뇌신경재활

게시일시 및 장소 : 10 월 18 일(금) 13:15-18:00 Room G(3F)

질의응답 일시 및 장소 : 10 월 18 일(금) 15:45-16:30 Room G(3F)

P 2-36

Discriminating functional connectivity patterns during motor imagery and execution

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Introduction

Motor imagery activates similar brain areas to motor execution, lead to promising therapeutic strategy for rehabilitation (Mulder, 2007). Since brain works as a network, identifying motor-related functional network during motor imagery and execution is important. We choose the left primary motor cortex as a seed region and constructed seed-based functional connectivity during both conditions, and examined whether and where the connectivity patterns between motor imagery and execution were significantly different by using multivariate pattern analysis. First-person perspective visual (VI-1) and kinesthetic motor imageries (KI) were employed in this study.

Methods

Blocked-designed functional MR images (fMRI, 3T) were obtained from 18 individuals (30.3 ± 4.3 years, 9 males). Detailed experimental design was visualized on Fig 1. As a short, five conditions were given to the subjects in total of seven times, as counter-balanced order in 5 sessions. Before scanning, motor imagery training was given to the participants with duration of 15 minutes each. The fMRI data were preprocessed by Statistical Parametric Mapping 12. After individual analyses, group-level general linear model was performed to define the left primary motor area, by examining the contrast of motor execution (ME) and perceptual control conditions. The CONN functional connectivity toolbox (18.a) was used for seed-to-voxel connectivity analysis. Seed-to-voxel connectivity z-maps were created in every participant in every condition. Among the five conditions, we selected the VI-1, KI, and ME only for further analysis. To examine whether and where the connectivity patterns were different between conditions, the brain was segmented into 116 ROIs, using the Automated Anatomical Labeling template (Fig 2). The voxel-by-condition matrix was extracted from each individual, denoted by X. The loading for principal component of X was generated, and used for features of linear discriminant analysis with leave-one-sample-out cross validation. Linear discriminant analysis was used to discriminate the classes, in this case, the conditions (Fig 3). Statistical significance was tested using the binomial test with significance level alpha 0.05. This procedure was repeated 116 times to examine every ROI.

Results

There were six ROIs where the connectivity patterns between conditions were significantly different with each other; the right inferior frontal triangularis, anterior cingulate, cerebellum 6, cerebellum crus 1, left superior occipital gyrus, and median cingulate cortex.

Conclusions

The function of six ROIs we found was related with motor inhibition and imagery (Roland and Zilles, 1996; Aron et al., 2014; Cengiz and Boran, 2016), emphasizing importance of the connectivity patterns for discriminating motor imagery and execution.

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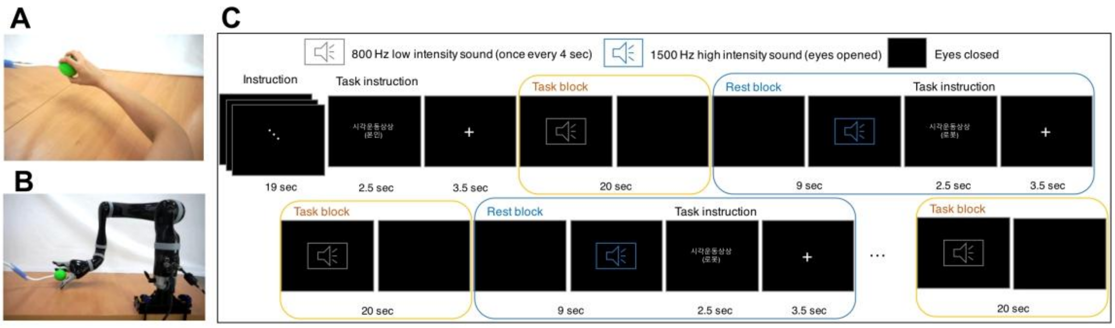

Fig 1. A session consisted of 7 task blocks, comprising 5 trials of grasping and releasing of the right hand in every 4 seconds. In a counterbalanced order, 5 task conditions were presented during 5 sessions. Each condition was presented 7 times as a block.

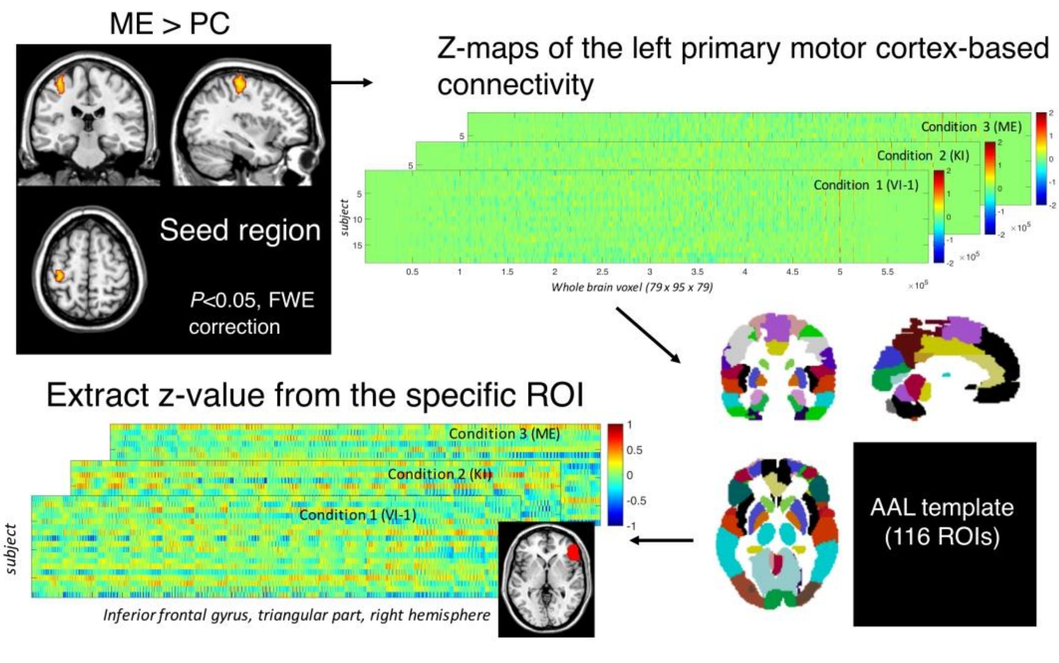

Fig. 2

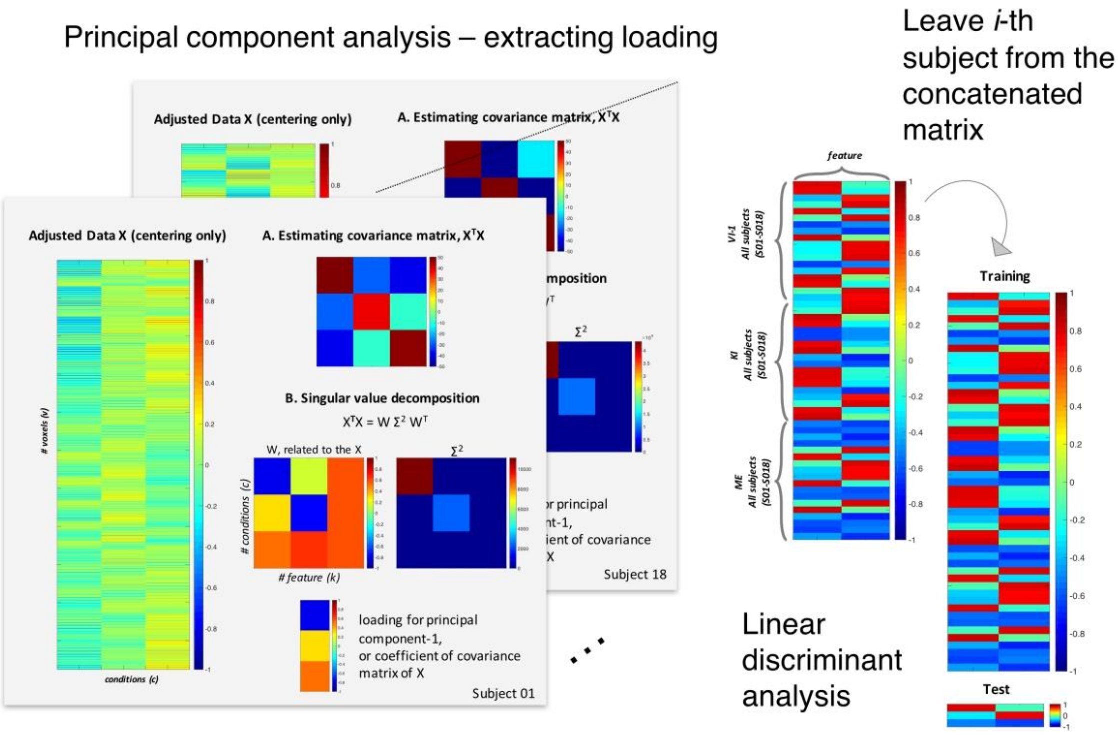
Principal component analysis – extracting loading
Adjusted Data X (centering only)
A. Estimating covariance matrix, X^T X
B. Singular value decomposition
X^T X = W Σ^2 W^T
W, related to the X
Σ^2
voxels (v)
conditions (c)
conditions (c)
feature (k)
loading for principal
component-1,
or coefficient of covariance
matrix of X
Subject 01
Subject 18
Leave i-th
subject from the
concatenated
matrix
feature
VI-1
All subjects
(S01-S018)
KI
All subjects
(S01-S018)
ME
All subjects
(S01-S018)
Training
Test
Linear
discriminant
analysis

Fig3.