FUNCTIONAL MEASURES IMPROVE SEPARATION OF MARIJUANA SMOKERS WITH COMORBID PSYCHIATRIC DISORDERS FROM HEALTHY CONTROLS AND MARIJUANA SMOKERS WITHOUT PSYCHIATRIC DISORDERS IN A THREE-GROUP LDA CLASSIFICATION

Piotr Bogorodzki[1], Melissa Lopez-Larson[2,3], Jadwiga Rogowska[4], and Deborah Yurgelun-Todd[2,3]

[1]Institute of Radioelectronics, Warsaw Technical University, Warsaw, Warsaw, Poland, [2]Psychiatry, University of Utah, Salt Lake City, UT, United States, [3]SLC VA MIRECC, Salt lake city, Utah, United States, [4]University of Utah, Salt Lake City, UTah, United States

Purpose: The objective of this study was to determine whether morphometric or BOLD fMRI features obtained from structural and functional MRI scans could discriminate between three groups of subjects including healthy controls (HC), marijuana using adolescents without comorbid psychiatric illness (MJ) and marijuana using adolescents with comorbid psychiatric diagnoses (MJP). Identification of accurate biomarkers for the early diagnosis of substance abuse is a critical concern for providing appropriate treatment. In addition, we evaluated the extent to which combined features improved classification accuracy.

Methods: Seventy-one subjects, including 36 HC (mean age 18 ± 2, females = 13) and a total of 35 marijuana-using adolescents (age 18 ± 1, females = 5) were included in this study. There were 24 MJ users and 11 MJP users. Structural (3D MPRAGE, TE/TR/TI = 3.38 /2000/1100 ms 1.0-mm isotropic voxel) and functional (GE EPI TE/TR 28/2000 ms 3 mm voxel, while performing 240s lasted blocked standard bilateral finger-tapping task) imaging was performed at the Utah Center for Advanced Imaging Research (UCAIR) using a 3T Siemens Trio scanner. The functional data were analyzed with standard SPM8 [1] processing pipeline and custom written routines in Matlab. For each subject, percent signal change (BOLD) was measured in 17 Automated Anatomical Labeling (AAL) regions of interest [2]. The morphological data were analyzed within the FreeSurfer image analysis environment [3] and cortical thickness (CT) measures from the Destrieux cortical atlas [4] and brain structure volumes based on the aparc atlas [5] were obtained. A linear discriminant analysis was performed on a set of features containing Volume, CT and BOLD measures for each ROI and each subject [6].

Results: Table 1 shows classification results for HC, MJ and MJP for 4 sets of features: Volume, CT, BOLD and combined BOLD with morphological data. Resulting miss-classification errors were: 29.6% for Volume, 31.0% for Thickness, 31% for BOLD, and 2.8% for the combined data.

Table 1. Classification results for three groups of subjects using a combination of functional and morphological features

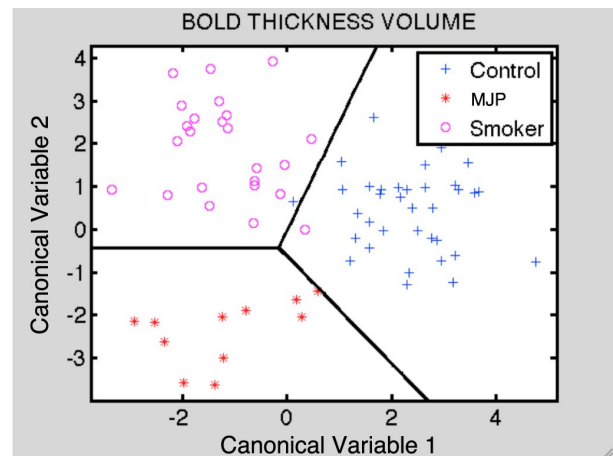| Accuracy of Classification of HC, MJ and MJP groups: number and % misclassification											
Volume			Cortical Thickness			BOLD			Combined		
HC	MJP	MJ	HC	MJP	MJ	HC	MJP	MJ	HC	MJP	MJ
5/36	7/11	9/24	7/36	5/11	10/24	7/36	8/11	7/24	1/36	0/11	1/24
13.8%	63.6%	37.5%	19.4%	45.5%	41.7%	19.4%	72.7%	29.2%	2.8%	0%	4.2%

Figure 1. A linear discriminant analysis canonical space for the combined feature set is shown in figure 2 showing almost perfect group separations corresponding to last column of table 1.

Conclusion

Our findings indicate that combination of morphological and functional features obtained in fMRI studies significantly improves classification accuracy and decreases diagnostic misclassification rate from 30% to 3%. These results also suggest that diagnostic biomarkers for adolescent substance abuse may be possible on the basis of a non-invasive MR protocol.

References

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[3] http://surfer.nmr.mgh.harvard.edu/
[4] http://surfer.nmr.mgh.harvard.edu/fswiki/CorticalParcellation
[5] http://surfer.nmr.mgh.harvard.edu/fswiki/SubcorticalSegmentation
[6] http://www.prtools.org