Differences in the resting-state functional brain networks of patients with major depressive disorder and bipolar disorder

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***Abstract*—In this work, we analyzed the functional connectivity between different groups of subjects. The groups included patients with major depressive disorder, and patients with bipolar depression that were obtained during experimental research. The data that had been subjected to preprocessing procedures were employed in order to identify the functional connectivity between the brain regions that displayed significant variations.**

***Index Terms*—fMRI; functional analysis; brain networks; connectivity; mutual information; bipolar depression; major depressive disorder;**

I. Introduction

Mental disorders have been established as significant contributors to the global burden of disease, accounting for 4.9% of the total years that are burdened with disability [5]. Among the illnesses that significantly contribute to this problem are major depressive disorder (MDD) and bipolar disorder (BD) [6]. Furthermore, these diagnoses have a relatively high frequency in children and adolescents, which can impede their development and, as a result, harm their overall mental health in adulthood [7]. From a practical standpoint, the prompt differentiation of MDD and BD is imperative not just in terms of the treatment of these disorders but also with regard to their predictions, with the intention of preventing relapses and disabilities. Additionally, both the first presentation of MDD and BD often occurs as a depressive episode, rendering them highly similar in their initial stages. Furthermore, there exist no reliable biomarkers for the differentiation between the two illnesses. These factors result in numerous iatrogenic complications, in particular, the prevalent risk of a hypomanic or manic episode in bipolar patients when they are prescribed antidepressants.

Within the recent research, it has been established that the increase in regional blood flow within the brain (BOLD effect) can be considered a viable marker for the activity of neurons [1]–[4]. Functional magnetic resonance imaging is typically considered an appropriate instrument for detecting areas of effectual brain activity. Furthermore, fMRI is commonly regarded as a suitable technique for the creation of spatial maps of activated neural groups [9], [10]. There are a number of works [11]–[15] in which the diagnosis of nervous diseases was carried out using network features of the organisation of functional brain networks, which were identified using both graph theory methods and various machine learning methods. The objective of this study was to examine the variations in functional connectivity throughout the brain between people suffering from MDD and BD based on the statistical approach using connectivity matrices.

II. Design of thr experiment

The experimental data was obtained from 37 patients with major depressive disorder, and 34 patients with bipolar depression. The experimental data was obtained from 97 healthy volunteers and 72 patients with major depressive disorder. In order to take part in the study, the following criteria were required to be met: aged between 18 and 65 years; the absence of metal implants and similar; no presence of other psychiatric conditions (addictions, anxiety and simi-

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lar); and no occurrence of severe neurological pathologies or a concussions. Patientsṕsychiatric histories were also taken into consideration for purposes of determining the inclusion criteria. Every subject provided written informed consent in accordance with the Declaration of Helsinki. (Ethics Comittee approval P-369 of 29.05.2015).

3 Tesla magnetic resonance imaging system (GE Discovery 750) was used for the magnetic resonance imaging procedure. The process involved using a structural scan of big resolution as part of the imaging protocol. The thickness of a slice was 1 millimeter, matrix 256 squared, time of relaxation 7.2 milliseconds, Time of reflection 2.3, angle of flip 12 degrees, and resting-state volume — two dimentional stack with width about 3 millimeters, matrix 64 squared, repeat time 2 thousand milliseconds, reflection time 30 milliseconds, number of images 36, straight angle, a total of 192 volumes. Before the procedure commences, the subjects are given the instruction to remain in a state of tranquility. They were instructed to keep their eyes closed, as well to avoid engaging in any particular thoughts or thought processes.

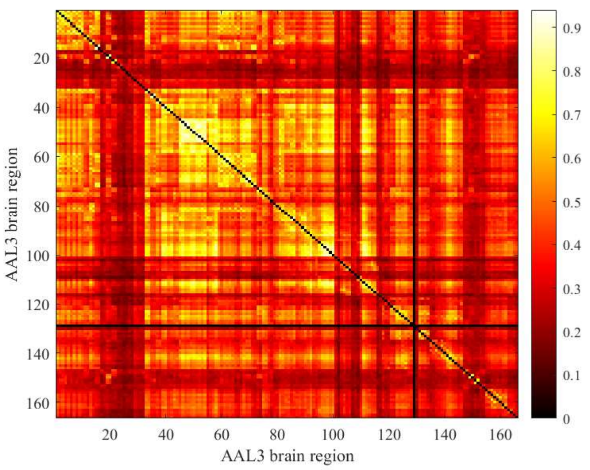

Fig. 1. Interconnectivity table for the parcellations of BD patients based on the Pearson method

III. Methods

The analysis of the MRI images was performed the same way as described in our previous work [16] with Anatomical Atlas Labels 3 [17] regions of the volumed and aligned with the initial high-quality image. We proceeded to calculate the average activity levels throug the regions for every subject. After that, we obtained cross-correlation tables for each averaged area activities. Averaged connection table for the patients with bipolar depression can be seen in the Fig. 1. To assess the presence of significant variations among the connectivity tables for the groups (MDD and BD), the FDR method with a significance p=0.025 together with 100 thousands permutations were employed [18], [19].

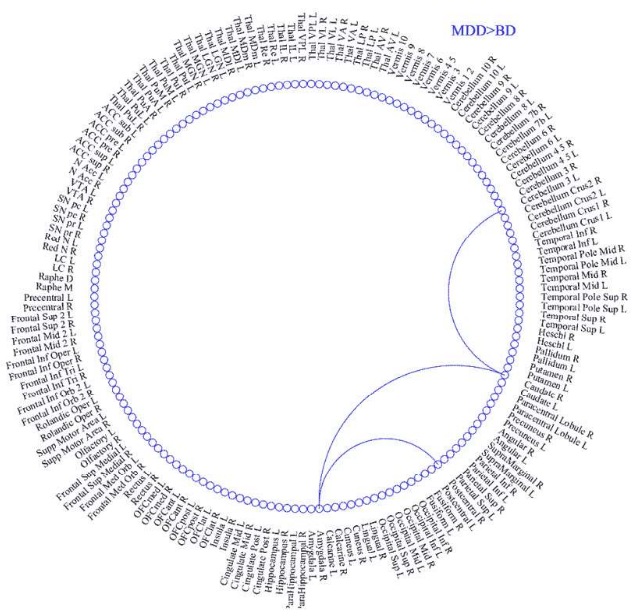

Fig. 2. The significant connection changes between patients with the major depressive disorder and bipolar depression

IV. Results

Among the results, only connections of significance were considered and displayed in the following graphical connectogram (Fig. 2). We discovered that the most significant changes in functional network connectivity include connections: Cerebellum 3L — Caudate R, which seems to be typical; Caudate R — Amygdala R; Amygdala R — Postcentral R that associates with typical biomarkers [21], [22].

V. Conclusion

It was shown that the significant connections found with the false discovery rate method with the help of the correaltion connectivity approach are only prevail in the direction MDD>BD. However no significant connections were found for the opposite direction BD>MDD. We hope our results will be useful for further development of diagnostic measures to objectively differentiate bipolar depression from major major depressive disorder.

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