

The Role of Prefrontal Lobe in FEP: Evidence from PPI Analysis

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Introduction The Fist-Edge-Palm (FEP) task refers to a widely used motor sequencing test, in which subjects are requested to successively place his/her hand in each of the postures: a fist resting vertically (fist), a palm resting vertically (edge), and a palm resting horizontally (palm). This task has been considered to be the typical Lurian task to detect a disorder of voluntary movement involving the frontal lobe region (1). Modifications of this task and other similar tasks of hand movements have been incorporated in standardized tests for frontal-executive functions (2). However, recent two imaging studies of FEP on healthy cohorts (3-4) both failed to observe any activation in prefrontal lobe except the motor related areas, which challenged the role of prefrontal lobe in FEP. We hypothesized that FEP would enhance the functional interaction between prefrontal cortex and motor cortex rather than directly increase the neural activity in prefrontal cortex, which would account for the inconsistency between neuroimaging and neuropsychological findings. The present study tested this hypothesis by using a psychophysiological interaction (PPI) analysis (5).

Methods Ten subjects (3 males, mean age 22.9 years) were scanned on a GE 1.5T Signa scanner with a standard EPI sequence (TR/TE=3000/60ms, FOV=24cm, Matrix=64x64, 12 slices, 7mm thk/2mm sp). Each subject performed three kinds of right hand manual motor tasks of different motor complexity: the simplest PT (palm tapping) task with a no motor resting condition as the control, the middle complexity motor task of palm pronation/supination (PS) with the PT task as the control, and the most complex FEP task with the PT task as the control. The left sensorimotor cortex activation clusters from the contrast of PT vs. Resting was defined as the reference area. Imaging data were analyzed by SPM5.

Results Consistent with our hypothesis, significantly enhanced functional connectivity with left sensorimotor cortex were found in two prefrontal regions, the right inferior frontal gyrus (GFi) and right middle frontal gyrus (GFm) for FEP than PS (Fig1 & Fig2a). However, the mean activation level (percentage signal changes) in these prefrontal regions showed no difference between the two tasks (Fig2b).

Conclusions The current study using PPI analysis in addition to the conventional GLM subtraction directly revealed the engagement of prefrontal cortex in FEP comparing to simpler motor tasks. These results suggest that the complexity of motor sequencing and coordination tasks does not directly modulate the neural activity of prefrontal lobe, but enhances the functional connectivity between prefrontal lobe and motor cortex.

References

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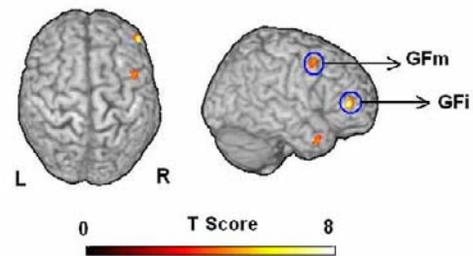


Fig1. Results from PPI analyses for FEP than PS.

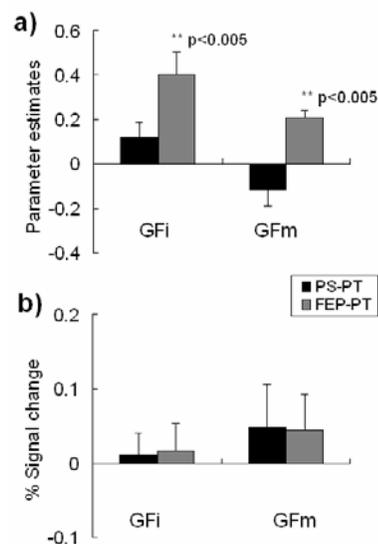


Fig2. (a) Mean functional connectivity, (b) Mean percentage signal changes in the prefrontal regions.