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A survey to study the effect of meditation on brain signals

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ABSTRACT

Stress is the major factor for numerous mental and physical health disorders. Meditation brings positive changes at psychology and physiology level which helps to reduce the stress. As per the existing research, meditation helps to decrease the anxiety, stress and increase in relaxation, focus and produces other well-being related to psychological level. These changes can be understood by studying the neurophysiological effects of meditation on brainwave signals using EEG (Electroencephalography). The aim of this paper is to review the studies based on neural mechanics using EEG brainwave signals of various meditation practices. This paper also covers the limitations of the existing studies.

Index Terms: EEG, Meditation, Brain Waves

1. INTRODUCTION

In today's world, many people are facing mental stress because of hectic and restless lifestyle, which leads to various health hazards like negative emotions, depression and insomnia [1]. From ancient times, meditation helped to enhance spiritual energy among individuals. It has been used as a therapeutic tool for self-development [2]. Earlier researches revealed that meditation provide extreme relief to body and mind. There are many methods to do meditation such as cognitive processes [3], focus on particular object [4] and take attention on emotions and on different parts of the body [5]. Although, each and every meditation technique differs from other but there is notable similarity among these techniques that either they used focused concentration or open mind (mindfulness) [6]. Meditation has positive effects on psychology and physiology level such as reduction in stress, enhancement in executive functions of brain, boost immunity and various well-being related to physical and mental health [7]. The EEG brain waves patterns for meditation practitioners are different from the ones who do not practice meditation, this motivates the researchers to study the effect of various meditation on normal human beings using EEG. In EEG, there are different types of brainwaves. These brainwaves are classified on the basis of frequency such as alpha (8-13 Hz), beta (13-30 Hz), delta (< 4Hz), theta (4-8 Hz) and gamma (40-100Hz) waves. Each of these waves gives different kind of information about the brain functions. Alpha waves indicate the relaxation and beta waves give information about the cognitive skills of the brain. On the other hand, delta waves reveal the learning ability of the brain, theta waves indicate the self-management of memory and gamma waves shows the attention ability of the brain. Various scientific studies has been carried out to check the neurophysiological effect of meditation by using EEG. But still much of the research is yet to be done on this area. This review aims to study the existing scientific studies to observe the effect of meditation on brain waves.

2. LITERATURE SURVEY

The various studies proposed in literature to study the effect of meditation on brain are discussed in this section.

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Ahani et al. [8] analysed the effect of mindfulness meditation on EEG signals on 34(28 women, 6 men) participants with mean age of 61 years. The data was collected from the group who just started meditation and from the group who were doing meditation from last 8 weeks. Linear Phase FIR (Finite Impulse Response) filter at 2-35 Hz was used for filtration. For removal of artifacts, a simple upper and lower voltage thresholding, flat channel effects and ICA (Independent Component Analysis) were used. PSD (Power Spectral Density) and Phase lock value (Synchrony) was calculated for different frequency bands i.e theta, alpha and beta band waves. PSD was measured by using Bartlett method and Stockwell transform was used to calculate the synchrony. For classification, Support Vector Machine classifier was used. Hence, there was an increase in the power of theta and beta band, slight increase in an alpha band and increase in the synchrony during meditation as compared to other situation.

Chanu et al. [9] analyzed the effect of transcendental meditation on brain signals. The number of individuals taken for study were 30 and their age lies between 18 to 30 years. EEG data was collected during 10 minutes period of meditation and after 10 minutes of rest. Results showed that alpha waves were observed only during meditation and were not affected by age, gender and mental stress. Time period of meditation can be increased in future work.

Xue et al. [10] examined the Integrative Body Mind Training (IBMT) effect on EEG signals. Total 45 (29 males) healthy Chinese students with mean age of 22.9 ± 1.55 (SD) years subjects were taken. They were divided into two groups i.e. experiment group and control group. Experiment group consists of 24 subjects and control group consists of 21 subjects. Band pass filters were used for filtration. Theta band frequency, clustering coefficient, global and local efficiency and average path length were examined. For decomposition, EMD (empirical mode decomposition) and DWT (Discrete Wavelet Transform) methods were used. After IBMT training, there was an increment in local and global efficiency, greater clustering coefficient and lessened average path length. Lessened average path and greater global efficiency revealed the effectual parallel processing, decreasing the signaling delay and boost the synchrony in brain. Although the greater clustering coefficient and local efficiency revert potential tendency of different regions to deal with same neural data. There was an increase in the theta power in frontal midline region of brain. Thus, after short term IBMT training there was an increase in the cognitive activities and reduction in stress, restlessness and enmity.

Faber et al. [11] recruited 15 subjects (9 males) with mean of 12.3 years' experience of zen meditation and mean age of 42 for analysis of zazen meditation on EEG signals. Independent component analysis was used for removal of artifacts. Computed frequency of alpha-1, alpha-2, beta-1, beta-2, beta-3, theta, delta, gamma waves. sLORETA (standardized low resolution brain electromagnetic tomography) was used for analysis of data. The outcome showed that there was an increase in the current density of alpha-1 and alpha-2 waves in right hemisphere and decrease in the current density in beta-1 and beta-2 waves in large bilateral posterior region during zazen meditation as compared to resting state. It was observed that there was an enhancement in memory, present-centered awareness and emotional processing during meditation.

Surangsrirat et al. [12] used consumer EEG device to record the EEG data of Buddhist Monks who practiced vipassana or mindfulness meditation regular and had experience of atleast 10 years. EEG signals were sampled at the sampling rate of 220 Hz. EEG signals were collected during three activities i.e general interview, meditation of 45 minutes and book reading of 15 minutes. Short time fourier transform was used for features extraction. The most dominated wave was delta. Results showed that they were in deep meditation and in deep sleep.

Chandra et al. [13] examined the sudarshan kriya effect on working memory task by using EEG. Total 25 subjects with age between 30 to 50 years were taken for study. Data was recorded before and after 90 days practice of sudarshan kriya. Butterworth bandpass filter was used for filtration, wavelet denoising technique was used for removal of noise and discrete wavelet packet was used for extraction of spectral

bands (gamma, alpha, theta). Welch method was used for calculation of Power Spectral Density (PSD). The working memory task scores was increased in study group after regular practicing of sudarshan kriya for 90 days as compared to control group. Only frontal, frontocentral, occipital, and parietal channels were studied as these regions were involved in working memory task and an increase in alpha energy in study group were observed. There was an efficient use of energy and PSD as represented by gamma, alpha and theta 2 brain rythms in study group as compared to control group.

Van et al. [14] analysed the effortless awareness meditation effect on 32 participants. Beaformer algorithm was used to extract the gamma band PCC activity. 2nd order infinite impulse response (IIR) Butterworth filter was used for filtration. 8th order band pass filter at 70-80 Hz was applied at T7 and T8 electrodes to detect the muscle artifacts. PCC (Posterior Cingulate Cortex activity) activity was assessed by using the low resolution brain electromagnetic tomography (LORETA) method. Brain vision Analyzer Software suite was used to calculate the LORETA PCC time series. For effortless awareness meditation, the relationship between PCC and control frequency band was calculated and a decrease in the PCC activity was observed in both groups. No difference was found in the results of eyes closed and eyes open meditators. This study showed the coupling between real-time gamma-band EEG neurofeedback from the PCC and cognitive states related to effortless awareness in novice and experienced meditators.

Table 1 summaries the reviewed studies and provides information regarding experimental results and limitations/future work of each individual study.

Table 1
Effect of meditation on Brain Waves

Author/Year	*Meditation Type*	*Signal Processing*	*Results*	*Remarks*
Ahani et al., 2014	Mindfullness meditation	FIR, ICA, Bartlett method and stockwell transform	Increase in theta, beta and alpha band	Expert meditators can be used
Chanu et al., 2014	Transcendental Meditation	—	Increase in alpha wave	Need of longitudinal studies.
Xue et al., 2014	IBMT	Low and high pass filters	Increase in theta power	Need of sequence events analysis in brainnetworks as well as the longevity of short term experience.
Faber et al., 2015	Zazen meditation	ICA, sLORETA	Increase in the current density of alpha and decrease in beta waves	Novice participants can be used
Surangsrirat et al., 2015	Vipassana or mindfullness meditation	STFT	Delta was dominated wave	Number of experienced participants can be increased.
Chandra et al., 2016	Sudarshan Kriya	Butterworth bandpass filter, Discrete wavelet packet, Wavelet packet transform and welch method	Increase in alpha power	Number of subjects can be increased in both groups
Van et al., 2016	Effortless Awareness Meditation	2nd order IIR, Butterworth filter, 8th 0rder band pass filter, Beamformer algorithm, LORETA	Decrease in the PCC activity	Study was single dimension, use of 40–57 Hz PCC neurofeedback can be investigated.

3. CONCLUSION

Understanding the effect of meditation on brain waves is very important area of research which will be helpful for the society and human well-being. Nowadays, meditation has also been used in clinical practice. It has been observed from various studies that meditation has various positive effects on brain waves which are related with improvement in anxiety, cognitive behavior, attention and memory of the brain. Generally, highly advanced methods are required for scientific study of meditation using more number of subjects to investigate the brain functions.

REFERENCES

[1] Kochupillai V, Bhardwaj N. Proceedings National symposium on Science of Holistic Living and Its Global Application. Arogyadham, Sevagram, MGIMS; Science of Holistic Living and Its Global Application; pp. 11–13, (2006).

[2] Brown, R. P., & Gerbarg, P. L. Sudarshan kriya yogic breathing in the treatment of stress, anxiety, and depression: Part II-clinical applications and guidelines. Journal of Alternative & Complementary Medicine, 11(4), 711-717, (2005).

[3] Lutz, A., Slagter, H.A., Dunne, J.D., Davidson, R.J., Attention regulation andmonitoring in meditation. Trends Cogn. Sci. 12, 163–169, (2008).

[4] Shapiro, D.H., Walsh, R.N.: Meditation: Classical and contemporary perspectives. Aldine, New York, (1984).

[5] Walsh, R., Shapiro, S.L. The meeting of meditative disciplines and Western psychology: a mutually enriching dialogue. Am. Psychol. 61, 227–239, (2006).

[6] Cahn, B.R., Polich, J., Meditation states and traits: EEG, ERP, and neuroimaging studies. Psychol. Bull. 132, 180–211,(2006).

[7] Jha, A., Krompinger, J., Baime, M.J., Mindfulness training modifies subsystems of attention. Cogn. Affect. Behav. Neurosci. 7, 109–119, (2007).

[8] Ahani, A., Wahbeh, H., Nezamfar, H., Miller, M., Erdogmus, D., & Oken, B., Quantitative change of EEG and respiration signals during mindfulness meditation. Journal of neuroengineering and rehabilitation, 11(1), 1, (2014).

[9] Chanu, Laishram Leimahanbi, and Ksh Gomti Devi. “Electro-encephalographic changes of short-term transcendental meditation.” Journal of Medical Society 28, no. 3, (2014)

[10] Xue, S. W., Tang, Y. Y., Tang, R., & Posner, M. I. Short-term meditation induces changes in brain resting EEG theta networks. Brain and cognition, 87, 1-6, (2014)

[11] Faber PL, Lehmann D, Gianotti LR, Milz P, Pascual-Marqui RD, Held M, Kochi K. Zazen meditation and no-task resting EEG compared with LORETA intracortical source localization. Cognitive processing. ,1;16(1):87-96, (2015).

[12] Surangsrirat, Decho, and Apichart Intarapanich. “Analysis of the meditation brainwave from consumer EEG device.” In SoutheastCon 2015, pp. 1-6. IEEE, (2015).

[13] Chandra, Sushil, Greeshma Sharma, Alok Prakash Mittal, and Devendra Jha. “Effect of Sudarshan Kriya (meditation) on gamma, alpha, and theta rhythm during working memory task.” International journal of yoga 9, no. 1 (2016): 72.

[14] Van Lutterveld, Remko, Sean D. Houlihan, Prasanta Pal, Matthew D. Sacchet, Cinque McFarlane-Blake, Payal R. Patel, John S. Sullivan et al. “Source-space EEG neurofeedback links subjective experience with brain activity during effortless awareness meditation.” NeuroImage (2016).