Multi-focal and phase-encoded retinotopy compared

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Introduction

Retinotopic (RT) mapping of visual cortex is usually conducted with a coherent stimulus (e.g., drifting wedges, rings, or bars).

Multi-focal (MF) mapping (Vanni 2005) divides visual space into discrete regions driven by pseudorandom sequences. A desirable property of the MF technique is that periods of fixation loss cause graceful degradation of data quality across the entire visual field.

Our simulations suggest that the two techniques should have equal detection power (assuming equivalent neural responses to the stimulus arrays).

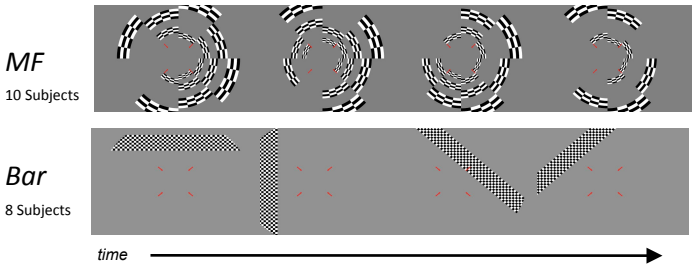
We compared retinotopic maps of area V1 using MF and Bar techniques and asked:

- Do these techniques converge on the same map?
- What is their relative empirical power?

Methods

3 Tesla Scanner, Voxel size: 3x3x3mm, TR Interval = 3 seconds

Two 12 minute periods of scanning, 5 Hz flicker rate



MF stimulation guided by quadratic residue sequences, constrained to prohibit simultaneous stimulation of adjacent sectors (Pihlaja 2008).

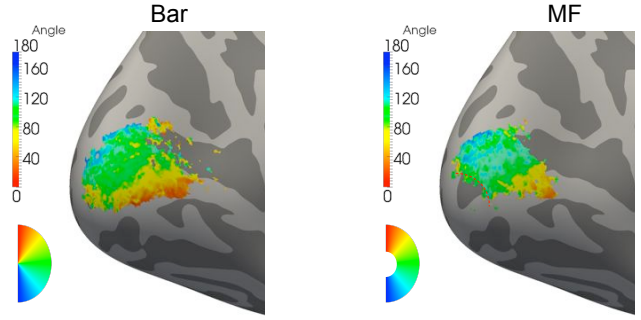
Detection power simulation

Detection power (DP) is the proportion of neural variance present in the BOLD fMRI signal after accounting for hemodynamic response and low-frequency noise. Neural responses to the MF and Bar protocols were modeled as step functions and DP calculated:

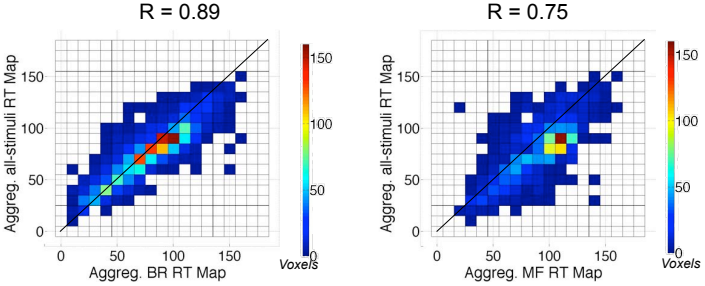
DP_{Bar} = 0.49 DP_{MF} = 0.47

Results

MF & Bar Techniques Converge on the Same Retinotopic Map

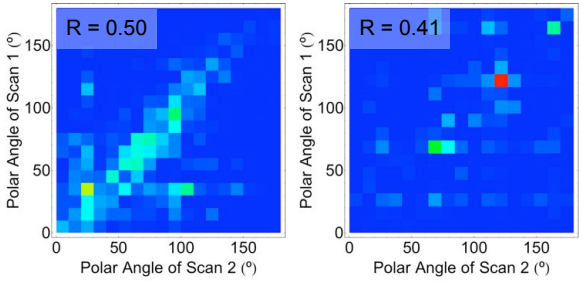


Data combined across subjects within area V1 defined by cortical topology (Hinds 2008, poster 63-324)

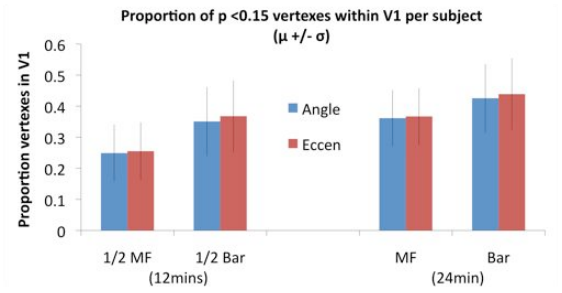


The aggregate (across subject) retinotopic maps from each technique are highly correlated with a template of V1 organization (poster 63-324)

MF Stimuli have Reduced Intra-session Reproducibility Compared to Bar stimuli



Split-halves analysis within subject reveals lower reproducibility (and resolution) of MF data



12 minutes of Bar scanning roughly equivalent to 24 minutes of MF scanning

Conclusions

- Despite theoretically equal power, retinotopic mapping with MF stimuli required twice the duration of scanning to produce results comparable to drifting Bar stimuli within area V1.
- Pihlaja (2008) argued that lateral inhibition reduces the power of the MF approach. We found decreased power despite a stimulus design in which adjacent sectors are never stimulated.

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Lab Website: http://www.cfn.upenn.edu/aguirre/

References

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Pihlaja M, et al (2008) Quantitative multifocal fMRI shows active suppression in human V1. *Human Brain Mapping*. 29: 1001-1014.