Identifying Cortical Areas Involved in Perceptual Decisions about Symmmetry

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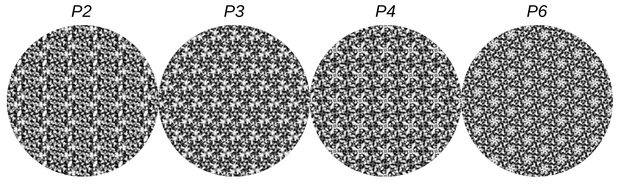
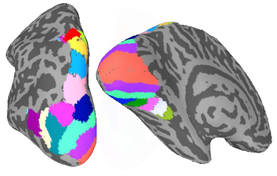
Background

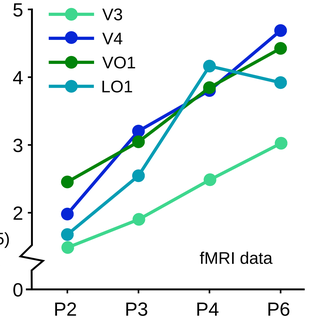


Regular patterns belonging to four crystallographic *wallpaper groups* elicit responses in several visual areas that increase parametrically with the order of *rotation* symmetries, within each group (Kohler et al., 2016).

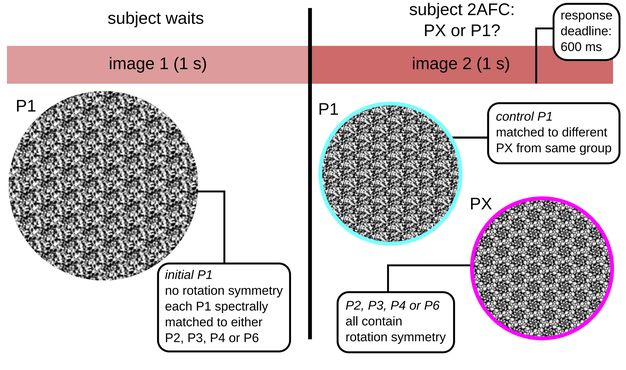


In order to link the brain data more closely to behavior, we recorded EEG data while participants made decisions about the presence of rotation symmetry in briefly presented patterns.

We used source-localization in combination with a novel response-locking technique (Cottereau et al., 2015) to identify visual areas that contribute to perceptual decisions about symmetry.

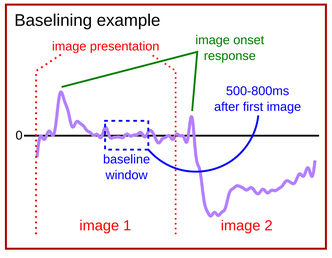


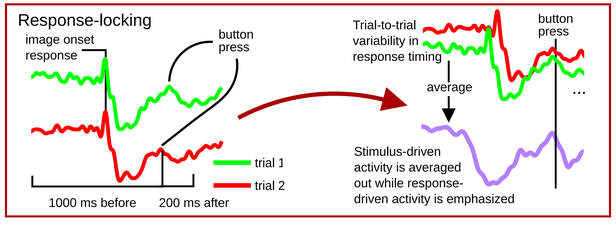
Symmetry detection task



EEG Data analysis

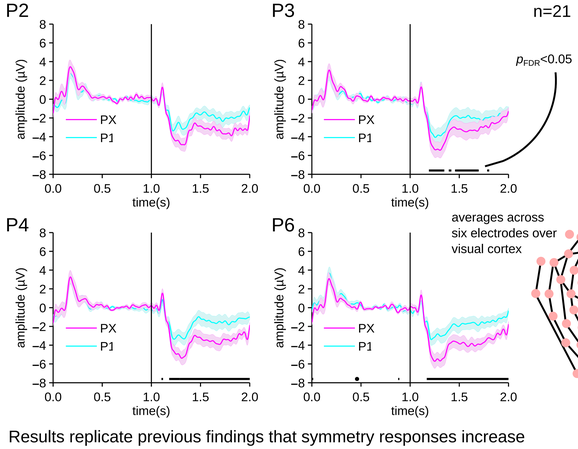
1) Reject trials and channels that have artifacts
2) Consider only correct responses
3) Baseline each trial based on a 300 ms window
4a) Stimulus-locked averaging
4b) Response-locked averaging: shift single-trials waveforms back and forth in time so that button-presses are aligned across trials





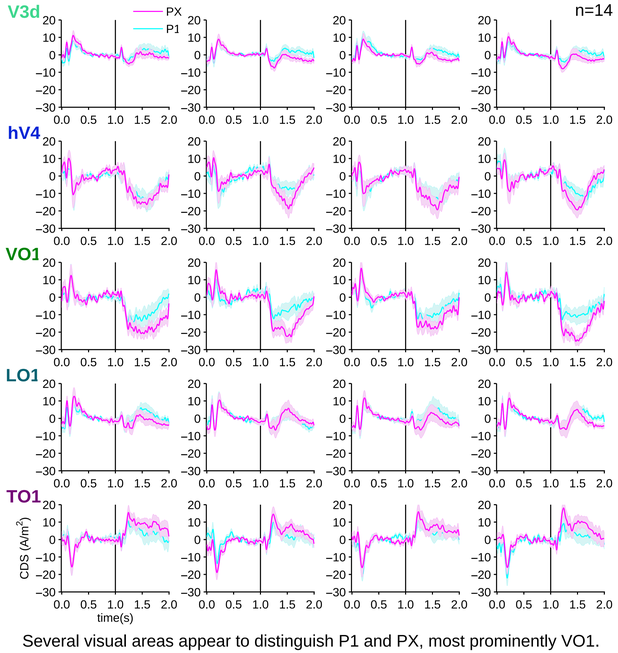
Response-locking allows us to determine the timing of EEG responses relative to participants' behavioral response.

Sensor Space: Stimulus-locked



Results replicate previous findings that symmetry responses increase parametrically with the maximum order of rotation symmetry (Kohler et al., 2016).

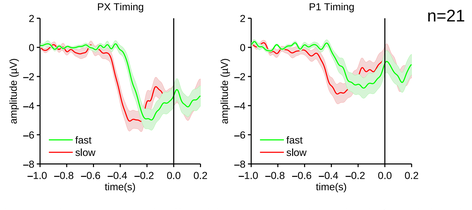
Source Space: Stimulus-locked



Several visual areas appear to distinguish P1 and PX, most prominently VO1. Further statistical analysis will identify significant time periods for each area.

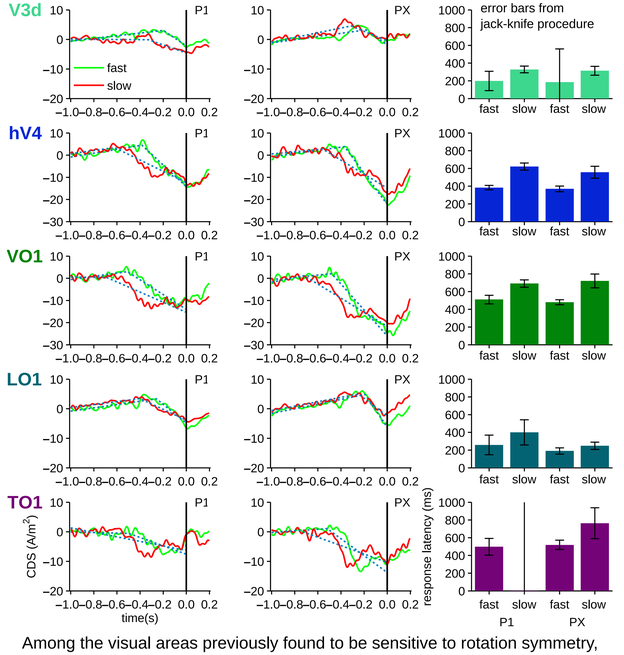
Sensor Space: Response-locked

In order to determine whether EEG data was predictive of response time, we split response-locked single trials into fast and slow responses and averaged the two sets together, irrespective of wallpaper group.



EEG onset time varies systematically with response time, both for trials when the second image had rotation symmetry (PX) and trials when it did not (P1).

Source Space: Response-locked



Among the visual areas previously found to be sensitive to rotation symmetry, only V4 and VO1 show response that vary systemically with response time.

Conclusions

Visual areas as early as V4 and VO1 show activity that can be directly related to perceptual decisions about rotation symmetry in wallpaper groups.

Responses in LO1 tracked less consistently with response time, and showed weaker stimulus-driven responses to rotation symmetry. This is particularly interesting given previous work indicating that LO plays a causal role in the detection of *mirror* symmetry (Bona et al., 2014).

References

Bona S, Herbert A, Toneatto C, Silvanto J, Cattaneo Z (2014) The causal role of the lateral occipital complex in visual mirror symmetry detection and grouping: An fMRI-guided TMS study. *Cortex* 51:46-55.

Cottereau BR, Ales JM, Norcia AM (2014) The evolution of a disparity decision in human visual cortex. *NeuroImage 92*:193-206.

Kohler PJ, Clarke A, Yakovleva A, Liu Y, Norcia AM (2016) Representation of Maximally Regular Textures in Human Visual Cortex. *The Journal of Neuroscience 36*:714-729.

Wang L, Mruczek RE, Arcaro MJ, Kastner S (2015) Probabilistic Maps of Visual Topography in Human Cortex. *Cerebral Cortex 25*:3911-3931.