Spatial Consistency of Independent Components of Structured fMRI Noise

G. H. Turner[1], D. B. Twieg[2]
[1]Vanderbilt University Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States, [2]Biomedical Engineering, University of Alabama at Birmingham, Birmingham, AL, United States

Spatial correlations, which remain largely fixed over time, have been shown to be useful in generating structured noise filters for fMRI data. One of the drawbacks of such filters is that they are univariate and time-consuming. Such filters use spatial correlations established in a baseline period to generate a model of the noise in the experimental period[1]. A potentially better approach would be a multivariate approach that allowed large groups of correlations in the baseline period to be compared to groups in the experimental period. ICA has great potential for this type of filtering. If the spatial components remain consistent over time, then noise components during the fMRI protocol could be matched to similar components in the baseline period and removed. In this study, the spatial consistency of ICA components under fMRI baseline conditions was investigated by matching components via the correlation coefficient.

Methods

Four sets of baseline noise data were acquired from cross-sectional human brain images via a sinusoidal EPI sequence using the UAB/Bruker 4.1 T whole-body scanner (64X64, FOV=22X22X.5 cm, 600 reps, TR/TE 250 ms/38.5 ms for two sets, TR/TE 1s/38.5ms for two sets). Two additional sets of data with an effective TR of 2s were generated by taking every odd image in the 1s TR datasets. All images were reconstructed with in-house software and analysis was performed using Matlab (The Mathworks, Inc.).

Each dataset was broken into three segments and each segment was decomposed using Hyvrinen's fixed point ICA algorithm[2]. All components were scaled to z-scores without thresholding and correlations between z-maps of the first and third segment were calculated. The second segment was excluded so there would be a temporal separation between the datasets. The percentage of components that matched with a correlation coefficient greater than or equal to .5, .8, and .9 was calculated. Each dataset was decomposed using reductions of 20 and 50 components and the results were compared.

Results and Discussion

Figure 1 shows the results of the 20 component decomposition. In all datasets all components were matched with a cc of .5 or greater. At the cc $\geq$ .8 level a large percentage of the components matched. At cc $\geq$ .9 over half of the components still matched in all cases. Increasing the number of components to 50 still resulted in all components matching at a cc $\geq$ .5 level (Figure 2). However, at the cc $\geq$ .8 level the percentage of matching components is reduced and is reduced further at the cc $\geq$ .9 level. This is likely due to how the structured and random noise gets distributed among a larger number of components. For the purpose of component matching, a smaller number of components is preferable. While reducing the data to such a degree could obscure small activations, for fMRI data spatial ICA is an overdetermined problem. For the datasets in this study, 99.8% of the variance was maintained in a 20 component decomposition. Data reductions in the range of 15-20 components have been used effectively in previous fMRI studies [3,4]. Human studies were made under an institutional-review-board-approved protocol.

Conclusion

Spatial consistency of independent components of fMRI baseline noise was investigated. Smaller decompositions were found to produce a higher percentage of components that match at a higher correlation (cc $\geq$ .8). These results support the idea that matching to a set of baseline components has the potential for filtering structured noise in fMRI data.

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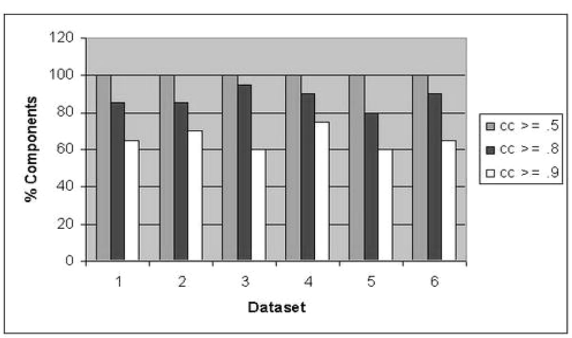

Figure1 : Percentage of components matched for a 20 component decomposition

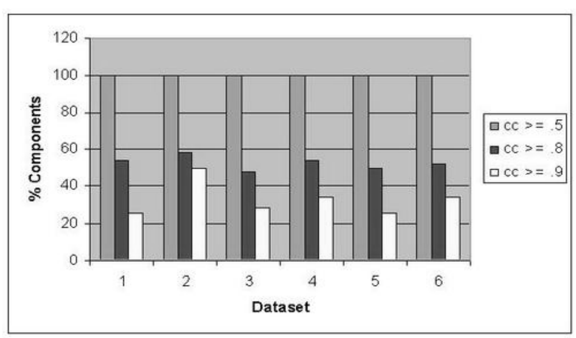

Figure 2: Percentage of components matched for a 50 component decomposition