Observation scale dependent variability in functional Magnetic Resonance Imaging (fMRI)

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Background

One fundamental goal of functional imaging studies is getting reliable and exact correlations between brain function and anatomically defined cortical areas like the motor or visual cortices. The reliability of such function-to-anatomy assignments depends to a large extent on their reproducibility when slightly altering parameters of data preprocessing within reasonable scales. Against this background, in our current study we investigated the influence of spatial smoothing of functional MRI (fMRI) data on the assignment of local maxima ("peaks") in fMRI activation maps to probabilistically defined anatomical areas (Eickhoff et al., 2005).

Methods

Blood Oxygenation Level Dependent (BOLD) signals were measured in 12 healthy subjects during a visuomotor task, using a 3 T scanner (Siemens, Trio). Anatomical assignments of the resulting activation maps were examined using smoothing filter widths from 3 to 14 mm.

Results

Our results indicate that altering filter width by only 1 mm might lead to changes in peak allocation in the primary sensory-motor cortex. In contrast to this, we retrieved reproducible results in the area of the primary and secondary visual cortex, the variability being less affected by filter width.

Conclusion

Different outcomes for visual and sensory-motor cortices could originate from more widespread average spatial extension of the visual areas. The main conclusion we draw is that for exact anatomical assignments of fMRI results to anatomically defined areas, the robustness of these assignments to variations in data preprocessing, especially regarding filter width, has to be evaluated and taken into account when interpreting results. Therefore, multi filter approaches are clearly recommended in order to ensure precise data analysis (Poline et al., 1994b; Worsley et al., 1996).

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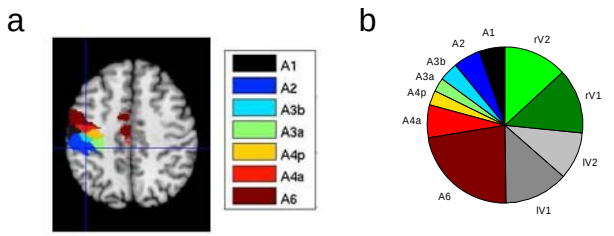

Fig. 1 (a) Defined areas of the Maximum Probability Map (MPM) of Eickhoff et al (1) depicting the sensory-motor cortex (SMC). This map allows assignment of functional data to anatomical areas based on the anatomical post mortem analysis of several individual brains. **(b)** Relative volumes of SMC areas and left and right primary and secondary visual cortex. The MPM permits subdivision of small subregions, for instance A3b and A3a. These smaller areas are affected to a higher extent by smoothing with different filter widths (see below). Assignments within larger areas like A6 or visual areas are more resistant against effects of differential smoothing.

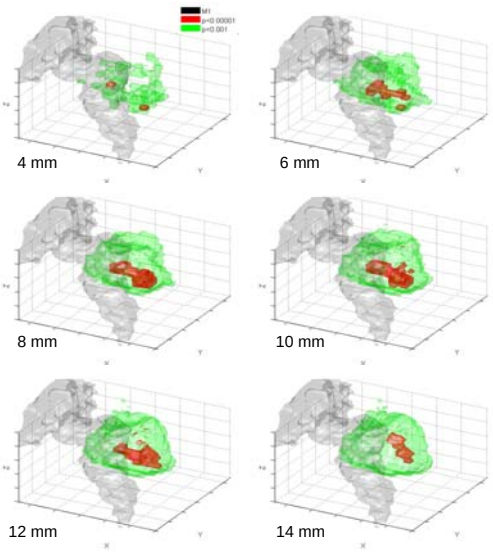

Fig. 2 Active volume within the SMC as a function of differentially smoothed group results. As an orientation, the primary motor cortex (M1) is shown in grey. Volumes are depicted with two significance thresholds (green: p<0.001, red: p<0.00001). Both volumes accumulate with increasing spatial smoothing. The green volume grows continuously as filter width increases and remains stable regarding its position. The red volume only increases in size up to a filter width of 10 mm and starts decreasing beyond that value. In addition, the red volume gradually moves to the postcentral SMK region.

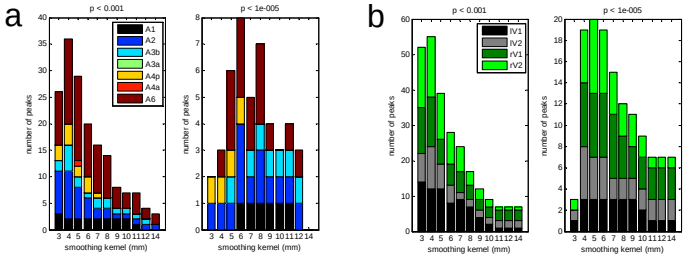

Fig. 3 The activation maxima ("peaks") of two different significance thresholds were assigned anatomically using MPMs. The number of peaks along with their respective assignment as a function of smoothing filter width ("smoothing kernel") are shown. **(a)** Regions of the sensory-motor cortex. At lower significance threshold (left), a difference in filter width by 1 mm (e.g. from 7 mm to 8 mm) determines if activity of the primary motor cortex is observed or not. Variability at the higher threshold value (right) is even higher. **(b)** Left and right primary and secondary visual cortex. Smoothing kernel-dependent variability of peak assignment to the single regions is less pronounced.

References

(1) Eickhoff, S.B. *et al.* (2005), Neuroimage vol. 25, no. 4, pp. 1325-35.

(2) Poline, J.B. *et al.* (1994b), Journal of Cerebral Blood Flow & Metabolism vol. 14, no. 4, pp. 639-642.

(3) Worsley, K.J. *et al.* (1996), Human Brain Mapping vol. 4, no. 1, pp. 74-90.