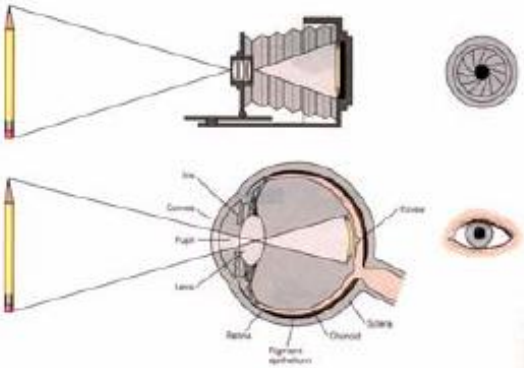
HVS (Human Visual System) and GESTALT Theory: Premessa alla Biometria

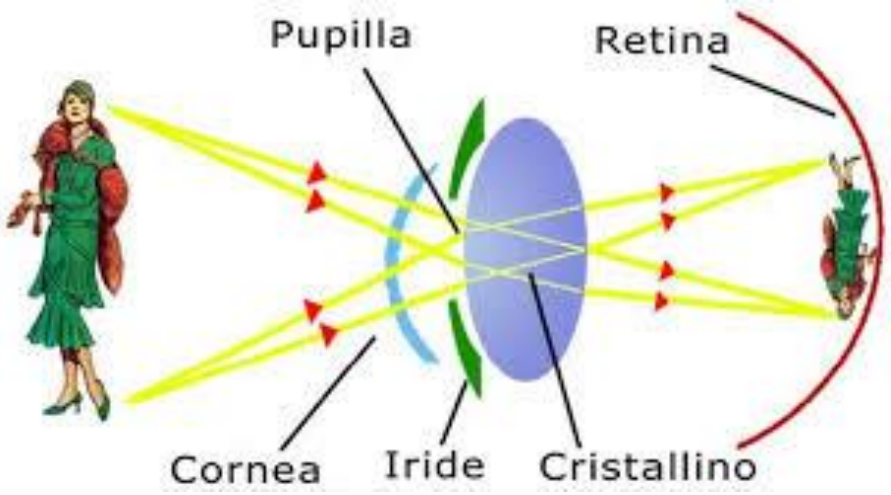
Michele Nappi, Ph.D
Università degli Studi di Salerno

mnappi@unisa.it

The Problem of Perception

The eyes are much more than a camera.

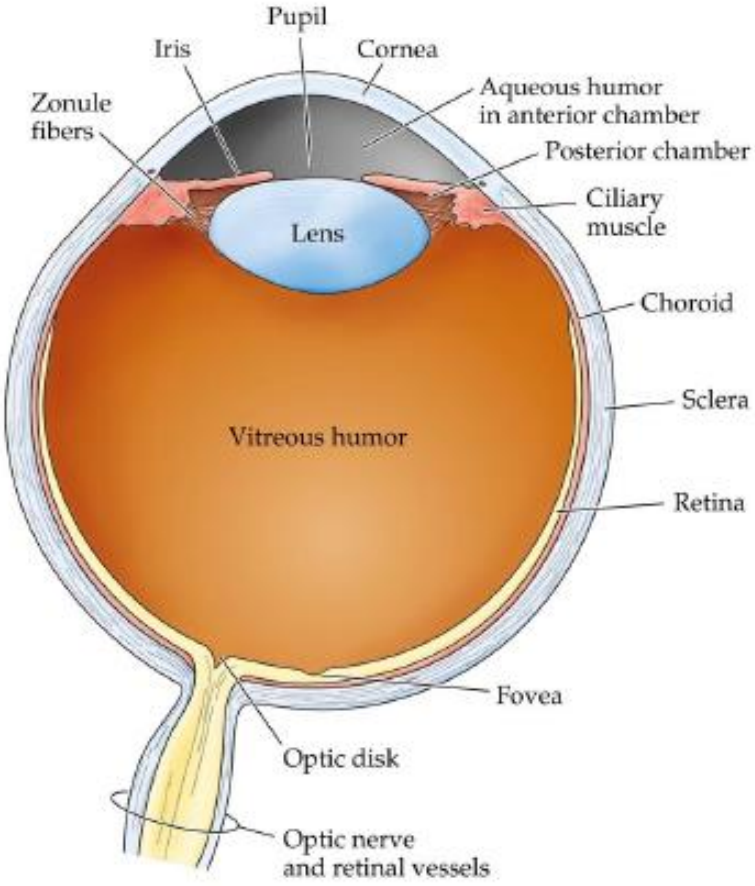


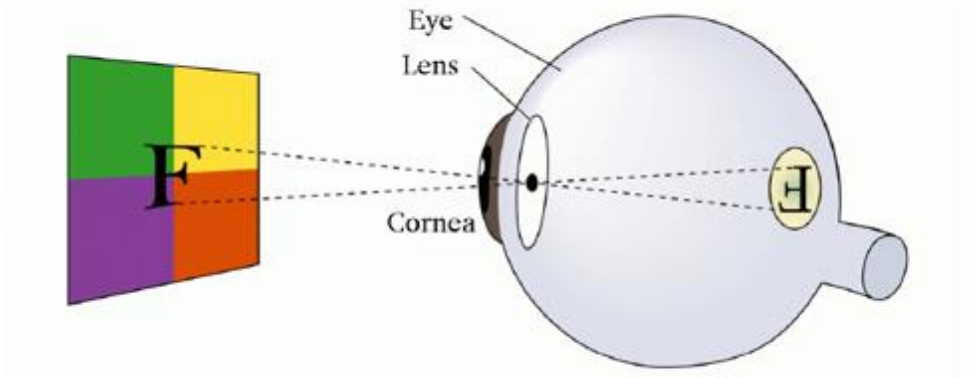


L’Occhio

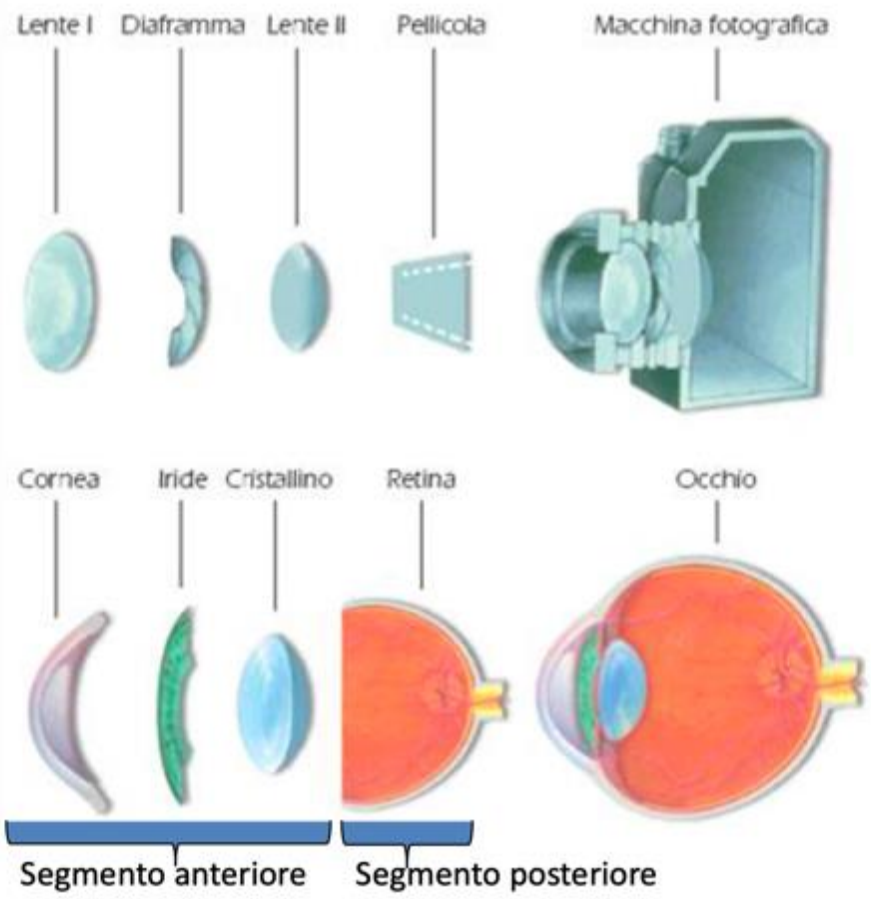
- Dimensioni: Diametro Sfera 20mm
- Membrane Concentriche:
  - Cornea (trasparente)
  - Sclera (opaca)
  - Coroide (rete di vasi sanguigni)
    - Corpo Ciliare (agisce sul cristallino)
    - Iride (diaframma con un foro: pupilla --- 2 to 8 mm)
  - Retina
    - Fovea:
      - » Coni (circa 6\10 milioni) – Sensibili ai colori: Photopic Vision
      - » Bastoncelli (75/150 milioni – Scotopic Vision)
- Cristallino
  - 60/70 % Acqua – 6% Grasso – Proteine
  - Assorbe 8% dello spettro visibile (Infrarossi e ultravioletti)

The human eye

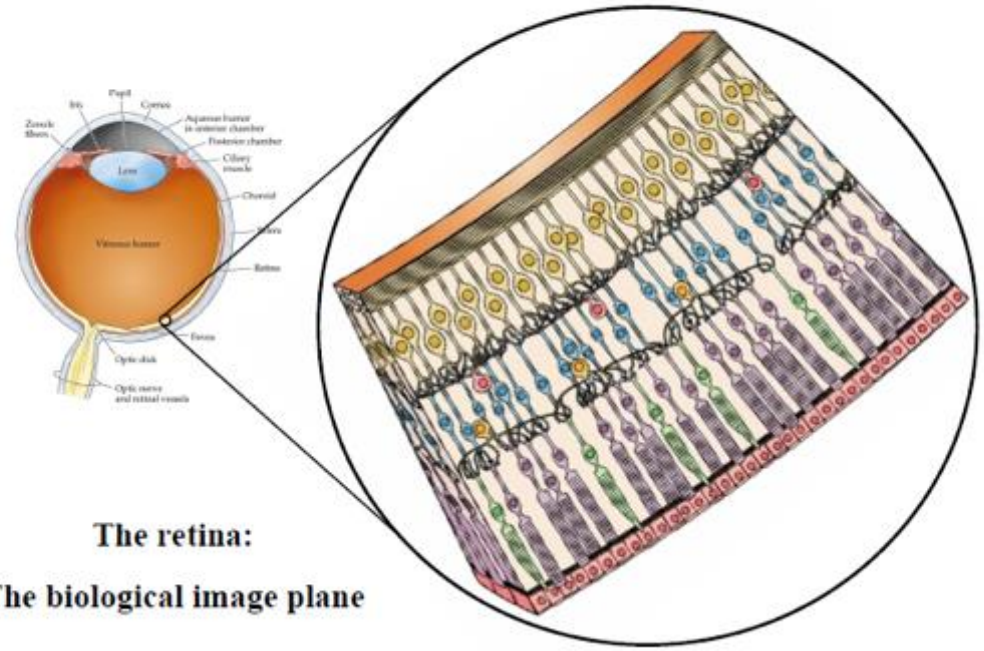




Occhio e Macchina Fotografica

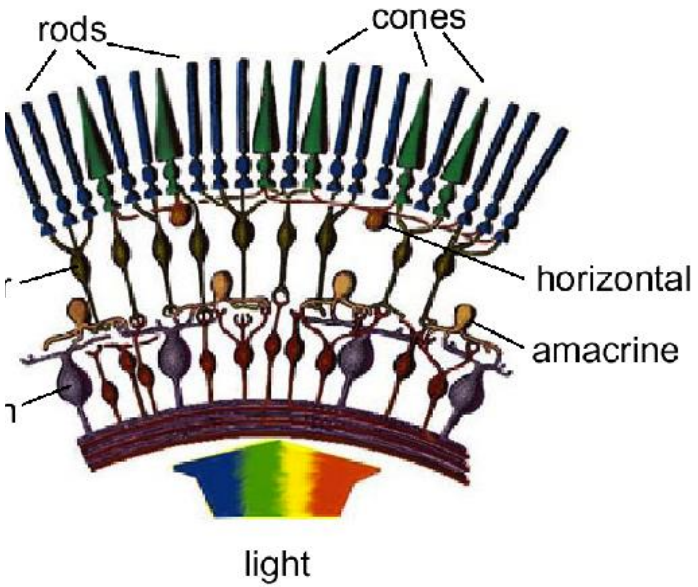


The human eye

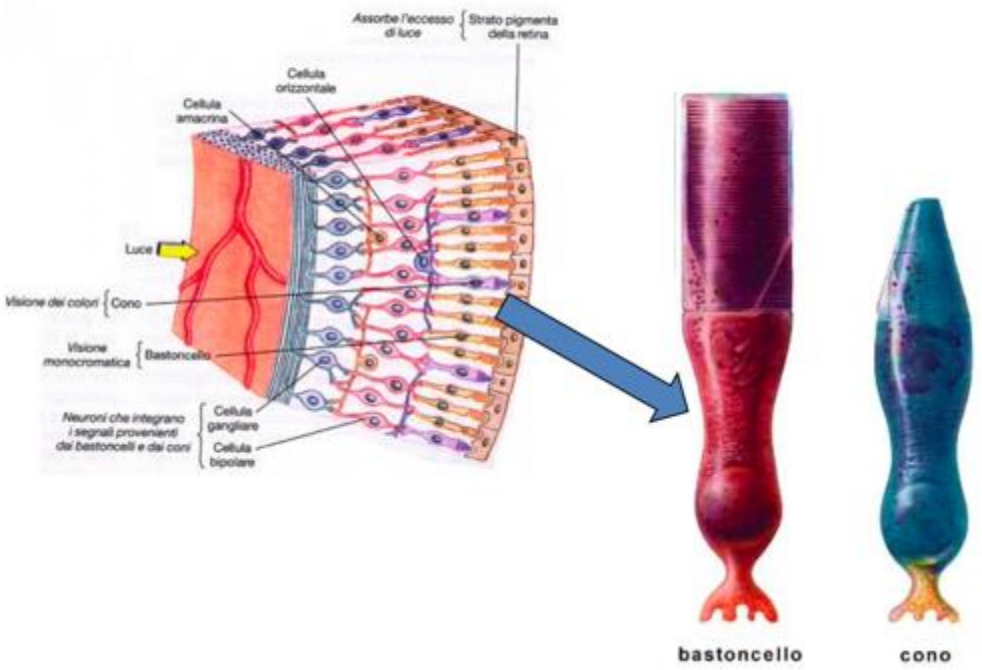


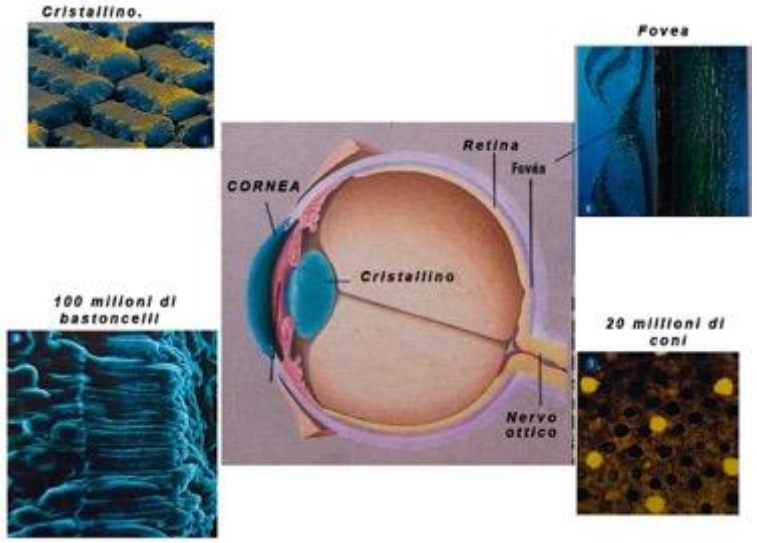
The retina:

The biological image plane

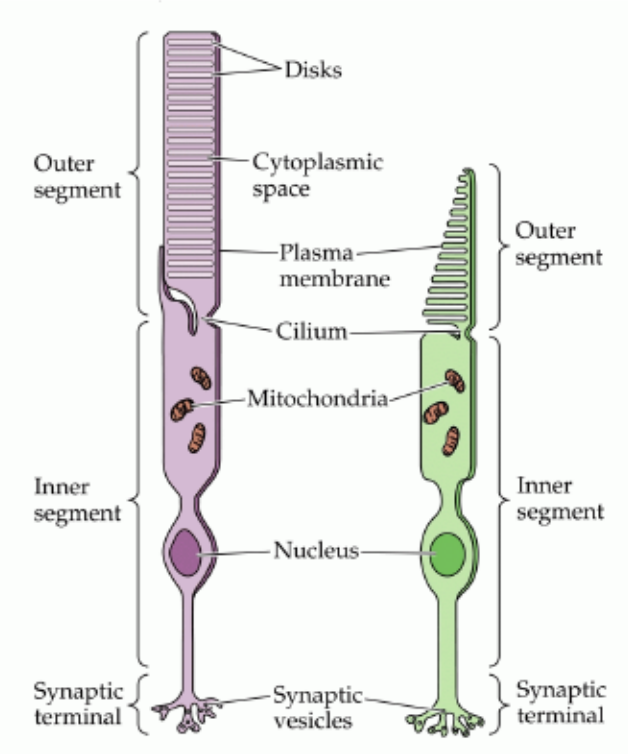


Retina


Assorbe l'eccesso di luce
Strato pigmentato della retina
Cellula orizzontale
Cellula amacrina
Luce
Visione dei colori
Cono
Visione monocromatica
Bastoncello
Neuroni che integrano i segnali provenienti dai bastoncelli e dai coni
Cellula gangliare
Cellula bipolare
bastoncello
cono


Cristallino.
Fovea
Retina
Fovea
CORNEA
Cristallino
100 milioni di bastoncelli
20 milioni di coni
Nervo ottico

The human eye



Rods and cones

Rods:

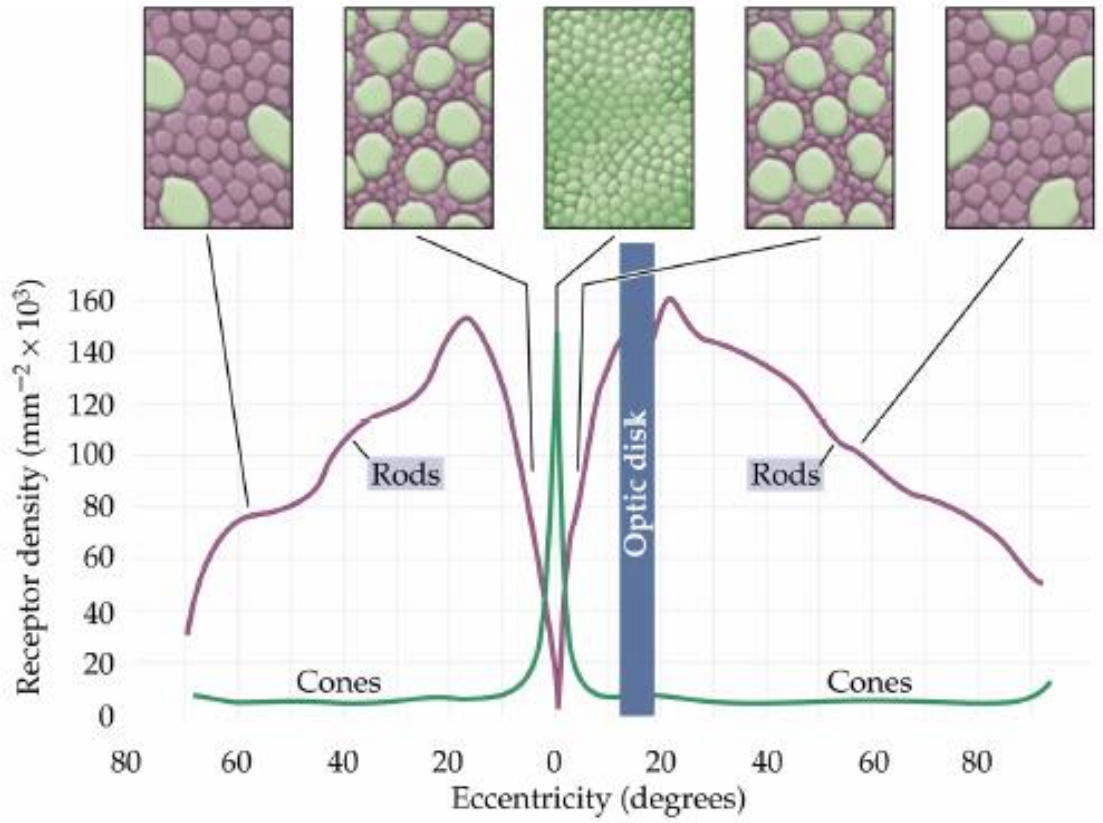
- **Extremely sensitivity to light**
- **Single photon response**
- **Low spatial resolution**
- **Single response profile**
- **B&W night vision (scotopic)**

Rods and cones

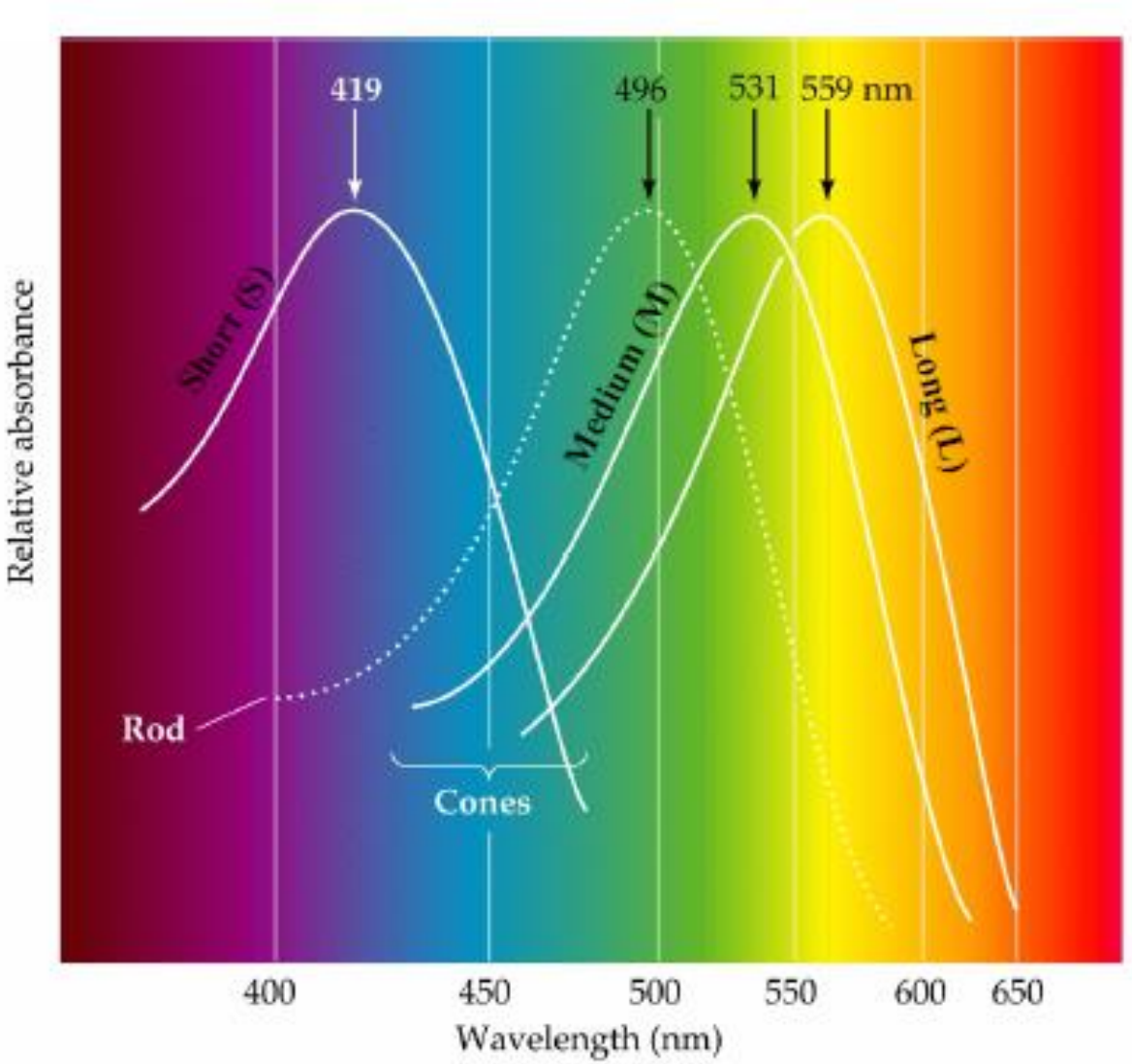
Cones:

- **Relatively insensitive to light**
- **100 photos for response comparable with rods**
- **High spatial resolution**
- **Different (3 types of) response profiles**
- **Color daylight vision (photopic)**

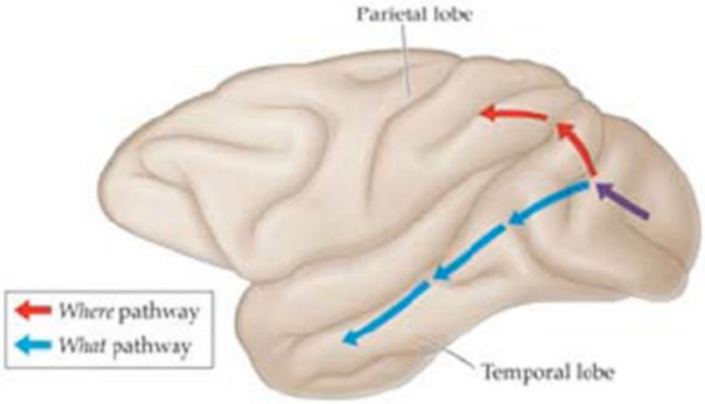
Rods and cones: distribution across the retina

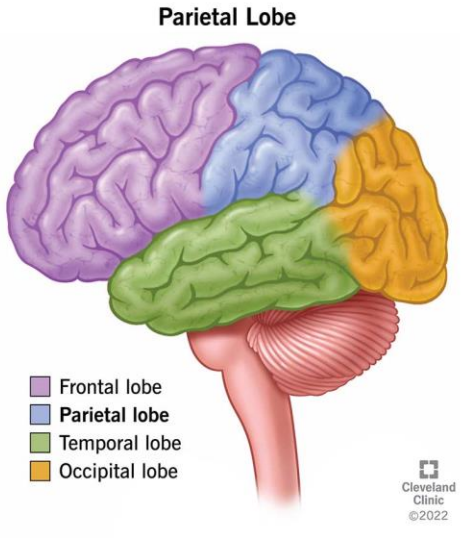


Rods and cones



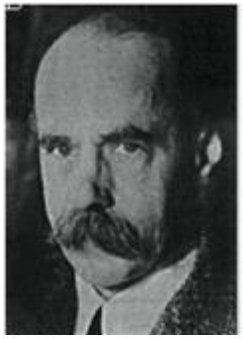
Brain: Where and What





THE GESTALT THEORY OF VISUAL PERCEPTION

- The main characters of Gestalt Psychology were Max Wertheimer, Kurt Koffka, and Wolfgang Kohlers.
- Although later psychologists were strongly influenced by Gestalt theory, especially in social psychology (e.g., Solomon Asch), there was never really any second generation of Gestalt theorists trained by the originals.



Max Wertheimer
(1880 – 1943)

Kurt Koffka
(1886-1941)

Wolfgang Kohler
(1887-1967)

THE GESTALT THEORY OF VISUAL PERCEPTION

- Origin: From the German word meaning form or shape. Developed by German psychologist Max Wertheimer in 1910. After some experimentation with a stroboscope (more commonly known as a flip book) he concluded that the eye merely takes in all the visual stimuli and that the brain arranges the sensations into a coherent image.

- Gestalt psychologists further refined Wertheimer's work to conclude that visual perception was a result of organizing sensual elements or forms into various groups. Discrete elements within a scene are combined and understood by the brain through a series of four laws of grouping

"The whole is different from the sum of its parts."

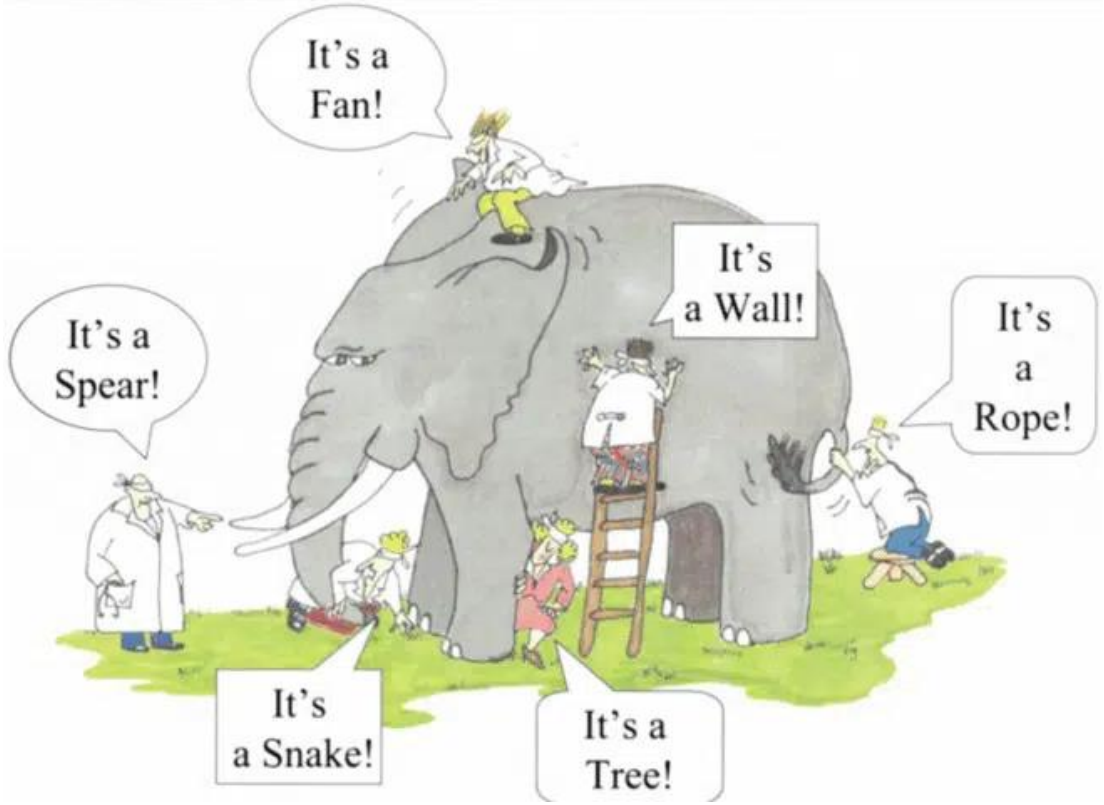
The basic idea of Gestalt Psychology is that sensory features (e.g., lines, edges, corners, colors, etc.) are combined by the brain to form a new pattern or configuration – to produce something that does not exist in the set of features taken one by one.

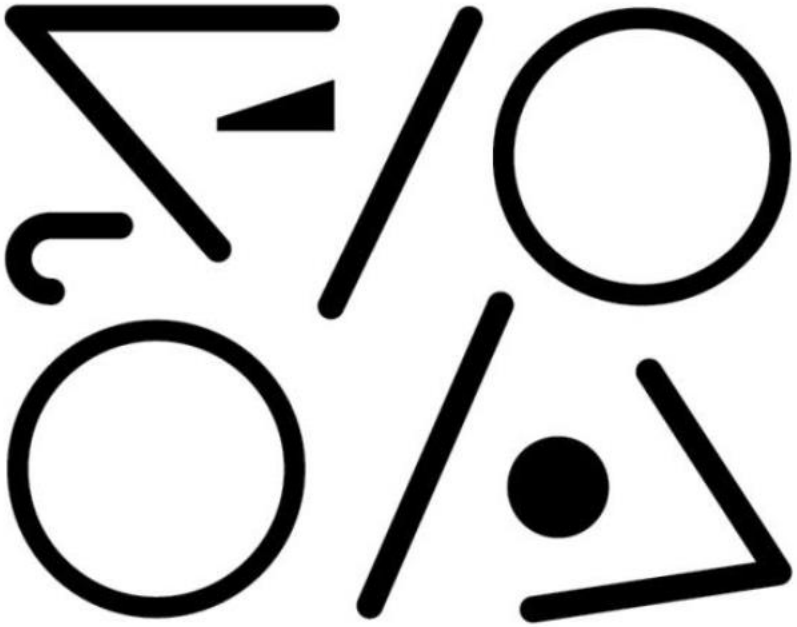
The main target of this idea was the atomistic psychology of Wundt and von Helmholtz.

olismo

s. m. [der. del gr. ὅλος «tutto, intero, totale»]

Tesi secondo cui il tutto è più della somma delle parti di cui è composto.





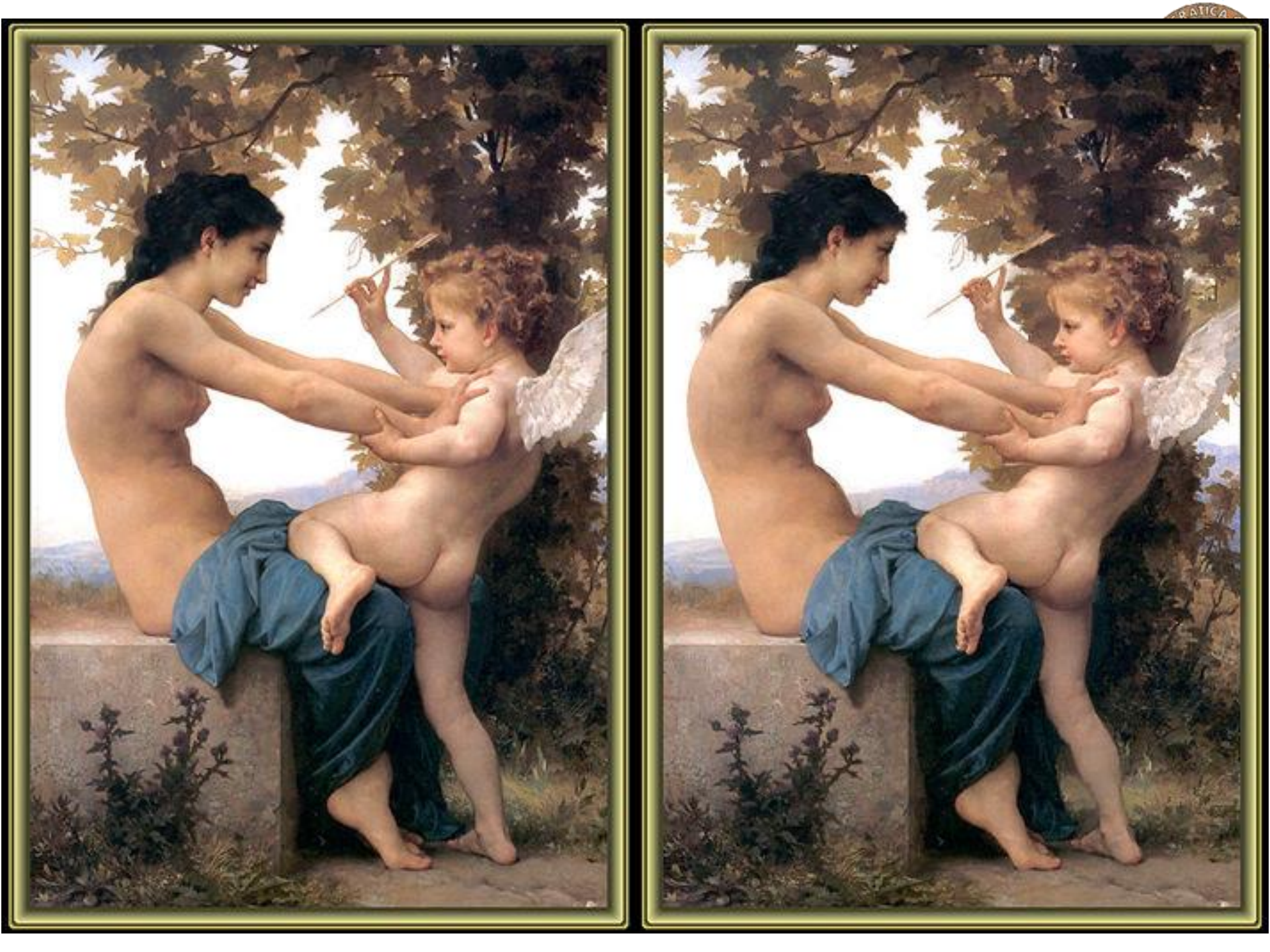
SECNODO UN PFROSSEORE
DLEL'UNVIESRITA' DI
CMABRDIGE, NON IMORPTA
IN CHE ORIDNE APAPAINO
LE LETETRE IN UNA PAOLRA,
L'UINCA CSOA IMNORPTATE
E' CHE LA PIMRA E L'ULIMTA
LETETRA SINAO NEL PTOSO
GITUSO. IL RIUSTLATO PUO'
SERBMARE MLOTO CNOFSUO,
MA NOONSTATNE TTUTO
SI PUO' LEGERGE SEZNA
MLOTI PRLEOBMI.

Q357O M3554GG1O 53RV3 4 PROV4R3
CH3 L3 NO57R3 M3N71 PO55ONO F4R3
GR4ND1 CO53 ! CO53 1MPR3551ON4N71 !
4LL'1N1Z1O 3R4 D1FF1C1L3, M4 G14' 1N
QU3574 R1G4 L4 7U4 M3N73 574 L3GG3NDO
4U7OM471C4M3N73 53NZ4 P3N54RC1 5U E
S11 ORGOGL1O5O !

Sensation and Perception

- Sensation
  - The process through which the senses pick up visual, auditory, and other sensory stimuli and transmit them to the brain; sensory information that has registered in the brain but has not been interpreted
- Perception
  - The process by which sensory information is actively organized and interpreted by the brain

If you make a list of all the individual sensations you experience when you see this as a vase, and also make a list of the sensations when you see it as two faces, the two lists would be identical! But the percepts are different – so the lists must be missing what makes them different



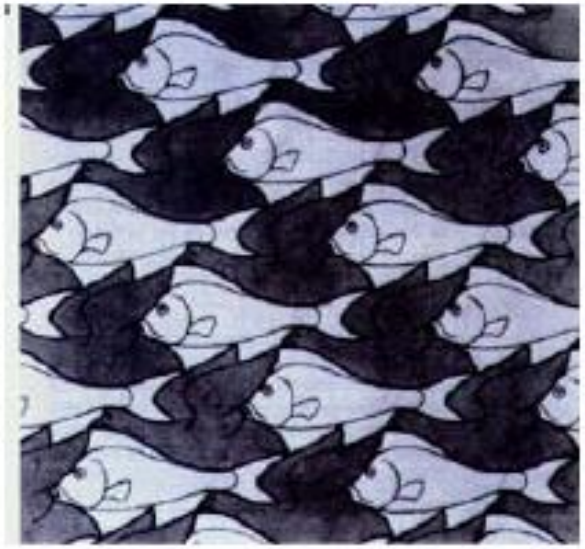
Principles of Gestalt Psicology

- Figure-ground
  - Organization depends on what we see as figure (object) and what we perceive a ground (context).
- (Law of) Proximity
  - Objects close together in space or time perceived as belonging together.
- (Law of) Similarity
  - Objects that have similar characteristics are perceived as unit.
- (Law of) Continuity
  - We tend to perceive figures or objects as belonging together if they appear to form a continuous pattern.
- (Law of) Closure
  - We perceive figures with gaps in them to be complete.

Figure-Ground

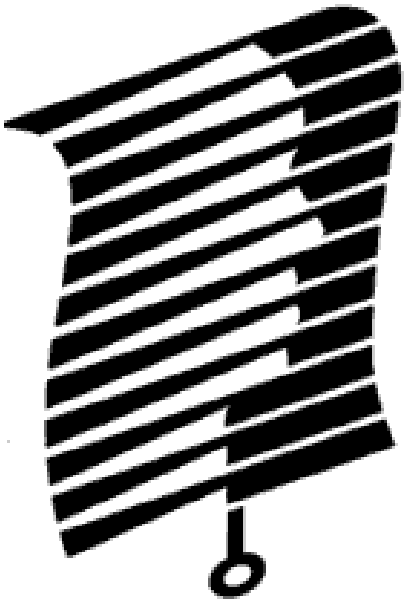
In 1915, Danish Gestalt psychologist Edgar Rubin experimented with reversible figure-ground patterns (known in painting and photography as positive and negative space). He designed this image to show that the object could be interpreted as either two faces or a vase. However, the brain cannot see both images at once—you must make a conscious decision whether to see a face or a vase in the drawing.

Figure-Ground



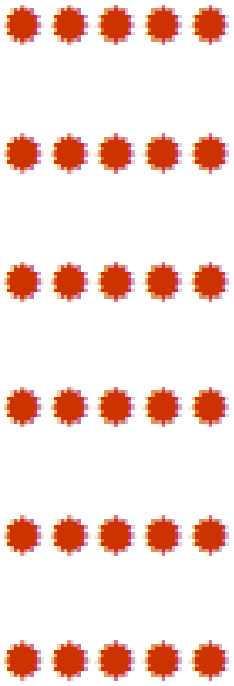
When an image contains two or more distinct regions, we will divide the image into *figure* and *ground*.

Figure-Ground



Gestalt: Law of Proximity

- The Rule of Proximity. This rule applies to how elements of a piece are grouped based on their proximity or closeness. These individual pieces may be different or the same.

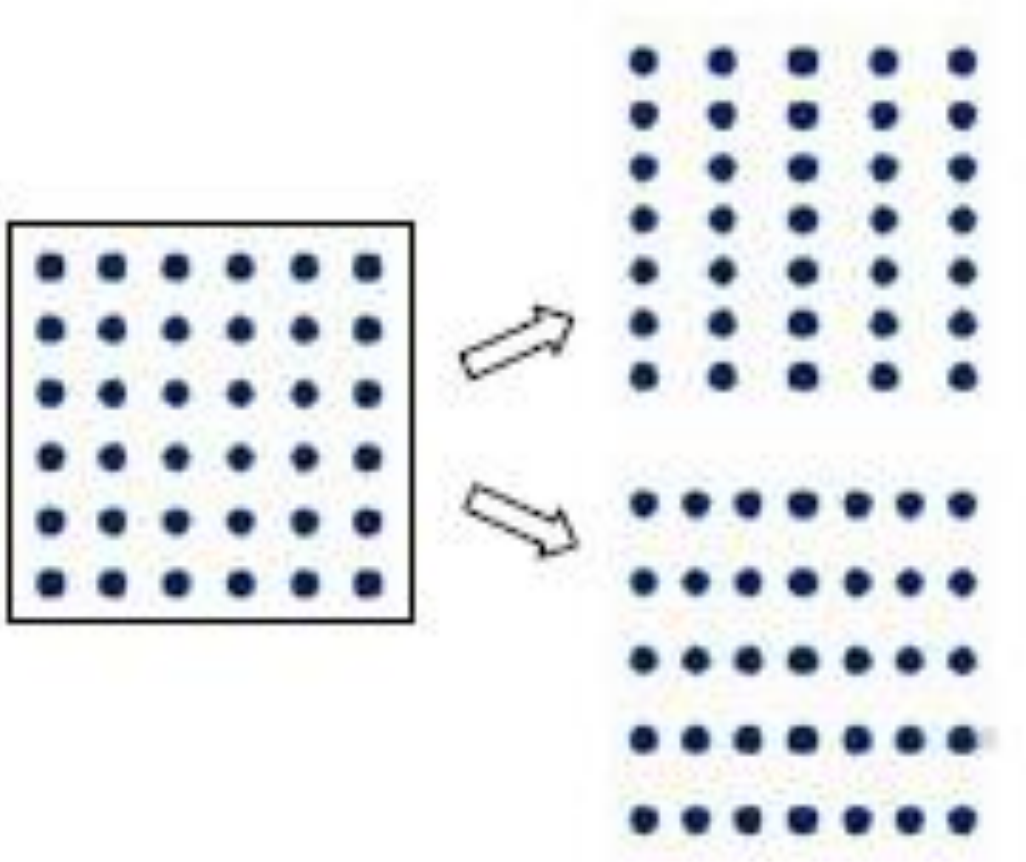


ABC
Fig 1a

A
BC Fig 1b

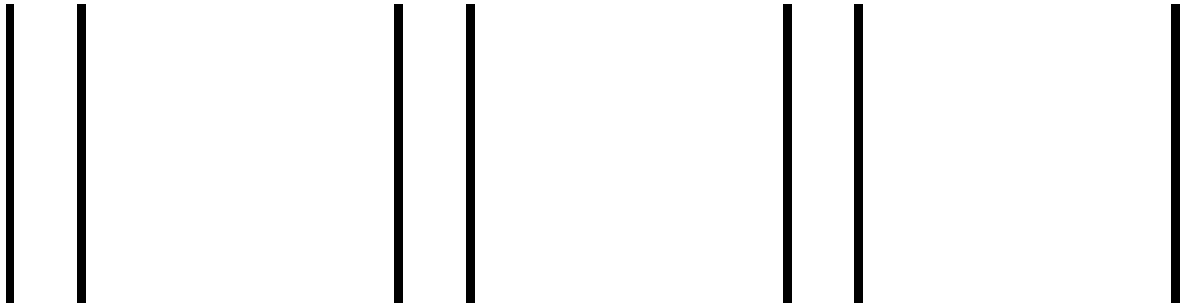
C A B
Fig 1c

Gestalt: Law of Proximity



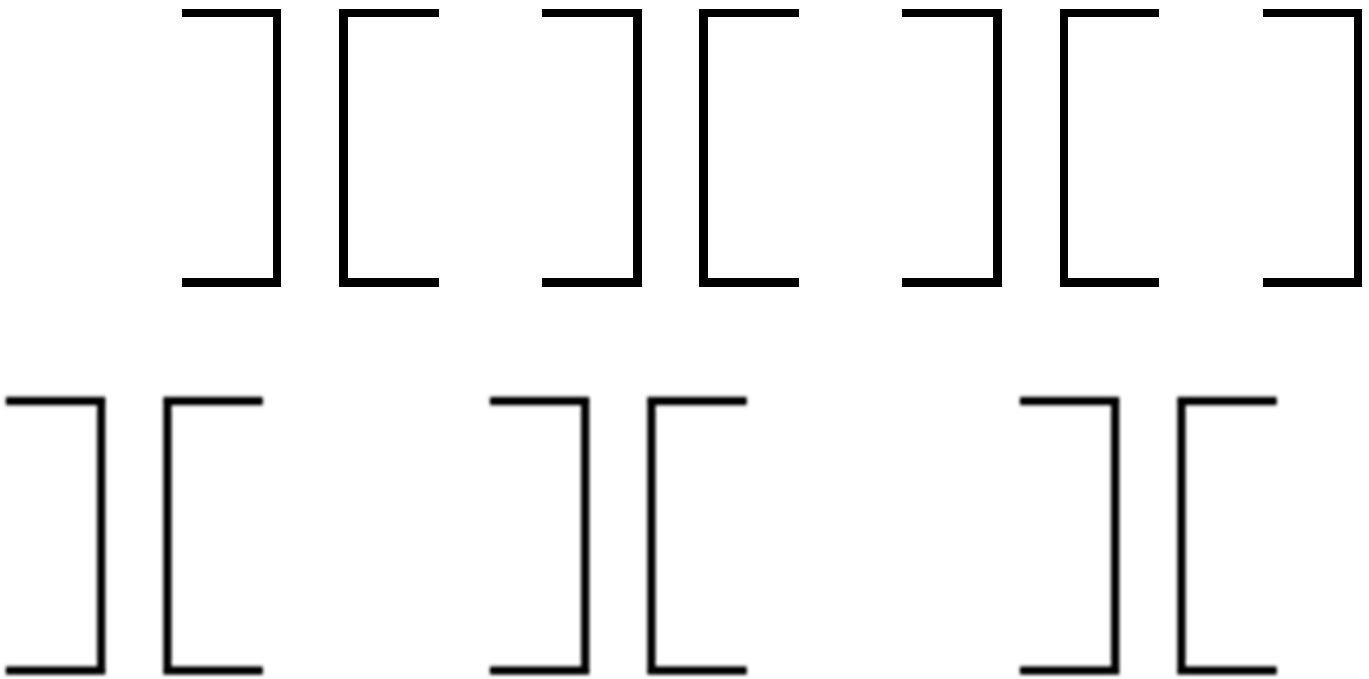
Gestalt: Law of Proximity

The brain more readily associates objects that are close to each other than those that are farther apart. Two friends standing next to each other will be viewed as more closely related than someone else twenty yards away.



Elements grouped close together will be perceived as belonging to the same group.

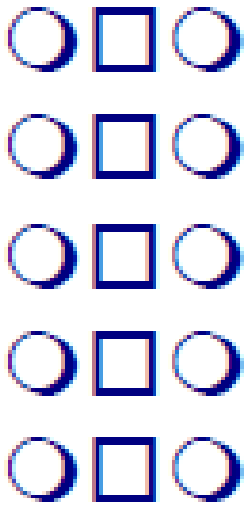
Gestalt: Law of Proximity



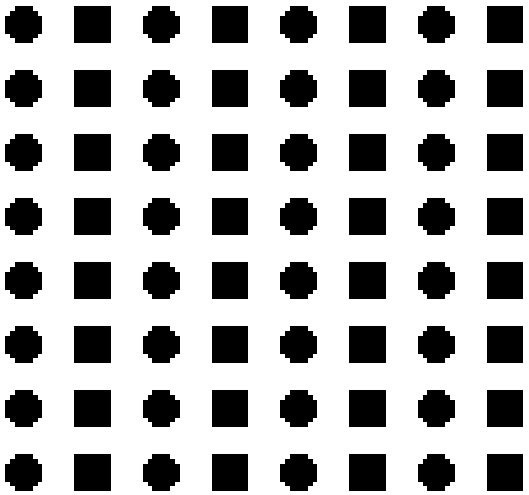
Gestalt: Law of Similarity

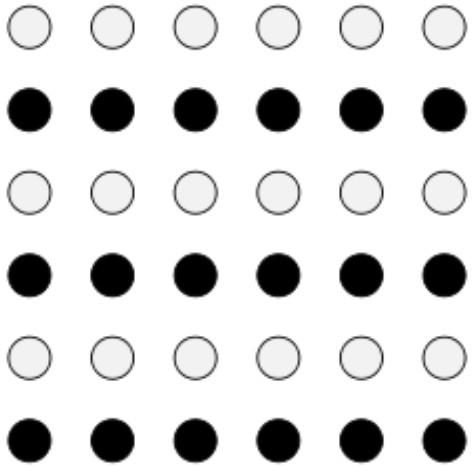
Similarity:

We see this form as columns rather than as rows because of similarity

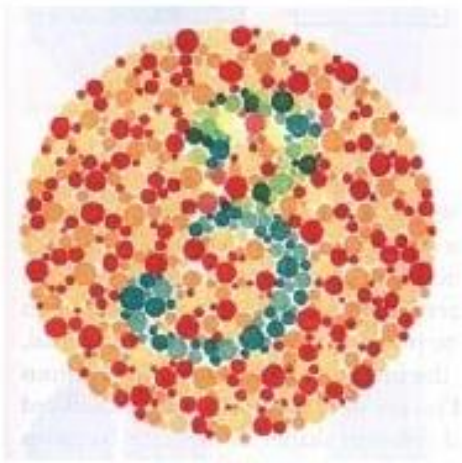


Gestalt: Law of Similarity





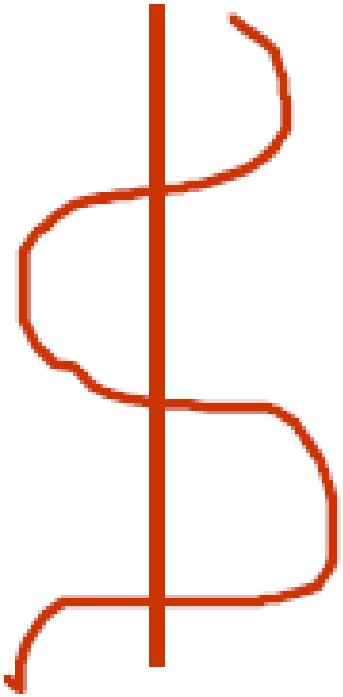
Elements that share qualities will be perceived as part of the same form.



Gestalt: Law of Continuity (or Common Fate)

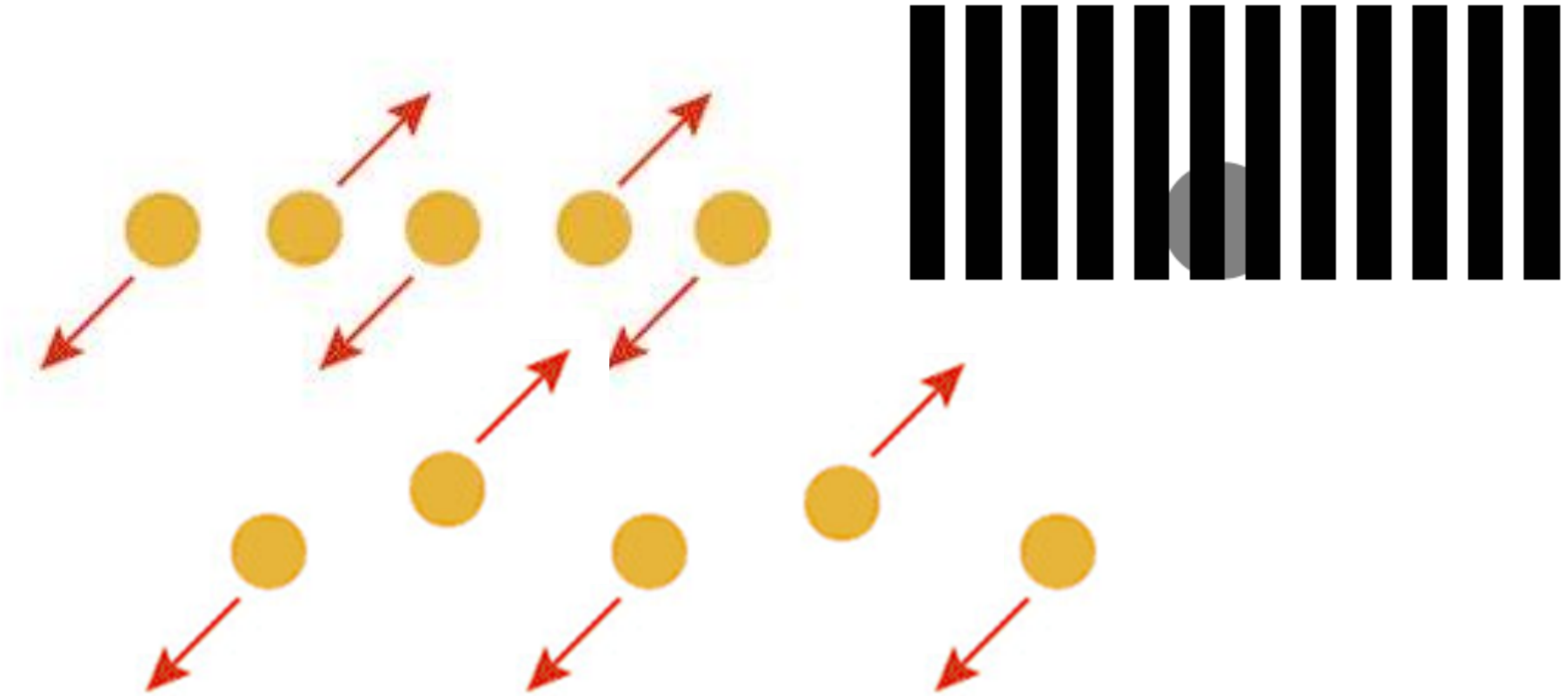
Continuity

What we see is determined by the flow of lines



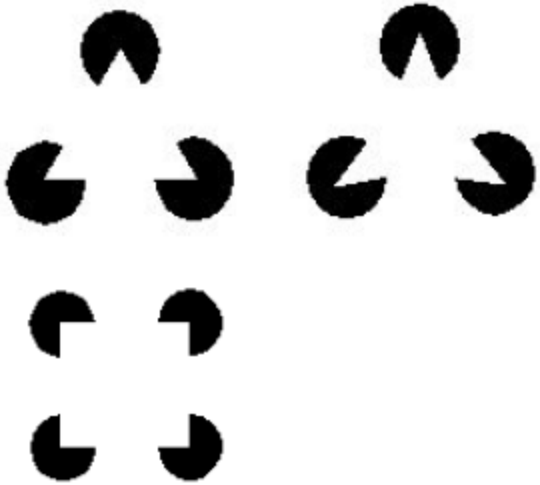
Gestalt: Law of Continuity (or Common Fate)

The law of common fate **states that when objects move in the same direction, we tend to see them as a unit.**

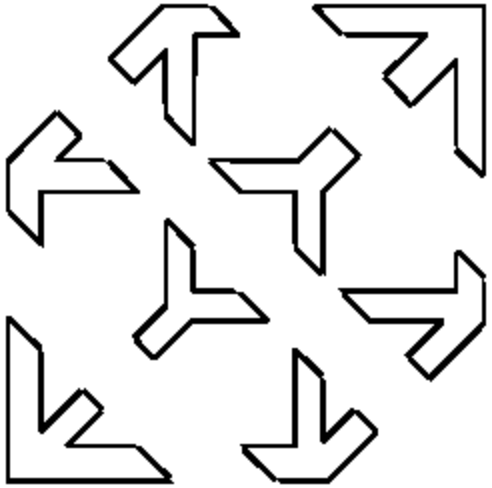


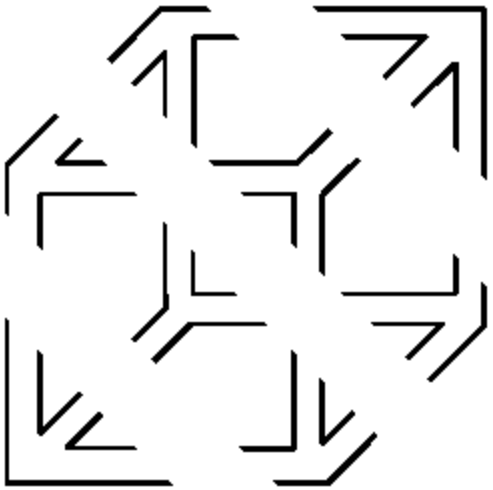
Gestalt: Law of Continuation (Closure)

The brain does not prefer sudden or unusual changes in the movement of a line. The line can be a continuous line in the traditional sense, or can be a series of objects placed together to form a line. Objects not in that line will be mentally separated.

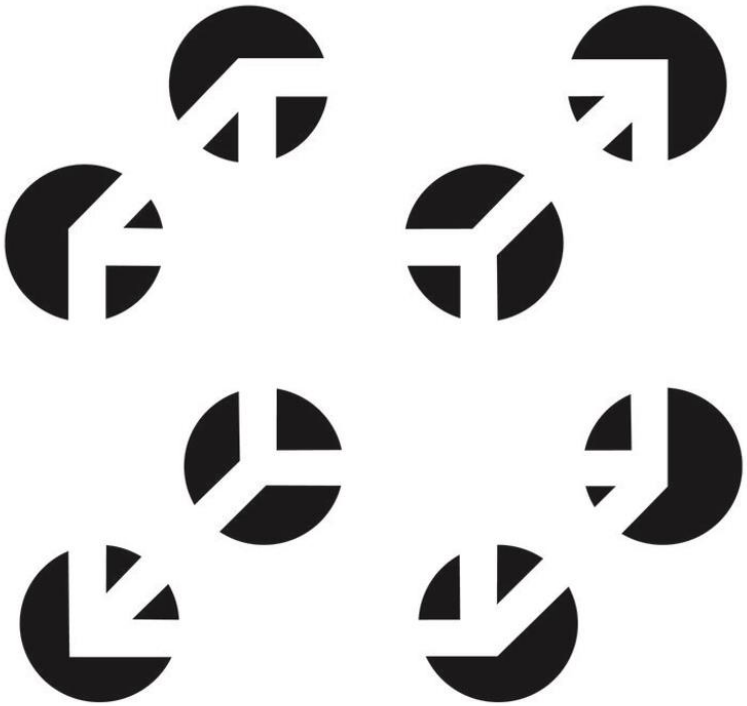


Gestalt: Law of Continuation (Closure)

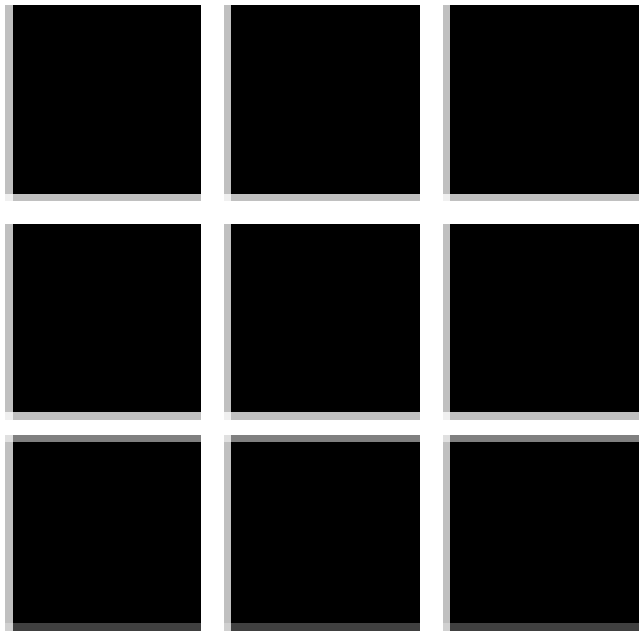




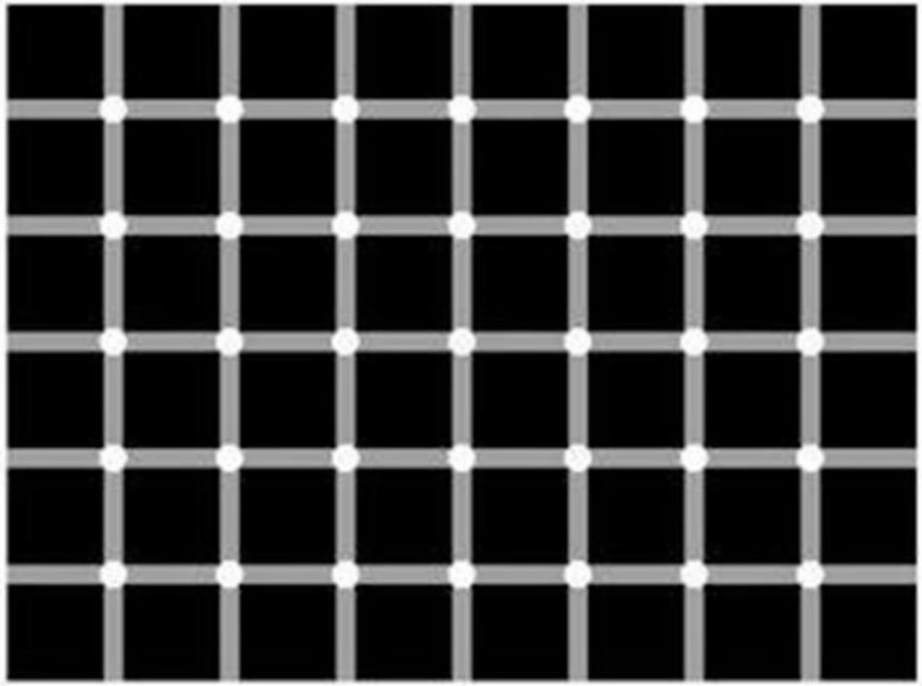
Gestalt: Law of Continuation (Closure)

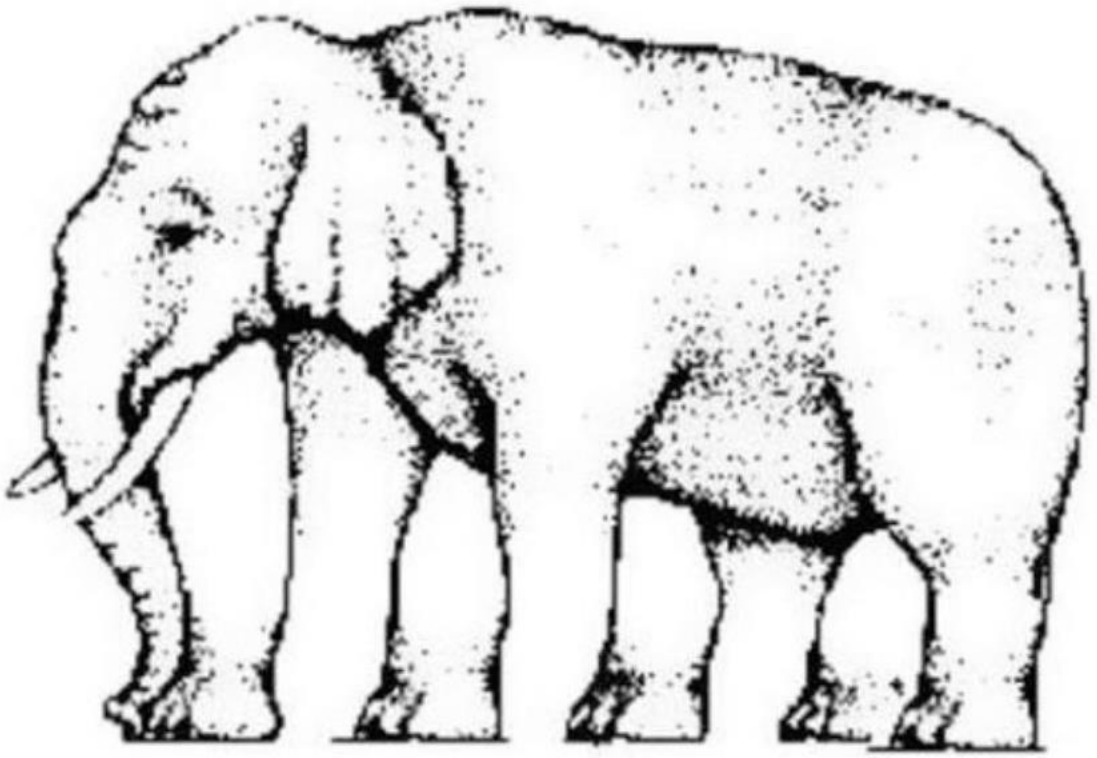


Quanti Punti Neri (Versione Debole)?

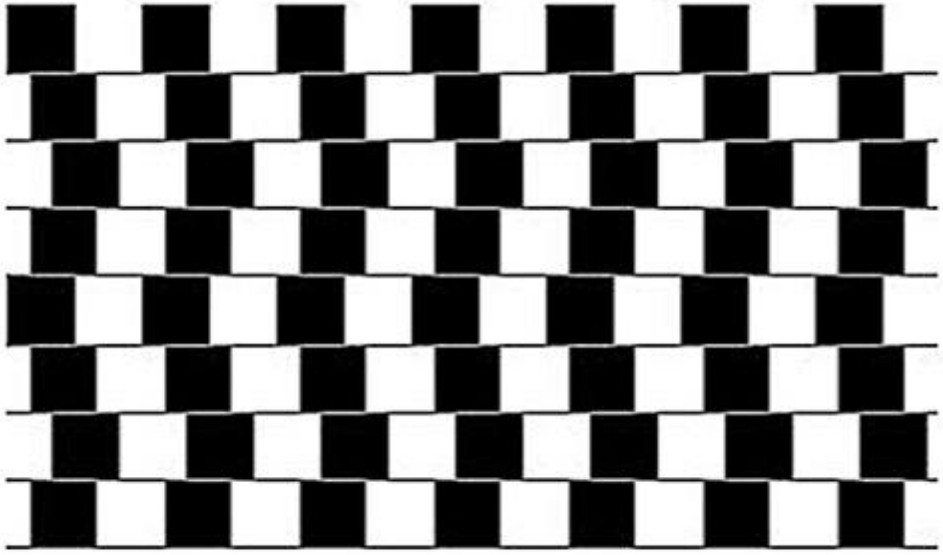


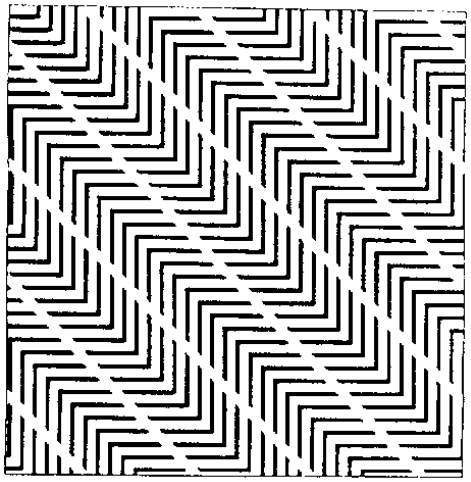
Quanti Punti Neri (Versione Forte)?



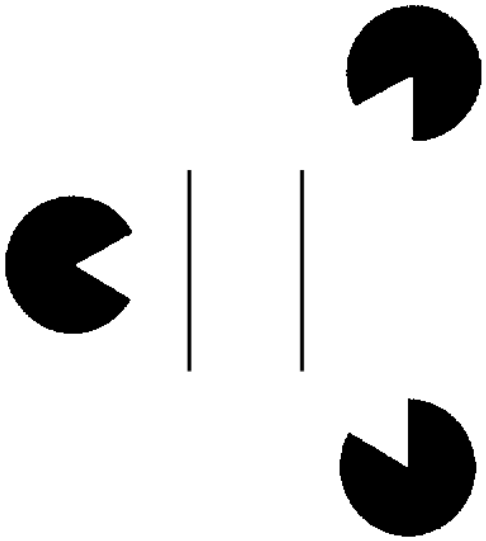


How many legs does this elephant have?

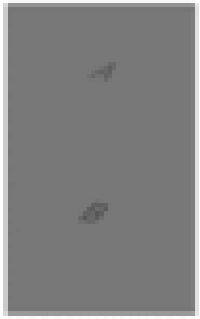


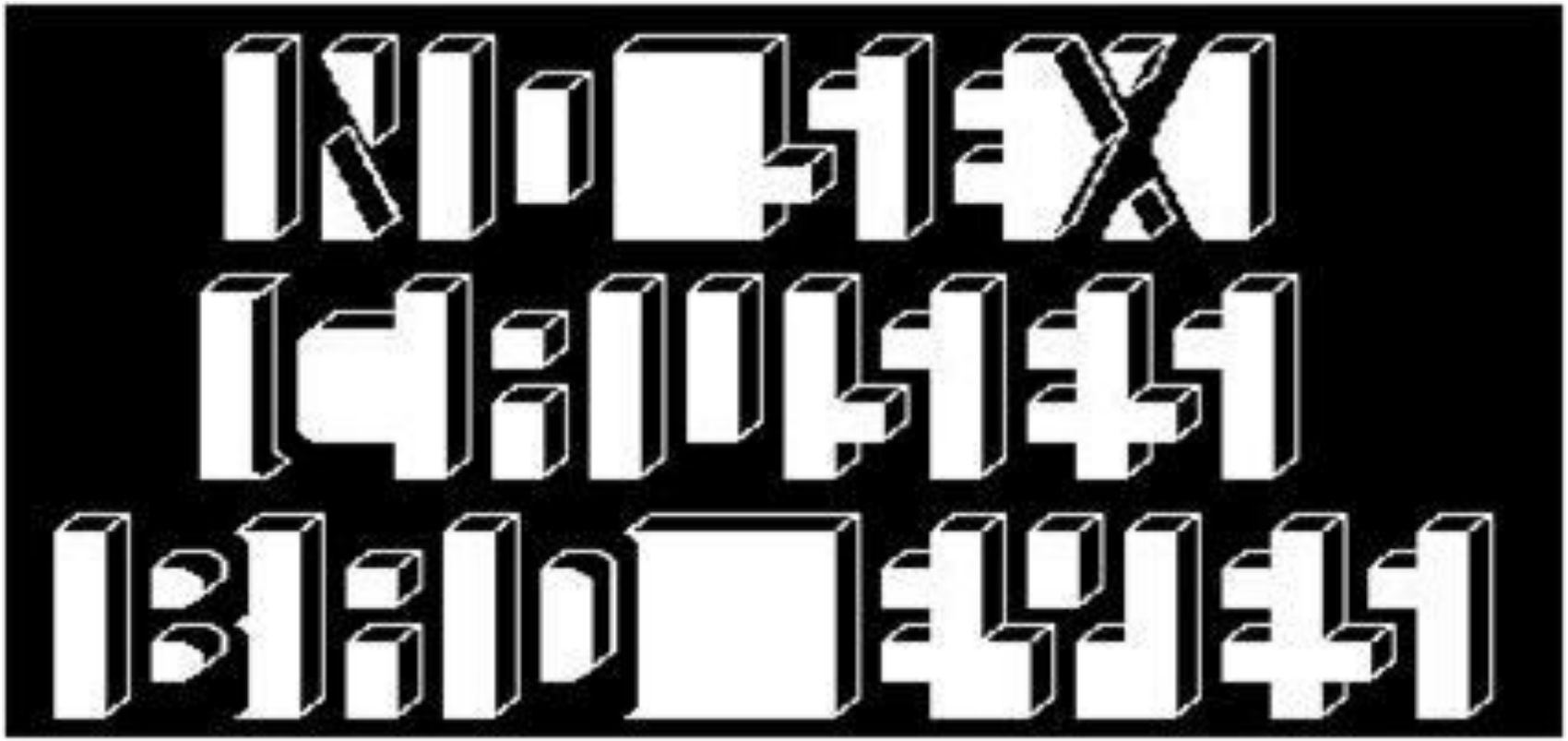


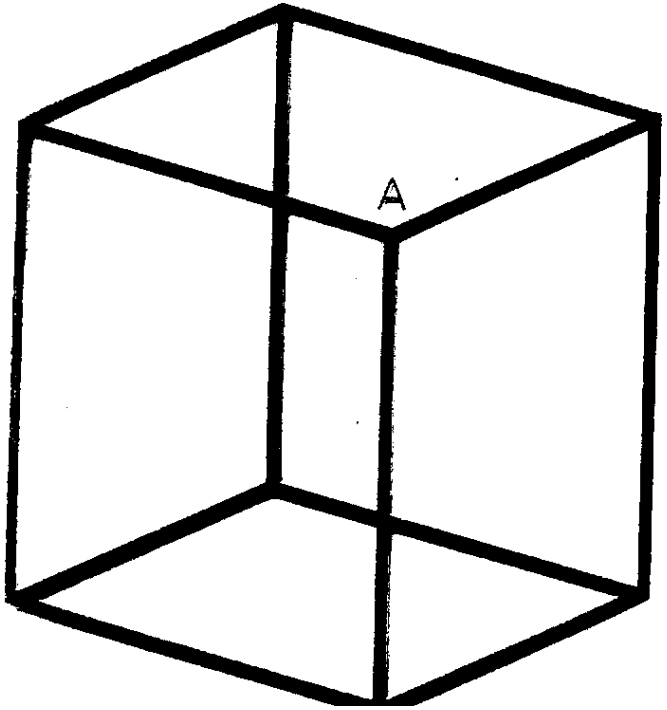
Are the horizontal lines parallel or dc

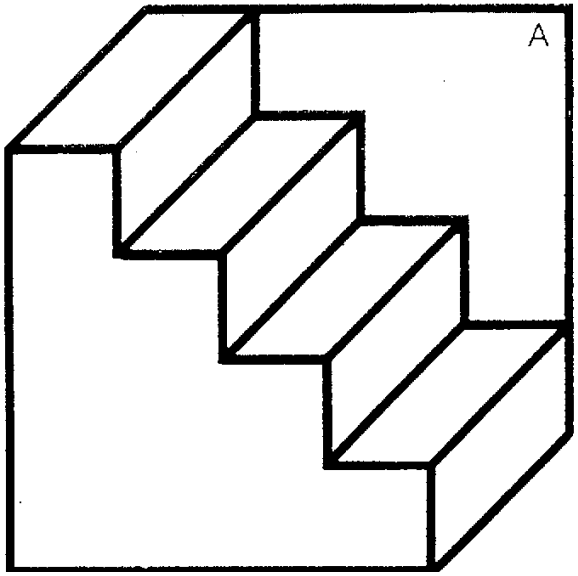


L’illusione di Adelson






A


A

Curiosità – Illusione della Thatcher

Curiosità – Illusione della Thatcher

Le capacità di riconoscimento di un sistema biometrico sono invarianti rispetto all' orientamento dell'immagine.
L'occhio umano non lo è!

Curiosità – Illusione della Thatcher

- Come mai nella versione rovesciata non è stato possibile individuare subito l'incoerenza dell'immagine di destra? La risposta starebbe nel fatto che il cervello umano percepisce i volti non dettaglio per dettaglio, ma come totalità percettiva, come gestalt.
- Inoltre gli occhi e la bocca sono gli elementi che convogliano le informazioni più significative per il nostro cervello, addestrato a trarre da questi elementi informazioni sulle intenzioni e le emozioni degli altri.
- Alcune evidenze scientifiche suggeriscono che il cervello abbia una regione specializzata nel fare esclusivamente questo: riconoscere facce. Si tratta dell'area facciale fusiforme, che negli studi di neuroimaging si attiva particolarmente se un soggetto osserva volti, ed è più silente quando osserva altri tipi di stimoli.
- Inoltre esiste una condizione patologica chiamata prosopagnosia che impedisce a chi ne soffre di riconoscere volti noti, lasciando intatta praticamente ogni altra facoltà cognitiva.

Il Volto di Marte

- Che esista o meno un'area specificatamente coinvolta in questo processo, è indubbio che gli esseri umani abbiano sviluppato una particolare abilità a riconoscere volti. Abilità utilissima per farci vivere assieme ai nostri simili e talvolta persino sovrautilizzata. Ricordate la faccia su Marte?
- La **pareidolia** è la tendenza del cervello umano a ricondurre a forme note oggetti o profili naturali o artificiali dalla forma casuale. E' una tendenza istintiva che ricrea immagini significative da materiale non strutturato, mischiando percezione sensoriale con immaginazione.

Riferimenti Bibliografici

– File pdf: Gestalt1 e Gestalt2