# Magnetic Resonance Imaging-Assisted Diagnosis of Major Depressive Disorder Using a Multiparameter Classification Approach based on Gray Matter Abnormality

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## Introduction

Support Vector Machine (SVM) is a promising analytical technique which allows the classification of individual observations into distinct groups or classes based on high-dimensional data [1]. For voxel-based image data, SVM takes inter-regional correlations into account and is therefore particularly suited to detect differences which are subtle and distributed [2]. So it provides a promising framework for investigating psychiatric disorders such as depression which are likely to affect a distributed network of regions. Past studies applied SVM to structural MRI scans had yielded promising results including predict response to antidepressant medications [3]. However, only volumetric information had been consideration in those past studies using SVM in MDD with structural images. In present study, we aimed to (1) use multiparameter classification approach to distinguish first-episode, drug-naïve MDD patients from normal controls based on complex and subtle structural pattern of gray matter anatomy; (2) explore whether these parameters equally contribute to differentiate individuals.

## Methods

Thirty-two first-episode, drug-naïve depressed patients and 32 healthy controls individually matched for age, sex, handedness and years of education were recruited in the present study (age range:18-60, female:male=23:9). High resolution 3-dimensional T1-weighted images were acquired on a 3.0T scanner (GE Signa, Milwaukee, USA) using the SPGR sequence. Image processing was performed using the FreeSurfer (http://surfer.nmr.mgh.harvard.edu/) software, which uses automated surface reconstruction, transformation and high-resolution inter-subject alignment procedures to accurately and rapidly measure the morphometric parameter based on surface data of the entire cortex [4]. Seven morphometric parameters including volumetric and geometric features (Table 1) at each spatial location on the cortical surface were calculated for each depressed patients and controls and used for pattern classification analysis with Probid software (http://www.brainmap.co.uk/probid.htm). This software takes a support vector machine analytical method to find a spatially distributed pattern of regions with maximal classification weights and discriminates patients from controls using leave-one-out cross-validation.

## Results

Classification accuracies as well as sensitivity and specificity for each classifier of combined left and right morphometric parameters are listed in Table 1. Overall, the sensitivity and specificity of all the combined morphometric parameters were 68.75%, and 62.52% respectively, and the cortical thickness provided highest and above chance prediction accuracies for the first-episode, treatment naïve MDD patients (accuracy=71.88%, $p<0.001$) (Table 1, Fig 1).

## Conclusions

Our results confirm that multiple cortical features were affected in the first-episode, treatment-naïve MDD patients and the cortical thickness measurement showed the highest accuracy in revealing group differences, which might be useful for detecting early MDD. Given confounds such as heterogeneity or chronicity of patients and medication effects, both of which will influence the structure of MDD, our result may not be generalized to evaluate other MDD populations with different clinical profile. Further longitudinal studies on the same patient cohort or multicenter studies with different type of patients may help to build a more generalized pattern for diagnosis and evaluation of MDD.

| Morphometric parameters | Sensitivity (%) | Specificity (%) | Accuracy (%) | p-value |
|---|---|---|---|---|
| Cortical Thickness | 65.63 | 78.13 | 71.88 | 0.001* |
| Volume | 53.13 | 62.50 | 57.81 | 0.114 |
| Curvature | 56.25 | 68.75 | 62.50 | 0.034 |
| Sulcal depth | 65.63 | 65.63 | 65.63 | 0.005* |
| Pial area | 65.63 | 71.88 | 68.75 | 0.003* |
| Area | 65.63 | 62.50 | 64.06 | 0.017 |
| Jacobian metric distortion | 62.50 | 68.75 | 65.63 | 0.013 |
| All combined parameters | 68.75 | 62.50 | 65.63 | 0.007* |

**Table 1.** Results of SVM classification between first-episode, drug-naïve MDD patients and control group using different brain morphometric features

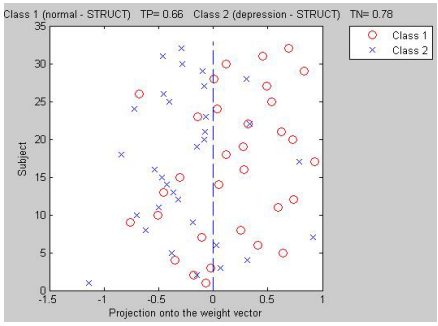


**Fig 1.** The classification plots for cortical thickness.

## References

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