HIGH SPATIAL FREQUENCY SUPERIORITY OF MOTION AFTEREFFECT

Satoshi Shioiri and Kazumichi Matsumiya
Research Institute of Electrical Communication
Tohoku University
High Spatial Frequency Superiority Of Motion Aftereffect

Even motion impression is stronger in low spatial frequency gratings, motion aftereffect of high spatial frequency gratings is seen.

MAE of the high SF component

Adaptation stimulus

Test stimulus
High spatial frequency superiority of motion aftereffect suggests that there are two types of motion detectors with different spatiotemporal frequency tunings.

Slow motion detector: 
Sensitive to high spatial and low temporal frequencies

Fast motion detector: 
Sensitive to low spatial and high temporal frequencies

Several studies have suggested the existence of slow motion detectors. 
(Previous talk, VSS 06; Hawken et al, 1994; Maarten et al, 1999; Alais et al, 2005)
Slow and fast motion detectors with different spatiotemporal frequency tunings

Fast motion detector could be more effective for flicker test
To test the hypothesis, we compare MAE direction and duration of static and flicker tests.

The hypothesis is supported
We also compared MAE for uniform and relative motion adaptation.

Since sensitivity at slow speeds is higher for detecting relative motion than for uniform motion (e.g., Shioiri, Ito, Sakurai & Yaguchi, JOSA 2002), we expect larger effect of slow motion detector in the relative condition.

- **Uniform motion**
  - Lower sensitivity

- **Relative motion**
  - Higher sensitivity
Uniform motion adaptation

Relative motion adaptation
Adaptation Stimulus (relative or uniform)

Contrast:
30 times of threshold
(measured in motion)

Standard grating:
0.53 c/deg

Test grating:
0.13~2.13 c/deg

Velocity: 5 Hz
Mean Luminance:
59 cd/m²
The observer responded the direction and duration of MAE
Static Test

Ave. n=3

MAE of Test

MAE of Standard

Relative: Static

Uniform: Static

Spatial Frequency (c/deg)

MAE duration (s)

Standard

High SF Superiority MAE

Stronger High SF Superiority MAE for relative motion
Flicker Test

Ave. n=3

Same or slightly less Low SF Superiority for relative motion
Static and Flicker Test

Ave. n=3

- Red: Uniform: Static
- Black: Relative: Static
- Orange: Uniform: Flicker
- Blue: Relative: Flicker

High SF Sup: Larger for relative motion (sensitive to relative motion)
Low SF Sup: Similar for both motion (sensitive to local motion)
Results suggest that the visual system has slow motion detector with sensitivity to higher spatial frequencies and to relative motion.

**Slow motion detector:**
sensitive to high spatial frequency
sensitive to relative motion

**Fast motion detector:**
sensitive to low spatial frequency
less sensitive to relative motion
(sensitive to local motion)
Next, we investigated the effect of stimulus orientation to compare the orientation selectivity of the hypothesized slow and fast motion detectors.

Any differences in MAE transfer to different orientation?
Orientation selectivity

Adaptation

Test: 0 deg 45 deg

0.53 c/deg and 2.1 c/deg
Static test: less transfer to 45deg test -> orientation selective
Flicker test: transfer to 45deg test -> less orientation selective
Results suggest that slow motion detector has a narrow orientation tuning.

Slow motion detector:
  narrow orientation tuning
Fast motion detector:
  wide orientation tuning
Conclusions

The experiments suggest that there are fast and slow motion detectors with different stimulus selectivity as summarized below.

**Slow motion detector:**
- high spatial and low temporal frequency
- narrow orientation tuning
- sensitive to relative motion

**Fast motion detector:**
- low spatial and high temporal frequency
- wide orientation tuning
- less sensitive to relative motion
  (sensitive to local motion)

We found similar effect for pursuit eye movements
(Matsumiya & Shioiri VSS ‘06 #106)