fMRI investigation of voluntary and involuntary motor activation in hypnotic paralysis

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Introduction: The neurobiological basis of nonorganic movement impairments is still unknown. As conversion disorder and hypnotic states share many characteristics, we applied an experimental design established in conversion disorder (1) to investigate hypnotic paralysis.

Methods: Movement imitation and observation were investigated by fMRI in nineteen healthy subjects with and without hypnotically induced paralysis of their left hand. Two sessions of experimental scanning were performed, one with subjects under hypnotic suggestion of a left arm paralysis, the other while subjects were awake.

In the hypnosis session, hypnotic induction was done before scanning, hypnotic depth was tested. Videos of 12 s duration of either a left or a right hand were presented, projected onto a screen at the rear end of the scanner. In 'control' condition, subjects had to watch a photo of a resting hand, in 'observe' condition they had to observe a hand opening and closing, and in 'imitate' condition they were instructed to imitate the motion with their identical hand, i.e. left or right. Six different blocks of stimulation resulted during hypnosis or non-hypnosis. Blocks were presented in fixed order and repeated in pseudo-randomized manner for each hand. The degree of hand movement was observed and rated.

fMRI data were acquired on a 3 T scanner (Gyroscan Intera, PMS) using a transmit/receive birdcage head coil with a single shot EPI sequence covering the whole brain (TE/TR/FA: 50 ms/3 s/90 deg., 36 transversal slices parallel to AC-PC, matrix 64 x 64, resulting in isotropic voxels of 3.6 mm edge length).

Paralysis-specific activation changes were explored in a multivariate model. To explore the interdependencies of brain regions influenced by hypnotic paralysis, an exploratory factor analysis was conducted. Data were processed using SPM5 (2). Parameter estimates for each block of stimulation (hypnosis condition, task, side) were generated voxelwise. Motion parameters from realignment were entered as additional regressors. Contrasts comparing the main effects were obtained by standard t-tests. The resulting contrast images were then used to evaluate the effect of factor 'hypnosis' and the interaction of the factors 'hypnosis' and 'side' (i.e. paralyzed vs. non-paralyzed) in each design.

Results and Discussion: Hypnotic paralysis during movement imitation induced hypoactivation of the contralateral sensorimotor cortex (SMC) and ipsilateral cerebellum, indicating a specific impact of hypnosis on executive control. Increased activation of anterior cingulated cortex (ACC), middle frontal gyrus (MFG), and insula did not correlate with activation of these motor areas and might reflect altered motor representation during hypnotic paralysis, but not active inhibition. Movement observation did not reveal paralysis-specific effects, suggesting that paralysis-specific neurobiological processes are bypassed by observation, such as movement initiation or the “will to move”.

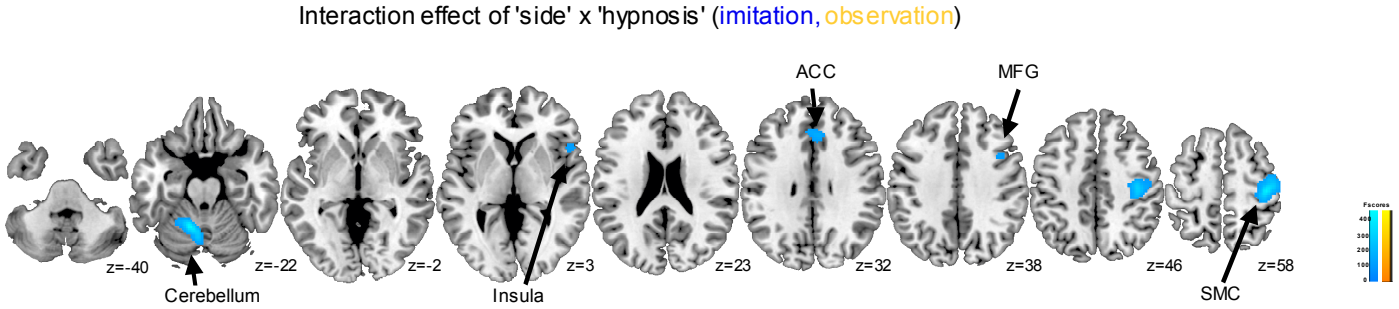

Fig 1. Interaction effect 'hypnosis' x 'side' during imitation only, drawn on single subject MNI template.

References: (1) Burgmer M et al., Neuroimage 2006; 29:1336-1343 (2) www.fil.ion.ucl.ac.uk/spm