower or higher than normal are a sign of inefficiency in either the brain's ability to process incoming information or in attending to and executing specific tasks.

Asymmetry - The Brain's Balancing Act. Asymmetry scores reveal to us whether the brain waves between the various parts of the brain are balanced. Excessive, localized activity may indicate an overtiring of brain cells. Insufficient activity may suggest brain cells are not firing sufficiently to maintain proper brain function.

Coherence - Who's Talking to Whom? In order for us to understand the complexity of the

world and to make and execute decisions, the different parts of the brain must share information. Coherence is one of the ways we measure how well the brain is able to perform this inner self-talk. Coherence gives us an indication of how efficiently our brain is working to connect and disconnect different parts of itself to accomplish a particular task.

Excessive Coherence tends to indicate two or more areas of the brain are "overly connected or locked together." That is, the brain has become overly dependent on those centers and is not efficiently processing and executing information. This tends to result in poor day-to-day performance. Serious traumatic brain injury classically results in excessive Coherence. On the other hand, deficient Coherence is the EEG sign of a brain not able to efficiently connect cortical areas to perform specific tasks. Learning Disabilities may show either (or both) excessive and deficient Coherence characteristics.

Phase - Tortoise or the Hare? Many of the brain's functions are timed events; the energy from one part of the brain should arrive at another area at just the right moment to perform a specific task. The QEEG measurement of this important factor is called Phase. Excessive Phase statistics mean the signals arrive too early and deficient Phase means the signals arrive too late. In either case, the brain is not able to do its job with peak efficiency.

How Do We Use the Maps?

The brain map allows us to view the brain in a dynamic, functional state so that we can literally "see" problems. Unlike other methods of "viewing" the brain, QEEG Brain Mapping allows us to see more than the physical structure of the brain. This is especially valuable for those sensitive to psychiatric illnesses, which are often characterized by disturbances of brain organization rather than brain structures.

When we are considering a set of symptoms from a brain processing point of view, the contribution of each brain wave dysfunction can often be quite revealing. For example, when we are considering focal slow waves (delta waves) we generally will find them at the root of many learning difficulties. In those with Dyslexia, slow brain wave activity can be found in one or more key areas. These can include the occipital lobes at the back of the brain, where incoming visual information is received and processed; Wernicke's area located in the left parietal lobe where the brain processes words for understanding; Broca's area located in the left frontal lobe, where words are put together for expression; and often in the sensorimotor area, where speech is converted from a feeling for verbalization of thoughts.

As another example - our brain uses its 8-13 cycles per second Alpha waves to idle itself; to rest areas not actively processing and acting on incoming sensory and motor information. While this idling is a normal and favorable phenomenon for the healthy brain, if Alpha wave activity becomes "locked" and inhibited, active participation of vital brain areas cannot occur with efficiency. The frontal lobes are the areas most commonly affected by excessive (flooding) and non-reactive (inhibited) Alpha waves. Our brain uses its frontal lobes to focus attention outside itself and to understand the complexities of the

world. It is not unusual to find high amplitude, frontal Alpha in those failing academically and those having trouble meeting job demands.

Keep in mind that there is no one brain wave pattern seen in all of those with a specific disease, disorder, or inefficiency. In fact, the QEEG in those with Attention Deficit Disorder, for example, may show high amplitude Delta slow waves, excessive Theta activity, or a locked-in Alpha state.

We also use the Brain Map to identify and guide treatment for behavioral disorders such as depression. Excessive Alpha and Beta brain activity is the brain's most reliable signature for depression; a common side effect of Learning Disabilities. Those with depression may show high Alpha or Beta, excessive coherence problems, or poor communication between the left and right frontal lobes.

Brain problems can also arise due to physical trauma such as in a traumatic brain injury or TBI. In these cases, because the brain has a natural ability to adapt, a damaged brain will attempt to survive by releasing neuro-inhibitors to protect its limited resources. In doing so, it locks itself into a particular electro-chemical pattern in order to not make matters worse. When this happens, we find ourselves losing attentional flexibility, which reduces our ability to adapt to varying circumstances. Over time, our personality generally becomes rigid and we begin to feel that there are no solutions to our problems. This is often the root of an overwhelming sense of helplessness and hopelessness and tends to drive us to mood extremes, such as depression, anger and even uncontrollable rage. The Brain Map can help the clinician identify these specific changes and deficits early to prevent long-term problems.

Unfortunately many brain processing related disorders present with similar symptoms. Without the QEEG, it is almost impossible to differentiate what is what. It is the QEEG that helps the Neurotherapist sort out what is causing the symptoms in any particular individual. With the QEEG Brain Map, treatment, whether it is neurotherapy or treating a metabolic deficit or disorder, is more precise which makes recovery faster and more complete.

For more information, please call the NeuroCognitive Brain Center at (907) 561-2330, email our Medical Director at drgrove@ak.net. Extensive information on QEEG mapping and its use in treating neurological and behavioral disorders can be accessed at the Crossroads Institute website at www.crossroadsinstitute.org