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Population receptive field coverage provided by different retinotopic stimuli in healthy subjects

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Introduction

Population receptive field (pRF) mapping, a variant of retinotopic mapping, has been performed with both healthy subjects and patient populations. Different stimulus approaches can be used to elicit visual cortex responses during fMRI measurements and reveal underlying retinotopic maps. Although the maps obtained in pRF scans have been shown to be stable over multiple runs (van Dijk, J.A. 2016), these retinal cortex representations regularly show decreased pRF coverage in some parts of the visual field, even in healthy subjects without any visual deficits. Here, our aim was to compare inhomogeneities of pRF coverage maps based on different visual stimuli and to assess options for mitigating these issues by combining estimated pRF model fits across stimulus types.

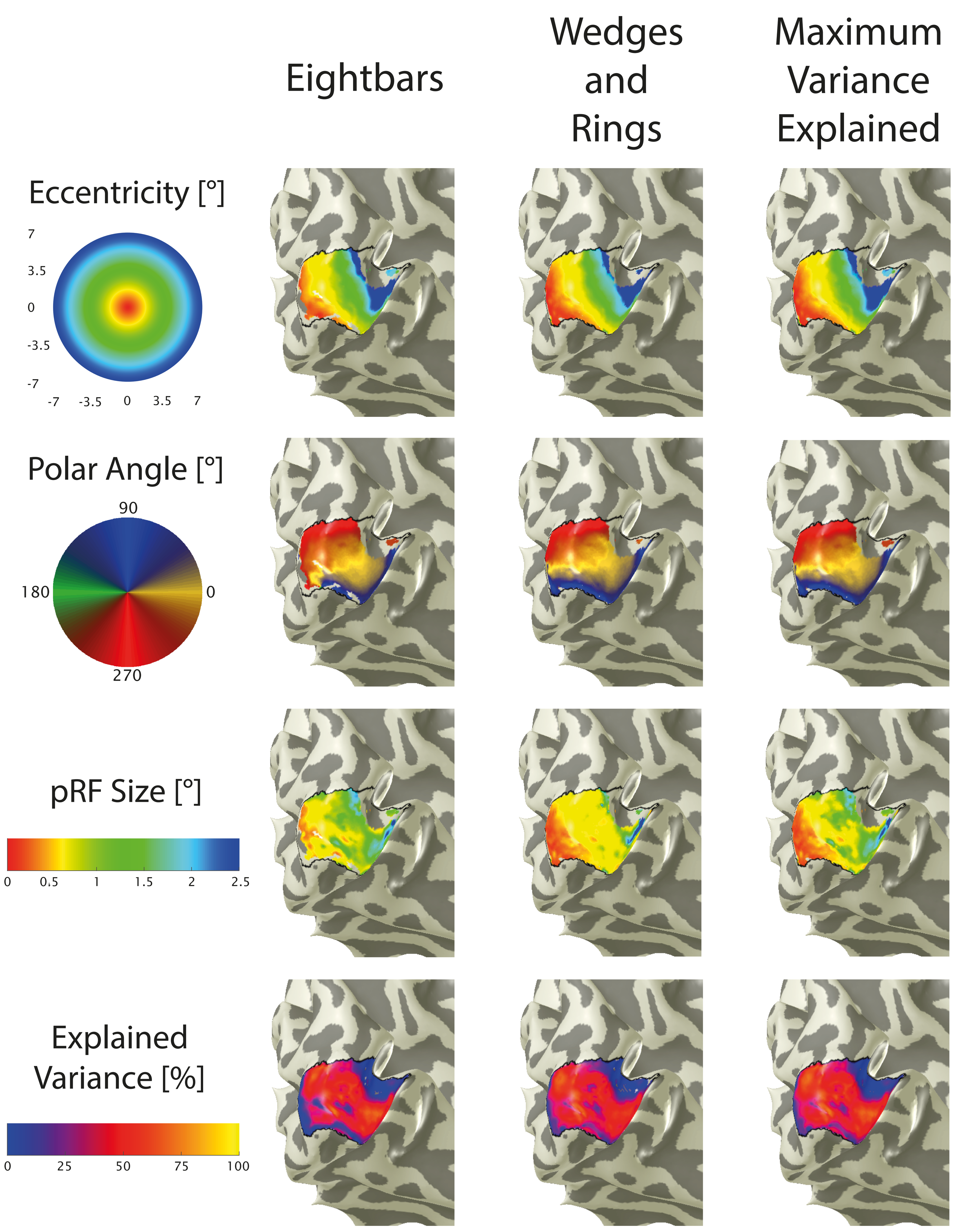

Figure 1. Retinotopic maps, representing estimated pRF parameters of a single subject are overlaid on the anatomical mesh of left visual cortex. The maps are based on the two, concatenated, runs of each stimulus type and shown inside V1 (outlined in black). PRF maps are thresholded at 10% explained variance.

Methods

Nine subjects (age 25.1 ± 3; six female) were measured on a Siemens MAGNETOM 7T scanner with a 32-channel head coil. Anatomical data were acquired using a T1-weighted MPRAGE sequence (0.7mm isotropic resolution) and the multi-band accelerated CMRR EPI sequence (1mm isotropic resolution, TE/TR=25.2ms/1s, 32 slices) was used to record BOLD fMRI data. The first stimulus comprised classic „wedge and ring" stimuli, while the second stimulus was based on the „eightbars" stimulus (Dumoulin 2008). Both stimuli covered the central 14° of the visual field and two runs of each stimulus type were acquired. FMRI pre-processing was performed with Freesurfer, MATLAB and SPM12. mrVista was used for the estimation of pRF parameters. By comparing pRF model fits from „eightbars" and „wedges and rings" runs voxelwise and selecting the model with higher explained variance, we also constructed a combined pRF model for each subject. To highlight regions of the visual field which are problematic with regard to pRF coverage, coverage maps were created and averaged over subjects for each of the three pRF model types.

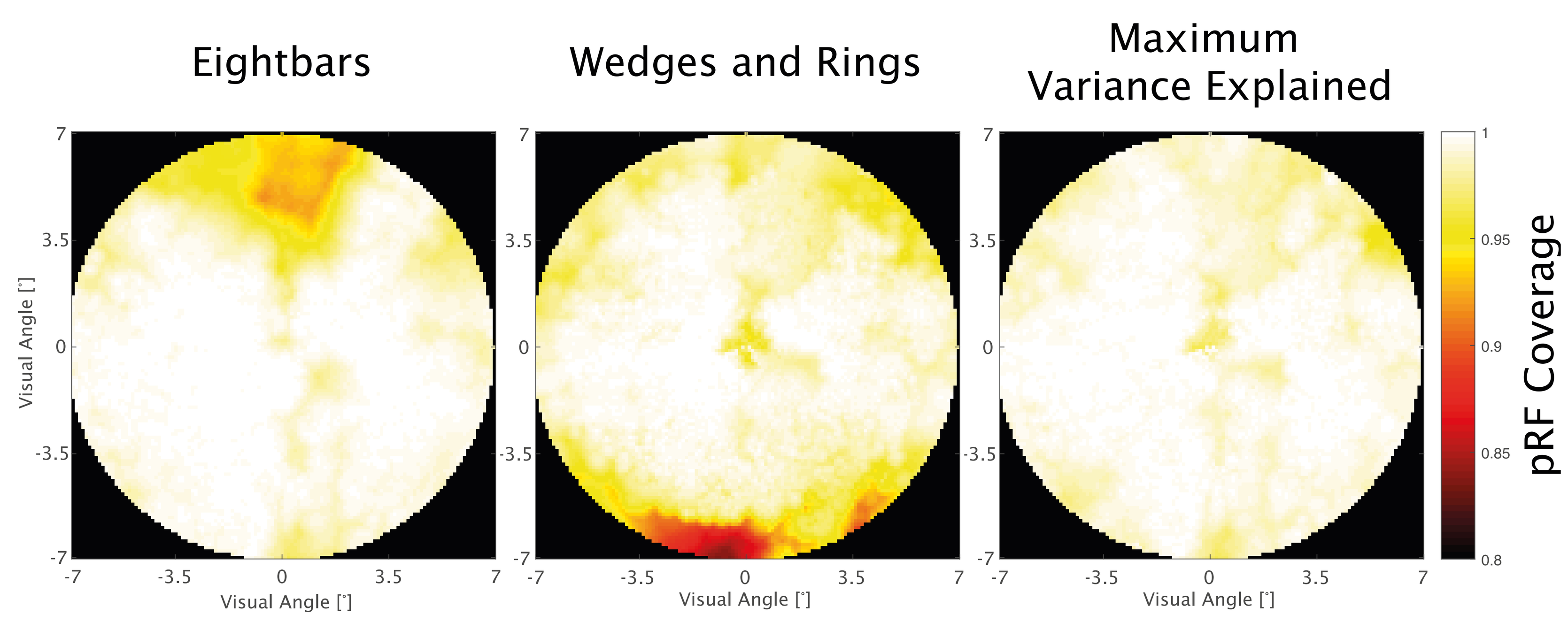

Figure 2. Mean pRF coverage maps of all subjects show problematic areas related to stimulus type. These maps are created by placing a 2D Gaussian (maximum height=1, std=pRF size) at the estimated pRF centre for each suprathreshold voxel.

Results

Figure 1 shows pRF mapping results of a typical subject. While the „wedges/rings" stimulus shows more significant voxels in regions associated with central visual field areas, the „eightbar" stimulus shows slightly more activation in peripheral regions. The combined stimulus displays advantages of both stimulus types. The average coverage maps are depicted in Figure 2. While the „eightbar" stimulus map shows reduced coverage along the vertical meridian, particularly in the upper part of the visual field, the „wedges/rings" stimulus displays reduced pRF coverage at the center and lower visual field meridian. The combined stimulus, created from voxels with maximum variance explained, shows a more uniform coverage.

Conclusion

The pRF parameter and coverage maps based on the combined pRF model showed increased uniformity. Further investigation could provide more general information on pRF coverage differences related to stimulus shape and trajectory, that could be used to optimize stimuli for pRF mapping of specific central visual field regions.

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References

Dumoulin, S.O. (2008), Population receptive field estimates in human visual cortex, *Neuroimage*, vol. 39(2), pp. 647-660

van Dijk, J.A. (2016), Intersession reliability of population receptive field estimates, *Neuroimage*, vol. 143, pp. 293-303

Hummer, A (2018), Artificial scotoma estimation based on population receptive field mapping, *Neuroimage*, vol. 169, pp. 342-351

Hummer, A (2016), Eyetracker-based gaze correction for robust mapping of population receptive fields, *Neuroimage*, vol. 142, pp. 211-224