EECS 431
Human Perception and Electronic Media
Lecture 1

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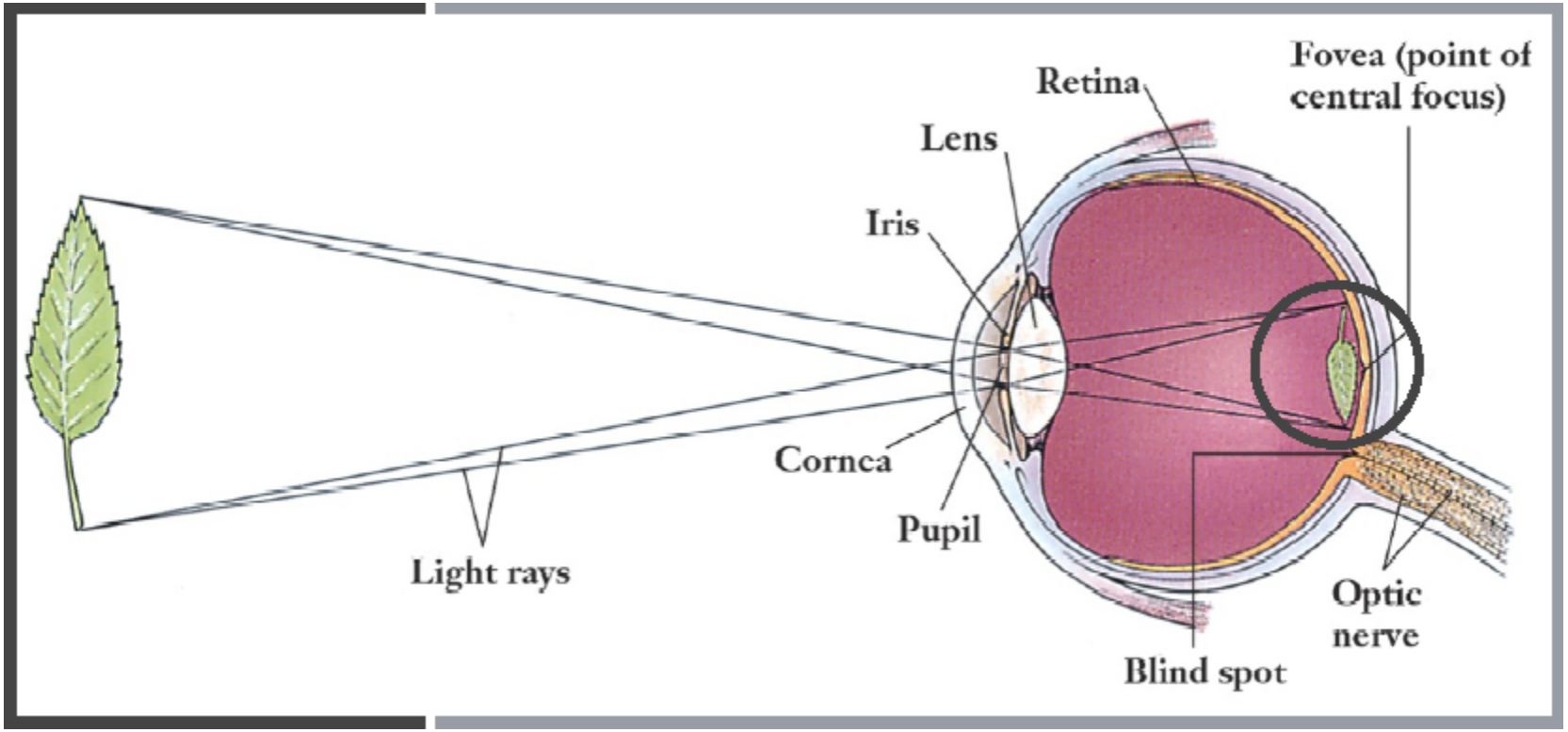
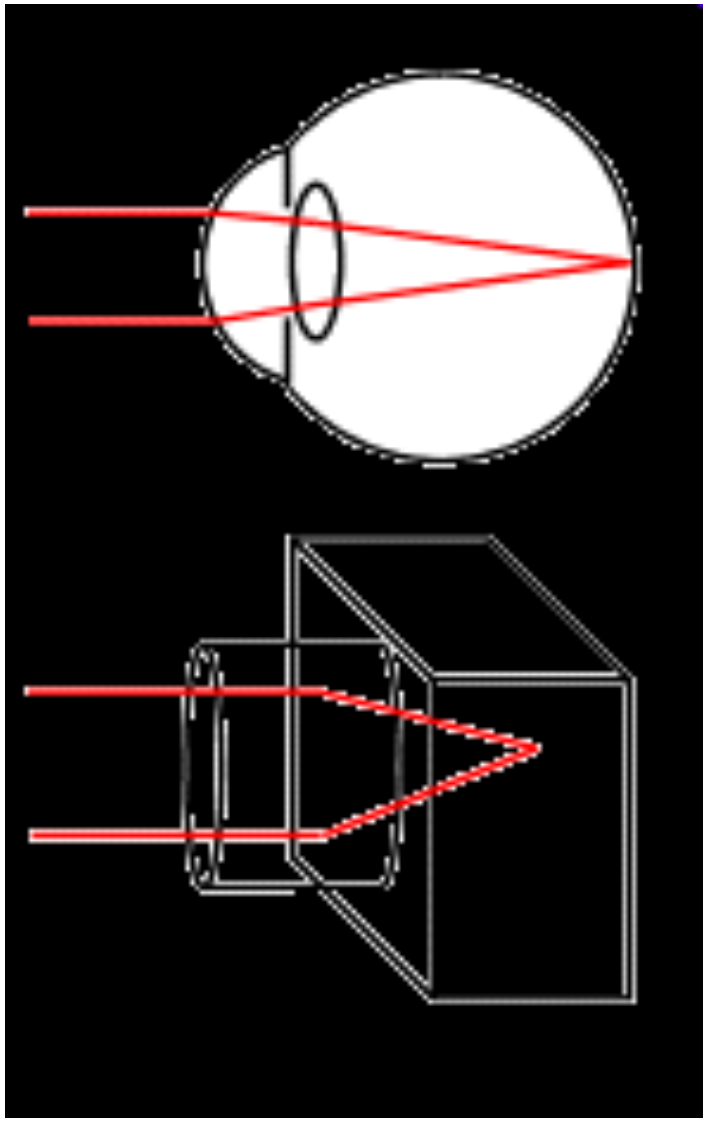
Electrical Engineering & Computer Science Department
Northwestern University

Winter 2018

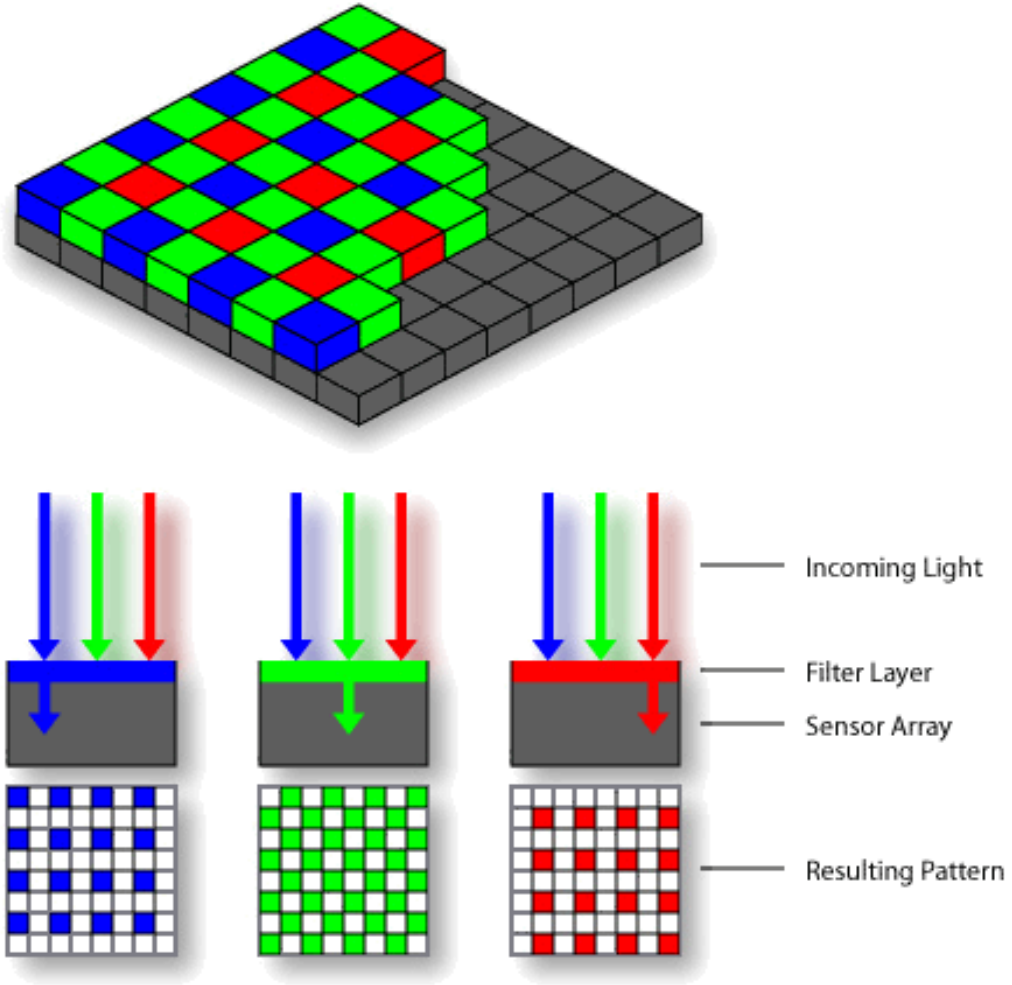
Human Eye


Fovea (point of central focus)
Retina
Lens
Iris
Cornea
Pupil
Light rays
Optic nerve
Blind spot

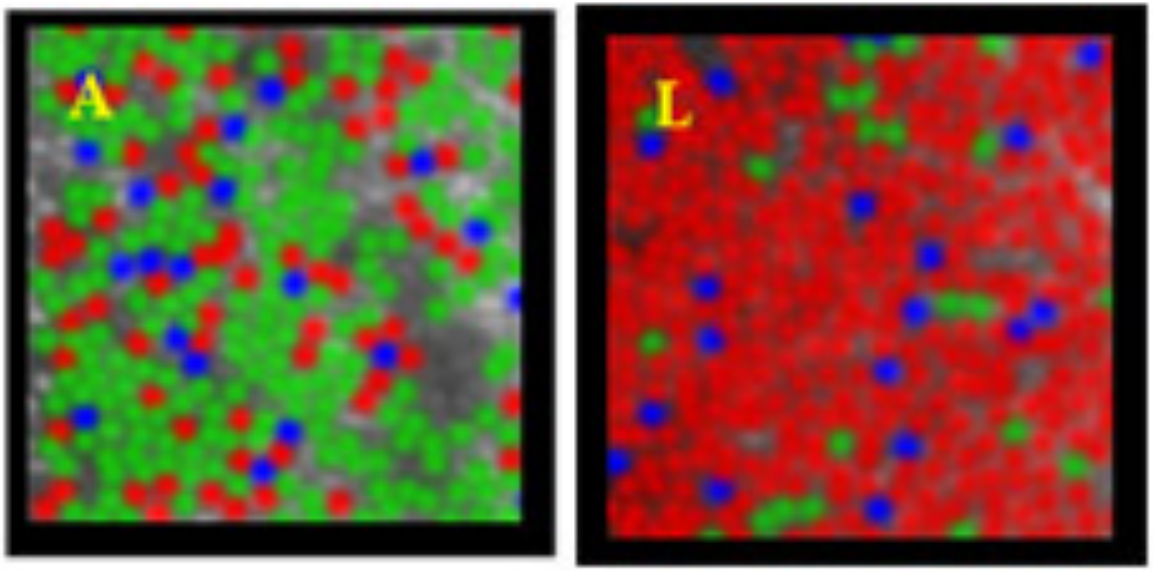
Human Eye vs. Digital Camera



Digital Camera



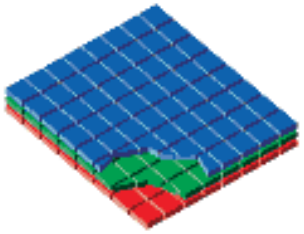
Human Eye: Cone Distribution



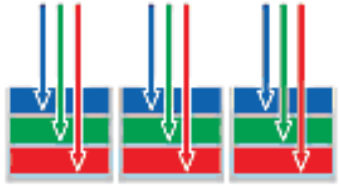
Cones: Eye Sensors

Digital Camera

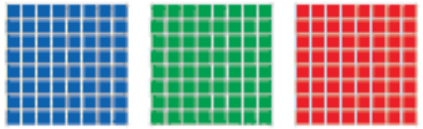
Foveon X3® Capture



A Foveon X3 direct image sensor features three separate layers of pixel sensors embedded in silicon.

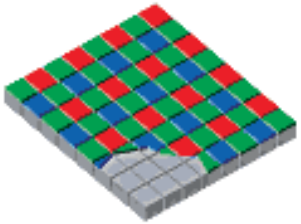


Since silicon absorbs different wavelengths of light at different depths, each layer records a different color. Because the layers are stacked together, all three colors are captured.

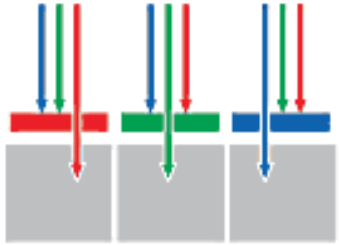


As a result, only Foveon X3 direct image sensors capture red, green, and blue light at every pixel location.

Mosaic Capture



In conventional systems, color filters are applied to a single layer of pixel sensors in a tiled mosaic pattern.

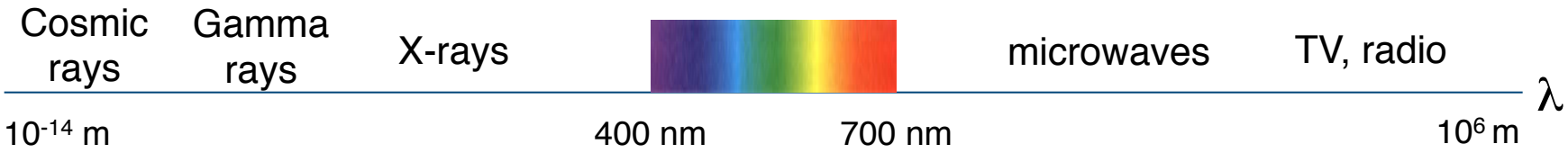


The filters let only one wavelength of light–red, green, or blue–pass through to any given pixel location, allowing it to record only one color.

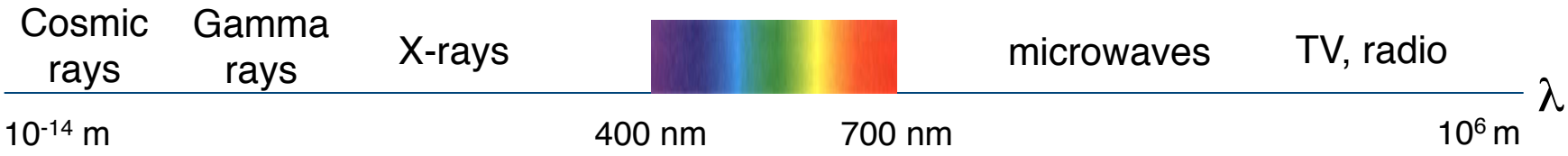
As a result, mosaic sensors capture only 25% of the red and blue light, and just 50% of the green.

Visible Light

- ElectroMagnetic spectrum



Visible Light



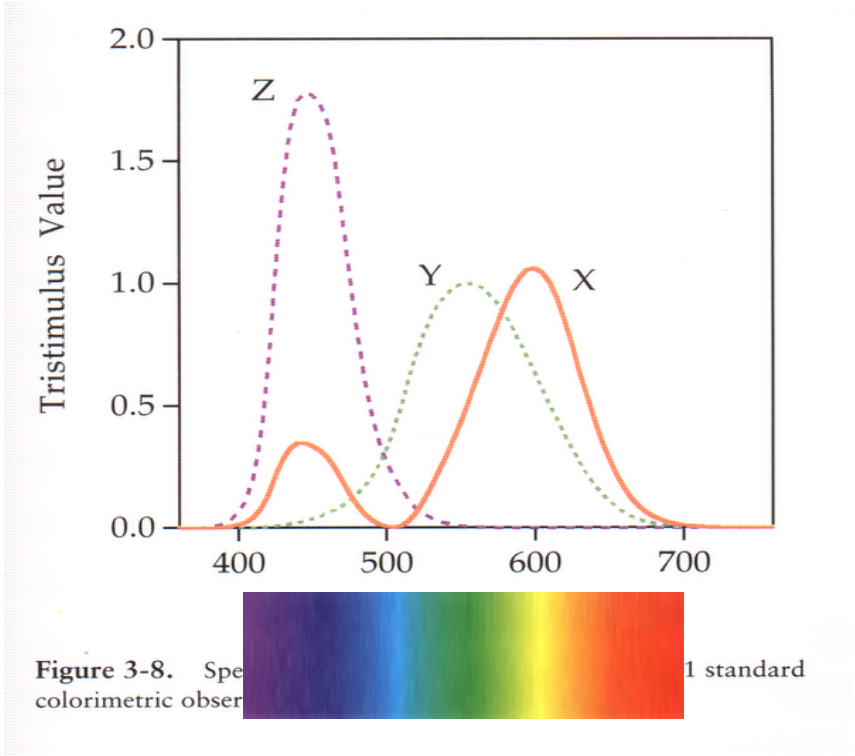
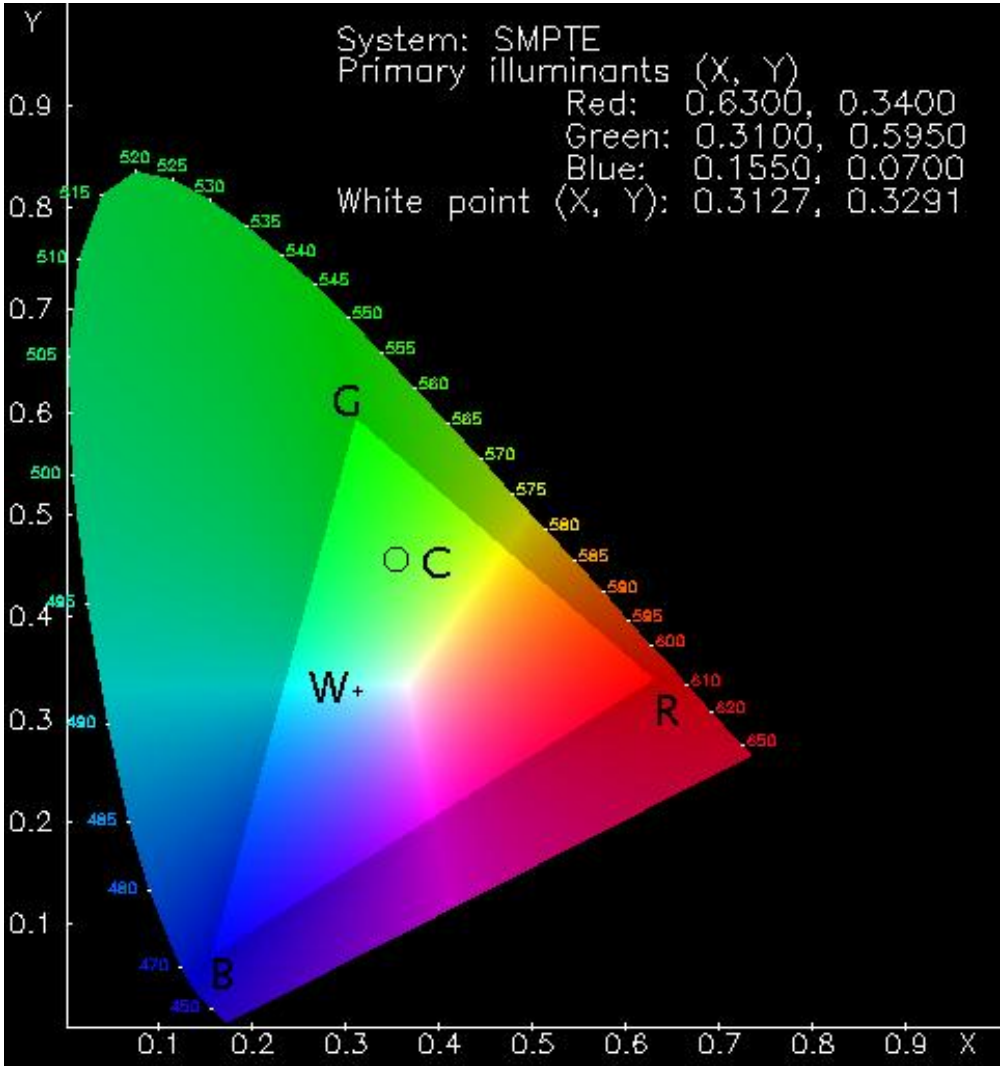
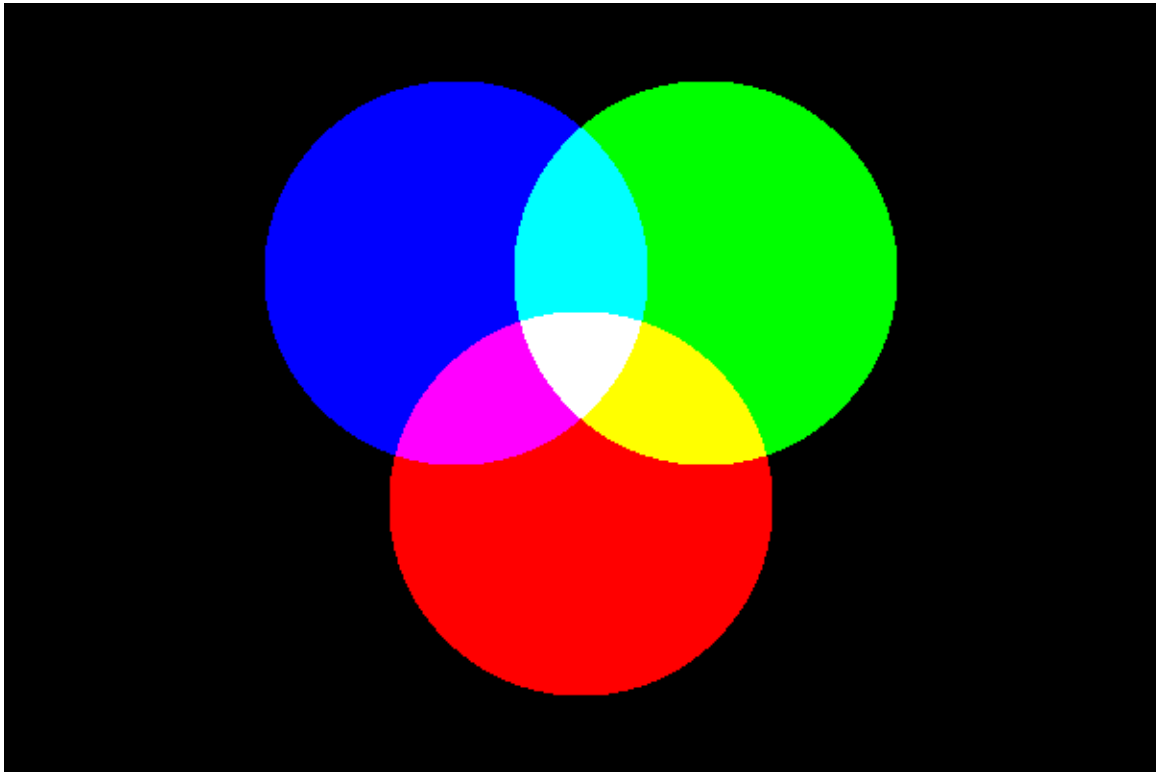


Figure 3-8. Spe 1 standard colorimetric obser

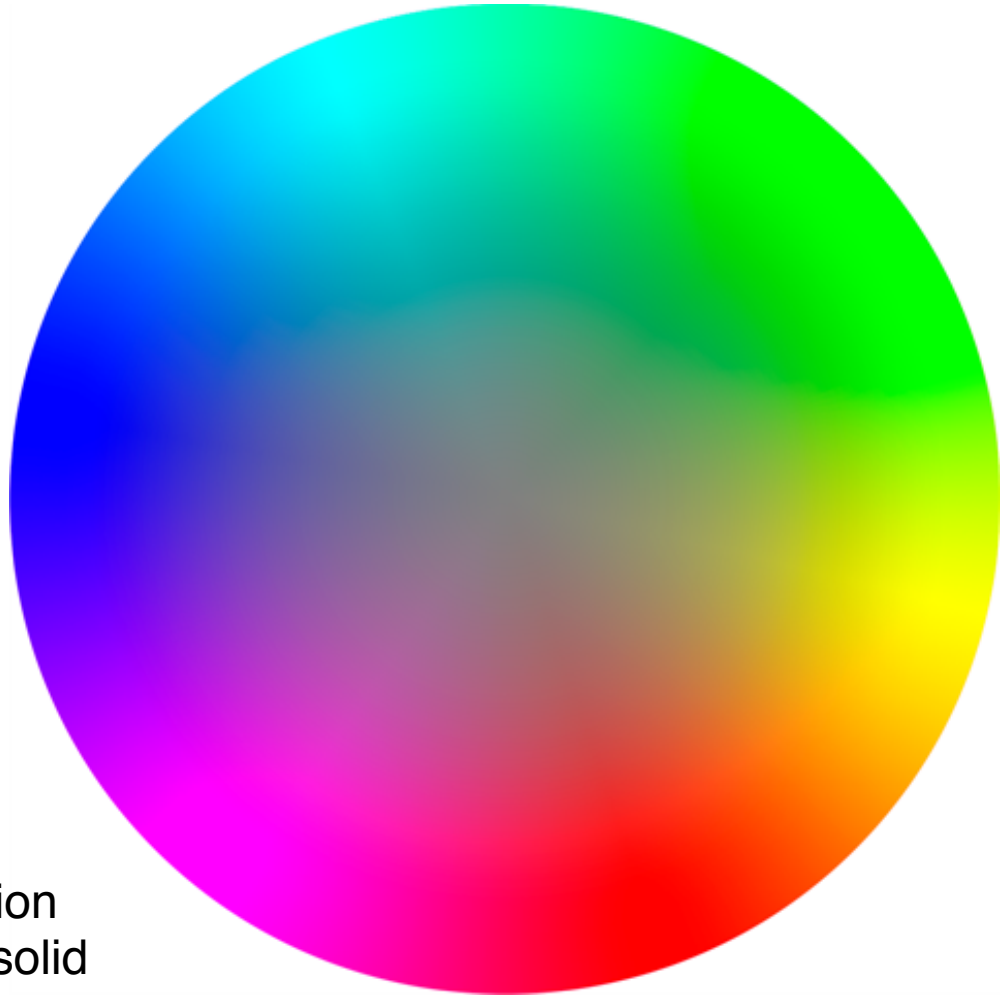
Color Perception



TV: Additive Color

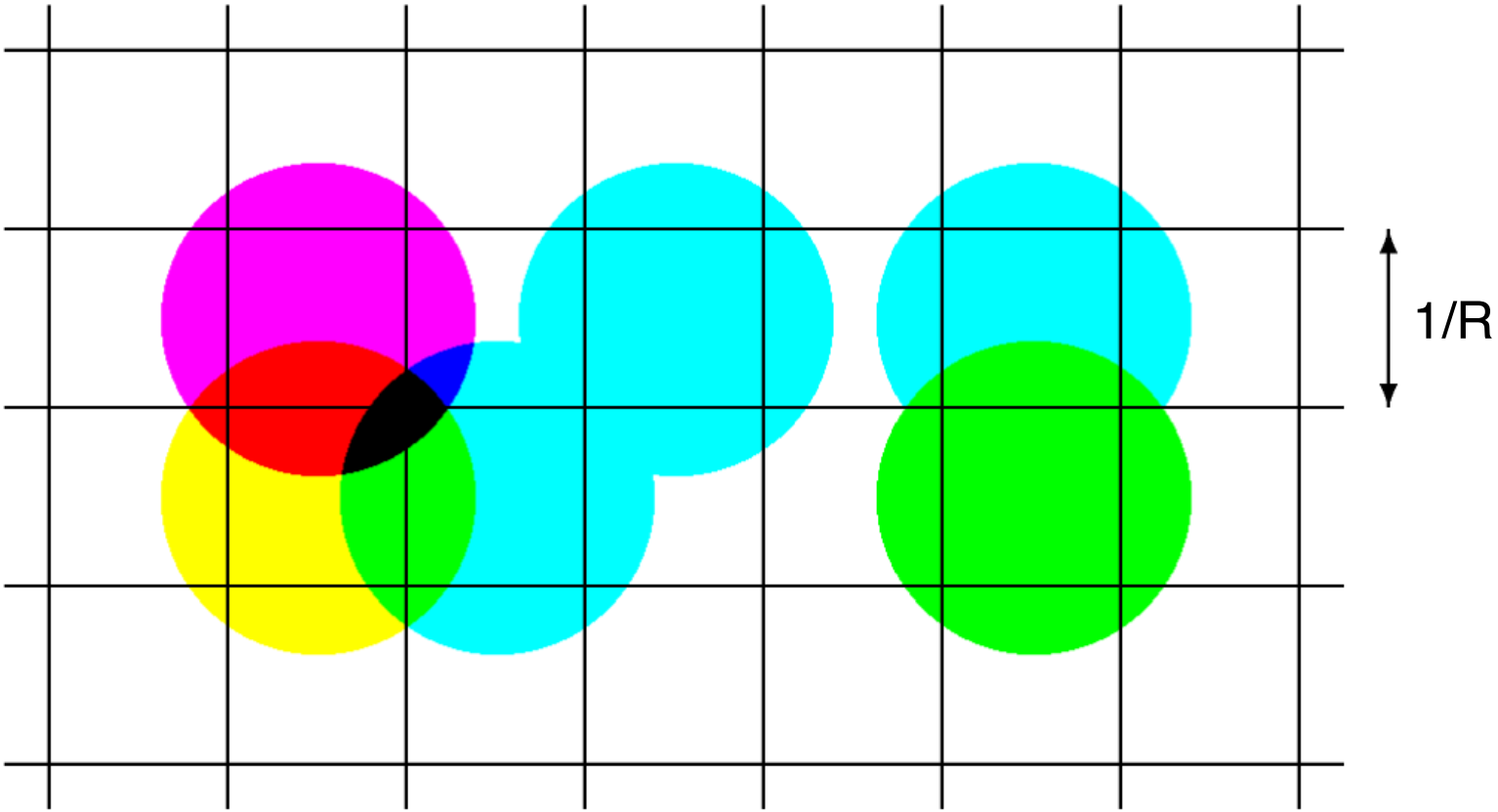


Color Circle



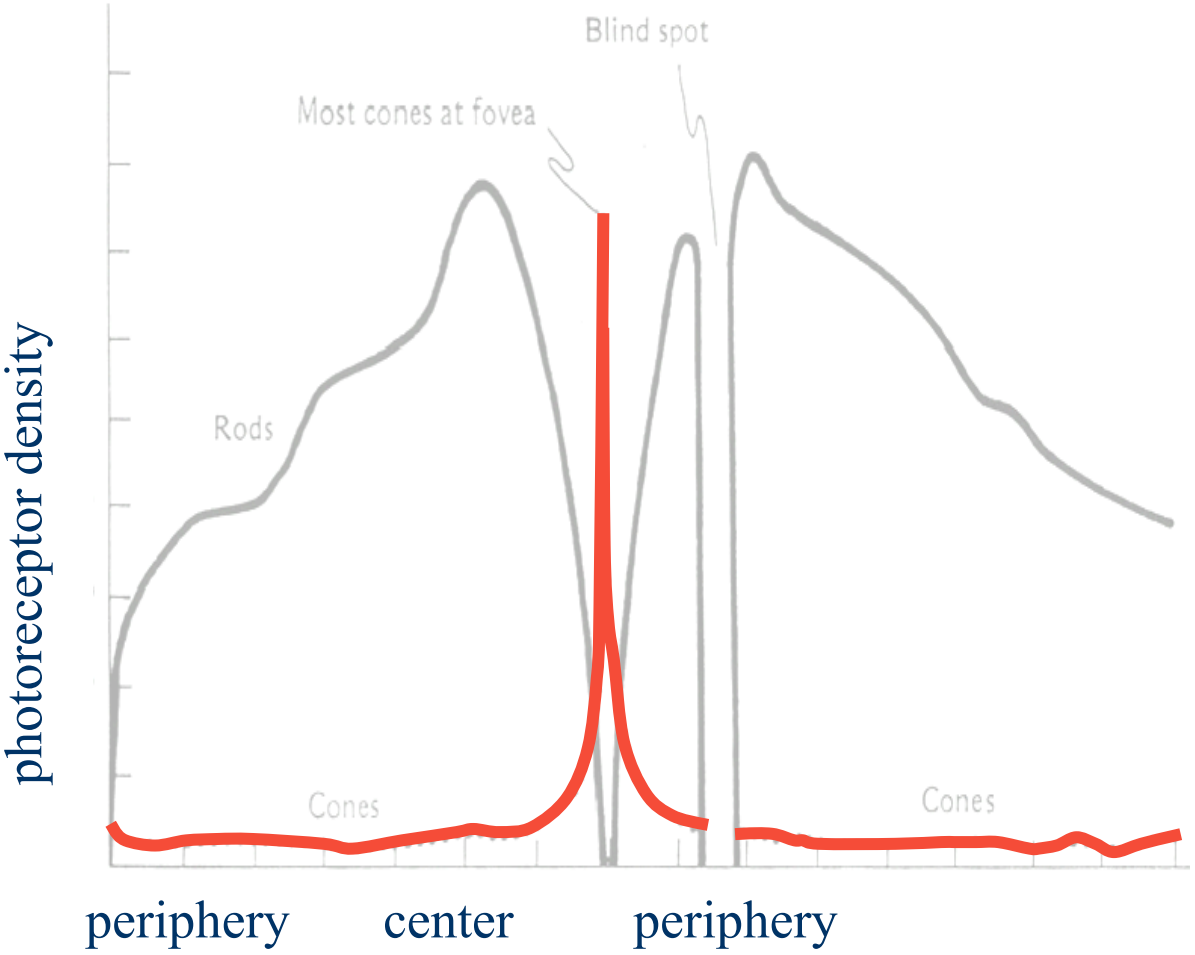
Oblique section
through color solid

Color Printer: Subtractive Color



Daniel Simons, UIUC

Eye Sensors

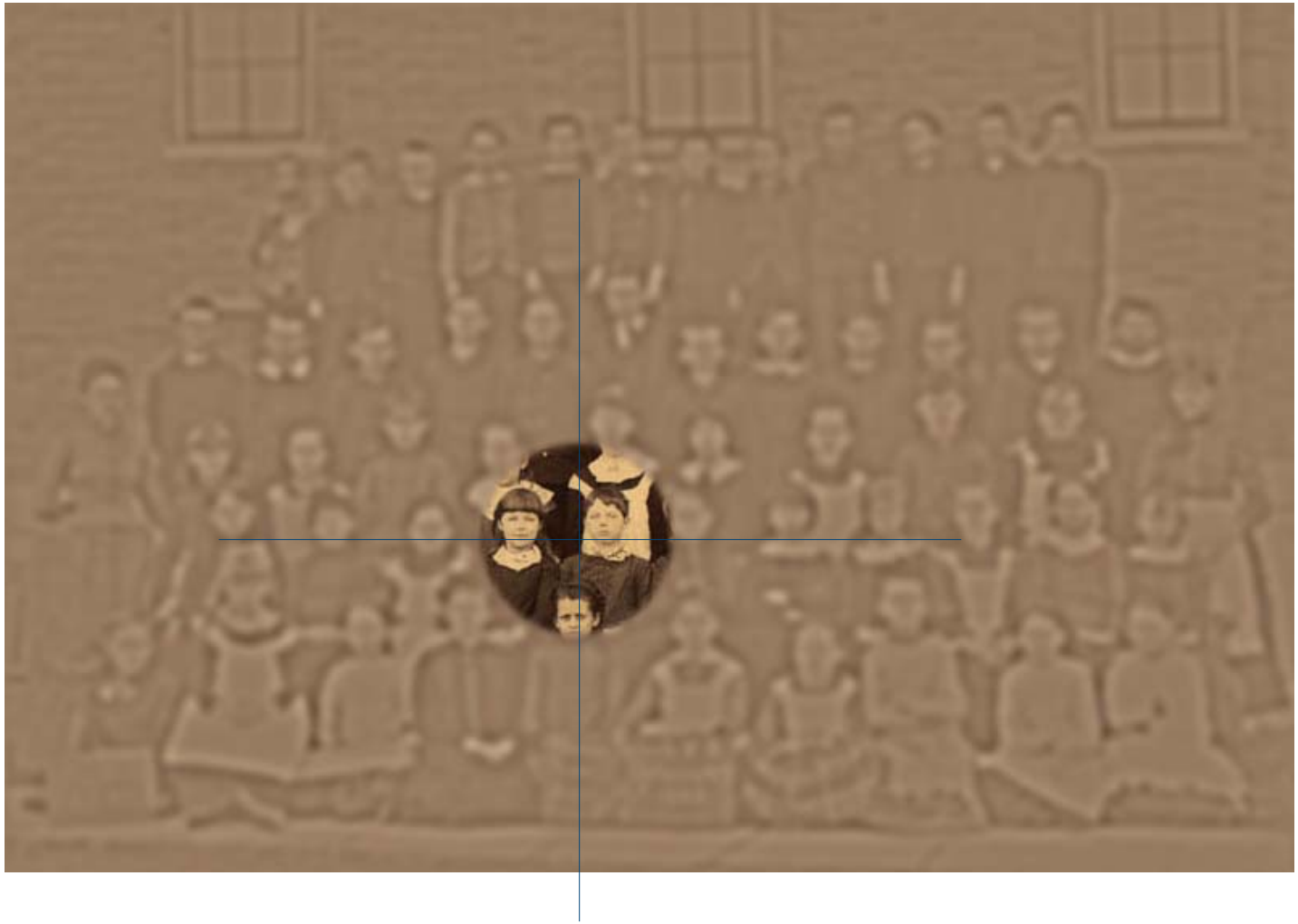


Jeff Pelz, RIT

Thrasos Pappas, Winter 2018

How The Eye Captures An Image

How The Eye Captures An Image



How The Eye Captures An Image

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How The Eye Captures An Image

How The Eye Captures An Image

“Change Blindness”

If we scan the environment to build up a high-fidelity image, then it should be easy to detect even small differences between two images.

Jeff Pelz, RIT

Try to identify the difference between *Image **A** & B*

Image A

Jeff Pelz, RIT

Try to identify the difference between *Image A & B*

Jeff Pelz, RIT

Try to find difference between *Image A & **B***

Image B

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Try to find difference between *Image A & B*

Try to find difference between *Image **A** & B*

Image A

Try to find difference between *Image A & B*

Try to find difference between *Image A & **B***

Image B

Jeff Pelz, RIT

Thrasos Pappas, Winter 2018

Try to find difference between *Image **A** & B*

Image A

Jeff Pelz, RIT

Thrasos Pappas, Winter 2018

Try to find difference between *Image A & **B***

Image B

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Attention Blindness

Attention Blindness

Image Understanding

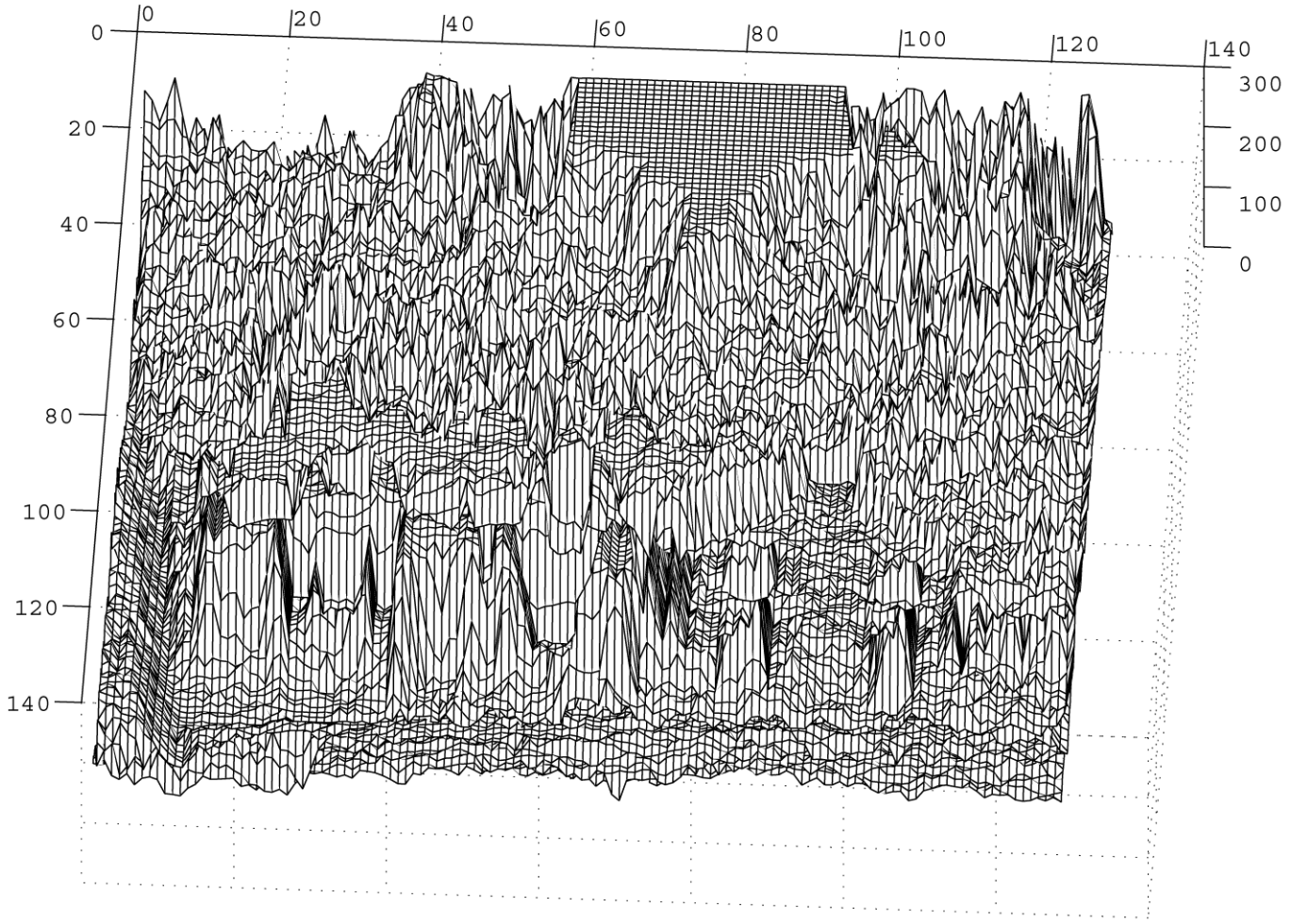


Image Understanding

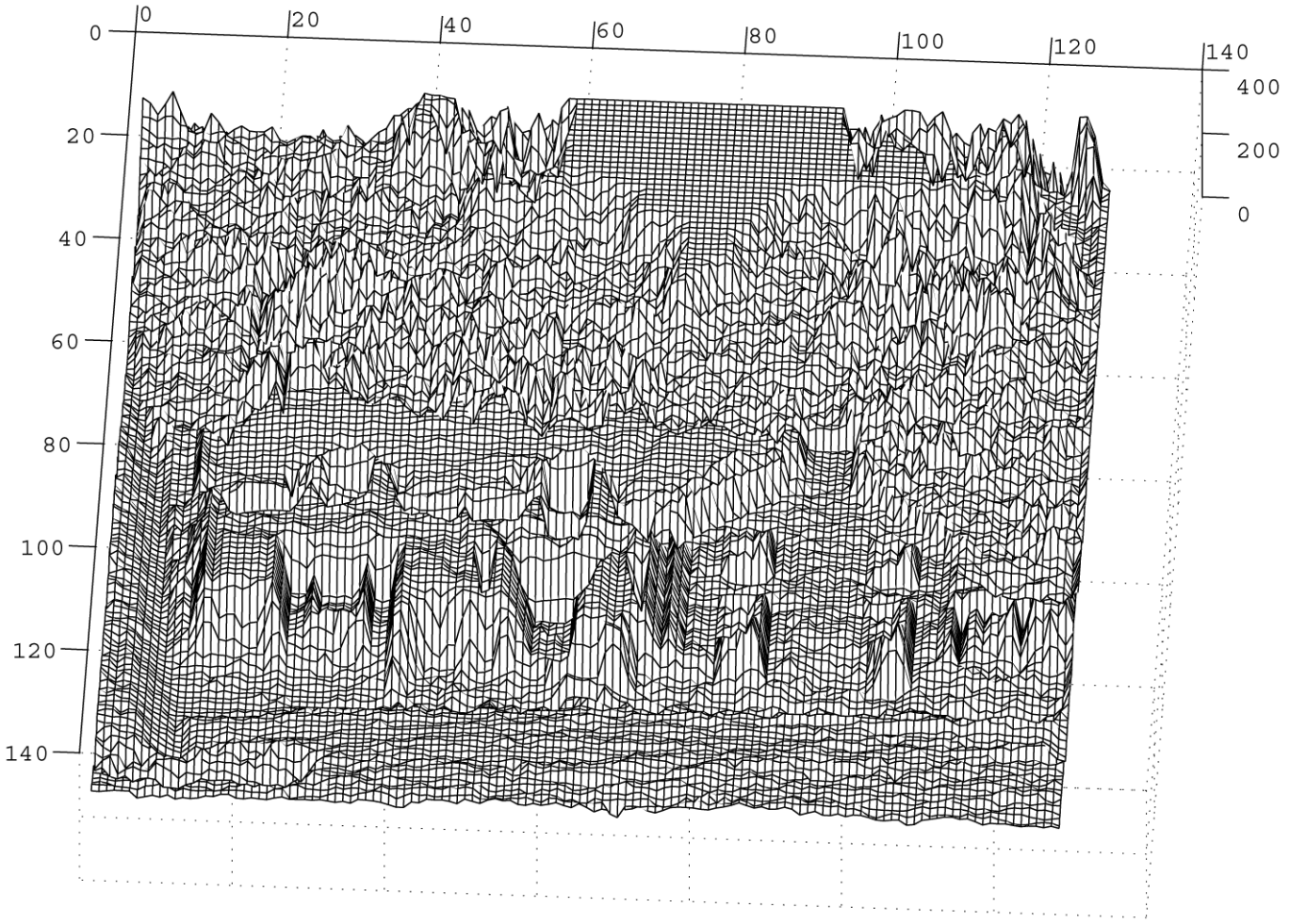


Image Understanding

Image Understanding

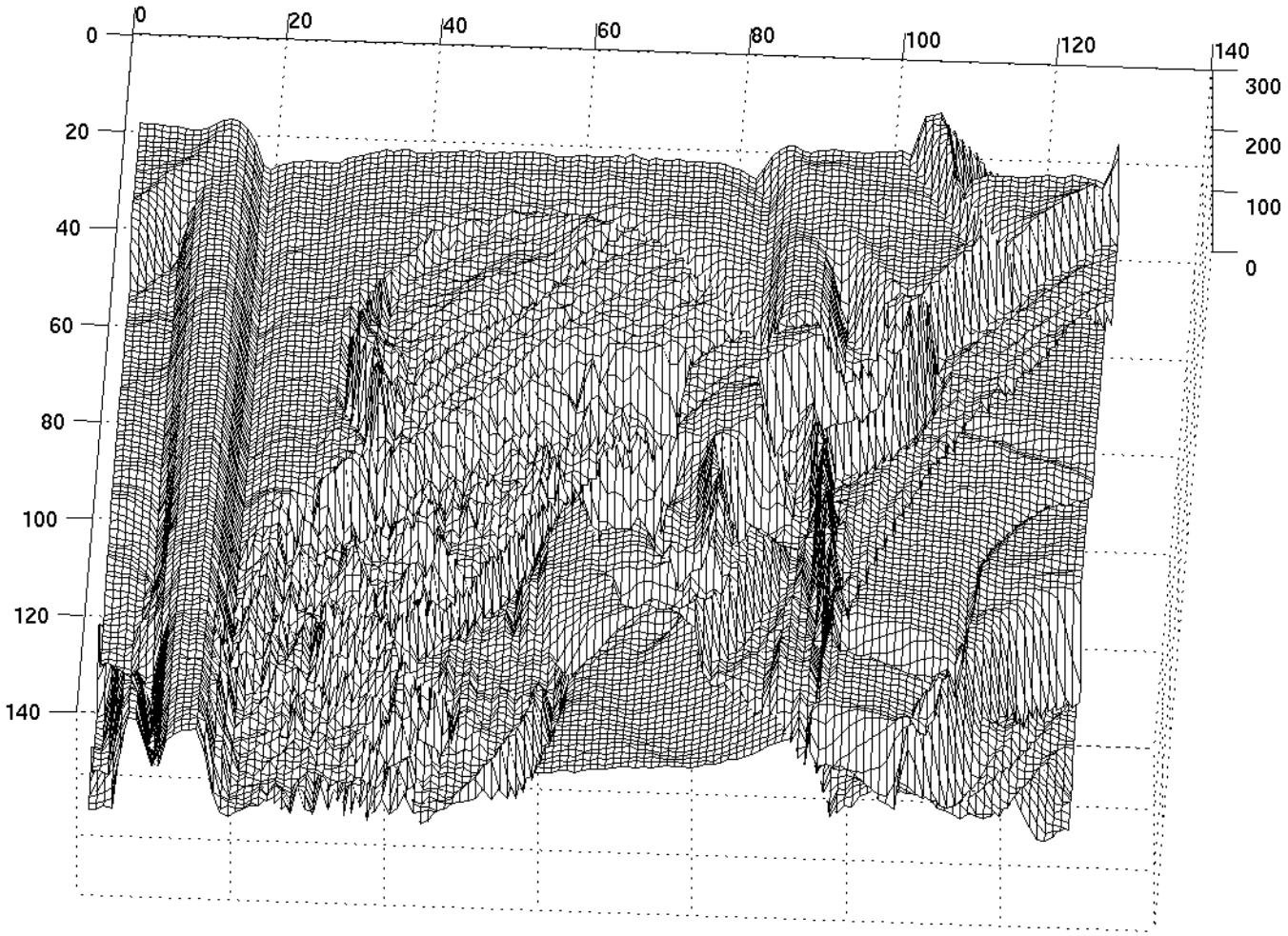


Image Understanding

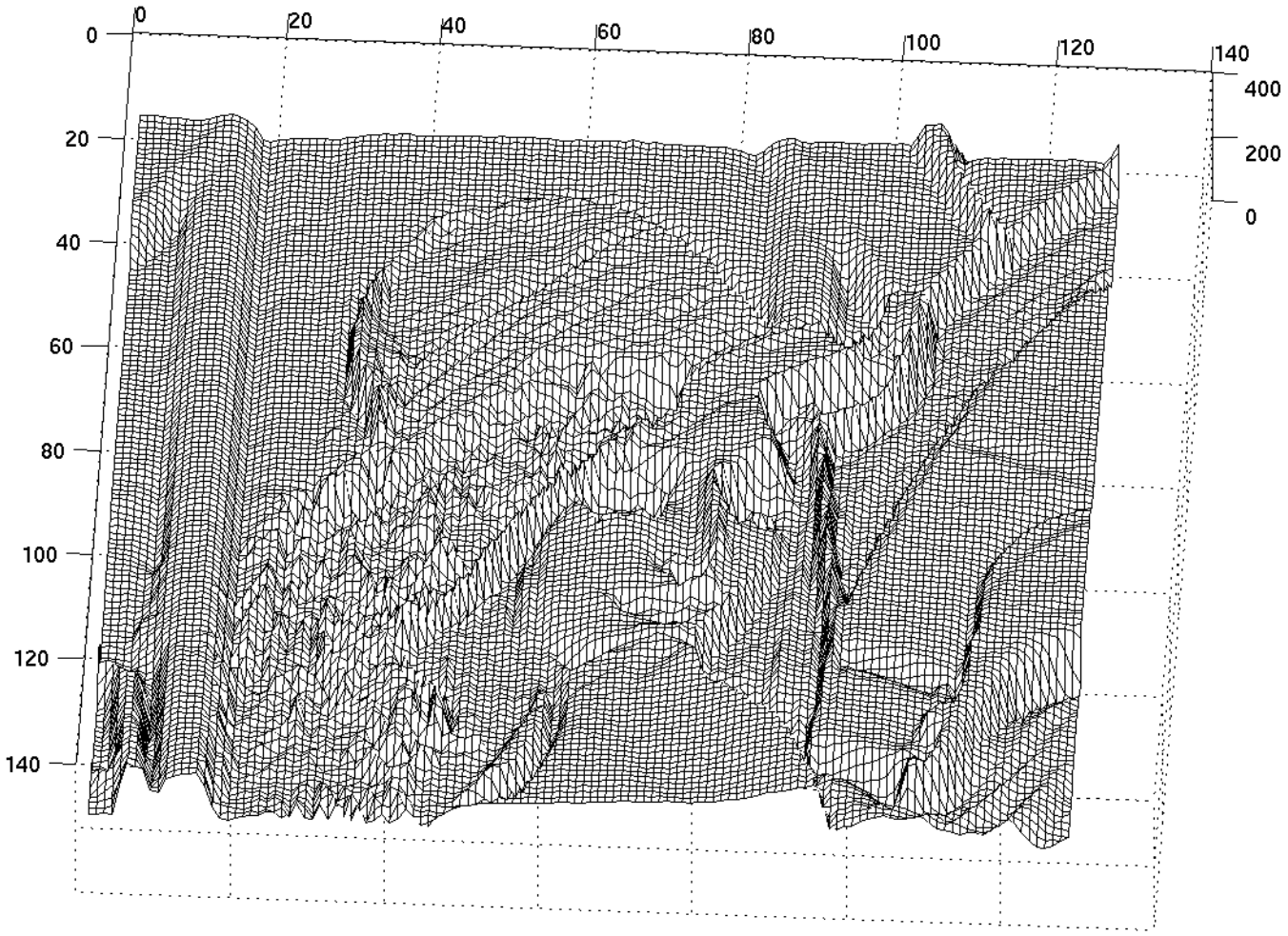


Image Understanding

Image Compression

Image Compression

original

compressed

Image Compression



Image Compression

Image Compression

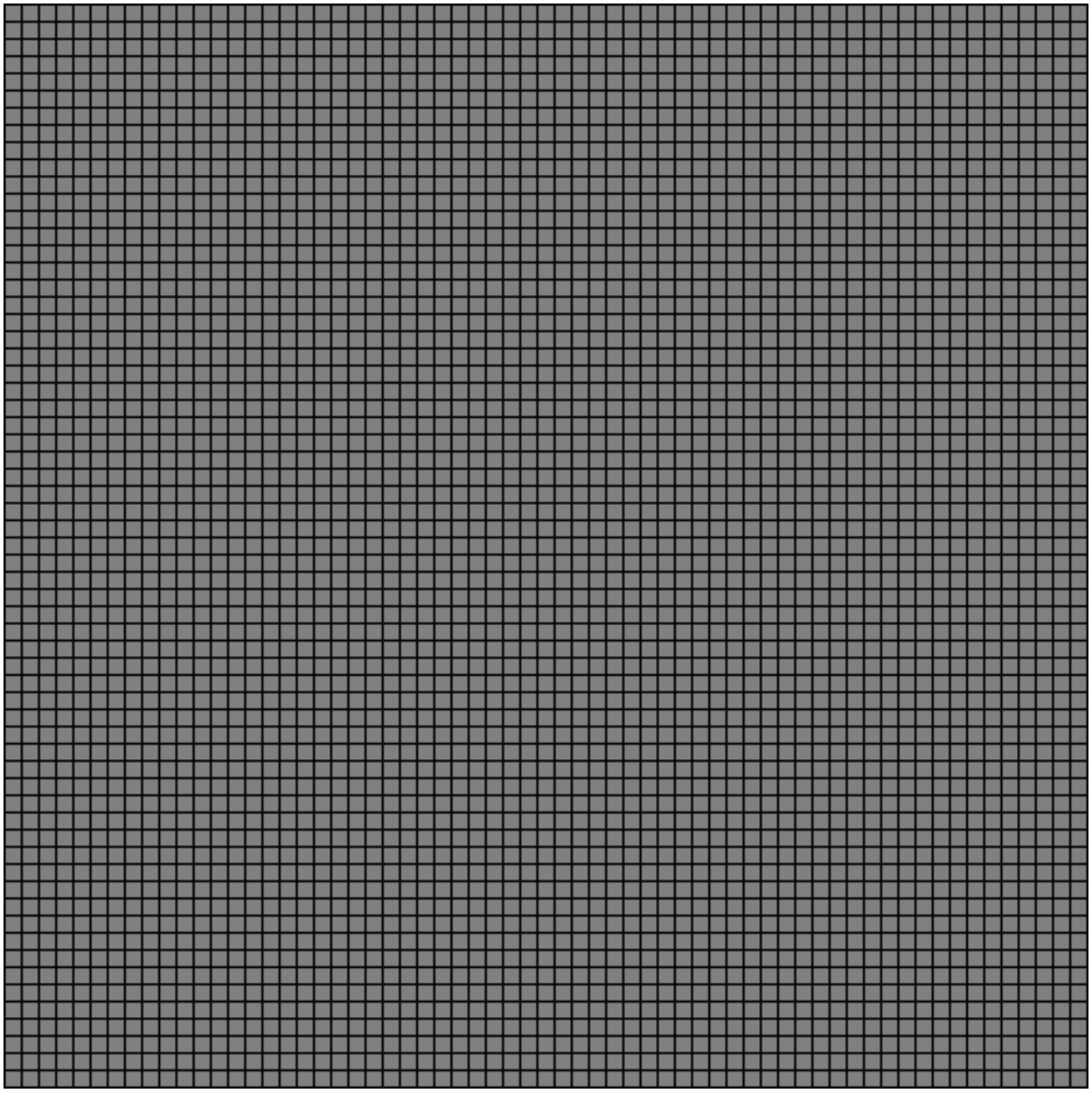
Image Compression

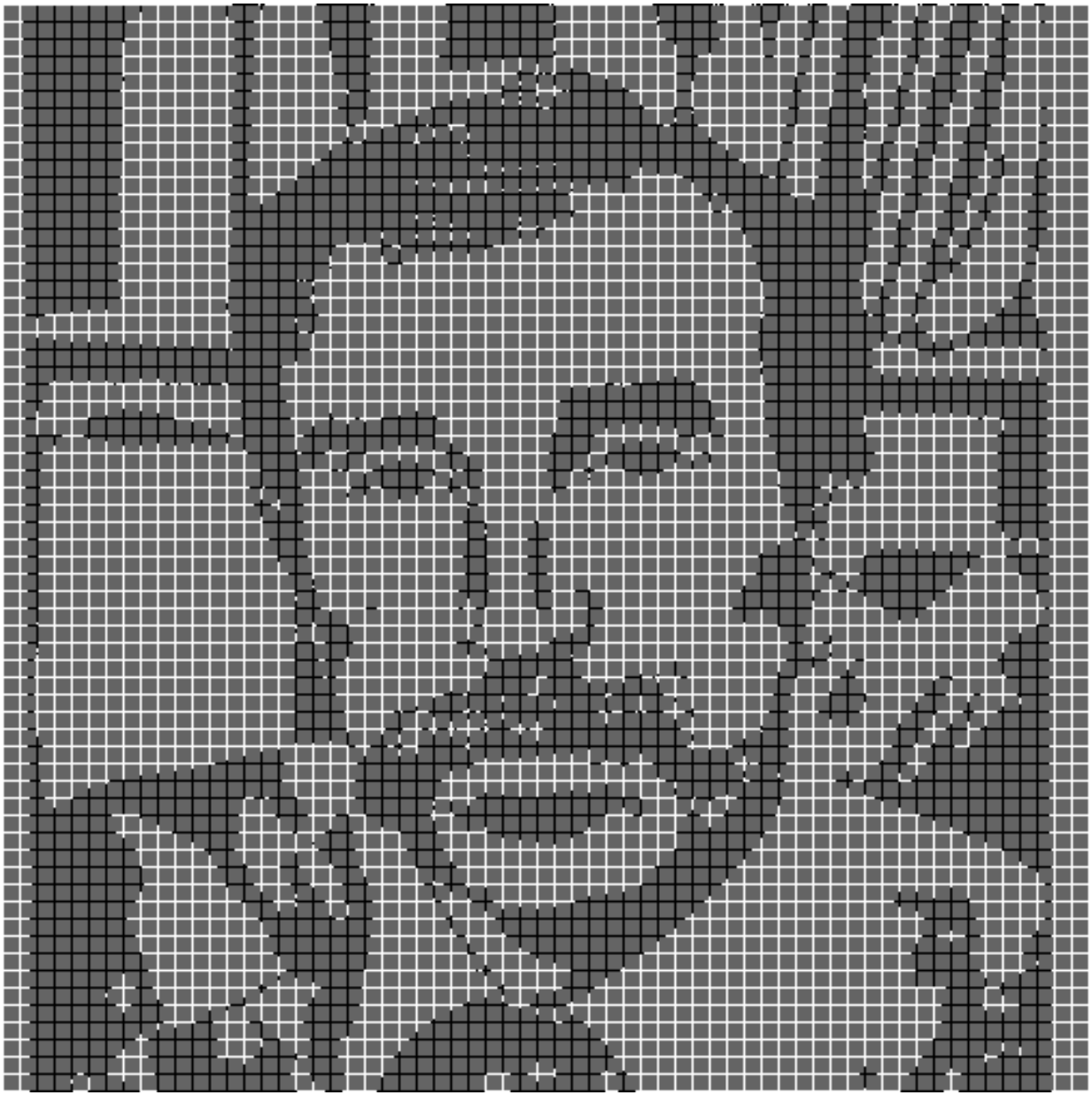
Structurally Lossless Compression

More than 20% pixels are different

Mean Squared Error = 392

Structurally Lossless Compression





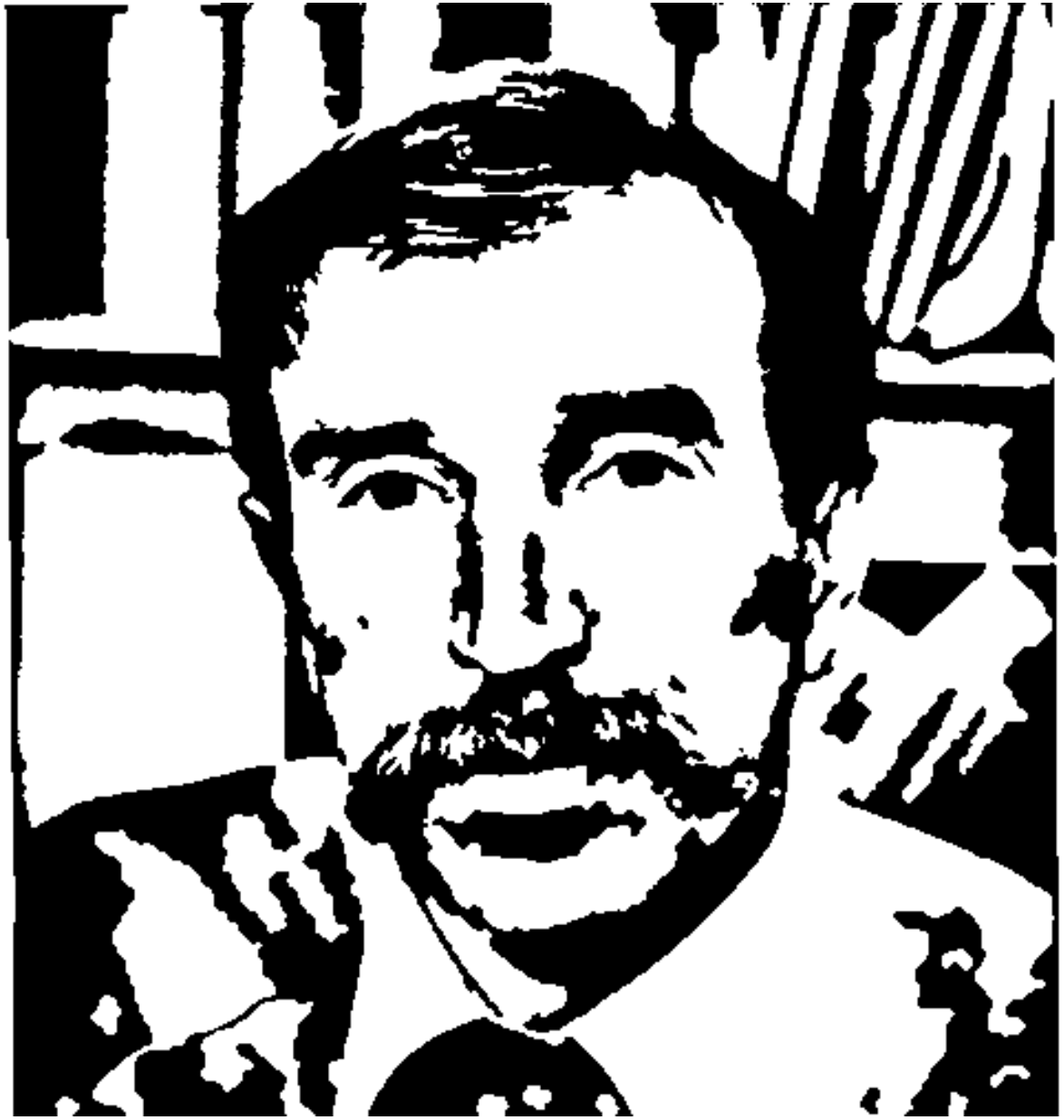
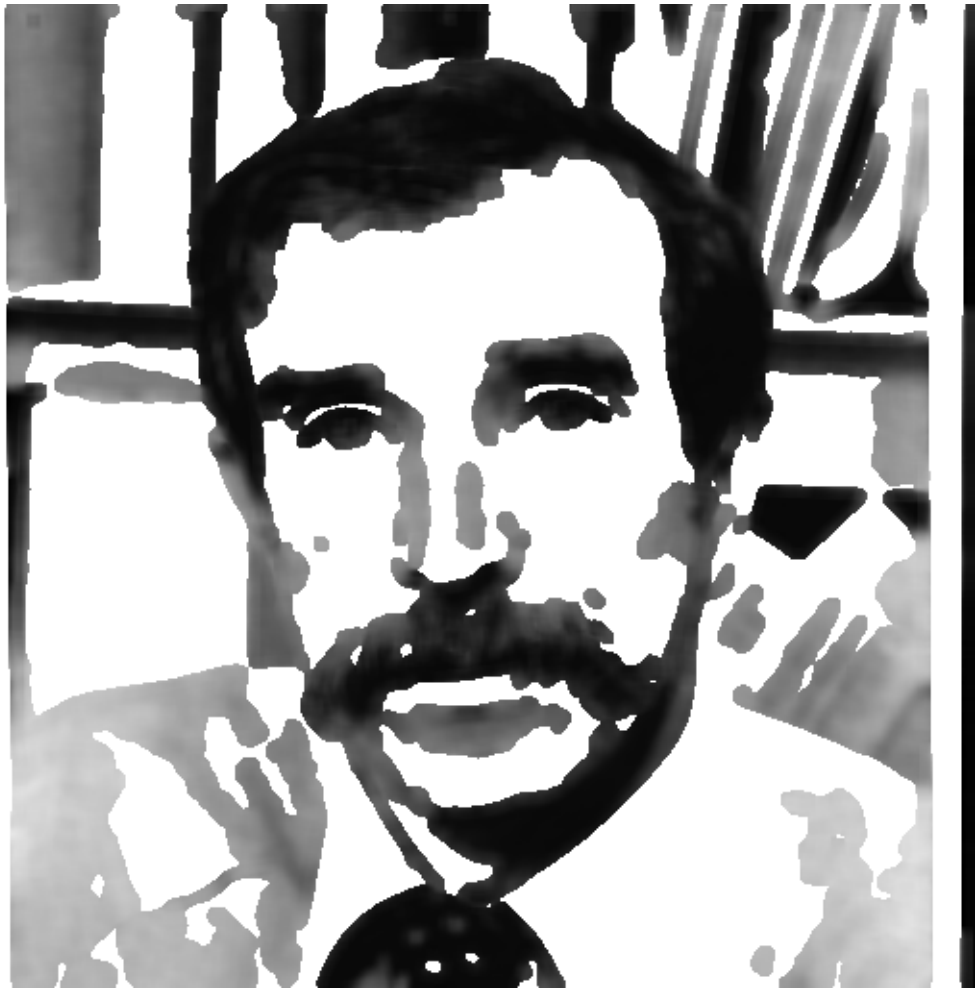


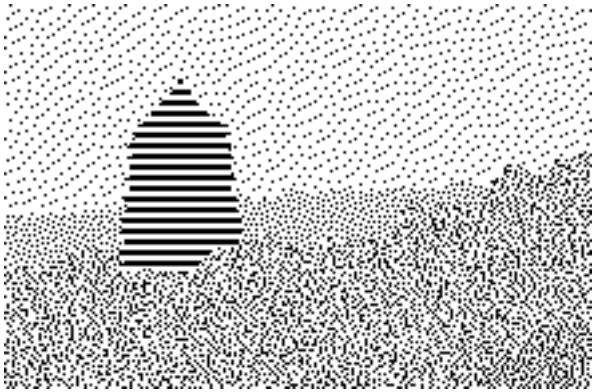
Image Segmentation



Visual to Tactile Mapping

Original Color Image

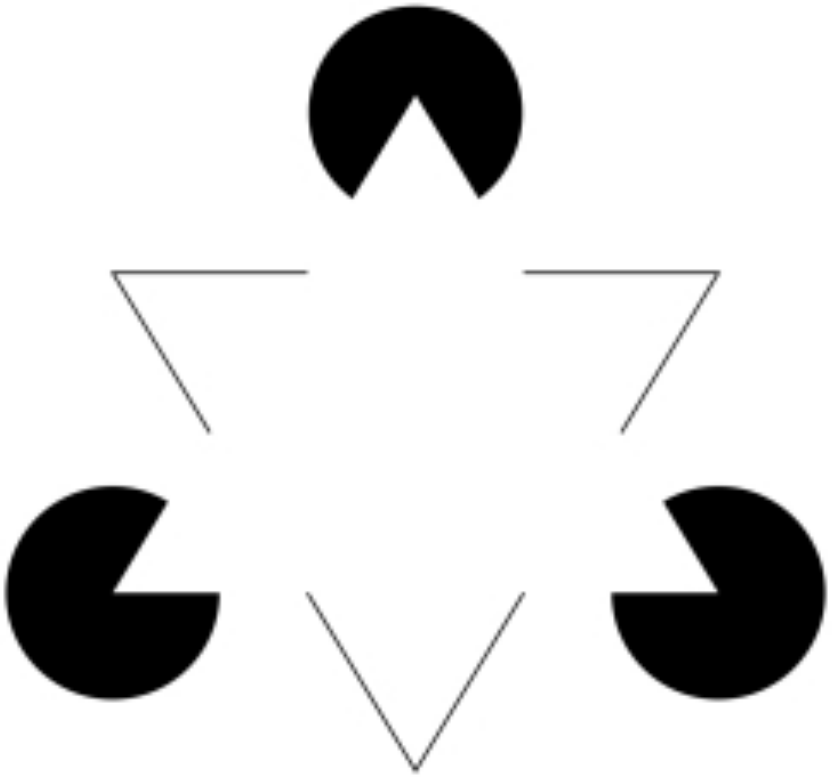
Segmentation



Tactile Display

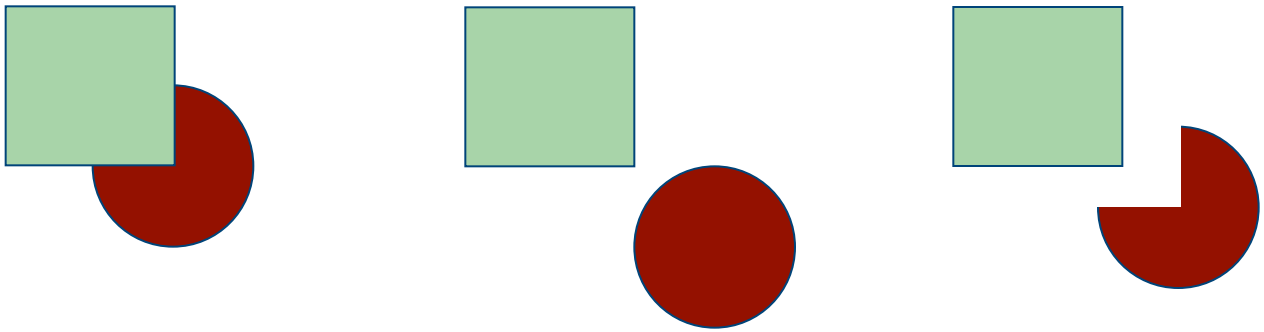
- Present a picture as a collection of segments with different tactile textures
- Perceptually distinct tactile textures
- Haptic space perception and scene perception
  - Advantages over line drawings

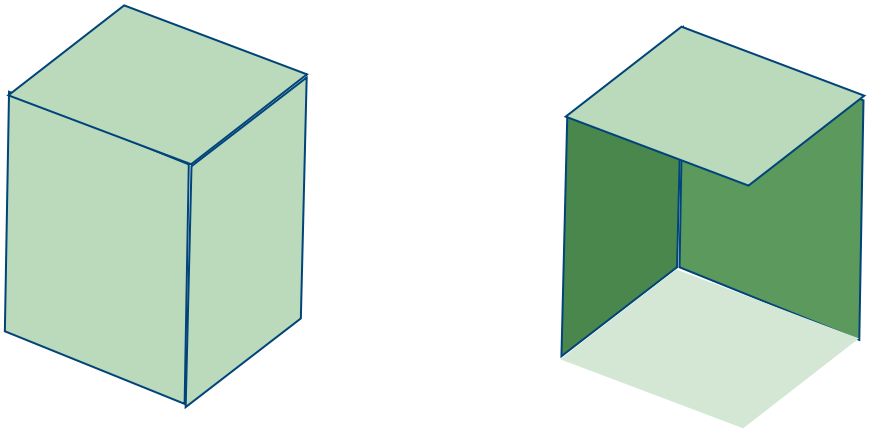
Visual Illusions: Kanitza Triangle



Visual Completion

- Different interpretations





Visual Completion

Street Art

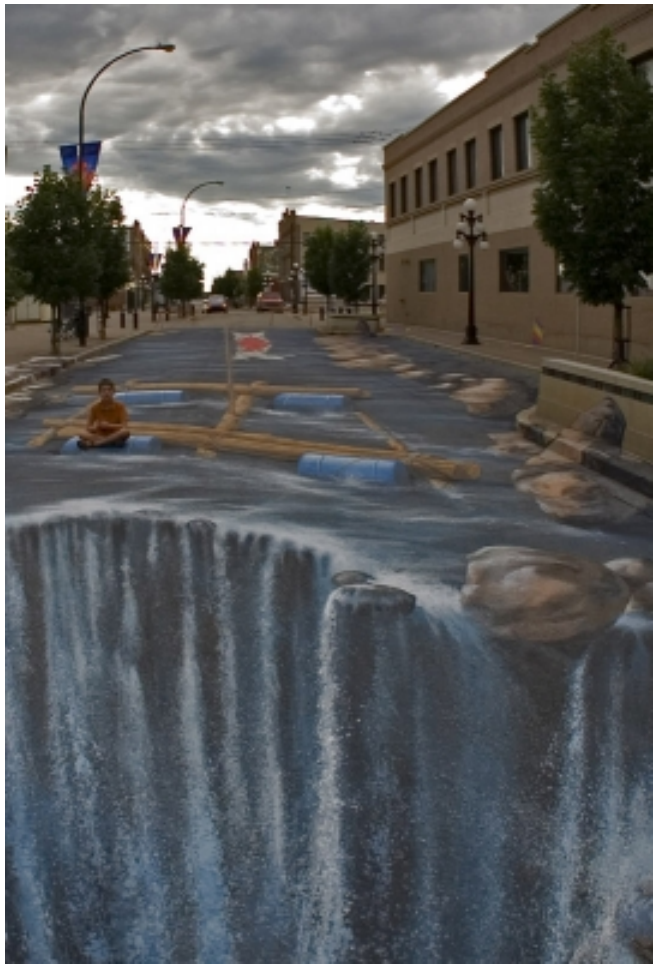
Street Art

Street Art

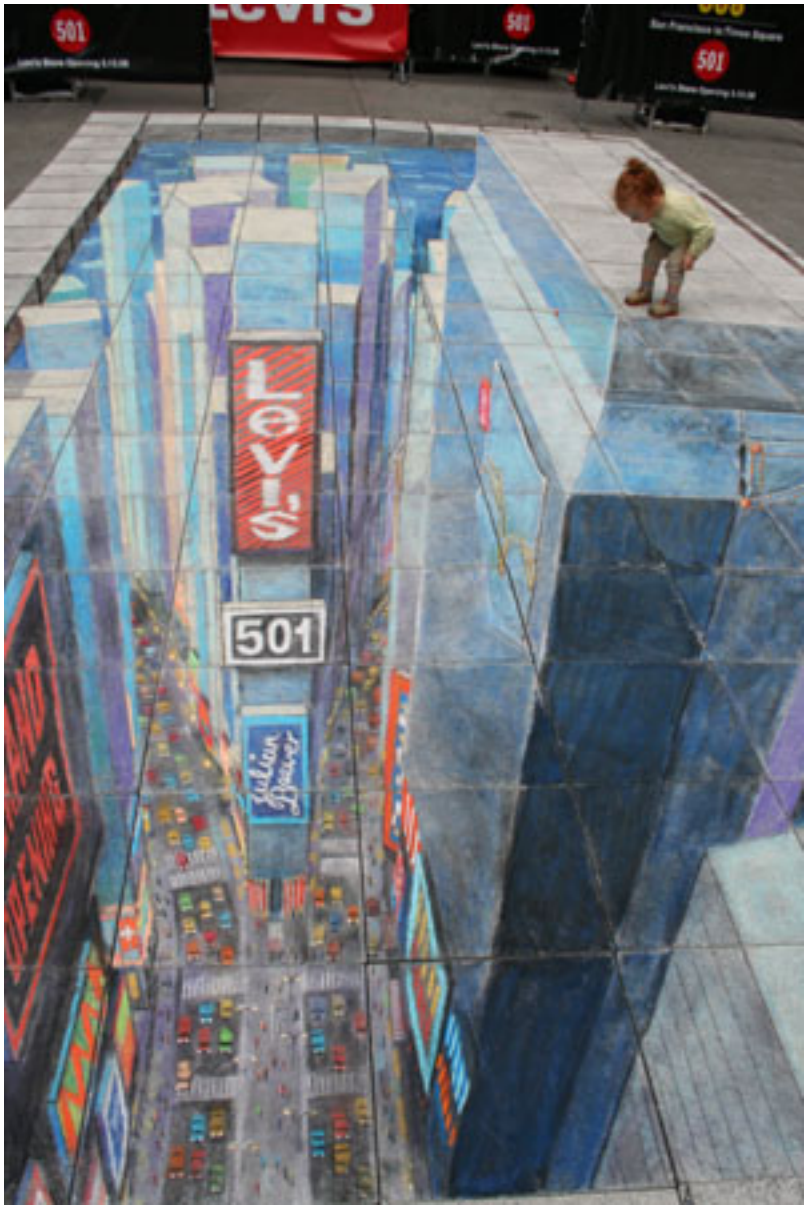
Street Art

Street Art

Street Art

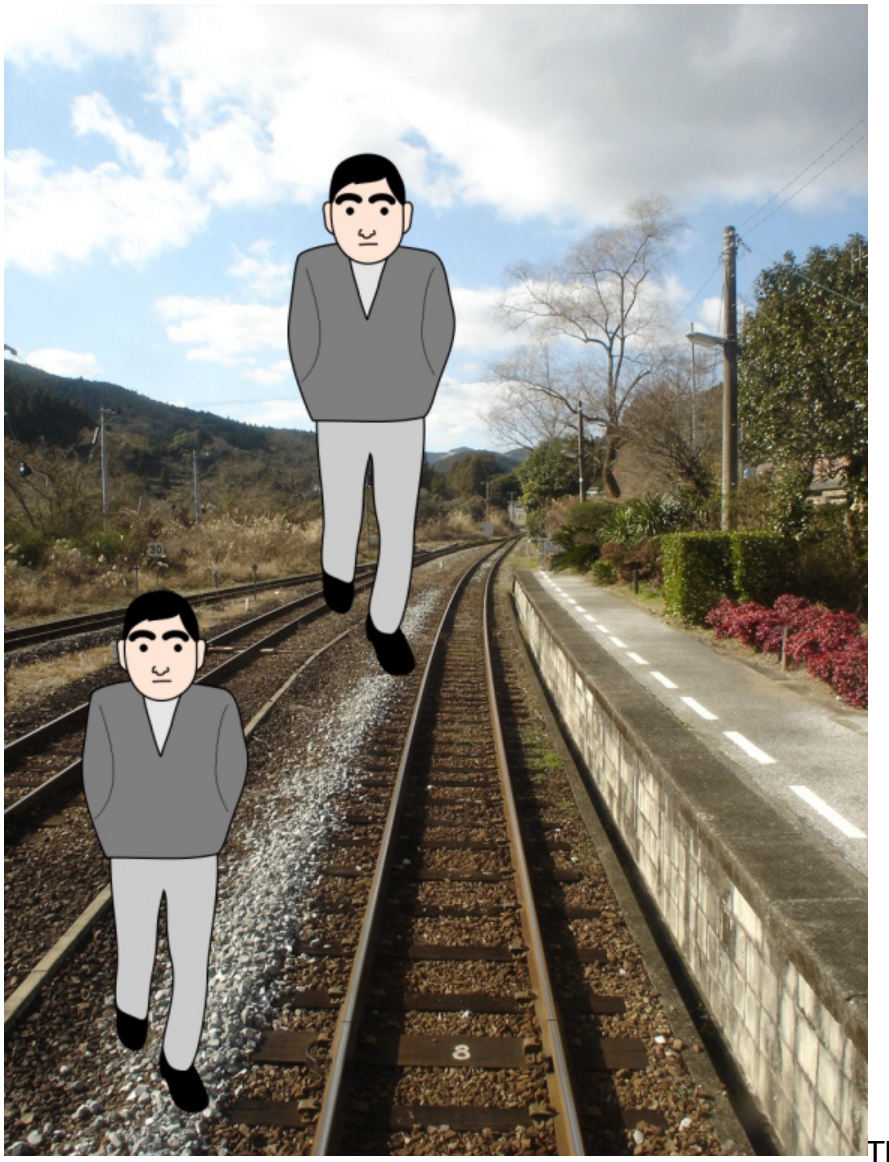


Street Art


501
LEVI'S
501
Fashion Bureau

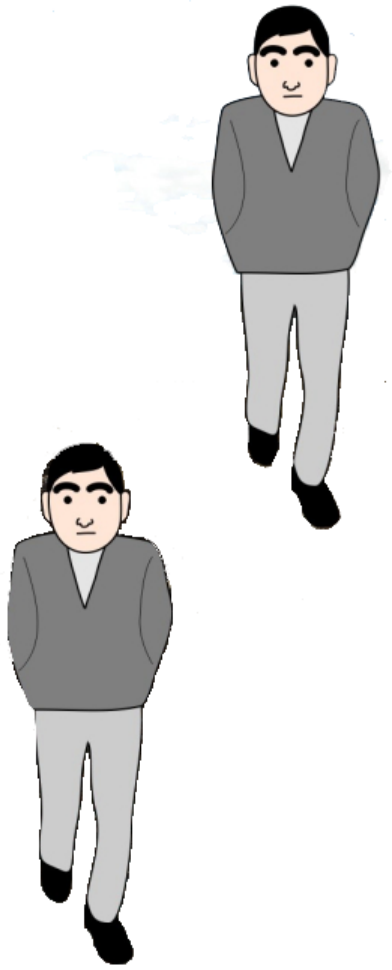
VISUAL ILLUSIONS

Corridor Illusion on a Railway



produced by
Akiyoshi Kitaoka
2009

Corridor Illusion on a Railway



produced by
Akiyoshi Kitaoka
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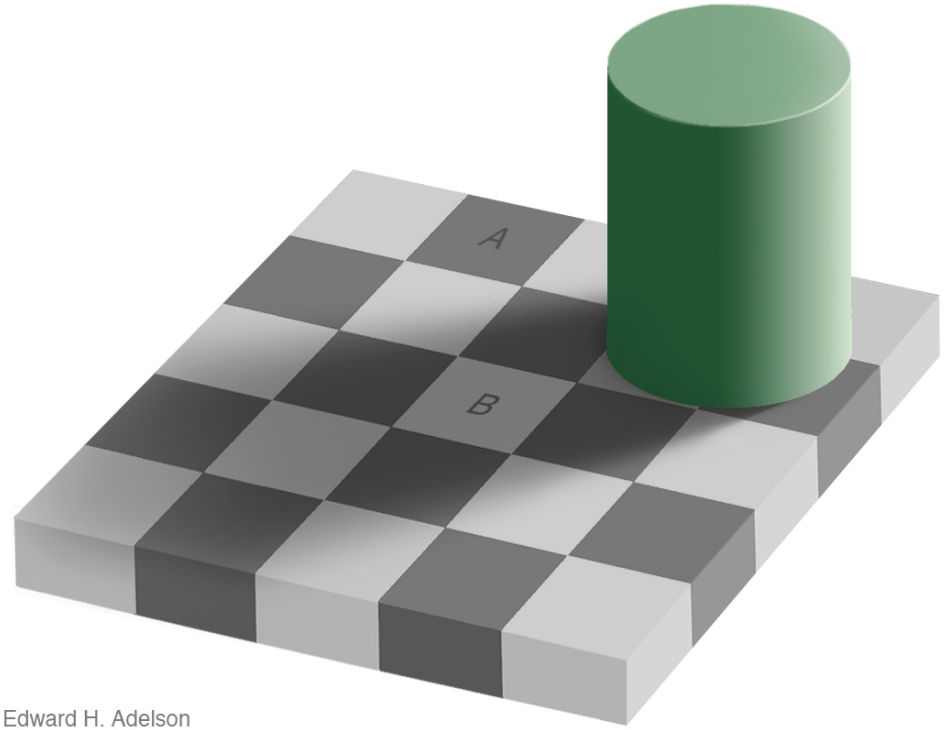
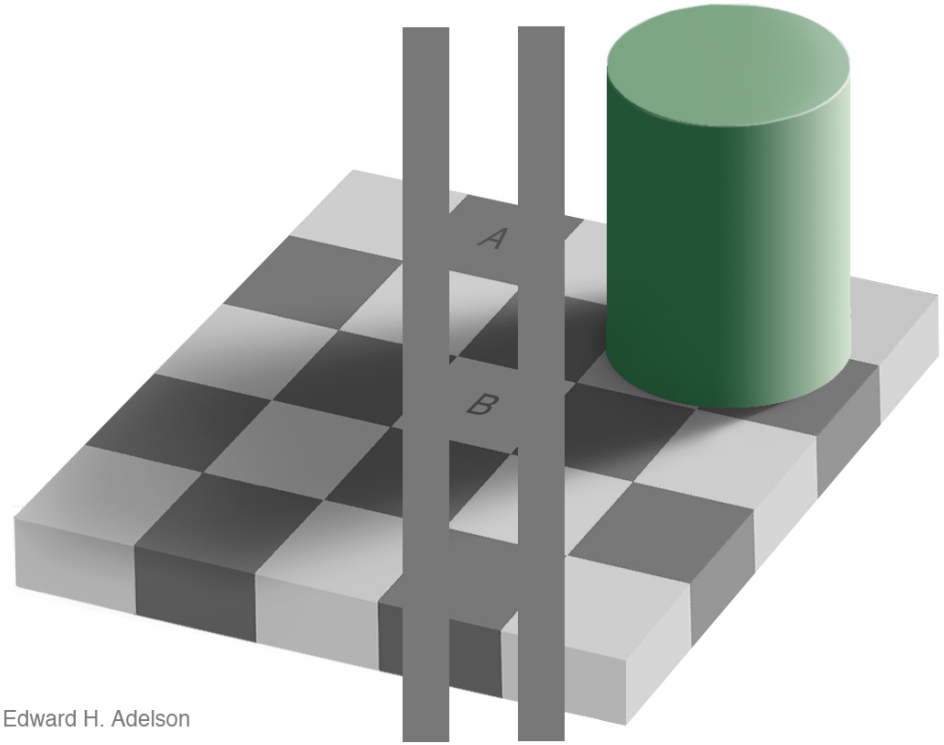
Simultaneous Contrast



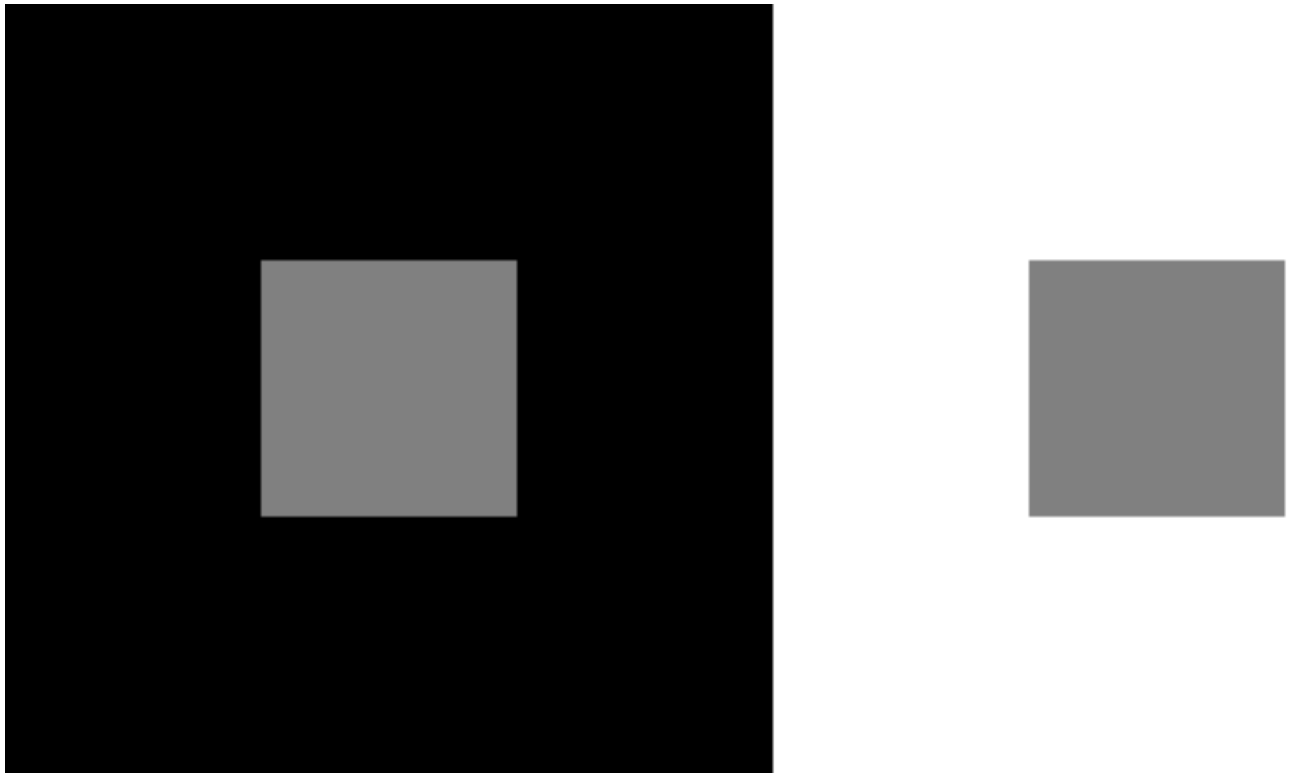
Edward H. Adelson

Simultaneous Contrast



Edward H. Adelson

Simultaneous Contrast



Simultaneous Contrast

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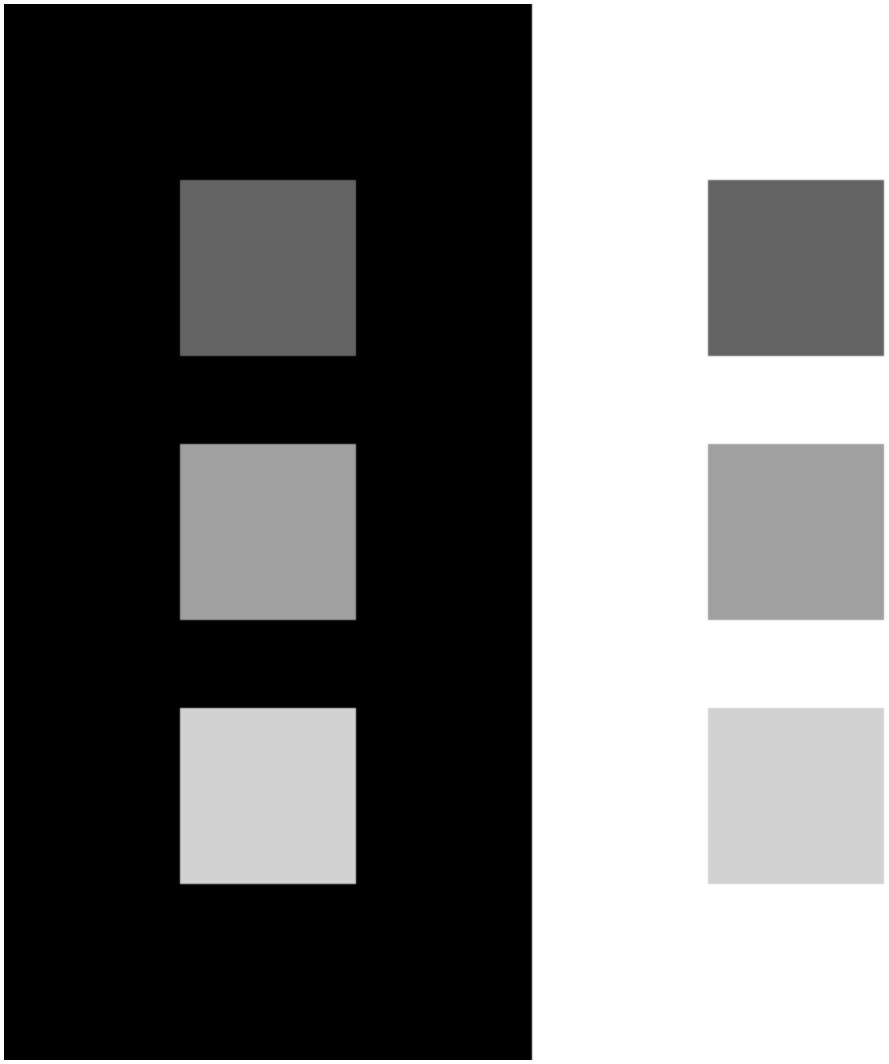
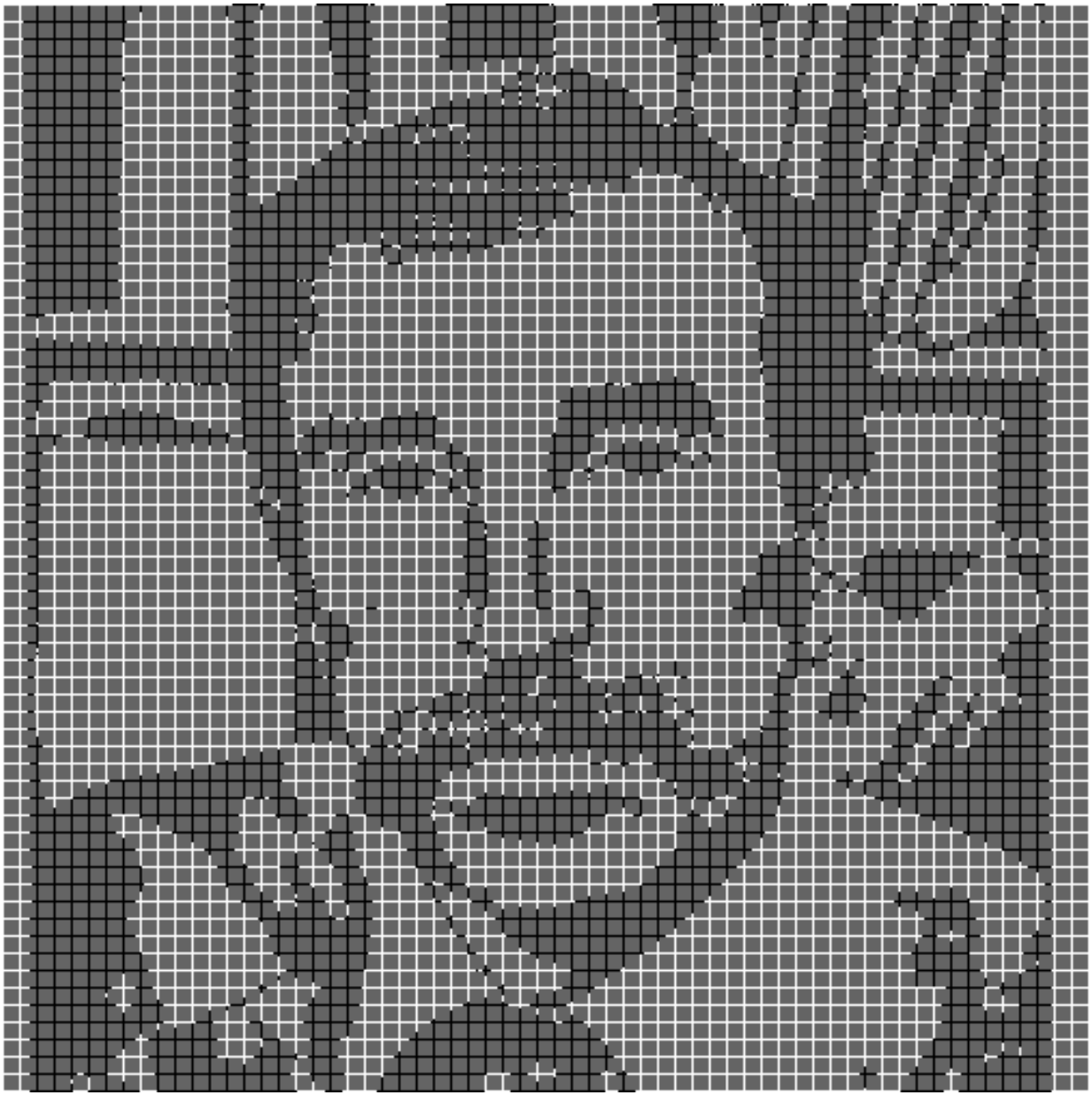
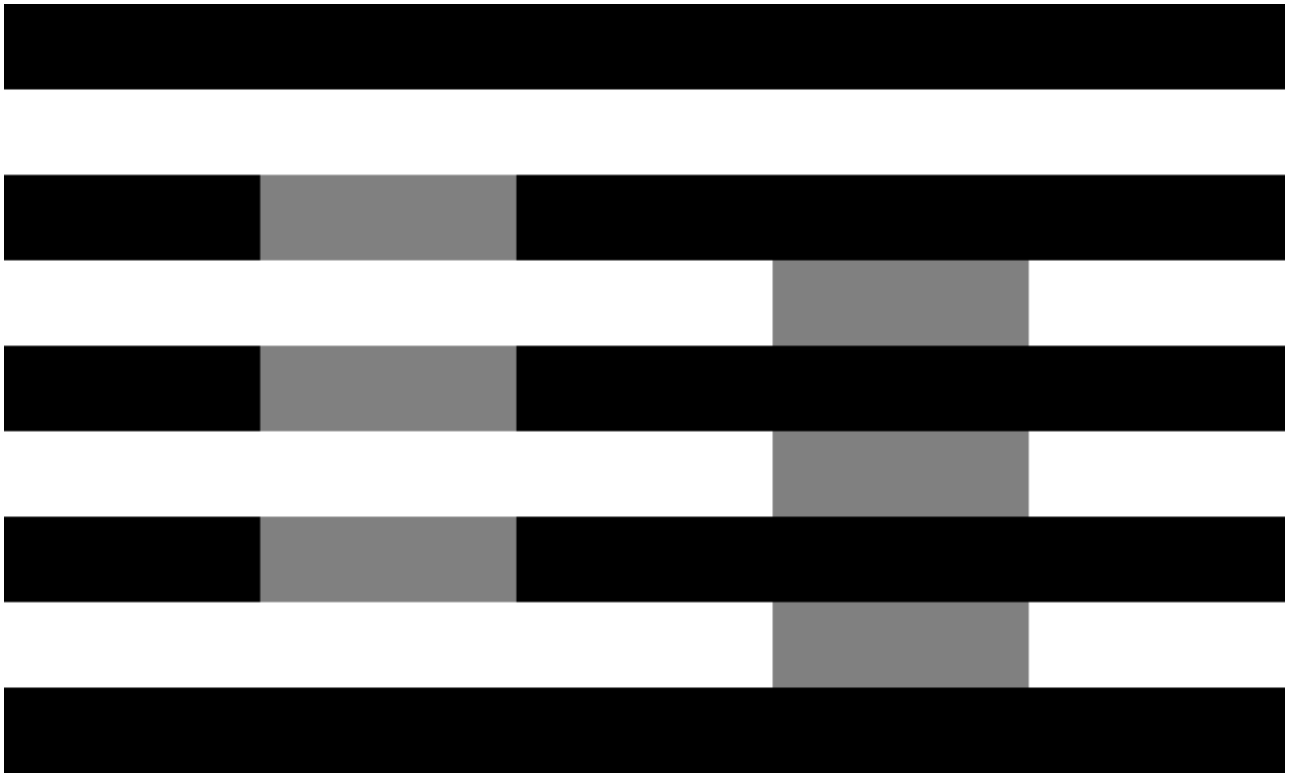
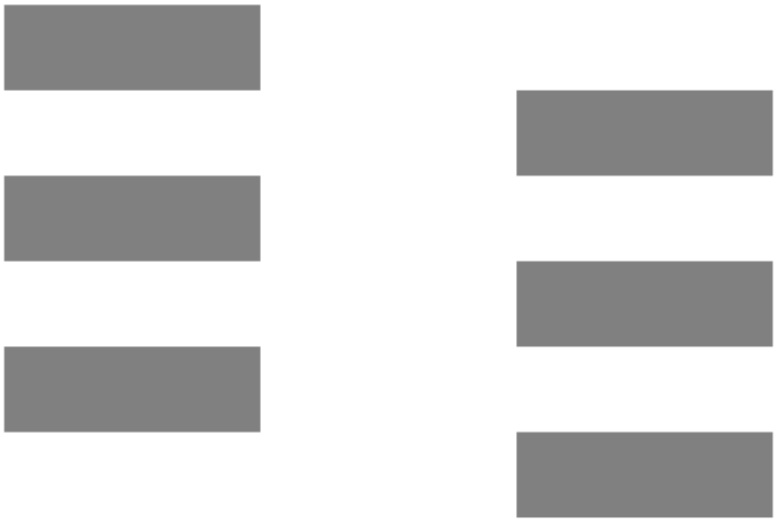




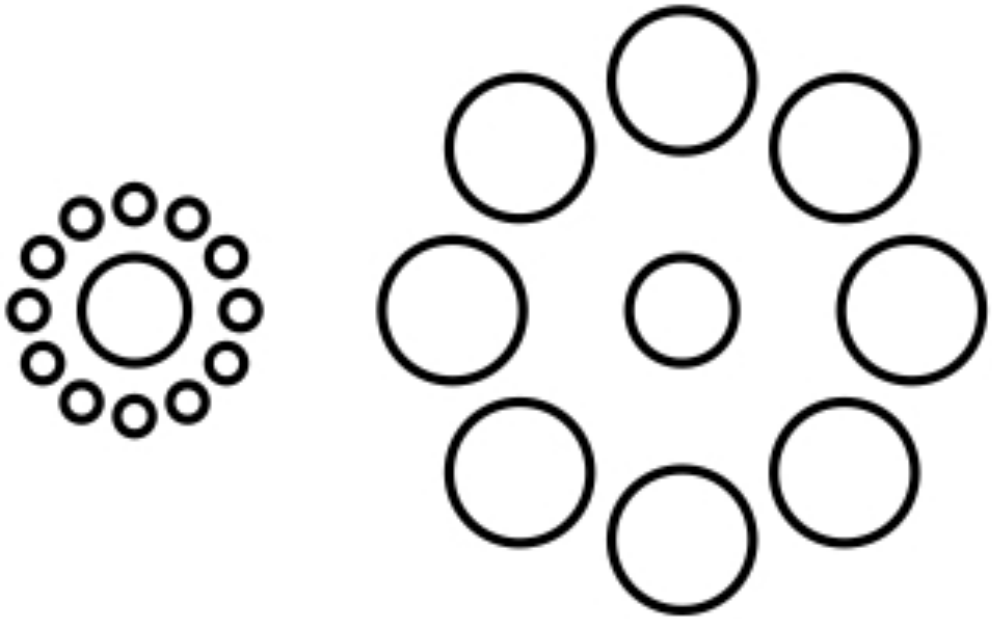
White's Effect



White's Effect

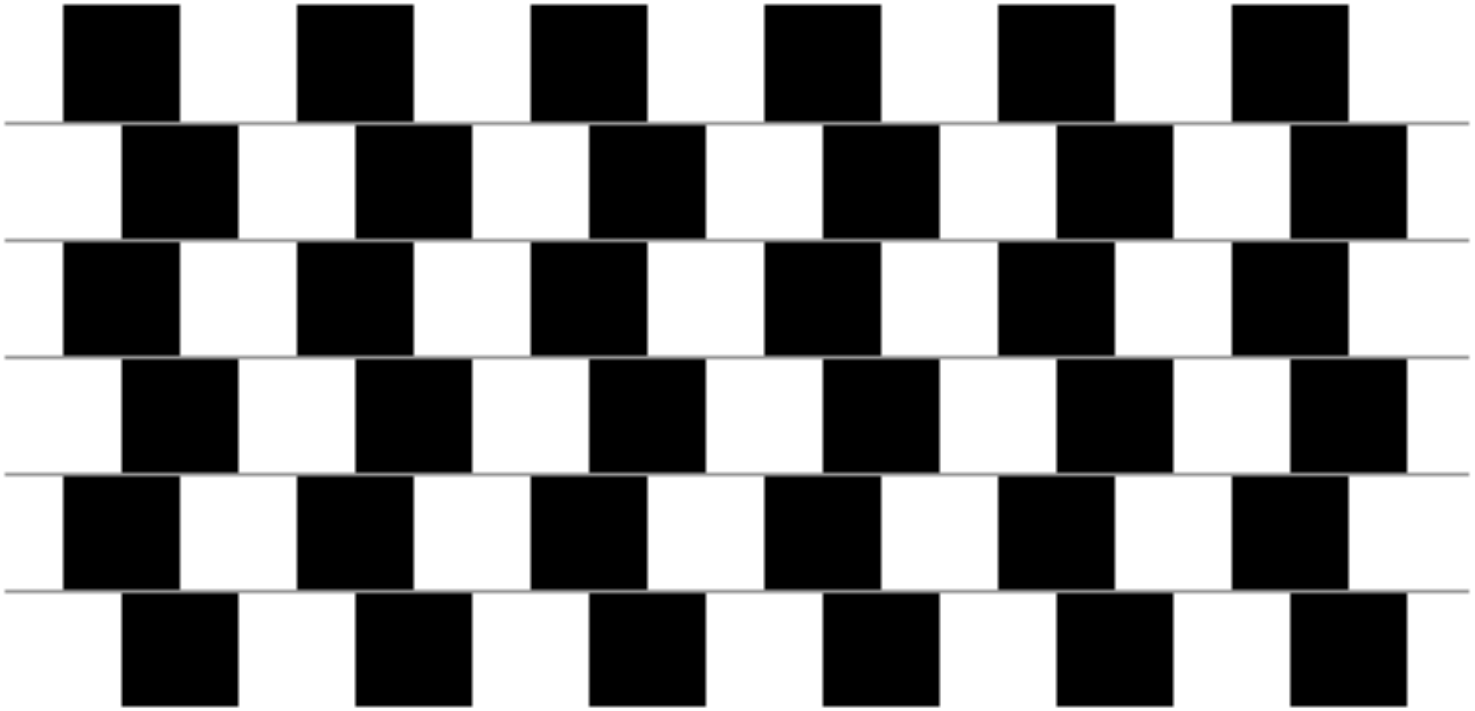


Ebbinghaus Illusion



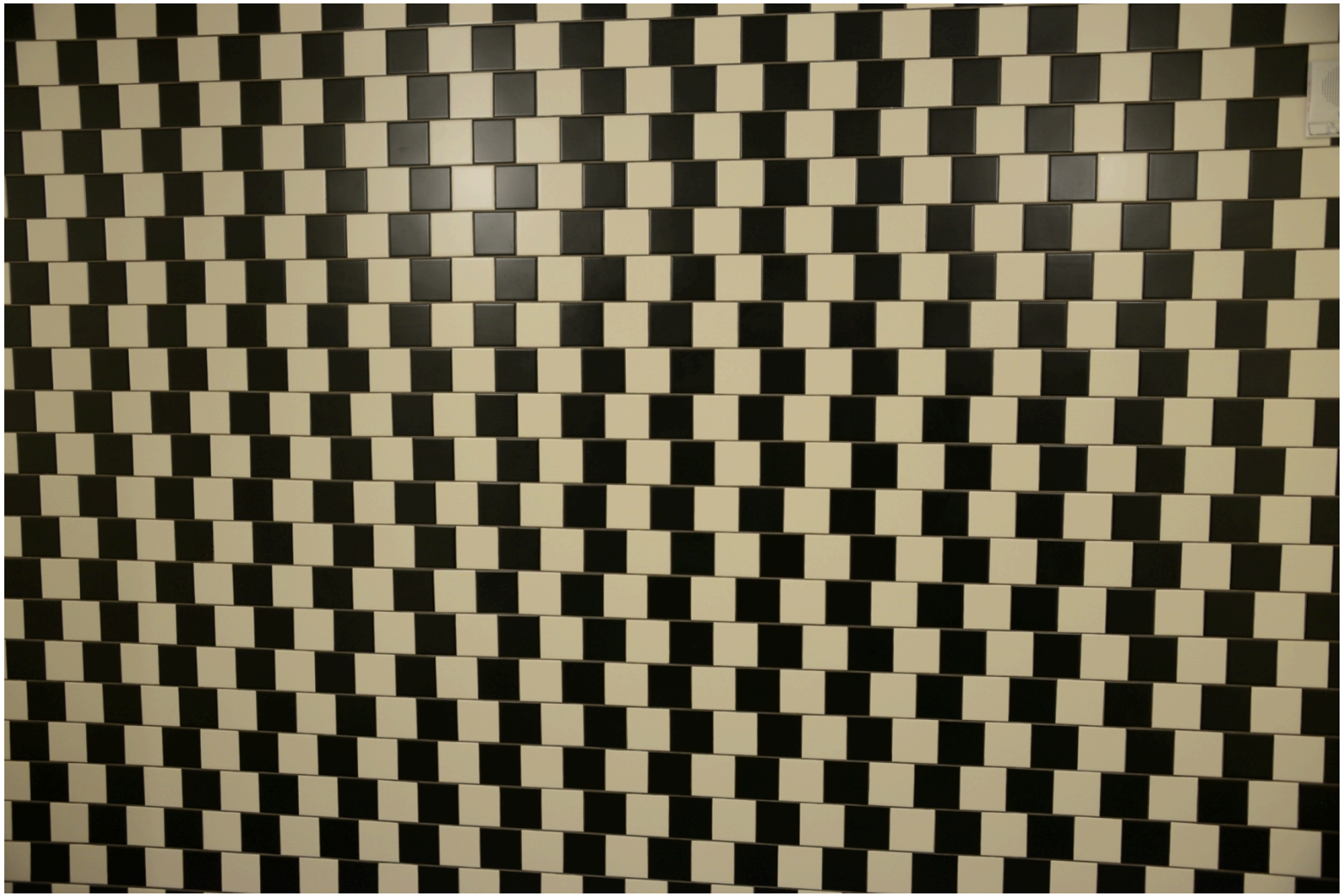
Ebbinghaus Illusion

Café Wall Illusion



Café Wall Illusion

Café Wall Illusion



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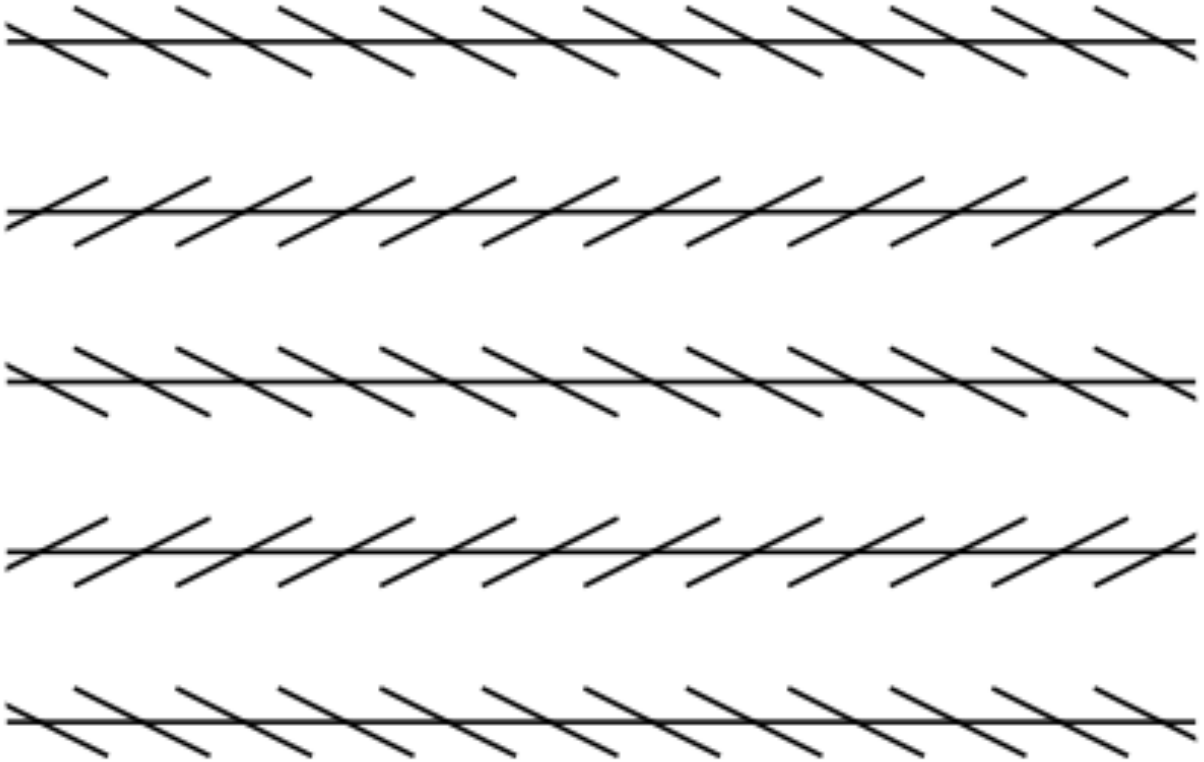
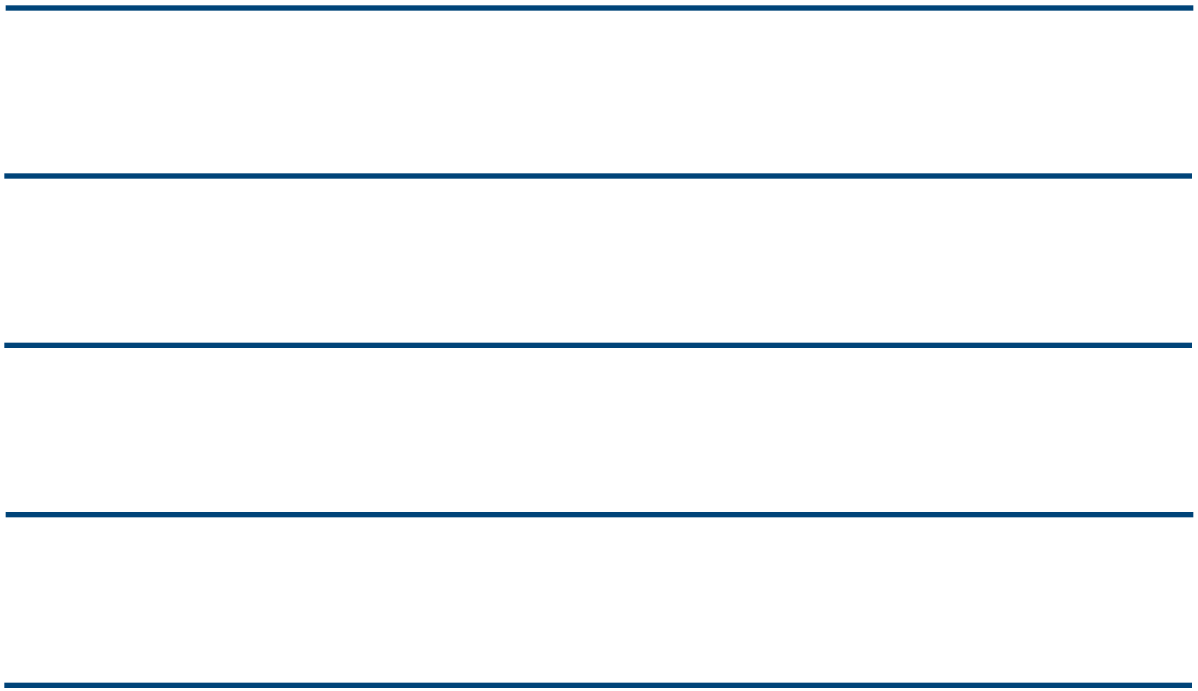
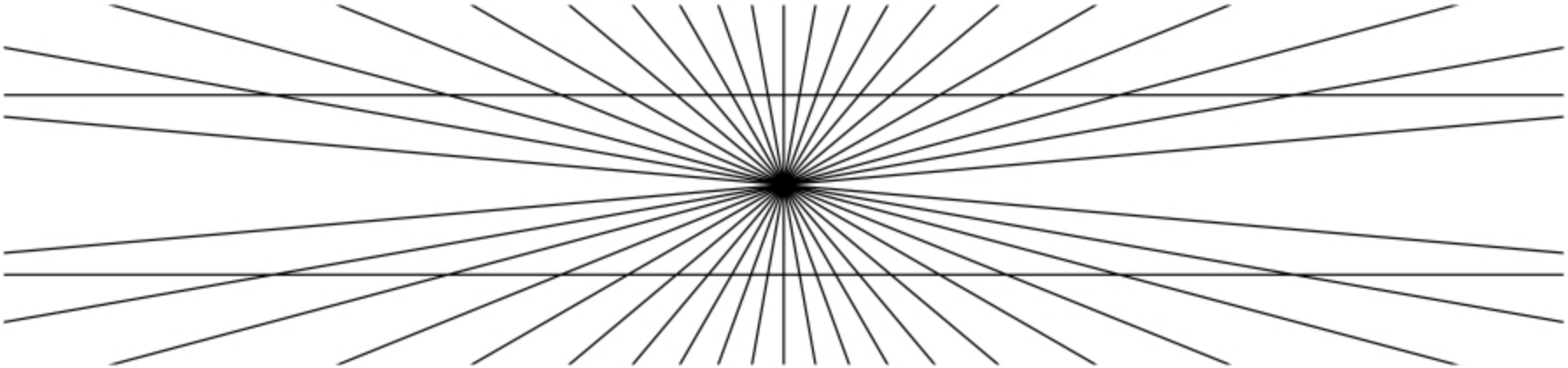
Zollner Illusion



Zollner Illusion

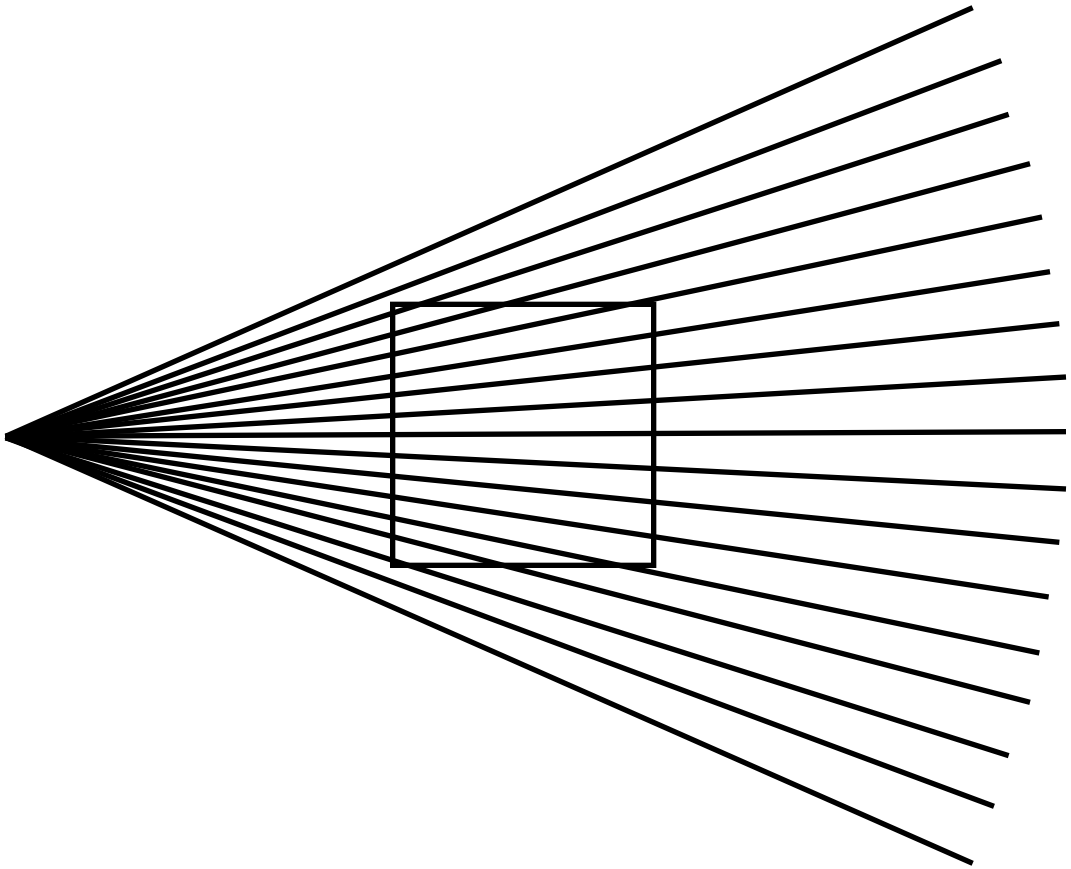


Herig Illusion

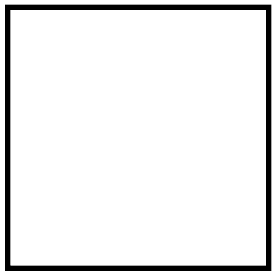


Herig Illusion

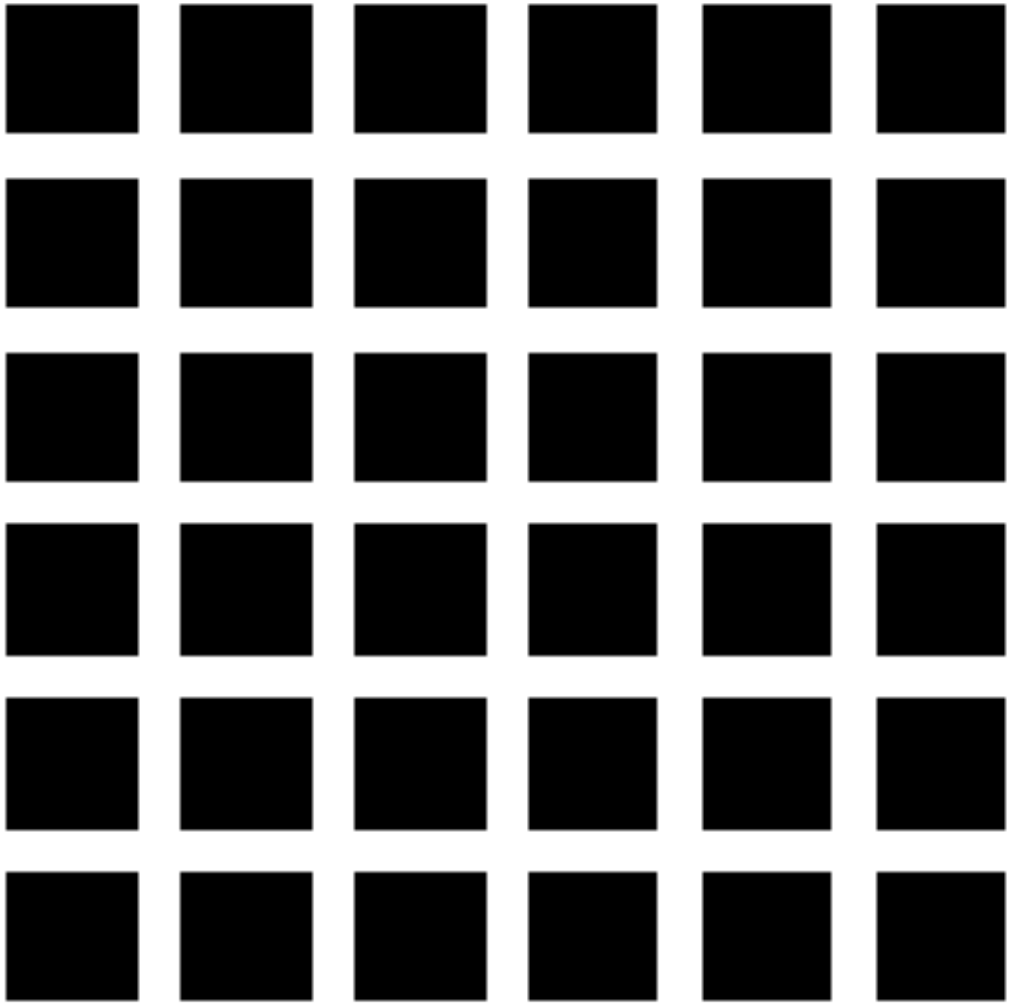
Ehrenstein Illusion (1925)



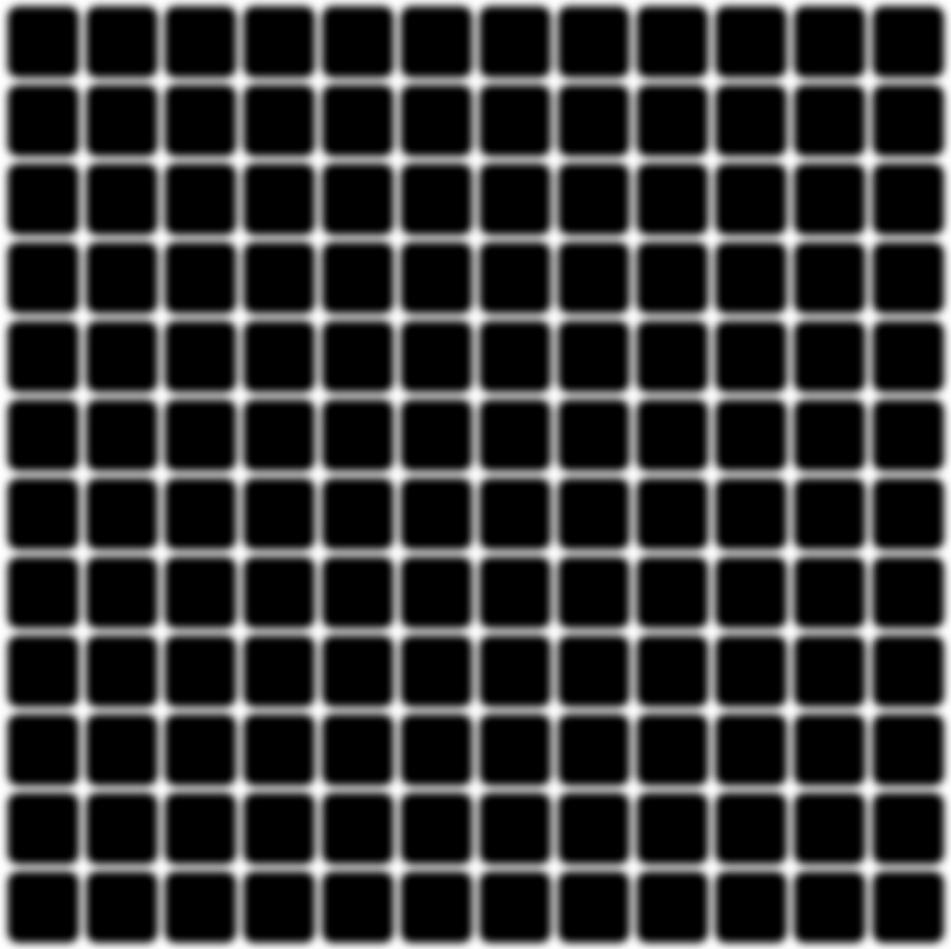
Ehrenstein Illusion (1925)



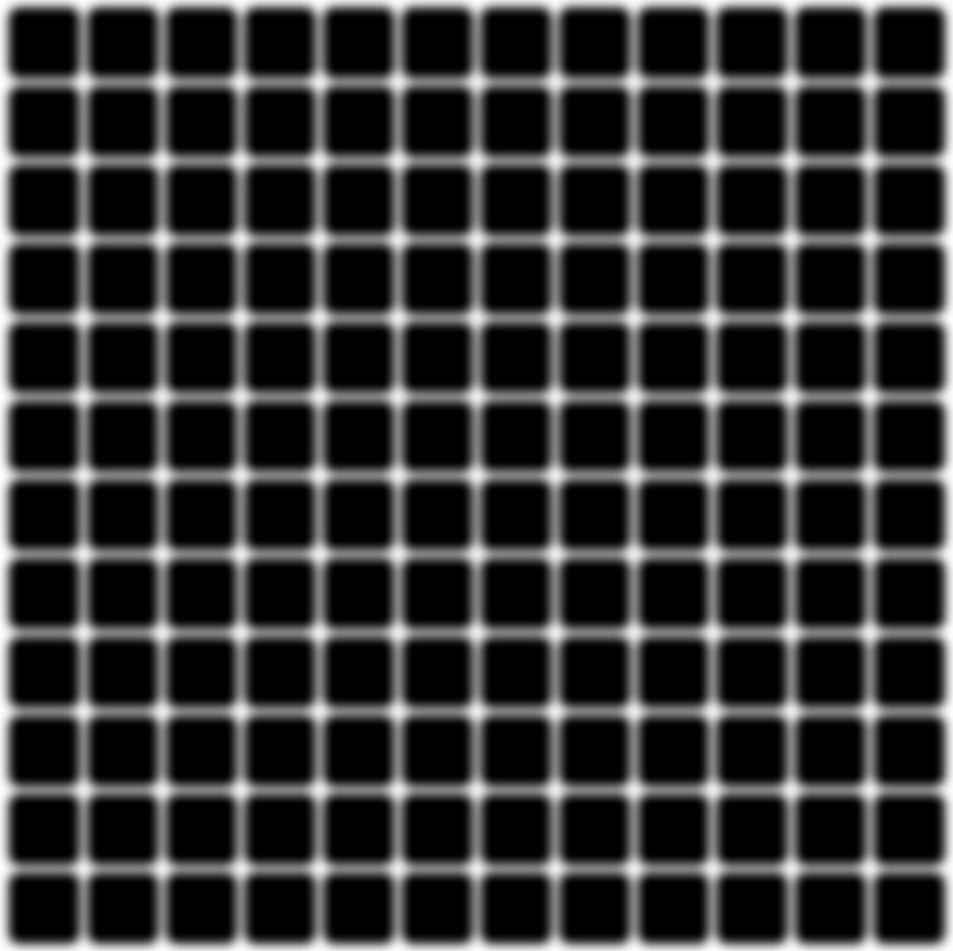
Hermann Grid



Bergen Illusion (1985)



Bergen Illusion (1985)



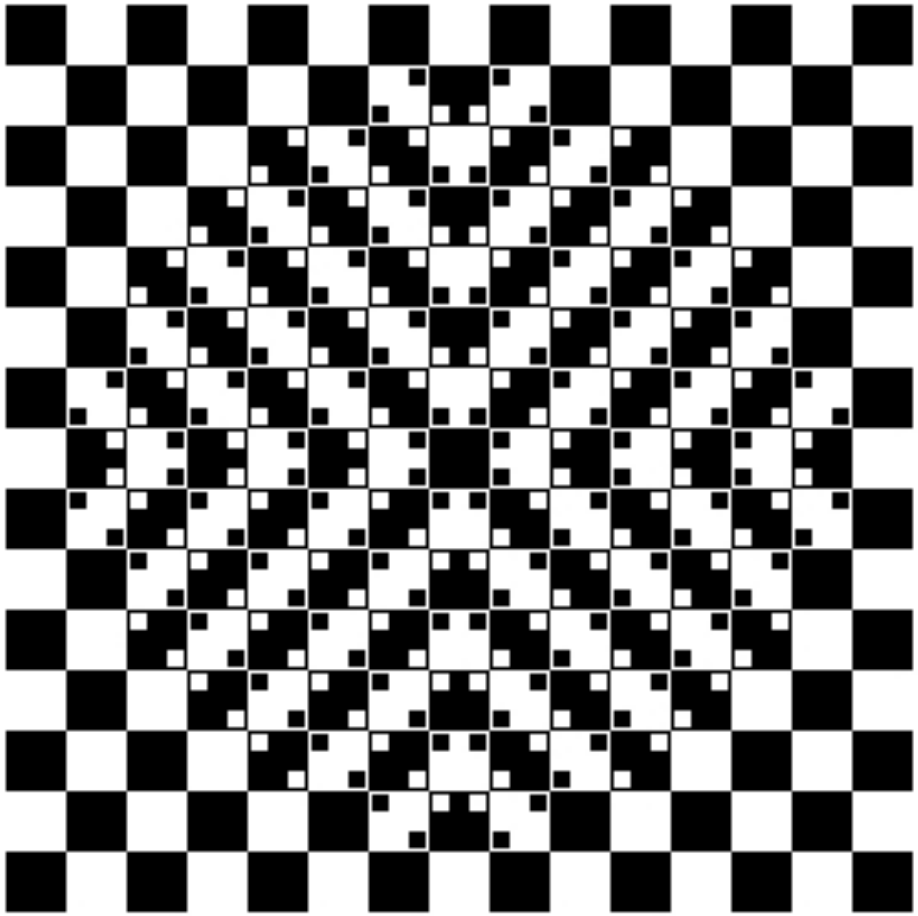
Thatcher Illusion

Thatcher Illusion

Blair Illusion

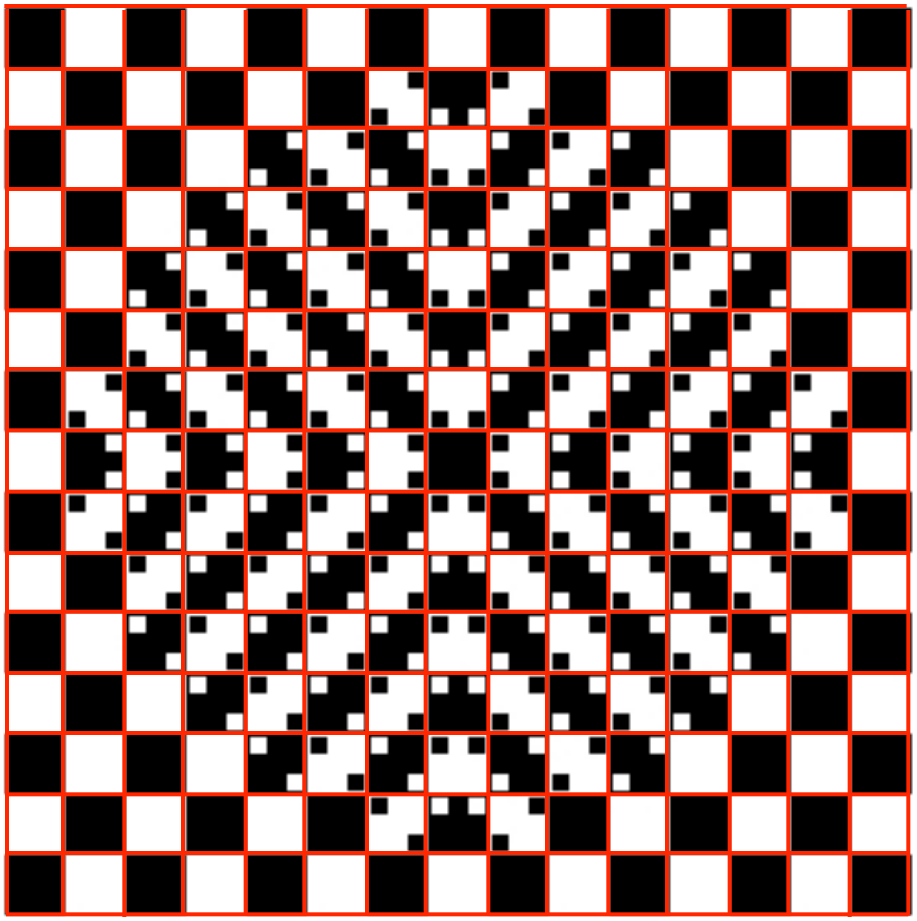
Blair Illusion

Bulge



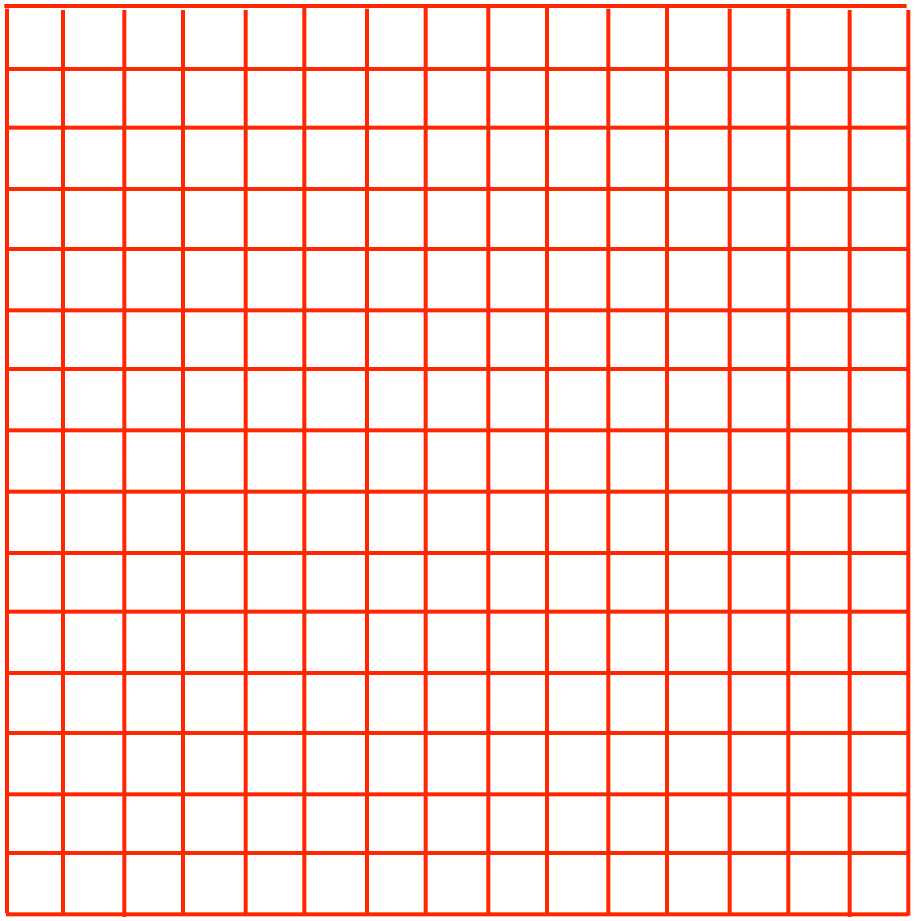
produced by Akiyoshi Kitaoka 1998

Bulge



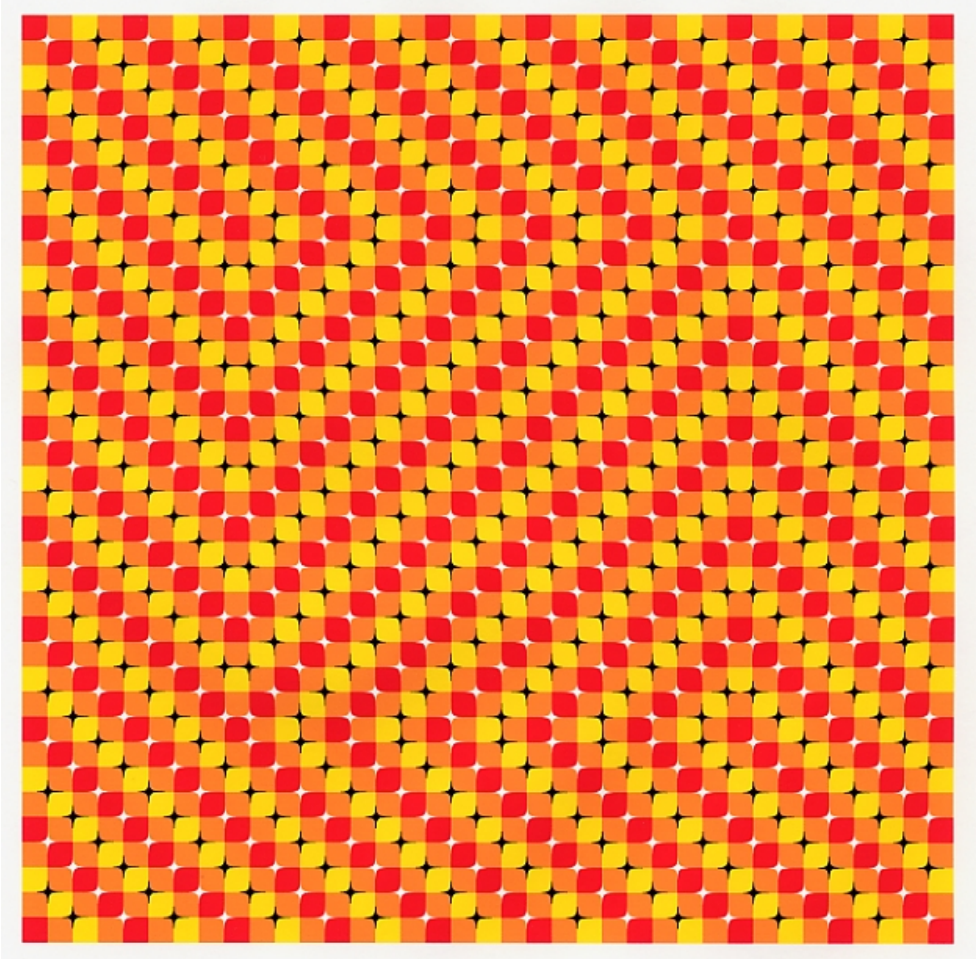
produced by Akiyoshi Kitaoka 1998

Bulge



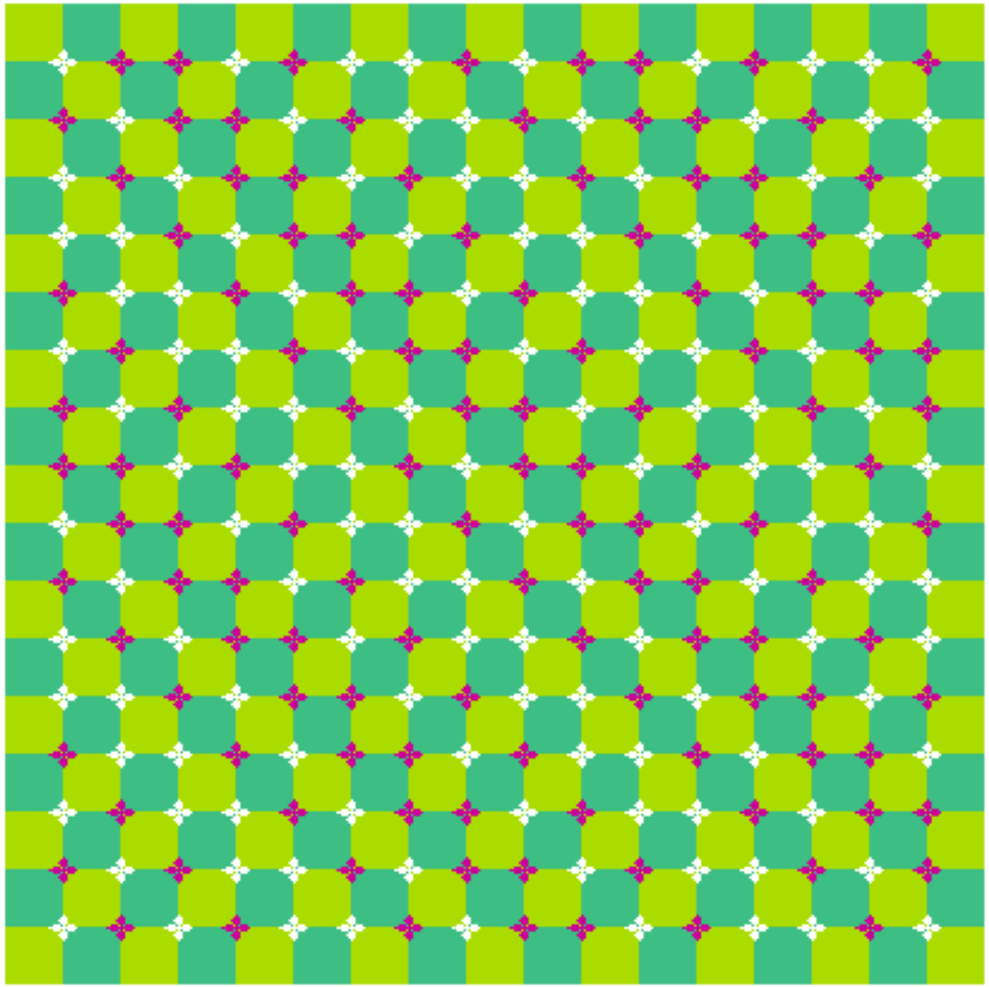
produced by Akiyoshi Kitaoka 1998

Autumn Color Swamp



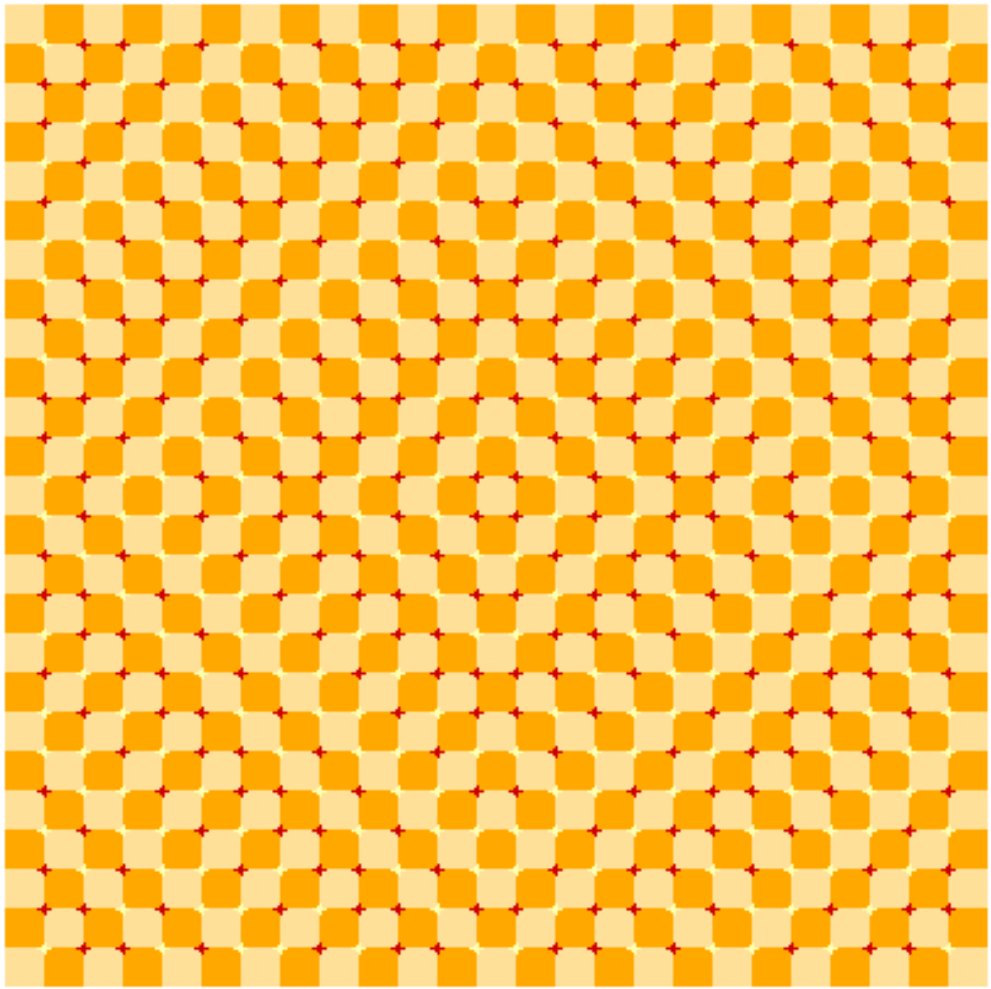
produced by Akiyoshi Kitaoka 2000

Primrose's Field Illusion



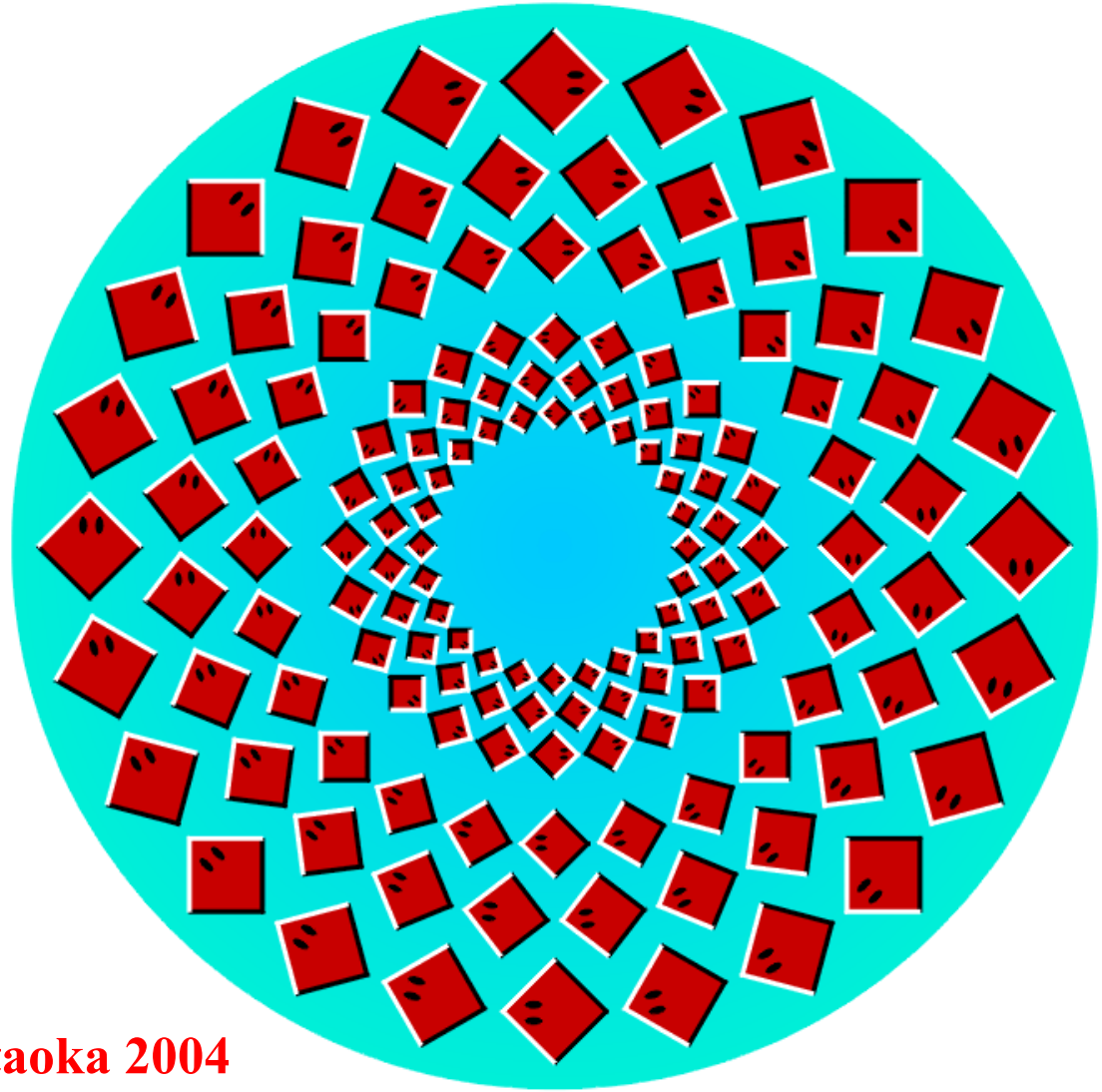
produced by Akiyoshi Kitaoka 2002

Spreading



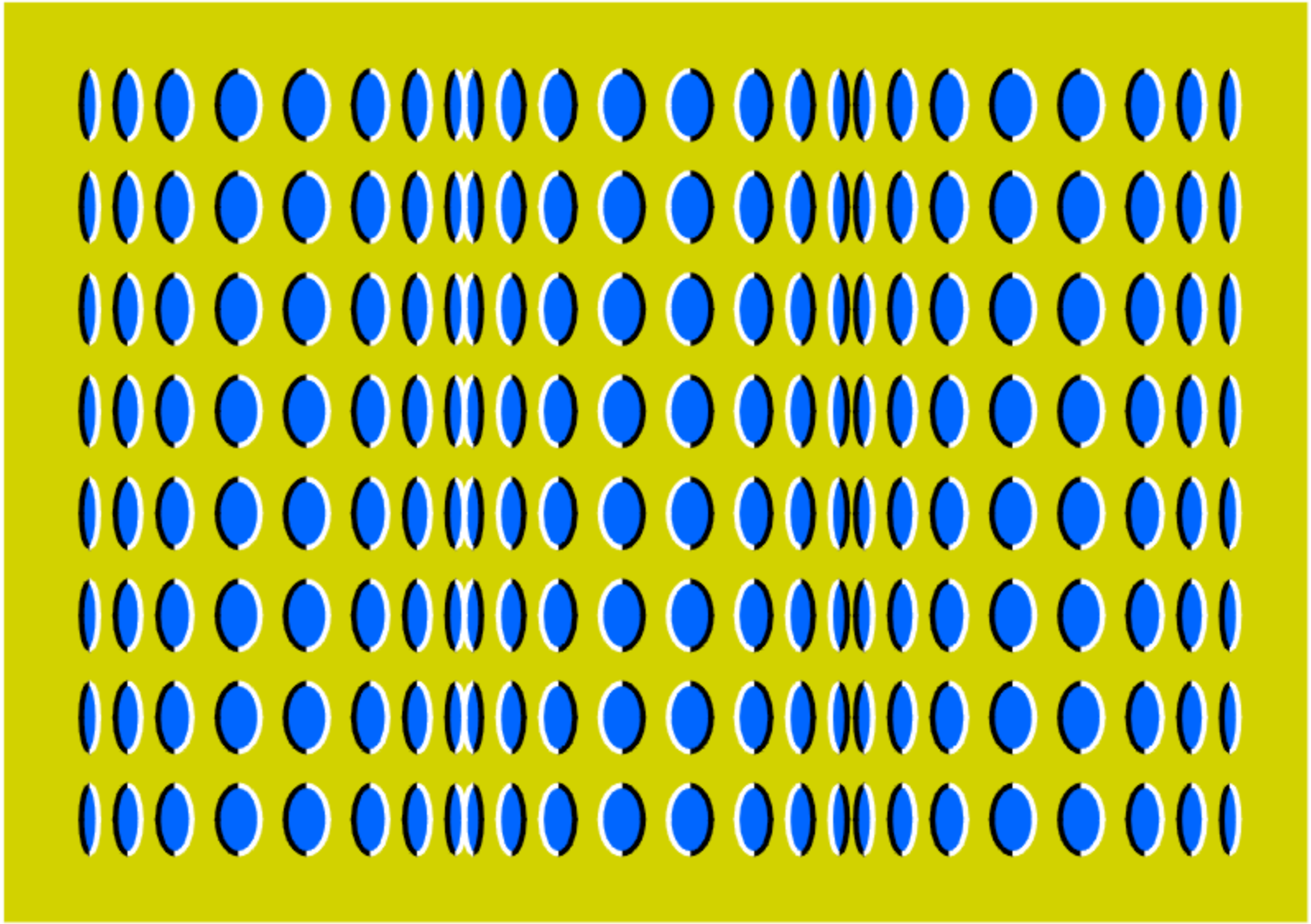
produced by Akiyoshi Kitaoka 2002

Rotating Rays



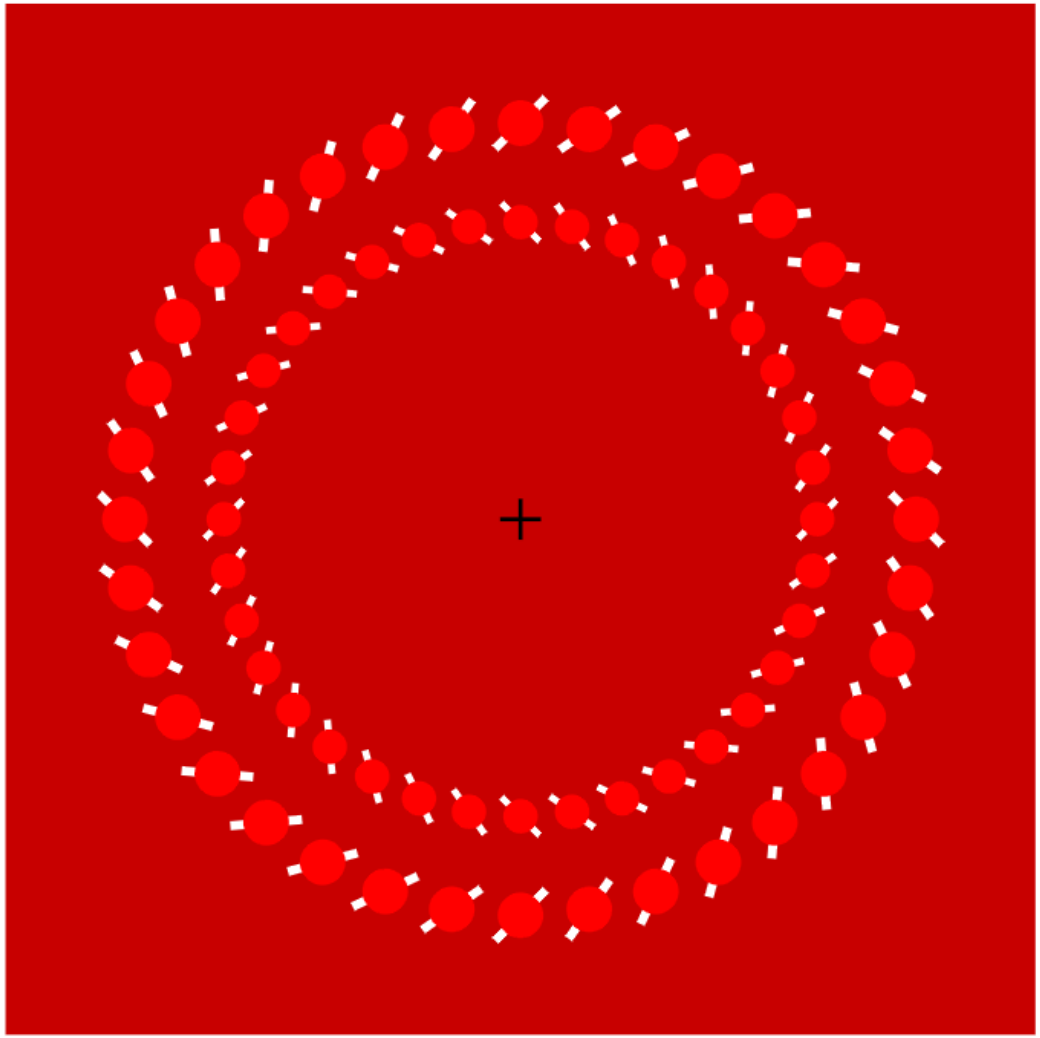
produced by
Akiyoshi Kitaoka 2004

Rollers

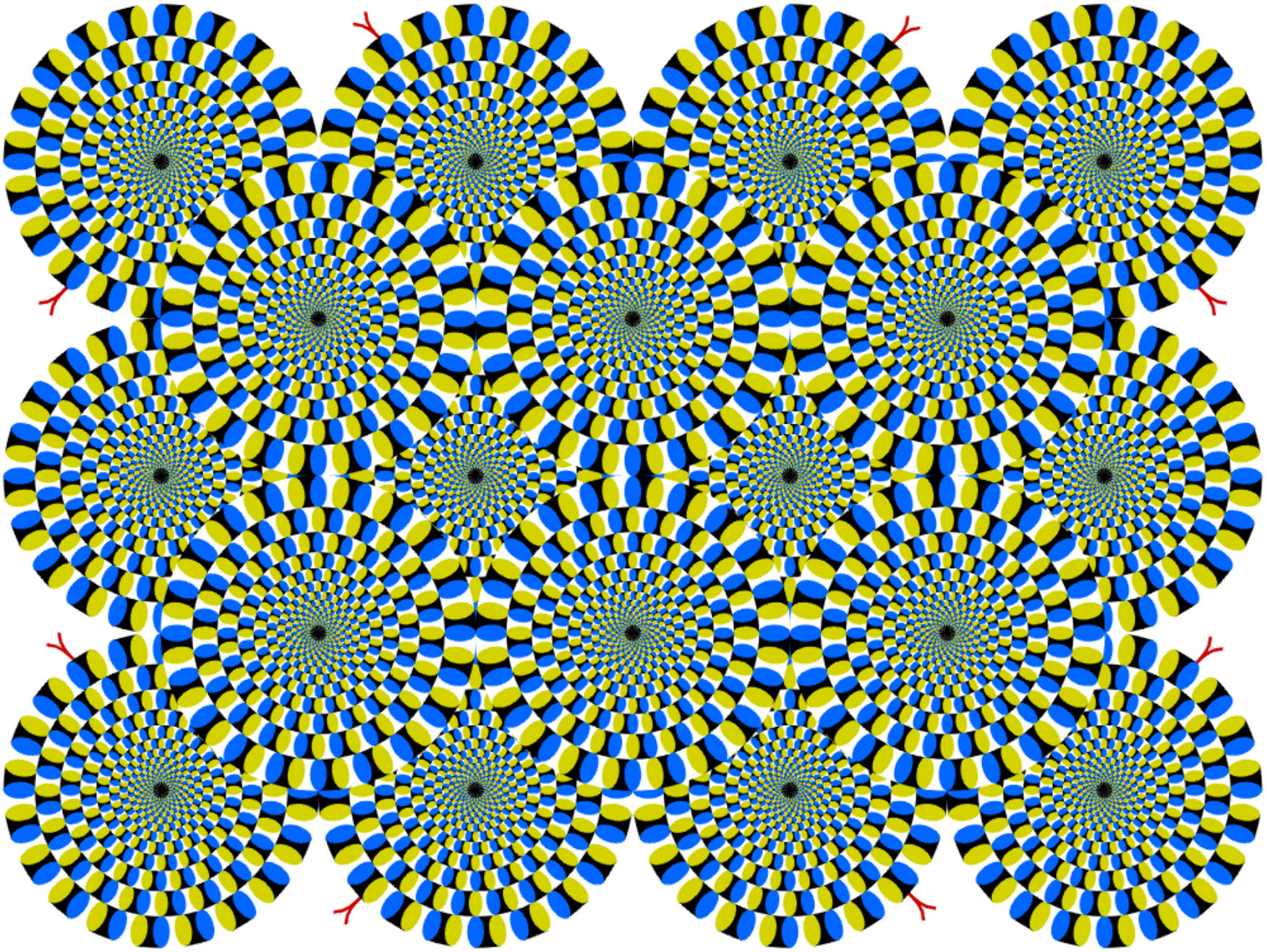


produced by Akiyoshi Kitaoka 2004

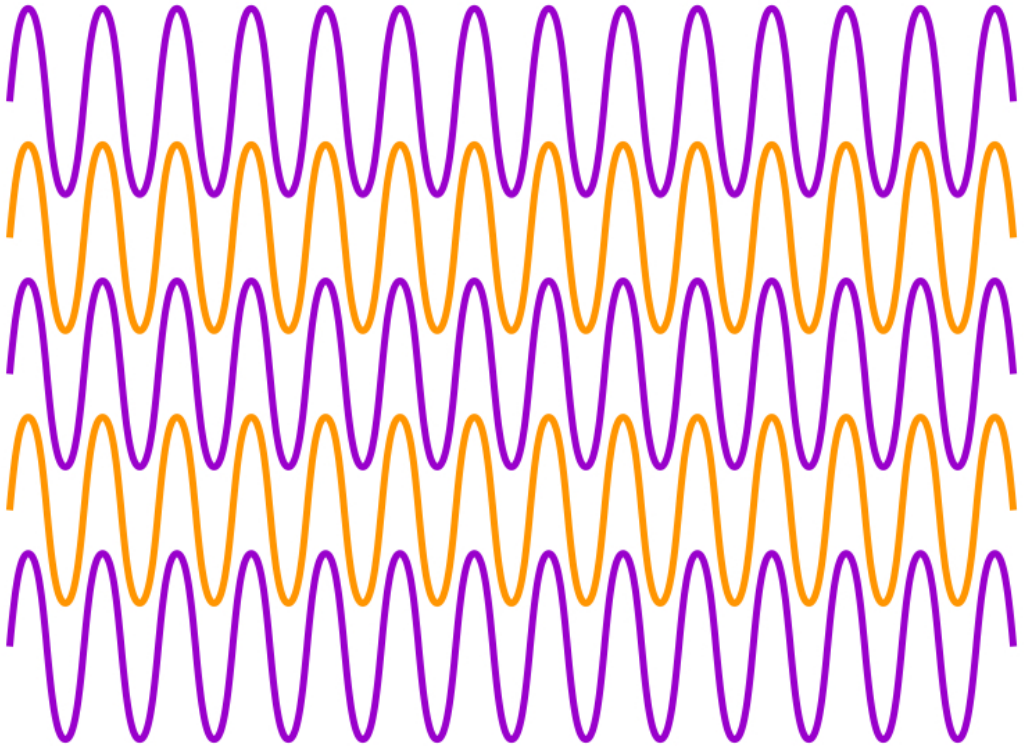
Rotation



KITAOKA (2003)

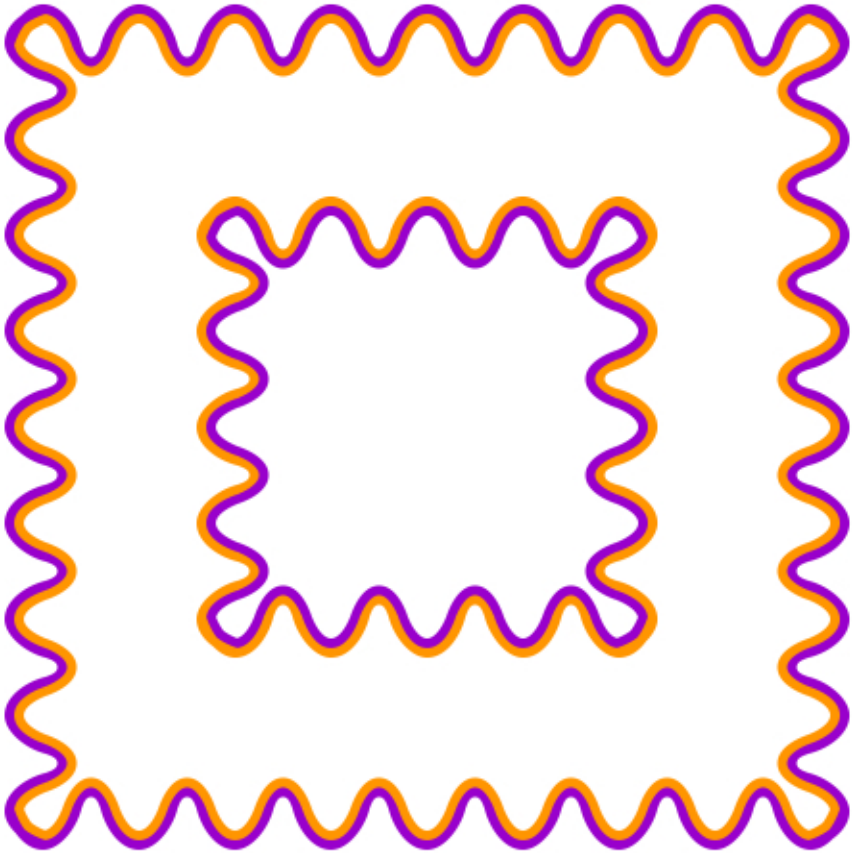


S. SOHMIYAA (2007)



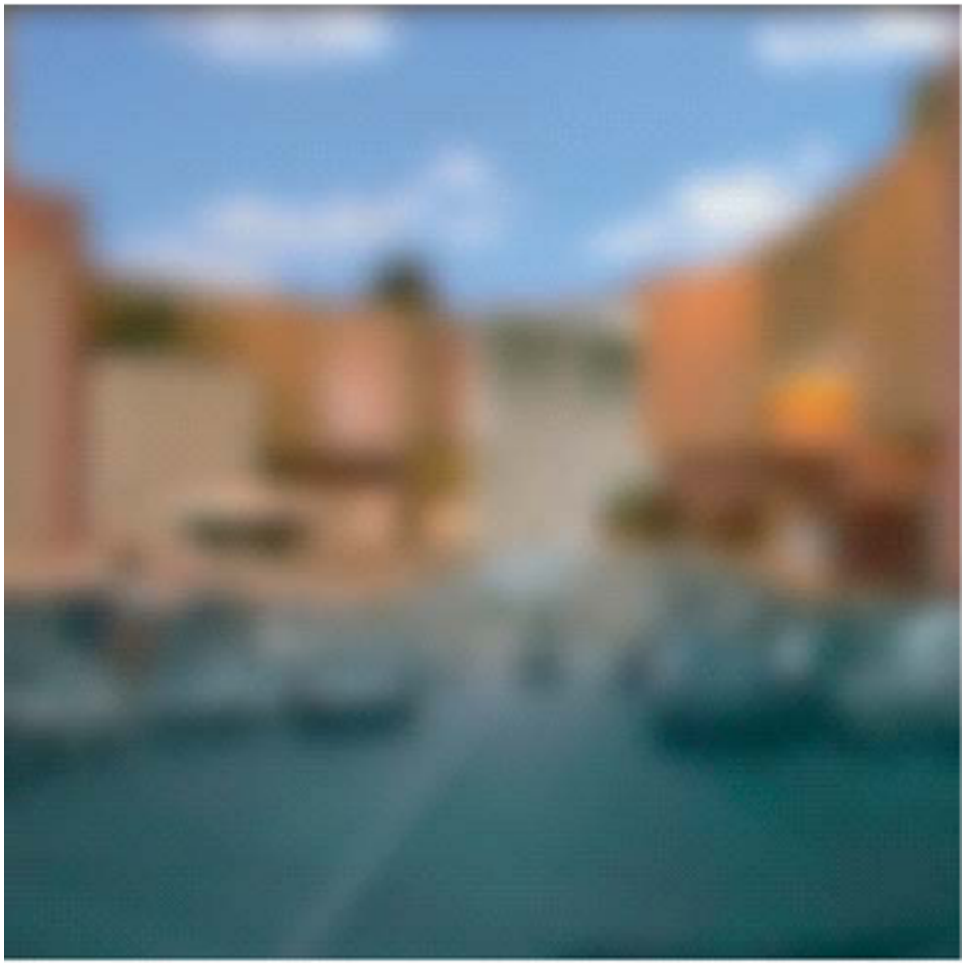
produced by Akiyoshi Kitaoka 2009

Watercolor Illusion



produced by Akiyoshi Kitaoka 2009

What is this scene?



What is this scene?

VISUAL ILLUSIONS

VISUAL ILLUSIONS

VISUAL ILLUSIONS

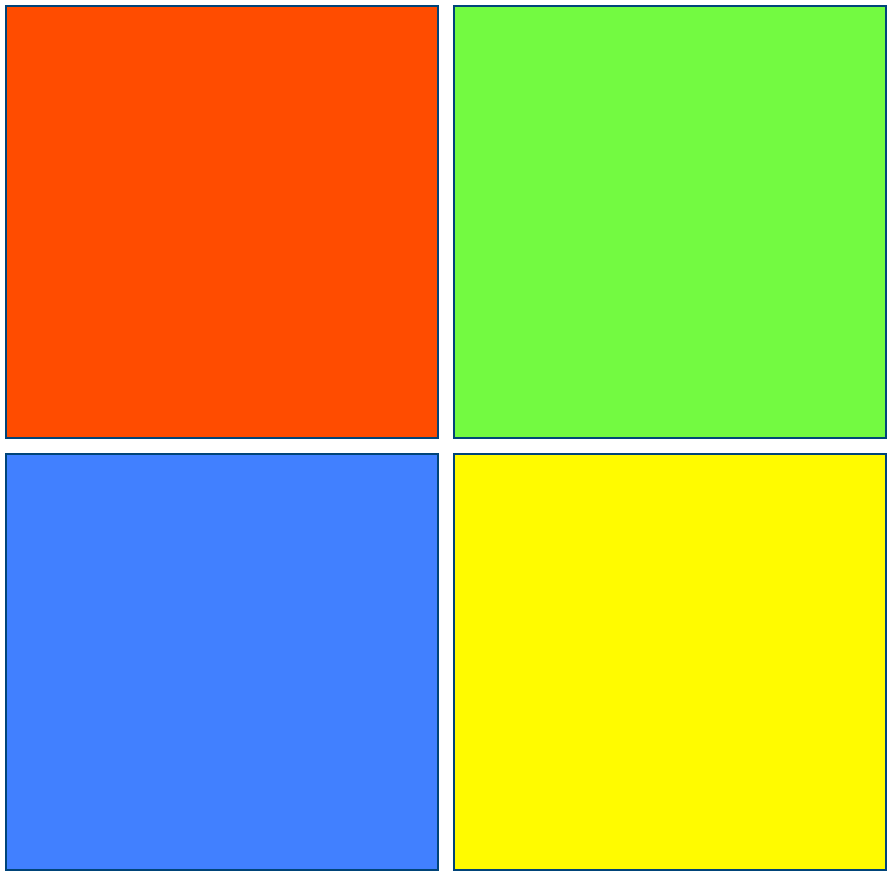
VISUAL ILLUSIONS

Visual Adaptation and the Relative Nature of Perception

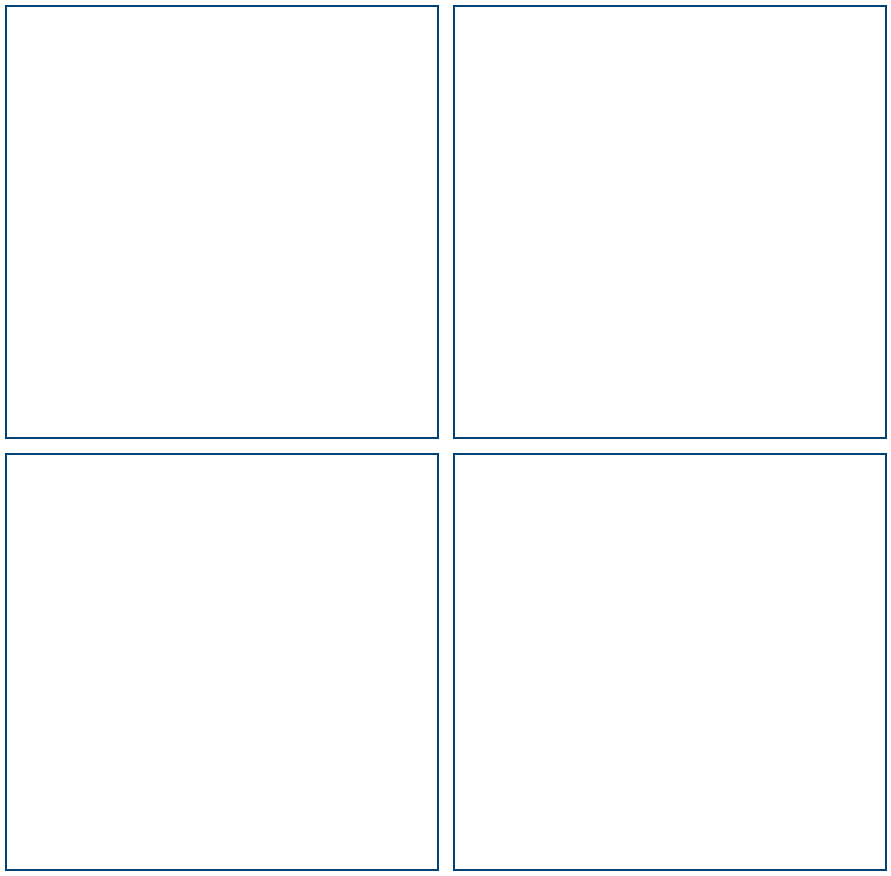
Michael A. Webster
University of Nevada, Reno

A Further Example: Adaptation to Color

Stare at the center of the pattern for a few seconds and then note the afterimages when the slide is switched



A Further Example: Adaptation to Color



Visual sensitivity rapidly adjusts to the average color in the image.

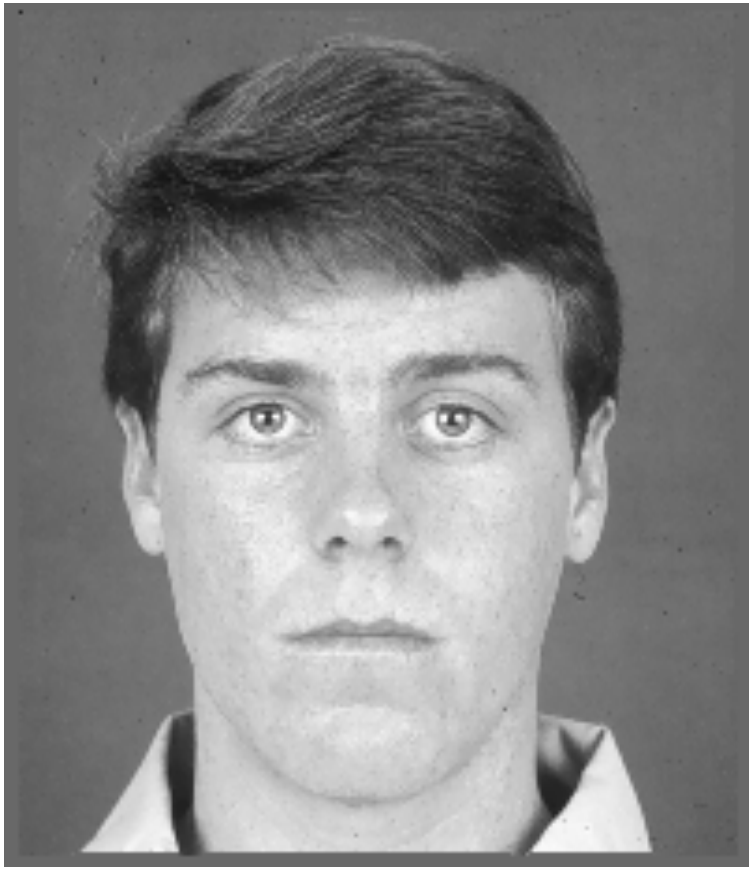
A demonstration of adaptation to blur

Continue to fixate on the green circle. In the next slide the left image will be blurred, while the right will be sharpened. After adapting to these for a few seconds, the original image will appear sharper on the left, and blurrier on the right.

Blur induction does not depend on the precise alignment of edges

The center images are the same, but the image within the sharpened context may appear blurrier, especially if you fixate off to the side

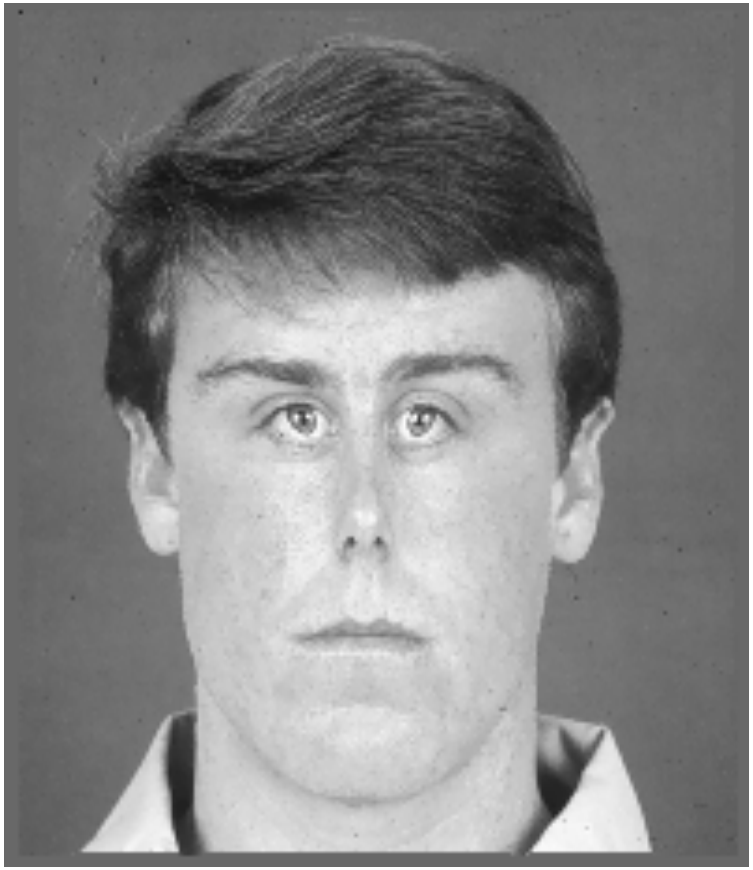
A demonstration of face adaptation



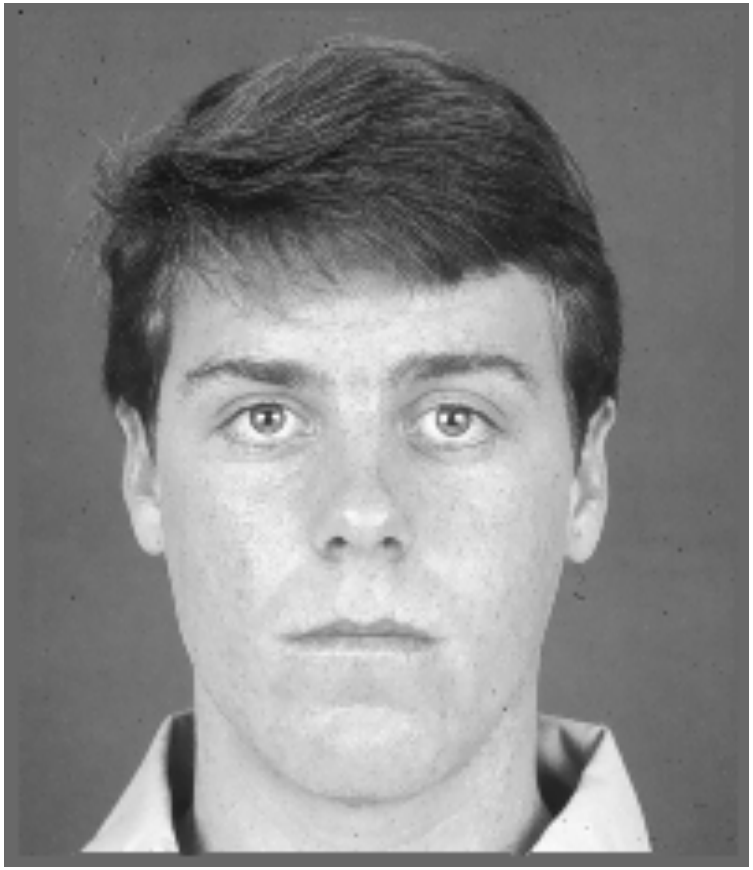
In the next slide, stare at the contracted face for several seconds.

When the original is shown again it should appear too expanded

A demonstration of face adaptation



A demonstration of face adaptation



Adaptation to color in natural images

Natural scenes have a restricted range of colors

The color distributions vary both across scenes and within the same scenes over time (e.g. with the changing seasons)