Computational Analysis and Prediction Of EEG Signals To Monitor Calmness Percentage Using A Wearable EEG Headset – Muse

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Abstract- *One in four people – about 450 million people worldwide – suffer from mental disorders in both developed and developing countries. One of the probable reasons for an unprecedented rise in mental health disorders is the lack of objectivity in measuring mental states of an individual. But in last few years, there has been a surge of technology devices like Emotiv, Muse and Insight which record electrical activity (EEG) inside our brain. The analysis of EEG signals could give us markers of mental health for an individual. We propose to monitor a few mental health parameters using computation and analysis of EEG signals recorded on a subject using Muse device. Calmness percentage is calculated and prediction of next session is done.*

Keywords- Muse, Elecroencephalography,bird points, calmness percentage,recoveries

I. INTRODUCTION

1.1 Problem - Mental Health

Mental illness has a staggering impact on the global economy: about $2.5 trillion/year today. By 2030, that amount will increase to around $6 trillion a year – more than heart disease and more than cancer, diabetes and respiratory diseases combined. By 2030, depression will be the second highest cause of disease burden in middle-income countries and the third highest in low-income countries. Depression is the leading cause of disability worldwide, and is a major contributor to the global burden of disease. In the last 45 years suicide rates have increased by 60% worldwide. More than 90% of people who kill themselves have a diagnosable mental disorder.

1.2 CHOOSING THE DEVICE: MUSE

Current technology devices for capturing brain data

Data from the brain can be recorded through multiple techniques. Invasive techniques are the ones in which electrodes are put inside the brain with the help of a neurosurgery. On the other hand, non invasive techniques are the ones in which electrical signals are recorded from the scalp surface itself just by placing the electrodes. We intend to analyse three wearable EEG headsets for recording electrical signals of the brain:

Muse - It is a personal meditation assistant, with 7 sensors which also provides a developer Software Development Kit (SDK) to build brain sensing applications.

Fig1. Muse

1.3 EEG -

Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain. It is typically noninvasive, with the electrodes placed along the scalp, although invasive electrodes are sometimes used such as in electrocorticography. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain.[1] In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a period of time,[1] as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus either on event-related potentials or on the spectral content of EEG. The former investigates potential fluctuations time locked to an event like stimulus onset or button press. The latter analyses the type of neural oscillations (popularly called "brain waves") that can be observed in EEG signals in the frequency domain.

II. RESEARCH USE

EEG, and the related study of ERPs are used extensively in neuroscience, cognitive science, cognitive psychology, neurolinguistics and psychophysiological research. Many EEG techniques used in research are not standardised sufficiently for clinical use. But research on mental disabilities, such as auditory processing disorder (APD), ADD, or ADHD, is becoming more widely known and EEGs are used as research and treatment.

WHY MENTAL HEALTH

Mental health issues affect everyone—whether in their family, their classroom, or on their streets. In any given classroom, there will be at least 2 children with ADHD, which affects the teacher and classmates. . In offices, workers struggle with anxiety and depression—even Jon Hamm has talked about his struggle with depression. On the streets, unfortunately, the people we see railing at the sky are often schizophrenic.

III. METHODOLOGY (data collection and analysis using Muse)

What does my session data mean?

In your session data after a meditation, the times for calm, neutral and active represent the proportion of time spent in each state during the session.

Muse measures your brain's natural electric field from outside your head while you meditate. At the end of your session, review of your session is given data in a way that helps you reflect on that session.

We have plotted a graph from the review - The graph divides your session into three regions:

Active: This is time spent with a wandering mind. Your attention was fluctuating. Whenever you notice your active mind and bring your attention back to the breath, you are awarded with a recovery

Neutral: This is your natural resting state. Your attention isn't fluctuating, but you aren't deeply focused either

Calm: A deep restful focus on your breath. These are moments when you're truly concentrated on your breath. If you're calm for long enough, you'll hear birds.

Birds: When you find a deep, restful focus on your breath for an extended period of time, you'll start to hear birds singing. Don't worry, this is part of the process! Over time, you'll learn to use the birds as a cue to settle even more deeply into focused attention.

Recoveries : Whenever you notice your mind wandering and bring your attention back, you are awarded with a recovery. Recoveries celebrate the moment when your mind traverses from active (wandering mind / fluctuating attention) to neutral (a natural state of rest). These are key to building the skill of focused attention and integrating the benefits of meditation into your daily life. Tap into your graph to see the exact moments where you recovered your attention highlighted in orange.

Calm Points are awarded for time spent meditating with a restful, focused mind. You receive 1 point for every second that your brain is in a natural state of rest (neutral), and 3 points for every second spent with deep restful focus on your breath (calm).

You don't receive any points for time spent active, but an active mind is very useful. When you hear the weather pick up and your mind is active, treat it as an opportunity to notice your wandering mind and bring your attention back.

Fig: Subject using the device

S No.	Calm percentage	Calm points	Birds	Recoveries	Calm period (in sec)	Neutral period (in sec)	Active period (in sec)
1	6	98	0	10	7	77	36
2	17	151	1	4	20	91	9
3	21	163	1	4	25	88	7

4	26	172	0	4	31	79	10
5	25	173	0	3	30	83	7
6	28	156	2	5	33	57	30
7	30	183	2	7	36	75	9
8	31	180	2	4	37	69	14
9	33	174	3	5	39	57	24
10	37	202	6	2	44	70	6
11	39	210	3	1	47	79	4
12	53	237	9	1	63	48	9
13	46	228	6	2	55	63	2
14	63	268	10	1	76	40	4
15	66	276	7	1	79	39	2
16	68	282	12	0	81	39	0
17	69	286	10	0	83	37	0
18	74	298	13	0	89	31	0
19	76	299	14	1	91	26	3
20	90	336	18	0	108	12	0
21	92	340	20	0	110	10	0

Fig. Data

How does Muse know whether my mind is active or calm?

Muse passively measures your brain's natural electric field from outside your head while you meditate. When your mind is in a deep restful focus on breath, your brain will transmit more energy at certain brain frequencies, and less energy at others. When your mind is at a neutral state of rest, that pattern will change. When your mind wanders and becomes more active, Muse will pick up a different characteristic energy pattern from your brain, which reflects your changing state.

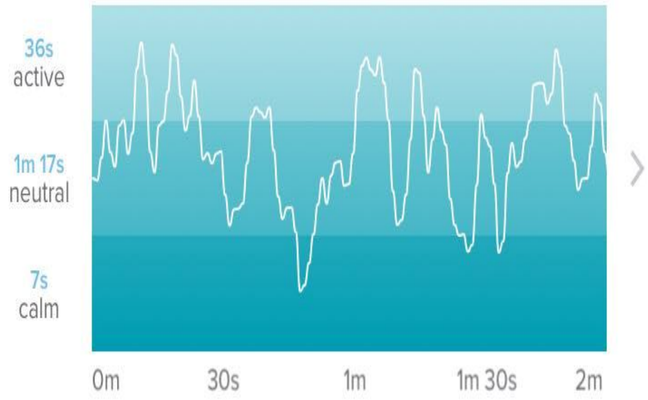
Muse translates your brain signals into a rich, real-time audio experience on your mobile device to help guide your meditation. A calm mind will hear the sounds of a tranquil environment. An active mind will hear the weather soundscape change.
Make sure to keep your eyes closed and relaxed during the calibration and session for the most accurate possible results.

IV. RESULTS AND CONCLUSIONS

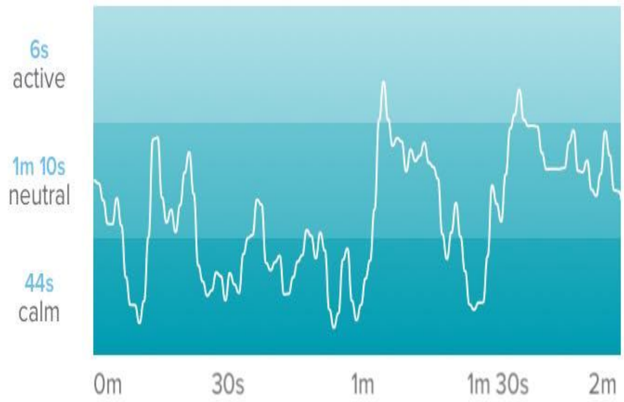
Analysis

Following graphs were plotted using the 21 session data recorded on the subject. As we can analyse from the graphs, with meditation training the calmness increases.

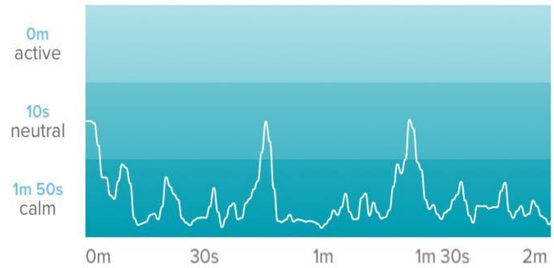
1st session



10th session



21st session



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