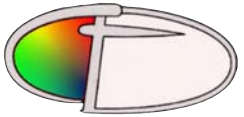


Research and Education for Vision and Color Sciences in Chiba University

Hirohisa Yaguchi

Graduate School of Advanced Integration Science

Chiba University

Education of Vision and Color

Department of Information and Image Sciences

- Introduction to Visual Information Processing (Prof. Yaguchi)
- Color and Image (Prof. Miyake)
- Psychophysics

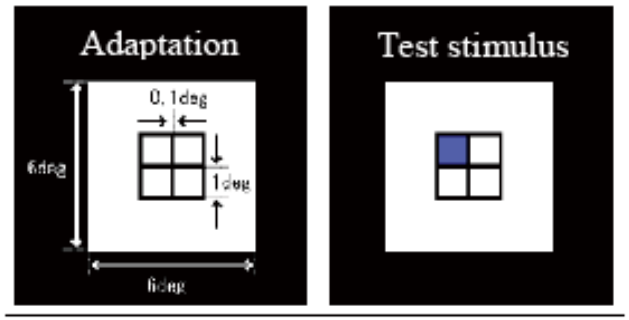
Graduate School of Advanced Integration Science

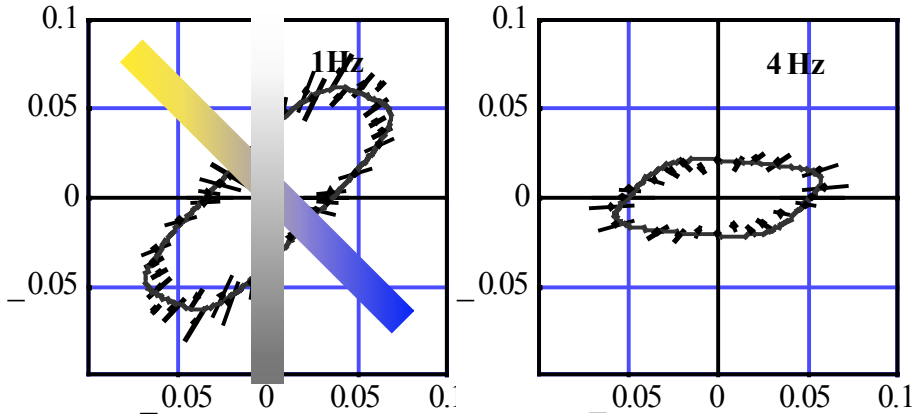
- Visual Science (Prof. Yaguchi)
- Color Reproduction (Prof. Yaguchi)
- Image Evaluation and Analysis (Prof. Miyake)
- Electronic Imaging (Prof. Tominaga)

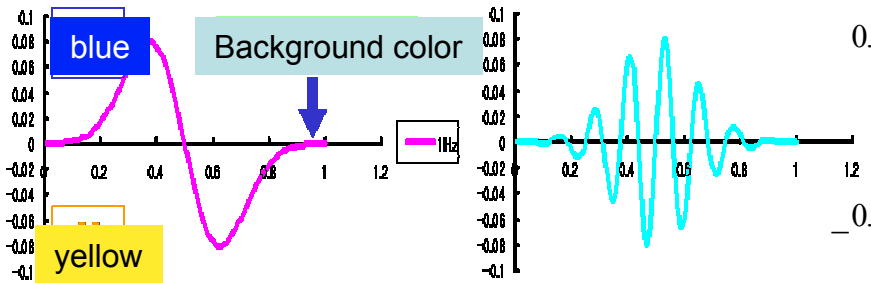
Current research projects in Yaguchi labo.

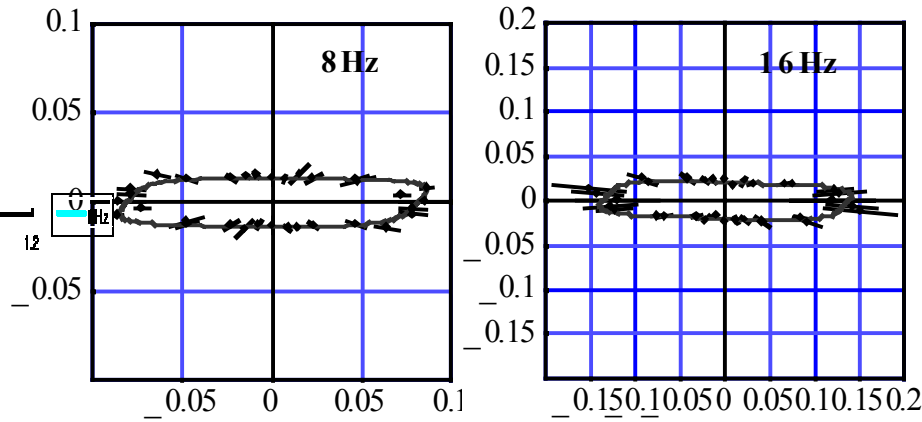
- Color discrimination and visual attention
- Mesopic color reproduction
- Color discrimination for color deficiencies and universal color design
- Measurement of contrast sensitivity functions using color images
- Spatiotemporal contrast sensitivity functions and image quality of static images and movies: Motion sharpening
- Color rendering evaluation based on color appearance for solid state light sources
- Visual environment and color perception, etc.

Temporal Characteristics of Color discrimination







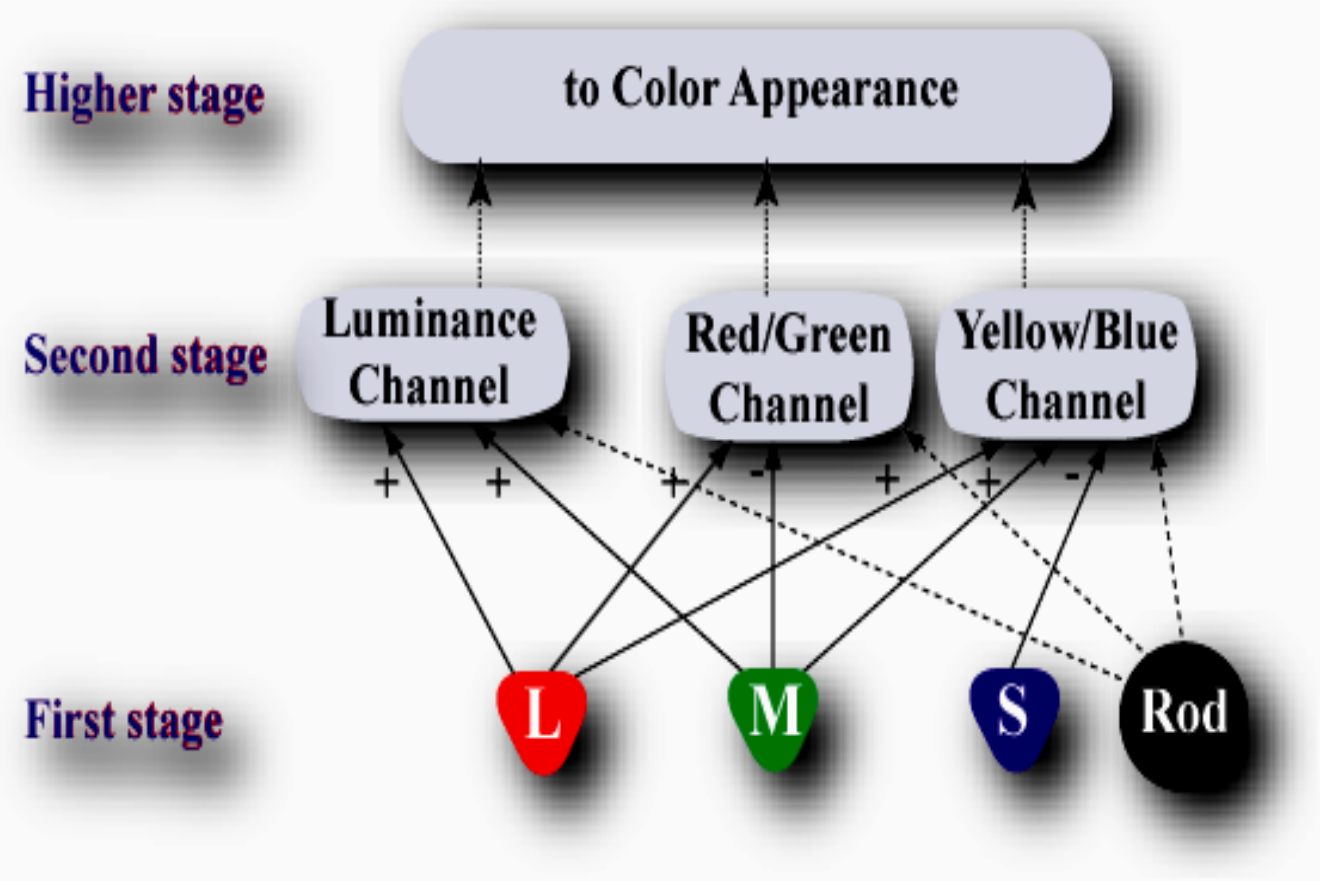


Cs

Published papers on color discrimination

- Correlation Between Visual and Colorimetric Scales Ranging from Threshold to Large Color Difference, *Color Res.Appl.,* Vol.27, No.5, 360-373 (2002)
- Color Discrimination Characteristics Depending on the Background Color in the (*L, M*) Plane of a Color Space, *OPTICAL REVIEW,* Vol.10 No.5, 391-397 (2003)
- Visual Evaluation at Scale of Threshold to Suprathreshold Color Difference, *Color Res.Appl.,* Vol.30, No.3, 198-3208 (2005)

Color Appearance in Mesopic Vision



Imaging System of Mesopic Color Reproduction

Input → MODEL → Output

000(lx) 1000(lx) 1000(lx) E(lx) E(lx) E(lx)

R G B → X Y Z Y' → L M S Y' → Lum r/g y/b → X_o Y_o Z_o → R_o G_o B_o

(Judd)

sRGB

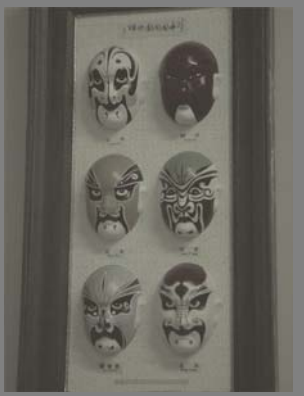
Mesopic Color Reproduction

original

100 lx

10 lx

1 lx



0.1 lx

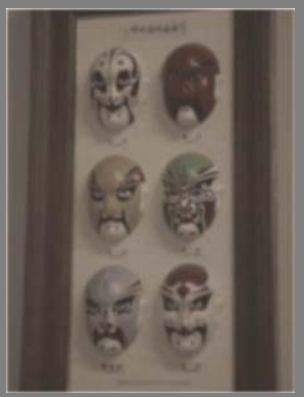
0.01 lx

Mesopic Color and Sharpness Reproduction

original

100 lx

10 lx



1 lx

0.1 lx

0.01 lx

Published papers on Color appearance in mesopic vision

- Change of Color Appearance in Photopic, Mesopic and Scotopic Vision, *OPTICAL REVIEW*, Vol.11 No.4, 265-271 (2004)
- A Color Appearance Model Applicable in Mesopic Vision, *OPTICAL REVIEW*, Vol.11 No.4, 272-278 (2004)
- Imaging system for mesopic vision, *Proceedings of the 10th Congress of International Colour Association*, Part1, pp.251-254 (2005)

Color appearance for dichromats

Normal

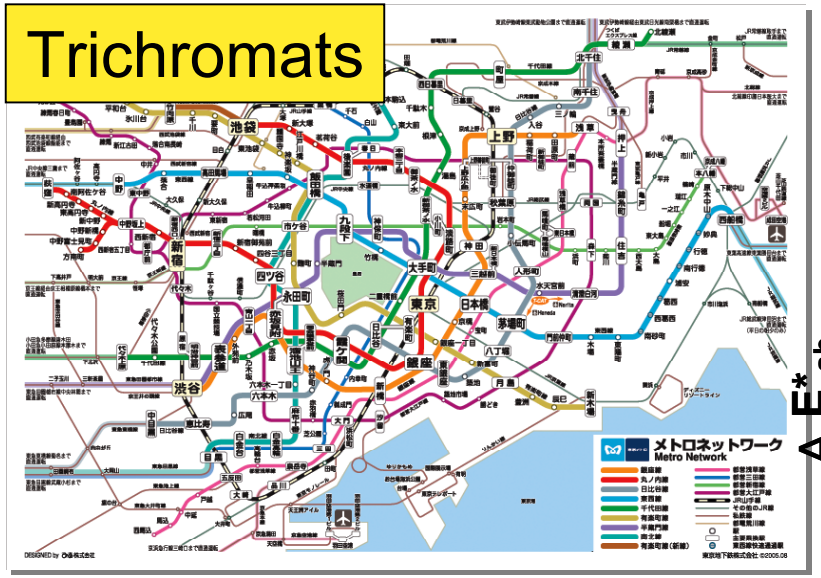
Protanope
(missing L-cone)

Deuteranope
(missing M-cone)

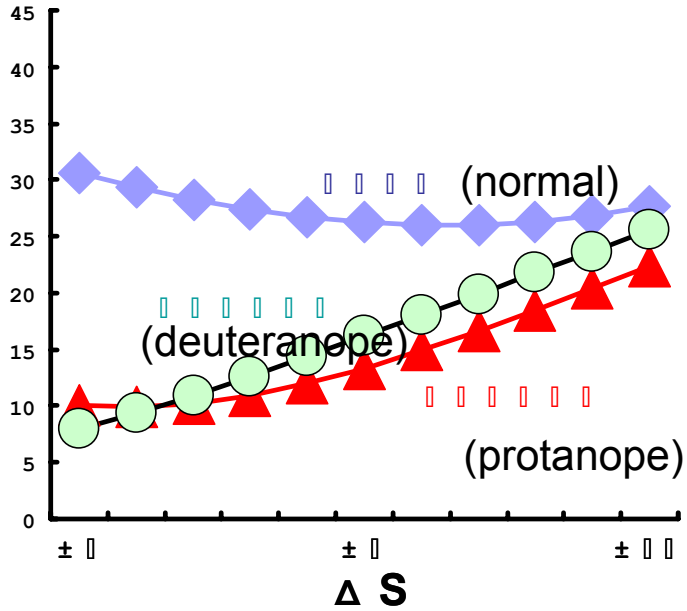
Tritanope
(missing S-cone)

Universal Color Design

Trichromats



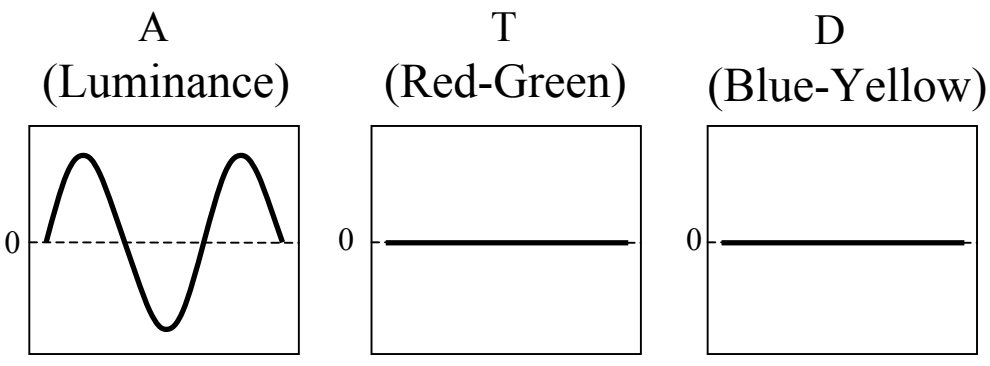
Deuteranope

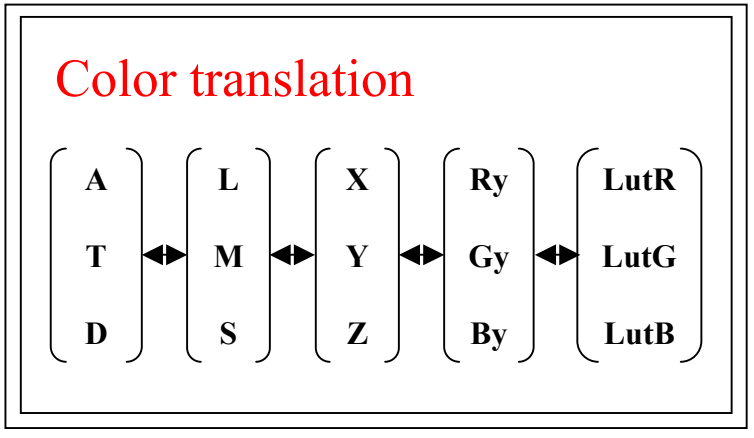


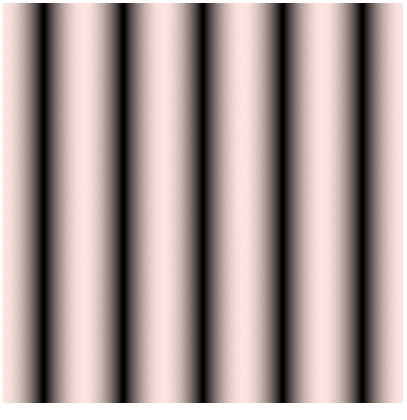
Paper on Universal Color Design

- Quantification of Color Universal Design for Red-green Color Blind, *VISION*, 18, 231 (2006), presented at the 4th Asian Conference on Vision.

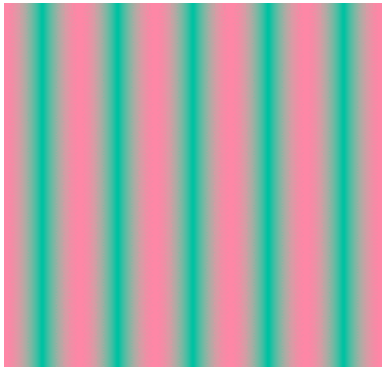
Contrast sensitivity functions



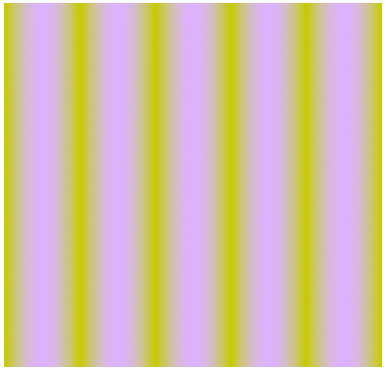




A grating

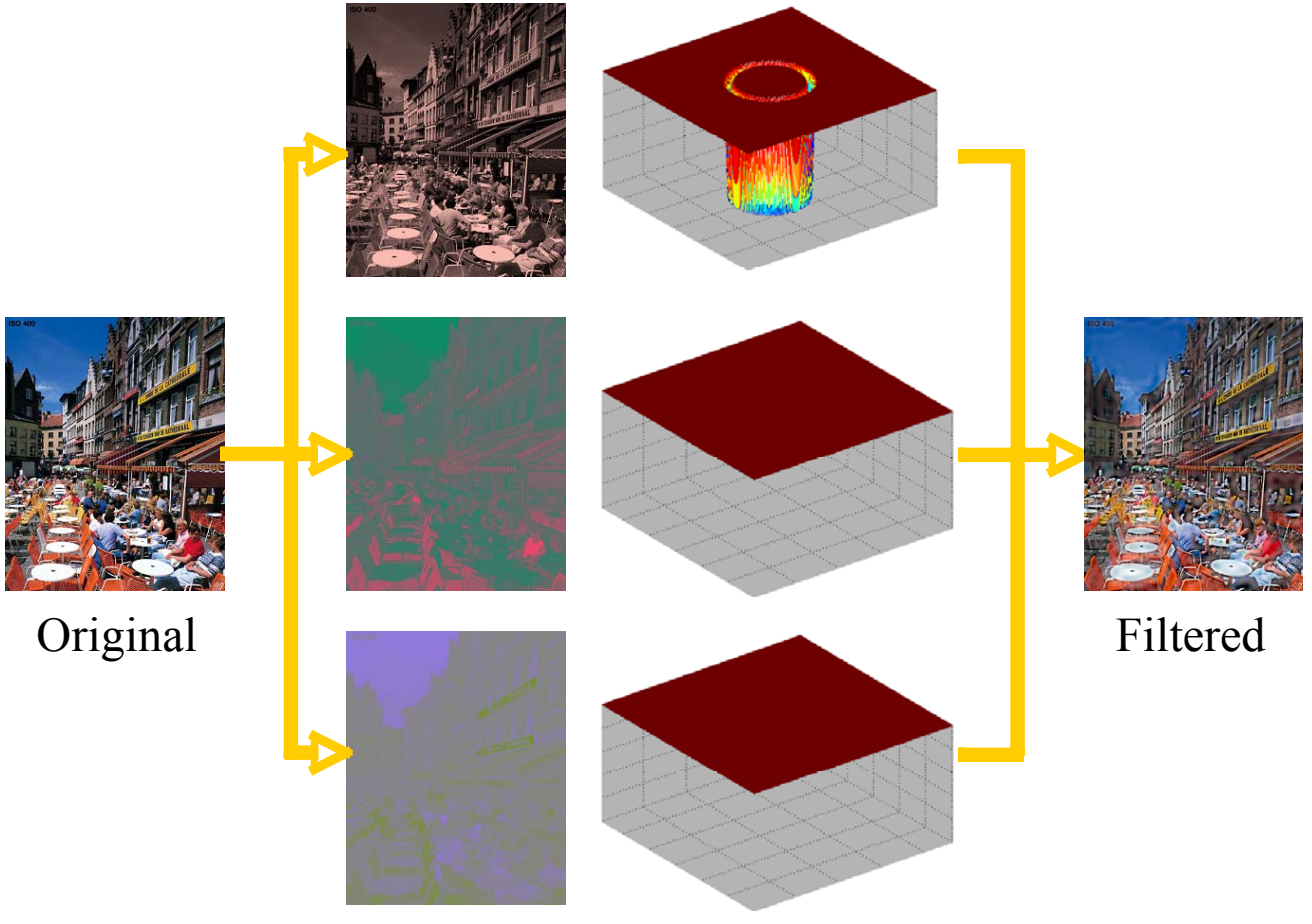


T grating

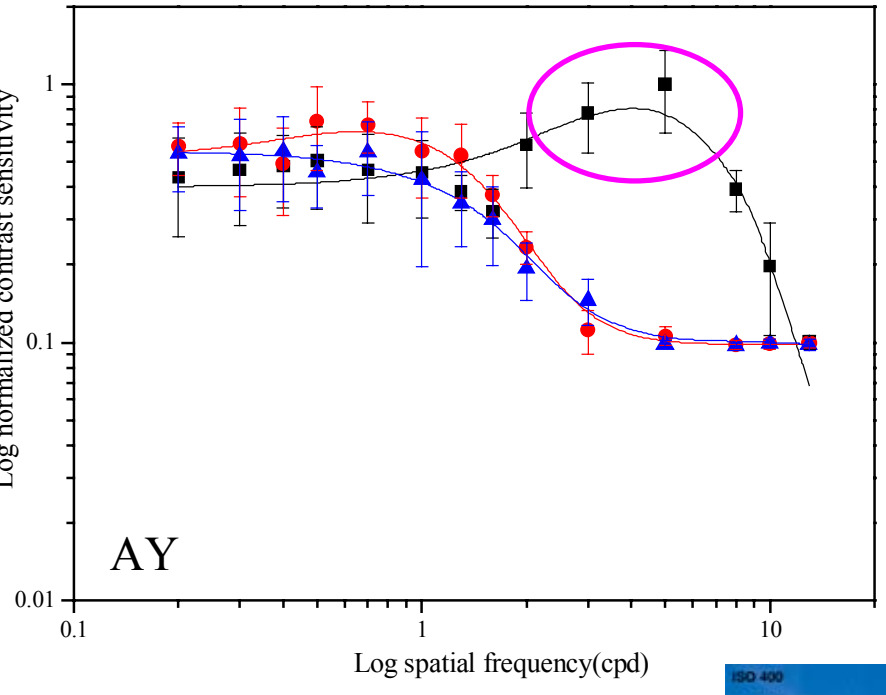


D grating

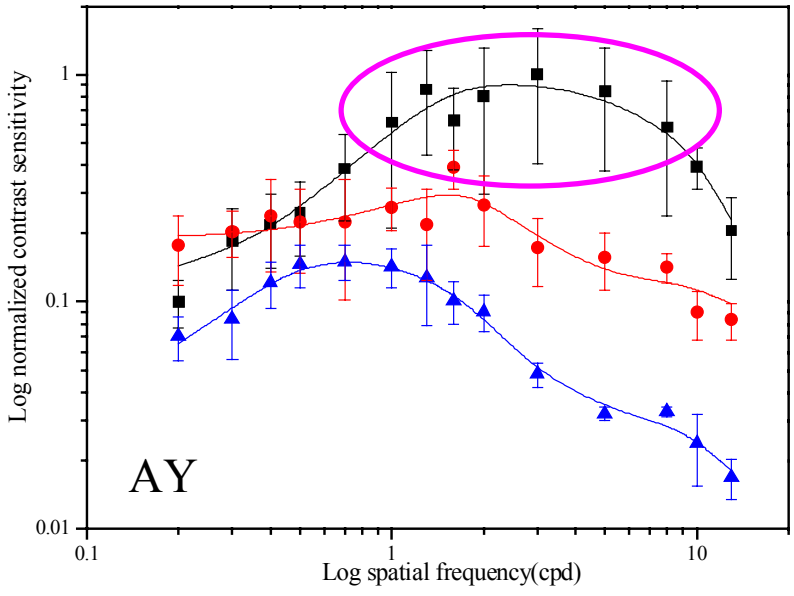
Measurement of contrast sensitivity functions using color image

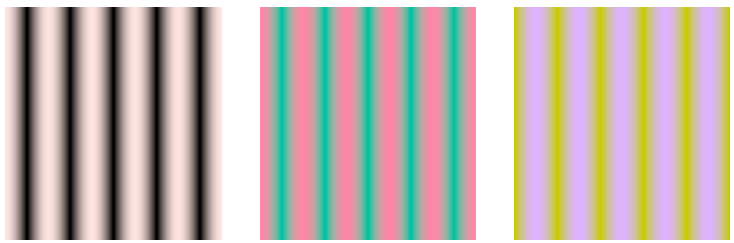


k=0
k=0.2
k=0.4
k=0.6
k=0.8
k=1
f=0.2
f=0.4
f=0.7
f=1.3
f=2
f=5



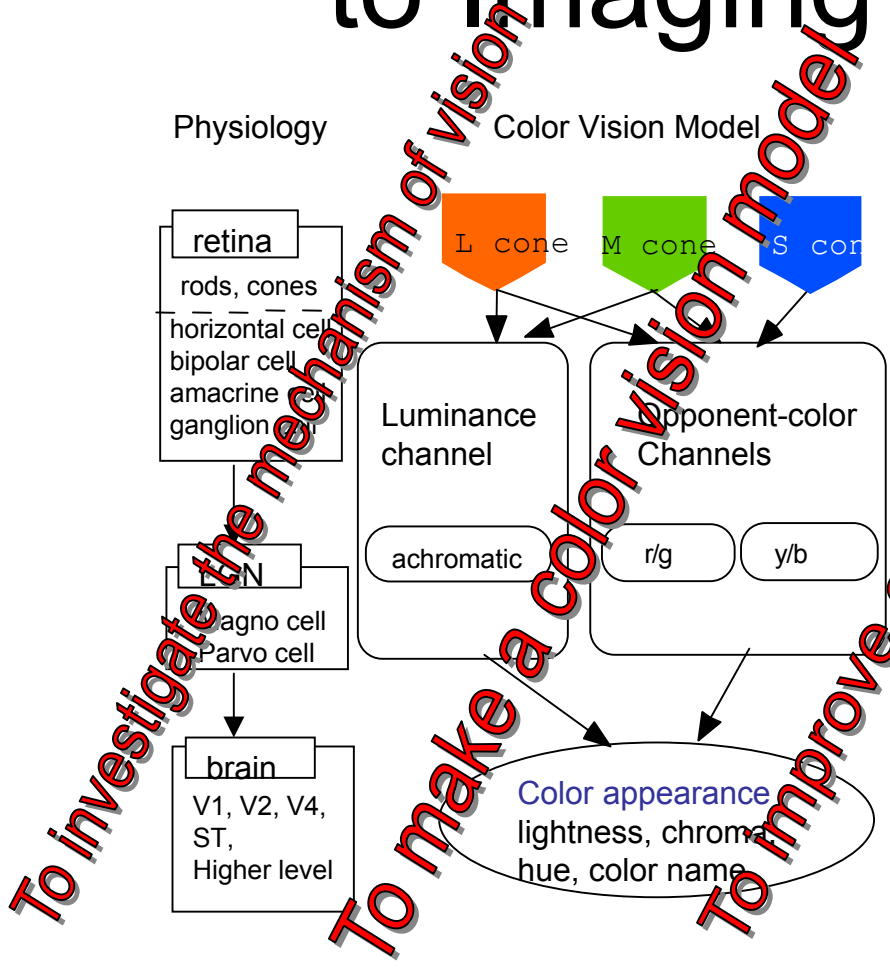
Ex.1：Grating CSF





Ex.2：Contrast sensitivity function for ATD filtered image stimuli **(Cafe)**

Color Vision and Application to Imaging Science



To investigate the mechanism of vision

To make a color vision model

To improve colorimetric systems

To apply the human color vision to imaging systems

Colorimetric System	Application to Imaging
CIEXYZ (1931)	Spectral sensitivity of image sensor Array of Image sensor Colorimetric color reproduction Multi-spectral imaging
CIELAB (1976)	Color difference formula Image difference Image compression Color space for communication White balance
CIECAM02 (2001)	Color reproduction for different image media Gamut mapping Categorical color reproduction Total image quality
CIEiCAMxx	