Persistent hemispheric differences in the perceptual selection of spatial frequencies

Elise A. Piazza*[1,2] & Michael A. Silver[1,2,3]

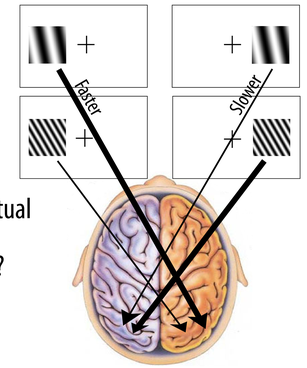
[1]Vision Science Graduate Program, UC Berkeley; [2]School of Optometry, UC Berkeley; [3]Helen Wills Neuroscience Institute, UC Berkeley

Background + Motivation

Previous work has shown hemispheric asymmetry in spatial frequency processing

- Low SFs preferentially processed by RH (in LVF)
- High SFs preferentially processed by LH (in RVF)

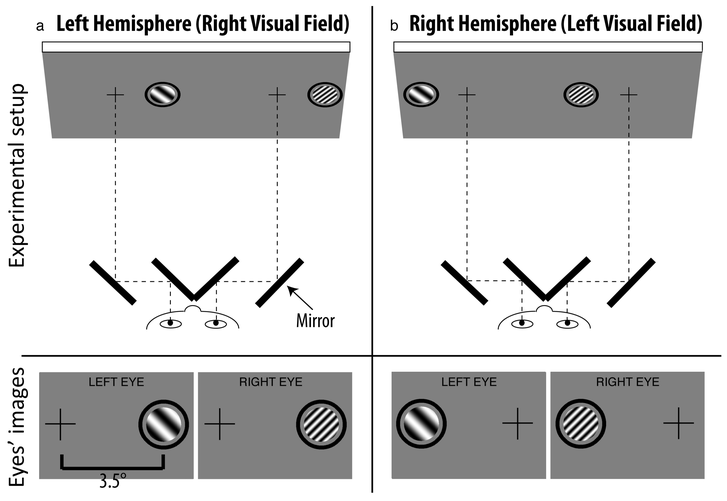
Most studies have measured RTs to individual, briefly-flashed stimuli, asking subjects to judge a single SF at a time



Are there hemispheric differences in perceptual selection from multiple spatial frequencies simultaneously present in the environment?

What is the time course of this asymmetry?

We used binocular rivalry to measure continuous perceptual selection from multiple frequencies competing for conscious awareness



Methods

2 orthogonal gratings of differing spatial frequency at 3.5° eccentricity viewed through a mirror stereoscope

Subjects fixated the alignment cross

Tilt (45°, 135°) and spatial frequency (1 cpd, 3 cpd) of each eye's grating counterbalanced

30-second trial duration

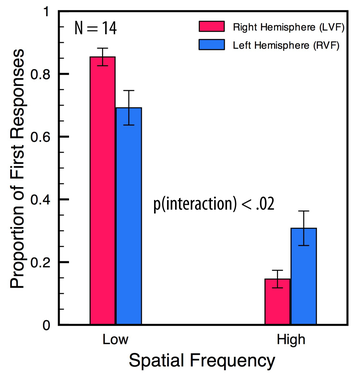
Participants perceive alternation between the gratings over time and respond by continuously reporting the tilt they observe at any moment

N = 14

Results

Initial Response Analysis: Are there hemispheric differences in initial perceptual selection of spatial frequency information?

Proportion of Initial Responses



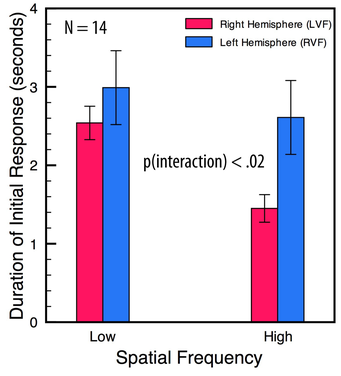
Significant SF x Hemisphere interaction for **proportion** of initial responses

- Lower SF was first seen in the RH more often than the LH
- Higher SF was first seen in the LH more often than the RH

Significant main effect of SF, consistent with known properties of spatial frequency channels

- Lower SF was first seen more often than the higher SF overall
- Explanation: Low SF channels have shorter latencies (Breitmeyer, 1975) and low SF stimuli evoke larger neural responses (Peyrin et al., 2004)

Initial Response Duration



Significant SF x Hemisphere interaction for **duration** of initial responses

- Initial responses corresponding to the higher SF were longer in the LH than the RH
- Initial responses in the RH were longer for the lower SF than the higher SF

Again, significant main effect of SF

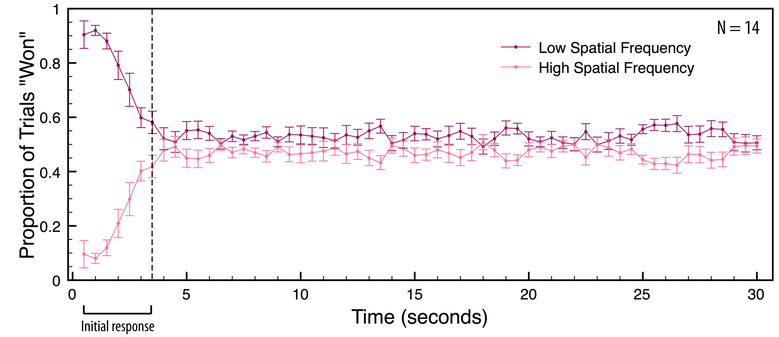
- Lower SF responses were longer than higher SF responses overall

Time Course Analysis: Does this asymmetry dissipate quickly or persist beyond the initial response?

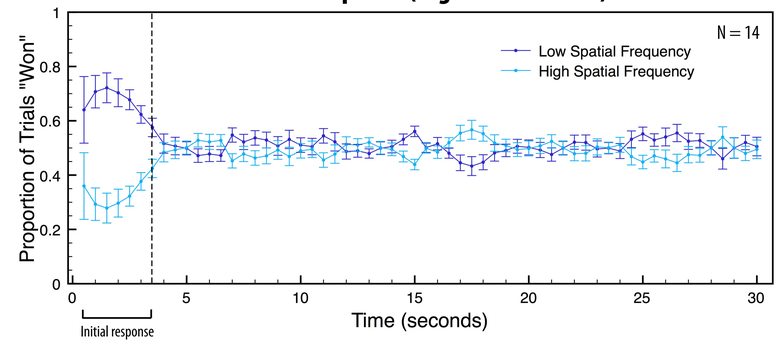
Each 30-second trial was divided into 60 non-overlapping time bins (500-ms each)
Winner-take-all procedure to classify each bin as "low SF" or "high SF" based on responses in that bin
For each bin, computed proportion of "low SF" trials and averaged those proportion values across subjects. Same for proportion of "high SF" trials.

Initial response (which ended in bin 7, or 3.5s, on average) accounts for the **significant SF x Hemisphere interaction in bins 1-7**. In **bins 8-60**, there was also a **significant SF x Hemisphere interaction, demonstrating persistent asymmetry** beyond the initial response.

Right Hemisphere (Left Visual Field)



Left Hemisphere (Right Visual Field)



Conclusions + Future Directions

Spatial frequency selection differs between the two hemispheres both during the **initial response** *and* **throughout the remainder of stimulus presentation**

Relative, not absolute, frequency information drives hemispheric differences in SF perception (Hellige, 1993). Is the asymmetry we found in binocular rivalry due to relative processing as well?

How do hemispheric differences in visual and auditory frequency processing interact?

References

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***Corresponding author**. Please contact Elise Piazza at elise.piazza@gmail.com.