Advances in Visual Perception
PSYC 526 Fall

Profs. Fred Kingdom & Kathy Mullen

Lecture 9
"Modularity in vision"

Reading

Livingstone & Hubel "Through the eyes of monkeys and men", Ch. 3 in Gregory et al.'s (eds) The Artful Eye (1995), pp 52-65.

Mullen & Boulton "Absence of smooth motion perception in color vision", *Vision Research*, 32, (1992).

Kingdom "Colour brings relief to human vision", *Nature Neuroscience*, 6, (2003).

What is a module ?

Definition: *A module comprises a group of mechanisms localised within the brain, dedicated to the processing of a particular stimulus dimension*

Evidence for Modularity

1. Phenomenonological irreducibility

2. Anatomical localization

3. Selectively tuned neurones

4. Separable behavioural properties

Colour versus luminance

Colour vision and form/motion perception

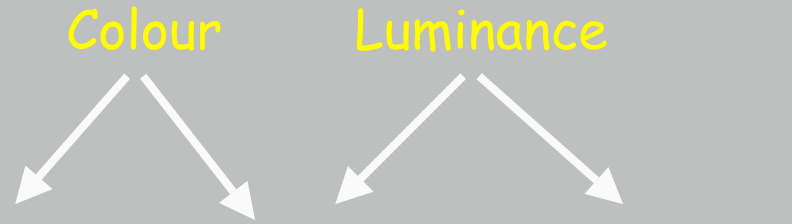
Two views

Livingstone & Hubel (1987)

Colour → Colour, Shape

Luminance → Lightness, Shape, Stereo-disparity, Depth, Motion, Texture

An alternative view



Colour reveals camouflaged objects

Colour reveals camouflaged objects

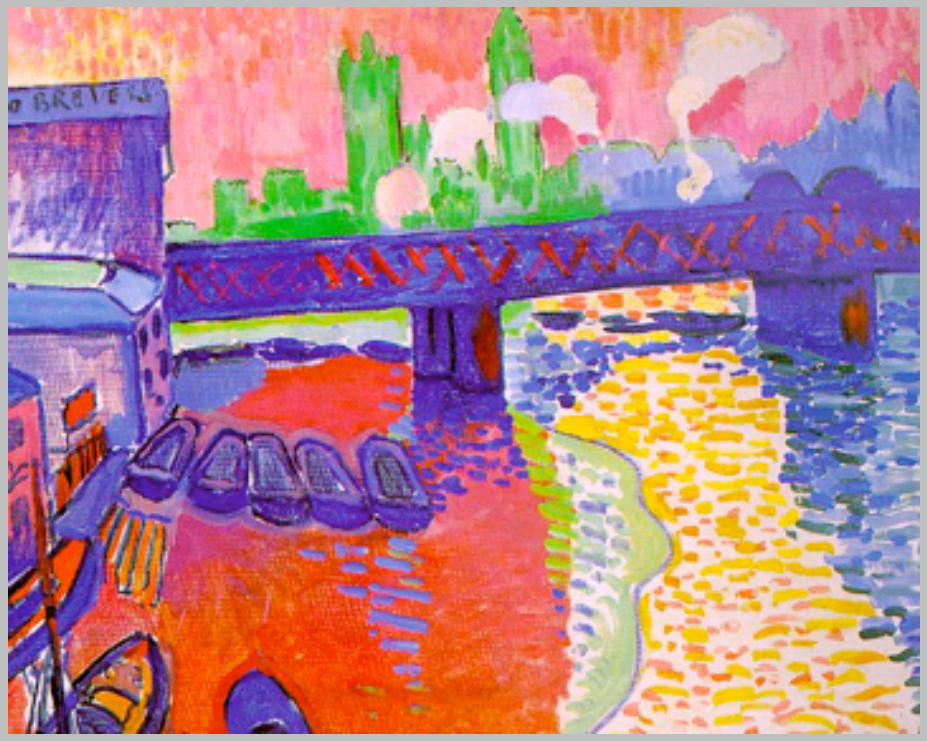
more camouflaged objects……

more camouflaged objects……

and more…….

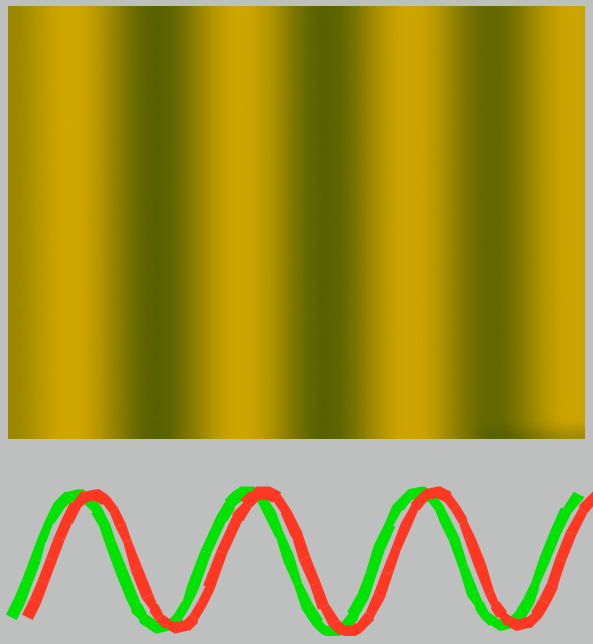
and more…….

Isoluminance is rare…..

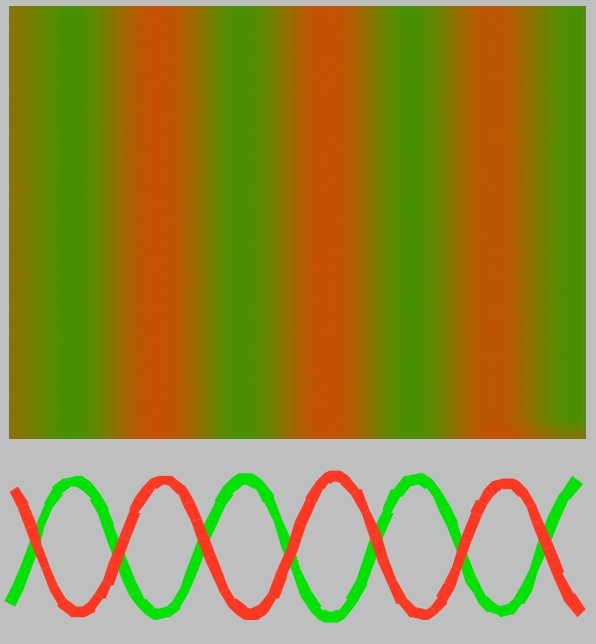


by Derain

Isochromatic
yellow-black

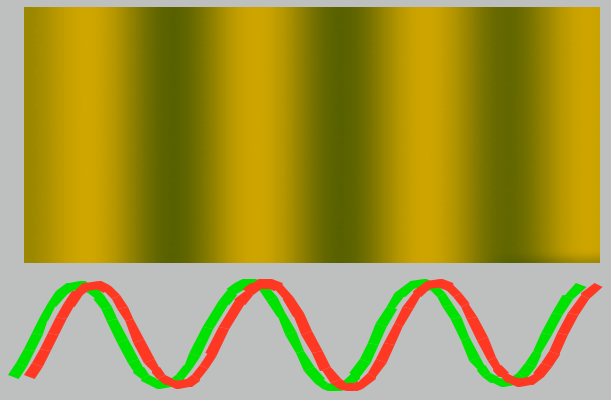


Isoluminant
red-green

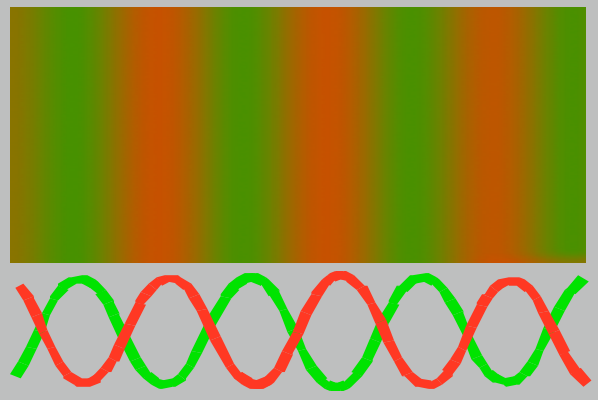


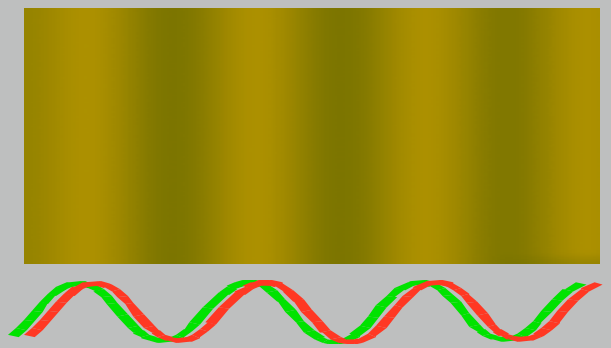
Varying contrast

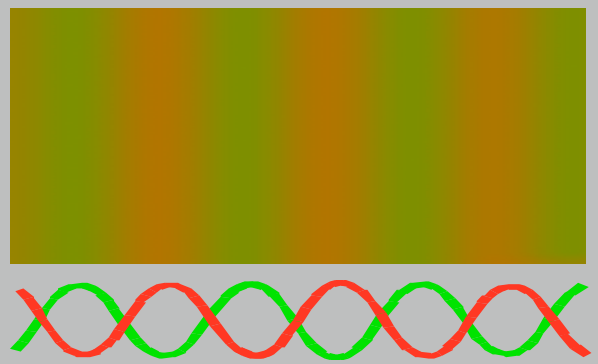
Isochromatic yellow-black

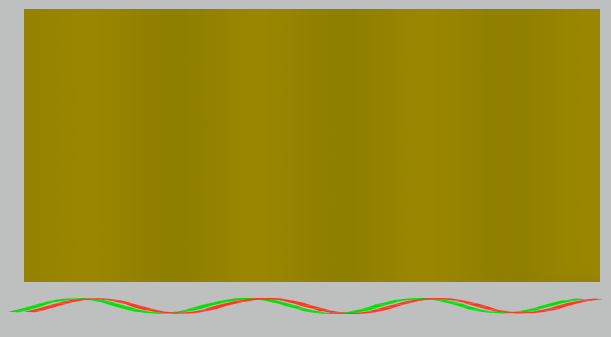


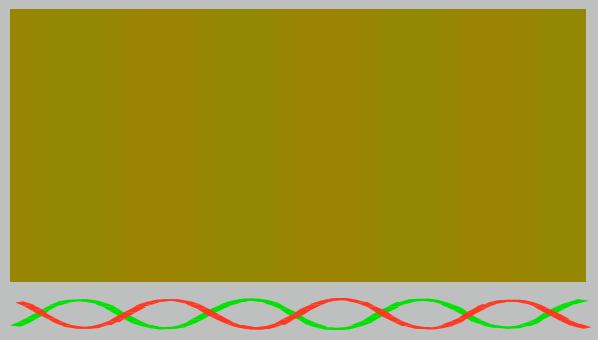
Isoluminant red-green





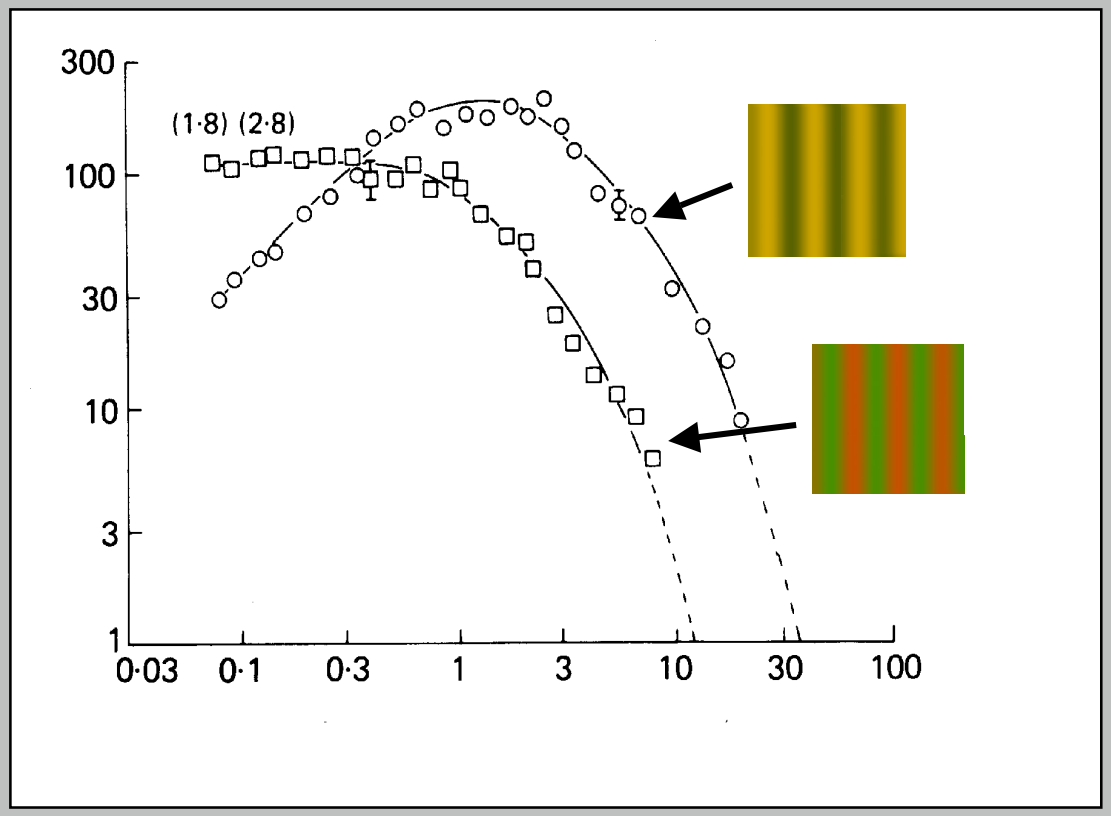






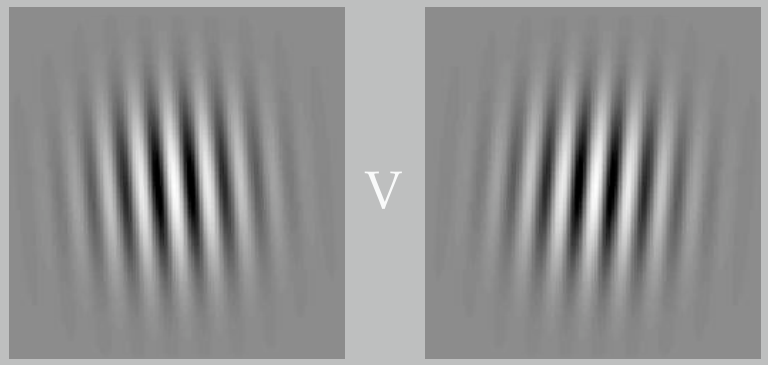
Colour versus luminance contrast sensitivity

(from Mullen, 1985)

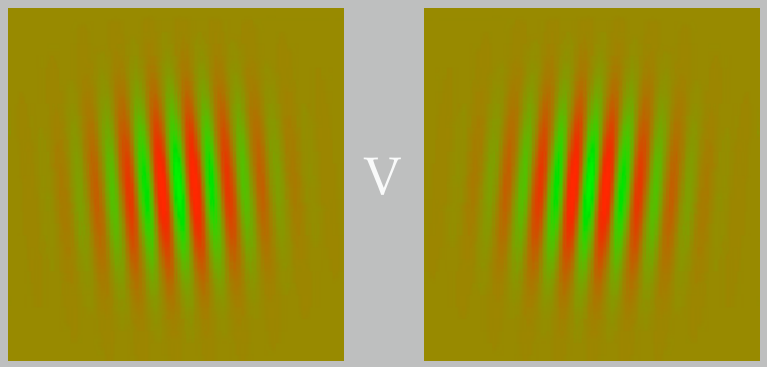


Orientation discrimination task

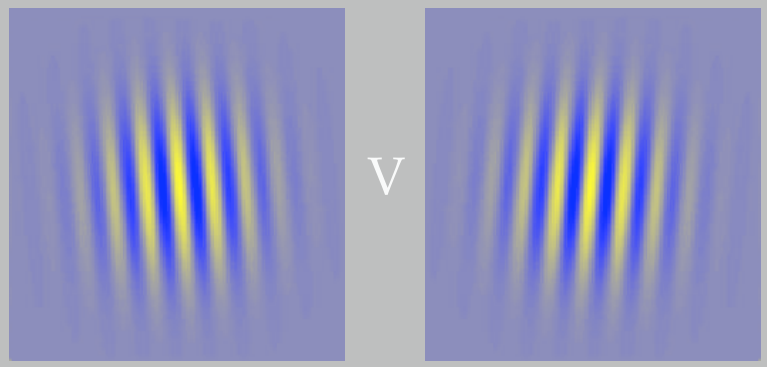
Isochromatic black-white



Isoluminant red-green

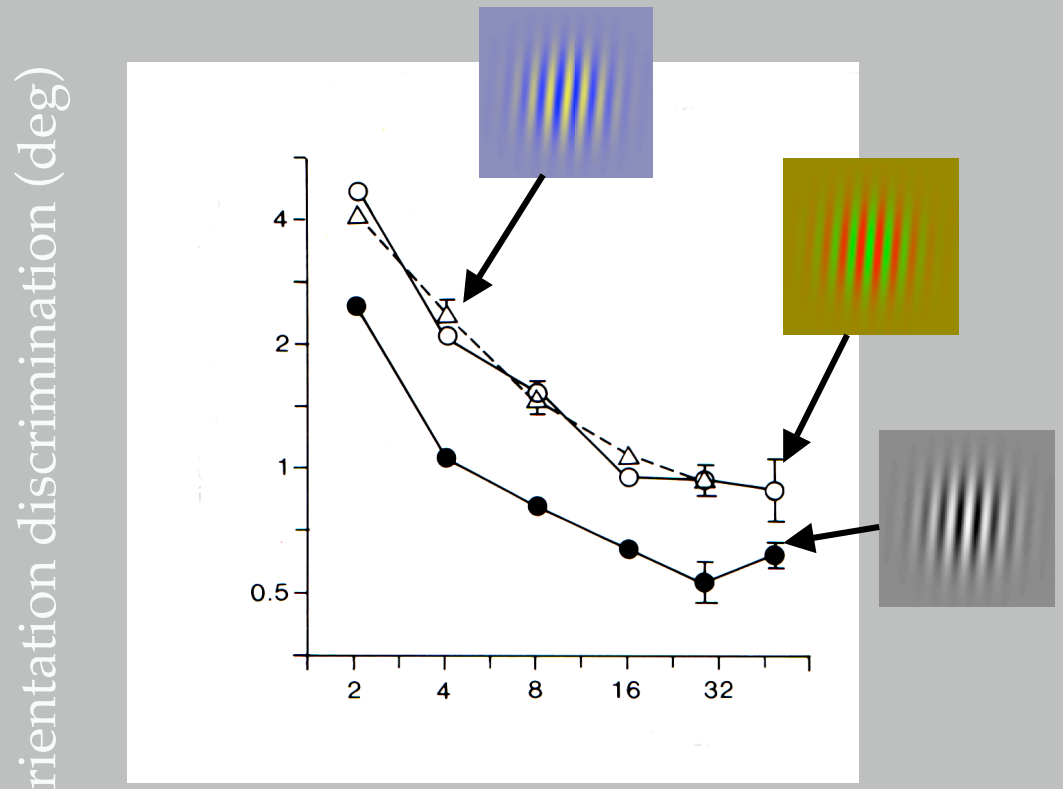


Isoluminant blue-yellow



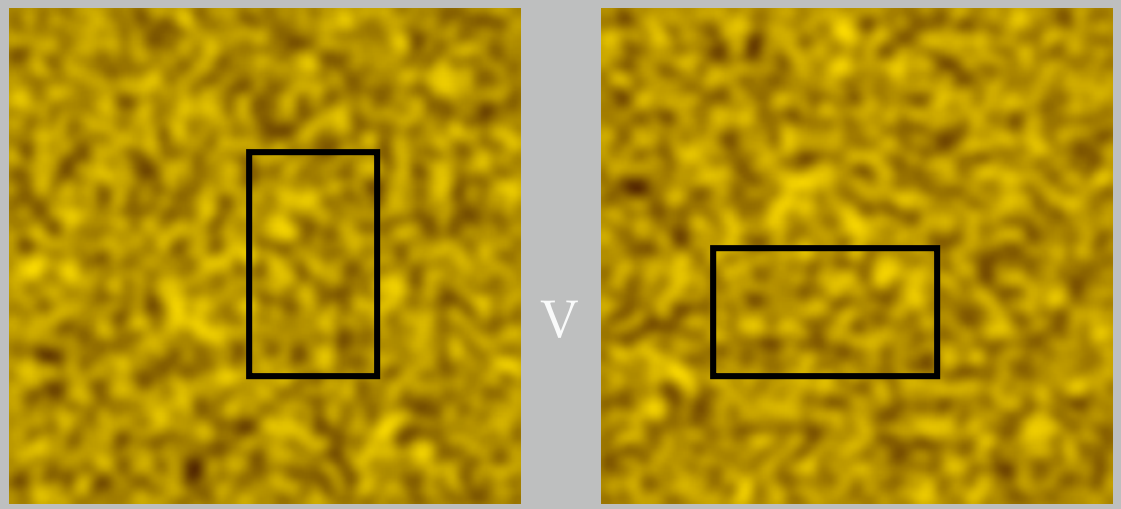
Orientation discrimination task

(from Webster et al. 1990)

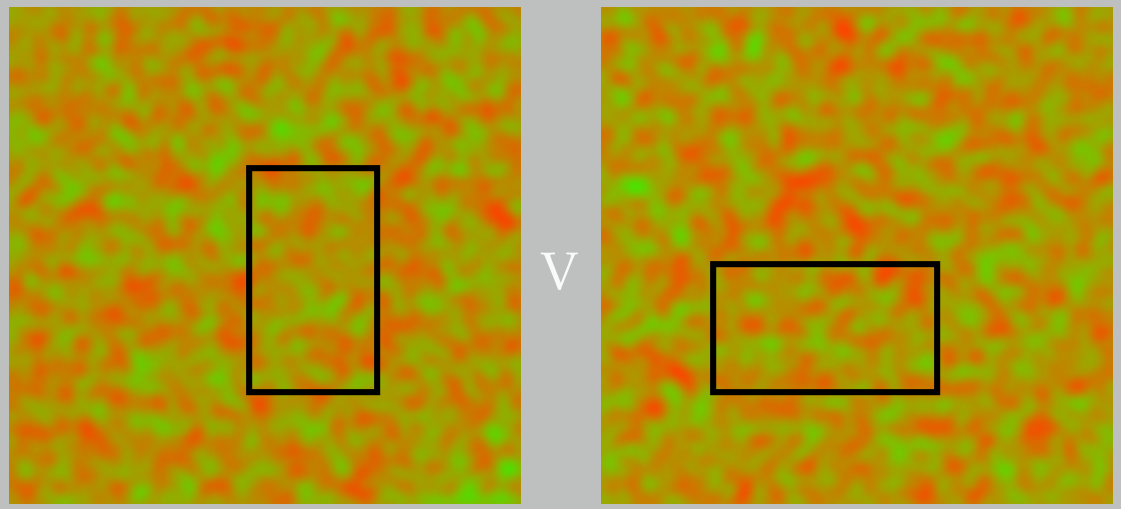


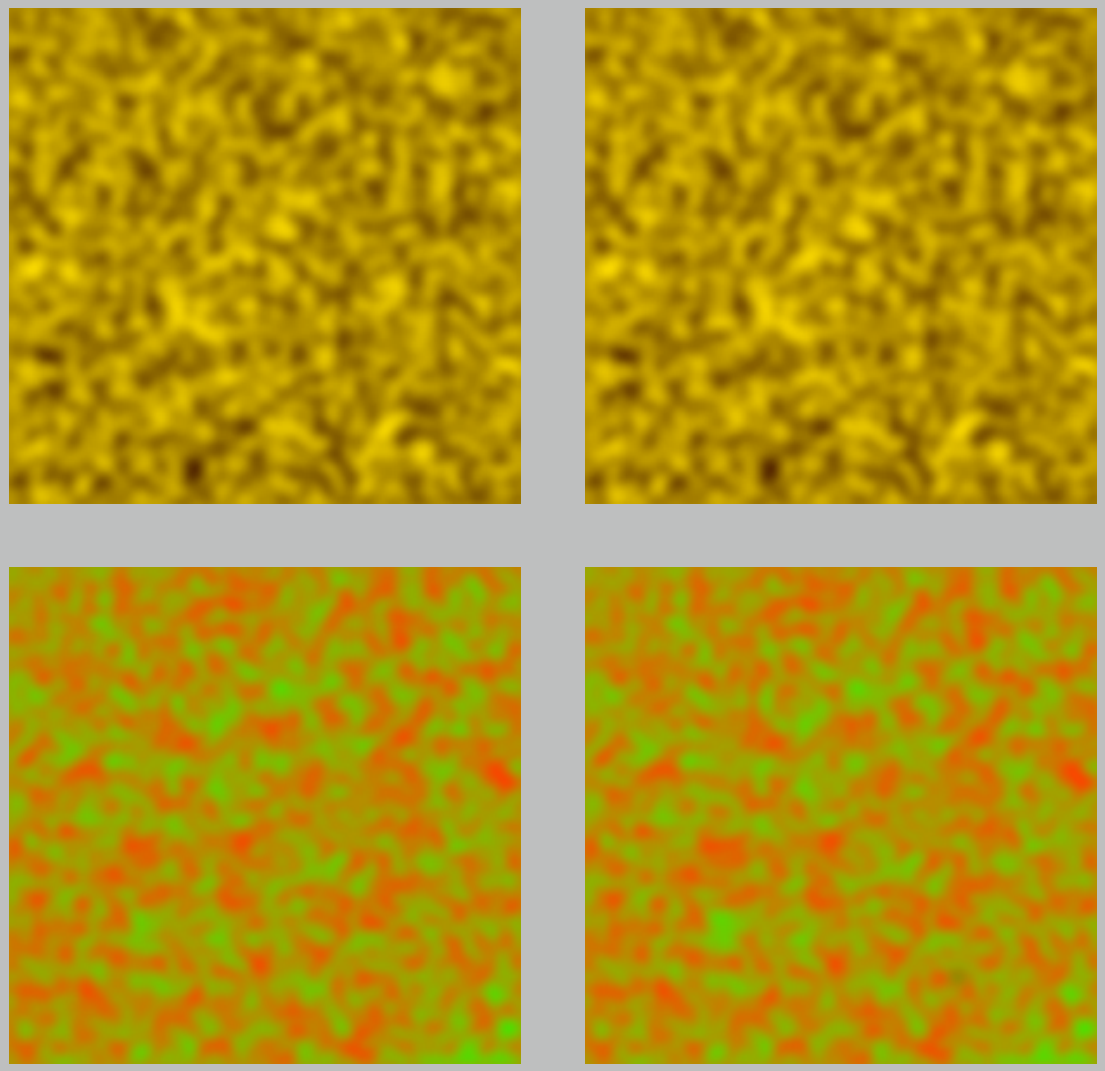
Stereo-defined shape discrimination

Isochromatic
yellow-black



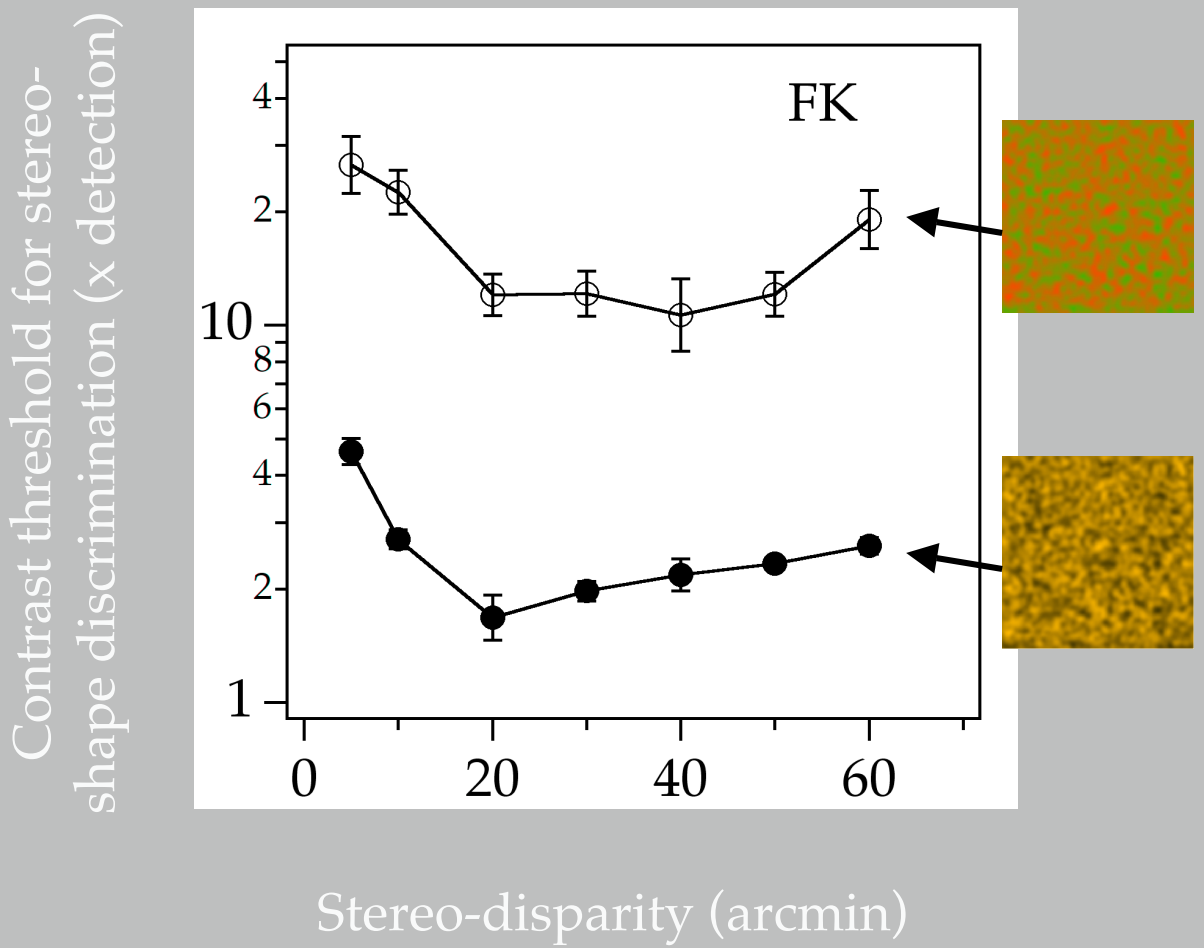
Isoluminant
Red-green



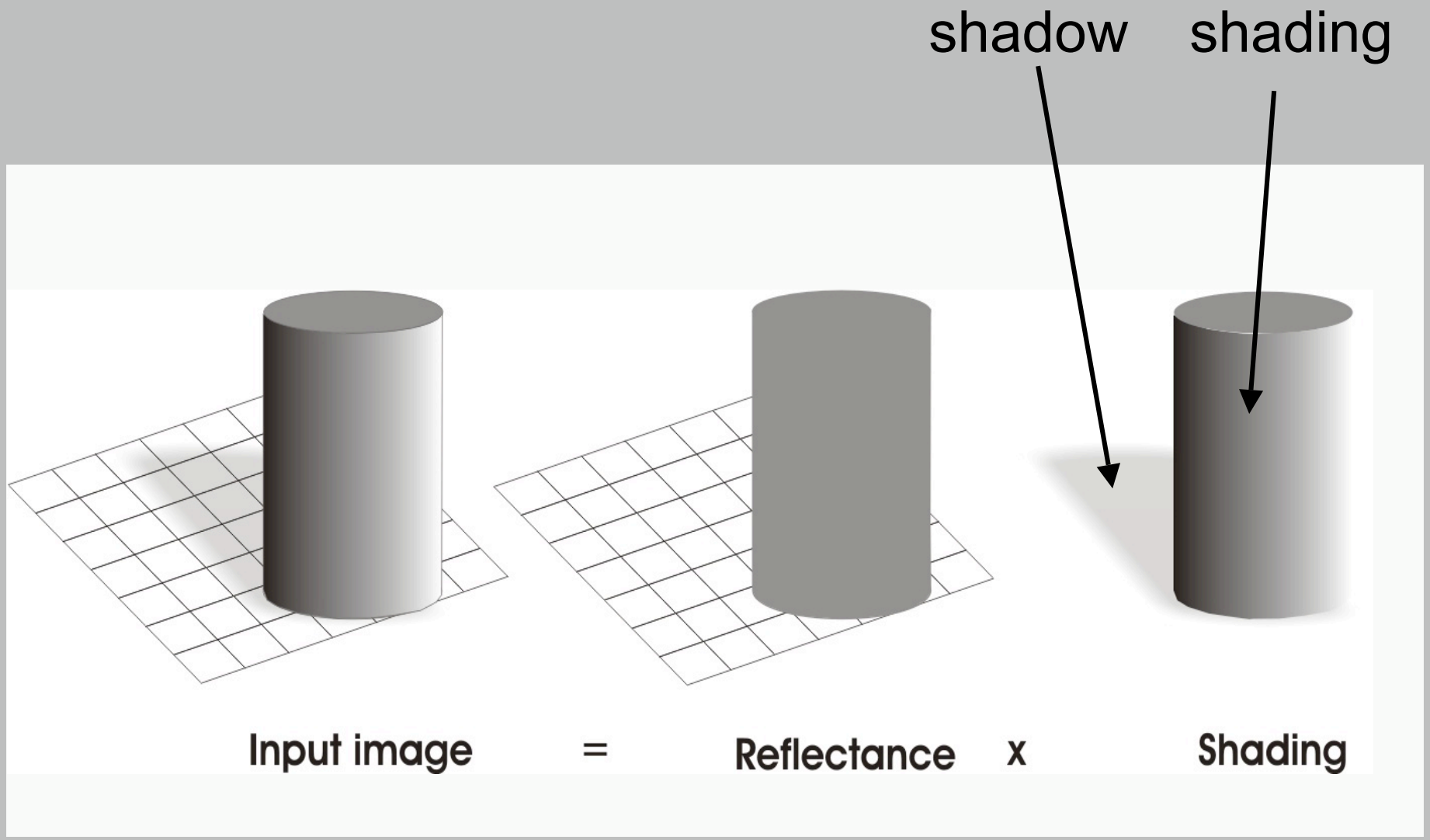


Stereo-defined shape discrimination

(from Kingdom et al. 1999)



'Intrinsic images'



Natural shadow

Illumination border

Material border

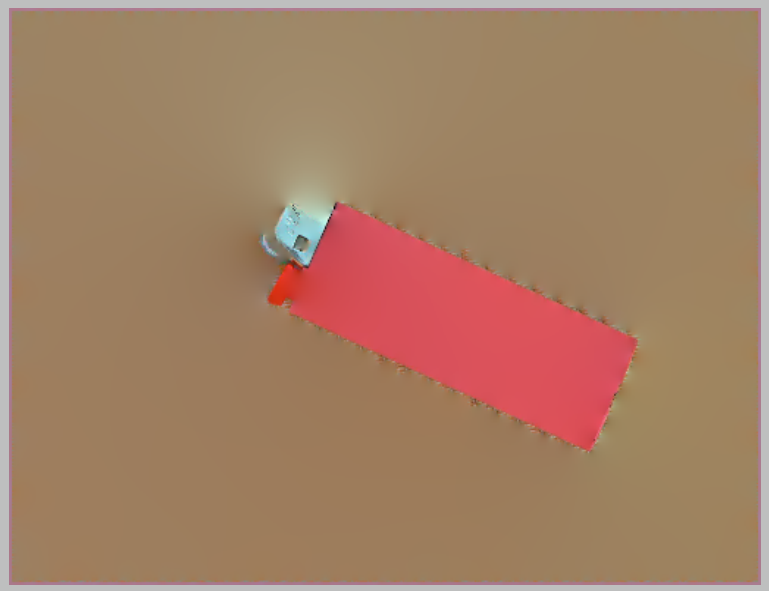
Original

Reflectance

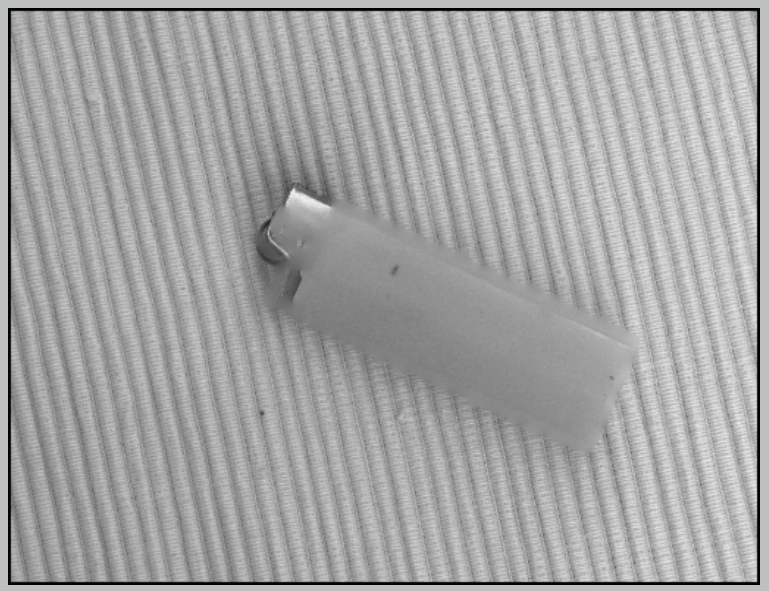
Shading

Olmos & Kingdom's (2004) reflectance-shading separation algorithm

Original



Reflectance



Shadows & Shading

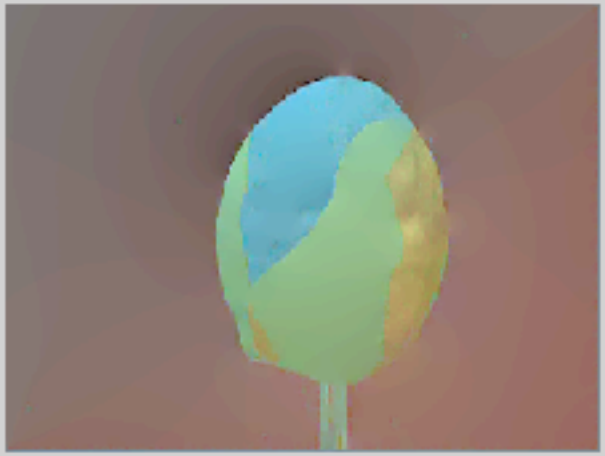
Original

Reflectance

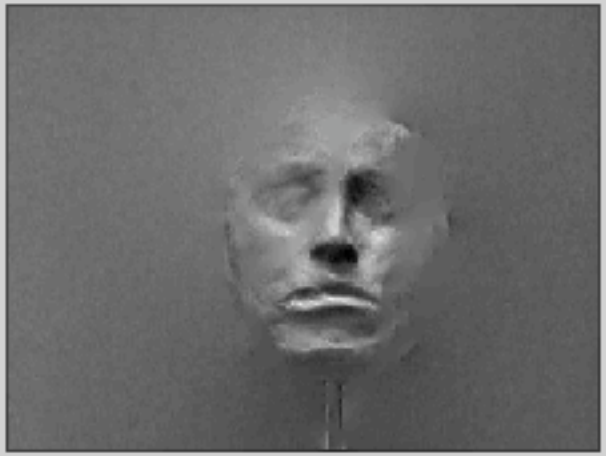
Shadows & Shading

Original Image

Reflectance Image



Shading Image



Original

Shadows & Shading

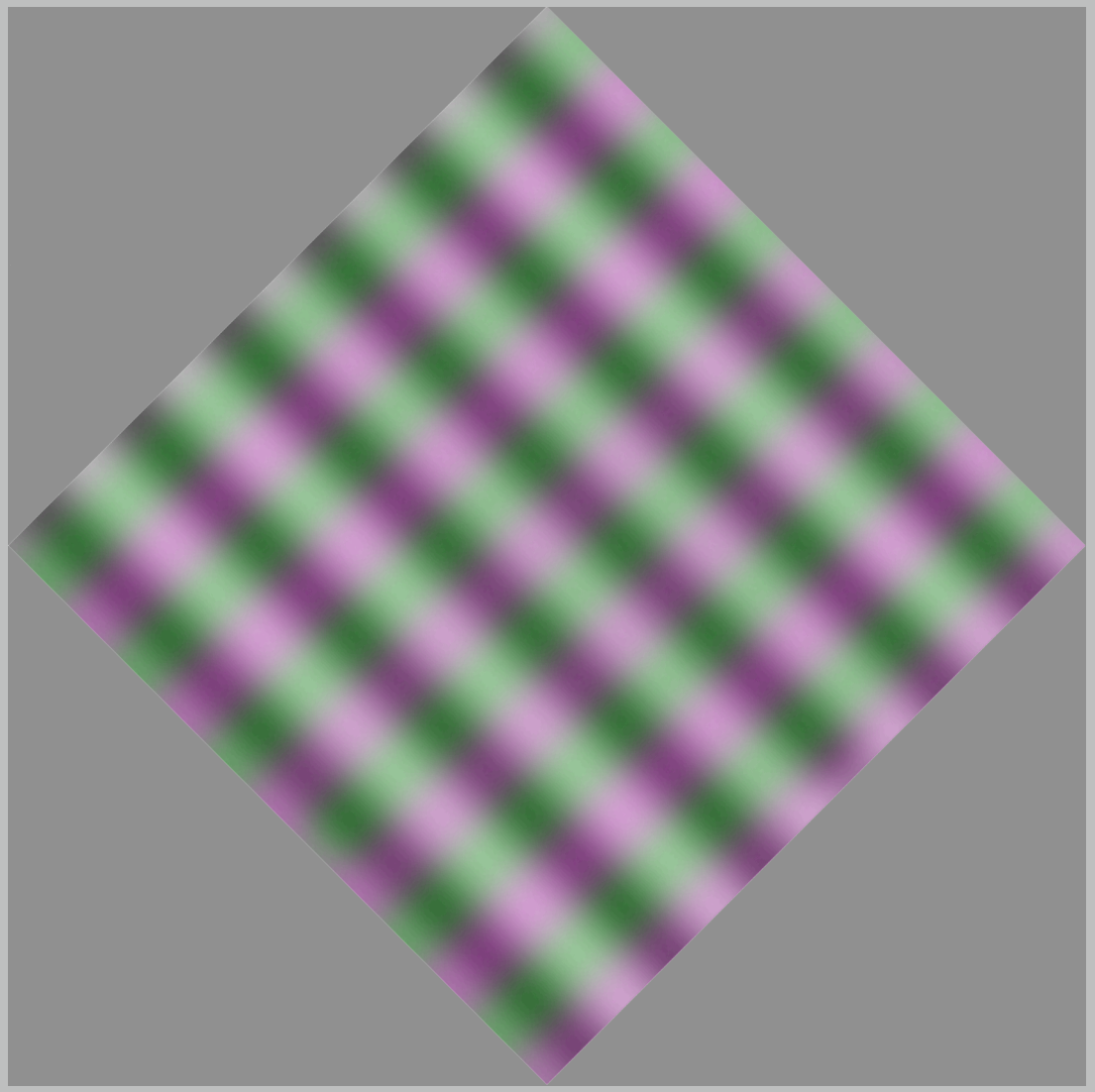
Reflectance

Colour disambiguates reflectance from illumination

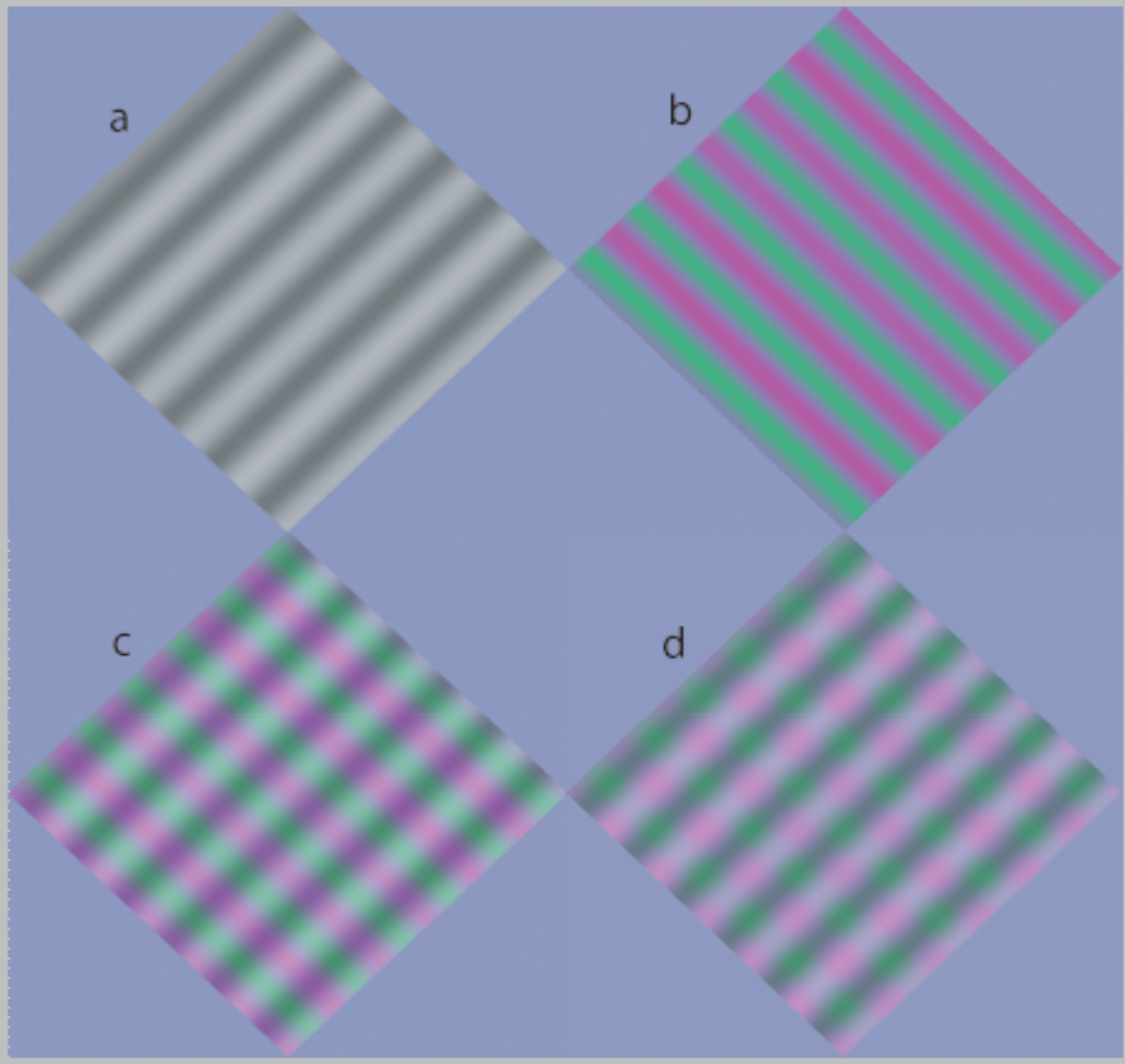
Shadows or dye ?

Shadows or dye ?

The 'colour shading effect'
Kingdom (2003)



Colour shading effect



Colour shading effect - controls

(from Kingdom, 2003)

c = a + b

d = a+ b rotated

e = a+ a rotated

f = b + b rotated