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Application of Machine Learning Algorithms for the detection of brain tumours in images acquired through Magnetic Resonance Imaging

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Abstract

The absence of biological markers makes it exceptionally difficult for neurologists to diagnose a person with a mental disorder. Currently, diagnosis of mental disorders is based on behavioral observations and patient-reported symptoms and the Diagnostic and Statistical Manual of Mental Disorders (DSM) classification.

Although there have been studies that implement imaging techniques for deciphering the etiology and the physical cause of several mental disorders, the findings from brain imaging do not appear amongst the diagnostic criteria. This essentially means that neuroimaging is not widely accepted in the process of psychiatric diagnosis. The primary reason for this is reverse fallacy.

Nonetheless, a defiant minority now have started to implement neuroimaging techniques such as fMRI, SPECT, PET for the diagnosis psychiatric disorders, however, there are no solid molecular or imaging basis that are widely accepted for the assessment of mental disorders.

Here in the proposed research we will be *assessing* MR images of 35 subjects who, are suffering or have suffered, from one major depressive disorder and *making an attempt* at arriving to a comprehensive conclusion about how the "limbic brain network" of patients suffering from Major Depressive Disorder compare to that of healthy individuals who share similar socio-demographic parameters as the subjects.

1 Introduction

Major Depressive Disorder is one of the most commonly diagnosed mental disorder in the entire world.

MDD has similarities with schizophrenia and bipolar disorder.

diagnosis based on symptoms and behavioral observations.

2 Problem Statement

2.1 Need For An Imaging Basis

The diagnosis procedures that are the gold standard for diagnosis of psychiatric disorders are wholly based on behavioral observations and patient reported symptoms. There are two most widely established symptoms that are used to classify these manifestations, one is the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the other is International Classification for Diseases (ICD).

Despite each being as widely used as the other, both of these diagnosis manuals are more like frameworks provide a way of classifying a psychiatric disorder depending on patterns of behaviour rather than interpreting the etiology and the physical cause of those disorders.

This statement alone raises an argument that "although reliable, current diagnostic procedures in psychiatry are not entirely valid".

Let us take an example of the diagnostic procedure involved in the diagnosis of Major Depressive Disorder. The DSM-V, published in 2013, is the most up-to-date manual and is based upon the work of expert study groups and makes use of large sets of data. According to the DSM-V, for a person to be classified as "suffering from Major Depressive Disorder", *he/she must report with either depressed mood or anhedonia (inability to feel pleasure in normally pleasurable activities) along with four out of eight additional symptoms.*

This makes it totally possible for 2 distinct individuals who do not share a single symptom in common and yet receive treatment (or medication) for MDD.

Furthermore, the current diagnostic procedures such as the DSM-V are not entirely bulletproof. For example, impulsivity, emotional lability (the property of changing rapidly), and difficulty with concentration each occurs in more than one disorder.

Now, the fact that,

1. Different exemplars of the same category can share no symptoms and
2. The exemplars of two different categories may share common symptoms

raises questions about the validity of the current diagnostic procedures in psychiatry. Therefore, an imaging basis is necessary for the diagnosis of mental disorders.

WHY IMAGING WON'T WORK?

There exists thousands of published research studies using functional neuroimaging methods such as SPECT, PET, and fMRI.

Findings from brain imaging do not appear amongst the diagnostic criteria. aside from its use to rule out potential physical causes of a patient's condition, for example a brain tumor, neuroimaging is not used in the process of psychiatric diagnosis.

Why has diagnostic neuroimaging not yet found a place in psychiatric practice? Sensitivity, specificity and standardization in psychiatric brain imaging.

- Diagnosis must be made for individuals and not groups - meta-analyses of neuroimaging studies has yet to reveal patterns of neural activity that are unique to specific mental disorder

Sensitivity

Imaging studies are generally not highly sensitive to the difference between illness and health

Specificity:

Most psychiatric imaging studies involve subjects from only two categories- patients from a single diagnostic category and people without any psychiatric diagnosis (healthy individuals), the most that can be learned from such a study is how brain activation in those with a particular disorder differs from brain activation in those without a disorder.

This raises a dilemma for the diagnosing clinician, as the question is not "does this person have disorder X or is she healthy? " but "does this patient have disorder X,Y,Z or is she healthy?" because the pattern of images that distinguishes patients with disorder X from healthy people may not be unique to X but shared with a whole alphabet of other disorders.

For example, Amygdala ko example

- (more sophisticated) methods of image analysis may hold promise discerning the underlying differences among the many disorders that feature similar regional abnormalities !??

- "statistical approach" to image analysis makes it possible to discover, spatial and temporal patterns that correspond to performance of specific tasks and specific diagnoses. Such statistical methods have only been begun to be applied to clinical disorders but show promise for increasing the "specificity" of brain imaging markers for mental illness.

near-term and long-term prospects of neuroimaging? and what obstacles block the use of such methods? Answer to the 2nd: The nature of imaging studies and of psychiatric diagnosis.

Standardization

Standardization is relevant in the sense that protocols for imaging studies differ from study to study, particularly amongst functional imaging studies.

The results of psychiatric imaging research are often summarized by stating that certain regions are under or over active or more or less functionally connected.

Findings on the patterns of activation acquired in studies of psychiatric patients depends strongly on the task being performed by the subjects and the statistical comparisons made by the researcher afterwards. Such findings are pretty much incomplete unless they include the information about what task evoked the activation in question: whether the patient wa resting, processing an emotional stimuli, resisting emotional stimuli or engaged in some other task?

Therefore the fact that imaging study's conclusions are relative to the tasks performed adds further complexity to the problem of consistently discriminating patterns of activation of healthy and ill subjects.

3 Review of Literature

Implementation of fMR-imaging techniques to research the core aspects of structural and functional brain alterations in patients suffering from MDD.

Past work seems like structural MRI and fMRI look promising for providing excellent and reliable indexes for the aid in the diagnosis and ultimately treatment of MDD

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