



Utrecht University

Shape Matching Part 1: Perception

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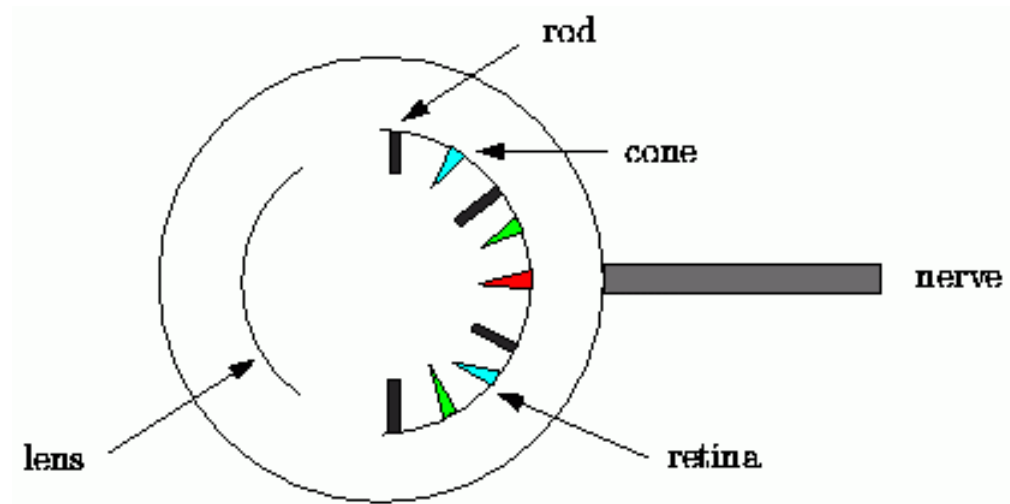
www.cs.uu.nl/centers/give

Optics, perception, cognition

- Be aware of human visual system, perception, and cognition

Human visual system

Optics:

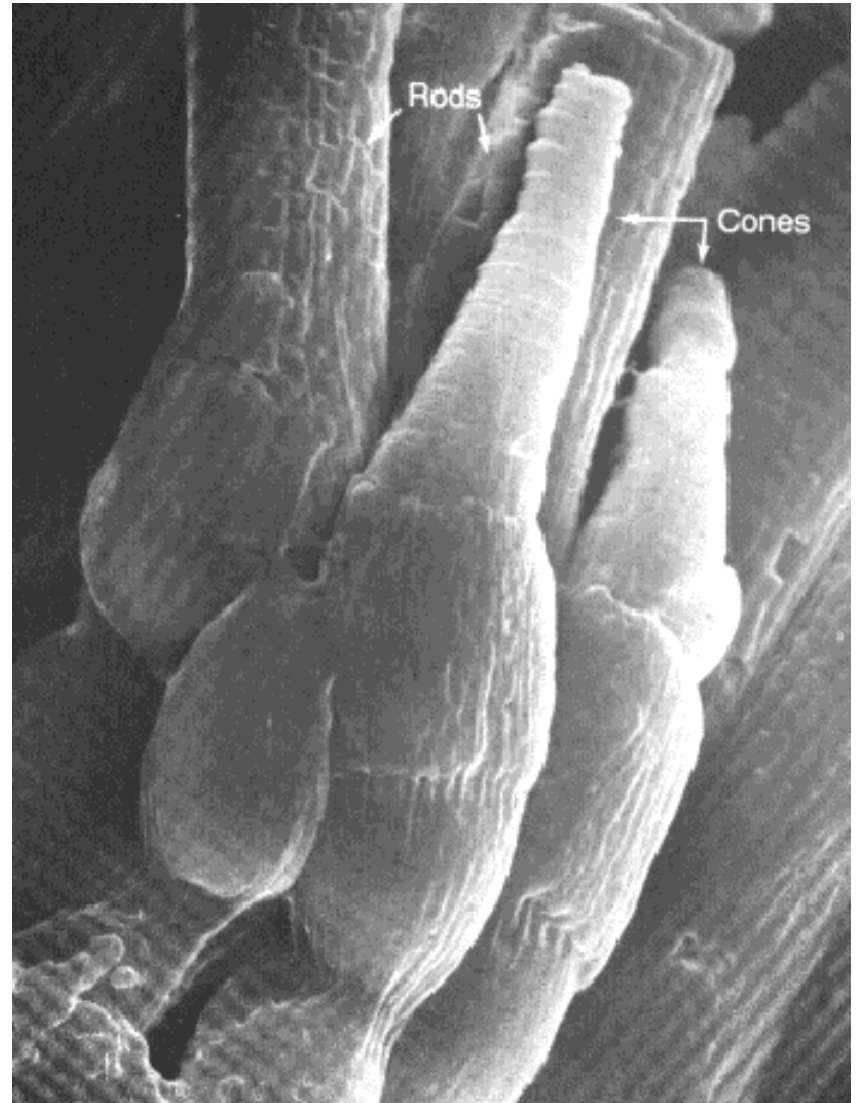


Human visual system

Rods for b/w

Cones for color

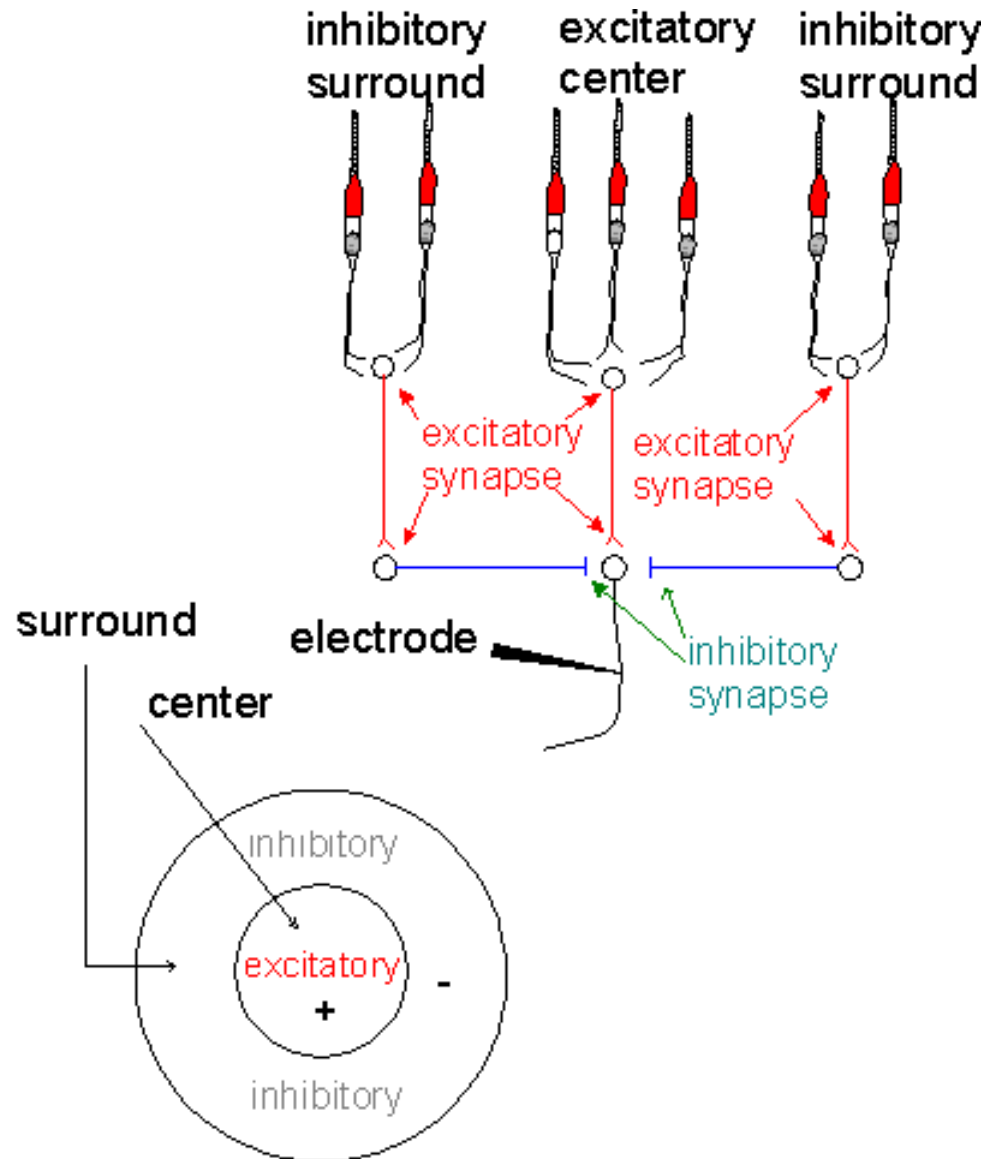
Rods have higher spatial resolution and are more light sensitive



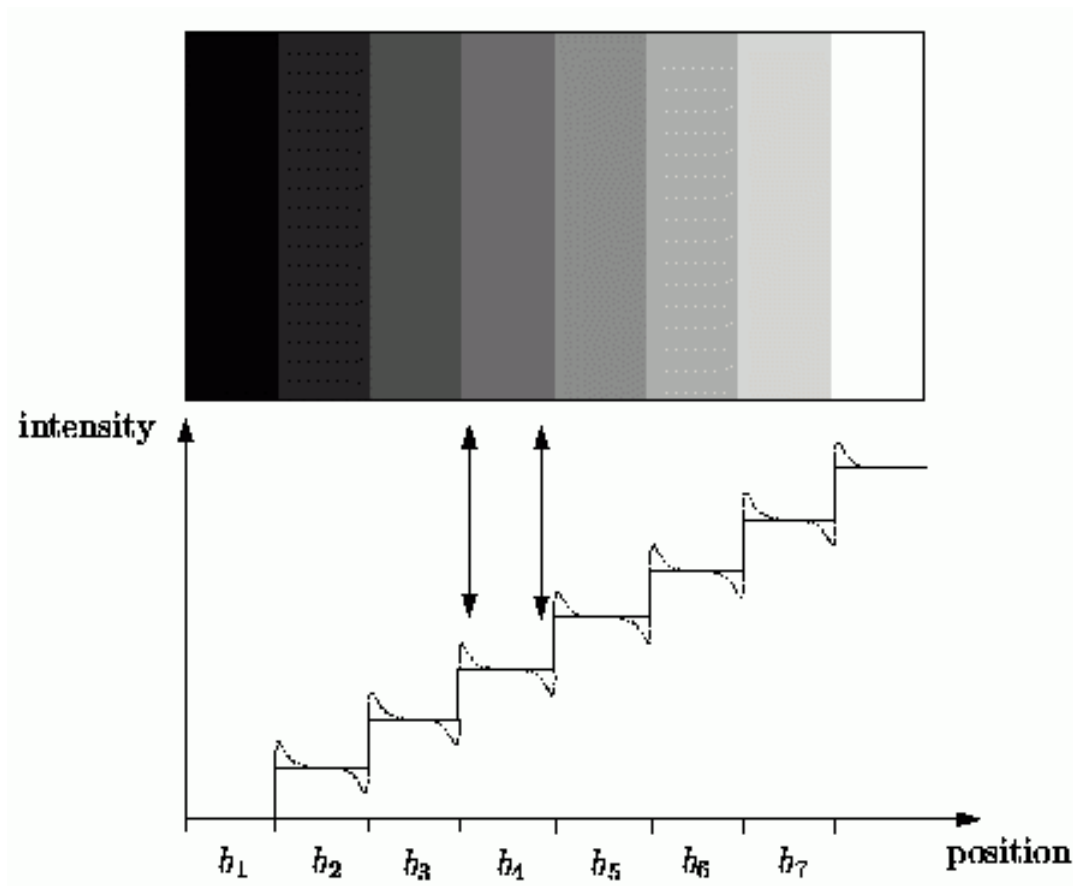
Human visual system

Complex working

One example:
lateral inhibition



Optical truth \neq perceptual truth

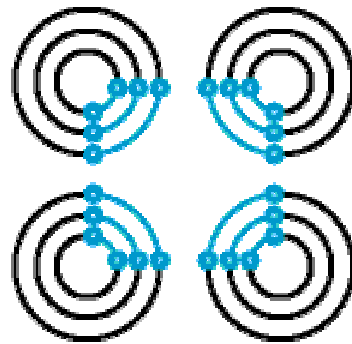


solid: real
dashed: perceived

Mach bands, caused by lateral inhibition

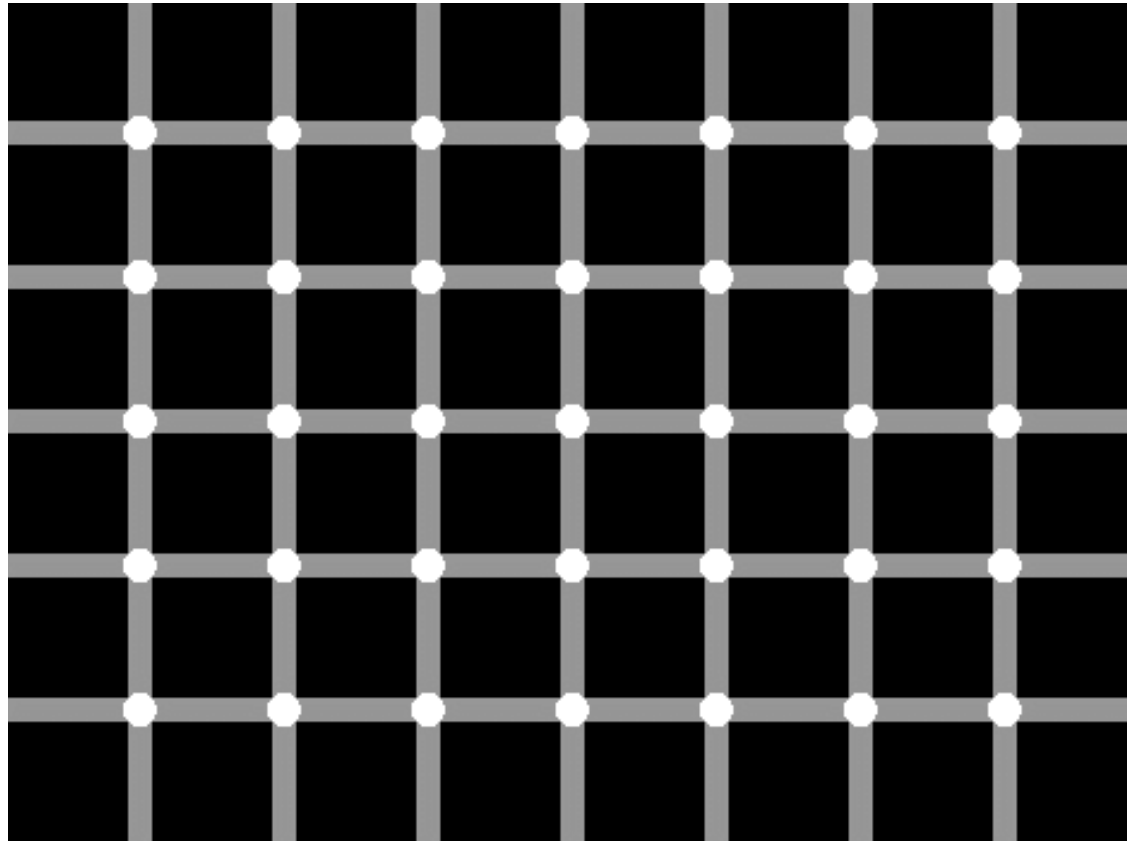
Optical truth \neq perceptual truth

Human visual system favors ‘generic interpretation’ over nongeneric



- With dots: generic interpretation is blocked
- Without dots: generic \Rightarrow blue square

Optical truth \neq perceptual truth



Hermann grid: count the black dots

Color perception

- Bright, saturated colors emphasize
- Different objects of same color interpreted the same
- HVS cannot distinguish color of small objects
- Common color deficiency: red = green at low saturation and luminance
- Red area perceived as larger than same green area
- Red area perceived closer than blue area

Color cognition

- Color has meaning
e.g. red is danger
- Cannot instantly remember more than 7 meanings

Size perception

Perceived size depends on:

- Visual angle: all other things being equal, the object with largest visual angle seems larger
- Phenomenon of size constancy: objects of known size seem to have constant size regardless small changes in distance
- Perspective: objects of same size in strong perspective appear larger at greater distance

Size illusion



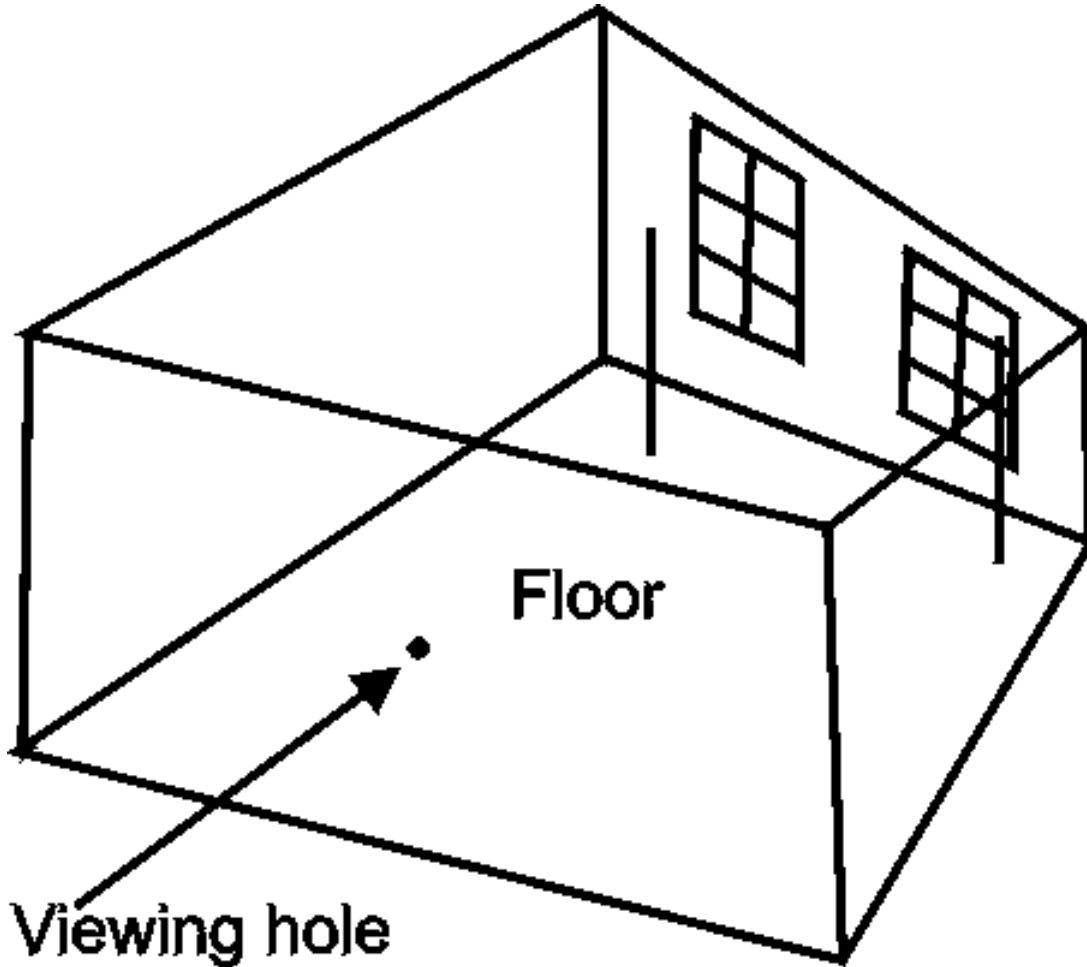
The Ames room

Size illusion



The Ames room

Size illusion



The Ames room

Size illusion

Ponzo illusion:
horizontal segments
have same size

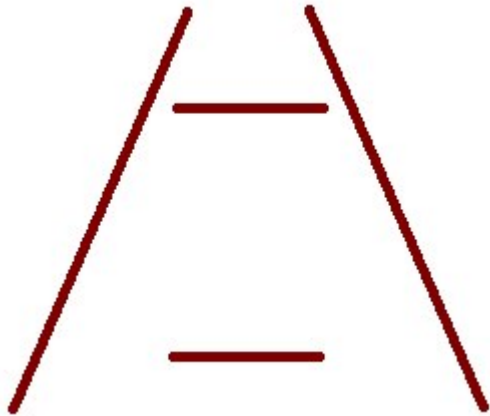
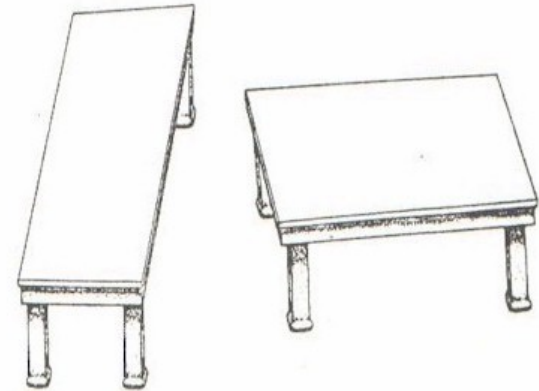
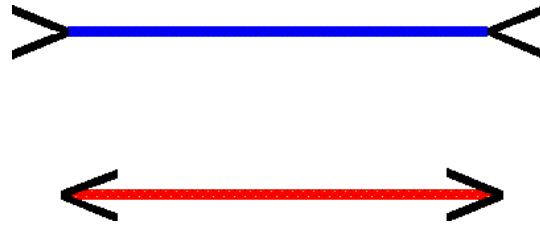


Table tops have same
size and shape
(print, cut, and lay left table
top over right one)



Both illusions caused by perspective

Size illusions



Müller-Lyer illusion

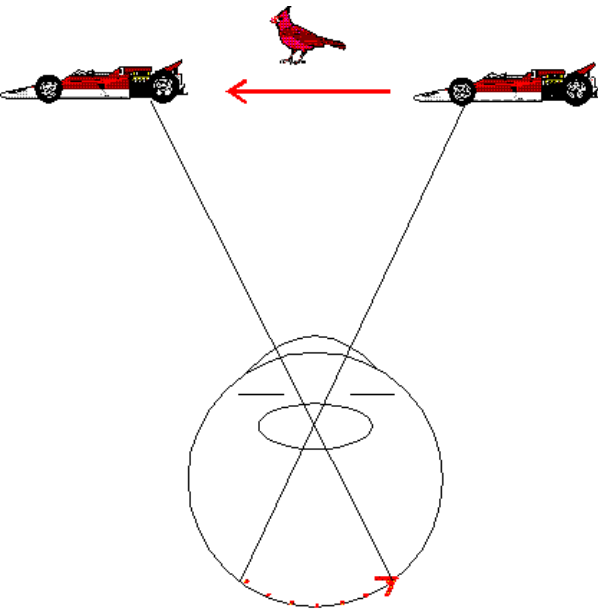
[animated](#)

Distance perception

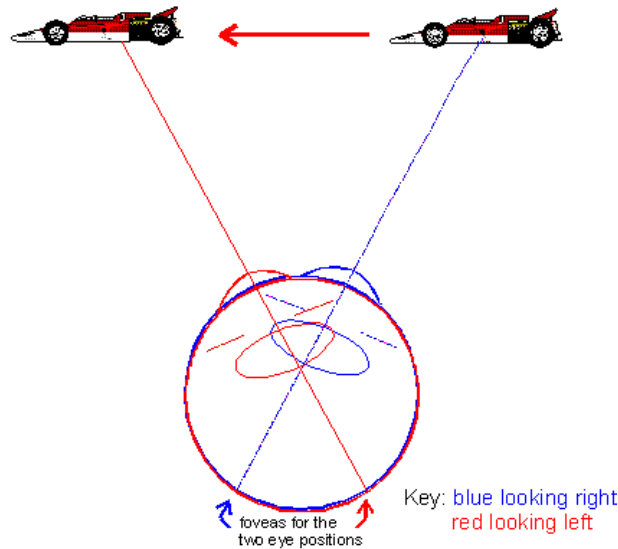
- Overlap (overlapping object closer)
- Color, intensity (fainter object further, atmospheric aberration)
- Size constancy
- Visual angle
- Texture gradient
- Perspective
- In real 3D: convergence; not on 2D screen

Motion perception

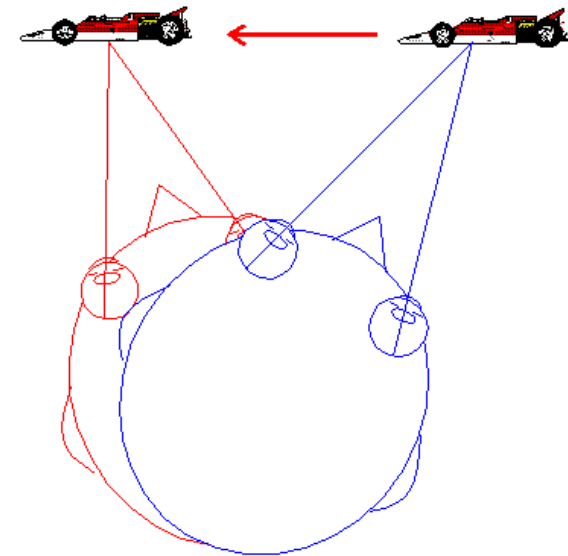
Projection moves
across retina



Eyes are moved,
projection not

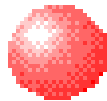


Head is moved,
projection not



Motion illusion

- Phi phenomenon: two objects flashing on and off perceived as a single moving object

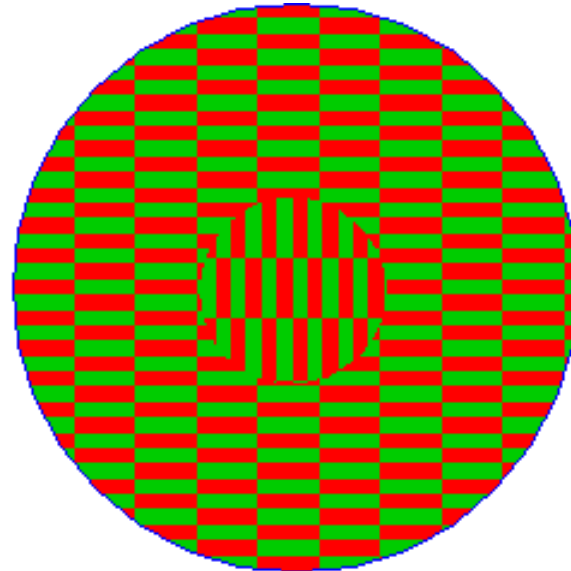
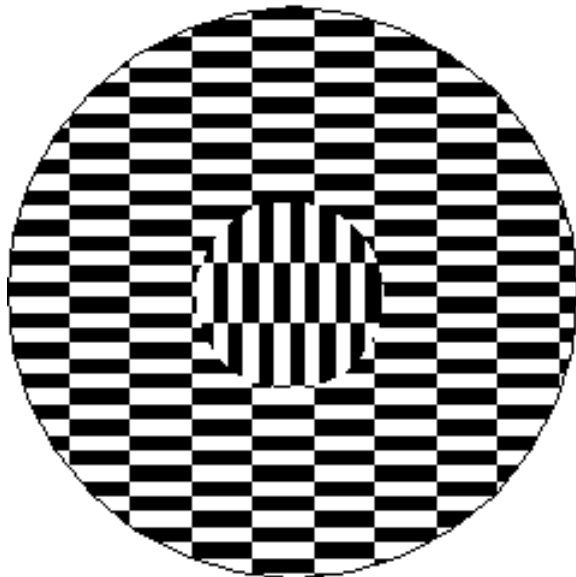


Motion illusion

- 30 times per second perceived as smooth motion: film

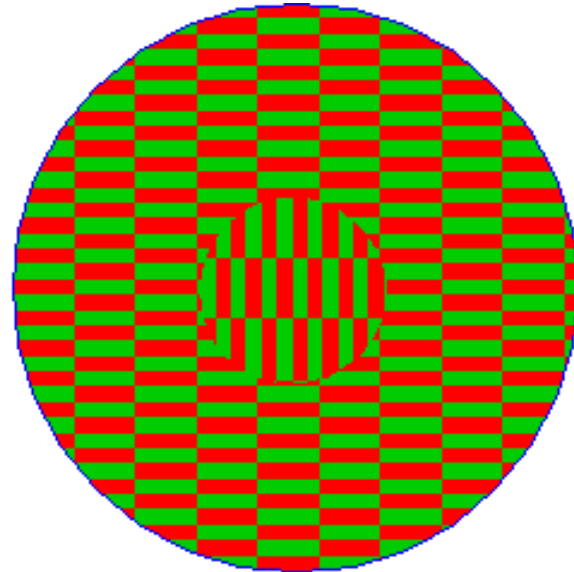
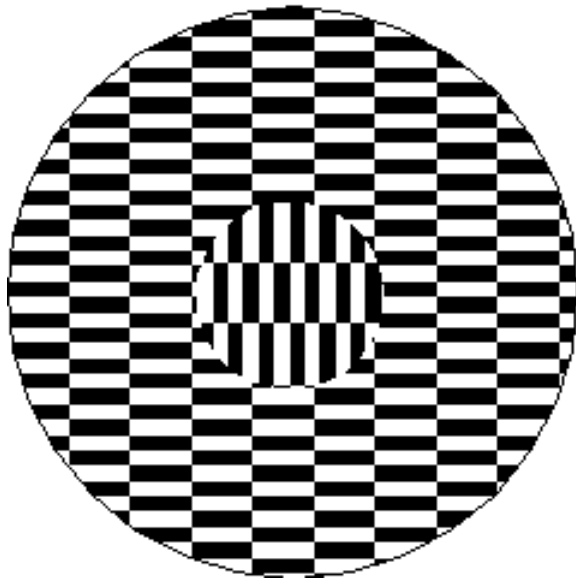


Motion illusion



Ouchi motion illusion:
relative motion of inner w.r.t. outer part

Motion illusion



Ouchi motion illusion:
relative motion of inner w.r.t. outer part

Symmetry

in human perception, a variant is more similar to its prototype, than the prototype is similar to its variant

variant A:



prototype B:

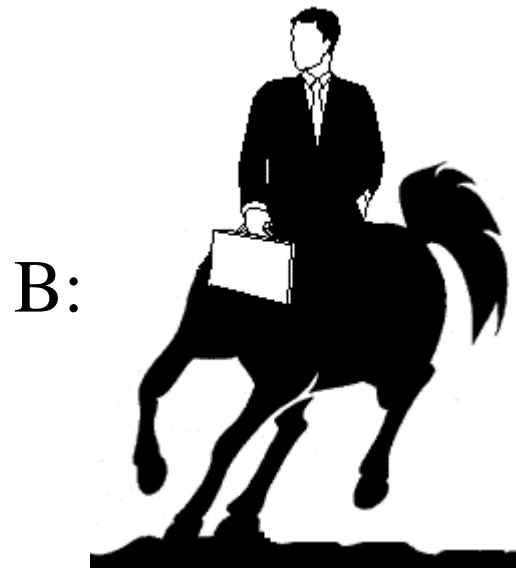
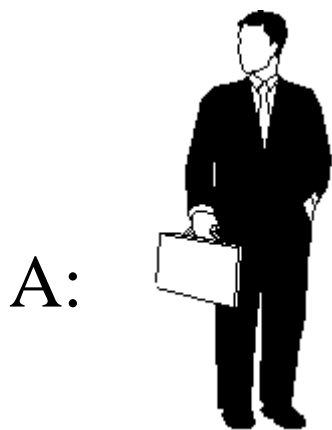


$$d(A,B) < d(B,A)$$

Triangle inequality

$$d(A,B)+d(B,C) \geq d(A,C)$$

However, in human perception, A can be similar to B, and B similar to C, but A need not be similar to C



Gestalt Theory

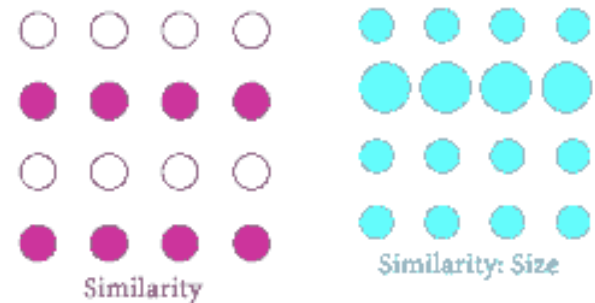
- Initiated by Wertheimer
- “The whole is more than the sum of the parts”
- Goal: explain relation between patterns and their perceptual organization

Gestalt Principles/Laws

1 Figure and ground:
elements are
separated based
on contrast

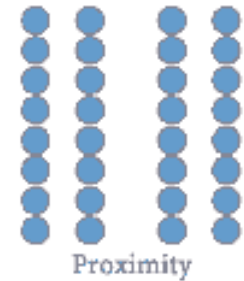


2 Similarity:
similar elements
seen as group



Gestalt Principles/Laws

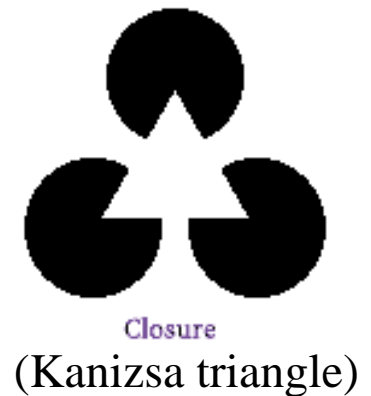
3 Proximity/contiguity:
elements close together
seen as group



4 Continuity/continuation:
preference for good
continuation

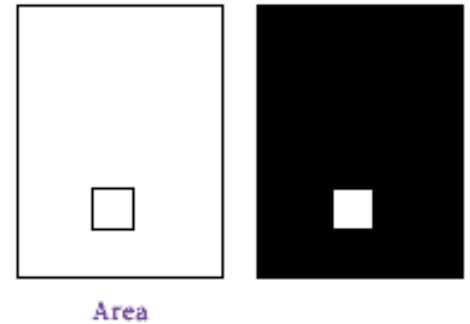


5 Closure: tend to see complete
figures



Gestalt Principles/Laws

6 Area: larger of two overlapping objects is seen as ground, smaller as figure

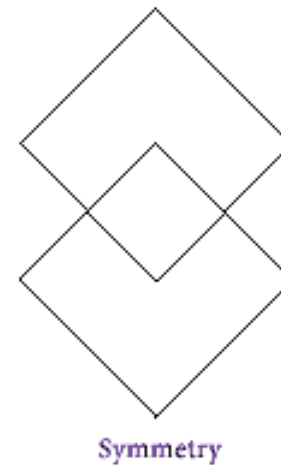
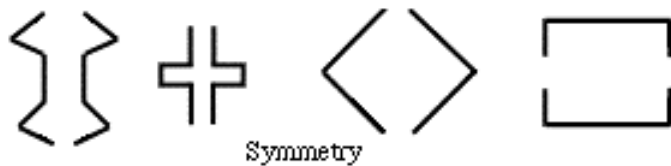


Gestalt Principles/Laws

- No strength ordering among different Gestalt laws: no unambiguous perceptual organization
- Koffka introduced law of Prägnanz: conveying the essence of something
- See a shape pattern as being as regular, simple, or symmetrical as possible
- Not part of the theory: measure for Prägnanz

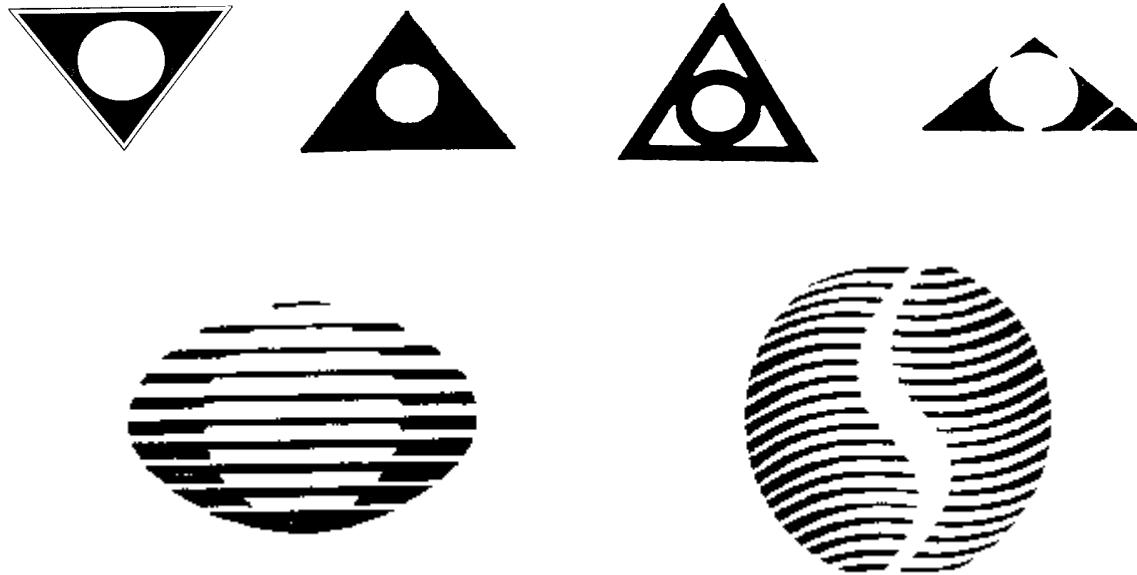
Gestalt Principles/Laws

7 Prägnanz/Simplicity/Symmetry:
regions bound by symmetrical borders seen
as coherent



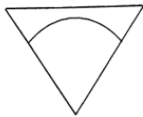
Perceptual Grouping

For example on the basis of Gestalt principles:

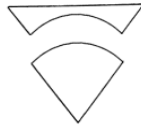


Perceptual grouping

original
logo:



alternative human
segmentations:



Perceptual Matching

two geometrical partial matches:



confusingly
similar

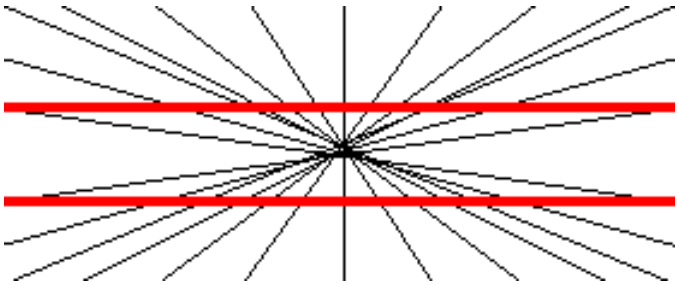


not confusingly
similar

Gestalt Illusions

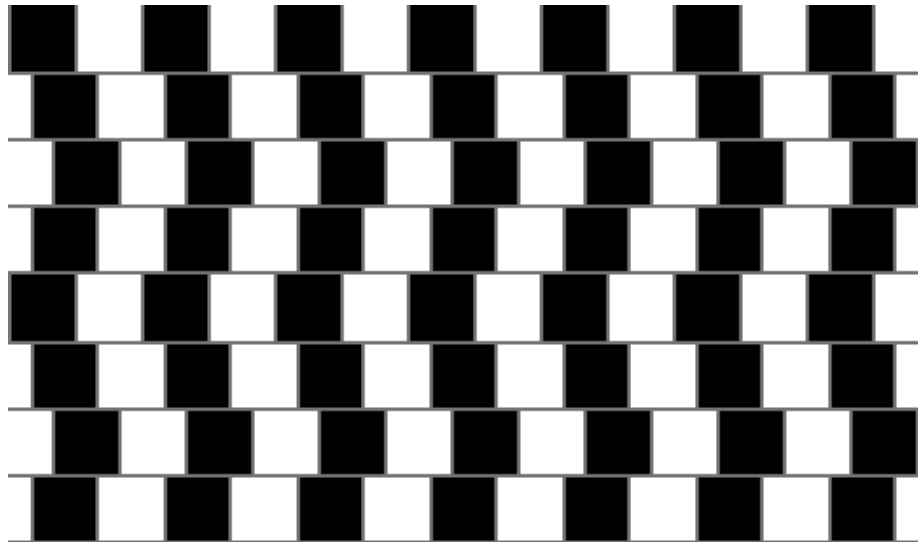
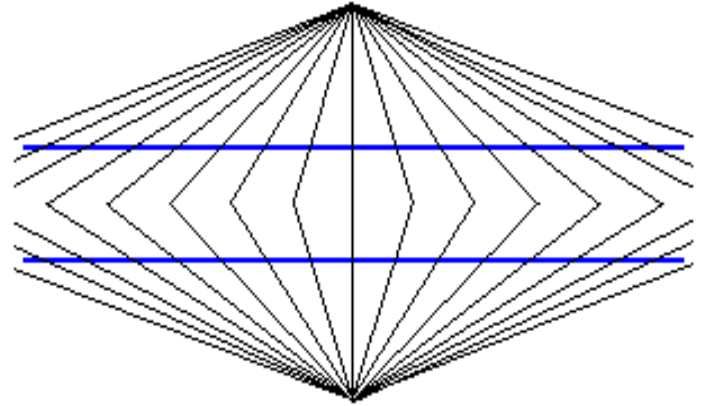
Hering illusion

Red lines are straight and parallel

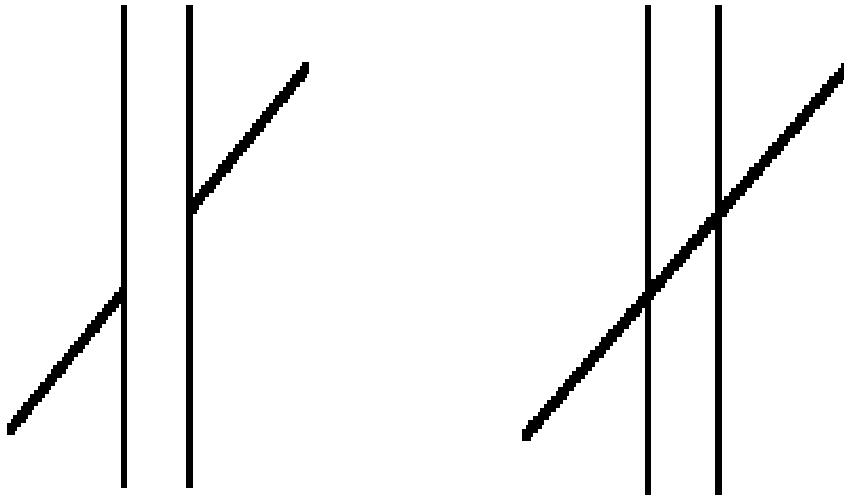


Wundt illusion

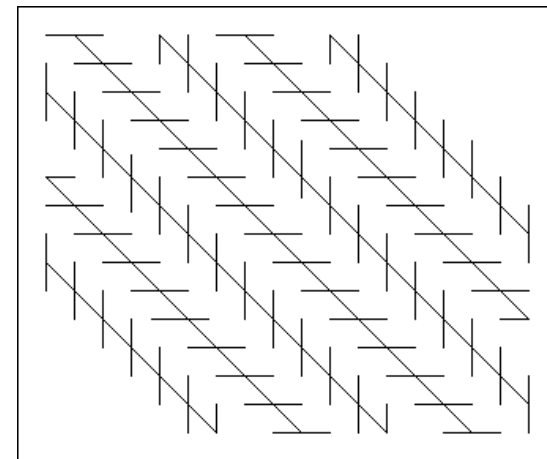
Blue lines are straight and parallel



Gestalt Illusion



Poggendorf illusion



Zöllner illusion

Interactive:

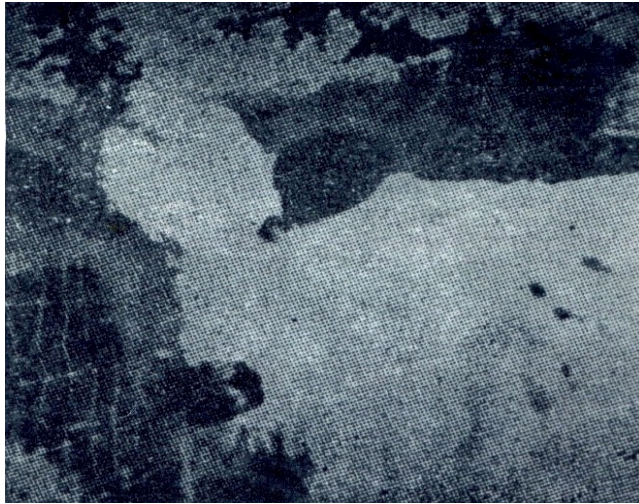
http://www.questacon.edu.au/html/poggendorff_illusions.html

Ambiguity



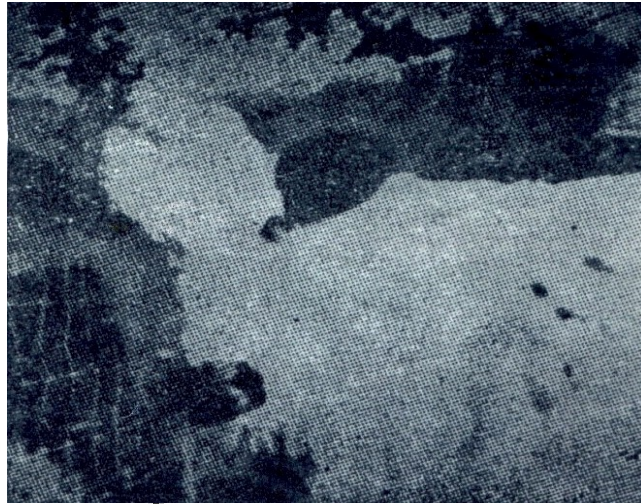
Young or old?

Ambiguity



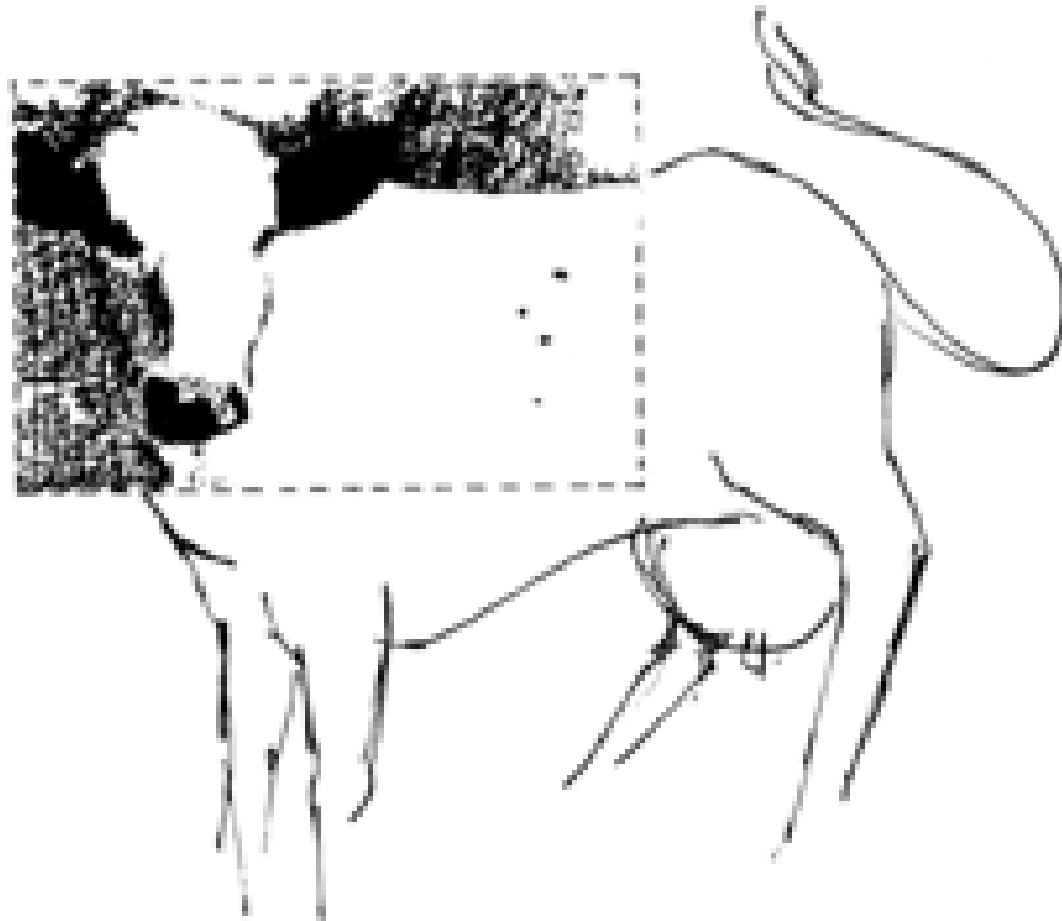
Satellite image

Ambiguity



Satellite image or cow?
Satellite image

Ambiguity



Satellite image or cow?
Satellite image

Ambiguity



Image

Ambiguity



Image or text?

Ambiguity in art

Dali: Slave Market



Figure and ground

Ambiguity in art

Sandro del Prete: The Window Opposite

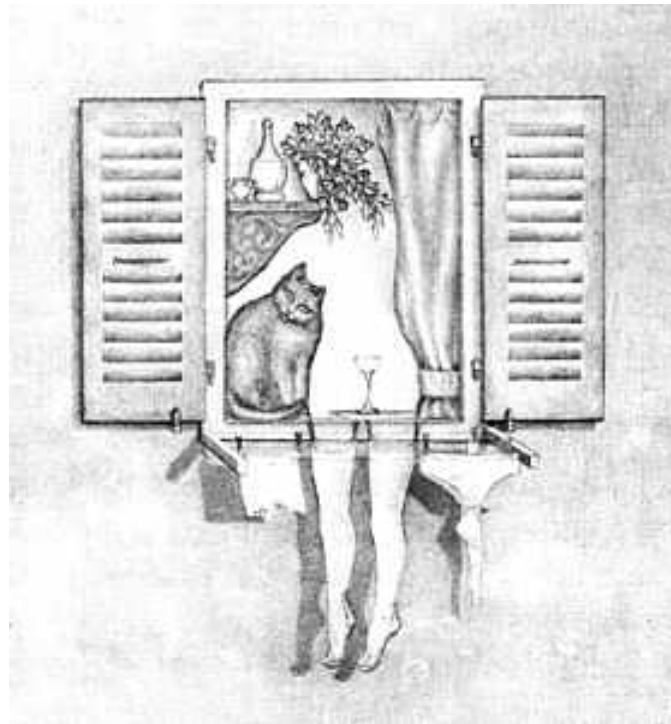
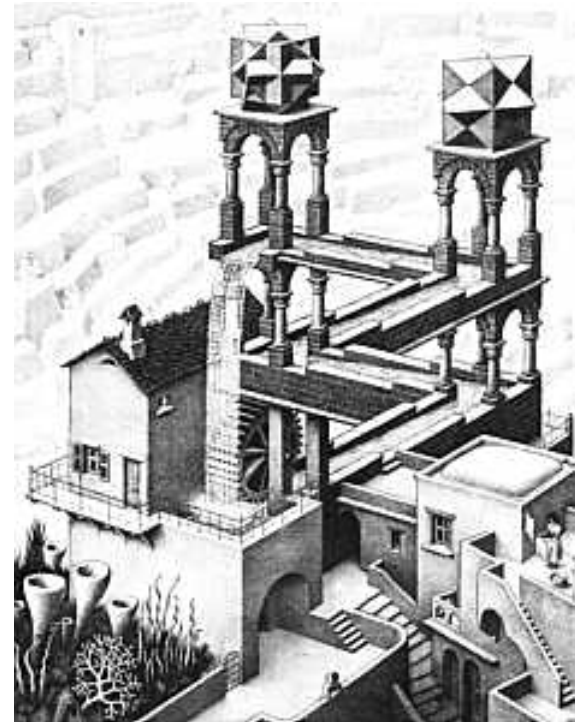
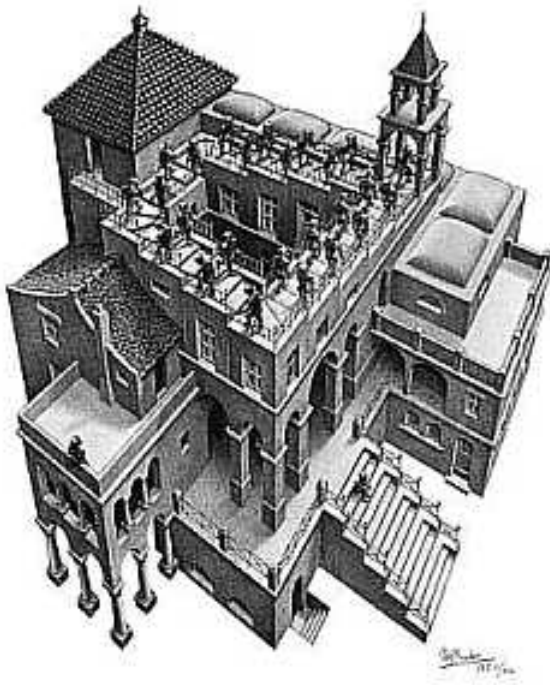


Figure and ground

Ambiguity in art

Escher: Ascending, descending; Waterfall



distance, size, perspective

Ambiguity in trademarks

