

Review on Effect of Mindfulness Meditation on Brain through EEG Signals

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Abstract - Science begun to expose the many sakes of meditation using enlightened tools like neuro-imaging, functional magnetic resonance imaging, brain mapping technology, electroencephalography, thus allowing scientists an unrivalled ability to measure the effects of meditation on the brain and brainwave constitutions. Within the past few decades, there has been a lot much of temptation in the study of mindfulness as psychological states and as a form of clinical approaches. In today's fast life and hectic schedule arises lot much physiological, psychological problems on human body, meditation is one of the best solution in physiological, negative psychological problems, attention. Numerous researchers already conduct the many research study on meditation the outcome of meditation on stress relief and disease improvement. In this review we see the mindfulness meditation plays an important role in the mental health and mindfulness meditation theory and also effects of mindfulness meditation, Transcendental Meditation, Zen Meditation, Samatha-vipassana, Yoga, Sahaji yoga, Sudarshan Kriya , Raj Yoga on Neuroimaging studies, behavioral studies, and structural imaging studies. The effect of meditation on human brain and body using EEG signals. To get the awareness into the nature of EEG during meditation.

Keywords - Introduction, Meditation, EEG, Literature Review.

INTRODUCTION

The mind is the primary source of human joy and misery, and is central to the understanding of the natural world as a whole this premise begins from the Buddhism.[1] A lot of constructive changes have been reported to happen in the brain and the other parts of the human body for those practicing meditation. Practicing meditation is no hassling task that helps bringing in structural and functional modifications in the human organs including the heart and brain with recurrent practice over a prolonged period. Meditation is practiced all across the world and diverse countries have given different names for the meditation that they practice. A case study has revealed a considerable, constructive behavioral modification of the human entity that practice meditation, thereby reducing the number of visits to the physicians by a great extent and the individual concerned is found to save \$200 on the clinician's visit with effective practicing of meditation.[2] Also, another study has concluded the reduced use of medical care by Meditators in comparison to those who don't practice meditation.[3]

MEDITATION

"In meditation, a person learns to focus his attention and suspend the stream of thoughts that normally occupy the mind. This practice is believed to result in a state of greater physical relaxation, mental calmness, and psychological balance. Practicing meditation can change how a person relates to the flow of emotions and thoughts in the mind."[4]

TYPES OF MEDITATION

Mindfulness meditation practice to approach our experience in new ways moment by moment non-judgmental awareness of body sensations, thoughts and emotions. Raj Yoga is concerned with focusing the mind and using its power to control the body. There should be a relationship between the mind and body in order to be disciplined.[5] Transcendental meditation(TM) fits somewhat within the concentrative forms, because practice centers on the repetition of a mantra, but the method places a primary emphasis on absence of concentrative effort and the development of a witnessing, thought-free "transcendental awareness." VM requires becoming aware of all of one's senses and acknowledging any negative feelings, pain, or blockages in order to achieve equanimity. Equanimity is defined as not interfering with the flow of the senses at any level, including the level of preconscious processing [6].

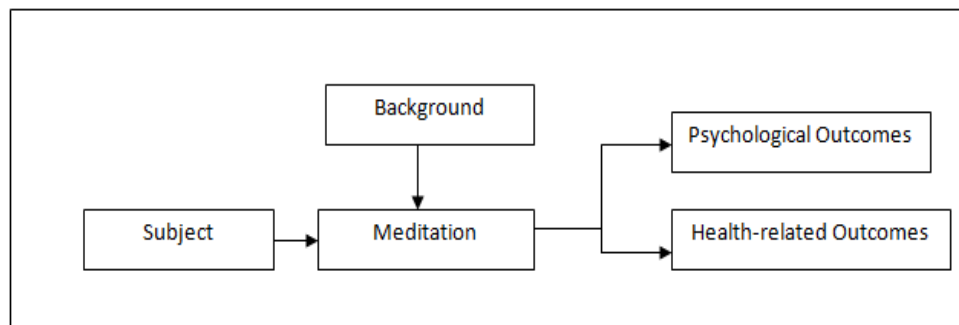


Fig. 1 Meditation



Fig. 2 Mindfulness Meditation[7]

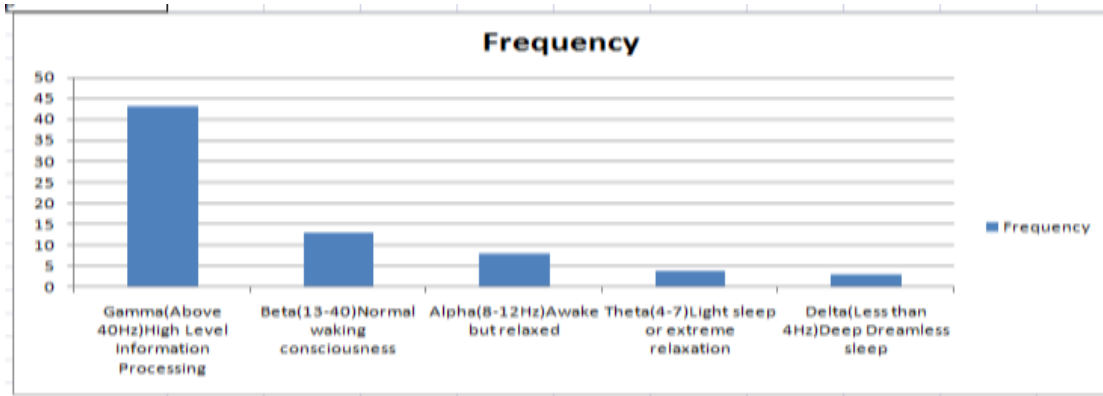
EEG

Many current behavioral, electroencephalographic, and neuroimaging studies have revealed the importance of investigating meditation states to achieve an increased understanding of cognitive and affective neural plasticity, attention, and self-awareness as well as to evaluate their possible clinical implications. The function of electroencephalography is to detect and amplify the bioelectric potential of the brain by electrodes placed on the surface of the scalp. EEG has several strong points as a tool for exploring brain activity. The EEG measures brainwaves of different frequencies within the brain. In relation with the EEG signals, a lot of work has been done to find the significant changes between the signals and the mental states by using different advanced signal processing techniques. EEG studies have utilized these methods to portray the brainwave changes that occur in meditation. [8]

MEDITATION AND BRAIN WAVES EFFECT ON BRAIN

- **Beta Waves (14-24Hz):** Beta Brainwave correspond to the typical “busy mind experience”. The beta frequency range is characterized by a chaotic, fragmented, unbalanced thinking typical of left brain dominance, commonly referred to as the monkey mind.
- **Alpha Waves (8-13Hz):** In the alpha waves the balanced brainwave activity occurs. The more alpha waves that a person is able to produce in ordinary states of consciousness, the easier it is for them to access deeper meditative states.
- **Theta Waves (4-7.5Hz):** In the theta waves balanced brainwave activity increases. The theta state corresponds to the experience of visionary, creative and intuitive levels of experience. It is characterized by inner images and visions that correlate with increased theta activity.
- **Delta Waves (0.5-4Hz):** The delta brings a level of balance that corresponds to the beyond the mind experience at the subtest levels of meditative awareness possible. This is the range in which meditators experience what is termed unified consciousness.[9]

The brainwaves having different frequencies within our brain can be classified as shown in the following graph (with its respective frequency band and the mental state.



LITERATURE REVIEW

In this review paper review various meditation types and the methods used and observes the remarks of these meditation types.

TABLE 1. MEDITATION LITERATURE REVIEW

Sr. No	Author	Year	Meditation Type	Method	Remark	Reference ID
1	Anand B.K. Chhina G.S. Singh B.	1961	Rajyoga Meditation	EEG	No alpha suppression in response to variety stimuli of two yogis	[10]
2	The Venerable Mahasi Sayadaw	1965	Buddhist Satipatthana Meditation	Samatha & vipassana meditation practice	The Stages of Purification performs insight progress	[11]
3	Kasamatsu A, Hirai, T.	1969	Zen Meditation	EEG	Zen meditation could help treat attention deficit and hyperactivity disorder, obsessive-compulsive disorder, anxiety disorder, major depression and other disorders marked by distracting thoughts.	[12]
4	Brown, Daniel P.; Engler, Jack	1980	Mindfulness Meditation	of contemporary indigenous Buddhist meditation practice	The classical subjective reports of meditation stages are more than religious belief systems.	[13]
5	Jon Kobat-zinn	1982	Mindfulness Meditation	Stress Reduction and Relaxation Program	This work does not prove that the meditation practice is directly responsible for stress reduction and relaxation changes.	[14]
6	Shapiro DH Jr.	1982	TM	Long-term and short term meditaors group	A family of techniques which have in common a conscious attempt to focus attention in a non analytical way and an attempt not to dwell on discursive, ruminating thought	[15]

7	Cranson R. Goddard P.H. Orme –Johnson D.	1990	TM	P300	Latency reduced in long term meditation	[16]
8	Lou HC, Kjaer TW, FribergL, Wildschiodtz G, Holm S, Nowak M.	1999	Yoga, Yognidra	H20 PET technique	The (H2)150 PET method may measure CBF distribution in the meditative state as well as during the resting state of normal consciousness, and that characteristic patterns of neural activity support each state.	[10]
9	Elizabeth R. Valentine Philip L.G. Sweet	1999	Mindfulness Meditation	Wilkin's Counting	Improvements in performance on a task of sustained attention for both concentrative and mindfulness meditators in comparison with controls, with greater improvements being associated with longer durations of practice.	[17]
10	Harald Walach , Nina Buchheld , Valentin Buttenmullerc Norman Kleinknecht , Stefan Schmidt	2001	Mindfulness (Vipassana)	FMI(Freiburg Mindfulness Inventory)	The FMI is a useful, valid and reliable questionnaire for measuring mindfulness.	[18]
11	Fabio Ferrarelli Richard Smith Daniela Dentico Brady A. Riedner Corinna Zennig Ruth M. Benca Antoine Lutz Richard J. Davidson Giulio Tononi	2003	Mindfulness Meditation	hdEEG	EEG gamma activity during sleep represents a sensitive measure of the long lasting, plastic effects of meditative training on brain function.	[19]
12	• L. I. Aftanas • S. A. Golosh eikin	2003	Sahaja Yoga Meditation	High Resolution EEG	The θ and α activities in narrow frequency bands reflect the activity of multifunctional neuronal networks selectively associated with processes of cognitive and affective activity.	[20]
13	Baer RA, Smith GT, Allen KB.	2004	Mindfulness Meditation	THE KENTUCKY INVENTORY OF MINDFULNESS SKILLS	Mindfulness skills are differentially related to aspects of personality and mental health, including neuroticism, psychological symptoms, emotional intelligence, alexithymia, experiential avoidance, dissociation, and absorption.	[21]
14	Wiveka Ramel Philippe R. Goldin, Paula E. Carmona John R. McQuaid	2004	Mindfulness Meditation	MBSR	MM practice primarily leads to decreases in ruminative thinking, even after controlling for reductions in affective symptoms and dysfunctional beliefs.	[22]

15	B. Rael Cahn John Polich	2006	Mindfulness and Concentrative meditation	EEG ERP fMRI	Meditation state and trait shows considerable discrepancy among results, a fact most likely related to the lack of standardized designs for assessing meditation effects across studies.	[23]
16	Neela Iyer A.Prabhu Britto Vladimir Petrov Velikov Justin Chernow Elizabeth Maier Dr. A.Nagappan Dr.M.Rangasamy Dr. N. Malmurugan Dhyanyogi Omdasji Maharaj	2008	Yoga	EEG	The Divine Sound is expected to be very safe for human physiological systems and may be used as a good meditative guidance, even for a whole day continuously.	[24]
17	Eberth J. Sedlmeier P.	2012	Mindfulness	MBSR	MBSR seems to have its most powerful effect on attaining higher psychological well-being, whereas pure mindfulness meditation studies reported the largest effects on variables associated with the concept of mindfulness.	[25]
18	G. Madhavi Kanakadurga	2012	Yogic Meditation	Quasi Experimental Design	Significant improvement in the attention regulation of the students after meditation practice.	[26]
19	Yugandhara Meshram, Prajakta Fulpatil	2012	Sudarshan Kriya	EEG	Wavelet Transform proves out to be the best method for the time-frequency analysis of EEG signals as it gives the required frequency information along with the time instance at which it occurs.	[27]
20	Peter Sedlmeier, Juliane Eberth, Marcus Schwarz, Doreen Zimmermann, Frederik Haarig, Sonia Jaeger, and Sonja Kunze	2012	TM, Zen Meditation	Meta-analysis		[28]
21	David W. Orme-Johnson Vernon A. Barnes	2013	TM	CMA(Comprehensive Meta-Analysis	TM Practice is more effective than treatment as usual and most alternative treatments with greatest effects observed in individuals with high anxiety.	[29]
22	Oldrich Vysata	2014	Samatha –	EEG	Increased FD during	[30]

	Martin Schatz Jakub Kopal Jan Burian Ales Prochazka Kuchynka Jiri Jakub Hort Martin Valis		vipassana		meditation can be interpreted as an increase in self-similarity of EEG signals during self organisation of hierarchical structure oscillators in the brain.	
23	Mane Satish Ra, Deokar Rekha Rb, Kambale Shubhangi R	2014	Yoga	Experimental group with high and low stress	The high stress affects students' performance negatively. Yoga gives good effects on stress reduction that.	[31]
24	Florian Kurth, AllanMacKenzieGraham, Arthur W. Toga, and Eileen Luders	2015	Mindfulness	MRI, VBM(Voxel-Based Morphometry	The positive correlation between meditation practice years and asymmetry near the posterior intraparietal sulcus may suggest that meditation is accompanied by changes in attention processing.	[32]
25	Aviva Berkovich-Ohana, Joseph Glicksohn, Abraham Goldstein	2015	Mindfulness	EEG	Studying the Default Mode Network using EEG Functional connectivity as well as the importance of studying meditation in relation to it.	[33]

CONCLUSION

In the present review we studied all type of meditation gives the positive effects physically and mentally, It can reduce stress, improve concentration level, attention level and give the positive energy. Mindfulness meditation is not the new concept in most of the clinical problems in both physical and psychological problems mindfulness meditation gives the very effective positive results. Using EEG data we can observe the brain states improvement due to the mindfulness meditation and avoid the mental, behavioral and structural problems. Meditation can improve the functional connectivity also.

REFERENCES:

- [1] Wallace, B.A. "The Buddhist tradition of Samatha: Methods for refining and examining consciousness" *Journal of Consciousness Studies*, 6, 175-187, 1999.
- [2] J. Achterberg, Mind body interventions, meditation, in B. Berman (Ed.), *Alternative medicine, expanding medical horizons* (Washington DC: Office of Alternative Medicine, National Institute of Health, 1992).
- [3] E. McSherry, Medical economics, in D. Wedding (Ed.), 463-484, *Medicine and behaviour*, (St Louis: Mosby and Co, 1990).
- [4] [Onlineavailable] <http://nccam.nih.gov/health/meditation/>, accessed Feb, 2006.
- [5] [Onlineavailable] http://freemeditations.com/raja_yoga.html
- [6] Young, Shinzen "Purpose and method of Vipassana meditation" *Humanistic Psychologist*, 22, 53-61, 1994.
- [7] Yi-Yuan Tang, Britta K. Hölzel and Michael I. Posner "The neuroscience of mindfulness meditation", nature reviews neuroscience, Macmillan Publishers Limited. Volume 16, 215, April 2015.
- [8] Shih-Feng Wang, Yu-Hao Lee, Yung-Jong Shiah, Ming-Shing Young, "Time-Frequency Analysis of EEGs Recorded during Meditation," Robot, Vision and Signal Processing (RVSP), First International Conference on , vol., no., pp.73,76, 21-23, November 2011.
- [9] [Onlineavailable] <https://synchronicity.org/free-infographics/meditation-and-its-effects-on-brainwaves>.
- [10] Lou HC, Kjaer TW, Friberg L, Wildschiodtz G., Holm S, Nowak M.A. "150-H2O PET study of meditation and the resting state of normal consciousness" *Hum Brain Map*,98-105,1999.
- [11] The Venerable Mahasi Sayadaw "The Progress of Insight (Visuddhiñāna-katha)"1965.
- [12] Kasamatsu A. & Hirai T. "An electroencephalographic study of Zen meditation(zazen)" *Psychologia*,12.225, 2015.

- [13] Brown, Daniel P. Engler, Jack “The stages of mindfulness meditation: A validation study” *Journal of Transpersonal Psychology*, 12, 143-192, 1980.
- [14] Kabat-Zinn, J. “An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical Considerations and preliminary results” *General Hospital Psychiatry*, 4, 33-47, 1982.
- [15] Shapiro DH Jr.” Overview: clinical and physiological comparison of meditation with other self-control strategies”. *Am J Psychiatry*. 139(3):267-274, 1982.
- [16] Cranson,R.,Goddard, P.H., & Orme-Johnson, D. “P300 under conditions of temporal uncertainty and filter attenuation: Reduced latency in long-term practitioners of TM” *Psychophysiology*,27,S23,1990.
- [17] Elizabeth R. Valentine, Philip L.G. Sweet, ”Meditation and attention: a comparison of the effects of concentrative and mindfulness meditation on sustained attention”, *Mental Health, Religion & culture*, Volume 2, November 1, 1999.
- [18] Buchheld, N., Grossman, P., & Walach, H. “Measuring mindfulness in insight meditation(Vipassana) and meditationbased psychotherapy: The development of the Freiburg Mindfulness Inventory(FMI)” *Journal of Meditation and Meditation Research*,1, 11-34,2001.
- [19] Fabio Ferrarelli, Richard Smith, Daniela Dentico, Brady A. Riedner, Corinna Zennig, Ruth M. Benca Antoine Lutz, Richard J. Davidson, Giulio Tononi ”Experienced Mindfulness Meditators Exhibit Higher Parietal-Occipital EEG Gamma Activity during NREM Sleep” Open access *PLOS* Vol.8, Issue 8, August 2013.
- [20] Aftanas,L.I., Goloshekin, S.A.”Changes in cortical activity in altered states of consciousness: the study of meditation by high-resolution EEG.Human” *Physiology*,28,2,143-151, 2003.
- [21] Baer, R.A., Smith, G. T., & Allen, K.B.”Assessment of mindfulness by self report: The Kentucky Inventory of Mindfulness Skills” *Assessment*, 11, 191-206, 2004.
- [22] Wiveka Ramel, Philippe R. Goldin, Paula E. Carmona,and John R. McQuaid ” The Effects of Mindfulness Meditation on Cognitive Processes and Affect in Patients With Past Depression” *Cognitive Therapy and Research*, Vol. 28, No. 4, , pp. 433–455, August 2004 2.
- [23] B.Rael Cahn, John Polich ”Meditation States and Traits: EEG, ERP and Neuroimaging Studies” *Psychological Bulletin*, Vol.132, No.2, 180-211, 2006.
- [24] Neela Iyer, A.Prabhu Britto, R.Satyasundari, D.Saraswady, A.Nagappan, N.Malmurugan and Dhyanyogi Omdasji Maharaj,” Low Decibel Power Infrasound in Divine Sound Meditation”, ISSN: 0974 – 3987 *IJBST*, 1(1):1-9,2008.
- [25] Eberth, J., & Sedlmeier,P. “The effect of mindfulness meditation: A meta-analysis. *Mindfulness*” ,3, 174-189, 2012.
- [26] G. Madhavi Kanakdurga, Dr. D. Vasanta Kumari,”Attention Regulation of Mediators and non-mediators of class IX”, *Indian Journal of Applied Research*, vol 1,Issue 5, February 2012.
- [27] Yugandhara Meshram, Prajakta Fulpatil,” Review Paper on Electroencephalographic Evaluation of Sudarshan Kriya”, *International Journal of Science and Research (IJSR)* ISSN (Online): 2319-7064,2012.
- [28] Peter Sedlmeier, Juliane Eberth, Marcus Schwarz, Doreen Zimmermann, Frederik Haerig, Sonia Jaeger, and Sonja Kunze” The Psychological Effects of Meditation: A Meta-Analysis”, *Psychological Bulletin*, Vol. 138, No. 6, 1139–1171, 2012.
- [29] David W. Orme-Johnson Vernon A. Barnes ,”Effects of the Transcendental Meditation Technique on Trait Anxiety: A Meta-Analysis of Randomized Controlled Trials”, *The journal of alternative and Complementary Medicine*, vol 19, 2013.
- [30] Oldrich Vysata, Martin Schatz, Jakub Kopal, Jan Burian, Ales Prochazka,Kuchynka Jir, Jakub Hort, Martin Valis “Non-Linear EEG Measures in Meditation”, *J. Biomedical Science and Engineering*,7, 731-738, 2014.
- [31] Mane Satish Ra, Deokar Rekha Rb, Kambale Shubhangi Rc,” Management of Stress through Yoga Practice in Academic Performance of College Students”, *Online International Interdisciplinary Research Journal*, {Bi-Monthly}, ISSN 2249-9598, Volume-IV, Issue-II, March-April 2014.
- [32] Florian Kurth, Allan MacKenzie-Graham, Arthur W. Toga, and Eileen Luders, “Shifting brain asymmetry: the link between meditation and structural lateralization”, *Soc Cogn Affect Neurosci* (2015) 10 (1): 55-61. doi: 10.1093/scan/nsu029 First published online: March 17, 2014 .
- [33] Aviva Berkovich-Ohana, Joseph Glicksohn, and Abraham Goldstein, “Studying the default mode and its mindfulness-induced changes using EEG functional connectivity”, *a Soc Cogn Affect Neurosci* (2014) 9 (10): 1616-1624. doi: 10.1093/scan/nst153 First published online: November 4, 2013.