The role of sleep in motor adaptation consolidation assessed by fMRI

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The aim of this study was to characterize the cerebral correlates of overnight procedural memory consolidation, using a motor adaptation task. The task, performed with a mouse in the scanner, consisted in reaching a target displayed on the screen. A 60° angular deviation was introduced in the trajectory of the mouse displayed on the screen. Subjects had to adapt their movement to the angular deviation to reach the target as fast as possible.

Thirty-one subjects were trained to the task then divided in two groups whether they slept (N=16) or were totally sleep-deprived (N=15) on the post-training night. Both groups were tested on the task 3 days later, allowing 2 recovery nights for the sleep-deprived subjects. Functional MRI data were acquired during both training and testing sessions (3T *Allegra MR scanner*, Siemens) and analysed using SPM2 (http://www.fil.ion.ucl.ac.uk).

Speed (time to reach the target) significantly increased in both groups during training ($p<0.0001$) and this effect did not differ between groups ($p>0.9$). A significant response to the practice of the adaptation task modulated by performance improvement was observed bilaterally in the ventral putamen.

Performance during retest in sleepers did not improve nor deteriorate but were maintained as compared to the end of training ($p = 0.15$). In contrast, performance in sleep deprived subjects significantly decreased (deterioration, $p = 0.006$) at retest as compared to the end of training and more than in sleepers ($p = 0.04$).

Cerebral responses to the adaptation task did not increase from training to retest sessions in sleepers as compared to sleep deprived subjects. In contrast, right intraparietal sulcus, bilateral cerebellum hemispheres, right superior frontal gyrus and anterior cingulate

cortex were more activated during retest as compared to training in sleep deprived subjects as compared to sleepers.

Our results suggest that post-training sleep leads to maintained motor skill performance at delayed retest session whereas performance were deteriorate after sleep deprivation. This deterioration was linked to the activation of a cerebello-cortical network in sleep deprived subjects as compared to sleepers. In the latter, cerebral responses did not increase but were maintained between sessions as compared to sleep deprived subjects. It suggests that sleep after training on a motor adaptation task would maintain the memory trace whereas sleep deprivation would hinder this process.

Key words: memory, sleep, motor adaptation, fMRI

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