

SHIFTS IN CONTROL LOCUS DURING MOTOR SKILL ACQUISITION

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Introduction

The internal–external control hypothesis (Goldberg, 1985) for movement planning and execution suggests that for movements guided by external cues, cortical activation flows from the parietal cortex and cerebellum to pre–motor cortex, which activates the primary motor area. For movements generated internally (i.e., from memory), activation flows from the pre–frontal cortex and the sub–cortical basal ganglia to the SMA, which activates the primary motor area. It is also suggested that a shift from PMC–channelled to SMA–channelled primary motor activity takes place during the acquisition of novel motor skills. Using a unimanual, multi–digit sequence learning task, we tested this hypothesis, specifically to establish the temporal relationship between this control–locus shift and the behavioural learning curve.

Methods

Right–handed subjects learned a 10–item button–press sequence across four fingers of their right hand. The sequence was visually presented in 'learn' trials, but was recalled from memory in 'test' trials. There were three consecutive sessions: visual and motor baselines followed by the learning task which was continued longer than required to learn the sequence, allowing fluency to develop. A box car design with alternating 12s, REST/TASK conditions was used. Whole brain fMRI data with BOLD contrast (16, 64x64 matrix slices) were acquired using an EPI GE sequence on a 1.5T GE Signa system (TR=3s/TE=40ms). SPM99 was used to produce parametric maps for 4 intervals of the learn/test sessions to assess the change in regional activations over the course of learning.

Results

Activation in the internal–control areas developed over the course of training, in concordance with the behavioural performance curves (accuracy and inter–element latency). The timing of this activation shift suggests correspondence with the behaviourally identified intermediate phase of motor learning (Fitts, 1964), involving stabilisation and standardisation of the coordination pattern.

References

- Fitts, P. (1964). *Perceptual–motor skill learning*. In A.W. Melton (Ed.), *Categories of human learning* (pp.244–285). New York: Academic Press.
- Goldberg, G. (1985). *Supplementary motor area structure and function: Review and hypothesis*. *Behavioural and Brain Sciences*, 8, 567–616.