Neurofunctional Segregation of Observed and Mentally Imagined Human Body Movements

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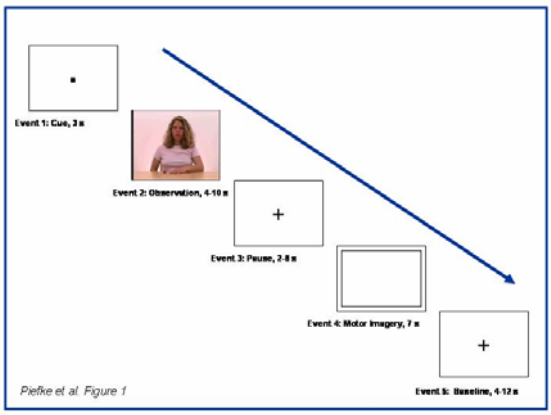
Introduction

The neural circuits underlying the cognitive processing of human body movements include areas of the extrastriate, parietal, and frontal cortices (Decety et al. 1994). The issue of whether there are regions which differentially respond to specific features of body movements and/or distinct kinds of motor cognition is still a matter of debate. The present study aimed at investigating the specificity of neural mechanisms underlying the observation and mental imagery of buccofacial and limb movements with or without object using event-related functional magnetic resonance imaging (fMRI).

Methods

Applying a 2 x 2 x 2 factorial event-related fMRI design, we assessed the neurofunctional modulation of movement processing in the brain by the factors ***body part*** (limb vs. face), ***object reference*** (with vs. without object), and ***task*** (observation vs. motor imagery) in 12 male healthy, right-handed subjects (mean age ± SD = 24.2 ± 3.5 years). Body movements were presented by video-clips (see *Fig 1*). For the group analysis, individual contrast images were entered into an ANOVA model (SPM2 software; random effects model). Behavioral data were acquired by inclusion of a reaction time task into the experiment and by the use of post-scanning questionnaires.



Results

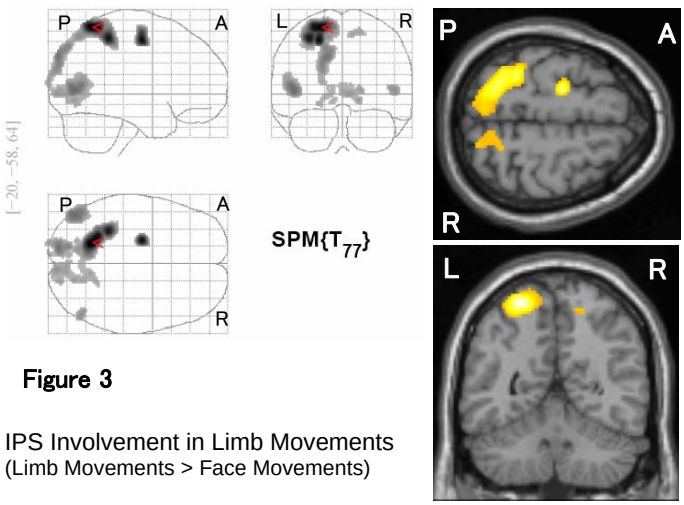


Figure 3

IPS Involvement in Limb Movements
(Limb Movements > Face Movements)

A neural network including extrastriate, parietal, and frontal regions was commonly activated during all experimental conditions *(Fig 2)*.

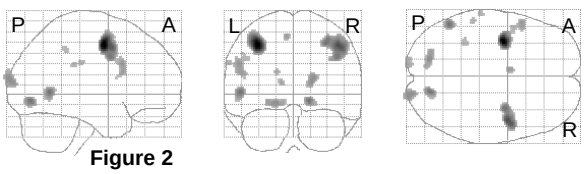


Figure 2

The EBA differentially responded during the observation conditions, the SMA was specifically involved in motor imagery. Face movements triggered the EBA to a lesser degree than limb movements. Area MIP of the intraparietal sulcus was selectively recruited by the processing of limb movements irrespective of whether these were object-related, or not (*Fig 3*).

Discussion and Conclusion

We conclude that regions of the extrastriate cortex (visuo-spatial motor cognition), the SMA and precuneus (mental imagery, self-control during imagery), regions of the middle frontal gyrus (motor inhibition during motor imagery), area MIP (cognitive processing of upper limb movements), area 5 of the somatosensory cortex (somatosensory integration of face movements), and the supramarginal gyrus (control of mirror neuron mechanisms) differentially interact during the cognitive processing of body movements according to the forms of motor cognition and movement features involved.

Reference: Decety et al. (1994) Nature 371: 600-602.

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