



# BodyWave<sup>®</sup> Brain Wave Monitoring



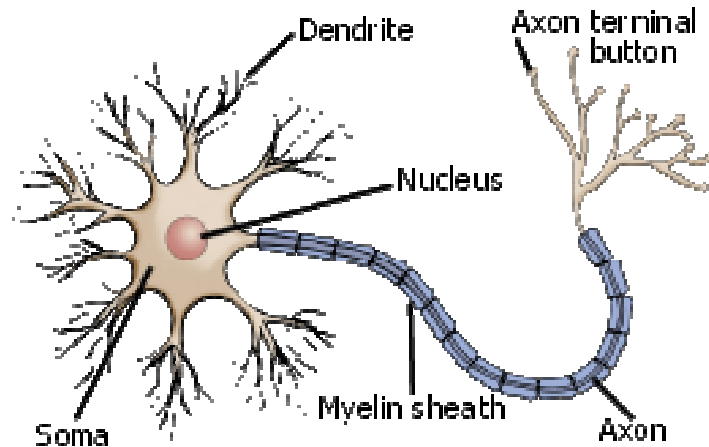
## BodyWave® Brain Wave Monitoring

### *The beginning: Neurons*

Billions of neurons (nerve cells) comprise the brain. Neurons are largely responsible for automatic and unconscious brain function. They are also the source of the brain's electrical charge which is measured by an electroencephalograph or EEG.

Neurons are very small and their electrical charge is also minute. The neuron's electrical charge is caused by its polarization; it has negative ions (charged particles) inside its membrane and positive ions outside. Enzymes pump ions across their membranes. The ions traveling across the neuron's membrane create

discrete electrical signals known as *action potentials* that travel down the axon. One may think of the axon as the major cable through which the electrical current passes. It is enclosed in a myelin sheath which serves as an insulator. When the action potential reaches the terminal buttons, it causes the release of chemical neurotransmitters into the synaptic cleft, a minute gap between two neurons. A *synapse* occurs when those neurotransmitters stimulate or inhibit another neighboring neuron. Thus, the electrical activity of the brain initiates from the currents within a single dendritic spine, passes through the axon as an action potential, and then causes the neighboring neuron to either fire or inhibit.



Here's a simple way of thinking of ions pushing each other: Many children often set dominoes upright, create a trail, and tip the first domino to begin a delightful chain reaction. When this process occurs in neurons en masse, it's termed *volume conduction*. When an initial neuron fires its neurotransmitters into the synaptic cleft (think of a baseball pitcher), it activates a receptor (think baseball catcher) in the dendrite or body of the neuron that is adjacent to the synaptic cleft. The adjacent neuron is termed the *post-synaptic* neuron. The neurotransmitter, when combined with the receptor, typically causes an electric current within the dendrite or body of the post-synaptic neuron. Thousands of post-synaptic currents from a single neuron's dendrites and body then sum up to cause the neuron to generate an action potential. This neuron then synapses on other neurons, and so on as in a domino reaction.

When this domino effect occurs -- a neuron receiving a neurotransmitter signal from an adjacent neuron via an action potential -- the neighboring neuron responds by releasing its ions in the synaptic cleft outside the cell. This is obviously a very tiny process emitting a very tiny amount of electricity. However, when many ions of like charge repel

each other (remember like charges repel and opposites attract) coming from many post synaptic neurons simultaneously, and if they are lined up spatially just like dominoes, they can nudge their adjacent neurons, who spark their neighbors. This wave is the product of volume conduction. A volume conduction wave is similar to the wave an audience produces in a football stadium. The wave formed by volume conduction is formed of electrons instead of being formed of a throng of football fans. If the wave is strong enough to be pushed through the skull to the scalp or body surface, sensors, usually made from metal or a conductive plastic, will have their electrons pulled or pushed. The difference in push between two sensors is known as voltage. The EEG is a sophisticated and highly sensitive volt meter that records voltages passing between the sensors over time. Because voltage fields fall off with the square of the distance, recording EEG activity away from the scalp has been virtually impossible until now.

### ***BodyWave® and the new EEG Monitoring Paradigm***

In the recent past, monitoring EEG away from the scalp was incredibly difficult. The miniscule size of the discrete voltages produced by a single neuron mandates that EEG can only be read from the summation of many thousands or millions of neurons that have similar spatial orientation and that are firing in synchrony. If the neurons don't have similar spatial orientation, they won't line up, no pushing of ions occurs, and brain waves won't push on the sensors to be detected. They are even more difficult to measure away from their source – the head.

The incredibly minute size of the electrical potentials measured by EEG most likely come from pyramidal cells in the cortex because they are close to the surface, are aligned, and fire synchronously. Ionic currents once thought to travel down the axon sheathed by myelin are not thought to be chief producers of the process known as volume conduction. Volume conduction produces a wave or field which is distributed over the entire folded surface. The field measured by BodyWave is thought to be produced by dendritic activity and post synaptic activity. The fact that volume conduction produces waves in a large field distributed over a large surface means that it can be measured away from the head.

For the purposes of BodyWave, it is not necessary to claim localization or non-localization of brain wave fields. BodyWave simply views brain energy as a field, collects the field energy as if the brain were a radio tower broadcasting from the brain and through the body. A sophisticated series of proprietary algorithms and hardware then displays them on a computer or controls a computer program wirelessly through Bluetooth technology. This advanced paradigm pictures the field produced by the brain as composed of some combination of global field and neural network activity that can be monitored by sensors connected to any part of the skin on the human body as it is essentially part of the neural system. The skin is in fact the largest organ of the body. The human body is 70%+ saline, a good conductor.

The fact that brain wave fields can be detected from the body surface poses some limitations to the use of BodyWave; it would not be appropriate for topographical brain mapping or clinical/medical use. However, using BodyWave for applications like

relaxation, attention training, reducing stress – in fact a host of common, practical uses – is highly appropriate and quite doable.

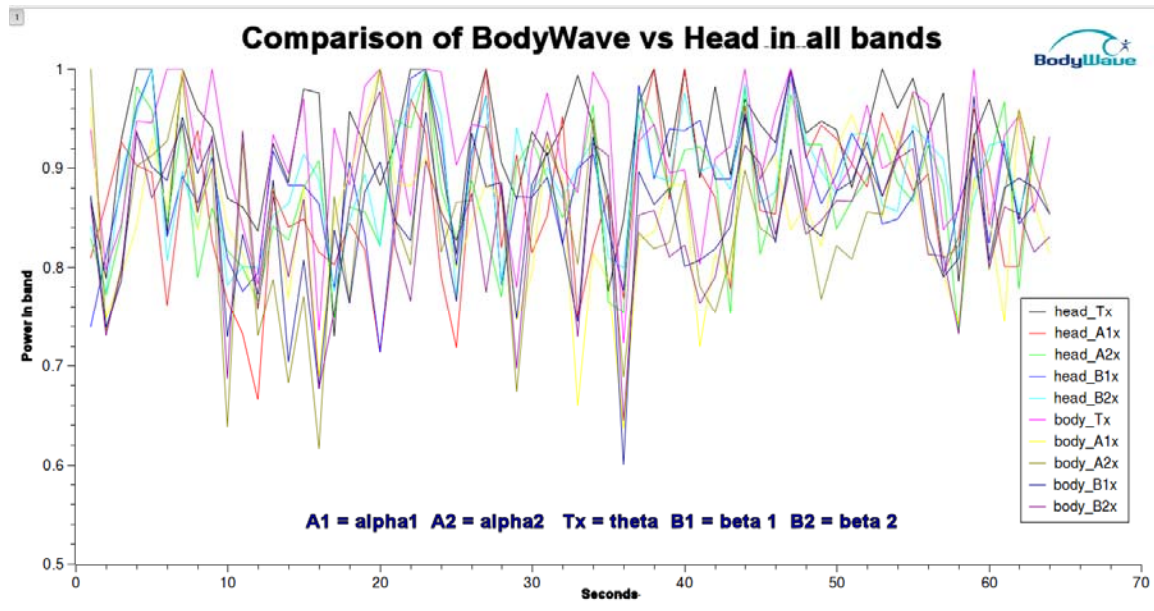
The fact that no intrusive or invasive headset must be worn to collect brain activity makes BodyWave incredibly useful to achieve peak performance, meditation, or to use it with one's Droid or iPhone totally discretely -- even while sitting on a crowded train.

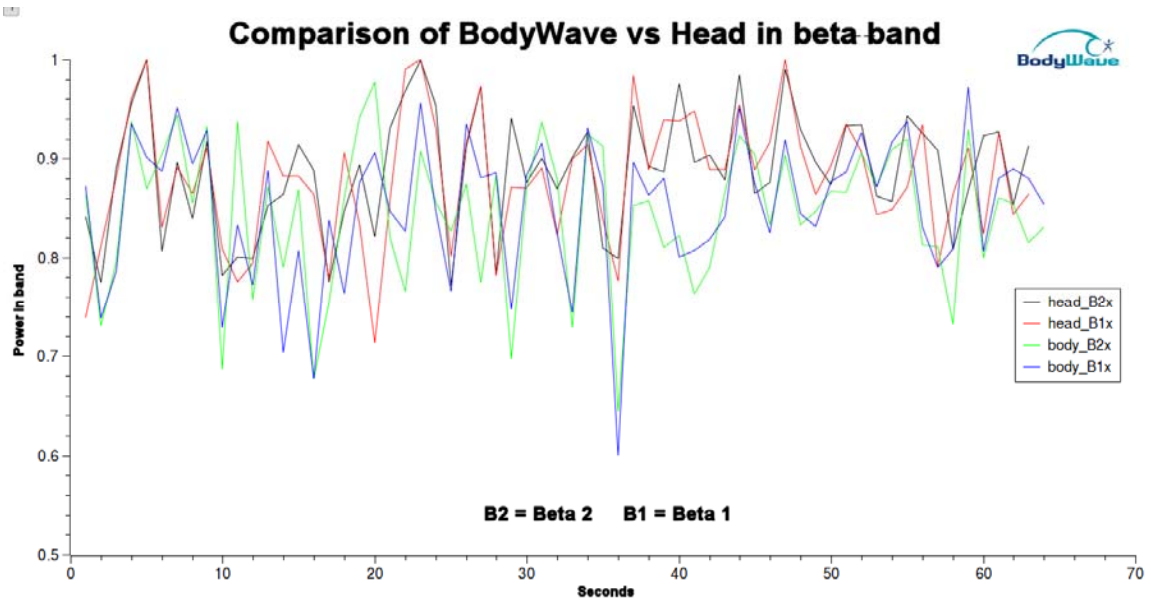
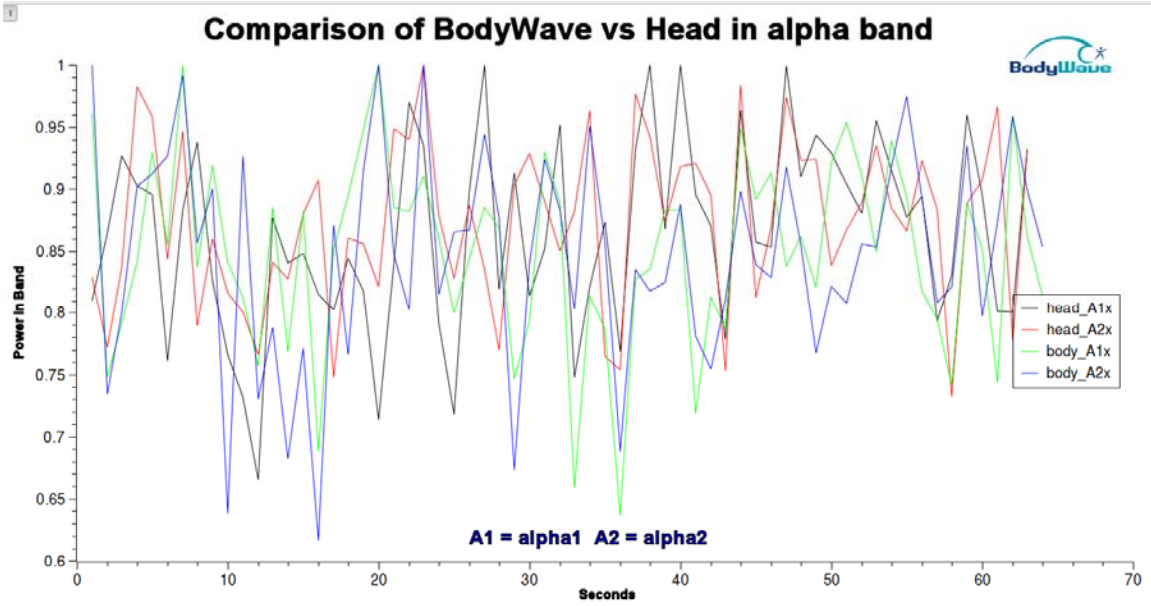
### ***BodyWave® and EEG Waves***

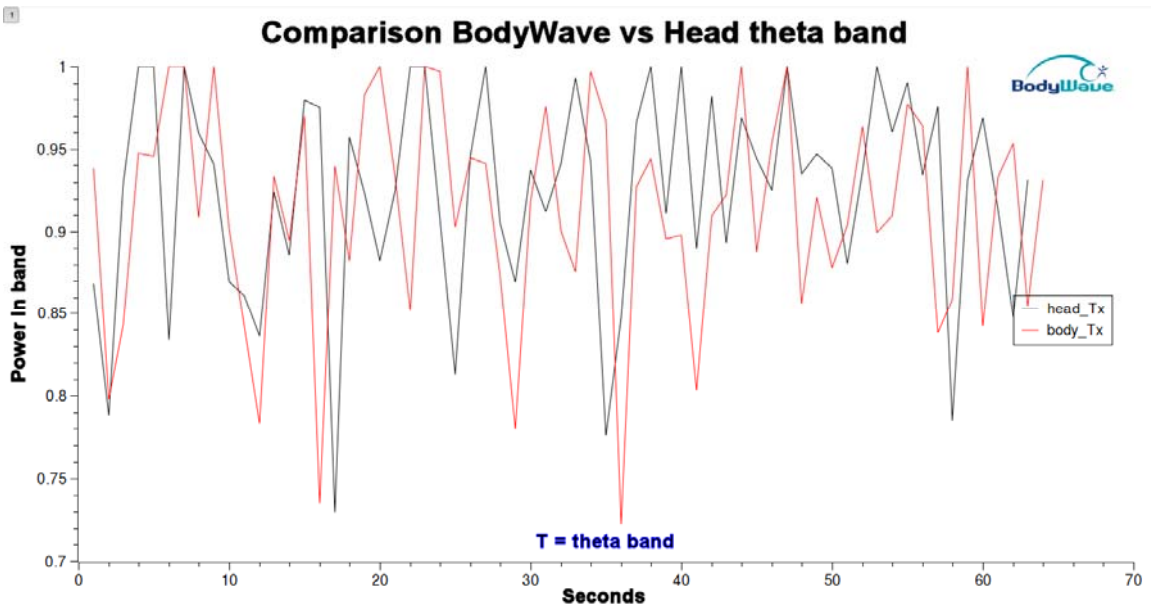
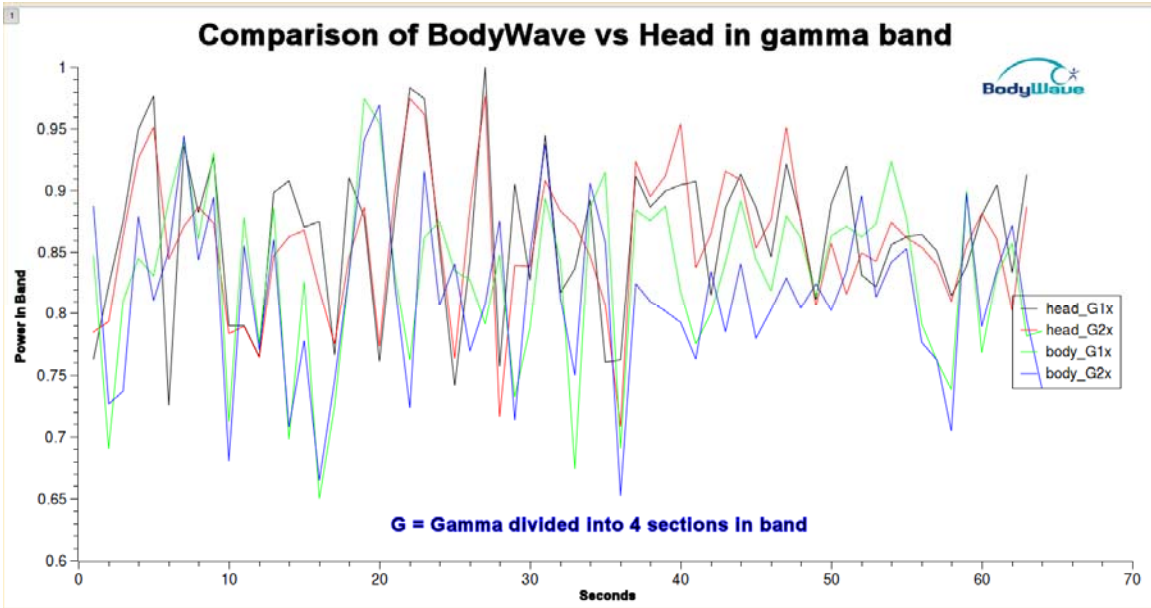
Acquisition and monitoring of brain activity away from the head is both proprietary and different than clinical EEG monitoring. However, used for fun, education, training, or other fields of endeavor, BodyWave is quite practical.

BodyWave measures electrical activity in the brain commonly referred to as brain waves. Scientists studying the brain have found that it continuously produces four or more distinct speeds or frequencies of brain waves. Although these different brain waves are produced simultaneously and in combination, a person's state of consciousness depends on the dominant (strongest) frequency band at each time. During sleep, the brain produces dominant slow delta waves. During daydreaming or in the twilight of sleep, the brain produces dominant theta waves that are slow but a bit faster than delta. When the brain is calm and mentally unfocused --for example when a person relaxes with the eyes closed – the still faster alpha waves are dominant. Finally, when the brain is actively engaged on mentally demanding tasks in an alert and focused way, beta waves, the fastest of these four classes of brainwaves become dominant.

The following graphs are a comparison between EEG taken from scalp locations and BodyWave. They are quite similar in form and function no matter the frequency.







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