NeuroImage Human Brain Mapping 2002 Meeting

Order to appear: 467

Multivariate modeling of voluntary movements and behavior using Partial Least Squares

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Subject: Modeling & Analysis

Abstract
Introduction
Human brain mapping experiments provide quantitative electrical or hemodynamic data and, sometimes, behavior measurements associated with the experiment design. We report robust multivariate linear modeling approach to correlate behavior measurement and fMRI BOLD signal. This modeling technique derives from Partial Least Squares (McIntosh et al., 1996) and it provides fast computation and multiple comparisons, which corresponds to various orders of basis functions in the modeling. The results of parametrically designed motor fMRI experiments reveal loci exhibiting sensitivity to rate of movement in models correlating finger flexion rates and BOLD contrast signals for dominant and non-dominant hands. Active brain areas are consistent with our previous study (Fa-Hsuan Lin, 2000). An optimally robust model is identified by minimizing model residuals as well as cross validation cost for various orders of the basis function. Statistical model inferences suggest rate dependent models for both hands with estimated model variations.

Methods
Data from a block-design finger flexion fMRI experiment involving 12 subjects were acquired and preprocessed. A detailed description of the experiment design was described in (Fa-Hsuan Lin, 2000). Finger tapping rate was also recorded as behavior measurement. Legendre bases normalized between 0 Hz and 3.5 Hz were adopted for robust multivariate modeling. The significant latent variables from Singular Value Decomposition of collapsed effect space from fMRI data and orthonormalized basis were used to identify brain loci responding to different models correlating finger tapping rate and fMRI signal. ¡§Leave-one-out¡¨ cross validation was used to select the optimal model when we varied the order of Legendre basis from 1 to 10.

Results
The most significant (first) latent variables from dominant (right) hand tapping and non-dominant (left) hand from multivariate modeling demonstrated the most activation of contra-lateral motor cortex as well as cerebellum and visual cortex, as depicted in Fig. 1. Visual areas are activated due to visual cues for