

Task based and resting state fMRI for pre-surgical mapping of language function

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Introduction: Task based fMRI (tb-fMRI) has become a commonly used tool for assessing eloquent brain regions for pre-surgical planning, but it relies heavily on patient's cooperation and cognitive integrity. Resting state fMRI (rs-fMRI), a method that examines spontaneous brain fluctuations, may be used as an alternative when the patients have difficulty to comply with the instructions of tb-fMRI. Our goal was to obtain preliminary information on the potential of task free fMRI to detect language areas as compared to tb-fMRI. We examined both the similarity of group activation maps and the functional connectivity between classical language areas at individual level.

Methods: Imaging data was collected on a 3 Tesla GE MRI scanner (General Electric, Milwaukee WI USA). Three task based (Verb generation –VG, word generation from letters –WGL, and word generation from categories-WGC) and one resting state (RS) fMRI data sets were acquired in 8 patients referred for pre-surgical evaluation of language function. All language tasks were designed for patient use and were all presented visually, with each tests lasting 3.5 min. During the 5 min. long RS scan, the patients were asked to lie in the scanner with their eyes closed. Data was analyzed using FSL software and included typical pre-processing steps (motion correction, slice timing correction, non-brain signal removal). Task-based fMRI data sets were further analyzed using GLM to compute group activation maps. Two ROIs were anatomically defined in classical language areas in the left hemisphere (inferior frontal gyrus -LIFG and posterior superior temporal lobe -LSTL) using the probabilistic Harvard-Oxford cortical structural atlas available in FSL. The average time series from the LIFG ROI was used to further analyze the resting state data and obtain group maps showing the correlation between LIFG and the rest of the brain. At individual patient level, correlations coefficients (cc) between the average time series in the two ROIs were computed for each patient and each data set. Fisher's Z -transformation was applied to the set of correlations and further analyzed for effects of task in a repeated measures ANOVA. Functional connectivity between LIFG and LSTL for each language task was then compared to that for the RS data set to determine the similarity between RS data and task based fMRI at individual level.

Results: Group activation maps for the tb-fMRI ($Z > 2.3$, $p = 0.05$) and rs-fMRI ($Z > 4$, $p = 0.01$) are presented in Fig1. They demonstrate a high similarity of language networks when obtained using the two methods. The pattern for rs-fMRI is more bilateral than that of the tb-fMRI, due to known inter-hemispheric correlation of homologue brain areas. The results of the repeated measures ANOVA indicated that there was no significant effect of task (either language task or RS) on the correlation coefficients ($F(3,21) = 0.745$, $p = 0.537$). Direct comparisons between cc for each language task and those for the rs-fMRI set are presented in Fig.2 and again demonstrate high similarity between tb- and rs-fMRI data sets.

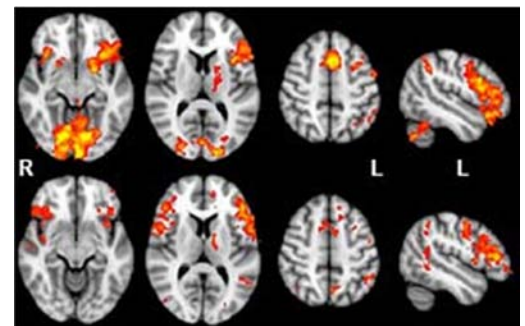


Fig1. Group language activation maps for the task (top) and RS (bottom) fMRI.

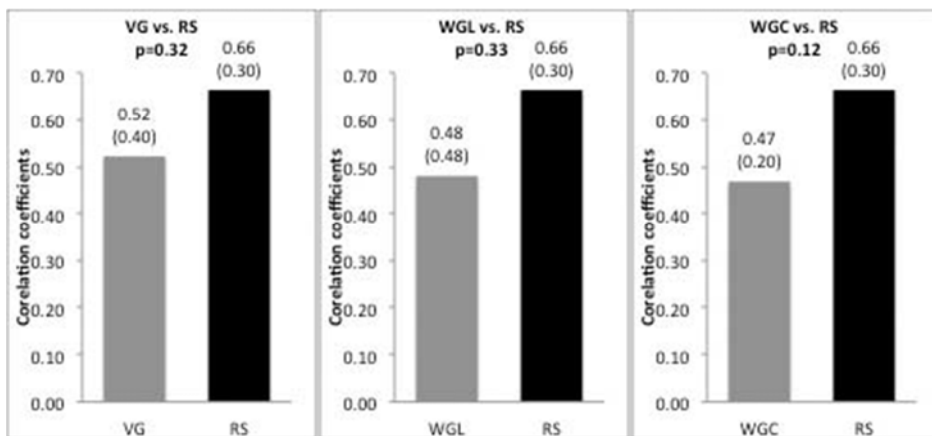


Fig2. Mean correlations between average time series in the LIFG and LSTL for each language task compared to RS.

Discussion: Similarity between group activation maps obtained for either tb-fMRI or rs-fMRI suggests that spontaneous brain fluctuations could be used to detect language networks in a group of patients. At individual level, correlations between classical language areas in the LIFG and LSTL were not significantly different between tb-fMRI and rs-fMRI, suggesting that the RS method could potentially be used to assess eloquent language areas when the patient is cognitively impaired and unable to comply with the tb-fMRI demands.