Findings: IBMB has developed a customized EEG header consisting of 60 elements, including subject demographics, and data technical information, which covers data syntactic, semantic, and pragmatic aspects. This metadata combined with EEG is organized into three main hierarchical levels of Study, Session, and Task, corresponding to the same levels of physical EEG storage.

Conclusion: We introduced a new EEG data structure hierarchy and file content with embedded header information. This data structure encompasses all the information needed for reporting and analyzing EEG; thus, it can facilitate EEG data reuse, as well as large-scale analysis. We propose this approach for archiving EEG datasets in research-oriented EEG repositories.

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Prediction of General Intelligence Using DTI Data

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Abstract

Background: Intelligence can be defined as the capability of a person to purposeful performance, logical thinking, and effective interaction with the environment. What we study as intelligence is a collection of talents, such as memory, accuracy, learning, and perception, which are different in different individuals.

Objectives: Using diffusion tensor imaging (DTI) data, we studied relationships between mean fractional anisotropy (FA) in brain structural pathways and full-scale general intelligence (FSIQ) scores.

Methods: The structural connectivity matrix for the whole brain was estimated using 116 regions defined by the AAL atlas. The superiority of this study to others was that the ROIs covered the whole brain and each node represented a small region of the brain; thus, the related connections would be more specific. We identified connections and features that played key roles in FSIQ. Besides, FSIQ was predicted using four regression techniques and the results were compared. The dataset consisted of the data of 29 subjects (15 males and 14 females), with the age range of 18 - 28 years, and the mean age of 25.10 years, recorded in our national brain mapping lab (NBML), Tehran, Iran. All the subjects were healthy, without any brain damage. In addition, none of them had a history of mental illness, brain surgery, or brain-damaging disease. All DTI data were processed using Explore-DTI software to perform eddy current correction and motion correction. Then, all images were registered to the AAL atlas template with 116 nodes using the Explore-DTI software (version 4.8.6). For each subject, DTI-based tractography was done for the whole brain by a deterministic approach based on streamline algorithms. FSIQ was measured using the WAIS-III test. This score was calculated by assessing cognitive abilities such as verbal reasoning, attention to verbal principles, fluid reasoning, spatial processing, and visual stimulations. The dataset mean (standard deviation) of the FSIQ scores was 96.93 (± 10.24). To identify the most important connections for FSIQ prediction, we performed a linear regression between each variable and the FSIQ scores. The significant variables were selected as the connections related to the FSIQ scores. To remove collinearity among variables, a correlation analysis was performed and variables that had a high correlation with another variable ($r > 0.95$) were deleted. Moreover, to reduce the number of features, PCA was applied to the remaining connections. Then, four regression models including linear regression, a support vector regression, a convolutional neural network, and a multilayer perceptron were applied to the data to predict the intelligence scores. In this case, 48 connections were selected after applying correlation analysis and 14 features were the outcome of the PCA step. Highly connected nodes were in the prefrontal, cerebellum, parietal, and limbic regions. These regions may play a key role in human intelligence.

Results: After applying PCA, the SVR model with a linear kernel and a constant parameter of 10 was optimal for our dataset. It was utilized to predict FSIQ using leave-one-out cross-validation. The correlation between the predicted and measured intelligence scores was r = 0.72 (P = 9.03×10-6). It is noteworthy that the proposed model for predicting intelligence had a higher determination coefficient (R2 = 0.52) than previous methods. Moreover, previous methods widely used the functional MRI technique to extract features for predicting intelligence. In contrast, we used DTI data and mean FA of connections to predict intelligence and the results indicated that these data conveyed more information about intelligence.