Linking retinotopic fMRI mapping and anatomical probability maps of human occipital areas V1 and V2

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[3]Neurologische Klinik, Universitätsklinikum der RWTH Aachen, Germany; [4]Arbeitsbereich Psychologie, Max Planck Institut für Kognitions- und Neurowissenschaften, München, Germany; [5]C. & O. Vogt - Hirnforschungsinstitut, Heinrich-Heine-Universität Düsseldorf, Germany

Introduction It has been known for long that the cytoarchitectonic organization of the human visual cortex is associated with functional organization. **We here compare retinotopic fMRI mapping and anatomical probability maps** derived from post-mortem studies of cytoarchitecture to establish whether or not the two methods lead to converging results. To allow for a comparison, 3D-probability maps for occipital areas V1 and V2 were created from functional data and compared to cytoarchitectonically defined probability maps of V1 and V2.

Methods

❖ 12 subjects, fMRI and T1-weighted measurement on Siemens Sonata 1.5T-scaner

❖ standard periodic retinotopic stimuli [1]:
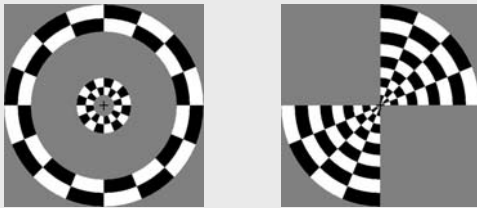
❖ preprocessing in spm99 including normalization to ICBM 152 brain

❖ calculation of **3D-fieldmaps** according to [2]

❖ creation of probability maps of areas with positive (V1) and negative (V2) field sign as mean images

❖ **comparison to anatomical probability maps of BA17 and BA18** from cytoarchitectonic analyses of post-mortem brains [3]

❖ **statistical test** using a-priori measure κ [4]:

$$\kappa = 1- NE(\mathrm{H}1)/NE(\mathrm{H}0),\ \text{with}$$

$NE(\mathrm{H}1)$ = number of errors under H1 and $NE(\mathrm{H}0)$ = number of errors under H0, where H1 = 'a voxel is only in V1 if it is also in BA17' and H0 = 'a voxel being in V1 or BA17 is independent' or equivalently for V2 and BA18

(κ = 1 means that a brain region can only be in the functionally defined retinotopic area if it is also in the anatomically defined one. κ = 0 means that being in the functionally defined area and the anatomically defined could equally be independent)
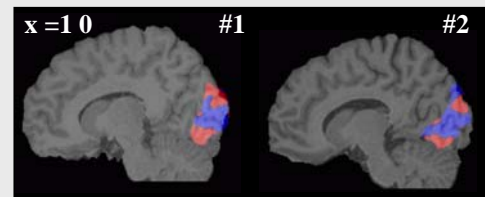

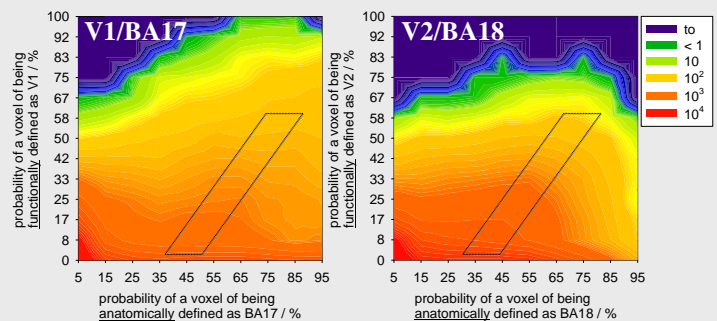*Fig.1: examples of field sign maps (blue = +1, red = -1)*

Fig.2: correlation plot of functional and anatomical data (voxel numbers on logarithmic scale)

Results V1: maximum probability found functionally was 92 % in an (overlap-)volume of 104 mm[3] with centres of gravity in the right hemisphere (RH) at 10, -80, 0 and in the left hemisphere (LH) at –8, –82, –1.
Corresponding anatomical map BA17: the respective coordinates were 15, –82, –1 (RH) and –10, –84, –2 (LH).
V1 and BA17: **κ = 0.99**.

V2: peak probability of 67 % in 196 mm[3] with centres of gravity at 11, –95, 15 (RH) and –13, –97, 10 (LH)
Corresponding anatomical map BA18: 16, –85, 1 (RH), and –10, –89, 0 (LH)
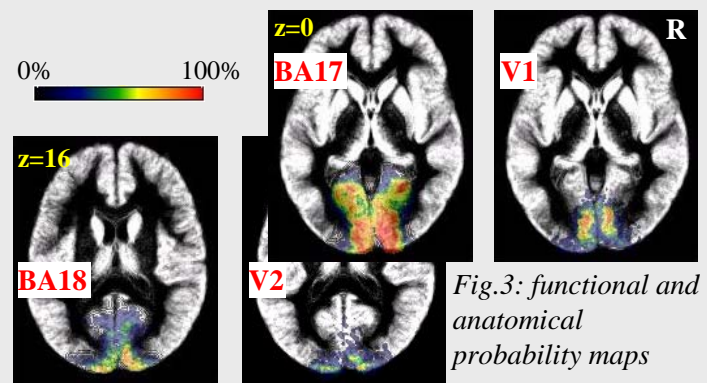V2 and BA18: **κ = 0.76**.

Fig.3: functional and anatomical probability maps

Discussion Comparison of functionally derived probability maps of V1 and V2 with cytoarchitectonically derived anatomical probability maps shows a **good spatial agreement**. Observed discrepancies are likely to reflect restrictions in the maximum angle of visual stimulation during the functional measurements and inter-subject variability.

[1] Engel et al. (1997) Cereb. Cortex 7:181-192.
[2] Dumoulin et al. (2003) NeuroImage 18:576-587.
[3] Amunts et al. (2000) NeuroImage 11:66-84.
[4] Cohen J (1960) Educational and Psychological measurement 20:37-46.