# A pilot study on Cognitive Enhancement using Meditation as Intervention

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**Abstract**

This article reports the results of a pilot study made on 5 young healthy engineering students on the effect of meditation in enhancing the cognitive abilities of attention and working memory. Customed designed meditation using a fusion of concentrative and mindfulness meditation resulted in high attention and better working memory. This is quantified by the tasks performed by subject wherein error attention reduces from 0.018261 to 0.0175 and memory span increases from 8.6 to 9.2. This is also verified by analysing physiological signals that for tasks involving attention, alpha power in F7 gets decreased and beta power of F8 increases. In case of working memory, theta power increases in the frontal area and alpha power increases in O1, O2 and FP1. Thus, with these results, enhancement has been observed in subjects.

## 1. Introduction

The abilities of brain to perform several tasks are known as cognitive abilities. Every person is born with some inherent cognitive abilities. These abilities can be enhanced by applying several techniques. In psychological science, these techniques are called interventions the present research reports enhancement in attention and working memory using meditation as intervention [1].

### 1.1  Hypothesis

1)  Meditation improves attention as assessed through tasks as well as through physiological signals
2) Meditation improves working memory through task as well as through physiological signals.

## 2) Proposed method

Any Cognitive enhancement technique involves application of suitable intervention. Pre and post cognitive assessment is made to confirm the cognitive enhancement achieved, if any. The protocol proposed for this research involves the following:

### 2.1 Selection of participants

A group of 6 participants participated in the study. All the participants shall be engineering students from undergraduate or postgraduate level**.** None of the participant shall have any psychological or neurological illness history. The subjects shall be informed about the purposes, methods, and protocol of the experiment before starting experiment. All the participants shall voluntarily participate in the study. All experiments shall be conducted in the Laboratory of Thapar University.

### 2.2 Preparation of participants for EEG

Participants shall sit on a comfortable armchair in the front of monitor. They shall be explained about complete procedure, that is, hardware (EEG system), data acquisition, and all the tests to be carried out, as a result of which subject shall become familiar with the experiment. The scalp of subject shall be prepared by light abrasion to remove dead cells [2].

### 2.3 Baseline data acquisition

For attentional task baseline data shall be collected from the participants with their eyes closed, as the visuo-spatial attention reduces with closing eyes. For working memory task data shall be collected from participants with eyes open as baseline. Details of data acquisition are given in our previous study on Changes in Brain wave rhythms during tasks involving Attention and Working memory [3].

**2.4 EEG data shall be acquired while performing cognitive tasks for pre assessment**
Go/No-go task shall be used for assessing attention and for assessing working memory D-span task shall be used. Details of both tasks are given in our previous study on Changes in Brain wave rhythms during tasks involving Attention and Working memory [3].

**2.5 Statistical Analysis of data**
Analysis of data shall be done using one tail paired type t-test and correlational studies shall also be made. Details of both are given in our previous study on Changes in Brain wave rhythms during tasks involving Attention and Working memory [3].

**2.6 Intervention**
For enhancing cognitive abilities (attention and working memory) meditation shall be used as intervention. Meditation used shall be custom designed meditation comprising of both concentrative and mindfulness meditations. It is of half hour duration meditation and subjects shall perform it daily for 15 days [2].

**2.7 EEG data shall be acquire while performing cognitive tasks for post assessment**
Post assessment shall be done to find the improvements after intervention. In post assessment EEG data acquired while performing Go/No-go task for attention and D-span for working memory.

**3. Results and Discussions**
In this study results for attention and working memory are computed for both task oriented and physiologically assessment. For physiologically assessment EEG is taken and power of alpha (8-13 Hz) and beta (13-30 Hz) bands are computed for attention; and power of theta (4-8 Hz) and alpha (8-13 Hz) bands for working memory. In task oriented assessment computer based tasks like Go/No-go and D-span tests for attention and working memory respectively were performed.

**3.1 Physiologically assessment**
**1) Attention task**
For attention task in particular channels alpha decreases and beta increases. Alpha in AF3 (fp1, f3) and F7 decreases and beta increases in F8 and AF4 (FP2, F4) [4].
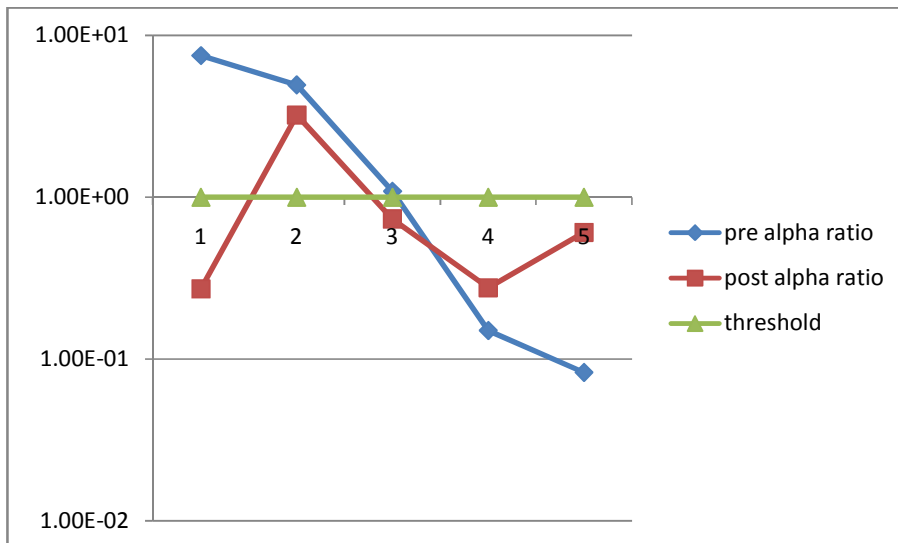


Figure1:Fp1 alpha (8-13Hz) ratio attention task
From figure 1 it is inferred that alpha band of Fp1 does not represent so good results (i.e. decreasing) as expected but still acceptable in pre-post comparison for attentional task. Results are also verified statistically

using t-Test. For Fp1 t-Test value is p =0.145779.Therefore it is concluded from this pilot study that Fp1 decreases in attentional test, which is evident from the figure.
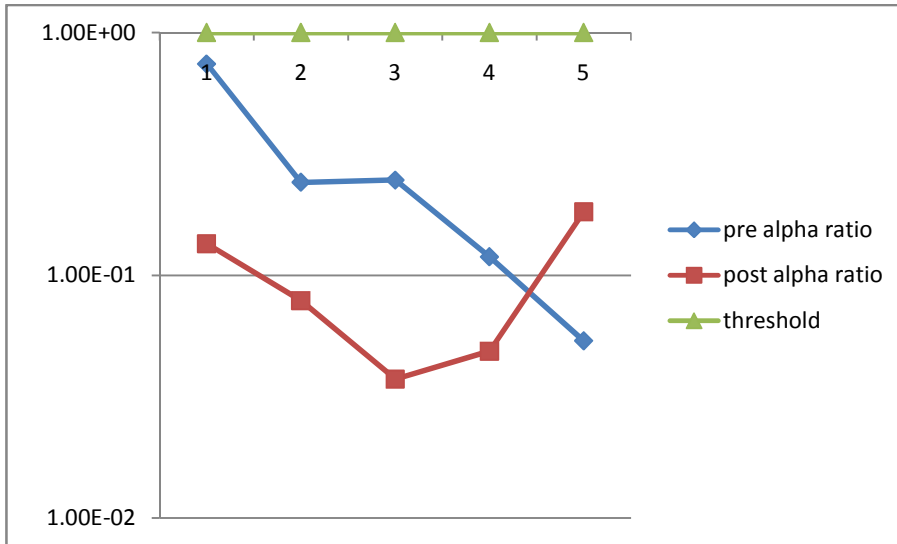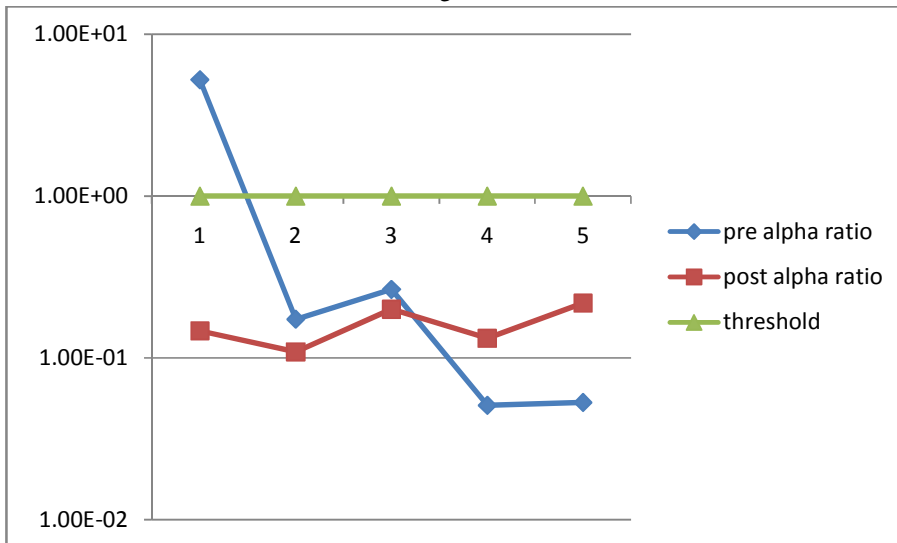


Figure 2:F3 alpha (8-13Hz) ratio attention task

From figure 2 it is inferred that alpha band of Fp2 does not represent so good results (i.e. decreasing) as expected but acceptable in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For Fp2 t-Test value is p =0.100729.Therefore it is concluded from this pilot study that Fp2 decreases in attentional test, which is evident from the figure.



Figure 3:F4 alpha (8-13Hz) ratio attention task

From figure 3 it is inferred that alpha band of F4 does not represent so good results (i.e. decreasing) as expected but acceptable in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For Fp2 t-Test value is p =0.193303.Therefore it is concluded from this pilot study that F4 decreases in attentional test, which is evident from the figure.
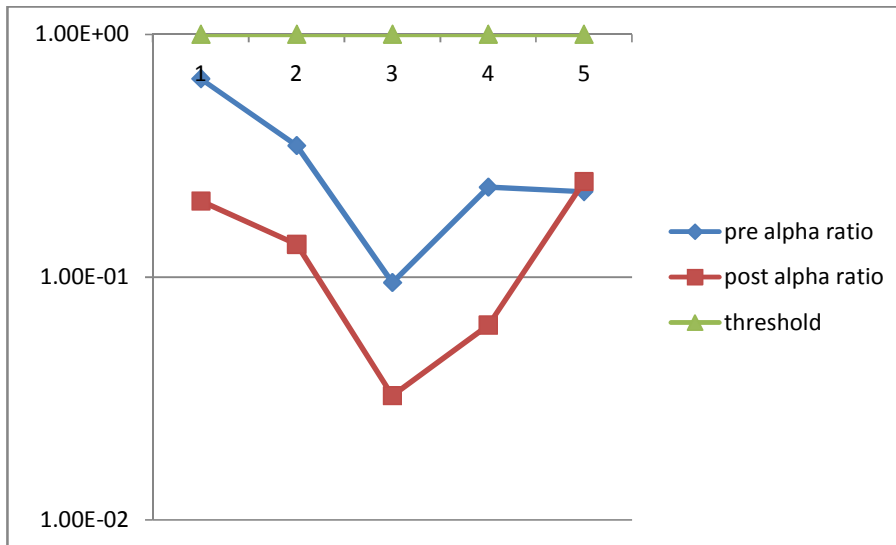
Figure 4:F7 alpha (8-13Hz) ratio attention task

From figure 4 it is inferred that alpha band of F7 decreasing as expected in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For F7 t-Test value is p =0.047535.Therefore it is concluded from this pilot study that F7 decreases in attentional test, which is evident from the figure. Moreover the p value is 0.047535 which is less than 0.05. Though the numbers of subjects are less still the results are proven to be statistically significant.
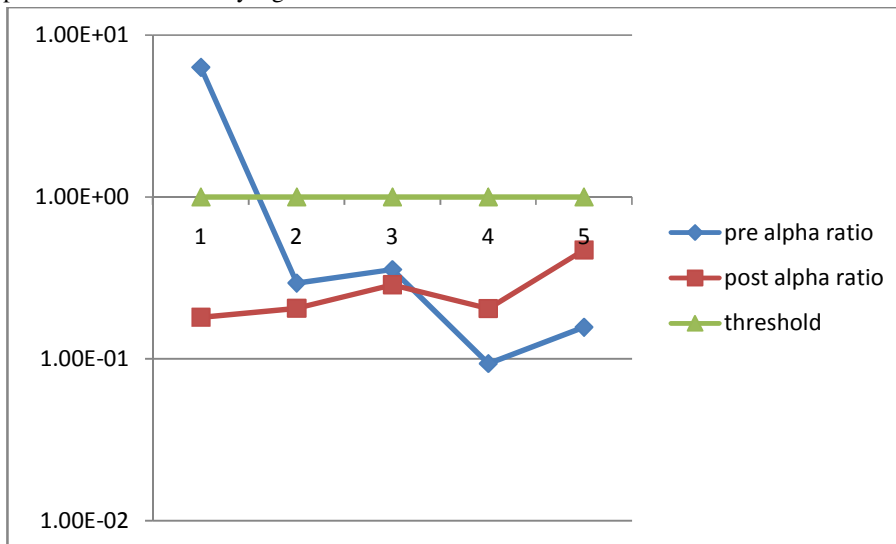


Figure5:F8 alpha (8-13Hz) ratio attention task

From figure 7.50 it is inferred that alpha band of F8 does not represent so good results (i.e. decreasing) as expected but acceptable in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For F8 t-Test value is p =0.199178.Therefore it is concluded from this pilot study that F8 decreases in attentional test, which is evident from the figure.
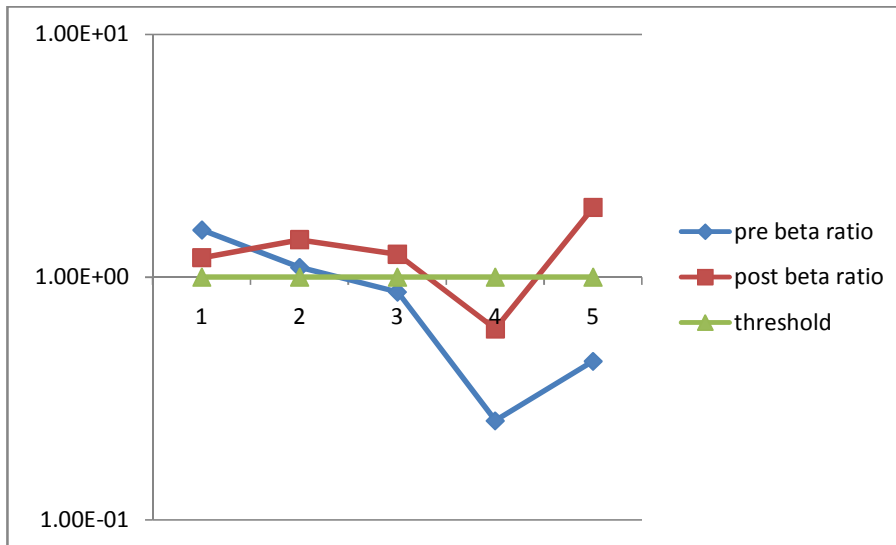
Figure6:Fp2 beta (13-30Hz) ratio attention task

From figure 6 it is inferred that beta band of Fp2 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For Fp2 t-Test value is p =0.107442.Therefore it is concluded from this pilot study that Fp2 increases in attentional test, which is evident from the figure.
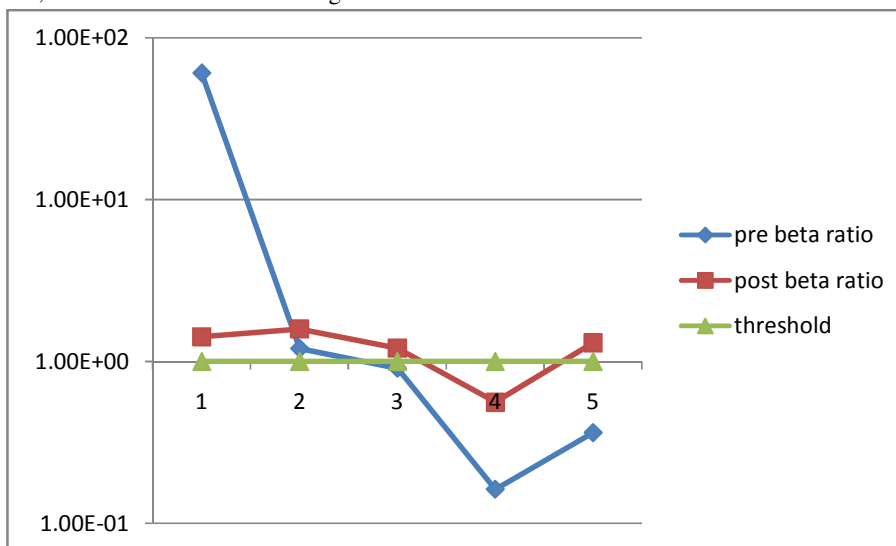


Figure7:F4 beta (13-30Hz) ratio attention task

From figure 7 it is inferred that beta band of F4 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For F4 t-Test value is p =0.196304.Therefore it is concluded from this pilot study that F4 increases in attentional test, which is evident from the figure.
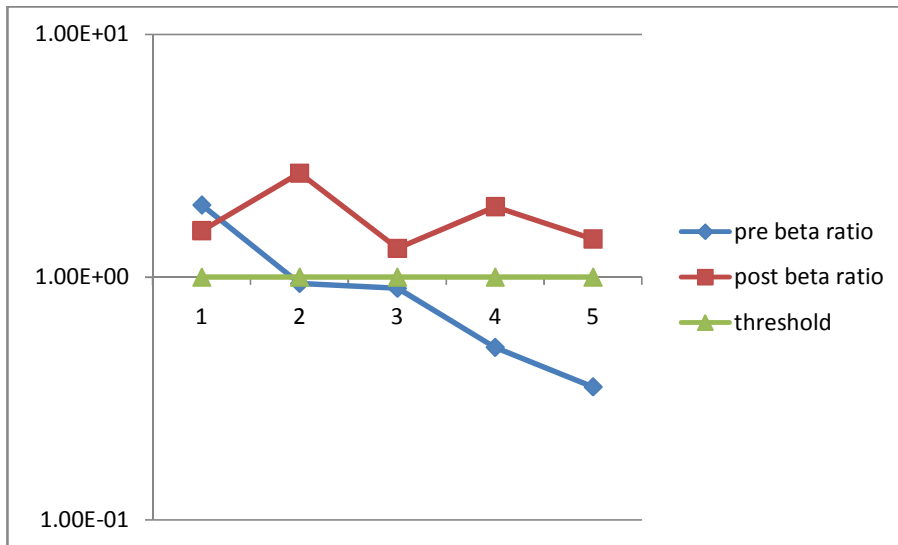
Figure8:F8 beta (13-30Hz) ratio attention task

From figure 8 it is inferred that beta band of F8 increases as expected in pre-post comparison for attentional task. Results are also verified statistically using t-Test. For F8 t-Test value is p =0.046671.Therefore it is concluded from this pilot study that F8 increases in attentional test, which is evident from the figure. Moreover the p value is 0.046671which is less than 0.05. Though the numbers of subjects are less still the results are proven to be statistically significant.

**2) Working memory task**

For working memory in particular channels theta and alpha increases. Theta increase in frontal region ( fz,f3,f4,fp1,fp2,f7 and f8) and alpha increase in posterior (Pz,Cz,O1,O2) and bilateral central areas (Fc5, T4, Fc8, T8)[5].
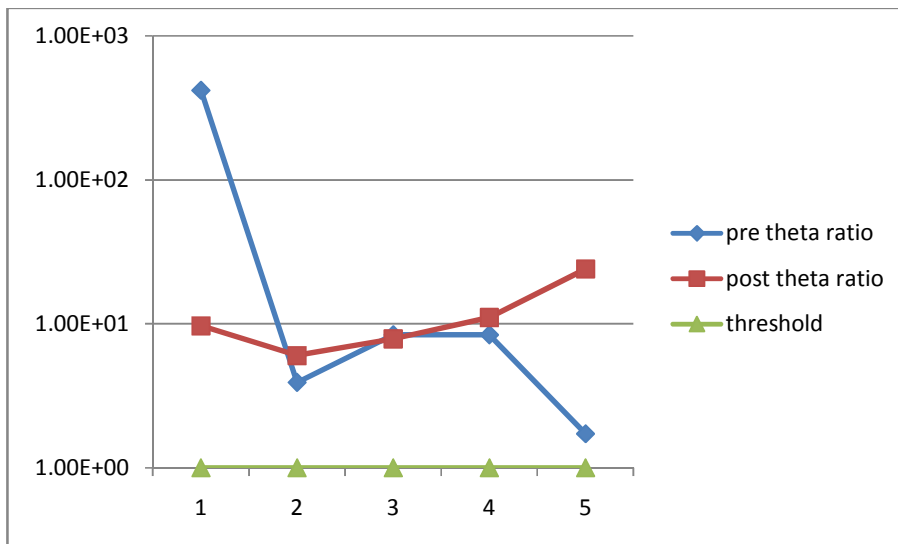


Figure 10:Fp1theta (4-8Hz) ratio working memory task

From figure 10 it is inferred that theta band of Fp1 does not increase as expected in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For Fp1 t-Test value is p =0.205149.No conclusion is drawn from this result as value of p is very large then 0.05.
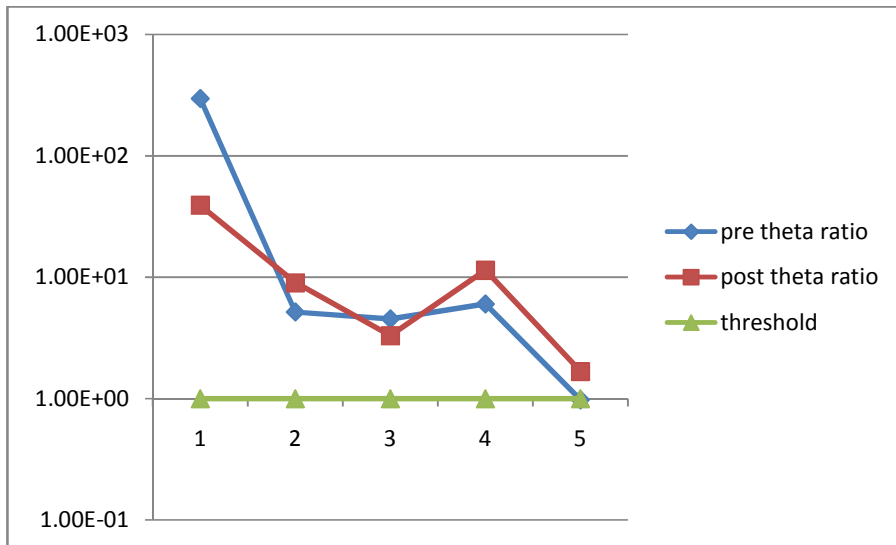
Figure 11:Fp2 theta (4-8Hz) ratio working memory task

From figure 11 it is inferred that theta band of Fp2 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For Fp2 t-Test value is p =0.196146.Therefore it is concluded from this pilot study that Fp2 increases in working memory test, which is evident from the figure.
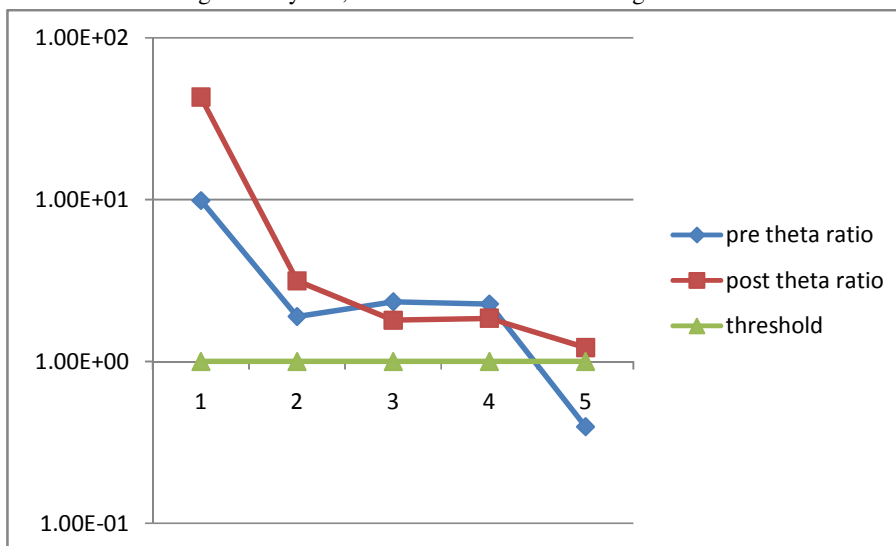


Figure 12:F3 theta (4-8Hz) ratio working memory task

From figure 12 it is inferred that theta band of F3 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For F3 t-Test value is p=0.178304.Therefore it is concluded from this pilot study that F3 increases in working memory test, which is evident from the figure
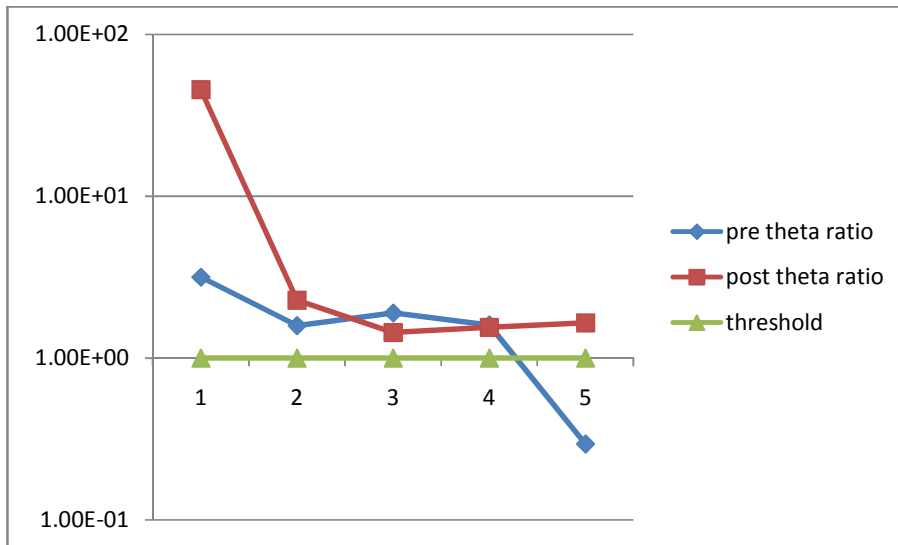
Figure 13:F4 theta (4-8Hz) ratio working memory task

From figure 13 it is inferred that theta band of F4 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For F4 t-Test value is p=0.177515Therefore it is concluded from this pilot study that F4 increases in working memory test, which is evident from the figure.
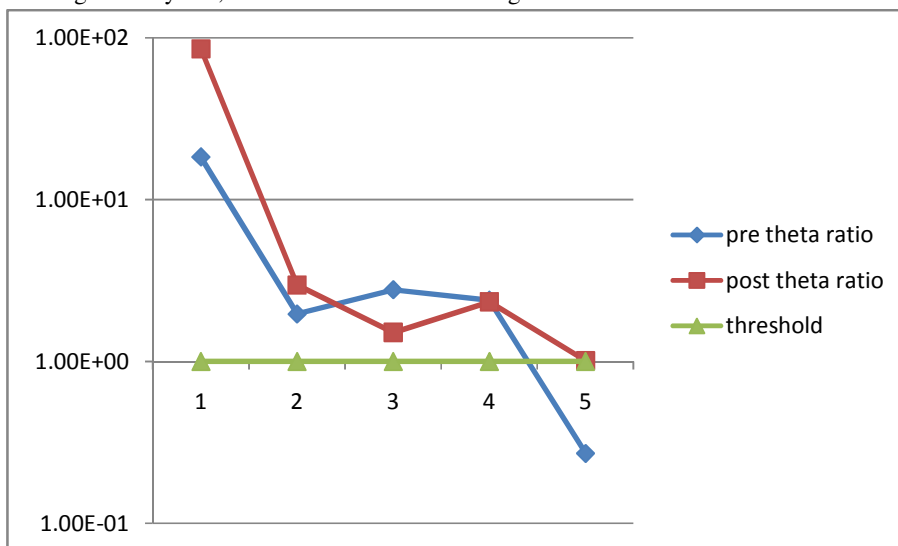


Figure 14:F8 theta (4-8Hz) ratio working memory task

From figure 14 it is inferred that theta band of F8 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For F8 t-Test value is p=0.1853. Therefore it is concluded from this pilot study that F8 increases in working memory test, which is evident from the figure.
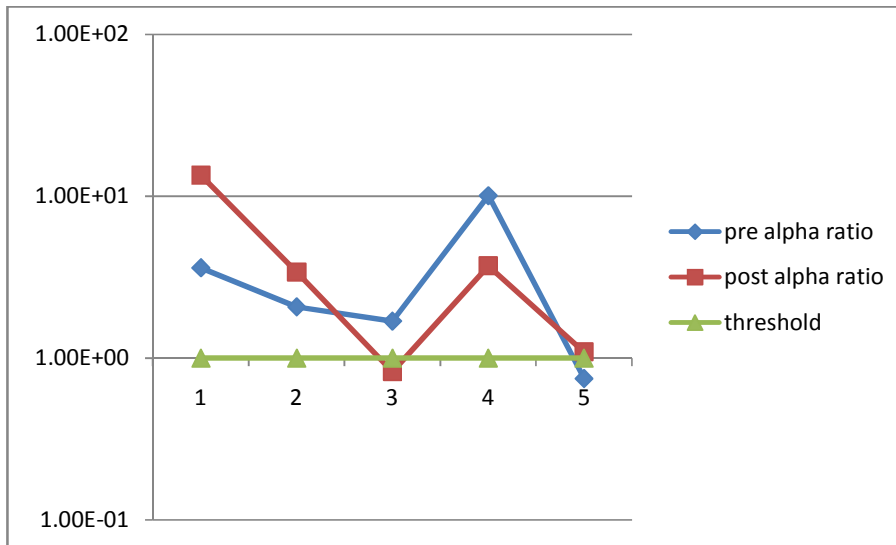
Figure 15:Fp2 alpha (8-13Hz) ratio working memory task

From figure 15 it is inferred that alpha band of Fp2 does not increase as expected in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For Fp2 t-Test value is p =0.379956.No conclusion is drawn from this result as value of p is very large then 0.05.
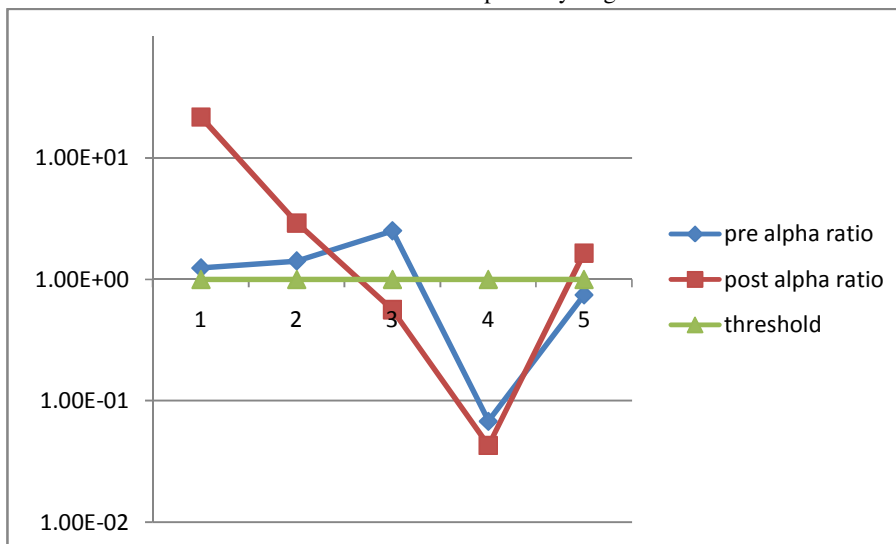


Figure 16:O2 alpha (8-13Hz) ratio working memory task

From figure 16 it is inferred that alpha band of O2 does not represent so good results (i.e. increasing) as expected but acceptable in pre-post comparison for working memory task. Results are also verified statistically using t-Test. For O2 t-Test value is p= 0.183655. Therefore it is concluded from this pilot study that O2 increases in working memory test, which is evident from the figure.

### 3.2  Task oriented assessment

As observed from the data, the error for post intervention gets reduced during attention test (go-no-go) as compared to the pre intervention session. That is, the error during post session of go-no-go comes out to be 0.0175 and that of pre session is 0.018261. Also, it is inferred that memory span increases during post intervention test for working memory (D-span) as compared to the pre intervention session. The value of memory span is calculated to be 9.2 during post session and in that of pre session it comes out to be 8.6.

### Conclusion

It can be concluded from this pilot study that for attention task, for alpha power, results are good in case of FP1, FP2, F3, F4, F8, O1, O2 but results have improved significantly in F7. Along with this, for beta power, results

are good in case of FP2 and F4 but are much better than them in F4. For working memory, in all the frontal channels (FP1, FP2, F3, F4, F7, F8), theta power gives good results. As well, for alpha power, outcomes are good in case of O1, O2 and Fp1 but are not acceptable in channel FP2.

**Future scope**

It is suggested to increase the number of subjects in future in this research. Also, there should be one control group which does not involve in any sort of intervention so that the results can be compared. The study may involve the effect of meditation on other cognitive abilities like motor speed, reaction time, fatigue, etc.

**References**

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