

# The Changes of Brain Signals by use of Meditation during Problem Solving

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**Abstract**— Improving human performance is a highly desired interest at present. Many industries concerned about the factors whether internal or external, effect subject productivity. Numerous methods have been introduced for this task. Meditation is just one technique helping users to reduce stress, prevent episodes similar to frustration, and aid in the accomplishment of one's goals in a timely and repeatable manner. Our study required participants to solve mathematical testing, with increasing levels of difficulty over time, to stimulate a change in mental state. Subjects' EEG signals were collected and compared. With the administering of meditation, stress reducing techniques, subjects were capable of repeating equally difficult mathematical tests more easily.

**Index Terms**— Electroencephalography (EEG), Meditation, Stress, Relaxation, Internal Factors, Mathematical, BioRadio.

## 1 INTRODUCTION

THE brain's cerebral cortex structure is divided into four lobes (Frontal lobe, Parietal lobe, Occipital lobe, and Temporal lobe). Each lobe is responsible for performing different functions and generates various waveforms: Gamma (> 30 Hz), Beta (12.5 - 30 Hz), Alpha (7.5 - 12.5 Hz), Theta (4 - 7 Hz), and Delta (0 - 4 Hz). Each waveform is responsible for certain characteristics and details.

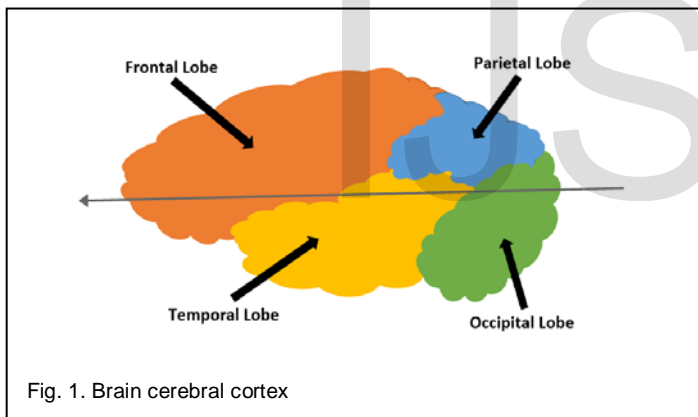


Fig. 1. Brain cerebral cortex

Scientists have proven confidence and relaxation are important elements that affect peoples' lives directly[1]. Furthermore, people improve faster when they know how to control those components[2]. Learning to master the subconscious reduces anxiety, stress and anger issues people encounter daily. This is why development coaches and natural healers teach self-discipline. One such example included neuroscientists recommending certain activities and sports to trigger the temporal lobe which generates gamma waves[3]. Which generated during thinking and higher executive processing to control consciousness.

Psychiatrists believe twisting minds (referred to as mindfulness) is a real phenomenon. Twisting the mind and mindfulness terminology is used by medical professionals to practice training the brain to respond differently when encountering a real world situation[4]. For example, when a person wants to achieve a goal they draw on mindfulness tactics to increase efforts to accomplish the task.

Numerous researchers have studied this concept. One investigation showed EEG signaling was affected when binaural-beats were applied to a user's sensory environment[5]. Other investigators have monitored brain and respiration signals during meditation to evaluate the body's response to the treatment[6]. Psychologists have concentrated on these same principles when helping smokers to quit. After a couple months, results showed 66% of the group responded positively[7].

Stress and anxiety are reactions reflected on the physical body and through emotions. If they are reduced and relieved, the body reacts positively to the change. However, some people do not know how to manage their emotions and heal their stress[8]. Scientists have found that the brain communicates with the subconscious through the transfer of visual constructs, more so than vocal relay[9]. These transmissions cause a change in state of being, such as discomfort to comfort and vice versa. Using scientific discoveries such as these will offer options and solutions to people interested in positively impacting their life when reducing stress.

Meditation techniques derived through the improved understanding of brain signals, allows people to directly enhance the quality of their lives without the use of chemicals or drugs. The purpose of our research is to test users' problem solving skills with the aid of meditation techniques and to investigate for improved performance.

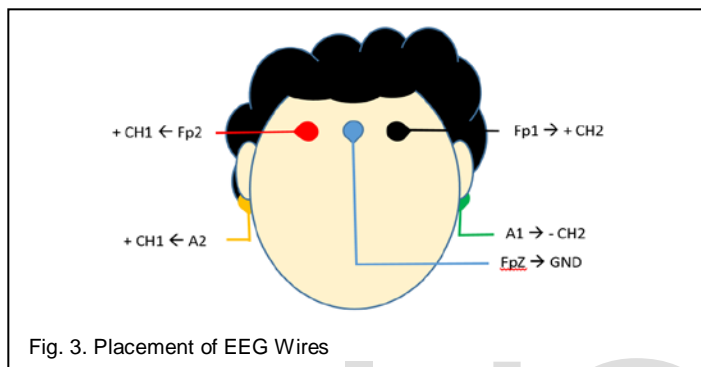
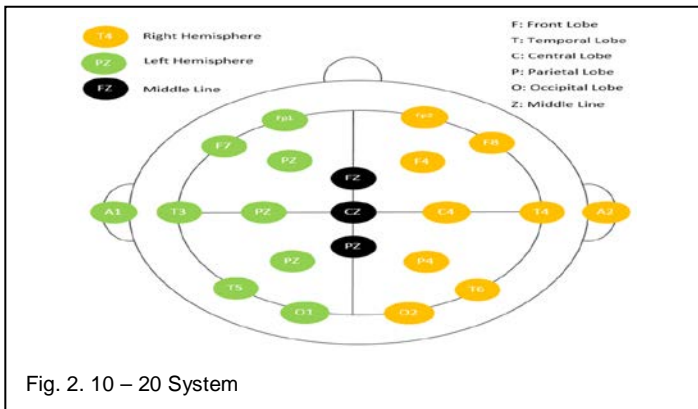
## 2 METHODOLOGY

### 2.1 EEG

Figure 2 shows the 10 - 20 System (Setup) named because it refers to the percent distance between each electrode from one another in relation to the size of the head.

Letter (indicates the region) and number (indicates the hemisphere) correlates to location and side of the head (four lobes of the brain). C indicates the center, and A is for mastoid which is the pony portion behind the ear.

BioRadio 150 device required five cables to read EEG signal. The gold cup electrode attached to the Fp1, Fp2, A1, A2, and Fpz positions on the cerebral cortex



Shown in Figure 3 were the metal electrode wires attached to the participant's cerebral cortex on the scalp surface without any open wounds. The electrodes wired connected to a portable device of the USER UNIT BioRadio which sent signals wirelessly to a receiver.

## 2.2 Participants

There were a total of 30 participants. Subjects were a mix of gender and they were 18 years and older. Each participant was voluntary and signed a consent form after it had been explained by the investigator. The participants were informed about the study and its procedure, as well as the aim behind the project before the study took place.

The investigator cleaned the subject's skin to remove impurities which may have otherwise interfered with signal. Electrodes placed at selected spots.

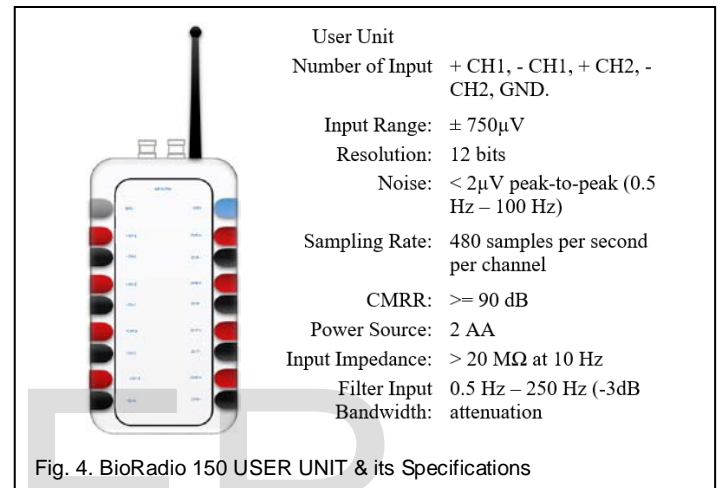
Subjects were instructed to do mathematical problems in an isolated room for 10 minutes while researchers observed reactions on a monitor as suggested by past research. Afterwards there was a small break for an additional 10 minutes. Participants were instructed to relax and meditate about things that were occurring in their personal lives. Details to relax were mimicked from past research by calming themselves and supervising their brain. The final portion of testing required

participants to repeat a new set of math problems for at least 10 minutes. The study took 40 minutes which included preparation

Each participant wore EEG monitoring equipment to collect participants' brain signals at all times. Data processing compared brain signals, as well as the time taken when solving problems before and after the meditation.

## 2.3 Hardware

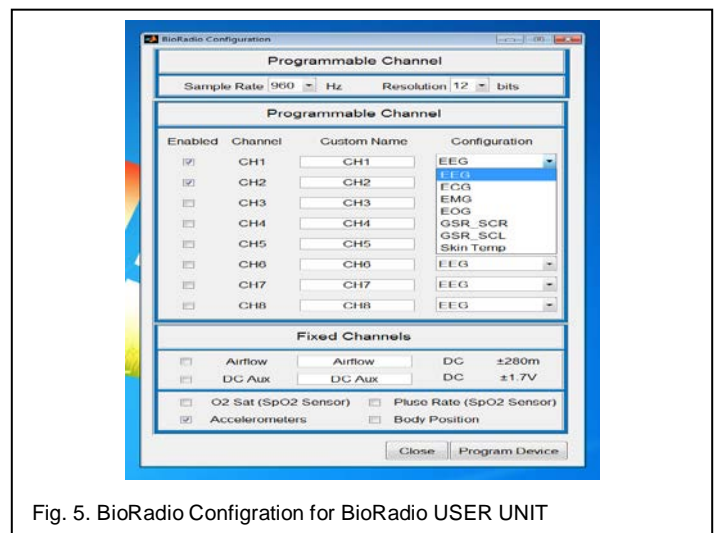
Hardware used in this study: Windows 7 pro as the PC's operating system installed on a powerful machine with Intel Core i7 CPU and 16 GB of memory, and a BioRadio wireless device (USER UNIT) as displayed in Figure 4.



Signal were sent wirelessly via antenna from USER UNIT. A USB Receiver attached to the PC's to transfer the brain signals.

## 2.4 Software

The program's software used was the MATLAB 2014a version 64 bit used during implementation and simulation. BioCapture was used to read signal data.



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Figure 5: Through BioRadio Configuration, we could

change USER UNITs for specific input data to read EEG for brain signals. Including other purposes such as Electromyography (EMG) for muscle activity, Electrooculography (EOG) for eye movements and Arterial oxygen Saturation (SpO2). They will store selected configuration data in the USER UNIT and give the results of the signals received from participants.

### 3 RESULT

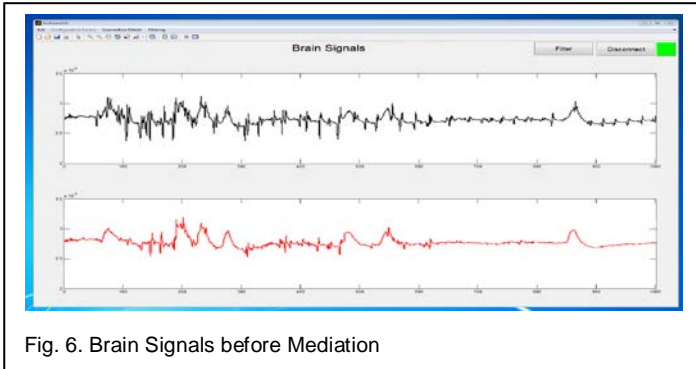


Fig. 6. Brain Signals before Meditation

Figure 6 shows the brain signals began to change during mathematical testing over time. This was due to stress and/or deep thinking. The signal indicated the brain was switching from a comfortable status to a rough status of thinking. This transition in thought requires more energy to provide an efficient response during questioning. Also, while in this transition, the brain produces different waveforms.

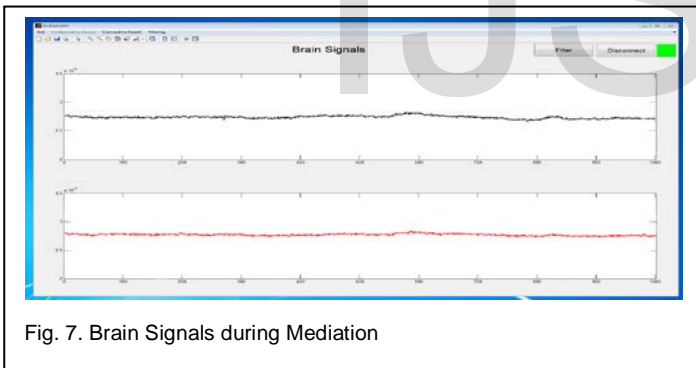


Fig. 7. Brain Signals during Meditation

Brain signaling is visually different according to EEG data, during meditation. This status has an impact on different organs and their function; for example: muscles movements, lungs and their breathing function, and the heart's cardiac regulation. Figure 7 showed when participants freed their mind releasing stress; this was the meditation phase data. The brain began to generate different signal frequencies and was consistent with past research findings[10].

Participants took the same level of mathematical testing. On average, their results improved when compared to their productivity before meditation. During meditation, subjects were asked to calm themselves, mentally, and oversee the thought processes within their mind. Figure 8 shows the participant's brain signaling was smoother as compare to the same participant's brain signal in Figure 6.

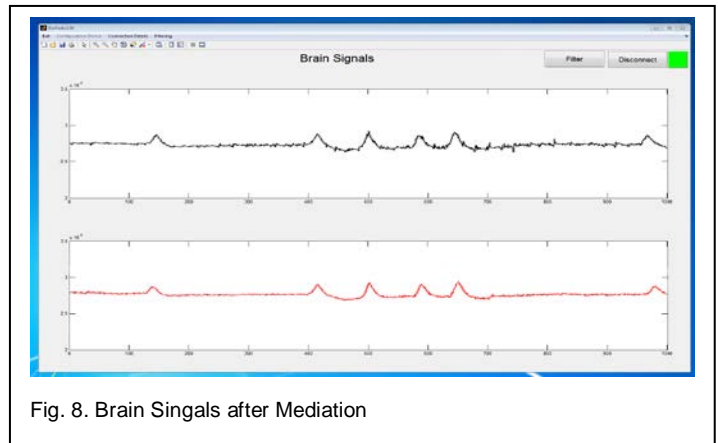


Fig. 8. Brain Signals after Meditation

### 4 DISCUSSION

The brain relies on daily acquired knowledge to deal with life, and keep it in a relaxed mode. However, sometimes people need to know how to fool their brain to overcome a mental obstacle. They need to gain knowledge in terms of thinking and power in terms of the physical body. However, controlling the subconscious is the ultimate way to achieve life goals and the successes in challenges.

When subjects performed mathematical problems, results suggest they may have been entering deep thought, struggling, and encroaching on frustration. Frustration and struggling are some of the emotions that limit humans' creativity. The hidden power of people's subconscious mind can be reached through meditation. In this experiment people had the same forms of difficulty with mathematical testing. But, on average, subjects performed better when given meditation techniques compared to their mathematical work before relaxing.

Performance during mathematical testing varied, although participants faced the same levels of difficulty. Their brain viewed the situation differently and uniquely. Yet, participant results improved when compared to their productivity before meditation, as was suggested by past research findings 8.

### 5 CONCLUSIONS AND FUTURE DIRECTIONS

By studying brain signals in different phases we have an interest to research how relatedness. The focus will lie primarily on a participant's productivity and increases in awareness of the brain. This research will give us more clues regarding brain functioning. The result will lead to better control over productivity. These results are also necessary to figuring out how to stimulate relaxation hormones without external influences such as place, material, and moment.



## APPENDICES



Electrodes (Fp1, FpZ, Fp2) on the Forehead



Electrodes (A1, A2) on back of the Ear



Gold cup electrode cables



USB Receiver

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