Modeling subject movement in fMRI

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Objective: FMRI data suffer from considerable movement-related variance, even after spatial realignment has been applied. This variance will cause loss of statistical power, and may cause bias if movement is related to the experimental paradigm. One approach to adjusting for these effects is to add some function of the estimated movement parameters (MPs) as covariates to the statistical analysis. There is limited evidence from real data as to what function of MPs to use. Here I report the results of applying different functions of MPs to a typical dataset.

Methods:
The analysis used data from a visual event-related design reported previously (ref 1). The visual events produced reliable activation in visual cortex. There were 11 subjects, 7 scan runs per subject, 126 scans per run, TR 2 seconds. Each scan run was analyzed using three different models: 1) simple model, no MPs; 2) MPs model, using 6 MPs only (translations, rotations); 3) spin-history model (ref 2) - MPs, MPs squared (MP2), MPs offset by one scan (MP+1), MP2 offset by one (MP2+1) - giving 24 design columns. Each model also included 2 event regressors (ERs) - the event onsets convolved with a standard haemodynamic response and its temporal derivative. I used F tests to assess variance explained by a) ERs b) MPs c) MP2 d) MP+1 e) MP2+1. To restrict focus to an area of activation, for each model and each each subject, one run was selected to define a visual ROI using the F test for the ERs. This run was not used for further analysis. The statistics below are for the mean signal from this ROI, for the remaining runs.

Results & Discussion:
The median F statistic within the visual cortex ROI, for the simple model, MP model and spin-history model were 26.4, 38.0 and 33.8 respectively. The median F statistic for the MPs was 6.4 and 4.5 for the MPs and spin-history model, which were significant ($p < 0.05$) in 88% and 79% of the analyses respectively. The remaining F values (% significant) for the spin history model were 1.7 (55), 1.4 (27) and 1.3 (21) for MP2, MP+1 and MP2+1 respectively.

Conclusions:

The fact that the F value increased when adding the movement parameters to the simple model suggests that, for this dataset, the movement parameters were useful in increasing signal to noise. Adding simple movement parameters as covariates to the statistical model is likely to be a useful default for analysing FMRI data. The use of further functions of movement parameters is less convincing in this dataset.

References & Acknowledgements:

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