A Case Study for Graphics Selection for Enhancing Meditation as Applied to Visual Therapy

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Abstract

Meditation remained in the outskirts of scientific research but is now gaining wide attention. Many methods to enhance meditation have been invented from Vedic ages till date. Currently, software based visual therapy techniques for improving meditation are been used. The proposed work makes a case study to relate meditation and attention levels through a computer game. The game uses Brain-Computer Interface technology and OpenGL Graphics Package. The study shows that high mental activity increases the attention levels of a player but at the cost of meditation levels. The observations made here can be used in designing effective software graphics packages for meditation enhancement. The brain dynamics were studied using Brain-Computer Interface technology using an Electro encephalogram.

Index terms: Meditation, attention, BCI, EEG, visual therapy.

1. Introduction

Derived from the Latin word 'meditatio', the word 'meditation' refers to an exercise which is ambiguous amid physical and intellectual nature of human beings. In either ways, it is concerned with the center of mind or the body. Meditation was anticipated in terms of reflection or relaxation in certain circumstances [1]. This aspect of viewing meditation has transformed due to its medical relationships [2] and its deeper understanding by considering its history and cultural backgrounds. The effect of meditation on human brain has been scrutinized using EEG or functional magnetic resonance (FMRI) as in [3, 13, 19-21]. It is found that meditators are better performers in the aspects of attention over non-meditators [12] and meditation can effectively reduce anxiety, exhaustion and enhance ones mood [18]. One such study was carried on meditators and on guitar practitioners and their BCI performance is in good agreement with the fact that meditation gears all round performance [14]. Meditation can significantly reduce chronic pain and other illness [22].

1.1 Meditation types

Meditation refers to various practices that range from relaxation promoting methodologies and exercises performed for physical and mental fitness. Based on this, meditation has been grouped under various categories. Mindfulness meditation deals with focusing on the perceptions like touch, smell, etc. Loving–kindness meditation (LKM) and compassion meditation (CM) are attributed to nurturing optimism, compassion, and kindness [5]. Modern conceptions of neuroscience and some traditional meditation texts classify meditation into Open Monitoring (OM) and Focused attention (FA) [9]. FA meditation is a Buddhist practice which involves focusing on a fixed object and sustains this state by mere perseverance in the beginning stages. Open monitoring includes the initial stages of FA and then culminates into mental distress by making the subject emotion reactive.

1.2 Computer Graphics

Computer Graphics has made tremendous progress in terms of simulation, graphics realism, artificial intelligence which has changed the richness of virtual worlds. Due to this, computer graphics is used exhaustively in a wide assortment of fields like entertainment industry, education, gaming, medical fields [23], etc. Many attempts have been made to utilize computer graphics as a tool to overcome many mental disorders and enhance meditation, and this attempt has bloomed into the so called 'Visual Therapy'. Computer graphics can be used to train people with learning disabilities too [24].

1.3 Brain Computer Interface

Human Brain consists of various waveforms as a result of neuronal activities. These waveforms are indicative of the various mental and physiological activities prevalent in the human body. The technique of effectively using these waveforms for running computer applications is termed as Brain-Computer Interface technology [10, 11] which has been a popular topic in the present day research community.

2. Implementation

Subjects ranging from 6 to 80 years were involved in the study who were bereft of any physical or mental illness. To avoid complexity, the overall experimentation was carried out in normal environmental conditions. Few of the subjects hailed from mind training institutes like abacus in the age groups ranging from 6-14 years. The users were supposed to play a BCI game discussed in section 2.2. During this activity, the brain data was captured using a NeuroSky Mindwave Mobile EEG device[4]. To read the meditation and attention values, the following APIs were used, TG_GetValue(connectionId, TG_DATA_MEDITATION) and the TG_GetValue(connectionId, TG_DATA_ATTENTION) respectively. The first parameter in the API is used to return the connection status of the device with the computer system and the second specifies meditation or attention. The values returned by the API are integer values representing the percentages of the second parameter in them.

2.1 Hardware and software details

A single channel acquisition wireless EEG device is used for the experimentation. The sensor on it captures the brain waveforms from the frontal cortex region of brain by making use of dry sensor technology. Data transfer from the EEG device to the computer is enabled through Bluetooth and the software named ThinkGear Connector (TGC) is used to connect the device to the computer. TGC directs headset data to open network socket from the serial port by running as a background process. The device computes and measures the meditation and attention eSense measure for every second. The translation into digital data from analog is achieved through AD converter embedded on to the EEG device.

2.2 Details of the BCI game

The BCI game developed required that the user pays attention greater than a fixed threshold

(50% in this study). When the attention was greater than or equal to the threshold, a graphics object ascends on the screen and the same descends when attention level drops. At the same time, the meditation values were computed. Figures 1 a,b are the snapshots of the game discussed above. The subjects were asked to play a simple BCI game developed using OpenGL (Open Graphics Library)- an Application Program Interface (API) for rendering 2D/3D graphics. The game involved a 3D sphere to be moved from the source to the destination on a black screen when the attention values increased above a given threshold. Few randomly appearing objects like torus, spherical rings with randomized lighting, shading and material properties were used to distract the user and test his/her mettle. The reason for deploying a BCI game was because they have paved a new dimension in attention enhancement using neurofeedback, where users control a specific game using controlled thought processes [6-8, 16, 17]. The algorithm for the above mentioned game is as discussed in section 2.3. The programming modules used to develop the BCI game using
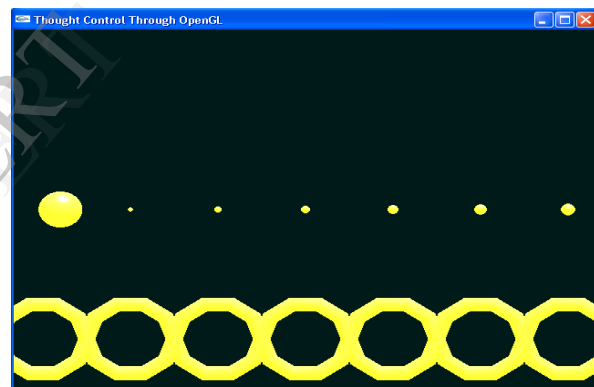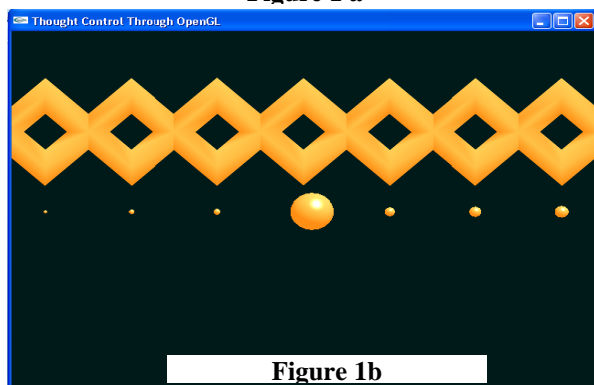

Figure 1 a

Figure 1b

OpenGL is mentioned in section 2.4.

Figure 1a,b showing the snapshots of the BCI game developed using OpenGL.

2.3 Algorithm of the BCI game

Input: Set of brain waveforms.
Output: Attention assessment using computer graphics.
Procedure:
1. Connect the EEG headset.
2. Call display function and set the lighting and shading properties.
3. Draw eight balls with increasing sizes showing direction.
4. Draw the main moving sphere at source.
5. Read attention values from the EEG device and start the timer.
6. If (attention value >= threshold)
 Move the sphere forward.
 Else
 Move the sphere backward.
7. When the sphere reaches the destination, read stop time. Display reward.
8. Stop.

2.4 Programming modules

```
//main function
 main()
 {
//Connect the EEG
/*Check for error*/
errorCode=(int)(check connection)
if errorCode<0
return Connection failure
p←initial screen position
Drawscene();
Reshape();
 }

 Drawscene()
{
 /*Clear the colour and depth buffer and
set the model view matrix*/
glLoadIdentity();
R←Random Number
 /*Set the material properties including
ambience, diffuse, specular and shininess
/*Set the light position and light diffuse
api's*/
 /* Randomize the above api's with R
passed as parameter*/
MoveBall();
DrawCircle();
 //Swap the buffers
glutSwapBuffers();
}

MoveBall()
{
for i←0 to 9999
if errorCode= =1
{
a←Get attention values
t←Set the threshold
if a>t
p+=0.2 /*Move the ball
ahead by 0.2 as step size*/
else
p-=0.2 /*Descend the ball
with 0.2 as step size*/
}
}

DrawCircle()
{
R←Random Number
//Direction Showing Balls
for i←0 to 9
glPushMatrix();
glTranslatef(i-5,0,0);
glutSolidSphere(i-(0.99*i),150,150);
glPopMatrix();

if p==final destination position
//display teapot
glutSolidTeapot(0.5);
return time taken to play
exit(0);

//main ball
glPushMatrix();
glTranslatef(a,0,0);
glutSolidSphere(0.25,150,150);
glPopMatrix();

/*similarly draw random balls with R
passed as parameter in it*/
/*R should be used in glTranslate(…) and
glutSolidSphere(…) to randomize their
movement and shape*/
}
```

2.5 Algorithm for the data analysis

Input: Brain waves of subjects.

Output: Comparison of their meditation levels with attention levels.

Procedure:
1. Connect the EEG device to the system.

2. If successful connection,
{
Read brain wave data in the structure variable declared below
n=number of subjects;
t=time taken to play the BCI game;
counter=0;

```
//structure for data storage
struct
{
int attention[t];
int meditation[t];
int result[n];
}data[n];

//store the attention and meditation values .
//using the ThinkGear API's discussed above.

for(i=0;i<n;i++)
{
for(j=0;j<t;j++)
{
data[i].attention[t]   =  TG_GetValue(connectionId,
TG_DATA_ATTENTION);

data[i].meditation[t]  =  TG_GetValue(connectionId,
TG_DATA_MEDITATION);
}
}
}
//if connection not successful
goto step 1.
```

3. Compare meditation with attention

```
for (i=0;i<n;i++)
{
for(j=0; j<t;j++)
  {
if(data[i].meditation[j]>= attention[j])
  {
        data[i].result[j]=1;
  }
else
{
data[i].result[j]=0;
}
}
}
```

4. Comparison
data[].result specifies the number of times, the meditation values exceeded attention.
5. Stop.

3. Results and discussion

It was observed that meditation levels in an individual were lesser when compared to their attention values while playing the BCI game. It was obvious for attention values to be higher as the BCI game required the attention to be increased in order to drive the graphics object to the destination. This creates zeal in the player to excel thereby disturbing the mental calmness and thus this shows reduced meditation values.

Figure 2 depicts the number of times the meditation excels attention (blue bars) and the red bars indicate the total number of seconds taken by each player to play the game.

Figure 3 shows the attention and meditation values in a six year old kid. Similar data sets were obtained for all the subjects chosen. An algorithm mentioned in section 2.5 was developed in this regard to compare the meditation and attention values and the result obtained by running the algorithm on a six year old kid is as shown in Figure 4. A value of one on Y –axis indicates the higher meditation values over attention values, and zero otherwise .The time for which the above observation is seen, is indicated on the X-axis. It was expected that the abacus practitioners who had their attention levels higher than the normal subjects to excel in terms of meditation too. But no difference was found in both the classes of subjects.

Figure 5 shows an area graph of abacus literates with red region indicating their attention and blue, meditation. Note that meditation levels is meager than attention. Thus it is seen that people having greater attention levels may lack the same proficiency in terms of meditation.
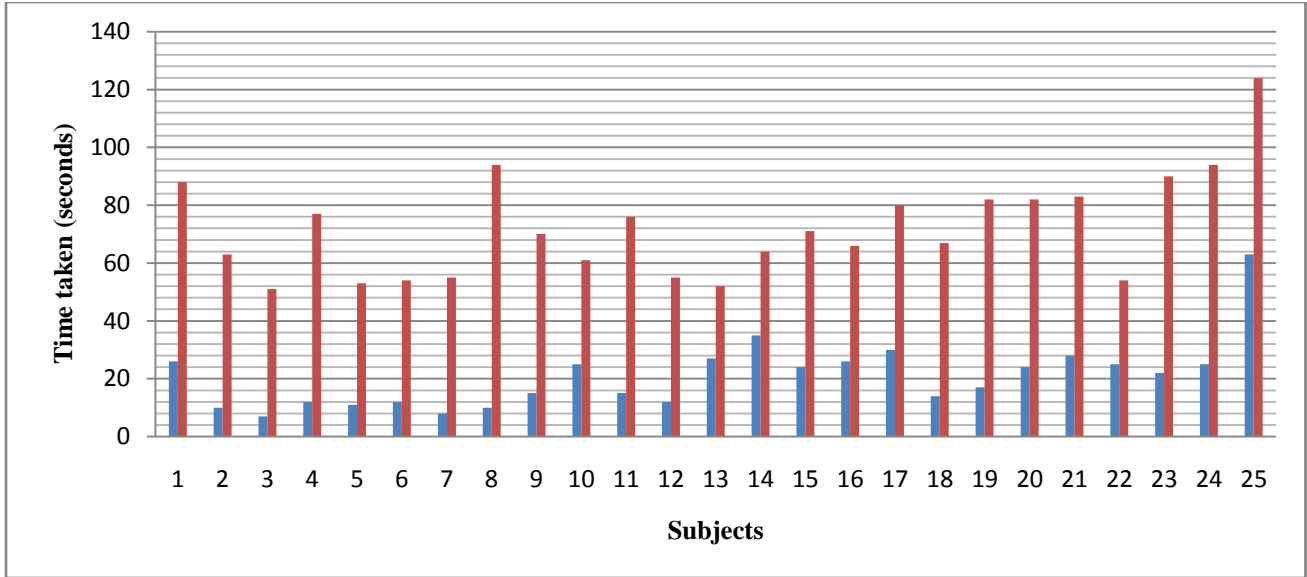
Figure 2. Graphical representation with blue bars indicating the number of times meditation excels attention. Red bars indicate the number of seconds to accomplish the game.
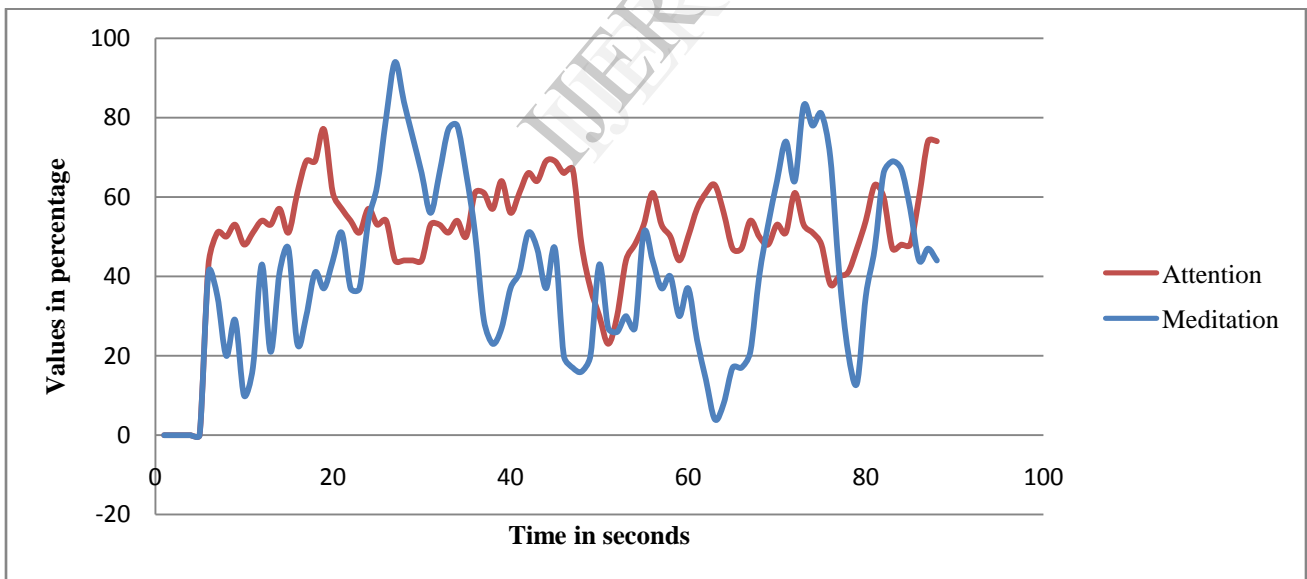

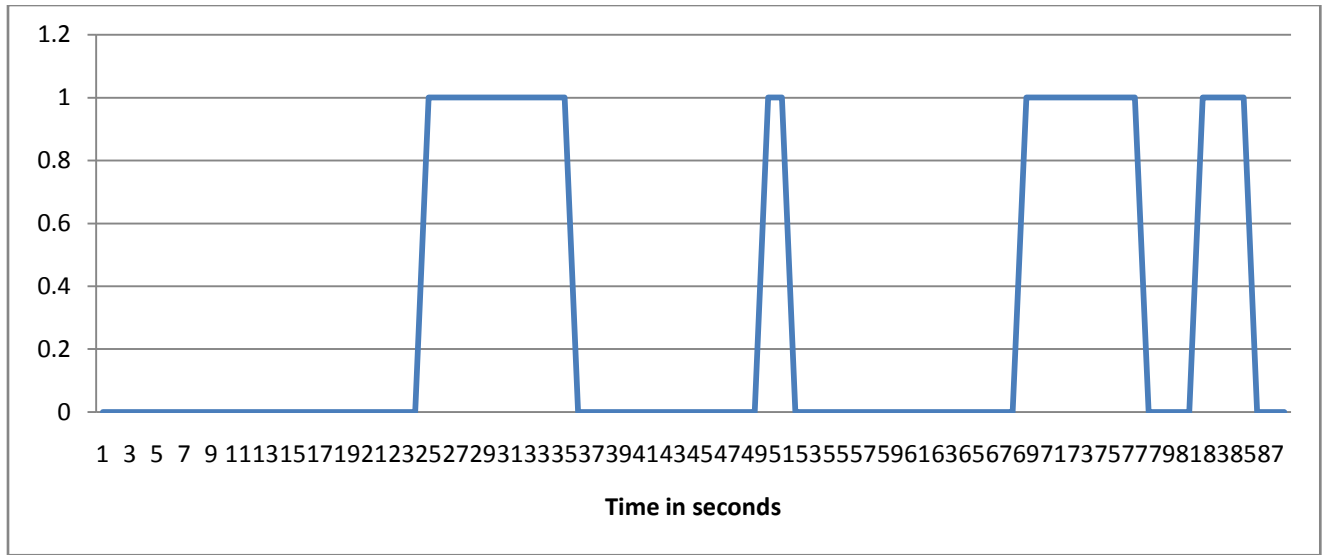**Figure 3. Graph showing the varying attention and meditation values in a 6 year old kid.**

Figure 4. Results obtained by running the algorithm on a six year old kid. Note the larger intervals of time when attention exceeds meditation.
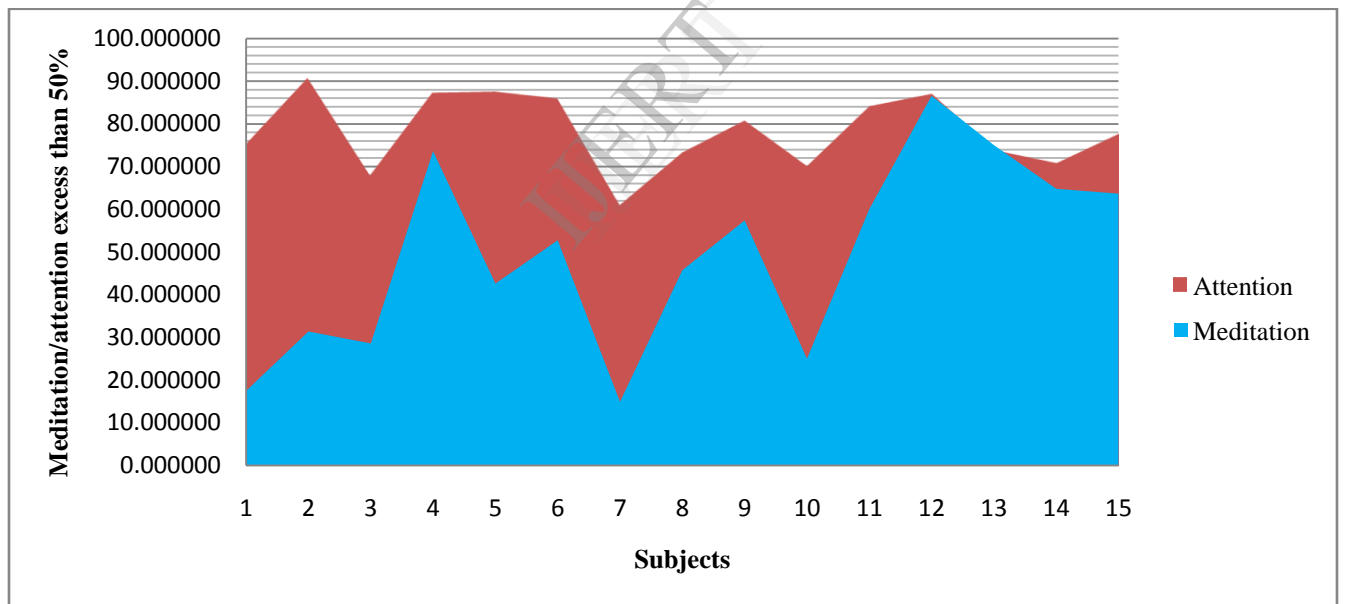

Figure 5. Area graph showing the red region as attention and blue as meditation in abacus literate subjects.

4. Conclusion

As a summary, the proposed work shows that careful selection of visuals and graphics is necessary for meditation enhancements. A new paradigm of so called visual meditation is introduced. The developed BCI game runs on the basis of attention levels but fails to increase meditation values. So visuals or games involving high mental activity should be avoided during meditation. BCI games should involve less thinking capabilities and include calm, soothing visuals to increase meditation levels, because enhanced meditation can enhance attention while the converse may not be true.

5. Future Scope

The technique can further be adapted to various graphics based applications that provide soothing visual effects and the resulting impact of each of these on the corresponding meditation and attention levels can be determined. This can foster software based techniques in visual therapy as in the treatment of attention deficit and hyperactivity disorder (ADHD) in children.

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