



A Brief Introduction to Brainwave Entrainment



Brainwave entrainment was first identified in 1934, although its effects had been noted as early as Ptolemy.

Not long after the discovery of the Alpha brainwave by Hans Berger in 1929, researchers found that the strength of the wave could be “driven” beyond its natural frequency using flickering lights. This is called “Photic Driving”, which is another word for brainwave entrainment using photic (light) stimulation. In 1942 Dempsey and Morison discovered that repetitive tactile stimulation could also produce entrainment and in 1959, Dr. Chatrian observed auditory entrainment in response to clicks at a frequency of 15 per second.

By the 1960s entrainment started to become a tool rather than a phenomenon of the brain. Anesthesiologist M.S. Sadove, MD, used photic stimulation to reduce the amount of anesthesia needed for surgery. Bernard Margolis published an article on brainwave entrainment used during dental procedures, noting less anesthesia required, less gagging, less bleeding and a general reduction in anxiety.

In a 1973 issue of Scientific American, Dr. Gerald Oster examined how combining 2 pure tones resulted in a rhythmic beat which he called Binaural and Monaural Beats. In comparing Binaural beats against Monaural beats, Oster noted that Monaural beats were shown to elicit extremely strong cortical responses, which is the electrical activity responsible for entrainment. Oster concluded that while Binaural Beats produced very little neural response (because the depth of a Binaural Beat is only 3db or 1/10 the volume of a whisper), they could be useful in diagnosing certain neurological disorders.

In the 1980's studies continued with Dr. Glen Solomon and others researching entrainment for headache relief as well as general relaxation. In 1981, Arturo Manns published a study showing the effectiveness of Isochronic Tones as a means of audio-based brainwave entrainment. This was later confirmed by others such as David Siever. Michael Hutchison also wrote his landmark book MegaBrain in 1981, outlining the many possible uses of entrainment from meditation to enhancing creativity. In 1980, Tsuyoshi Inouye and associates at the Department of Neuropsychiatry at Osaka University Medical School in Japan found that photic stimulation produced “cerebral synchronization”. The effect was confirmed in 1984 when Dr. Brockopp analyzed audio-visual brain stimulation and hemispheric synchronization during EEG monitoring.

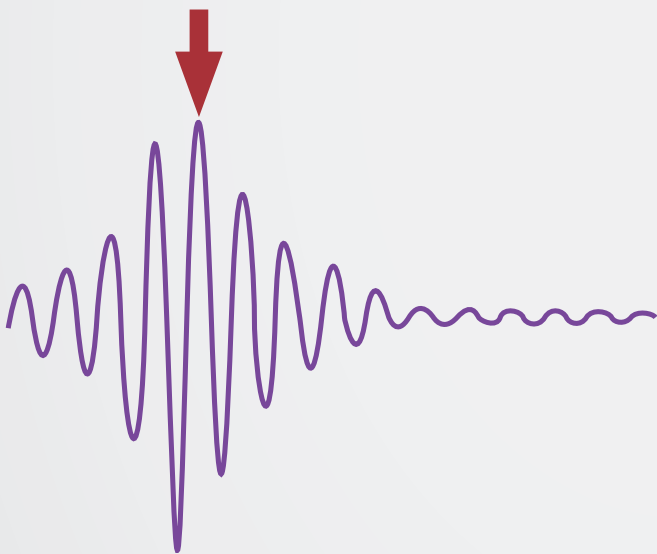
Studies continued into the 90's with researchers such as Dr. Russell and Dr. Carter who explored the potential of using entrainment with ADD and learning disorders. Research has also been conducted into Chronic Fatigue, Chronic Pain, Seasonal Affective Disorder, Hypertension and a number of other disorders.

Brainwave entrainment research continues today with the work of Dr. Thomas Budzynski, David Siever, psychologist Michael Joyce, Dr. Tina Huang and many others.

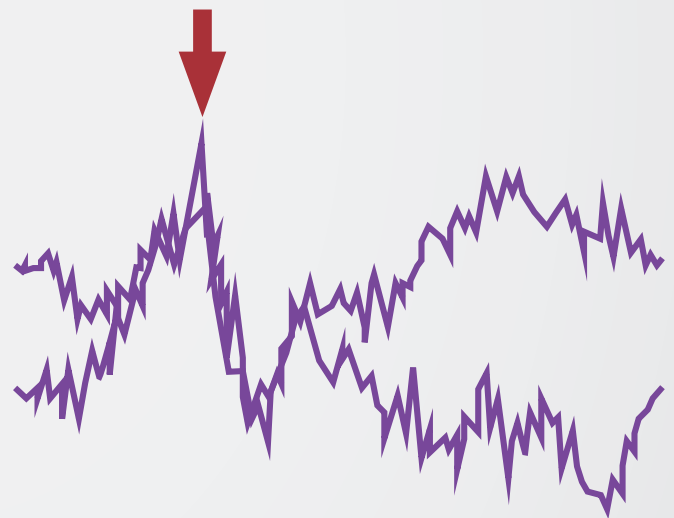
What is Brainwave Entrainment?

Brainwave Entrainment refers to the brain's electrical response to rhythmic sensory stimulation, such as pulses of sound or light. ^{1, 2, 3, 4, 5}

When the brain is given a stimulus, through the ears, eyes or other senses, it emits an electrical charge in response, called a Cortical Evoked Response (shown below). These electrical responses travel throughout the brain to become what you "see and hear." This activity can be measured using sensitive electrodes attached to the scalp.



Pulse of Sound

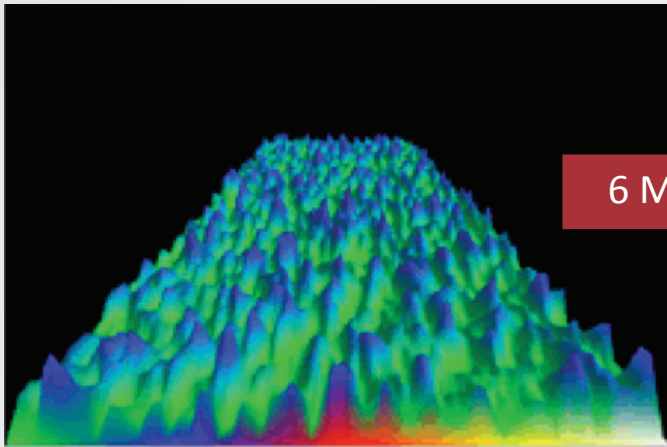


Cortical Evoked Response

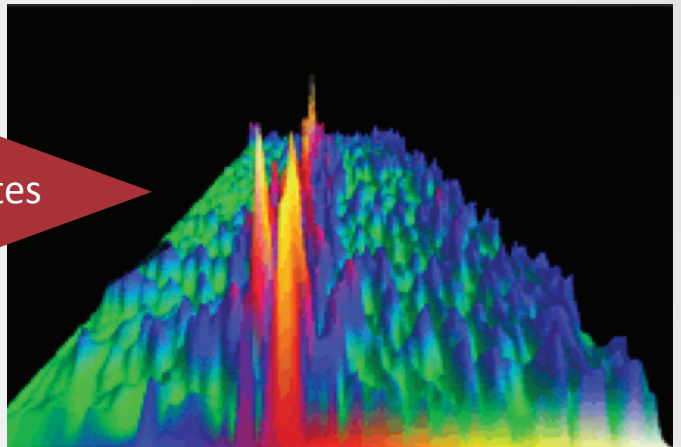
When the brain is presented with a rhythmic stimulus, such as a drum beat for example, the rhythm is reproduced in the brain in the form of these electrical impulses. If the rhythm becomes fast and consistent enough, it can start to resemble the natural internal rhythms of the brain, called brainwaves. When this happens, the brain responds by synchronizing its own electric cycles to the same rhythm. This is commonly called the Frequency Following Response (or FFR):

Brain Response to 10 Hz Entrainment

Brainwaves (Before)



Brainwaves (After)



6 Minutes

0 Hz 5 Hz 10 Hz 15 Hz 20 Hz

0 Hz 5 Hz 10 Hz 15 Hz 20 Hz

FFR can be useful because brainwaves are very much related to mental state. For example, a 4 Hz brainwave is associated with sleep, so a 4 Hz sound pattern would help reproduce the sleep state in your brain. The same concept can be applied to many other mental states, including concentration, relaxation and meditation.^{6,7,8} As a session progresses, the frequency rate of the applied pulses is changed slowly, thereby changing your brainwave patterns and guiding your mind to various useful mental states.

Brainwave Frequencies

With the discovery of brainwaves came the discovery that electrical activity in the brain will change depending on what the person is doing. For instance, the brainwaves of a sleeping person are vastly different than the brainwaves of someone wide awake. Over the years, more sensitive equipment has brought us closer to figuring out exactly what brainwaves represent and with that, what they mean about a person's health and state of mind.

Here is a table showing the known brainwave types and their associated mental states:

Wave	Frequency	Associated Mental State
Gamma	27 Hz and up	Gamma is associated with the formation of ideas, language and memory processing, and various types of learning. ^{2, 3, 4} Gamma waves have been shown to disappear during deep sleep induced by anesthesia, but return with the transition back to a wakeful state. ^{5, 6}
Beta	12hz - 27hz	Wide awake. This is generally the mental state most people are in during the day and most of their waking lives. Usually, this state in itself is uneventful, but don't underestimate its importance. Many people lack sufficient beta activity, which can cause mental or emotional disorders such as depression and ADD. ^{7, 8} and insomnia. And low SMR production (a sub-range of beta at 12-15hz) may be related to insomnia. ⁹ Stimulating beta activity can improve emotional stability, energy levels, attentiveness and concentration. ^{10, 11, 12}
Alpha	8hz - 12hz	Awake but relaxed and not processing much information. When you get up in the morning and just before sleep, you are naturally in this state. When you close your eyes your brain automatically starts producing more alpha waves. Many studies monitoring the EEG activity of experienced meditators have revealed strong increases in alpha activity. ¹³ Alpha activity has also been connected to the ability to recall memories, lessened discomfort and pain, and reductions in stress and anxiety. ^{14, 15, 16, 17}
Theta	3hz - 8hz	Light sleep or extreme relaxation. Theta is also a very receptive mental state that has proven useful for hypnotherapy, as well as self-hypnosis using recorded affirmations and suggestions. ^{18, 19}
Delta	0.2hz - 3hz	Deep, dreamless sleep. Delta is the slowest band of brainwaves. When your dominant brainwave is delta, your body is healing itself and "resetting" its internal clocks. ²⁰ You do not dream in this state and are completely unconscious.

The Significance of Brainwaves

You can tell a lot about a person simply by observing their brainwave patterns. For example, anxious people tend to produce an overabundance of high beta waves while people with ADD/ADHD tend to produce an overabundance of slower alpha/theta brainwaves.

Researchers have found that not only are brainwaves representative of mental state, but they can be stimulated to change a person's mental state, and this in turn can help with a variety of mental issues.

Color Therapy (Chromo Therapy)

Chromotherapy is a therapeutic science which has been used by many races for thousands of years. The ancient Egyptians used specially built solarium rooms with different colored glasses. The sun would shine through the colored glass onto the patient to achieve specific therapeutic benefits. Others used different colored silk clothes to filter varying shades of light onto their bodies. There are also reports of using colored waters and colored gels to achieve the same results.

Chromotherapy is a narrow band in the cosmic electromagnetic energy spectrum, known as the visible color spectrum. It is composed of reds, greens, blues and their combined derivatives, producing the perceivable colors that fall between the ultraviolet and the infrared ranges of energy or vibrations. These visual colors with their unique wavelength and oscillations, when combined with a light source and selectively applied, provide the necessary healing energy required by the body. Light affects both the physical and etheric bodies. Colors generate electrical impulses and magnetic currents or fields of energy that are prime activators of the biochemical and hormonal processes in the human body, the stimulants or sedatives necessary to balance the entire system and its organs.

These days, many natural therapists are using chromotherapy on their patients in interesting ways.

Colors influence us differently because they have different wavelengths and frequencies, and these affect different parts of the brain.

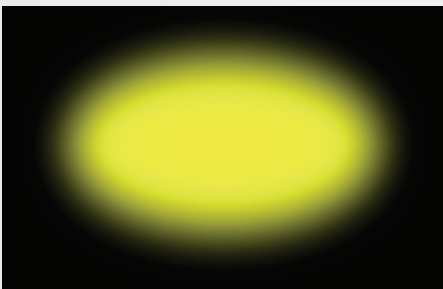
Colors and it`s described effects:



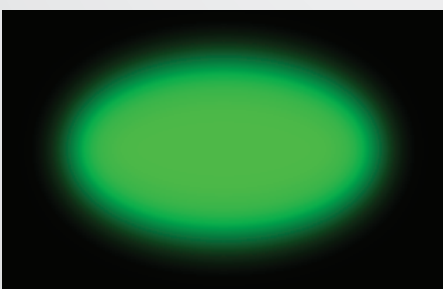
RED is hot, initiating, igniting, stimulating, vitality, life-force energy, revolution, change, ambition, grounding, passion, alert, pioneering, activity, positive, survival, material side of life, primal, awakening, emerging. In relation to the physical body, RED is documented to create positive effects on circulation, chronic illness, non-infected wounds, scar tissue, strengthens kidneys, heart, muscles, blood, lungs, bones.



ORANGE is joy, happiness, warmth, creativity, pleasure, sensuality, sexuality, generosity, moves energy gently, awakening to wisdom within oneself, sociable, aspiring, gregarious. In relation to the physical body, ORANGE is documented to create positive effects on depression, cramping anywhere in body, relaxant, sclerosis, heart disease, boosts immune system, circulation, raises blood pressure, artery disturbance (especially in legs), genitals, fear (alternate with blue), endocrine balancer (when used with blue), cleans and purifies hormonal system.



YELLOW is mental activity, learning, intellect, acquired/learned knowledge, individuation, alertness, concentration, focus, cheerful, sun, warmth, cleaning, fear, empowerment, self-esteem, confidence. In relation to the physical body, YELLOW is documented to create positive effects on combating fear (obsessive, habitual), digestion, stomach, gall bladder, liver, immune system, fortifies endocrine and nervous systems, nerve tonifier, motor stimulant, assimilation, lateral disturbances, helps chronic to become acute.



GREEN is sedative, cooling, calming, soothing, fluidity, growth, balance, money/prosperity, birth, new beginnings, nature, health, healing, heart, loving, expansion, curiosity, good for people who do precision work, space, trust, feelings, integrity, harmony, seeking

truth, relationships. In relation to the physical body, GREEN is documented to create positive effects on liver, swelling or growth, anti-inflammatory, eye problems, bronchial catarrh, gout, diabetes, cysts, tumors, pituitary stimulant, washes out endo-toxins, promotes healthy bones, painful joints, allergies.



TURQUOISE is a bridging color, higher heart, making contact with yourself, communication of the heart, creative communication, studying and gathering information, learning, unconditional love, self-respect, respect for all life, taking individual responsibility. In relation to the physical body, TURQUOISE is documented to create positive effects on immune system, skin (burns and infections), mental relaxation, acidic, tonifier, regulates lung/large intestine systems. TURQUOISE stimulates the thymus center.



BLUE is calming, deep inner peace, restful, openness, cooling, relaxing, assists in making deep changes, higher mental activities (3rd eye), insight, wisdom, sky, water, sadness, unity, safety, godliness, communication that comes through us, clarity. In relation to the physical body, BLUE is documented to create positive effects on anti-bacterial, anti-infection, anti-cramping, headaches, helps farsightedness, facilitates restful sleep, pain relieving, nervousness, insomnia, hemorrhage, herpes, warts, lowers blood pressure, fever.



INDIGO/ROYAL BLUE is the higher mind that is connected to the all-that-is, the akashic records, the cosmic library. It is the color that makes contact with your "inner vision" or intuition, that part of you which sees beyond the five senses.



VIOLET stimulates emotions, meditation, inspiration, intuition, inner emotional release, opening inner doors, stimulates dreams, wisdom, spirituality, higher mind, power, will, letting go, vision, transformation, alchemy, loyalty, synthesis, integration, mysticism, clairvoyance/clairaudience/clairsentience, service, union, artistry, balance of male and female. In relation to the physical body, VIOLET is documented to create positive effects on menopause, spleen, sedative, relaxant, build leucocytes, lymphatic relaxant, soothes solar plexus, neutralize mercury from fillings, anti-viral.

References

1. Berger, H. (1929). *Über das elektrenkephalogramm des menschen*. *European Archives of Psychiatry and Clinical Neuroscience*, 87(1), 527-570.
2. Crone, N. E., Hao, L., Hart, J., Boatman, D., Lesser, R. P., Irizarry, R., & Gordon, B. (2001). *Electrocorticographic gamma activity during word production in spoken and sign language*. *Neurology*, 57(11), 2045-2053.
3. Burle, B., & Bonnet, M. (2000). *High-speed memory scanning: a behavioral argument for a serial oscillatory model*. *Cognitive Brain Research*, 9(3), 327-337.
4. Miltner, W. H., Braun, C., Arnold, M., Witte, H., & Taub, E. (1999). *Coherence of gamma-band EEG activity as a basis for associative learning*. *Nature*, 397(6718), 434-436.
5. John, E. R., Prichep, L. S., Kox, W., Valdes-Sosa, P., Bosch-Bayard, J., Aubert, E., & Gugino, L. D. (2001). *Invariant reversible QEEG effects of anesthetics*. *Consciousness and cognition*, 10(2), 165-183.
6. Munk, M. H., Roelfsema, P. R., König, P., Engel, A. K., & Singer, W. (1996). *Role of reticular activation in the modulation of intracortical synchronization*. *Science*, 272(5259), 271-274.
7. Brenner, R. P., Ulrich, R. F., Spiker, D. G., Scwabassi, R. J., Reynolds III, C. F., Marin, R. S., & Boller, F. (1986). *Computerized EEG spectral analysis in elderly normal, demented and depressed subjects*. *Electroencephalography and clinical neurophysiology*, 64(6), 483-492.
8. Egner, T., & Gruzelier, J. H. (2004). *EEG biofeedback of low beta band components: frequency-specific effects on variables of attention and event-related brain potentials*. *Clinical Neurophysiology*, 115(1), 131-139.
9. Hauri, P. (1981). *Treating psychophysiologic insomnia with biofeedback*. *Archives of General Psychiatry*, 38(7), 752.

10. Siever, D. (2004). *The application of audio-visual entrainment for the treatment of seasonal affective disorder. Biofeedback, 32 (3), 32-35.*
11. Howard CE, Graham LE, 2nd, Wycoff SJ. *A comparison of methods for reducing stress among dental students. J Dent Educ. 1986;50(9):542-544*
12. Patrick GJ. *Improved neuronal regulation in ADHD: An application of 15 sessions of photic-driven EEG neurotherapy. J Neurother. 1996;1(4):27-36.*
13. Cahn BR, Polich J. *Meditation states and traits: EEG, ERP, and neuroimaging studies. Psychol Bull. 2006 Mar;132(2):180-211.*
14. Williams, J., Ramaswamy, D. and Oulhaj, A., 2006. *10 Hz flicker improves recognition memory in older people. BMC Neurosci. 7, 21.*
15. Williams JH. *Frequency specific effects of flicker on recognition memory. Neuroscience. 2001;104(2):283-286*
16. Nomura T, Higuchi K, Yu H, et al. *Slow-wave photic stimulation relieves patient discomfort during esophagogastroduodenoscopy. J Gastroenterol Hepatol. 2006; 21(1 Pt 1):54-58*
17. Ossebaard HC. *Stress reduction by technology? An experimental study into the effects of brainmachines on burnout and state anxiety. Appl Psychophysiol Biofeedback. 2000;25(2):93-101*
18. Wickramasekera I, I. E. (1977). *On attempts to modify hypnotic susceptibility: Some psychophysiological procedures and promising directions. Annals of the New York Academy of Sciences, 296, 143-153*
19. Sabourin, M. E., Cutcomb, S. D., Crawford, H. J., & Pribram, K. (1990). *EEG correlates of hypnotic susceptibility and hypnotic trance: spectral analysis and coherence. International Journal of Psychophysiology, 10(2), 125-142.*
20. Botella-Soler, V., Valderrama, M., Crépon, B., Navarro, V., & Le Van Quyen, M. (2012). *Large-scale cortical dynamics of sleep slow waves. PloS one, 7(2), e30757.*

The medical information on this site is provided as an information resource only, and is not to be used or relied on for any diagnostic or treatment purposes. This information is not intended to be patient education, does not create any patient-physician relationship, and should not be used as a substitute for professional diagnosis and treatment.

Please consult your health care provider for an appointment, before making any healthcare decisions or for guidance about a specific medical condition. Swiss Bionic Solutions expressly disclaims responsibility, and shall have no liability, for any damages, loss, injury, or liability whatsoever suffered as a result of your reliance on the information contained in this site.



Swiss Bionic Solutions Schweiz GmbH

Schulhausstrasse 17 | 8834 Schindellegi, Schweiz

Phone: +41 (62) 295 5951 | Fax: +41 (62) 295 5952 | E-Mail: ch@swissbionic.com

Swiss Bionic Solutions Deutschland GmbH

Biberacher Str. 87 | 88339 Bad Waldsee, Deutschland

Phone: +49 (7524) 996 950 | Fax: +49 (7524) 996 9518 | E-Mail: de@swissbionic.com

Swiss Bionic Solutions USA Inc.

1200 NE 7Th Ave Suite 7 | Fort Lauderdale, Florida 33304, USA

Phone: +1 (954) 766 4153 | Fax: +1 (954) 766 4156 | E-Mail: us@swissbionic.com

Swiss Bionic Solutions Canada Inc.

1195 North Service Rd W. Unit B8 | Oakville, ON, L6M 2W2, Canada

Phone: +1 (905) 465 0753 | Fax: +1 (1 866) 792 8182 | E-Mail: ca@swissbionic.com

Swiss Bionic Solutions Asia Ltd.

998 Canton Road | Mongkok | Kowloon | Hong Kong

Phone: +852 2337-8774 | E-Mail: asia@swissbionic.com

