Attention Enhancement using Meditation as an Intervention

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Abstract: Attention has a great role in soft skills and hard core task performances. Therefore its enhancement is imperative. This paper is validating that a short term meditation course of 15 days increases the attention of a person. In this research work, 14 volunteers have been made to undergo attention related tasks like Go/No-Go and Continuous Performance Task (CPT) from the Psychology Experimental Building Language (PEBL). They have been divided in two groups: 1) Meditators group which performed meditation for 15 days. 2) Control group which underwent no meditation program during these 15 days. After 15 days both the groups performed the same tasks which they performed before the intervention and comparative study has been done on pre and post-intervention scores of the two tasks. It is found that the meditators show greater improvement in tasks as compared to the control group.

Keywords: Attention assessment, attention enhancement, meditation.

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1. Cognition

Cognition can be defined as collection of mental skills and processes related to knowledge like language, attention, working memory, visual and spatial processing, interpersonal and intrapersonal skills, logical and verbal reasoning [1]. It has been proved scientifically that cognitive abilities improve by certain interventions like meditation, music and odor. In our research we have used meditation as an intervention for attention enhancement [2, 3, 4, 5].

2. Attention enhancement

The main aim of attention enhancement is to improve the attention of a person through external interventions.

Attention enhancement can be broadly classified into two categories:

1) Restorative

2) Facilitative

2.1 Restorative attention enhancement

This type of attention enhancement technique aims at regaining the attention which has reduced as compared to what it was in the past. This might be due to some neuropsychiatric conditions like Attention Deficit Hyperactivity Disorder (ADHD). This type of enhancement technique is more of a therapy given after a disease.

2.2 Facilitative attention enhancement

This type of attention enhancement technique aims at improving the level of attention as compared to the present level of attention. This technique is more like an exercise done by a healthy individual so as to improve fitness.

3. Attention enhancement techniques

Many methods have been followed for years to enhance cognition. For example, drinking of caffeine is said to improve attention.
Attention enhancement techniques are broadly classified as:
1) Psychological Intervention
2) Medical Intervention

3.1 Psychological Intervention

This intervention includes brain training through games, strategies, education and learning. This is a conventional type of intervention as it does not have any side-effects and is widely accepted.

3.2 Medical Intervention

This type of intervention is an unconventional intervention as it makes use of certain drugs, gene therapy and neural implants which are still in the phase of experimentation.

The intervention that we have used for attention enhancement is meditation. It is a conventional type of intervention and is widely used around the world for cognitive enhancement.

4. Psychological Assessment

Psychological assessment of the participants has been done using a psychological test battery called Psychology Experiment Building Language (PEBL) [6]. Two tasks of sustained and selective attention are performed by the participants. The tasks are as follow [7]:

1) PEBL Continuous Performance Task (PCPT)
2) Go/No-Go

4.1.1   PEBL Continuous Performance Task

Continuous Performance Task is a test for selective and sustained attention. It is available in PEBL as PEBL Continuous Performance Task (PCPT). This task runs for 14 minutes and is comparatively longer than Go/No-Go. In this task various characters flash on the screen. The participant has to respond to all the characters except 'X'. Reward point of '1' is given for every correct response. The score is automatically calculated by the PEBL software at the end of the task.

4.1.2   Go/No-Go

This task is also used to test the participant's selective and sustained attention. This task is 4 minutes long and is undertaken by the participants twice, one after the other with slight changes in instruction. In the first task on Go/No-Go the participant is instructed to respond to only 'P' flashing on screen and ignore the 'R'. This task is denoted by Go/No-GoP. In the other task the participant is instructed to respond to 'R' only. This is denoted by Go/No-GoR. A reward point of '1' is given for every correct answer and '0' for the wrong response. Accuracy of responding to 'P' and 'Q' is automatically shown at the end of the task using (1) and (2).

$$\text{Accuracy of responding to "P"} = \frac{\text{correct response on P}}{\text{total number of P's flashed}} \tag{1}$$

$$\text{Accuracy of responding to "Q"} = \frac{\text{correct response on Q}}{\text{total number of Q's flashed}} \tag{2}$$

Go/No-GoR is more difficult to be performed than Go/No-GoP as the task is immediately performed after Go/No-GoP and has instructions completely opposite to Go/No-GoP therefore it takes time to unlearn the instructions of Go/No-GoP and learn instructions of Go/No-GoR [8].

5. Method

The research has been carried out in Electronics & Instrumentation Department, Thapar University, Patiala, India.

5.1 Participants

Fourteen students taking part in the research work have been screened on the basis of following criteria [9]:

1) Participant should be in the age group of 20-25.
2) Participant should not have any illness related to central nervous system including multiple sclerosis, thyroid, diabetes and severe hypertension.
3) Participant should be willing to participate.

The participants volunteering in the research work have been informed about the objective, protocol and time taken by each task before starting the experiment. Written consent has been taken by the students before the task. The participants were asked about their interest in meditation and only the participants interested in meditation have been made part of the meditators group while the participants who showed no interest in meditation are made part of the control group and thus two groups were formed [10].

1) **Meditators' group:** This group undertook a guided meditation for 15 days.
2) **Control group:** This group carried out no meditation in their routine as an intervention.

5.2 Experimental Design

The experiment is carried out in three steps as shown in Figure 1:

5.2.1   Pre Test

During pre-tests all the participants of both the groups perform Go/No-Go and PCPT in PEBL and their scores are saved for comparison with post-test results.

5.2.2   Meditation as an intervention

Meditation is given as an intervention to the meditators group. Meditation given is custom designed 20 minutes long guided session that leads to progressive relaxation of muscles as well as mind. This meditation has reportedly been used earlier for cognitive enhancement [4]. This audio clip of guided meditation has been given to each participant in the meditators group so that they can practice it at any time in the day according to their comfort for 15 days, everyday. The participants have further been advised to practice meditation in a quiet room. No such intervention is given to the control group.

5.2.3   Post-Test

These tests are taken after the completion of intervention. The participants are made to perform the same tasks which they performed prior to intervention and the results are compared with pre test results.

Figure 1:   Experimental Design

6.   Data Analysis

For convinience
Go/No-GoP(P)= A
Go/No-GoP(R)= B
Go/No-GoR(P)= C
Go/No-GoR(R)= D
Thus mean of A, B, C, D is

$$\text{Mean}(A, B, C, D) = \frac{(A + B + C + D)}{4}$$

Percentage change in score/ accuracy can be given by

$$\text{Percentage change in score/accuracy} = \frac{\text{Post} - \text{Intervention Reading} - \text{Pre} - \text{intervention Reading}}{\text{Pre} - \text{intervention Reading}}$$

6.1 Pre and Post-Intervention Data of meditators:

Table 1 shows the pre-intervention data for meditators. The data consists of accuracy of "P's" and "R's" in both Go/No-GoP and Go/No-GoR. The accuracy can be anywhere in between 0 to 1. The mean of the four task accuracies is found. Score out of 360 is given in PCPT.

Table 1: Pre-intervention Test results of PEBL for meditators

Participant					Mean E	PCPT
	A	**B**	**C**	**D**	**(A,B,C,D)**	**(Pre)**
1	1	0.78125	0.98437	1	0.941405	347
2	1	0.96875	1	1	0.992188	338
3	1	0.9375	1	1	0.984375	303
4	1	0.84375	0.99218	1	0.958983	325
5	0.99218	0.46875	0.97656	1	0.859373	323
6	1	0.6875	0.9218	1	0.902325	337
7	0.99218	0.78125	0.99218	0.90625	0.917965	199

Table 2 shows the post-intervention data for the meditators' group. Same tasks which were performed pre-intervention are performed in post-intervention.

Table 2: Post-Intervention Test results of PEBL for meditators

Participant					Mean E	PCPT
	A	**B**	**C**	**D**	**(A,B,C,D)**	**(Post)**
1	1	0.78125	1	1	0.945313	353
2	1	0.96875	0.99218	1	0.990233	339
3	1	1	1	1	1	309
4	1	0.875	1	1	0.96875	339
5	1	0.65625	0.98437	1	0.910155	314
6	0.99218	0.99218	1	1	0.99609	349
7	0.99218	0.96875	1	0.96875	0.98242	209

We found changes in scores in a task during pre and post-intervention in meditators' group. Table 3 and Table 4 compare the pre and post-intervention scores of Go/No-Go and PCPT respectively.

$$\text{Change in Accuracy/Score} = \text{Post} - \text{Intervention Accuracy/Score} - \text{Pre} - \text{intevention Accuracy/Score}$$

$$\text{Percentage Change in Accuracy/Score} = \frac{\text{Change in Accuracy/Score}}{\text{Pre} - \text{intevention Accuracy/Score}}$$

Table 3: Percentage change in pre and post-readings of meditators in Go/No-Go Test

Pre-Intervention	Post-Intervention		
Mean E	**Mean F**	**Change in Accuracy**	
(A,B,C,D)	**(A,B,C,D)**	**(F-E)**	**Percentage Change in Accuracy**
0.941405	0.945313	0.003908	0.415124203
0.992188	0.990233	-0.001955	-0.197039271
0.984375	1	0.015625	1.587301587
0.958983	0.96875	0.009767	1.01847478
0.859373	0.910155	0.050782	5.909191934
0.902325	0.99609	0.093765	10.39148865
0.917965	0.98242	0.064455	7.021509535
P-value	0.024517431		

Table 3 shows that there is a statistically significant difference in pre and post-intervention accuracies of Go/No-Go with P-value of 0.02. Accuracy is seen to be increasing statistically post-intervention. Figure 2 shows a graph of pre and post-intervention accuracies of meditators for the task of Go/No-Go. X-axis shows the participant and Y-axis shows the accuracy which may be in range of 0 to 1. It can be seen from the graph that the accuracy has increased post-intervention for all the meditators except in case of participant 2 where there is a very small decrease in accuracy.
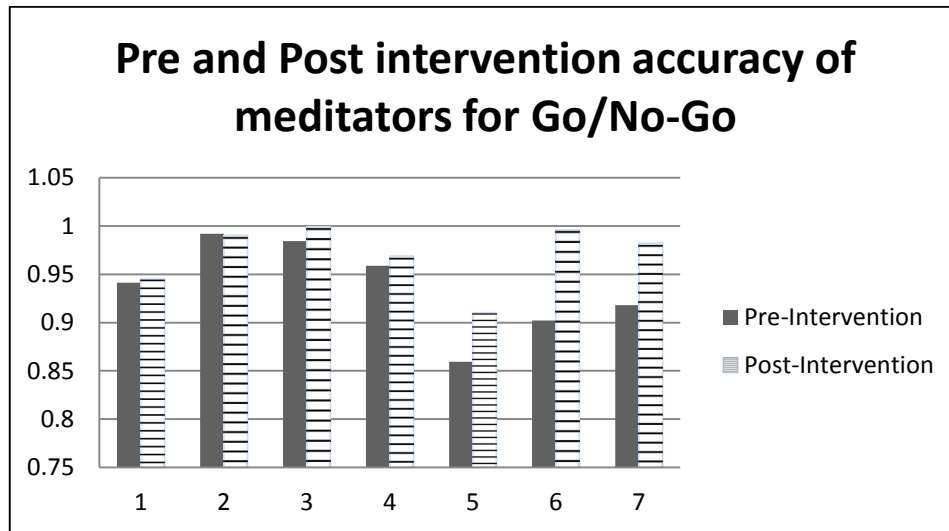

Figure 2:   Pre and Post-intervention accuracy of meditators for Go/No-Go

Table 4: Percentage change in pre and post-readings of meditators in PCPT

Pre-Intervention Mean E (A,B,C,D)	Post-Intervention Mean F (A,B,C,D)	Change in Score (F-E)	Percentage Change in Score
347	353	6	1.729106628
338	339	1	0.295857988
303	309	6	1.98019802
325	339	14	4.307692308
323	314	-9	-2.786377709
337	349	12	3.560830861
199	209	10	5.025125628
P-value	0.050412897		

Table 4 shows that there is a statistically significant difference in pre and post-intervention scores of PCPT with P-value of 0.05. Scores of the participants are seen to be increasing statistically post-intervention. Figure 3 shows a graph of pre and post-intervention scores of meditators for the task of PCPT. X-axis shows the participant and Y-axis shows the score out of 360. It can be seen from the graph that the scores have increased post-intervention in almost all the meditators except in case of participant 5 where there is a very small decrease in score post-intervention.
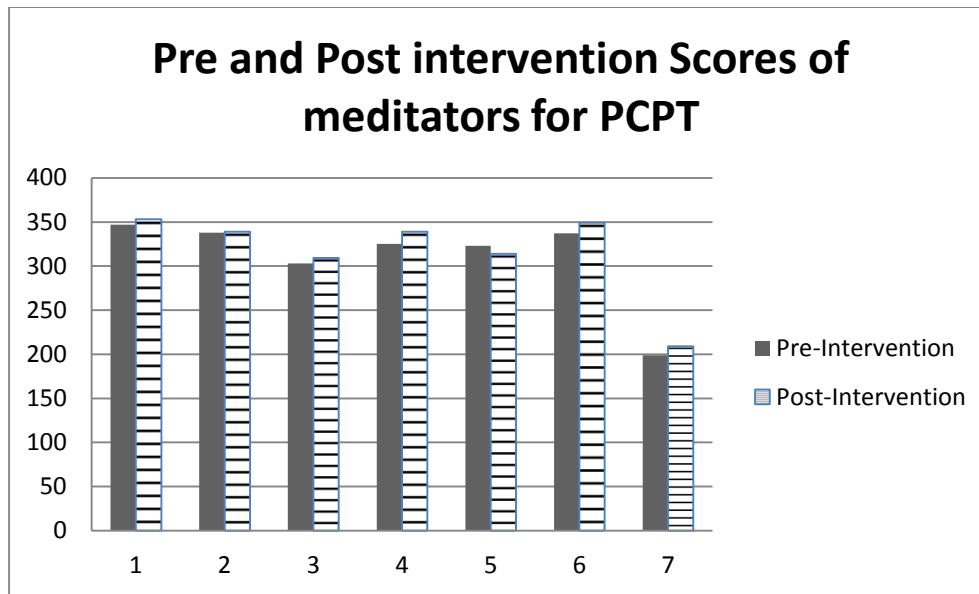
Figure 3:   Pre and Post-intervention Scores of meditators for PCPT

6.2 Pre and Post-Intervention Data of Control Group:

Table 5 shows the pre-intervention data for the control group. The data consists of accuracy of "P's" and "R's" in both Go/No-GoP and Go/No-GoR. The accuracy can be anywhere in between 0 to 1. The mean of the four task accuracies is found. Score out of 360 is given in PCPT.

Table 5: Pre-intervention Test results of PEBL for Control Group

Participant	A	B	C	D	Mean E (A,B,C,D)	PCPT
1	1	0.40625	0.97656	1	0.8457025	346
2	0.99218	0.6875	0.99218	1	0.917965	347
3	0.99218	0.9375	1	1	0.98242	337
4	1	0.875	0.99218	1	0.966795	348
5	0.99218	0.8125	0.99218	1	0.949215	326
6	1	0.84375	0.97656	1	0.9550775	348
7	0.96875	0.625	0.97656	0.96875	0.884765	337

Table 6 shows the post-intervention data for the meditators' group. Same tasks which were performed pre-intervention is performed in post-intervention.

Table 6: Post-Intervention Test results of PEBL for Control Group

Participant	A	B	C	D	Mean F (A,B,C,D)	PCPT
1	1	0.6875	0.97656	1	0.916015	333
2	1	0.6875	0.96093	1	0.9121075	333
3	1	0.65625	0.98437	1	0.910155	312
4	0.99218	0.75	0.97656	1	0.929685	344
5	0.98437	0.5	0.99218	1	0.8691375	317
6	1	0.90625	1	0	0.7265625	346
7	1	0.65625	0.98437	1	0.910155	339

We found changes in scores in a task during pre and post-intervention in control group. Table 7 and Table 8 compares the pre and post-intervention scores of Go/No-Go and PCPT respectively in the same way as in meditators.

Table 7: Percentage change in pre and post-readings of Control Group in Go/No-Go Test

Pre-Intervention Mean E (A,B,C,D)	Post-Intervention Mean F (A,B,C,D)	Change in Accuracy (F-E)	Percentage Change in Accuracy
0.8457025	0.916015	0.0703125	8.3140939
0.917965	0.9121075	-0.0058575	-0.6380962
0.98242	0.910155	-0.072265	-7.3558152
0.966795	0.929685	-0.03711	-3.8384559
0.949215	0.8691375	-0.0800775	-8.4361815
0.9550775	0.7265625	-0.228515	-23.926331
0.884765	0.910155	0.02539	2.8696886
P-value	0.122301		

Table 7 shows that accuracy is decreasing post-intervention for control group though this decrease is not statistically significant. Figure 4 shows a graph of accuracy of control group before and after 15 days for the task of Go/No-Go. X-axis shows the participant and Y-axis shows the accuracy which may be in range of 0 to 1. It can be seen from the graph that the change in accuracy is random before and after 15 days for the control group. It is increasing in participant 1and 7, decreasing in 3, 4, 5 and 6 and remains same in case of participant 2.
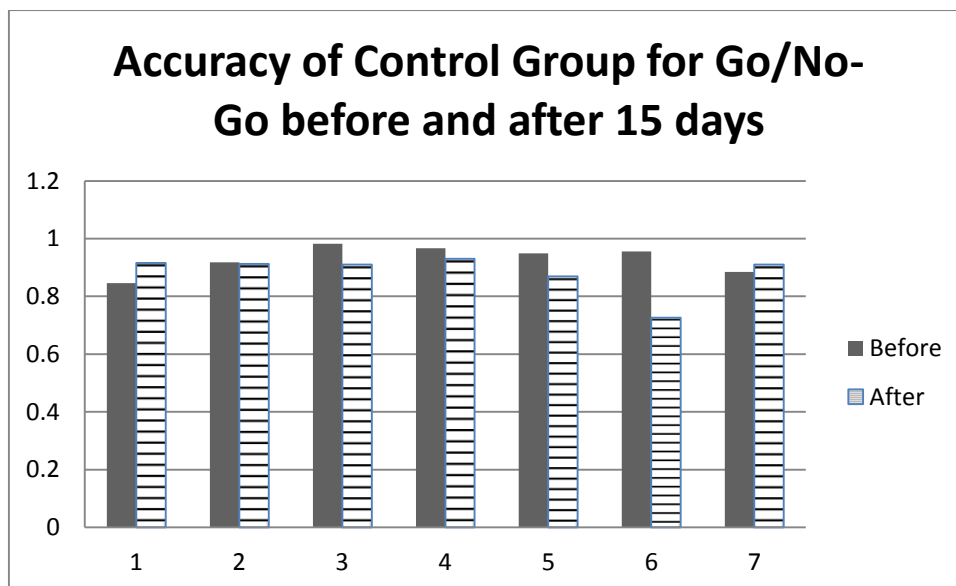

Figure 4:   Pre and Post-intervention accuracy of Control Group for Go/No-Go

Table 8: Percentage change in pre and post-readings of Control Group in PCPT

Pre-Intervention Mean E (A,B,C,D)	Post-Intervention Mean F (A,B,C,D)	Change in Accuracy (F-E)	Percentage Change in Accuracy
346	333	-13	-3.7572254
347	333	-14	-4.0345821
337	312	-25	-7.4183976
348	344	-4	-1.1494253
326	317	-9	-2.7607362
348	346	-2	-0.5747126
337	339	2	0.5934718
P-value	0.017446		

Table 3 shows that there is a statistically significant difference in before and after scores of PCPT with P-value of 0.01. Scores are observed to be decreasing significantly post-intervention. Figure 5 shows a graph of scores of control group before and after 15 days for the task of PCPT. X-axis shows the participant and Y-axis shows the scores out of 360. It can be seen from the graph that the change in score is random before and after 15 days for the control group. It is increasing in participant 7 and 8, decreasing in 1, 2, 3, 4, 5 and 6.
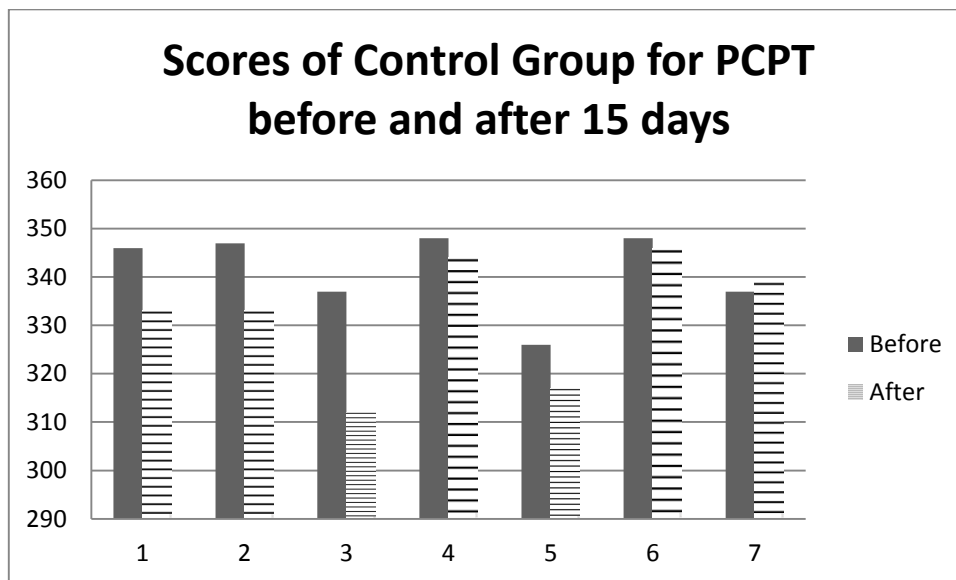

Figure 5:   Pre and Post-intervention accuracy of Control Group for PCPT

Figure 6 and 7 shows percentage change in accuracy and scores of participants in Go/No-Go and PCPT respectively.
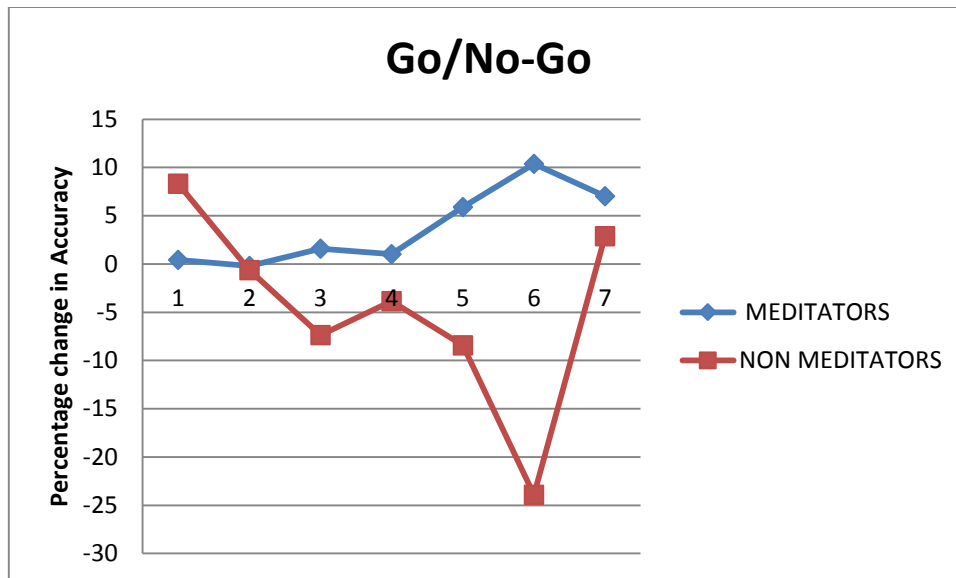
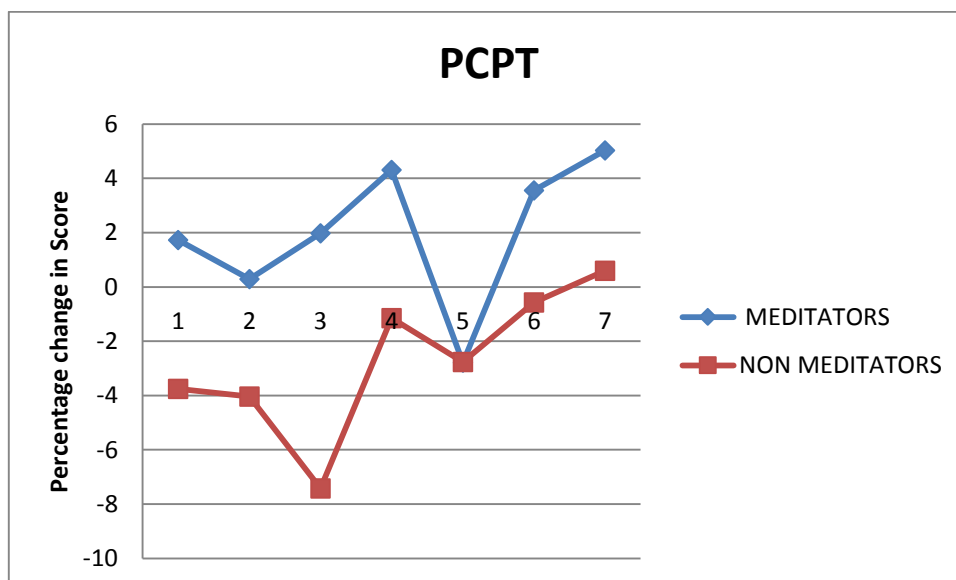Figure 6:   Percentage change in accuracy for Go/No-Go

Figure 7:   Percentage change in scores for PCPT

6.3 T-test:

We have applied T-test in our research to find out whether there is a difference in the population of meditators and control group. The null hypothesis, that the meditators and control group is same will be considered true until they are proven wrong by proving them to be different. The T-test gives a p-value which determines how likely the results could have come by chance. Conventionally, if the chance of getting the observed difference is less than 5 percent, the null hypothesis is rejected [11].

We have used one-tail, unpaired T-test for two-sample unequal variance data to determine whether there is significant change in the scores and accuracies of meditators and control group.

Table 11: Computing P-value using T-Test between scores/accuracy of Meditators and Non-Meditators

Go/No-Go		PCPT	
Percentage Change in Accuracy (Meditators)	**Percentage Change in Accuracy (Control)**	**Percentage Change in Score (Meditators)**	**Percentage Change in Score (Control)**
0.415124203	8.314093904	1.729106628	-3.757225434
-0.197039271	-0.638096224	0.295857988	-4.034582133
1.587301587	-7.355815232	1.98019802	-7.418397626
1.01847478	-3.838455929	4.307692308	-1.149425287
5.909191934	-8.436181476	-2.786377709	-2.760736196
10.39148865	-23.92633059	3.560830861	-0.574712644
7.021509535	2.869688561	5.025125628	0.59347181
T-TEST= 0.032962334		T-TEST= 0.003048503	

Conclusion:

It can be seen from Table 3 and 4 that the scores/accuracies have significantly increased post-intervention for meditators for both Go/No-Go and PCPT. It can be seen from Table 7 and 8 that scores/accuracies have decreased in post-intervention tasks for control group. This statistically proves that attention is enhanced after undertaking meditation as an intervention. It can also be clearly seen from Table 11 that the P-value of T-test is 0.03 in case of Go/No-Go and 0.003 in case of PCPT. This means that there is significant difference in percentage changes of meditators and non-meditators.

Future Work

In this research, we have found that meditation as an intervention has enhanced attention. This enhancement is observed through psychological assessment technique (PEBL). In future, we can use pyshiological assessment techniques like EEG for assessing attention. This can be done by extracting various parameters of EEG like alpha, beta, delta and theta and observing their change in power through various attention tasks.

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