GREY MATTER CHANGES AND MOTOR LEARNING OF MEANINGFUL AND MEANINGLESS ACTIONS: A TENSOR-BASED MORPHOMETRY STUDY

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Introduction

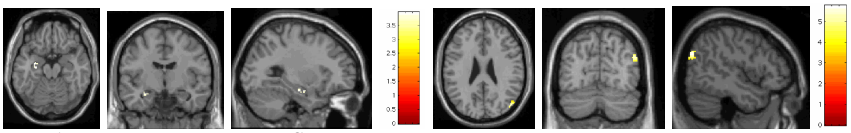
Learning of motor skills has been associated to changes of function and structures in adult healthy subjects (1-3). Recent cross-sectional voxel based morphometry studies have demonstrated learning-dependent changes in the adult human brain (4, 5). Aim of this study was to assess the longitudinal short- and medium-term structural brain grey matter (GM) changes associated with two different strategies of motor training in young healthy individuals.

Methods

Using a 3T scanner, the following sequences of the brain were obtained from 22 healthy subjects (M/F=8/14, mean age=22.5 years): a) dual-echo turbo spin echo (TSE) sequence (TR/TE=3500/24-120 msec; echo train length=5; flip angle=150°; matrix size=256 x256; FOV=240 mm^2; 44 contiguous, 3 mm-thick, axial sections) and b) 3D T1-weighted fast field echo (FFE) (TR/TE=25/4.6 msec; flip angle=30°; matrix size=256x256; FOV=230x230 mm^2; 220 contiguous, axial slices with voxel size=1x1x1 mm). All subjects performed a motor training for two weeks and brain MRI was obtained at three different time points: 1) before motor training; 2) at the end of the two weeks of training and, 3) three months later. During motor training, 11 subjects learned meaningful (MF) actions, and the other 11 meaningless (ML) actions. GM changes were assessed using tensor based morphometry (TBM) (6), as implemented in statistical parametric mapping (SPM2). A study-specific template was created from the images of healthy subjects at the different time points. To identify brain regions showing GM changes in both groups, a whole brain analysis, in which level of significance was set to $p<0.001$, uncorrected for multiple comparisons, was performed using an Ancova model, corrected for age and sex.

Results

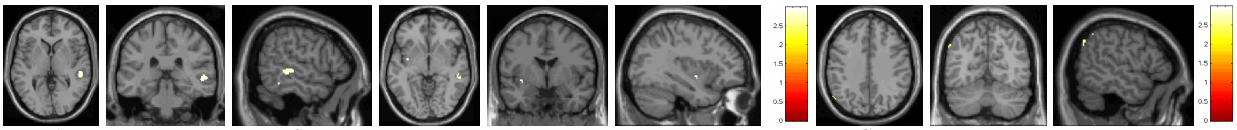
After motor training, compared to the ML group, the MF group had a significant GM volume increase in the left hippocampus (Figure 1). Conversely, compared to the MF group, the ML group showed a GM volume increase in the right inferior parietal lobe (Figure 1).



A B C D E F

Figure1. TBM results after motor training in MF and ML group. A-C, regions of significantly increased cortical GM volume in MF compared to the ML group. D-F, regions of significantly increased cortical GM volume in ML group compared to MF group.

After three months, compared to the ML group, the MF group had a significant GM volume increase in the right superior temporal sulcus and the left insula (Figure 2), while compared to the MF group, the ML group showed a GM volume increase in the left inferior parietal lobe (Figure 2).



A B C D E F G H I

Figure 2. TBM results after three months in MF and ML group. A- F, regions of significantly increased GM volume in MF compared to ML group. G-I, regions of significantly increased cortical GM volume in ML group compared to MF group.

Conclusions

The learning of MF and ML actions might result in structural GM changes in different brain areas which are part of specific neuronal networks (3-5). These findings might have important implications for the development of rehabilitation strategies in patients with neurological diseases.

References

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