Evaluation of therapy effects in patients with chronic spatial neglect using fMRI as a quantitative tool

J. Reinhardt[1], M. Wengenroth[1], G. Leifert-Fiebach[2], P. Schneider[1], M. Blatow[1], A. Welfringer[2], R. Babinsky[2], T. Brandt[2], and C. Stippich[1]

[1]Department of Neuroradiology, University of Heidelberg Medical School, Heidelberg, Baden Württemberg, Germany, [2]Kliniken Schmieder, Heidelberg, Germany

Background: Spatial neglect is a neurological condition which is usually caused by ischemic lesions in parietal association areas of the right hemisphere. Patients present with unawareness and disregard of the left side of body and space and may not move their left extremities, although their motor brain areas are normally intact. Therapy for chronic neglect is cumbersome and not routinely performed. In order to evaluate novel therapeutic approaches objective criteria for therapy effects complementary to clinical assessment are indispensable. We developed a functional MRI (fMRI) paradigm that allows for quantification of post-therapeutic changes on the neurobiological level.

Methods: Here we present preliminary fMRI data of eight patients (55.7 yrs; range 44-67 yrs) with chronic neglect (>6 months) who received novel motor imagery training. Within intensive daily sessions for four weeks patients were trained to imagine movements of their left arm and hand. Functional MRI was performed before and after the training period. We used an established block design paradigm with imagined hand movements separately for the affected and unaffected side (Stippich et al., Neuroscience Letters 2002). BOLD activations of motor areas were used to quantify therapy effects on a functional level.

Results: Patients reported subjective improvement after therapy and increased usage of the left hand within daily routine tasks. Pre therapy fMRI of the unaffected hand yielded expected motor activation patterns (Figure 1a) with equal activation levels of primary motor area (M1) and supplementary motor area (SMA) (Figure 2). The affected hand however showed decreased activation of M1, increased activation of the contra-lesional premotor area and normal activation of SMA (Figure 1b). Post therapy fMRI of both sides showed generally lower activation levels of all motor areas (Figure 1c,d), in particular down regulation of SMA (possibly indicating a general training effect). M1 and SMA of both sides demonstrated comparable activation patterns after therapy as a functional correlate of improved motor imagination.

Discussion: Employing fMRI as a quantitative tool, we were able to monitor therapy effects on a functional level. Future goals of the study include (i) analysis of long term neuroplasticity after 6 months of continuous training (ii) identification of particularly successful therapy responders and (iii) early detection of poor responders who require different therapy approaches.

Acknowledgements: This research was funded by the Dietmar Hopp Foundation. The authors would like to thank all patients for their participation in the study.

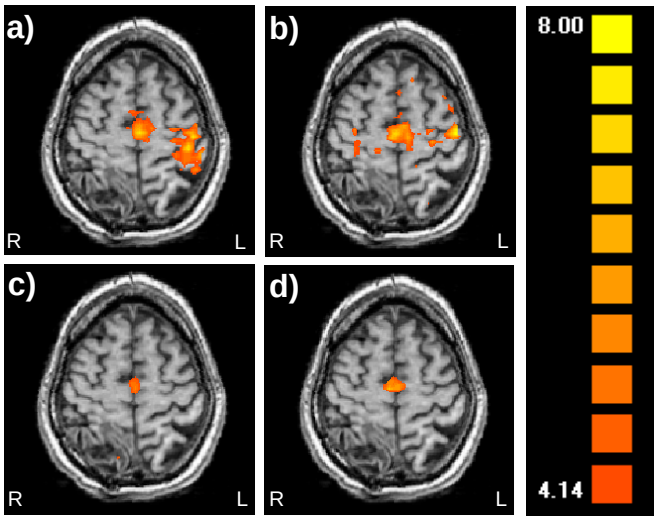

Figure 1. Group analysis of motor areas demonstrates functional training effects in neglect patients. Imagined movements of the right, unaffected hand prior to therapy shows normal activation patterns of M1 and SMA (a). The left, affected side demonstrates altered activation patterns (b). Subsequent to therapy, activation levels drop on both sides (c,d) resulting in dominant SMA activation (at a fixed threshold of qFDR< 0.001).

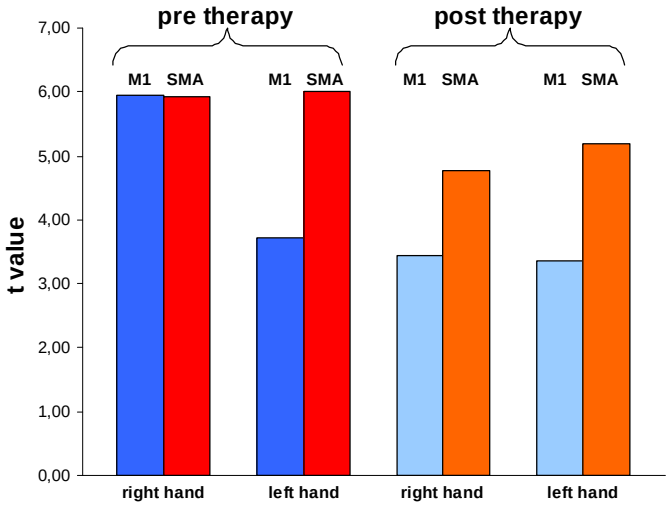

Figure 2. Comparison of motor area activations pre and post therapy. Before therapy M1 and SMA of the unaffected hemisphere show equal activation levels. In the affected hemisphere M1 activation is decreased, whereas SMA activation is normal. After therapy generally reduced activations of motor areas can be observed in both hemispheres, potentially indicating training effects. M1 and SMA of both sides demonstrate comparable activation patterns after therapy (at qFDR< 0.05).