Critical-Band Masking Estimation of 2nd-Order Filter Properties

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Outline

Introduction
Methods
Results
  Channel Estimate
  Independence of Carrier Orientation
  Lowest Channel

Neurons in primary visual cortex (V1) extract boundary information

Properties of visual boundaries:
  - orientation
  - position
  - scale

Boundary types in visual scenes:
  first-order and second-order

  - First-order: vary in luminance
  - Second-order: do not vary in luminance

Or:
What sort of mechanisms do we use to analyze?

Texture?

Or:
What sort of mechanisms do we use to analyze?
Computational models of boundary perception: filter-rectify-filter (FRF)

First stage: many small-scale first-order receptive fields
Rectify (threshold) output of first stage
Second stage: Sum rectified output with large-scale receptive field

The contrast sensitivity function (CSF)
(Campbell & Robson, 1968)

The contrast sensitivity function

2nd-order contrast sensitivity function

2nd-order filtering
2nd-order summation: Channel estimates

Task: Letter identification

2nd-order letter identification: Critical-band masking

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Stimulus Generation
**Experimental Details**

Viewing distance: 65 cm  
Stimulus duration: 250 ms  
Task: Modulator orientation discrimination (V vs. H)  
Interleaved staircases, ≥ 300 trials/condition  
Noise: low- and high-pass, cutoff frequency less than half of the carrier frequency, types: all orientations or “plaid”  
3 subjects, 10 datasets (condition x subject)

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Sample Data

Carrier: 4 cycle/deg
Modulator: .25 cycle/deg

Low-pass Noise
High-pass Noise

Cutoff frequency (cycle/deg)

Threshold Contrast

Normalized Power Gain

Estimated Channel

Carrier: 4 cycle/deg
Modulator: .25 cycle/deg

Normalized Power Gain

Frequency (cycle/deg)

Bandwidth

Bandwidth (octaves)

Center Frequency

Center Frequency

Modulator frequency (cycle/deg)
Channel frequency (cycle/deg)

All-orientation noise, vertical/horizontal carriers
Plaid noise, oblique carriers

4 cycle/deg carrier
8 cycle/deg carrier
2 cycle/deg carrier
4 cycle/deg carrier
8 cycle/deg carrier
Summary

• Garden-variety channels
  • 0.8 - octave bandwidth
  • Centered on the test frequency (usually)
• Carrier invariance
• Hint of a lowest channel ~0.25 cycle/deg
• No clear evidence of off-frequency looking