The Neural Response to Visual Symmetry in Wallpaper Patterns P.J. Kohler¹, A.D.F. Clarke², J. Liu-Shang³, A. Yakovleva¹, Y. Liu⁴ & A.M. Norcia¹

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Background

Any periodic pattern belongs to one of 17 wallpaper groups based on its symmetries. Previous work has focused on mirror symmetry. Here we investigate rotation symmetry by recording EEG responses to 4 wallpaper patterns, each having a different number of rotation folds. 6-fold (60°)





Stimulus



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Analytical Approach

Test condition: P6 pattern alternates with random-noise pattern Control condition: random-noise alternates with random-noise Spectral analysis isolates a configural response evoked by the wallpaper group, that consists of odd harmonics.

n=9 Test Control



Sensor Space Results



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Source Imaging

What are the sources of neural activity that generates the signals we measure on the scalp?



Electrode locations digitized in 3D with Polhemus Fastrack



MRI-based tissue geometry and conductivity model



Define source dipoles Minimum norm solution

Result:

A map of cortical current density that can be combined with ROIs derived from fMRI data.





⁺Anatomically defined based on cortical surface reconstructions (Benson et al, 2014) [‡]Functionally defined using standard functional localization method (Kourtzi, 2001)

References

Benson, NC et al. (2014). Correction of distortion in flattened representations of the cortical surface allows prediction of V1-V3 functional organization from anatomy. PLoS Comput. Biol., 10(3). Kourtzi, Z. & Kanwisher, N. (2001). Representation of perceived object shape by the human lateral occipital complex. Science, 293(5534), 1506-1509.

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Source Space Results

Configural evoked responses to the wallpaper groups were found in all 4 ROIs.



Activity scales with number of rotation folds at odd but not even harmonics.



Responses are progressively delayed as the signals ascend the visual processing hierarchy.



Conclusion

Configural evoked response amplitude increases linearly with the number of rotation folds in the wallpaper groups, indicating that the visual system parametrically represents rotation symmetry. Source localization suggests that this representation begins in early visual cortex.