Brain Waves

Brain waves come in a wide array from Gamma waves to Delta waves. These waves are musered and these measurements are used to provide information on the different states of the brain at certain times. Through examine these waves we are able to understand how they work and how to work with them to promote or lesson the desired effect. With today's biofeedback technology we are able to work with the brain and have automatic feedback of the activity in the brain.

Brain waves are musered with a different techniques. A couple of the techniques are, **Electroencephalography** (**EEG**) the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain and **Magnetoencephalography** (**MEG**) a technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain.

These brain activities cause a neural oscillation. A **Neural oscillation** is a rhythmic or repetitive neural activity in the central nervous system. Neural tissue can generate oscillatory activity in many ways, driven either by mechanisms localized within individual neurons or by interactions between individual neurons, oscillations can appear either as oscillations in membrane Other brain waves Potential or as rhythmic patterns of action potentials, which then produce oscillatory activation of post-synaptic neurons. The membrane potential arises primarily from the interaction between the membrane and the actions of two types of transmembrane proteins embedded in the plasma membrane.

In physiology, an **action potential** is a short-lasting event in which the electrical membrane potential of a cell rapidly rises and falls, following a consistent trajectory. Action potentials occur in several types of animal cells, called excitable cells, which include neurons, muscle cells, and endocrine cells, as well as in some plant cells. In neurons, they play a central role in cell-to-cell communication. In other types of cells, their main function is to activate intracellular processes. In muscle cells, for example, an action potential is the first step in the chain of events leading to contraction. In beta cells of the pancreas, they provoke release of insulin.

Delta waves are <4Hz. These waves cause a deep dreamless sleep and loss of body awareness. Delta waves are found frontally in adults, posterior in children.

- Adults slow wave sleep
- In babies
- Has been found during some continuous attention tasks

Delta waves are often associated with another EEG phenomenon, the K-complex. K-Complexes have been shown to immediately precede delta waves in slow wave sleep **K-complex** consists of a brief negative high-voltage peak, usually greater than 100 μV, followed by a slower positive complex around 350 and 550 ms and at 900 ms a final negative peak. K-complexes occur roughly every 1.0–1.7 minutes and are often followed by bursts of sleep spindles. They occur spontaneously but also occur in response to external stimuli such as sounds, touches on the skin and internal ones such as aspiratory interruptions. They are generated in widespread cortical locations though they tend to predominate over the frontal parts of the brain.

Both K-complex and delta wave activity in stage 2 sleep create slow wave (0.8 Hz) oscillation and delta (1.6–4.0 Hz). However, their topographical distribution is different, and the delta power of K-complexes is higher.

Restless legs syndrome-

Individuals with restless legs syndrome have increased numbers of K-complexes and these are associated with (and often precede) leg movements.

Obstructive sleep apnea syndrome is associated with aspiratory occlusions evoking fewer K-complexes during NREM sleep even though K-complexes are evoked normally to auditory stimuli and such individuals react normally to respiratory interruptions when awake. This suggests a link between such sleep apnea and a sleep specific blunted cortical response to respiratory problems.

Sex differences-

Females have been shown to have more delta wave activity, and this is true across most mammal species. This discrepancy does not become apparent until early adulthood (in the 30's or 40's, in humans), with men showing greater age-related reductions in delta wave activity than their female counterparts. It has been suggested that this discrepancy may be due to larger skull size in males, but this theory has been refuted by intracranial data from female cats, which still show more delta activity.

Physiological damage

Delta wave disruptions may present as a result of physiological damage, changes in nutrient metabolism, chemical alteration, or may also be idiopathic. Disruptions in delta activity is seen in adults during states of intoxication or delirium and in those diagnosed with various neurological disorders such as dementia or schizophrenia

Theta waves are in the frequency range of 4-8 Hz.

- Drowsiness or arousal in older children and adults
- Idling
- Associated with inhibition of elicited responses (has been found to spike in situations where a person is actively trying to repress a response or action).

Alpha waves are in the frequency range of 8–12 Hz arising found in the posterior regions of head, both sides, higher in amplitude on non-dominant side. Central sites at rest.

- Relaxed/reflecting
- Closing the eyes
- Also associated with inhibition control, seemingly with the purpose of timing inhibitory activity in different locations across the brain.
- Alpha waves are reduced with open eyes, drowsiness and sleep.

They are also called Berger's wave in memory of the founder of EEG. Hans Berger

Types of alpha waves

Some researchers pos that there are at least three forms of alpha waves, which may all have different functions in the wake-sleep cycle.

Alpha waves are present at different stages of the wake-sleep cycle. The most widely researched is during the relaxed mental state, where the subject is at rest with eyes closed, but is not tired or asleep. This alpha activity is centered in the occipital lobe, and is presumed to originate there, although there has been recent speculation that

it instead has a thalamic origin. This wave begins appearing at around four months, and is initially a frequency of 4 waves per second. The mature alpha wave, at 10 waves per second, is firmly established by age 3.

The second occurrence of alpha wave activity is during REM sleep. As opposed to the awake form of alpha activity, this form is located in a frontal-central location in the brain. The purpose of alpha activity during REM sleep has yet to be fully understood. Currently, there are arguments that alpha patterns are a normal part of REM sleep, and for the notion that it indicates a semi-arousal period. It has been suggested that this alpha activity is inversely related to REM sleep pressure.

The third occurrence of alpha wave activity is the alpha-delta or slow-wave (SWS) state. This activity spreads across the brain in an anterior-posterior gradient. It has long been believed that alpha waves indicate a wakeful period during sleep. This has been attributed to studies where subjects report non-refreshing sleep and have EEG records reporting high levels of alpha intrusion into sleep. This occurrence is known as alpha wave intrusion. However, it is possible that these explanations may be misleading, as they only focus on alpha waves being generated from the occipital lobe**.**

Zen-trained meditation masters produce noticeably more alpha waves during meditation. This fact has led to a popular trend of biofeedback training programs for everyday stress relief.

Psychologists are hoping to use this technique to help people overcome phobias, calm down hyperactive children, and help children with stuttering problems to relax enough to practice regular speech

Beta 12 – 20 Hz both sides, symmetrical distribution, most evident frontally; low amplitude waves

- Alert/working
- Active, busy or anxious thinking, active concentration

High Beta Brain Waves 16-20Hz

- High beta brain waves are associated with fear, anxiety, excessive thinking, rapid thinking, OCD (Obsessive-Compulsive Disorder), addiction, and states of peak performance.
- Sometimes, high beta brain waves are created in your brain to compensate for excessive theta brain wave activity.
- If you are highly alert, nervous, or a hypochondriac – you have likely experienced your share of high beta brain waves.

Gamma 30 – 100+Hz Somatosensory cortex

- Displays during cross-modal sensory processing (perception that combines two different senses, such as sound and sight)
- Also is shown during short term memory matching of recognized objects, sounds, or tactile sensations
- A decrease in gamma band activity may be associated with cognitive decline, especially when related the theta band; however, this has not been proven for use as a clinical diagnostic measurement yet

Mu 8 – 13 Sensorimotor cortex

- Shows rest state motor neurons.

Mu waves, also known as the comb or wicket rhythm, frequency range of 8–13 Hz and appear in bursts of at 9 – 11 Hz. referred to as the wicket rhythm because the rounded EEG waves resemble croquet wickets showed that the amplitude of mu waves could be suppressed by physical movements. Later studies showed that the simple intent to move, or certain other visual or mental tasks also can suppress mu wave amplitude A mirror neuron is a neuron that fires both when an animal acts and when the animal observes the same action. Research has suggested that a dysfunctional mirror neuron system may explain the pathology observed in autism spectrum disorders (ASD). Mirror neurons and mu waves may play a critical role in the ability to understand and imitate others' behaviors. Early research results, on enhancing mu wave activity through biofeedback a therapy for autism, have been promising thus far several different prospects of this training that are currently being explored.