

Masennus- A Technical Approach to Effectively Treat Depression Based on Brain Stimulation

Medha Sharma¹, Niharika Agrawal², Divya Agrawal³

Abstract: Researchers are deliberately searching for what happens inside the brain of depressed patients. The best attempts were to get the evidences that brain signals shows changes on EEG, this leads to further studies on how these can be read and relaxed. According to the new studies [1], application of low level direct currents has shown significant changes in brain signals. There are many sensors available but practicality and speed considerations exclude most of the sensors in option to detect the brain signals. Our technical idea after much research and contemplation consists of a device which can be used as a head band. It will include tDCS circuit and BCI used for producing and detecting signals respectively. That band will be autonomous and will be attached with the user's cell phone through an application. We have deliberated about an electronic device which will work in four stages: Detection, Transmission, Feature Extraction and Stimulation.

I. Introduction

Depression is an illness that involves the body, mood, and thoughts that affects the way a person eats, sleeps, feels about him or herself and reflects about things. Depression is not synonymous to blue mood phenomenon but it may start with a blue mood, and when left undiagnosed can grows up to many major mental illnesses and can ultimately ends up with suicide. It is not a sign of personal weakness or a condition that can be charted away at one's own wish.

This has been major concern in countries outside India to diagnose depression as early as possible. But in our country, instead of taking steps to find a solution to this, associated symptoms are ignored for the fear of being entitled 'INSANE'.

So this has become our motivation to introduce solutions that will help people to understand and fight against depression on their own, and when its technically advanced, it will be accepted readily.

II. What Is Depression?

Depression is defined as a mental illness in which a person experiences deep, unshakable sadness and diminished interest in nearly all activities[2]. The illness can affect all people, regardless of sex, race, ethnicity, or socioeconomic standing. Women are two to three times more likely to suffer from depression than men. Most psychologists believe depression results from an interaction between stressful life events and a person's biological and psychological vulnerabilities [3].

Studies have shown that certain brain chemicals called neurotransmitters [4] play an important role in regulating moods and emotions. Neurotransmitters involved in depression include nor epinephrine, dopamine, and serotonin. An imbalance of hormones may also play a role in depression. If depression goes untreated, it may cause psychotic episodes, severe damage to the brain and nervous system, and eventually death.

III. What Takes You Into Depression..??

Each type of depression is associated with different mixtures of causes. For psychotic or melancholic depression, physical and biological factors are relevant. In contrast, for non- melancholic depression, the role of personality and stressful life events are important.

IV. Brain Activity Under Depression

There are many neurotransmitters serving different purposes. However, three important ones that affect a person's mood are serotonin, noradrenalin and dopamine. In normal brain function, neurotransmitters interact with a series of nerve cells, with the signal being as strong in the second and subsequent cells as it was in the first. However, in people who are depressed, mood regulating neurotransmitters fail to function normally, so that the signal is either depleted or disrupted before passing to the next nerve cell. When EEG recordings were seen it showed changes in theta (5-7 Hz) and alpha (8-13 Hz) frequency bands. Resting alpha asymmetry determines one's risk for certain affective disorders, such as major depression and anxiety [5], while cortical theta activity is considered to serve as a gating function on information processing in the limbic region, particularly in anterior cingulate cortex (ACC).

V. Existing Solutions

There are many approaches available till date which include:

5.1 Medication:

Anti-anxiety drugs work on chemicals in the brain to affect the central nervous system. There are many different types of antidepressants. The group of drugs that are used the most are called selective serotonin re-uptake inhibitors (SSRIs).

5.2 Psychological Therapies:

In psychodynamic therapy the therapist uses the thoughts, images and feelings that pass through the person's mind, as well as their relationship with the person, to discover patterns that give clues about psychological conflicts of which the person is not aware. It also includes talk therapy.

VI. Their Side Effects

A study[6] says when you first begin antidepressant treatment, depression medication side effects can be physical symptoms like headache, joint pain, muscle aches, nausea, skin rashes, or diarrhea. These symptoms are usually mild and temporary.

Long-term use of anti-anxiety drugs can cause addiction, as well as withdrawal symptoms when the medication is stopped. There can also be a range of side-effects, including sleepiness, dizziness, headache, and in some cases, memory loss.

Other types of depression medication-related problems are sleep disturbances common with SSRIs including nightmares and sleepwalking[7].

6.1 Suicide:

It has been extensively studied that taking an SSRI or another antidepressant doubles the risk for suicidal thinking.

Other long term side effects include:

- Sexual Side Effects
- Migraine Headache
- Weight Gain
- Anti-social thinking

The psychological therapies are not instantaneously helpful it need a long term course which in turn gives a risk to face suicides before curing. So we need reliable solution which show results after few trials.

VII. Technical Solution

The technical solution proposed here basically includes extracting EEG signals and then producing some treatment to cure depression. To do the task first we need a device that can extract signals: The Electrodes. Next, that can read the extracted signals: the BCI, a computer based unit that can connect to our Smart phones. Then a device, which can produce counter signals. Since we need to add electrodes to this device and to make it more handy, a BAND like device will be better to use. Apparently the idea can be a projection of the available devices in the market like a device by NeuroSKy: MindSet (Figure 1) for a single channel[14] and for multi-channel control, EPOC device by Emotive Systems (Figure 2).[8] The BAND will include the electrode, the amplifiers, EEG circuit, and the counter signal producing circuit.[12]

While the Band will be all electronics circuitry, your smartphone will be doing the software controller. A user friendly, easy to use GUI will help the user to identify the level of depression and how to use the band to treat it.



Figure 1 Single Channel Device [8]



Figure 2 Multi-Channel Device [8]

7.1. How the Device Will Work

The device will work according to the following hierarchy.

1. **Detection:** The EEG signal will be recorded from scalp electrodes by a differential amplifier in order to increase the Signal to-Noise Ratio of the electrical signal that is attenuated by the skull. This signal is continuously sampled (typically 128 Hz - 512 Hz) to provide a high temporal resolution, making EEG an ideal method for capturing the rapid, millisecond-scale dynamics of brain information processing with a simple setup. For proper positioning, the Smartphone will provide directions to use device with the anode over the left dorso lateral prefrontal cortex, identified as pF3 on the international 10/20 EEG (electroencephalogram) system, and the cathode placed over the lateral aspect of the contra lateral orbit, at the F8 position (10/20 system).
2. **Transmission:** These signals will then be transferred to the filters and EEG circuits. After this the signals will be transmitted to the Smartphone. An Electroencephalogram based Brain-Computer-Interface (BCI)[8] provides a new non-muscular communication between a user and an external device by measuring the brain's activities.
3. **Feature Extraction:** Particular feature of brain waves have been found to differentiate neurocognitive states and to offer a rich feature space for studying neurological processes of both depressed and healthy users. The Smartphone will then process for feature extraction using an app (like one based on EEGLAB[9],[13]) and then command the device whether to produce the required signals for treatment or not.
4. **Stimulation:** The device will then produce a low level direct current to stimulate the brain whenever the command is received. Although the use of weak electrical currents to stimulate the brain has been described for centuries in the history of medicine, it has been reintroduced with higher intensity currents since 2000 as 'transcranial direct current stimulation' (tDCS).¹ It involves passing a weak, depolarising current through the brain. This shifts the resting membrane potential, with anodal stimulation depolarising the soma of pyramidal cells, whereas cathodal stimulation results in hyperpolarisation.² The effects of tDCS on neuronal excitability have now been demonstrated in numerous neuroimaging and physiological studies. Prior to 2000, early stimulation trials used relatively low current intensities (0.02–0.5 mA) with considerable variability in stimulation technique. As a result, outcomes were highly variable.^{3,4} Since then, the development of commercial equipment enabling the reliable delivery of currents in the 1–2mA range has led to renewed interest in tDCS in clinical research. Since 2000, three sham-controlled trials^[10] investigating the efficacy of tDCS for treating depression have reported encouraging results. These three trials were taken under different time periods: 1. tDCS given at 1mA, 20 min per session, 5 sessions on alternate days. 2. Given at 2mA, 20 min, 10 sessions on consecutive weekdays. 3. 1mA, 20 min, 5 sessions on alternate days followed by 5 further active treatments. All of the three found tDCS more effective and clinically meaningful improvement was seen with active tDCS over 10 sessions of treatment.

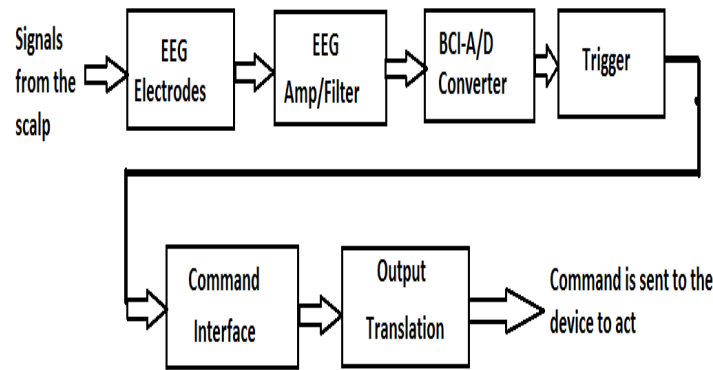


Figure 3 Block Diagram for the Device

VIII. Advantages Over Other Approaches

Cognitive Effects:

Tests for acute cognitive effects following the first tDCS session showed improvement. This finding suggests that tDCS may enhance acute attention and working memory in people with depression, in line with the acute attention-enhancing effects found following equivalent stimulation in individuals post-stroke. Neuropsychological tests after 3 weeks (15 sessions) of active tDCS did not show any changes in performance across multiple cognitive domains. These results demonstrate that multiple tDCS sessions are safe and not associated with any adverse cognitive outcomes. In the current study no improvement was found on these same measures after either 15 or 30 active tDCS sessions. This suggests that multiple tDCS sessions do not have cumulative cognitive enhancing effects independent of mood effects. Nonetheless, the use of more sensitive neurocognitive measures may help elucidate potential cognitive-enhancing effects of multiple tDCS treatments in future.

References

- [1] Neuroscience Research Australia(28/07/11), Lead researcher- DR. TOM WEIKERT, and University of New South Wales, Australia.
- [2] www.beyondblue.org.au
- [3] AUSTRALIAN BUREAU OF STATISTICS (2008) 2007 National Survey of Mental Health and Wellbeing: Summary of Results (4326.0). Canberra: ABS.
- [4] NATIONAL HEALTH AND MEDICAL RESEARCH COUNCIL (2000) POSTNATAL DEPRESSION: Not Just the Baby Blues. Canberra: Commonwealth of Australia
- [5] COAN AND ALLEN, 2004; Davidson, 2004
- [6] A study published in the journal 'CLINICAL THERAPEUTICS' about new patients consuming antidepressant.
- [7] A review of sleep disturbances in people taking SSRIs, published in the journal *Frontiers in Psychiatry*.
- [8] EMOTIVE SYSTEM. www.emotiv.com.
- [9] EEGLAB: <http://sccn.ucsd.edu/eeglab/>
- [10] (registered at www.clinicaltrials.gov: NCT00763230).
- [11] CAMPBELL, A., CHOUDHURY, T., HU, S., LU, H., MUKERJEE, M. K., RABBI, M., AND RAIZADA, D. NEUROPHONE: brain-mobile phone
- [12] Interface using a wireless EEG headset. In *Proceedings of the Second ACM SIGCOMM Workshop on Networking, Systems, and Applications on Mobile Handhelds (2010), MobiHeld '10*, pp. 3–8.
- [13] DELORME, A., AND MAKEIG, S. EEGLAB: An Open Source Toolbox For Analysis Of Single-Trial EEG Dynamics Including Independent Component Analysis. *Journal Of Neuroscience Methods* 134, 1(2004), 9–21.
- [14] NEUROSKY INC. www.neurosky.com. (last accessed: Feb. 11 2012).
- [15] VAN VLIET, M., MHL, C., REUDERINK, B., AND POEL, M. Guessing what's on your mind: Using the n400 in brain computer interfaces. vol. 6334. 2010, pp. 180–191. 10.1007/978-3-642-15314-3_17.
- [16] HOFFMANN, U., GARCIA, G., VESIN, J.-M., DISERENS, K., AND EBRAHIMI, T. A boosting approach to P300 detection with application to brain-computer interfaces. In *2nd International IEEE EMBS Conference on Neural Engineering (2005)*, pp. 97–100.