

# Review of Statistical Analysis and Effects of Meditation on Mental Health and Cognitive Skill Development

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## Abstract

Study of brain wave signals and proper analysis of them helps us to understand the impact of meditation in much more broader extent. This review paper examined various practices like Mindfulness, Full Attention, Open Meditation, Jhana, Yoga asanas, Mind Body Intervention and Heartfulness. It also extended to the study of effects of meditation on practitioners and narrates the cases with better cognitive skill development. Every meditation process analysis included with number of persons involved in the process along with the study of affected region in the brain due to the continuous practice of meditation. It is observed that signal frequency of communication from heart to brain is improved by Heartfulness meditation. This strengthens brain rewiring of a continuous meditation practitioners and its effects are visualized from the characteristics of EEG and fMRI signals. Analyzes from different literatures, it is evident that cognitive skills, contextual memory, attention, logical thinking, and problem solving capability are highly improved in the practitioner. Also, emotional and behaviour characteristics of the meditation practitioners are greatly improved, in turn life style enhanced.

**Keywords:** Meditation, Cognitive skills, fMRI, Heartfulness.

## Introduction

The human brain has Left and Right hemispheres. The Left is for Analytic thoughts, Logical thinking, and

Reasoning. The Right is for creativity, intuition, holistic thoughts. The brain signals are classified as  $\alpha$ ,  $\beta$ ,  $\theta$ ,  $\delta$  and  $\gamma$  based on the frequency of operation of the signals<sup>1</sup>. The network can be re-organized by External or Internal Stimulation called as Neuro-plasticity<sup>2</sup>.

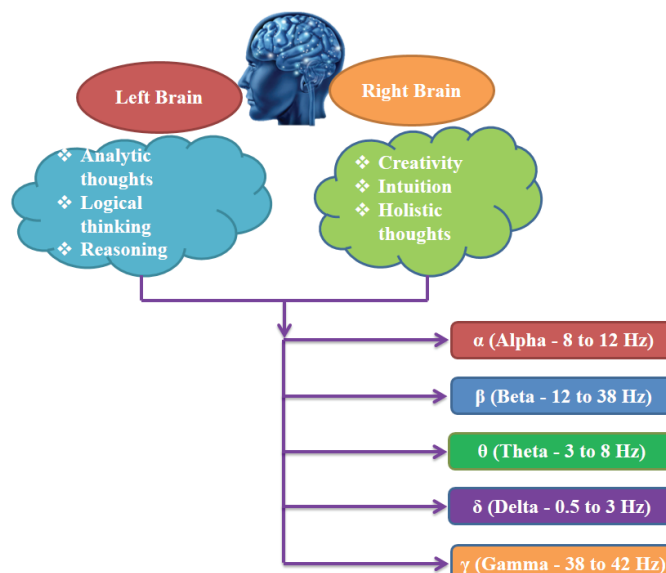


Fig. 1. Classification of Brain Signal

Fig. 1 shows the general classification of the left and right brain activities and brain signal frequency range. The researches are done based on Mindfulness Meditation (MM), Zen Meditation and few are addressing the other meditation techniques<sup>3</sup>. The meditation is classified as Full Attention (FA) and Open Monitoring (OM)<sup>4,5</sup>. The working memory (WM) capacity can be improved by adaptive and extended cognitive training<sup>6</sup>. The classification of medical data has been classified using Deep Learning Neural Network (DLN)<sup>7,8</sup>. The MRI and fMRI data of the Alzheimer's persons are effectively classified using DLN<sup>9</sup>.

Mind is full of thoughts; it is generating thoughts each and every moment. The regulation of thoughts creates better environment inside and outside<sup>10,11</sup>. The most popular meditation practices are Mindfulness, Zen Meditation<sup>7</sup>, Vipassana Meditation, and Heartfulness. Patanjali states that, yoga has 7 steps; starts with purification of mind as a first step to Samathi (Liberation) via meditation as the last step<sup>12</sup>.

Dr. Masaru Emoto proven that the words and thoughts are having impact on the crystal structure of the water<sup>13</sup>. The human body consists of around 70% of water; thus the mood, thoughts and the out spoken words have more impact on the human both mentally and physically. The Heart communicates to the entire body through nervous system through control signals. Therefore the electromagnetic (control) signals generated by the Heart affects the thoughts produced in the mind<sup>14</sup>.

There are many articles stating and proving the benefits of Meditation with experiments on Children, Students, Adults and family<sup>15,16</sup>. Few researchers extended their contribution on Meditation effects on disease cure<sup>17</sup>. The number of articles dealing with the meditation is increasing over the years as shown in Fig.2. More than 31,000 are conducted on various meditation techniques and its effects. Heartfulness technique is gaining popular for the last couple of years which provides positive results in a very short span of practice<sup>18</sup>.

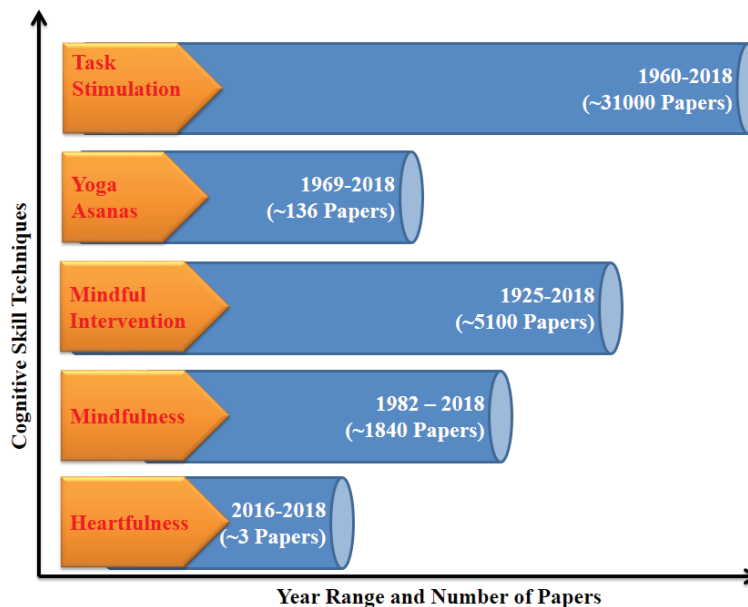


Fig.2. Number articles published in Meditation

**Mindfulness Meditation**

Mindfulness meditation has a positive impact on various parts of the brain; which are anterior, cingulate, thalamus, insula, amygdala, hippocampus and Gyrus<sup>19</sup>. Mindfulness meditation alters the rs-FC in the brain<sup>20</sup>. The EEG shows the positive reflection of meditation on

theta wave<sup>21</sup>. These are scientific proofs of Mindfulness meditation. Standard tests like KIMS, Stroop<sup>22</sup>, CAT<sup>23</sup>, COWAT, SDMT<sup>24</sup> and d2 tests<sup>25</sup> prove the improvements in the cognitive skills. The analysis of the effects of meditation is estimated using Analysis of variance (ANOVA)<sup>26,27</sup>. Thus the Mindfulness meditation produces good positive life changing

characteristics in the practitioners which improve their life in the society<sup>28</sup>. It has very positive impact on the Dementia / Alzheimer patients<sup>29</sup>.

HTKS and Ten-Sticker Sharing Tasks are used for testing the emotional change in kinder garden school children<sup>30</sup>. MAAS, SCS and EF are used for evaluate and improve the mind regulation cognitive intelligence

of School Students<sup>15</sup>. MOT methods are applied for adults for mind regulation observations<sup>31</sup>. SART is developed as computer based software testing system using SPSS-21 Software for estimating Self-sustain mindfulness capability of the practitioners<sup>32</sup>. BOLD testing was performed on stressed unemployed adults and the changes in the Gyrus and right parietal cortex area are observed<sup>33</sup>.

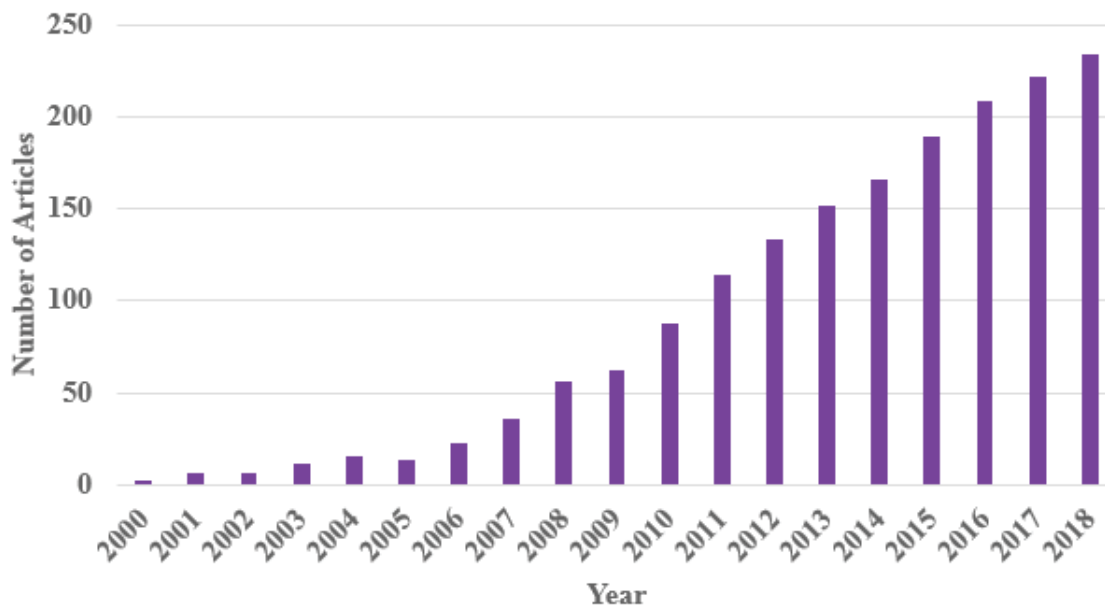


Fig.3. Mindfulness research articles

Fig.3 shows the statistics of mindfulness related research articles published for past two decades. The effects of mindfulness meditation practiced with different set of control group and members are listed in Table 1. Other impacts of Mindfulness meditation techniques are, reduction of Mind Wandering<sup>32</sup> and increase in functional connectivity<sup>24,34</sup> and Volume change in various parts of brain.

Table 1: Mindfulness

Ref. No.	Affected region	Analysis			No. of practitioner	
		EEG	fMRI	Other	Control	Meditation
[24]	-			KIMS, Stroop, d2-test	25	25
[34]	-			SDMT, COWAT, Digit span	25	24
[27]	Theta	Yes		SVM	-	34
[21]	White matter	-	Diffusion tensor imaging	-	31	33
[16]	Family characteristic					

Cont... **Table 1: Mindfulness**

[30]	Emotional Change			HTKS, Ten-Sticker Sharing Task		127
[15]	Mind regulation	-	-	MAAS, SCS and EF	-	210
[19]	Hippocampus	Yes				
[31]	Mind regulation			Visual for aging, Switching, MOT. ANOVA	30	41
[32]		SPSS 21 Software		SART		147
[11]	Working Memory			Cognitive measures		43
[20]	Gyrus, right parietal cortex		fMRI	Functional BOLD		35
[26]	Mood change			ANOVA		10
[29]	Dementia Patients		Yes			

**Full Attention and Open Meditation**

The research on Full Attention and Open Meditation are carried over the last decade. The research data are analysed using EEG, fMRI and other standard tests. It has been found that, gamma and alpha wave activity are increased<sup>35</sup>, functional connectivity and reorganization of brain is improved, and reduced mind wandering are some of the positive impacts of the meditation practitioners.

**Table 2: Full Attention and Open Meditation**

S. No.	Type of Practice	Affected region	Analysis			No. of practitioner	
			EEG	fMRI	Other	Control	Meditation
[4]	FA (Samatha) and OM (Vipassana)	Anterior Insula.	Yes	Yes		-	8
[3]	FA on Tanden	Pre-frontal cortex	Yes + ECG		BOLD, POMS	-	15
[36]	FA – Meditation	Cingulate		Yes		-	14
[37]	Vipassana, Himalayan Yoga and Isha Shoonya	Occipital	Yes		Analysis of variance (ANOVA)	32	67

### Heartfulness Meditation Techniques

Recently, Heartfulness meditation technique<sup>38</sup> is popular among the seekers. The research is carried on COPD patients<sup>17</sup>, Students, novices, Teachers<sup>39</sup> and normal human. The research platforms for this meditation technique are varying across Schools, Colleges and Hospitals. It has very positive results on them in a very short span of time across all platforms<sup>40</sup>. Telomeres length improvement<sup>41</sup>, Heart Rate and RR<sup>49</sup> regulation, brain coordination<sup>43</sup> and Stress reduction<sup>44</sup> are the changes observed on the practitioners. Most importantly, it brings out and develops the emotional balance on the practitioners; which is very much essential in today's living environment for the youngsters<sup>45</sup>. Recent

literatures started elaborating the effects of Heartfulness meditation and it is gaining highly popular because of its large positive effects in cognitive skill development. Table 3 lists the effects of Heartfulness meditation practiced observed from various recent literatures. It is studied that it drastically reduces the stress level of students<sup>46</sup> and thereby making them emotionally stable and be skilled with better cognitive skills<sup>47</sup>.

CRT and RAT are used for analyzing the effect of Heartfulness. It is observed that increased alpha in brain<sup>43</sup>. DASS 42 questioners based testing is used for estimating the stress scale with observations on 42 symptoms for a Heartfulness practitioners<sup>45</sup>.

**Table 3: Effects of Heartfulness Meditation**

Ref. No.	Affected region	Analysis			No. of practitioner	
		EEG	fMRI	Other	Control	Meditation
[41]	Telomeres length	-	-	-	12	35
[42]	HR, RR and SBP.	-	-	-	-	134
[43]	Alpha wave	Yes	-	CAT, RAT		60
[45]	-	-	-	DASS 42 and stress scale.	80	80
[46]	-	-	-	Questionnaire		848
[39]	-	-	-	INSPIRE		90
[49]	HRV, BP and HR	-	-	ANOVA	-	30
[44]	Stress reduction in Students			Stress Questionnaire		120

Heartfulness also develops their emotional intelligence to a larger extent. The statistics it is also observed that it improves heart rate, blood pressure<sup>48</sup> and cognitive function. Hence, Heartfulness meditation technique provides the very positive impact on the practitioners in a very short span (3 hours); both mentally and physically. So, we can say that Heartfulness meditation has good score of Intelligent Quotient (IQ), Emotional Quotient (EQ) and Spiritual Quotient (SQ)<sup>49</sup>.

### Conclusion

Human beings are daring to have a better world and safeguard themselves from other fellow beings with their improved Cognitive skills. This survey analyzed the effects of different meditation techniques like Mindfulness, FA and OM, MBI and Heartfulness practiced by experts and novices. The impact of the meditation practices are evaluated using EEG, fMRI and Standard Questionnaire processes. It is commonly observed that the meditation practice improved the functional connectivity and neural plasticity. It is

practically visible that practitioners had improved mind regulation, characteristic changes and Cognitive level. Recently, Heartfulness meditation is popular and its communication between heart and brain is effective. It has positive impact on sleep pattern, stress reduction and disease control in a short span. From the survey on different literatures, it is obvious that Cognitive skills and Life Style behaviour of the meditation practitioners are highly improved by consistent meditation.

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