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Near infrared spectroscopy (NIRS)와 fMRI 의 동시 측정 분석을 위한 statistical parameter mapping 기술의 개발

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Near-infrared spectroscopy (NIRS) is a non-invasive method to measure brain activity associated with regional changes of hemoglobin concentration through the intact skull. Since optically measured hemoglobin signals strongly correlates with BOLD signal, simultaneous measurement using NIRS and fMRI promises a significant mutual enhancement of temporal and spatial resolutions. Even though there exists a powerful statistical parameter mapping tool for fMRI, similar public domain statistical tools are not available for NIRS to our knowledge.

In this paper, we describe our new public domain statistical toolbox called NIRS-SPM for the quantitative analysis of NIRS signals. Specifically, NIRS-SPM statistically analyzes the NIRS data using the general linear model (GLM) which partitions the observed response into components of interest, confounds and error.   The covariates for the GLM models are obtained using the analytic model of haemodynamic response and its derivatives with respect to delay and dispersion. In order to obtain a correct inference, the temporal correlation structure of the NIRS should be investigated. We have compared various algorithms for error covariance estimate based on additional measurement of NIRS signal under null hypothesis.   Inferences are then pursued using t- or F- statistics.   For simultaneous recording NIRS signals with fMRI, the spatial mapping between fMRI image and real coordinate in 3-D digitizer should be estimated. We employ Horn's algorithm that gives a least-square solution for the absolute orientation. Furthermore, temporal filtering and detrending algorithms have been implemented using wavelet transform and minimum description length (MDL) principle. Our NIRS-SPM has been implemented as a MATLAB toolbox, and offers various computational tools from temporal filtering of NIRS data to visualization of statistic maps onto 3D rendered brain via a user-friendly interface with interactive tools. Combining the conventional statistical analysis software of fMRI data (SPM), our software makes it easy to analyze and compare the statistical results of NIRS and fMRI data.   Using NIRS-SPM, we successfully analyzed the finger tapping and verbal working memory experiment data. The results demonstrated that NIRS detection of neural activation is consistent with that obtained simultaneously using fMRI.