Influence of contrast on the pattern direction selectivity of macaque MT neurons

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Grating response

110 ips

Plaid response

110 ips

Component direction selective response

Pattern direction selective response
Geometric models of motion analysis

Adapted from Adelson and Movshon (1982)
Gratings

50%

25%

12.5%

Hybrid plaids

50% : 50%

50% : 25%

50% : 12.5%

All stimuli presented at optimal spatial frequency, temporal frequency, and size
**Grating responses**

- 90 ips: 50% contrast, 25% contrast, 12.5% contrast
- 80 ips: 50% contrast, 25% contrast, 12.5% contrast
- 120 ips: 50% contrast, 25% contrast, 12.5% contrast

**Hybrid plaid responses**

- 90 ips: 50:50% contrast, 50:25% contrast, 50:12.5% contrast
- 80 ips: 50:50% contrast, 50:25% contrast, 50:12.5% contrast
- 120 ips: 50:50% contrast, 50:25% contrast, 50:12.5% contrast
Grating responses

- 50% contrast
- 25% contrast
- 12.5% contrast

Hybrid plaid responses

- 50:50% contrast
- 50:25% contrast
- 50:12.5% contrast

Contrast levels: 50%, 25%, 12.5%

 speeds: 90 ips, 80 ips, 120 ips
Grating responses

- 50% contrast, 25% contrast, 12.5% contrast

Hybrid plaid responses

- 50:50% contrast, 50:25% contrast, 50:12.5% contrast
Grating responses

50% contrast, 25% contrast, 12.5% contrast

Hybrid plaid responses

50:50% contrast, 50:25% contrast, 50:12.5% contrast

90 ips, 80 ips, 120 ips
Hybrid plaid responses

50:50% contrast, 50:25% contrast, 50:12.5% contrast

Adapted from Carandini, Heeger and Movshon (1997)
Grating responses

Hybrid plaid responses

50% contrast
25% contrast
12.5% contrast

120 ips

50% : 50%

50% : 25%

50% : 12.5%
Grating responses

50% contrast
25% contrast
12.5% contrast

50% : 50%
120 ips

50% : 25%
120 ips

50% : 12.5%
120 ips

Hybrid plaid responses

Measured response
Linear/component prediction
Grating responses

50% contrast
25% contrast
12.5% contrast

120 ips

Hybrid plaid responses

Measured response
Linear/component prediction

50% : 0%
0% : 50%

120 ips

50% : 50%
50% : 25%
50% : 12.5%
Grating responses

- 50% contrast
- 25% contrast
- 12.5% contrast

Hybrid plaid responses

Measured response
Linear/component prediction

- 50% : 50%
- 50% : 25%
- 50% : 12.5%
Hybrid plaid responses

Grating responses

50% contrast
25% contrast
12.5% contrast

50% : 50%
50% : 25%
50% : 12.5%

120 ips

Measured response
Linear/component prediction
Cross-orientation suppression prediction
Response, response vectors, mean vector
Component contrasts

Preferred direction

All cells (n=73)
Population mean
Linear/component prediction
Cross-orientation suppression prediction

Δ

Veridical geometry of motion

50:50 50:25 50:12.5 50:6.25 50:3.125 50:0

0 10 20 30 40 50 60
1 c/deg, 10 Hz, 10 deg field, 10 deg eccentricity
1 c/deg, 10 Hz, 10 deg field, 10 deg eccentricy
Component contrasts

Δ Perceived direction

Population mean

HXW
RDK
RLD
PW
YES

Component contrasts:
- 50:50
- 50:25
- 50:12.5
- 50:6.25
- 50:3.125
- 50:0
Component contrasts

Δ Preferred/perceived direction

MT population mean
Psychophysical population mean

Veridical geometry of motion
Conclusions

MT responses to hybrid plaids are dominated by the higher-contrast component grating. When the contrast ratio is 4:1, little influence of the weaker grating can be detected.

The shift in preferred direction was not predicted well by geometric models (IOC) or linear predictions, but was well captured by a model incorporating cross-orientation suppression in the V1 afferent signal.

Human perception shows a qualitatively similar shift toward the direction of the higher-contrast component, but this shift takes place at higher contrast ratios than in MT neurons.
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