Role of Radiomic Texture Analysis in Identification of True Functional MRI Activity

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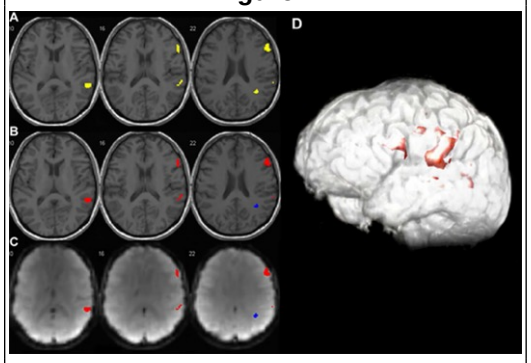
Introduction

FMRI maps commonly show multiple areas of false positive activity. We aimed to identify areas of true fMRI activation by using complex MRI texture analysis (TA) of raw EPI data, thus enhancing the identification of true activity.

Figure 1



A) fMRI activation maps overlaid on 3D-SPGR to delineate anatomy and show exact location of brain activity. (B) fMRI activity areas classified into E and NE based on their anatomical locations and reports from DCS data in literature. Blue areas represent non-expected fMRI activation within subgyral white matter, while red areas are within the expected activation area of language eloquent cortex. (C) fMR activity map overlaid on raw EPI data. (D) 3D view on fMRI activity map

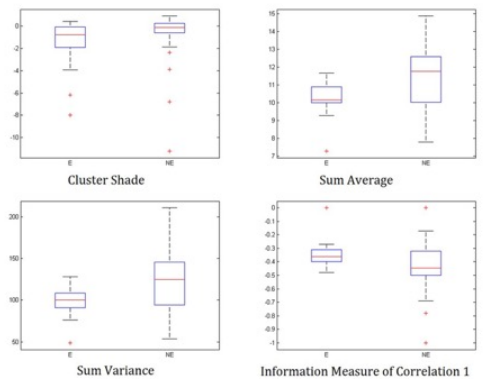
Methods

12 right-handed healthy volunteers were recruited (IRB approved). All scans were performed on a 3.0T GE MR scanner. FMRI consisted of a high resolution 3D T1-weighted structural scan and a gradient-echo EPI functional scan. FMRI data analysis was performed using SPM8 software for a sentence completion block design task. T-map for each individual was displayed using xjview toolbox and thresholded individually to optimize visualization of language area. Each activity cluster was selected and saved. Board-certified neuroradiologists and neuroscientists classified different clusters into two separate groups Expected (E) and Non-Expected (NE) based on their anatomical locations. TA was performed using the mean EPI volume for each individual, and 20 invariant texture features were obtained. Efficacy of TA in fMRI was assessed by decision tree and validated using a 4-fold cross validation.

Results

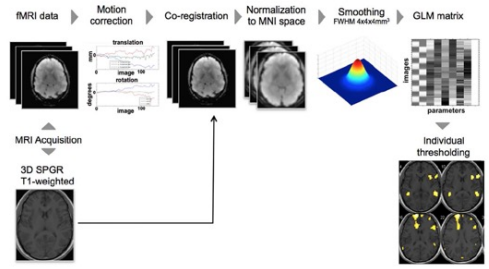
fMRI areas of activity in individual scans were identified based on their texture features with 95.3% accuracy, sensitivity 95.3% and specificity 95.3%. Sum of Variance, Cluster shade, sum of average and information measure of correlation were the most important texture features. These features had higher texture values in the NE ROIs indicating more homogeneous areas. Texture features were able to significantly differentiate areas of true versus false activity.

Figure 2



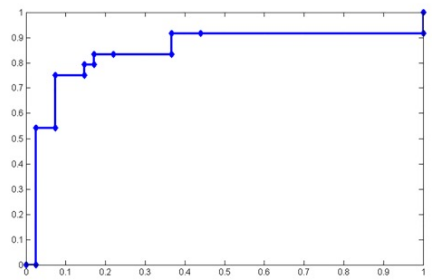
Boxplot representing the most significant invariant texture feature value differences between expected (E) and Non-Expected (NE) ROIs. This sows that NE ROIs show higher texture feature values which indicates a more homogenous area as compared to E ROIs.

Figure 3



Pipeline of fMRI preprocessing

Figure 4



ROC of 4 fold cross valiation of the decision tree

Conclusions

Extracted features indicated that true activity has more heterogeneous texture compared to non-expected activity. Quantitative TA of functional MRI using texture feature can enhance the accuracy and sensitivity of the test to true activity and help eliminate false activation.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of defining true functional MRI activity, 2) Discuss, in small groups the clinical impact of true and false functional activity 3) Identify an effective treatment approach respecting the presented results.