

## 6. Vision: Spatial Acuity, Detection and Discrimination, More on Channels

### I. Channels

#### Overview

CSF as MTF of a linear system – A single channel model  
vs Visual system as a Fourier analyzer  
vs Multichannel model

#### Evidence for multiple channels

##### Adaptation

Blakemore and Campbell - post adaptation threshold elevation  
Pantle and Sekuler - channels revealed by threshold-versus-adapting  
frequency functions  
Blakemore and Sutton - Spatial frequency shift

##### Masking

##### Grating masks

Wilson, McFarlane and Phillips - 6 channel model

##### Filtered noise masks

Henning, Hertz and Hinton - channel shape estimated  
using high- and low-pass noise masks  
Stromeyer and Julesz - masking by low-, high- and  
band-pass noise, S/N ratio, critical bands

##### Subthreshold summation

Campbell and Robson - Sine wave vs Square wave

Thresholds determined by fundamental

Discriminable when  $3f$  component is detectable

$f + 3f$ , Graham and Nachmias - independent channels vs 1-channel

Sachs, Nachmias and Robson - Probability summation for  $f, f + \Delta f$

Mostafavi and Sakrison - detection of narrowband noises  
with varied radial and angular bandwidth

Wilson and Bergen - DOG targets

Watson - multiple detectors at each location, at least 7 channels

##### Discrimination vs detection

Wilson and Regan - Different 'best' channel

Watson and Robson - Labelled lines

Olzak and Thomas - Nonindependence of channels

##### Frequency freaks vs Feature creatures

## Decision rules

### High threshold theory

- Peak response in the 'best' channel
  - noise free
  - with noise

### Probability summation

Kulikowski and King-Smith, Shapley and Tolhurst - too many channels

### Probability summation

#### Over space

Graham

$f + f + \Delta f$  implies it or get too narrow bandwidth

Stromeyer and Klein - FM gratings

#### Over channels - Graham

Graham, Robson & Nachmias -  $f + 3f$  supports multiple channels at each location

Watson - Probability summation over time

### Vector length/Line element models

ad hoc vs optimal decision rules (SDT)

### Nonlinear transducer function

#### Increment threshold functions (dipper functions)

Nonlinear transducer functions

Foley and Legge - detection versus contrast discrimination

Legge and Foley - increment threshold

Nachmias and Sansbury - detection versus contrast discrimination

Wilson - initially expansive then compressive/saturating

Pelli - Uncertainty

### Phase of channels

Field and Nachmias - evidence for sine and cosine phase only in  $f + 2f$

180° phase discrimination

Burr, Morrone and Spinelli - edge and bar - discrimination and pedestal effect

## II. Acuity

Acuity vs contrast sensitivity

Grating acuity

Vernier acuities

Hyperacuity

## III. Computable models

Carlson and Klopfenstein - hyperacuity model - channel, nonlinearity, noise proportional to signal, etc.

Watson - detection vs discrimination, multidimensional space

Bayesian vs vector length

Wilson - line element model for spatial frequency discrimination, hyperacuity, etc.

Nielsen and Wandell - quadratic model

null space

restrict stimulus space

quadratic form, estimation procedures

failure of quadratic

Measuring the template - classification image techniques

$C = (S1R2 + S2R2) - (S1R1 + S2R1)$  where, e.g., S1R1 is the average of the noise images for trials in which Signal 1 was displayed and the subject responded "1"

Double-pass Response consistency measurements

#### IV. 2nd-order processing

Beats

Henning, Hertz and Broadbent - beats mask low frequency gratings and vice versa

Nachmias and Rogowitz - several inconsistencies with distortion products from a logarithmic transform

Badcock and Derrington

too good for nonlinear distortion product

doesn't adapt, null, isn't interfered by static grating, reversal

=> 2nd order measure of contrast variations

Derrington and Badcock - beats don't adapt or otherwise act like either

low- or high-SF components. Thus, separate mechanisms

Perkins and Landy - off-frequency looking and superadditivity of maskers

Other 2nd-order processes

Texture segregation and Visual search (Lecture 9)

Gain control and 2nd-order pooling - Olzak & Thomas

2nd-order psychophysics