Classification of Patients with Mild Depression and Healthy Controls Using Nodal Brain Network Topology

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The potential to use functional brain network topology in classification of patients with mild depression and healthy subjects using machine learning is poorly studied. The resting-state fMRI data of 51 patients with mild depression and 21 healthy controls were used in the current study. The data were pre-processed using the GRETNA toolkit. Each brain was parcellated into 90 anatomical regions. Functional brain networks were constructed using Pearson correlation. Then nodal level functional brain network metrics such as betweenness centrality, degree centrality, nodal clustering coefficient, nodal efficiency, nodal local efficiency, and nodal shortest path were computed using a graph theory-based approach for a series of network sparsity thresholds. The area under the curve value of each node was used as features (90 features in total for each subject) in subsequent multivariate pattern analysis (MVPA). The MVPA was performed using the MVPANI toolbox combined with LibSVM's implementation of a linear support vector machine. The classification performances were assessed using a leave-two-subjects-out cross-validation procedure. Classification accuracies were obtained for the six different topological metrics separately and for the combination of significant nodal metrics (concatenating features from different measures). The MVPA results showed that information from three out of six different nodal network metrics could significantly distinguish patients with mild depression and healthy controls (nodal clustering coefficient: accuracy =79.41%, $p<0.001$; Nodal efficiency: accuracy =79.41%, $p<0.001$, nodal local efficiency: accuracy = 79.41%, $p<0.001$). Further, when combining these metrics together, we observed an improved classification accuracy (85.29%, $p<0.001$), indicating the fusion of different network measures may serve as a better neuroimaging marker for an objective depression diagnosis.

Keywords: *brain network topology, depression, resting-state fMRI, multivariate pattern analysis*