International Journal Of Public Mental Health And Neurosciences
ISSN: 2394-4668
(An Official publication of Sarvasumana Association)

Developing an Assessment Tool to Diagnose Depression by Investigating Speech Perception Patterns in Depressed Patients with The Help of Neuro-Imaging (EEG)

Sarah Ahamed
School of Cognitive Science, Department of Philosophy
Jadavpur University
Kolkata 700032, India
sarahahamed93@gmail.com

***Abstract*—One of the most common mood disorders is Depression which is also called as Clinical Depression or Major Depressive Disorder. According to Diagnostic and Statistical Manual - V, depression can have mainly five symptoms which include lack of interest in life, fatigue, a persistent feeling of sadness, weight loss or weight gain and recurrent suicide ideation. If the symptoms persist more than two weeks then with the help of clinical assessment, depression is diagnosed by a clinical practioner. The lifetime prevalence of Major Depressive Disorder is around 17% and has notable impact on overall quality of life, comorbid health conditions, risk of committing suicide, and utilization healthcare [1]. DSM (Diagnostic Statistical Manual of Mental Disorders - V) provides the guidelines to clinical practitioners for application of criteria to diagnose MDD (Major Depressive Disorder). Hit and Trial Method is applied with the first line of anti-depressants after a diagnosis of MDD. Initial Pharmacotherapeutic intervention works only for 50% of the patients [4]. Continued drug trials are required for months to the non-responding patients which may delay the recovery process to a great extent. Moreover, recent studies suggest cognitive deficits in depressed patients like attention level deficits, problems in executive function and working memory, task planning and problem solving. [3]. This paper aims to explore the cognitive aspect of speech perception in depressed people versus euthymic state in the normal population, as clinically depressed people have been reported to deviate from typical word usage. [6] Distinct linguistic patterns in depressed people can point towards devising a novel diagnostic marker which can further be validated by using Electroencephalography (EEG) Neuroimaging Techniques [2]. Machine learning algorithms can acquire neuroimaging data to distinguish the intensity of depression in the brain images of mildly depressed vs majorly depressed brains and predict outcomes efficiently [5].**

***Index Terms*—Depression, Speech Perception, Neurolinguistics, Neuroimaging, EEG, Neuroscience, Cognition, Machine Learning.** *(key words)*

INTRODUCTION

Depression affects more than 300 million people worldwide, as per World Health Organization data of 2017. An apparently normal functioning person may also suffer from depression silently which makes this disorder harder to detect and understand. Constant low mood often accompanied by physical symptoms such as weight gain or loss, impaired social relations are salient features of Major Depressive Disorder (MDD). Globally, MDD is the cause of more than 80,000 suicides annually and the most vulnerable age group is between 15-29 years, according to 2015 statistics. Around 30% of the depressed patients suffer from non-responsive anti-depressant treatment and life time prevalence rate for them is about 16.2%. Presently, the MDD diagnosis depends on patient's behavioral assessment based on personal reporting. In contrast to self-reporting, which might often be biased, distinct behavioral patterns especially in speech perception might help to detect depression in the behavioral plane. Furthermore, ongoing researches are aiming to pinpoint the precise neurobiological markers which might help in diagnosing this disorder with accuracy and ease. And for that Neuroimaging studies, especially EEG studies are gaining popularity for being non-invasive and repeatable with zero side effects on the patient's health. EEG provides precise clinically significant evidence that might help in individualization of therapeutic interventions. With the help of machine learning, neuroimaging data mining might help to develop potential (Linguistic) biomarkers for depression that might help to make the paradigm shift from DSM-V behavioral assessment to an evidence backed diagnosis of the disease.

DEFINITION OF DEPRESSION TRADITIONAL BEHAVIOURAL ASSESSMENT USED FOR DIAGNOSIS

According to American Psychiatric Association, depression is a serious mental illness. The exact reason behind this illness is yet unknown though the main factors contributing to the development of this disease is believed to be genetic, biochemical, environmental or personality factors. If within a span of two weeks continuously, any five of the following symptoms seem to be reported by an individual which doesn't match with the earlier state of the individual, clinicians classify the condition to be either (a) depressed mood or (b) loss of interest or pleasure.[10]

1. Subjectively reporting depressed mood every single day, for most of the days.
2. Reduced interest in day-to-day chores and hobbies
3. significant weight loss when not dieting or weight gain.
4. Changes in circadian sleep cycle: insomnia or hypersomnia almost every day, disturbed sleep cycle.
5. Restlessness or psychomotor retardation, sluggishness, both subjective report and as observed and reported by others.
6. Feeling of being drained or loss of energy almost every day.
7. Feelings of being inadequate and worthlessness, almost every day, misplaced guilt.
8. Reduction in the ability to think clearly, inattentiveness.
9. Suicide ideation and recurrent thought of death.

The symptoms cause clinically significant problems in social, occupational, and other important areas of life. Often these symptoms are caused due to underlying medical conditions such as hypothyroidism, or may be a result of sudden changes in life path, such as the pain caused by the loss of a loved one, or substance abuse and trauma. [9]

SPEECH PERCEPTION IN DEPRESSED PATIENTS

Apart from the behavioral assessment, linguistic parameters can be explored and can also help in diagnosis. Studies have previously shown clinical depression is characterized by atypical word usage. According to more recent studies, a distinct language pattern exists in patients with mild depression, major depressive disorder, and people with normal sadness and people in euthymic state in normal population. Linguistic marker can now be used as an additional diagnostic key to detect and differentiate between all of these different the cognitive states. A study involving hand coding procedure amongst 124 Russian Speakers with 77 Healthy Controls amongst which there was 35 cases of Normal Sadness was done and 402 written records were collected. The area upon which variations were measured were lexico-semantic and lexico-grammatical. In the semantic plane, rhetorical figures like similes and metaphors were observed. In the syntactic plane, single clause or multiclause sentence usage were noted as the predominant sentence type. Grammatical usage of indefinite or personal pronoun was also checked. The written accounts were then subjected to statistical analysis using Cohen's kappa for inter-rater reliability measures, a non-parametric approach (Mann–Whitney U-test and Pearson chi-square test), one-way ANOVA for between-group differences, Spearman's and point-biserial correlations to analyze relationships between linguistic and gender variables, discriminant analysis (Wilks' λ) of linguistic variables in relation to the affective diagnostic types, all using SPSS-22.

In mildly depressed patients, it was found that their responses took longer than people with normal sadness, their format of writing was more descriptive than analytic, the sentence word order were observed to be atypical. Single clause sentences were also observed to be dominant over multi clause sentences. Dominance of personal pronouns and use of paste tense or imperfect/continuous tense were also observed. People with normal sadness were observed to have repetitive sentences with usage of present continuous tense with respect to healthy controls. The experiment could successfully distinguish between mildly depressed and majorly depressed people from people suffering from normal sadness or healthy people in euthymic states. [6]

NEUROIMAGING STUDIES (EEG) TO VALIDATE CLINICAL DIAGNOSIS

After the discovery of Electroencephalogram by Hans Berger, scientists have used it as a leading tool to explore different functions in relation to the different areas of the brain, non-invasively. Brain disorders are difficult to diagnose due to the unavailability of neurological biomarkers and thus traditional evaluation still involves answering psychological questionnaires and self – reporting. According to Group et al, 2001, biomarker is defined as "a characteristic that is objectively measured and evaluated as an indication of normal biologic processes, pathogenic processes, or pharmacological responses to a therapeutic intervention" [11]. Keeping this in mind, scientist have worked to develop biomarkers using EEG to diagnose depression. Evoked potential or the specific potential that contextually correlates specific symptoms such as perception and emotional processing can be used as biomarkers to detect depression with accuracy. [13]. Further more machine learning can be applied to mine huge number of neurological data set and validate the distinction between the various cognitive states in related to depression such as major depressive disorder, mild depression, normal sadness and euthymic states. Usually, Deep Learning Neural Networks are used for this purpose. [12]

V. CONCLUSION

Self-reporting and psychological questionnaire based clinical evaluation has a high failure rate, thus paradigm shift has to happen for the accurate diagnosis of a mental disorder as complex as depression. A new pipeline needs to be developed which would combine evidence-based evaluation techniques along with neuroimaging data that can further be developed with the help of machine learning techniques to distinctly and accurately diagnose depression. Very recently, language has been used as a probe to explore the intra and inter hemispheric networks as well. EEG study confirms frontal asymmetry in resting state and hypofrontality in depressed people. Language establishes link between the hemispheres and asymmetry along the language plane in EEG studies further helps to develop language based diagnostic probes. [14]

Author and Affiliations

Sarah Ahamed, M.Sc. Neuroscience (University of Calcutta), M.Phil. Cognitive Science (Jadavpur University, Kolkata)

Mailing Address: Kadambari Apartment, Flat 7F, Block - 2, 144 Mohiary Road, Jagacha, Howrah 711112, West Bengal, India Email: sarahahamed93@gmail.com
Phone Number: 7003021257

ACKNOWLEDGMENT

I thank my supervisor Dr. Amrita Basu, PhD Jawaharlal Nehru University), Director of School of Cognitive Science, Jadavpur University, Kolkata to provide me the kind opportunity to work under her capable guidance on the topic of developing an assessment tool to diagnose depression by investigating speech perception patterns in depressed patients with the help of neuro-imaging (EEG).

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