AN ANALYSIS OF THE RELATIONSHIP BETWEEN BRAIN WAVES IN ELECTROENCEPHALOGRAPHY (EEG) AND CONCENTRATION MEDITATION PRACTICE IN THERAVĀDA BUDDHISM

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ABSTRACT

Nowadays in Eastern and Western countries, there is much interest in studies of Buddhist meditation practice. This article is focused on an analysis of the relationship between brainwaves in electroencephalography (EEG) and concentration meditation practices in Theravāda Buddhism. The following are the findings: concentration meditation has good effects on the brain. Despite the fact that we can detect these good effects by several methods, one of these methods (EEG measurement) shows that deep meditation activates slow brainwaves, and we can use concentration meditation in many ways to improve emotional and physical health. Based on the findings in this analysis, the more deep concentration, the more brain synchronization occurs, and the slower are the brainwaves. As a result, the body and the brain can rest. Therefore, our findings indicate that concentration meditation can be used to reduce stress, anxiety, and depression. It can also heal some diseases and improve some symptoms thereby contributing to disseminate concentration meditation practice in Theravāda Buddhism with the knowledge of modern science to create love, happiness, and wisdom to build world peace.

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Introduction

The "mind science" in Buddhism is very important to help humankind definitively achieve peace. So Buddhist science may be called mind science and it develops what the people in Buddhist studies have called mental development or meditation which consists of tranquility meditation *(samatha-bhāvanā)* and insight meditation *(vipassana-bhāvanā)*. Tranquility meditation *(samatha-bhāvanā)* aims at concentration and insight meditation *(vipassana-bhāvanā)* aims at wisdom. This type of method has brought about the eradication of suffering and sometimes mental illness of people. Brain waves can be improved due to concentration meditation practice. The more people practice meditation to gain deep concentration, the more improvement of brain waves we can observe. Besides, it will promote mental and physical health.

Buddhism is a pragmatic religion that aims to teach the understanding of the principles of the natural law of causality and conditionality which leads to an equilibrium between faith and wisdom based on the full understanding of nature, seeing things as they really are. Buddhism with what has two great methods of teaching which are: tranquility meditation and insight meditation. It is mind science and can be used to develop human competency and potentiality to develop the brain wave so that a person understands natural phenomena. By doing so, the mind is able to increase the ability of the brain waves for enlightenment. Especially in normal life, meditation has brought mind calmness, coolness, and purification, and this mind process, according to the teaching of the Buddha, is the threefold training *(tisikkhā)* which comprises morality, concentration, and wisdom. These wholesome actions provide the greatest foundation for human dignity with resulting in good behavior and good action towards one's self and other people. Thus, the tenets of Buddhist science are itself a course on the fundamentals of science. Accordingly, the researcher would like to study further details of Buddhist science, concerning brain wave development from meditation practice, which is the baseline to compare with the normal brain waves.

Western brain wave science studies the plasticity of the human brain by attention to the function of physical and chemical processes. However, there are many studies concerning the brain wave system. Mindfulness meditation is the method to sharpen and enhance the brain.[1]

These two sciences, ancient Buddhist science and modern science, are correlated or even support each other. Accordingly, the significance of studies is the study of analysis of the relationship between brain waves in encephalography (EEG) and concentration meditation practice in Theravāda Buddhism. There are many problems about stress that cause diseases called psychosomatic diseases: asthma, insomnia, peptic ulcer, anxiety, allergy, migraine, etc. At

[1] Boonton Dockthaisong, "Meditation and Mindfulness as Methods to Sharpen and Enhance the Brain," *PSAKU International Journal of Interdisciplinary Research* 7 (2018): 25-30.

present, there are a lot of people taking pills to cure their anxiety, stress, and strain by using medical therapy. Life with meditation and without excessive use of pills and medicine will result in good health and increased life expectancy.

EEG Signal and Normal EEG

Brain waves occur due to the combination of synchronized electrical activity in the brain.[2] That is called a "brain wave", because of its cyclic and "wave-like" in nature. Brain waves can be detected by using medical equipment such as an electroencephalogram (EEG) which measures the oscillation of electricity levels in different areas on the scalp. They are classified into five types: beta wave, alpha wave, theta wave, delta wave, and gamma wave.

Beta waves (14-30 Hz) typically dominate our normal waking states of consciousness and occur when attention is directed toward cognitive and other tasks. Beta is a "fast" wave activity that is present when we are alert, attentive, focused, and engaged in problem solving or decision making. Depression and anxiety have also been linked to beta waves because they can lead to "rut-like" thinking patterns.

Alpha waves (8-14Hz) are present when your brain is in an idling default- state typically created when you're daydreaming or consciously practicing mindfulness or meditation. Alpha waves can also be created by doing aerobic exercise.

Theta waves (4-8 Hz) occur during sleep but have also been observed in the deepest states of Zen meditation.

Delta waves (0.5-4 Hz) are the slowest brain waves and occur primarily during our deepest state of dreamless sleep, and transcendental meditation where awareness is fully detached.

Gamma waves (25-100 Hz) are typically over 40 Hz and are the fastest of the brain wave bandwidths. Gamma waves relate to the simultaneous processing of information from different brain areas and have been associated with higher states of conscious perception,[3] the state of enlightenment.

Concentration Meditation Practice in Theravāda Buddhism

The method of developing the kind of concentration is associated with the noble eightfold path. The practice in Theravāda Buddhism is called meditation or mental development *(citta-bhāvanā)*. Mental development (*bhāvanā*) consists of two things that are to

[2] Jeffrey L. Fannin, *Understanding Your Brainwaves*, Accessed April 19, 2020, https:// www.scrbd.com/document/339287713/Understanding-brainwaves-White-paper.
[3] Ibid.

be developed:[4] calm and insight (*samatho ca vipassanā ca*).[5] There are *samatha-bhāvanā* and *vipassanā-bhāvanā*: *samatha-bhāvanā* means tranquility development, which aims at concentration (*samādhi*), and *vipassanā-bhāvanā* means insight development, which aims at understanding or wisdom (*paññā*). *Bhāvanā* is sometimes called *kammaṭṭhāna* and means stations of mental exercises in meditation.

Concentration meditation practice in Theravāda Buddhism has three stages of concentration: momentary concentration *(khaṇika-samādhi),* access concentration *(upacāra-samādhi),* and attainment concentration *(appanā-samādhi).* One-pointedness of mind is the factor of the attainment concentration: the first, second, third, and fourth absorption, but one-pointedness of mind is different in each of the absorptions. The fourth absorption results in the most calmness so one-pointedness of mind has the most power.

Forty Subjects of Meditation

There are 40 subjects of meditation to cultivate concentration and wisdom called *kammaṭṭhāna* 40,[6] namely: meditation devices *(kasiṇa 10),* ten kinds of foulness; corpses at different stages of decay *(asubha 10),* recollection; constant mindfulness *(anussati 10),* holy abidings; sublime states of mind *(appamaṇṇā; brahmavvihāra 4),* perception of the loathsomeness of food *(āhārepaṭikūlasaññā),* analysis of the four elements *(catudhātu-vavaṭṭhāna),* and absorptions of the formless sphere *(arūpa 4).*

The attainments reached by the practice of tranquility development are the eight absorptions - the four *jhānas* and the four immaterial states - each of which serves as the basis for the next. Mindfulness of breathing, to which the Buddha devotes an entire *sutta,*[7] provides an ever accessible meditation subject that can be pursued through all four *jhānas* and also used to develop insight. The practice of mindfulness of breathing fulfills all foundations of mindfulness.

Another method for attaining the *jhānas* mentioned in the *suttas* is the four divine abodes (*brahmavihāra*) - boundless loving-kindness, compassion, appreciative joy (i.e., gladness at others' success), and equanimity.[8] Tradition holds the first three to be capable of leading to the three lower *jhānas*, the last of inducing the fourth *jhāna*.

Right concentration is defined in terms of the four *jhānas.* The first *jhāna* is characterized by five *"jhāna* factors": initial and sustained attention to the meditation object, zest, bliss, and one-pointedness of the mind. As the mind becomes more refined the coarser

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[4] Maurice Walshe, *Sangīti Sutta: The Chanting Together, The Dīgha Nikāya*, (Boston: Wisdom Publications, 1995), 482.; Maurice Walshe, *Dasuttara Sutta: Expanding Decade, The Dīgha Nikāya*, (Boston: Wisdom Publications, 1995), 512.

[5] D III 213; These are the two basic forms from which stems all Buddhist meditation.

[6] Vism 110; Comp 204.

[7] M 118.

[8] M 7, M 40.

jhāna factors fade away. The second *jhāna* is reached with the shedding of initial and sustained attention. The disappearance of zest signals marks the attainment of the third *jhāna.* With the loss of bliss, the mind enters the fourth and most subtle level of *jhāna,* distinguished by unshakable equanimity.

Table 1. *Jhāna* (absorption) consists of five factors, as the following table:

Stage of Absorption	**Factors**				
1st absorption *(paṭhama-jhāna)*	thought	sustain thought	zest	joy	one-pointedness
2nd absorption *(dutiya-jhāna)*	-	-	zest	joy	one-pointedness
3rd absorption *(tatiya-jhāna)*	-	-	-	joy	one-pointedness
4th absorption*(catuttha-jhāna)*	-	-	-	equanimity	one-pointedness

The immaterial attainments are to be reached by fixing the mind on the specific object of each attainment - infinite space, infinite consciousness, nothingness, and the state of neither perception nor non-perception.

The attainments possible through tranquility development were known to Indian contemplatives long before the advent of the Buddha. The Buddha himself mastered the two highest stages under his early teachers but found that they only led to higher planes of rebirth, not to genuine enlightenment.[9] However, because the unification of mind induced by the practice of concentration contributes to clear understanding, the Buddha incorporated the techniques of tranquility meditation and the resulting levels of absorption into his own system, treating them as a foundation and preparation for insight and as a "pleasant abiding here and now."

The Six Temperaments

There are six temperaments which are: greedy temperament, hating temperament, deluded temperament, speculative temperament, faithful temperament, and intelligent temperament. One who wants to practice meditation must know one's temperament in order to choose the proper subjects of meditation.

Greedy temperament is suitable for eleven meditation subjects, the ten kinds of foulness and mindfulness occupied with the body.

Hating temperament is suitable for the four divine abidings and four color *kasiṇas* (red *kasiṇa,* blue *kasiṇa,* yellow *kasiṇa,* white *kasiṇa*)

[9] M 26.15-16.

Deluded temperament and speculative temperament are suitable for mindfulness of breathing.

Faithful temperament is suitable for the first six recollections.

Intelligent temperament is suitable for mindfulness of death, the recollection of peace, the defining of the four elements, and the perception of repulsiveness in nutriment.

The remaining *kasiṇas* and the immaterial states are suitable for all kinds of temperament.

The Four foundations of mindfulness (*Mahāsatipaṭṭhāna*)[10]

This is one way[11] to the purification of beings, for the overcoming of sorrow and distress, for the disappearance of pain and sadness,[12] for the gaining of the right path,[13] and for the realization of *nibbāna.*

Table 2. The four foundations of mindfulness can be classified into four categories:

Satipaṭṭhāna **(the Foundations of Mindfulness)**	**Details**
1. ***Kāyānupassanā-satipaṭṭhāna*** (contemplation of the body)	1.1 Mindfulness of breathing 1.2 The four postures 1.3 Clear awareness 1.4 Reflection on the repulsive: parts of the body 1.5 The four elements 1.6 The nine charnel-ground contemplation
2. ***Vedanānupassanā-satipaṭṭhāna*** (contemplation of the feelings)	pleasant feeling; painful feeling;

[10] Maurice Walshe, *Mahāsatipaṭṭhāna Sutta: The Greater Discourse on the Foundations of Mindfulmess, Dīgha Nikāya*, (Boston: Wisdom Publications, 1995), 335-350.; Satipaṭṭhana. It is probably a compound of sati + upatthana (lit. 'placing near'), as in the old Sanskrit version (Smrty-upasthana Sutra). 'Foundations', though used by Nyanaponika and others, is really a makeshift translation. In any case, whatever the etymology, the meaning emerges clearly enough from the instructions that follow.Sati (Skt. smrti) originally meant 'memory' (and still, rarely, does in Pali). The rendering 'mindfulness'by RD was a brilliant one which is almost universally used (though 'recollection' or 'recollectedness' is occasionally found). The use of 'self-possession' by A.K. Warder in his otherwise excellent Indian Buddhism is regrettable. It should perhaps be mentioned that Buddhist Sanskrit smrti is clearly used in a different sense from the Hindu smrti 'oral tradition'.

[11] Ekāyano maggo. Sometimes translated 'the only way' or 'the one and only way' with, on occasion, a slightly triumphalist connotation. DA in fact offers a number of possibilities, thus showing that the old commentators were not entirely sure of the exact meaning. Ekdyana can be literally rendered 'one-going', wh ich is ambiguous. Nanamoli has 'a path that goes one way only'. In any case it should not be confused with the term sometimes found in Buddhist Sanskrit ekayana 'one vehicle' or 'career'.

[12] Domanassa: in t his context usually translated 'grief'.

[13] Ñāya: 'leading, guiding' (sometimes = 'logic'). Here

	neither-painful-nor-pleasant feeling
3. ***Cittānupassanā-satipaṭṭhāna*** (contemplation of mind)	lustful mind; free from lust; hating mind; free from hate; deluded mind; undeluded…
4. ***Dhammānupassanā-satipaṭṭhāna*** (contemplation of mind-objects)	4.1 The five hindrances 4.2 The five aggregates 4.3 The six internal and external sense-bases 4.4 The seven factors of enlightenment 4.5 The four noble truths

Table 3. *Satipaṭṭhāna* practice has four fundamentals of practice as follows:

Pāli Word	Four Fundamental of Practice
1. ***Ātāpa***	energy and determination
2. ***Sampajañña***	awareness and clear comprehension
3. ***Sati***	mindfulness is awareness fixed and firmly established without any drifting from the chosen object.
4. ***Vineyya loke abhijjhā-domanassaṃ***	having removed covetousness and displeasure regarding the world.

Insight (Contemplation of the Body)

'So he abides contemplating body as body internally, contemplating body as body externally, contemplating body as body both internally and externally. He abides contemplating arising phenomena in the body, he abides contemplating vanishing phenomena in the body, he abides contemplating both arising and vanishing phenomena in the body. Or else, mindfulness that "there is body" is present to him just to the extent necessary for knowledge and awareness. And he abides independent, not clinging to anything in the world.'

Insight (Contemplation of Feelings)

'So he abides contemplating feelings as feelings internally. He abides contemplating feelings as feelings externally... He abides contemplating arising phenomena in the feelings, vanishing phenomena and both arising and vanishing phenomena in the feelings. Or else, mindfulness that "there is feeling" is present to him just to the extent necessary for knowledge and awareness. And he abides independent, not clinging to anything in the world.'

Insight (Contemplation of Mind)

'So he abides contemplating mind as mind internally. He abides contemplating mind as mind externally… He abides contemplating arising phenomena in the mind ... Or else, mindfulness that "there is mind" is present just to the extent necessary for knowledge and awareness. And he abides detached, not grasping at anything in the world.'

Insight (Contemplation of Mind-Objects)

'So he abides contemplating mind-objects as mind-objects internally, contemplating mind-objects as mind-objects externally, contemplating mind-objects as mind-objects both internally and externally. He abides contemplating arising phenomena in mind-objects, he abides contemplating vanishing phenomena in mind-objects, he abides contemplating both arising and vanishing phenomena in mind-objects. Or else, mindfulness that "there are mind-objects" is present just to the extent necessary for knowledge and awareness. And he abides detached, not grasping at anything in the world.'

'Whoever should practice these four foundations of mindfulness for just seven years…seven months…seven days may expect one of two results: either arahantship in this life or, if there should be some substrate left, the state of a non-returner.'

Meditation in Modern Science

Meditation today has been reframed in terms of both mindful appreciation of the world of the sense – something pervasive in the contemporary articulation of mindfulness and mindful political or social activism to help improve the world, a prominent feature of Engaged Buddhism.

Meditation is beneficial for everyone from young children to the elderly. The level of responsibility can create much stress in the mind which will have a detrimental effect on his work performance and, at times, may result in impaired physical health as well. It's important, then, to learn how to rest and strengthen the mind, as well as the body.

Meditation practice will accumulate mind power which makes quick and effective decisions more frequently than normal. Stress levels will decrease, as problems and conflicts are averted due to high quality of decision-making. The practitioners who meditate consistently will develop a sharp, bright mind, filled with morality, concentration, wisdom, compassion, and increase consciousness. Decisions made by such a person will produce positive results for all concerned.

In summary, these qualities, obtained through meditation, will bring peace and harmony to any situation whether in the workplace, home life, community, or across the globe.

Relationship and Causal Connection between Brain Wave in Electroencephalography (EEG) and Concentration

In modern science, special instruments can verify that there are changes in the function and anatomy of the brain by changing brain waves. The more people who practice meditation to gain deep concentration, the more observable improvements in brain waves will occur. So, concentration practice in Theravāda Buddhism can improve the emotional, psychological, and physical health of practitioners.

A Scientific View of the Relationship and Causal Connection between Brain Wave in EEG and Concentration

Brain waves reduce the frequency from Beta wave→ Alpha wave → Theta wave → Delta wave and are related by the steps of deep of concentration respectively:

- Beta waves appear in the brain when the body and mind are alert in normal activity.
- Alpha waves appear in the brain when the body and mind calm down, and the mind-body attains momentary concentration and access concentration.

- Theta waves appear in the brain when the mind is in attainment concentration.
- Delta waves appear in the brain in the state of restful alertness characterized by hypersynchrony and rhythmicity.

It would be worthwhile to see how meditation works on an electronic level. The electrical activities of the brain during meditation show orderliness which correlates with the experience of consciousness. Significant positive correlations were found between psychological variables of different origins including EEG coherence, creativity, rapid motor neuron recovery, and clear experience of consciousness.

Brain wave frequency is related to the stage of concentration. When being overwhelmed by the disappearance of thoughts, one-pointedness of mind occurs. Additional deep concentration produces much lower frequency of brain waves.

There are many causes to facilitate concentration such as light music, investigating the breath, and doing aerobic exercise.

The concentration makes the circuit of neurons synchronize, and reduces to only an important path. In this way, the brain can rest and the brain wave pattern is slow.

When we start to recite, to be mindful, and to be aware of something continuously, the overwhelming thinking (conceptual proliferation) will disappear and the mind will be in a state of one-pointedness. That is, in the 1st, 2nd, 3rd, and 4th absorptions respectively.

The deeper the concentration, the deeper the absorption becomes. The deeper one-pointedness of mind becomes, the more calmness arises. Accordingly, one can describe the phenomenon of brain function. Studies of brain waves (EEG) have shown in functional MRI

that the brain function was reduced activity in the part of brain more and more by the increase of the deep concentration.

Brain function integrates all stimuli and correlates them with perception and memory in the hippocampus. Then brain function interprets emotion by the limbic system, and makes decisions. This happens when the amygdala sends messages to the executive area at the dorsolateral prefrontal cortex (DLPFC). When one's mind concentrates on one object, brain perception will receive only one message and the integration of data will be decreased also. In this way, the brain will screen out almost all stimuli with only the important object remaining so the brain can rest.

Table 4. Characteristics of brain waves are shown below:

		Brain Wave		
Name	**Symbol**	**Mental Stage and Condition**	**Comment**	**Area of concentration (Mind focus)**
Beta	**β**	Normal waking state, concentration, focus, five physical senses integrated	Conscious brain state, fast dyssynchronous activity	Dorsolateral prefrontal cortex (DLPC)
Alpha	**α**	Relaxed, light meditation, creative, super learning ability, conscious	Conscious brain state, synchronous activity	Occipital lobe
Theta	**θ**	Light sleep, deep meditation, creative, recall, fantasy	Usually unconscious, slow rhythmic activity	Medulla oblongata
Delta	**δ**	Deep, dreamless sleep, non-REM sleep, unconsciousness	Usually unconscious, very large rhythmic activity	Right atrium

A Buddhist View of the Relationship and Causal Connection between Brain Wave in EEG and Concentration Meditation Practice

If one controls one's state of mind, then one can control brain waves. By raising or slowing our brainwaves, one can alter how we think, feel and act. Meditation is the process of slowing our waking Beta brainwaves to the slower states of Alpha and Theta. By learning to control these states, we can improve our health and well-being.[14]

Brainwaves are the electrical movements in the brain. The frequency of these brainwaves can be measured using an electroencephalogram (EEG). Electrodes placed on the scalp measure the frequency of these brainwaves. From highest to lowest frequency, these brainwaves are called Beta, Alpha, Theta, and Delta.

The Beta state is the waking state with a concentrated focus while thinking. During Beta, brainwaves range from 14 to 30 cycles per second. In the Beta state, an individual thinking and listening, can solve analytical problems, make decisions, assimilate, and process information. This is our normal state of mind when working, going to school, and shopping. During the Beta state, one's mind is at its highest level of alertness.

The Alpha state is a slower state more indicative of relaxing and reflecting. During Alpha, brainwaves range from 8 to 14 cycles per second. In the Alpha state, an individual is fully aware of his/her surroundings but in a much more relaxed state of alertness.

The Theta state is an even slower state perfect for daydreaming and intuitive mind than Beta. Meditation is often practiced in the Alpha state of thinking. During Theta, brainwaves range from 4 to 8 cycles per second. It is the state between wakefulness and sleep. In this state of mind, memories, thoughts, and facts that deluded a person in a wakeful state can be recalled. It is often in this state that answers to problems seem to appear. Deep meditation and prayer are practiced in the theta state.

The Delta is the slowest of the four states where sleep occurs. During Delta, brainwaves range from 0.5 to 4 cycles per second. At the slowest Delta level, sleep is deep and dreamless. When one gains the fourth absorption state, one will absolutely detach from the environment.

During our waking and sleeping hours, the brain moves through all four of these stages. At any given level, a range in brainwaves affects how deeply one has entered that state. By knowing how these states function, one can knowingly enter a particular state and control how one's thoughts are processed.

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[14] Gaia Staff, *Meditation and Brain Wave*, Accessed December 18, 2021, https://www.gaia.com/article/meditation-and-brainwaves.

"When one is wide awake, doing and achieving in the workaday world, brain wave is in Beta or 'outer consciousness'. When one is daydreaming, or just going to sleep but not quite there yet, or just awakening but not yet awake, one has Alpha. When one is asleep, one has Alpha, Theta, or Delta, not just Delta alone, as many believe such as Phradhammavajiramunī (Boonchit Ñyāṇasaṃvaro), Elon Musk. With mind Control training one can enter the Alpha level at will and still remain fully alert".[15]

Alpha Waves, Biofeedback, Meditation, and Mindfulness[16]

Alpha waves in biofeedback have been shown to be a useful tool for treating anxiety and depression. Because Alpha waves are linked with relaxed mental states, and increase in alpha wave activity is the goal of most biofeedback training. EEG**s** can be used to provide moment-to-moment feedback when Alpha waves increase or decrease.

Mindfulness training and meditation tend to produce noticeably more Alpha waves without the use of technological machinery. Neuroscientists at Brown University are doing research on how the brain achieves "optimal attention" by changing the synchronization of brain waves between different brain regions.[17]

Meditation allows one's mind to move through these states leading to a healthy lifestyle. When one controls brainwaves, one can control thinking, feeling, reasoning, and reacting. Relaxation, creativity, and self-awareness flow naturally. As one meditates, emotional, psychological, and physical health will improve. Consciously controlling our brain. Concentration practice can control the brain waves which enhance healthy living.

Relationship of Brain Waves (EEG) and Concentration Meditation Practice in Theravada Buddhism

Meditation and its effect on brain activity and the central nervous system became a focus of collaborative research in neuroscience, psychology, and neurobiology during the latter half of the 20th century. Research on meditation sought to define and characterize various practices. Meditation's effect on the brain can be broken up into two categories: state changes and trait changes, alterations in brain activities during the act of meditating, and changes that are the outcome of long-term practice respectively.

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[15] Jose Silva and Philip Miele, *The Silva Mind Control Method*, (New York; Gallery Books, 2022), 9.

[16] Christopher Bergland, *Alpha Brain Waves Boost Creativity and Reduce Depression*, Accessed March 14, 2022, https://www.psychologytoday.com/blog/the athletes-way/201504/alpha-brain-waves.

[17] Ibid.

Many studies on mindfulness meditation, assessed in a review by Cahn and Polich in 2006, have linked lower frequency Alpha waves, as well as Theta waves, to meditation.[18] Much older studies report more specific findings, such as decreased Alpha blocking and increased frontal lobe activity, specifically Theta activity".[19] Alpha blocking is a phenomenon where the active brain, normally presenting Beta wave activity, cannot easily switch to Alpha wave activity often involved in memory recall. These findings would suggest that in a meditative state, a person is more relaxed but maintains a sharp awareness. Two large, comprehensive review works, however, point to poor control and statistical analyses in these early studies and comment that it can only be said with confidence that increased Alpha and Theta wave activity exists.[20]

Changes in the brain due to prolonged practice are shown in Electroencephalography

It is also important to note that these trait changes were observed during meditation. Although it does indicate that a practitioner's electroencephalographic profile is modified by the practice of meditation, these EEG studies have shown changes in non-meditating brains, even of experienced meditators.

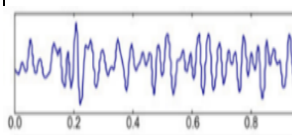
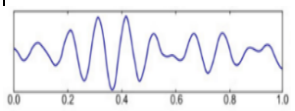
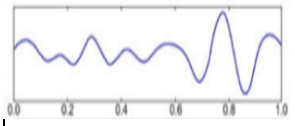
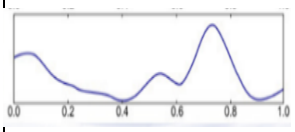
Nowadays they have much research about neuroscience and concentration meditation of Buddhism especially in the University of Wisconsin, USA. EEG is one of these researches, there is evidence that concentration improved functional brain imaging (FMRI) with have a good effect on the emotional, psychological, and physical health of practitioners. These benefits can cure some diseases such as insomnia, asthma, headache, migraine and heal many symptoms of stress and anxiety such as peptic ulcer, senile dementia, heart disease, and hypertension. The result will be to create a happy and peaceful world.

[18] Rael Cahn and John Polich, "Meditation States and Traits: EEG, ERP, and Neuroimaging Studies," *Psychological Bulletin* 132 (2006): 180–211.

[19] Akira Kasamatsu and Tomio Hirai, "An Electroencephalographic Study on the Zen Meditation (Zazen)," *Psychiatry and Clinical Neurosciences* 20 (1996): 315–336.

[20] Alberto Chiesa and Alessandro Serretti, "A Systematic Review of Neurobiological and Clinical Features of Mindfulness Meditations," *Psychological Medicine* 40 (2010): 1239–1252.

The relationships between brain waves and concentration[21] are as follows:

Concentration		Brain Wave				
			Symbol	Frequency/ sec	Amplitude (V)	
1	**Momentary Concentration**	Beta	β	14-30 Hz	1-5	
2	**Access Concentration**	Alpha	α	8-14 Hz	20-80	
3	**Attainment Concentration** - 1st, 2nd, 3rd, absorption	Theta	θ	4-8 Hz	5-10	
4	**Attainment Concentration** - 4thabsorption (*catuttha-jhāna*)	Delta	δ	0.5-4 Hz	100-200	

Understanding the function of brain waves is beneficial and can be applied in daily human life.

Since an Alpha wave is in between Beta and Theta waves, the brain can change move from Beta to Theta and vice versa anytime. An alpha wave occurs in the brain when the brain is relaxed -- listening to the favorite soft music such as the serenade of Schubert. On the other hand, Beta waves occur during the peak times of alertness, such as in decision-making situations.

Theta wave takes place when the brain has a new creative idea which is found in light meditation or deep relaxing time, especially in the rest area such as a hotel, department store, or restaurant. A comfortable place with light music will encourage people to make better decisions. In a department store, for instance, people will decide to buy a product while feeling relaxed, and in that phase, Alpha waves will work with Beta and Theta waves.

[21] Abhang, et al., *Introduction to EEG and Speech Based Emotion Recognition*, (London: Academic Press, 2016), 51-53.

In my experience working as a surgeon since 1982, when my friend and I performed an operation, we usually turned on our favorite light music during the operation. Relaxing helped us make good decisions to complete the operation.

In conclusion, the Alpha wave is useful for people's daily life, because it helps us make good decisions and complete work effectively. At present, people face many stressful conditions and much more anxiety than in the past. Therefore, if they relax and calm down for a while, it can heal and decrease many symptoms of stress and anxiety leading to a healthy body and mind.

We can apply this knowledge by meditating three times daily: morning, noon, and evening, five minutes per time. The mind will relax and have good judgement which will help people complete the task successfully. Performing meditation in Theravada Buddhism style even for a short time will benefit practitioners because it rearranges the brain waves. Their brain waves change from Beta wave to Alpha wave and Theta wave simultaneously.

That is why practitioners when they want to make a decision, usually close their eyes and meditate before they answer the question. We can describe the decision-making moment when the brain wave changes from Beta to Alpha and Theta wave respectively for making a good decision.

We found that the brain waves of geniuses such as Einstein or Elon Musk, their brains have an Alpha wave much more highly developed than ordinary people. This made their brains smarter. Therefore, they succeeded in work and life more than others. Scientific research has proven that if you calm down your mind during daily life, you will have good brain function.

People who practice meditation in daily life will have an active mind which is faster than ordinary people because they can relax both mentally and physically at the same time. As a result, they will have good health and look younger because of meditation. If Alpha, Beta, and Theta waves are in the stage of making a decision, it will be beneficial to health and daily work. In sum, mindfulness in working daily life in the four foundations of mindfulness results in many useful outcomes both in mundane stages and supermundane stages.

Conclusion

A brain wave is the integration of the brain circuit when it is working. Brain waves are the electrical movements in the brain. The frequency of these brainwaves can be measured using an EEG: electrodes placed on the scalp. Doing so measures the frequency of these brainwaves, from highest to lowest frequency: Beta, Alpha, Theta, and Delta. The brain frequency will change from Beta (general state) to Alpha (rest state) to Theta (concentration state) and Delta (deep sleep and deep concentration) consecutively.

Brain waves in electroencephalography (EEG) reduce frequency from Beta to Alpha to Theta to Delta waves related by the stages of calmness, and depth of concentration.

These effects have linked to brain wave frequency and dominate in the stage of priority of concentration, deeper concentration when they are much lower frequency of brain waves, there are many causes such as light music, investigative breath, and aerobic exercise.

The method of developing the kind of concentration associated with the noble eightfold path is the practices of Theravāda Buddhism which are together called mental development *(citta-bhāvanā)* or meditation. In mental development (*bhāvanā*), two things are to be developed: calm and insight (*samatho ca vipassanā ca*). There are *samatha-bhāvanā* and *vipassanā-bhāvanā*: *samatha-bhāvanā* means tranquility development, which aims at concentration (*samādhi*), and *vipassanā-bhāvanā* which means insight development. The second one aims at understanding or wisdom (*paññā*). *Bhāvanā* is sometimes called *kammaṭṭhāna* and means stations of mental exercises.

Concentration meditation practice in Theravāda Buddhism includes three stages of concentration: momentary concentration *(khaṇika-samādhi),* access concentration *(upacāra-samādhi),* and attainment concentration *(appanā-samādhi).* One-pointedness of mind is the factor of the attainment concentration: the first, second, third, and fourth absorption but one-pointedness of mind is different in each of the absorptions. The fourth absorption results in the most calmness**,** and so one-pointedness of mind has the most power.

The four foundations of mindfulness *(satipaṭṭhana)* are the keys (crucial means) to developing concentration and wisdom. This is one way to the purification of beings, for the overcoming of sorrow and distress, for the disappearance of pain and sadness, for the gaining of the right path, and for the realization of *nibbāna.*

The causal relationship between brain waves in electroencephalography (EEG) and concentration meditation practice in Theravāda Buddhism is that meditation has good effect**s** on the brain. We can detect these good effects by EEG measurement which shows that deep meditation activates slow brainwaves, and we can use meditation in many ways to improve emotional and physical health. Based on the findings in this analysis, the deeper the concentration there is, the more brain synchronization occurs, and the slower are the brainwaves. As a result, the body and the brain can rest. Therefore, our findings indicate that meditation can be used to reduce stress, anxiety, and depression. It can also heal some diseases such as insomnia, asthma, headache, and migraine and improve some symptoms such as peptic ulcer, heart disease, hypertension, and senile dementia. Thereby contributing to disseminate concentration meditation practices in Theravāda Buddhism with the knowledge of modern science in order to create love, happiness, and wisdom to build world peace.

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