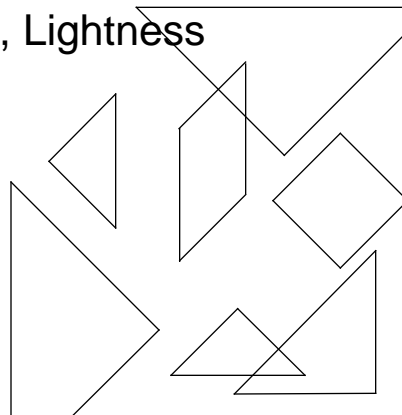


# Lightness & Brightness Perception

Ming Huan Lee  
Jan. 27, 2003

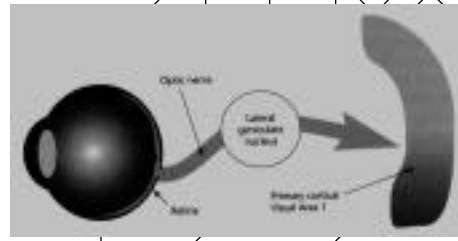
## Agenda

- ◆ Neurons, Receptive Fields, and Brightness Illusions
- ◆ Luminance, Brightness, Lightness
- ◆ Lightness Constancy
- ◆ Monitor Brightness
- ◆ More Illusions



# Neurons and Receptive Fields

- ◆ perception of “differences”
  - relative amount of light (differ/change)
  - nonlinear, no absolute values
- ◆ Difference of Gaussians (DOG)
  - brightness contrast effects

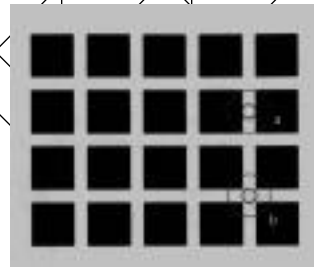


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# Hermann Grid Illusion

- ◆ there is more inhibition at the points between two squares, and hence they seem brighter than the points at the intersections

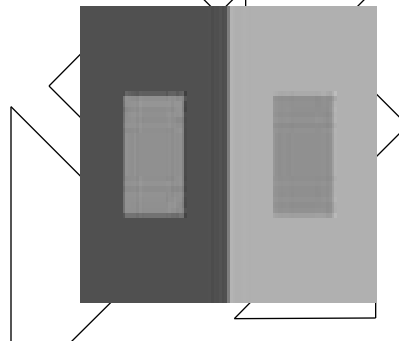


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# Simultaneous Brightness Contrast

- ◆ the general effect whereby a grey patch placed on a dark background looks lighter than the same grey patch on a light background

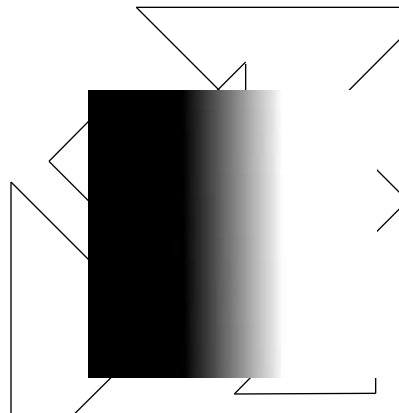


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# Mach Band

- ◆ the bright and dark vertical lines at the margins of the luminance ramp are not physically present

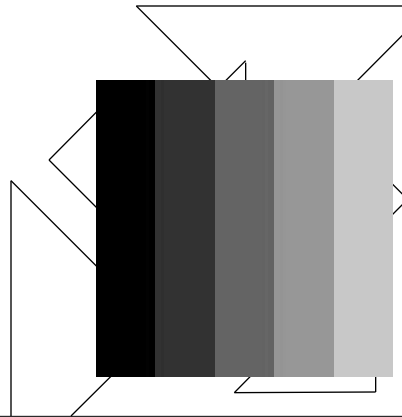


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# Chevreul Illusion

- ◆ the bands appear darker at one edge than at the other

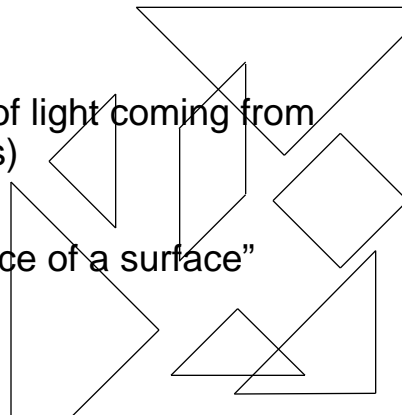


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# Quantity of Light

- ◆ Luminance  
“the measured amount of light coming from some region of space”
- ◆ Brightness  
“the perceived amount of light coming from a source” (self-luminous)
- ◆ Lightness  
“the perceived reflectance of a surface”



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# Merriam-Webster

## ◆ Luminance

“the luminous intensity of a surface in a given direction per unit of projected area”

## ◆ Brightness

“the attribute of light-source colours by which emitted light is ordered continuously from light to dark in correlation with its intensity”

## ◆ Lightness

“the attribute of object colours by which the object appears to reflect or transmit more or less of the incident light”

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[www.m-w.com](http://www.m-w.com)

# Luminance

## ◆ physical measure

- candelas per square meter

## ◆ luminance channel

- vision research, pattern perception, depth perception, and motion perception

## ◆ example

- text contrast
- the finer the detail, the greater the contrast

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# Lightness Constancy

- ◆ the apparent overall reflectance of a surface
- ◆ objects' spectral reflectance characteristics
- ◆ human vision system evolved to extract information about surface properties of objects, often at the expense of losing information about the quality and quantity of light entering the eye

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# Adaptation

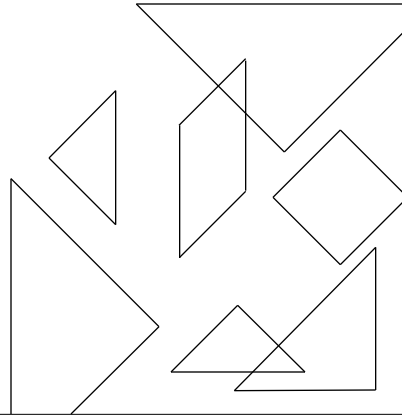
- ◆ luminance is completely unrelated to perceived lightness or brightness
  - a black object on a bright day in a beach environment may reflect 20 times more light than white paper in an office
- ◆ the changing sensitivity of the receptors and neurons in the eye helps factor out the overall level of illumination
  - briefly blinded when coming into a darkened room out of bright sunlight

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# Contrast

- ◆ help to achieve constancy by signalling differences in light levels (edge of objects)
- ◆ simultaneous contrast

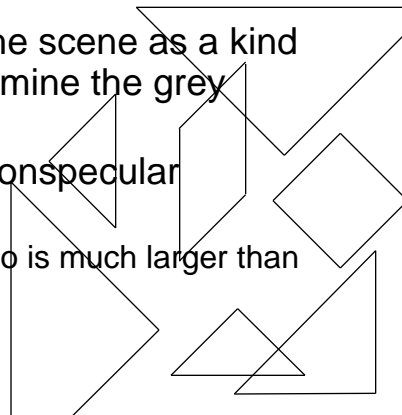


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# Additional Factors

- ◆ take the direction of illumination and surface orientation into account in lightness judgements
- ◆ use the lightest object in the scene as a kind of *reference white* to determine the grey values of all other objects
- ◆ the ratio of specular and nonspecular reflection
  - in the all-dark world, the ratio is much larger than in the all-white world



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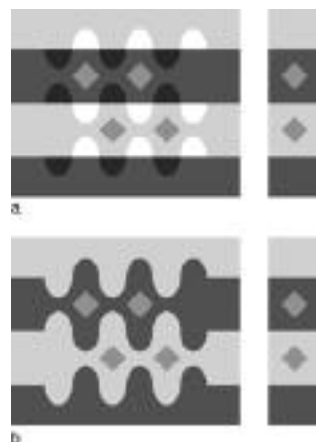
# Monitor Brightness

- ◆ the colour and the brightness of the surround of the monitor can be very important in determining how screen objects appear
- ◆ the adaptation effect produced by room light
- ◆ overall contrast is much reduced where the room light falls on the display

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# Snake Illusion

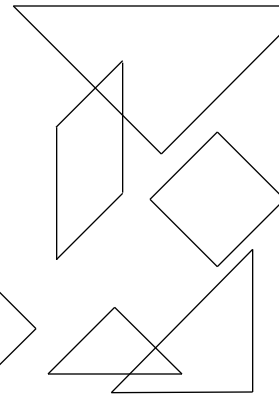
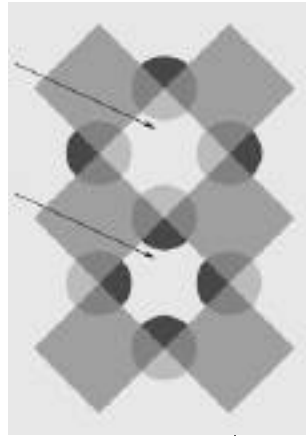
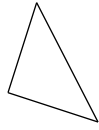


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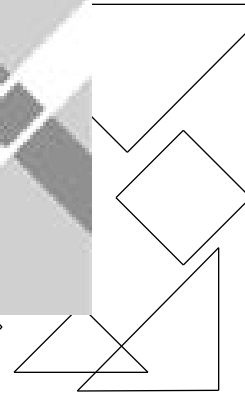
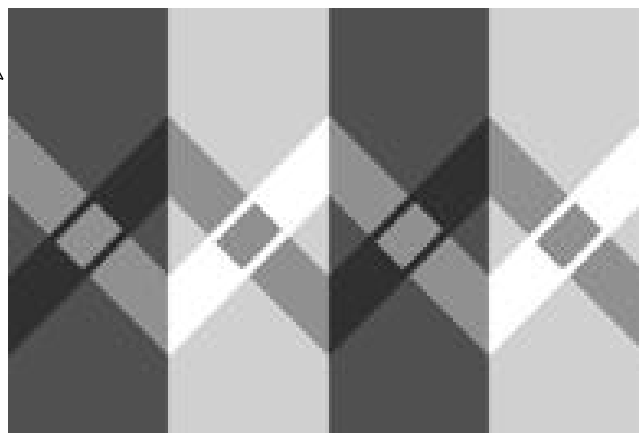
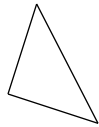
# Illusion of Haze



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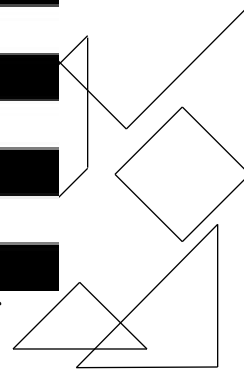
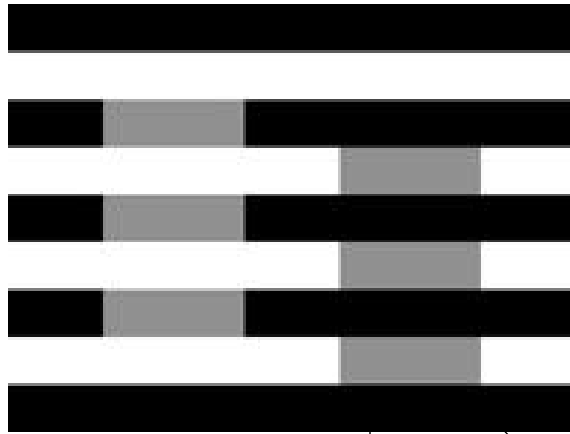
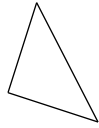
# Cross-cross Illusion



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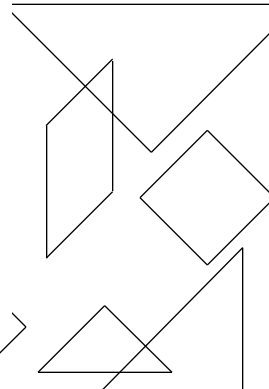
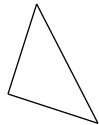
# White's Illusion



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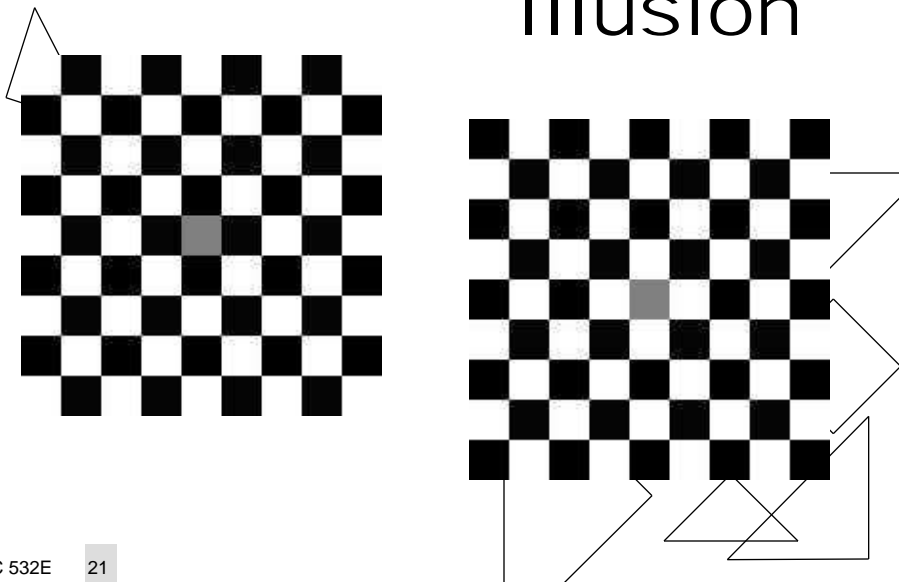
# Benary Cross



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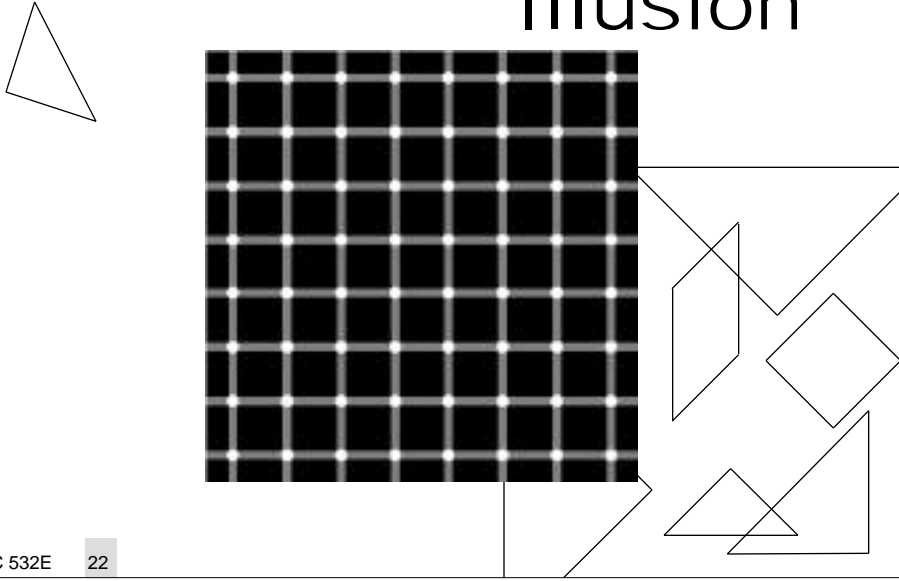
20

# Checkerboard Illusion



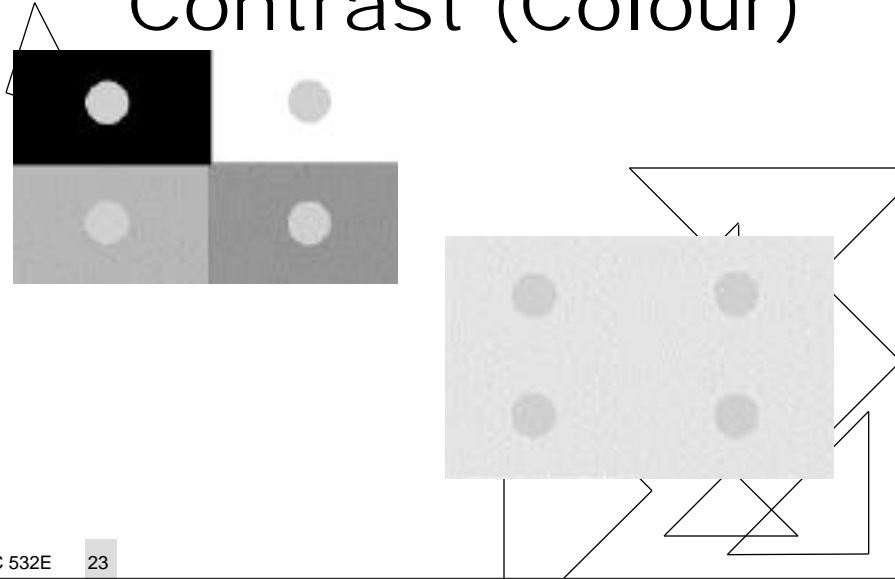
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# Scintillating Grid Illusion

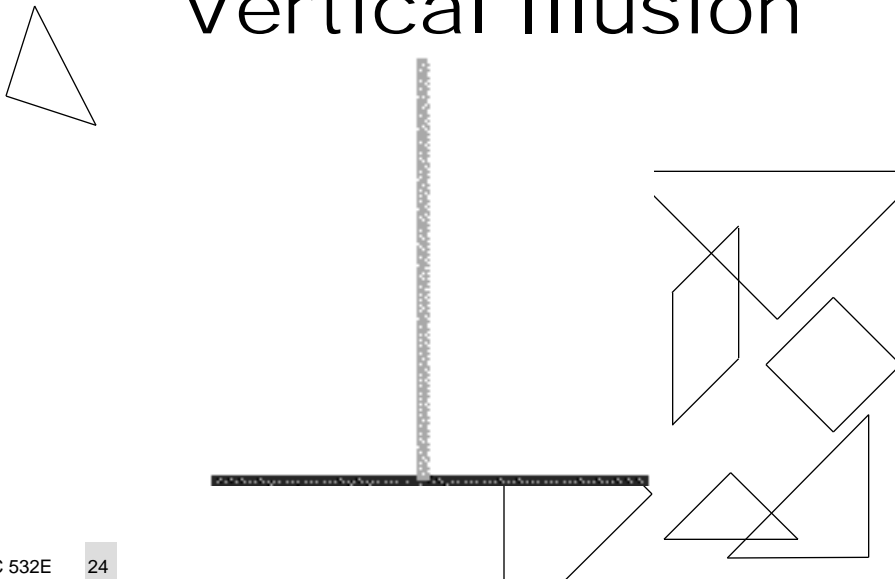


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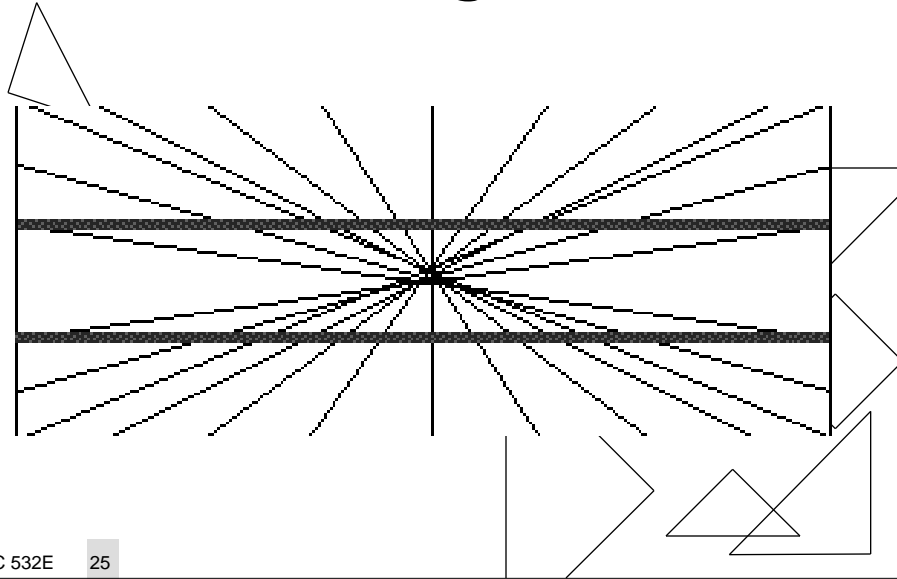
# Simultaneous Contrast (Colour)



# Horizontal-Vertical Illusion

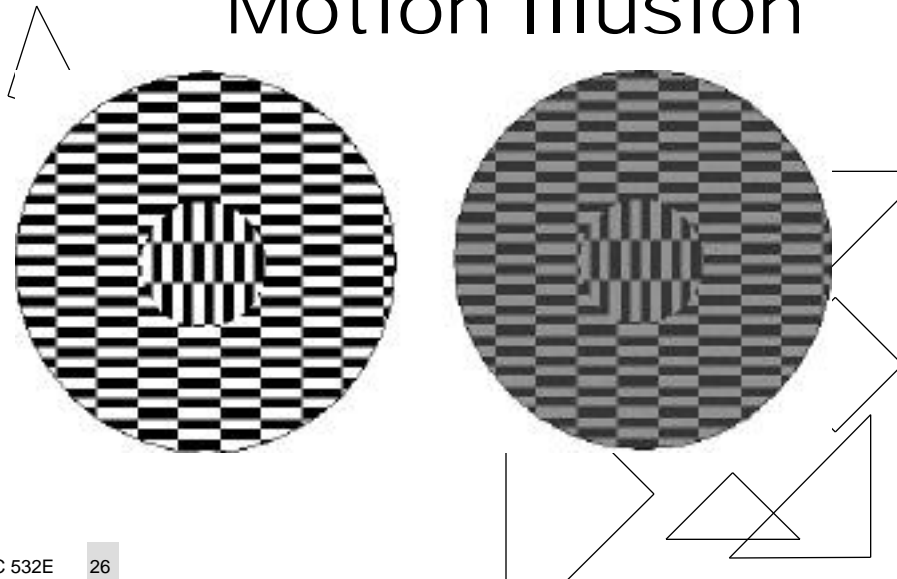


# Hering Illusion



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# Ouchi Apparent Motion Illusion



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