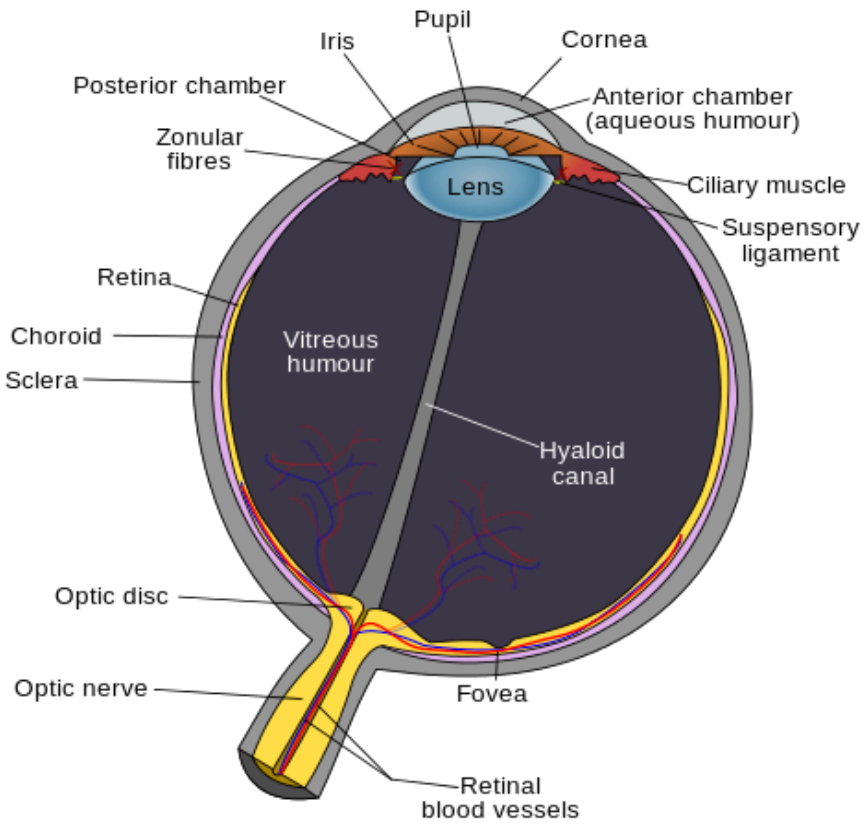
S. Rinzivillo – rinzivillo@isti.cnr.it

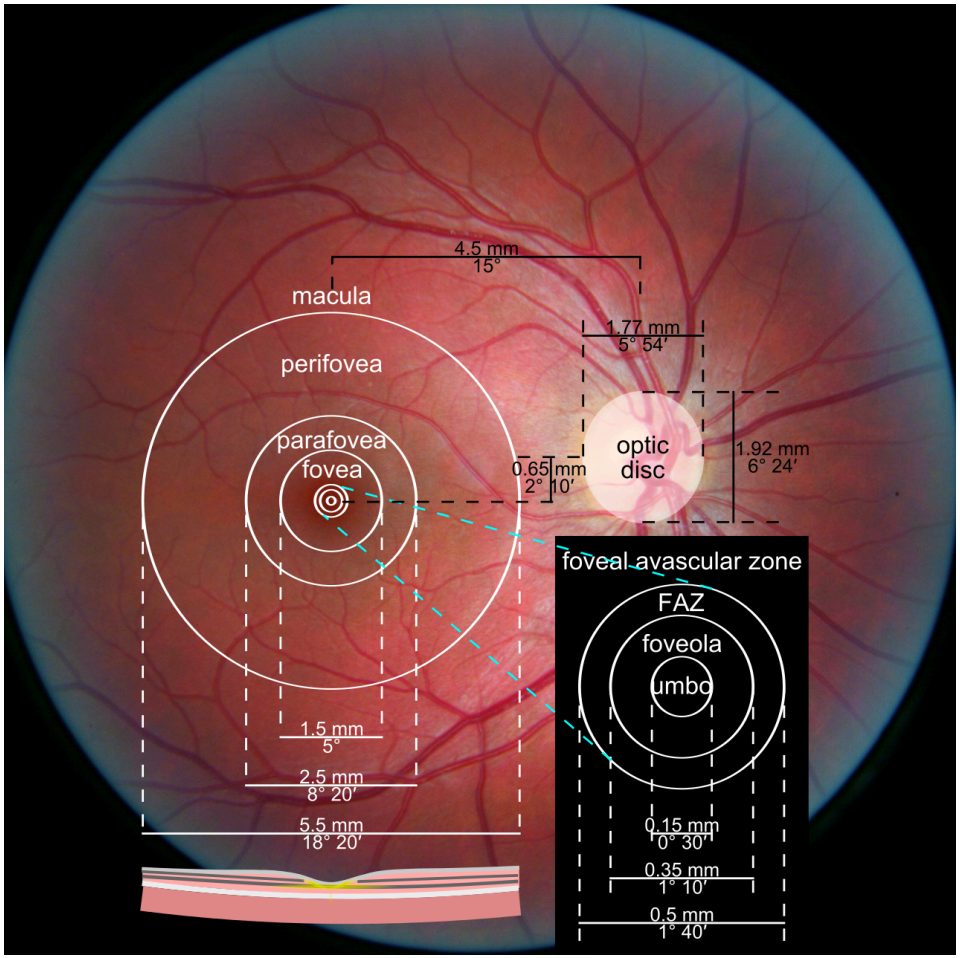
DATA VISUALIZATION AND VISUAL ANALYTICS

VISION AND PERCEPTION

Human Eye



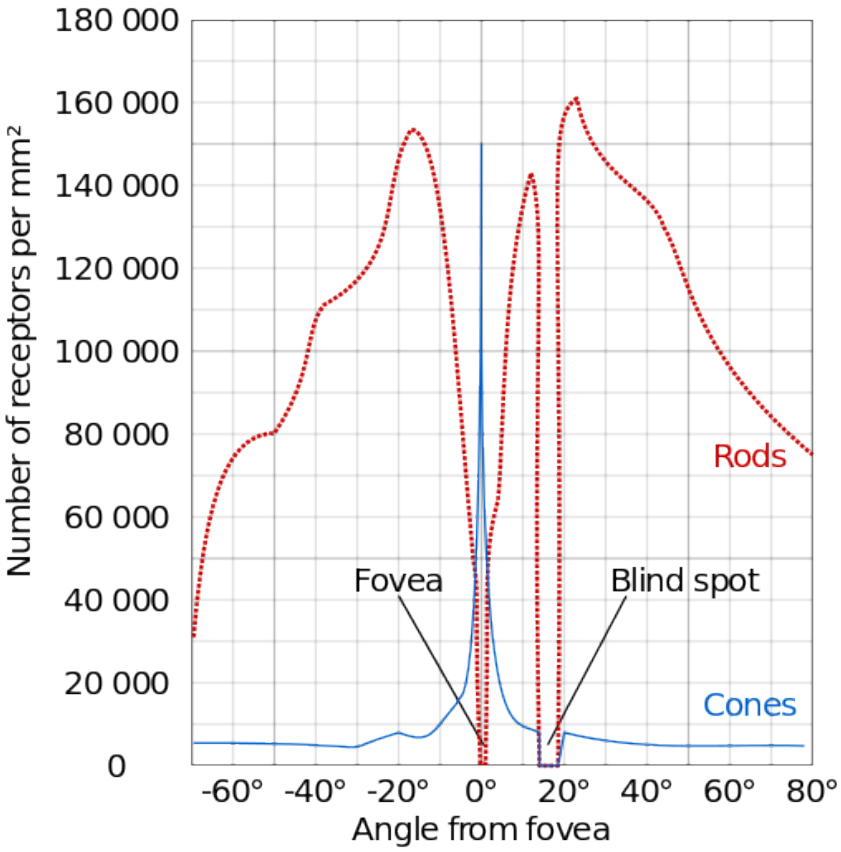
Macula and Fovea



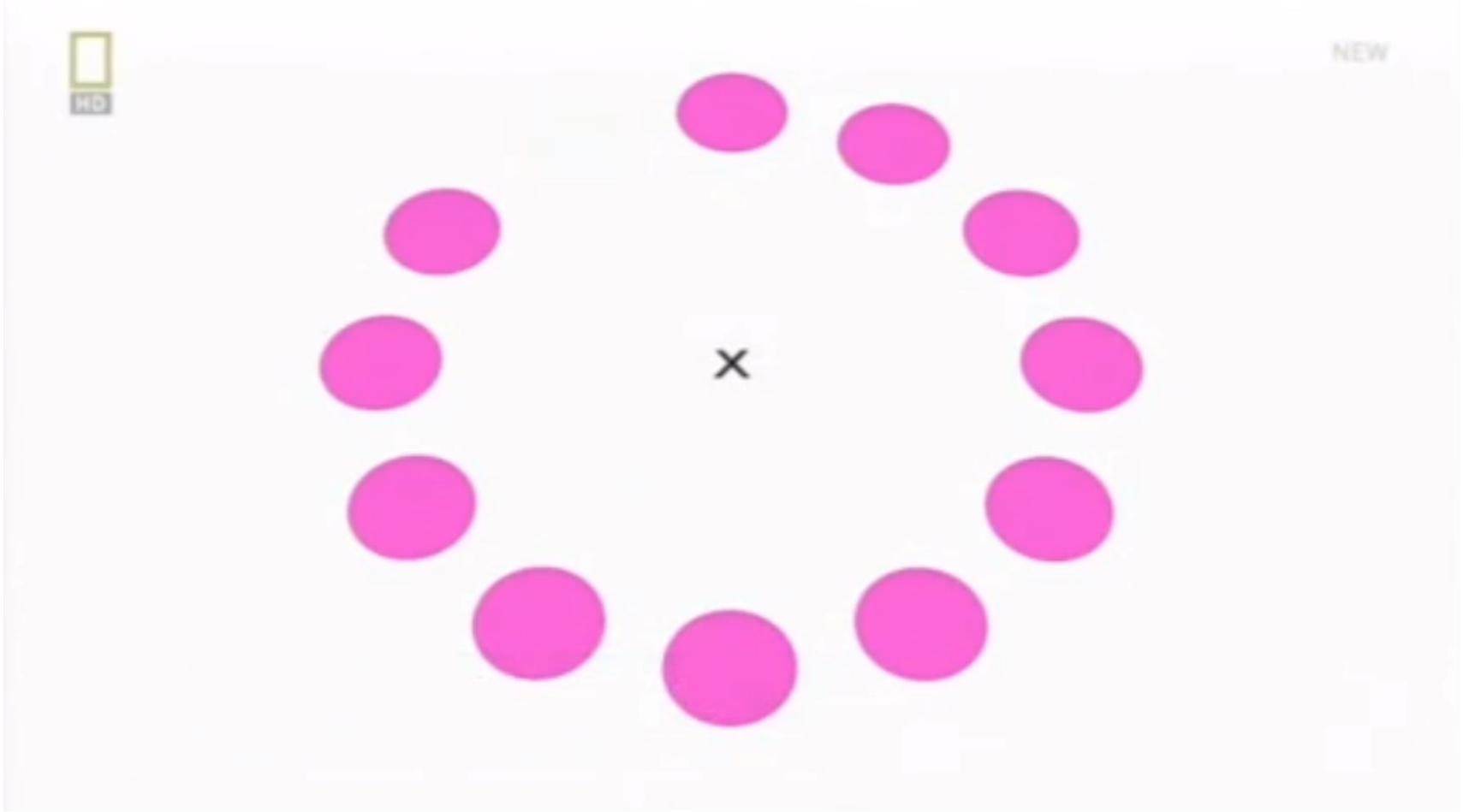
"Macula" by Photograph: Danny Hope from Brighton & Hove, UK - File:Righ_eye_retina.jpg (which come from My Right Eye). Licensed under CC BY 2.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Macula.svg#mediaviewer/File:Macula.svg

Photo Receptor Cells

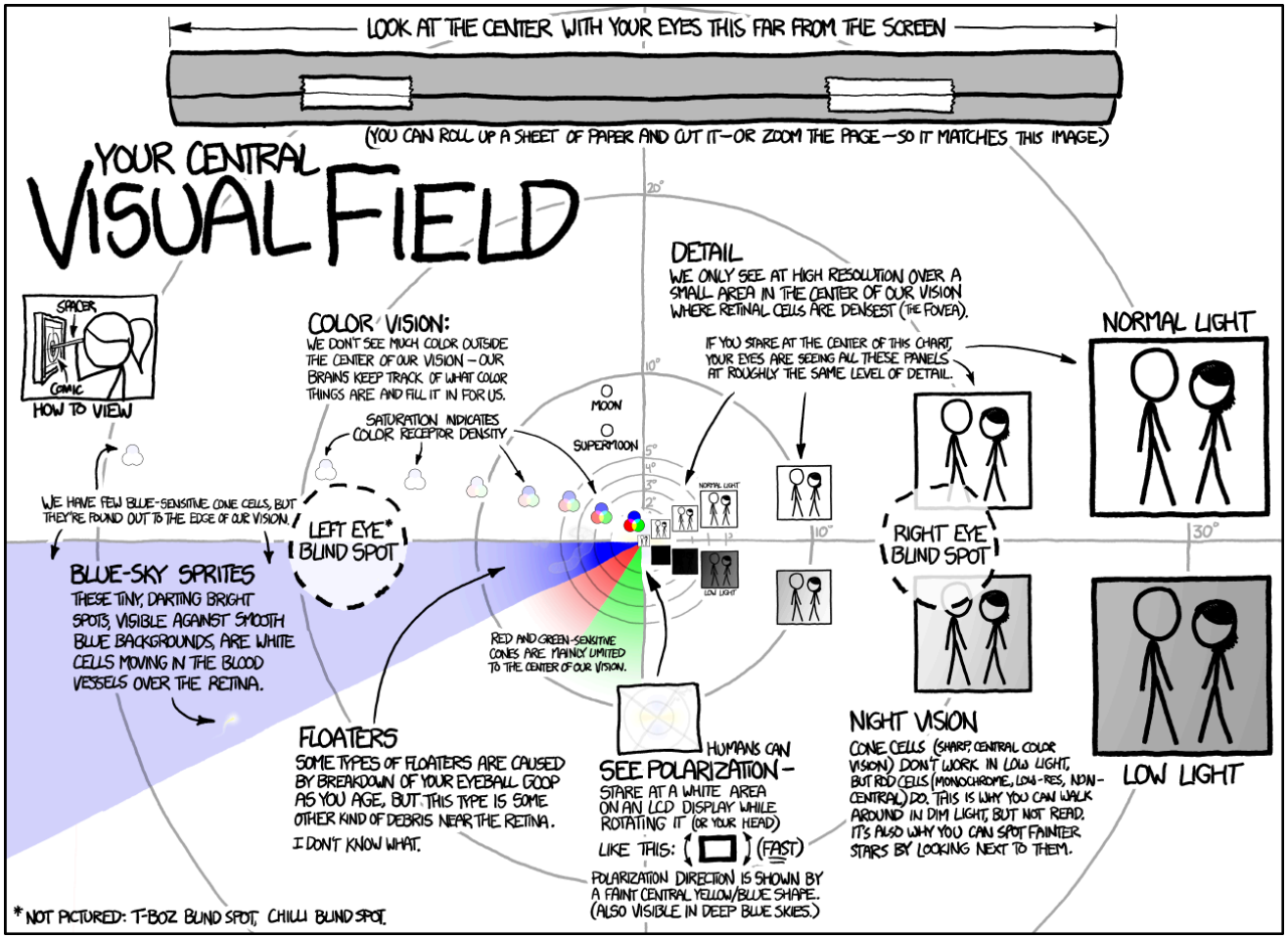
- Two types of light sensitive cells
  - Rod Cells (~120M)
    - Provide low-light vision
    - Peripheral vision
    - Almost no role in color vision
  - Cone cells (~6M)
    - Provide normal vision
    - Three sub-types of cells
      - Sensitivity to different light wavelengths
      - Used for colored vision



Peripheral Vision Test – Game #1

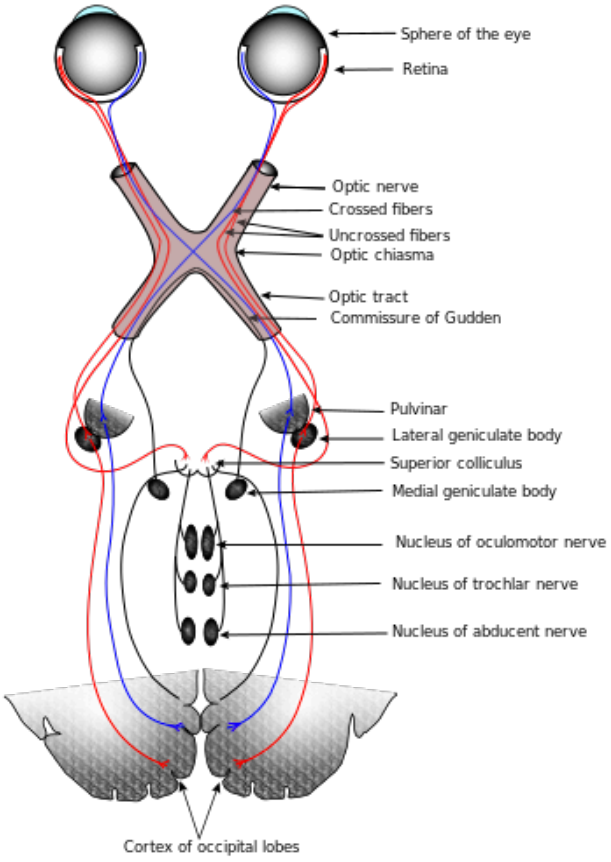


Vision Resolution

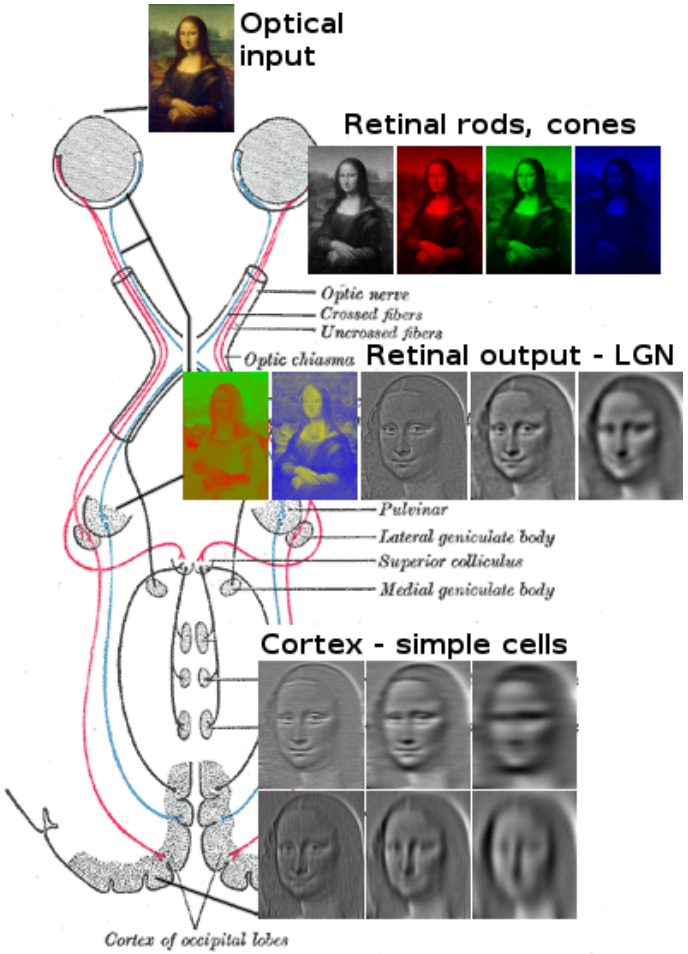


http://xkcd.com/1080/

Visual System



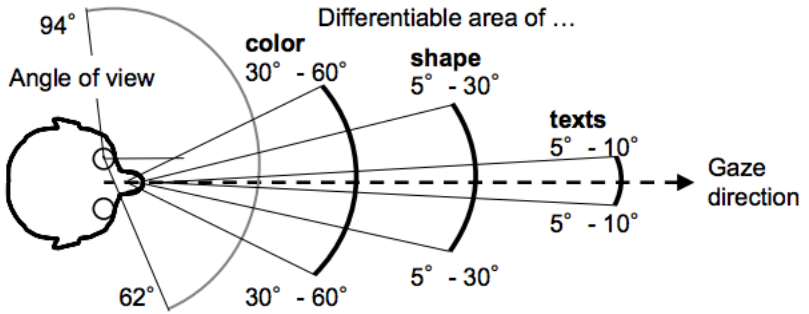
"Gray722-svg" by KDS444 - https://commons.wikimedia.org/wiki/File:Gray722.png. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Gray722-svg.svg#/media/File:Gray722-svg.svg



"Lisa analysis" by Clock - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Lisa_analysis.png#/media/File:Lisa_analysis.png

Vision Resolution

- Fovea yields the highest resolution (normal light)
- Fovea occupies around 15° of visual field
- Highest resolution is provided by *fovea centralis* (around 1°)



Komatsubara, A. Human error, Maruzen co. ltd. 2008. (In japanese)

Photo Receptor Cells

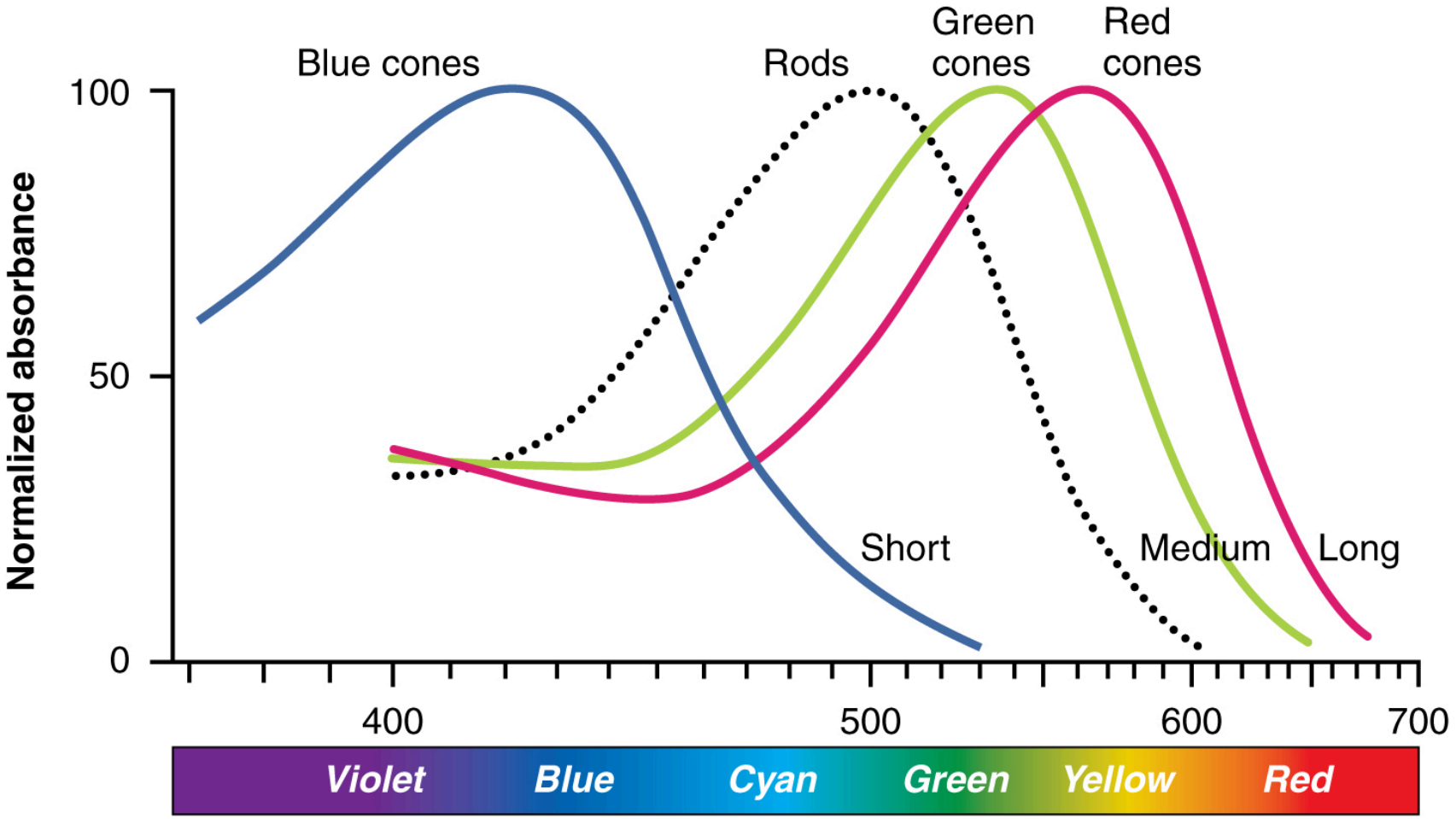
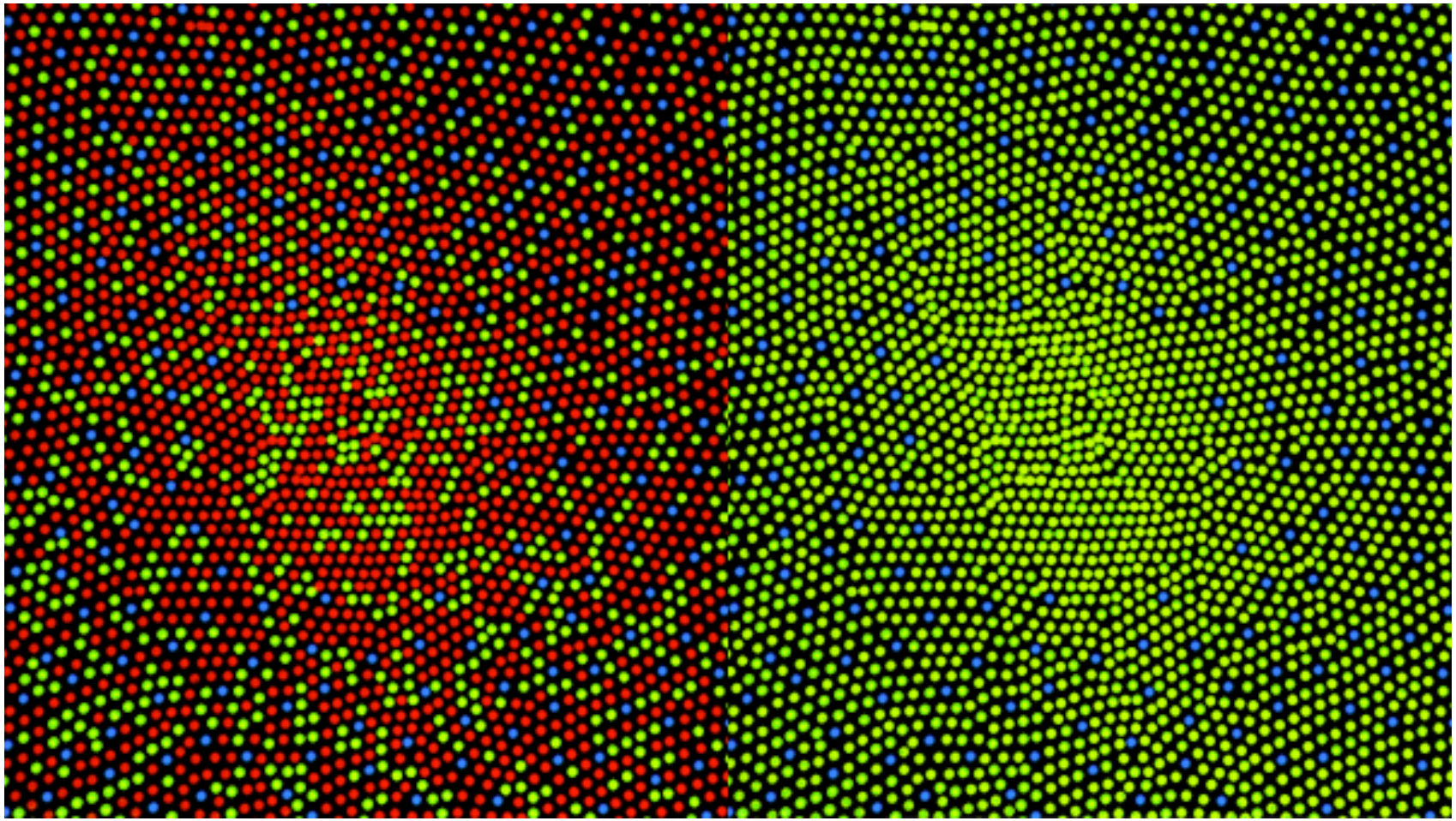


Photo Receptor Cells

Distribution of cone cells in the fovea of an individual with normal color vision (left), and a color blind retina.



Where is Waldo? – Game #2

THE GOBBLING GLUTTONS

ONCE UPON A TIME, WALDO EMBARKED UPON A FANTASTIC JOURNEY. FIRST, AMONG A THRONG OF GOBBLING GLUTTONS, HE MET WIZARD WHITEBEARD, WHO COMMANDED HIM TO FIND A SCROLL AND THEN TO FIND ANOTHER AT EVERY STAGE OF HIS JOURNEY. FOR WHEN HE HAD FOUND 12 SCROLLS, HE WOULD UNDERSTAND THE TRUTH ABOUT HIMSELF.

IN EVERY PICTURE FIND WALDO, WOOF (BUT ALL YOU CAN SEE IS HIS TAIL), WENDA, WIZARD WHITEBEARD, ODLAW, AND THE SCROLL. THEN FIND WALDO'S KEY, WOOF'S BONE (IN THIS SCENE IT'S THE BONE THAT'S NEAREST TO HIS TAIL), WENDA'S CAMERA, AND ODLAW'S BINOCULARS.

THERE ARE ALSO 25 WALDO-WATCHERS, EACH OF WHOM APPEARS ONLY ONCE SOMEWHERE IN THE FOLLOWING 12 PICTURES. AND ONE MORE THING! CAN YOU FIND ANOTHER CHARACTER, NOT SHOWN BELOW, WHO APPEARS ONCE IN EVERY PICTURE EXCEPT THE LAST?

High Resolution Vision

- HiRes vision is limited to a narrow angle of field vision
- Eyes move to scan an object in order to expose the image on the fovea
- The movement of eyes is not regular or linera

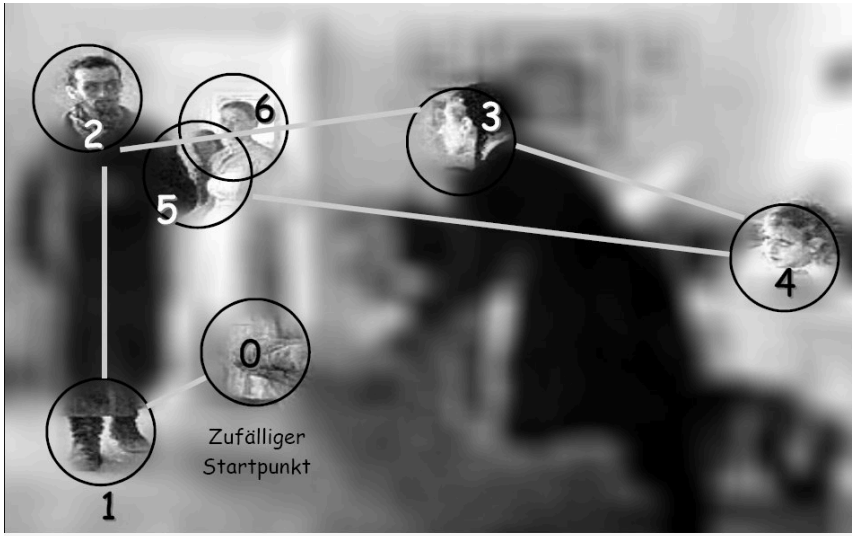
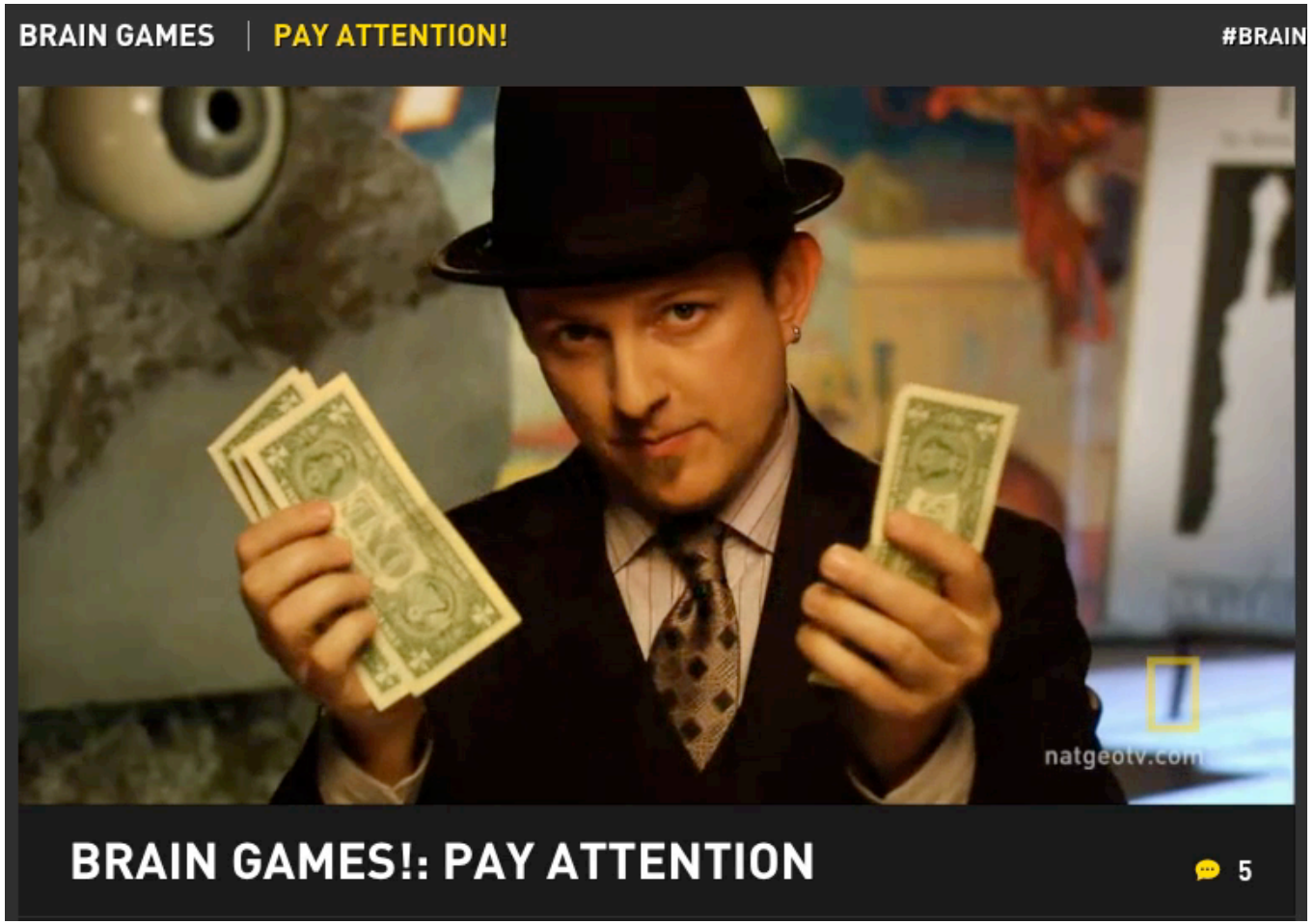


Bild 11: Foveale Ergänzung durch die ersten 6 Fixationen (nach Daten von *Yarbus,1967*)

Eye Tracking for Design

Top-Down Attention



http://channel.nationalgeographic.com/brain-games/videos/brain-games-pay-attention/

Perception and Cognition

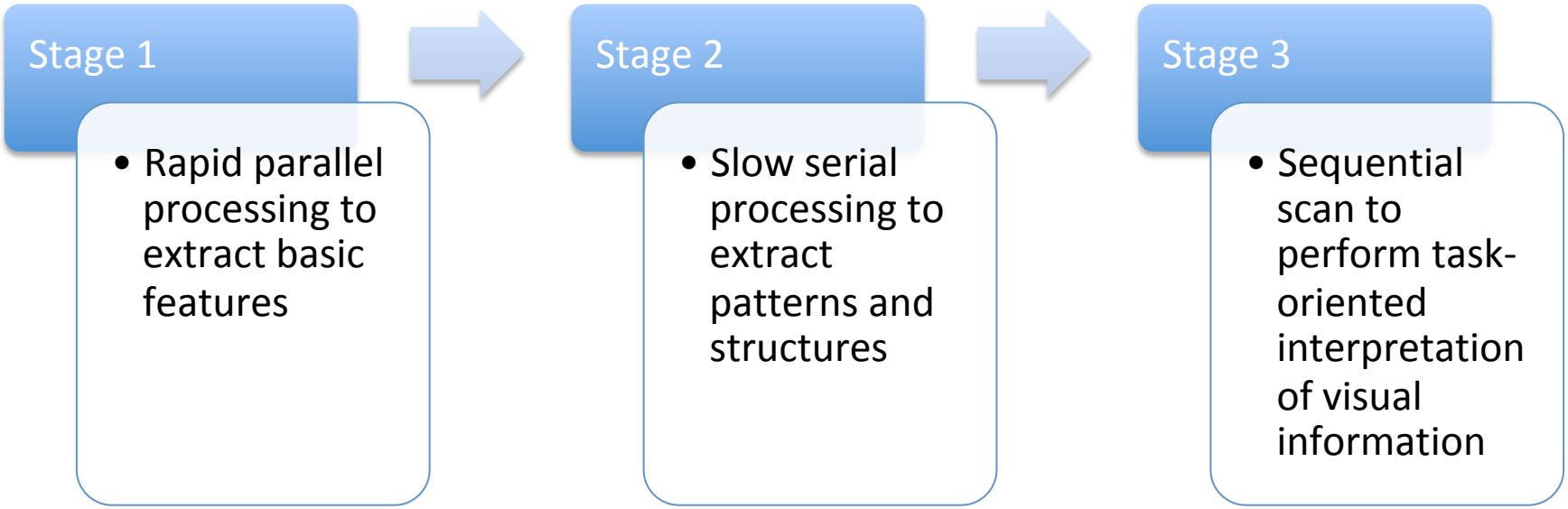
VS

Game #4 – How many 3s?

125896516876513216894321 3
546347965432132035496841 3
206879841718452952928714 9
217495317819529392654683 1
354651650989855468498298 4

How many “3”?

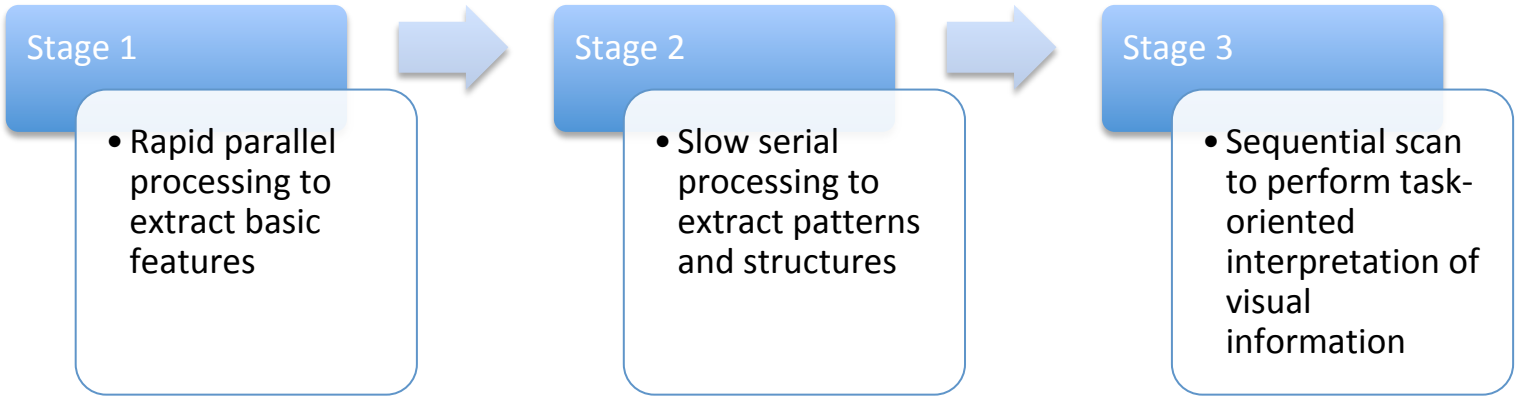
Perception and Cognition



Ware Colin. Information Visualization, third edition. 2004

Visual Perception

- Early visual processing takes places without our conscious intervention
- Graphs that convey information at this level allow the observer to be more efficient in decoding



Visual Cognition

- At second stage, the observer is required to consciously analyze the image/scene
- At this level, the observer can perform higher level reasoning
  - This object is larger than the other one
  - This street slope is lower than the previous

Timer

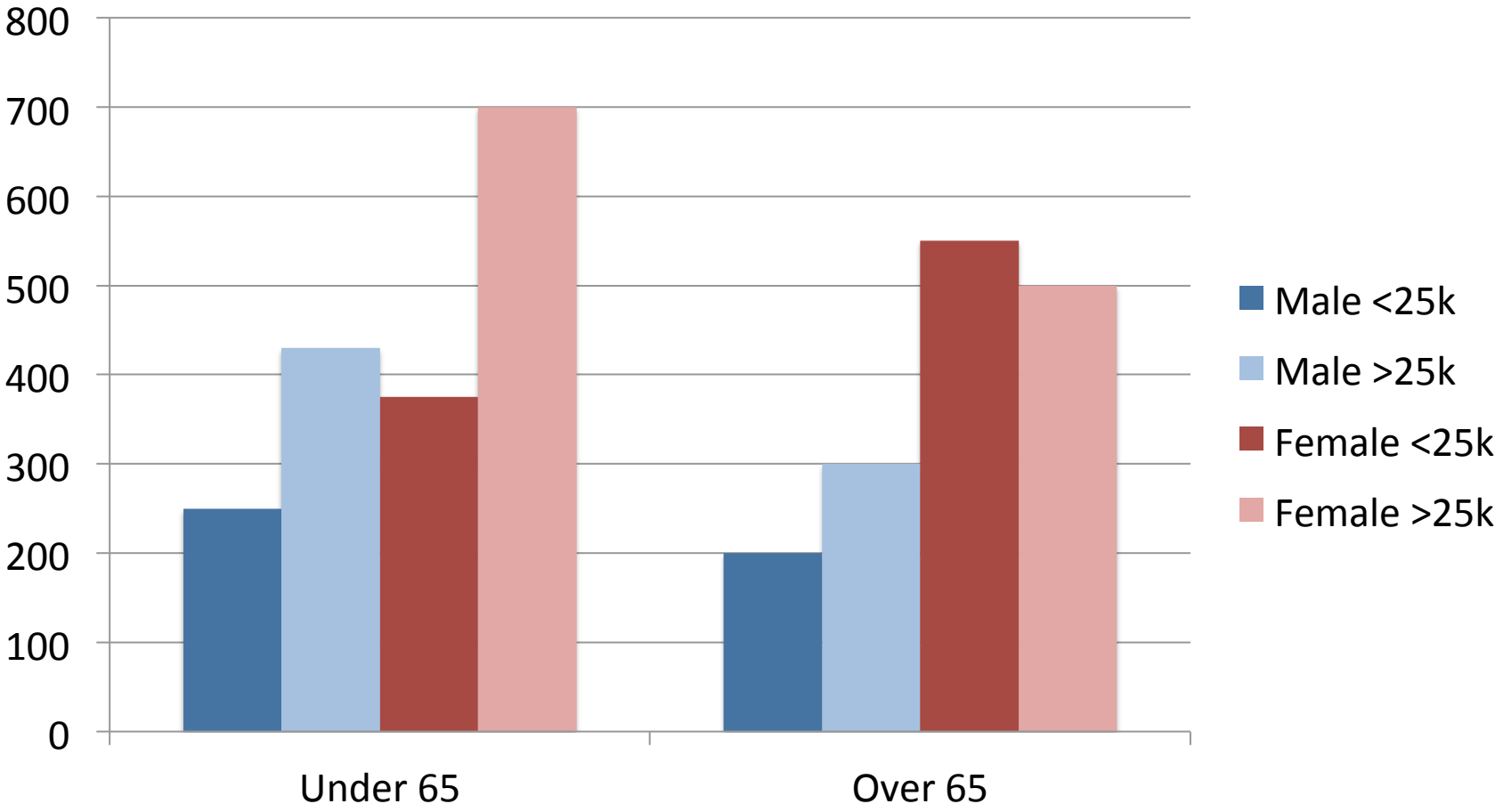
GAME #5 – CHOLESTEROL, AGE, AND GENDER

Game #5 – Cholesterol, Age, and Gender

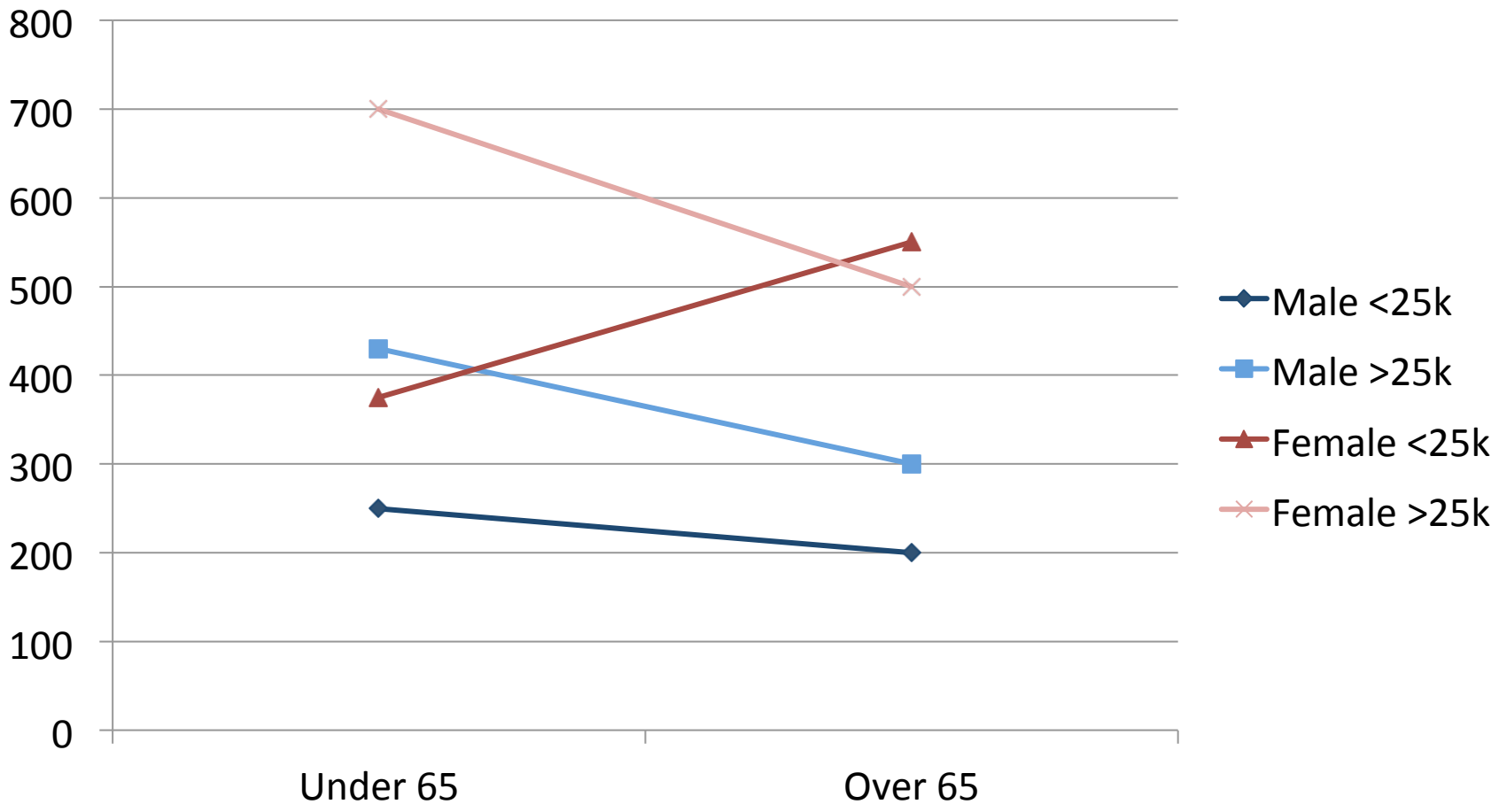
Which relation between gender or income level groups?

	Males		Females	
Income Group	**Under 65**	**65 and Over**	**Under 65**	**65 and Over**
0 – 24,999$	250	200	375	550
25,000$ +	430	300	700	500

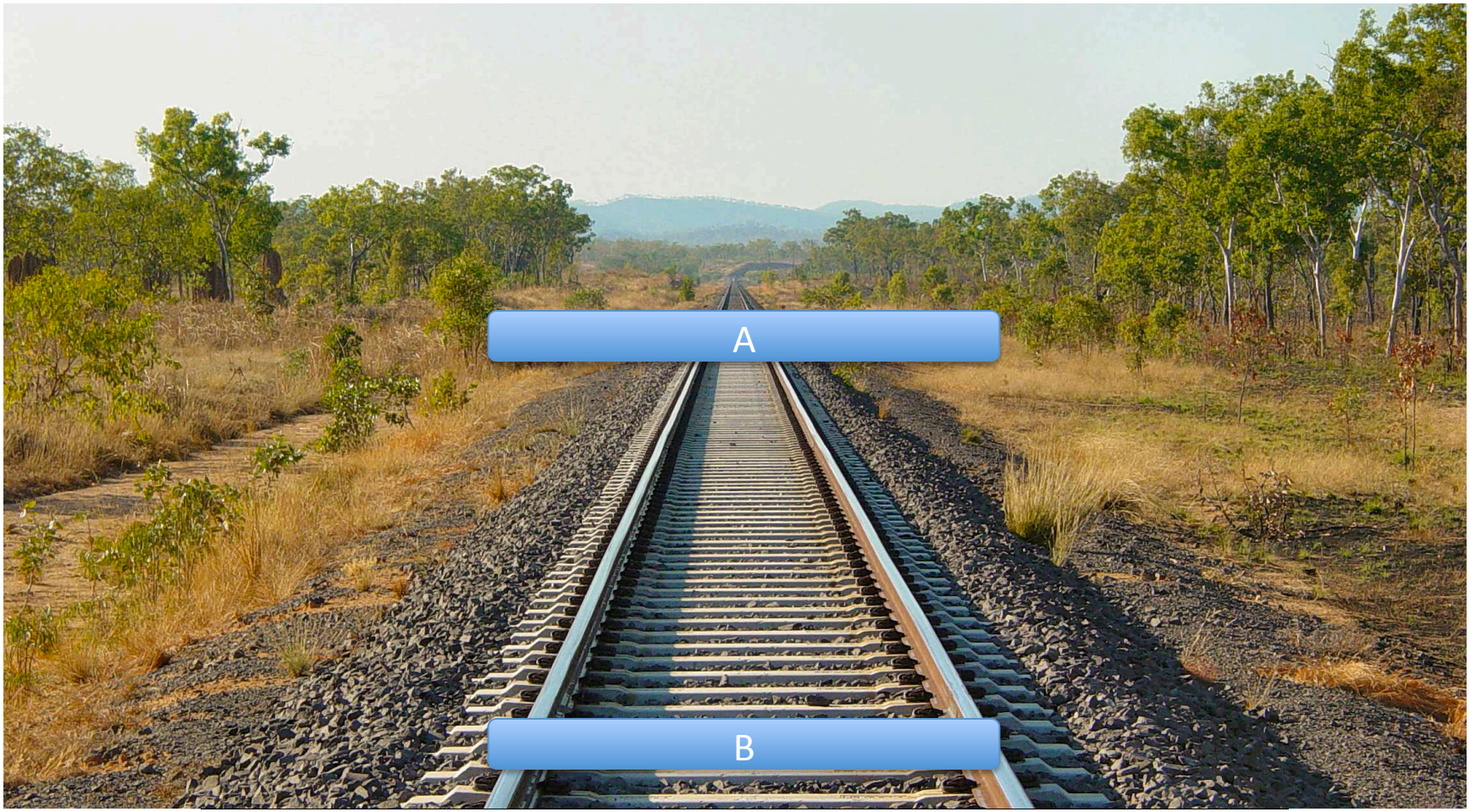
Game #5 – Visual Solution (2)



Game #5 – Visual Solution



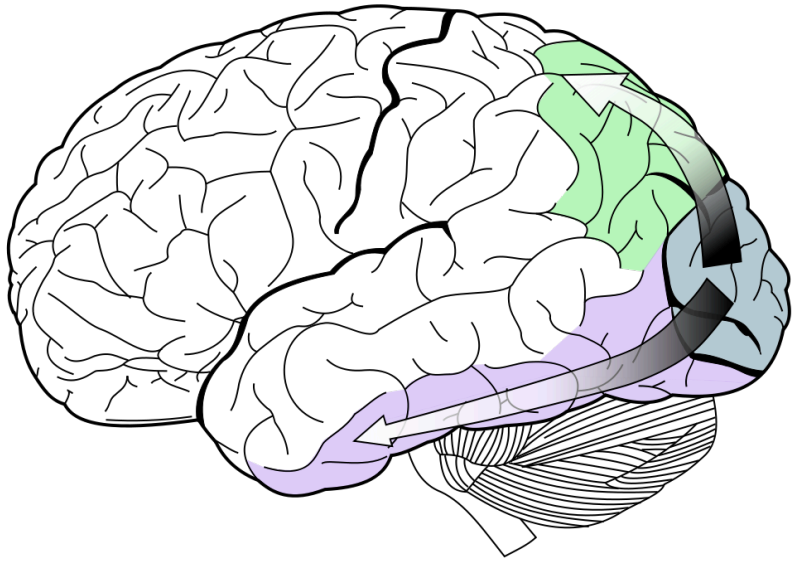
Game #6 – Length comparison



Perception

- Perception: the way in which something is regarded, understood, or interpreted (Oxford Dictionary)
- Electrical signals from vision system are interpreted and organized by the brain
- Two-stream hypothesis:
  - Ventral Stream
  - Dorsal Stream

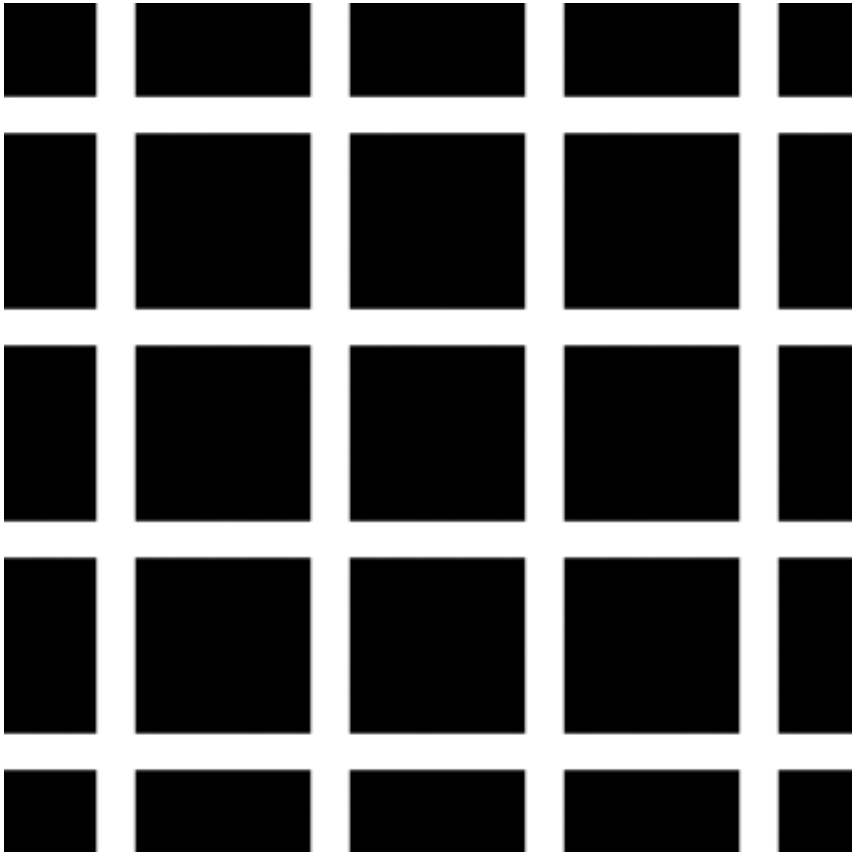
The dorsal stream (green) and ventral stream (purple) are shown. They originate from a common source in the visual cortex



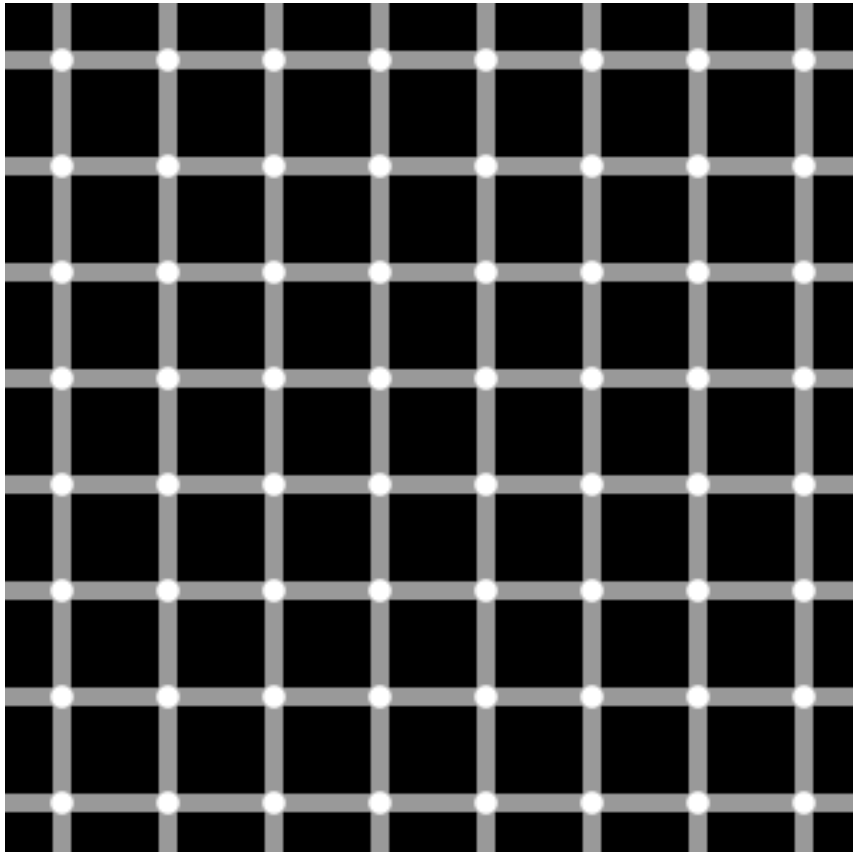
Visual Illusions

- Perceived images differ from measurable reality
  - Optical Illusions
  - Physiolagical illusions (Mach Bands)
  - Cognitive illusions
    - Arise by unconsciuos inferences based on assumptions about real world

Physiological Grid Illusion

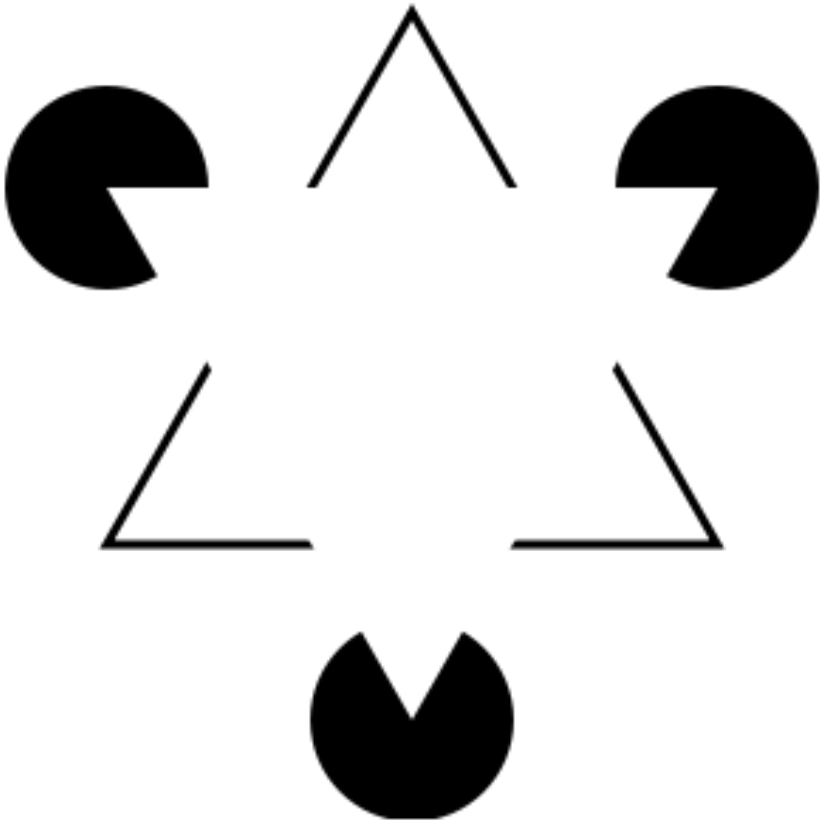


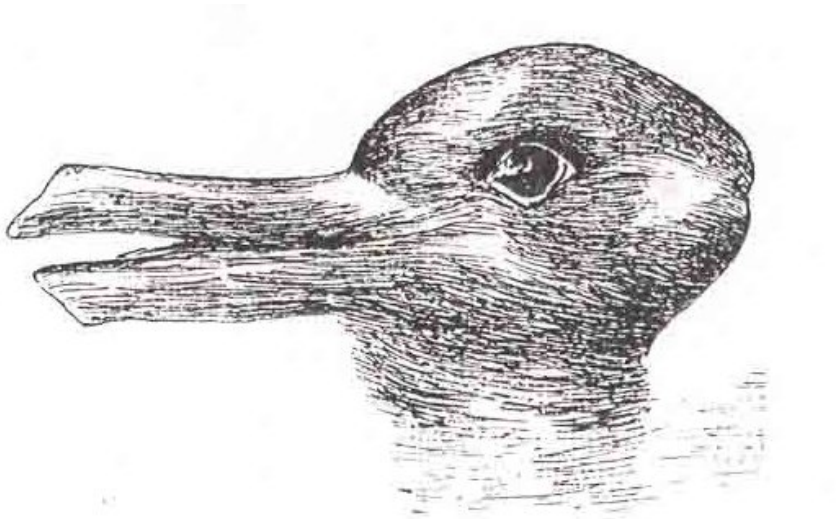
"HermannGrid" by en:User:Famousdog - http://en.wikipedia.org/wiki/File:HermannGrid.gif. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:HermannGrid.gif#/media/File:HermannGrid.gif



"Grid illusion" by User:Tó campos1 - Own work. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Grid_illusion.svg#/media/File:Grid_illusion.svg

Paradox Ambiguos Illusions



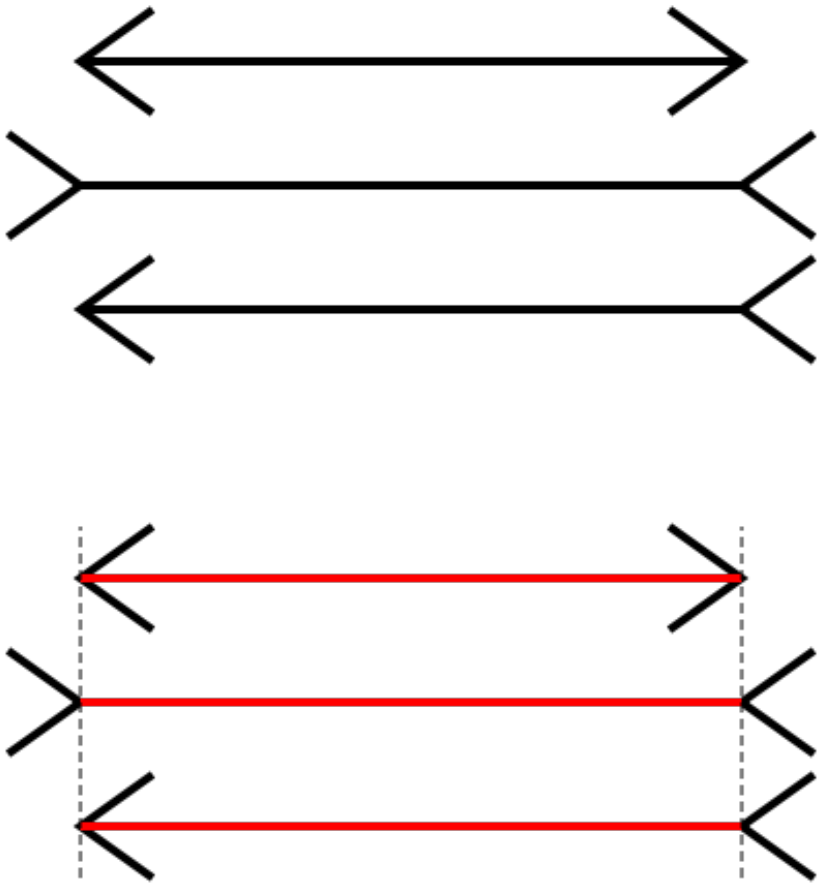


"Kanizsa triangle" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Kanizsa_triangle.svg#/media/File:Kanizsa_triangle.svg

"Duck-Rabbit illusion". Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Duck-Rabbit_illusion.jpg#/media/File:Duck-Rabbit_illusion.jpg

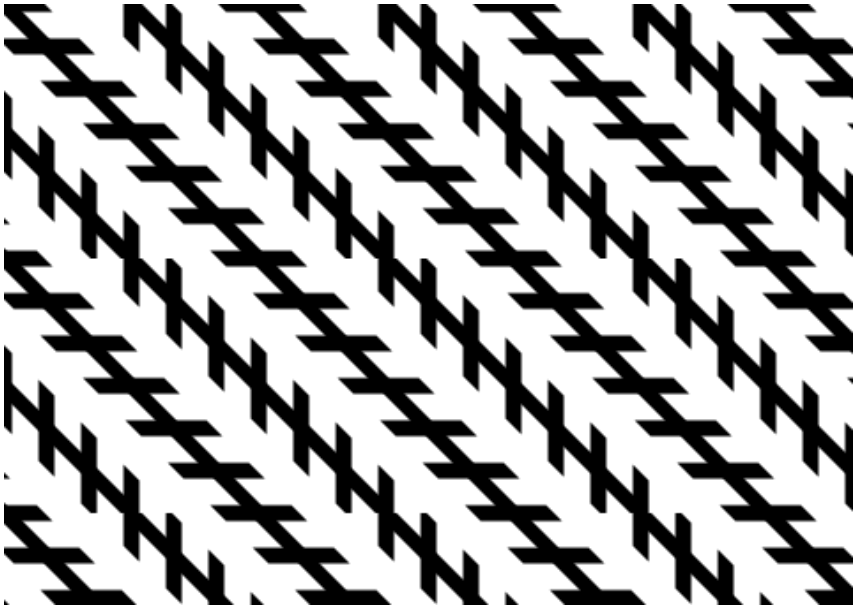
Lengths Distortion

Müller-Lyer illusion

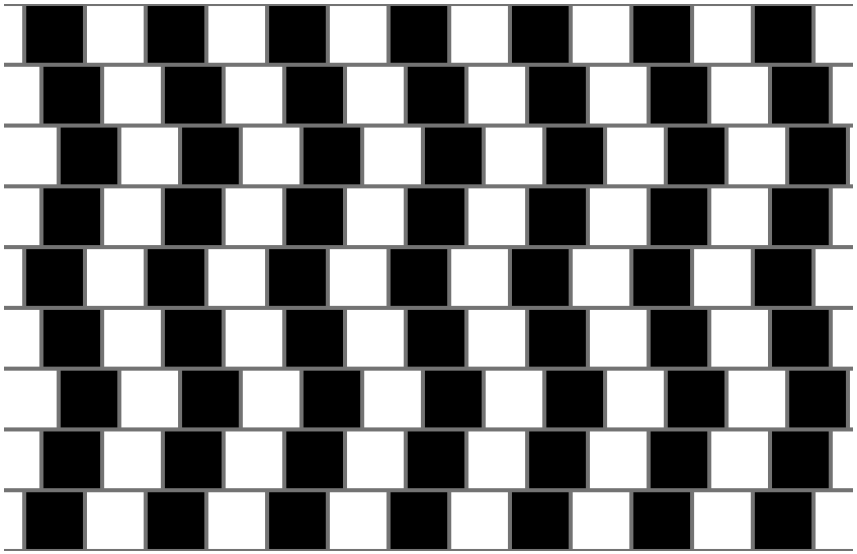


Orientation Illusion

Zöllner illusion

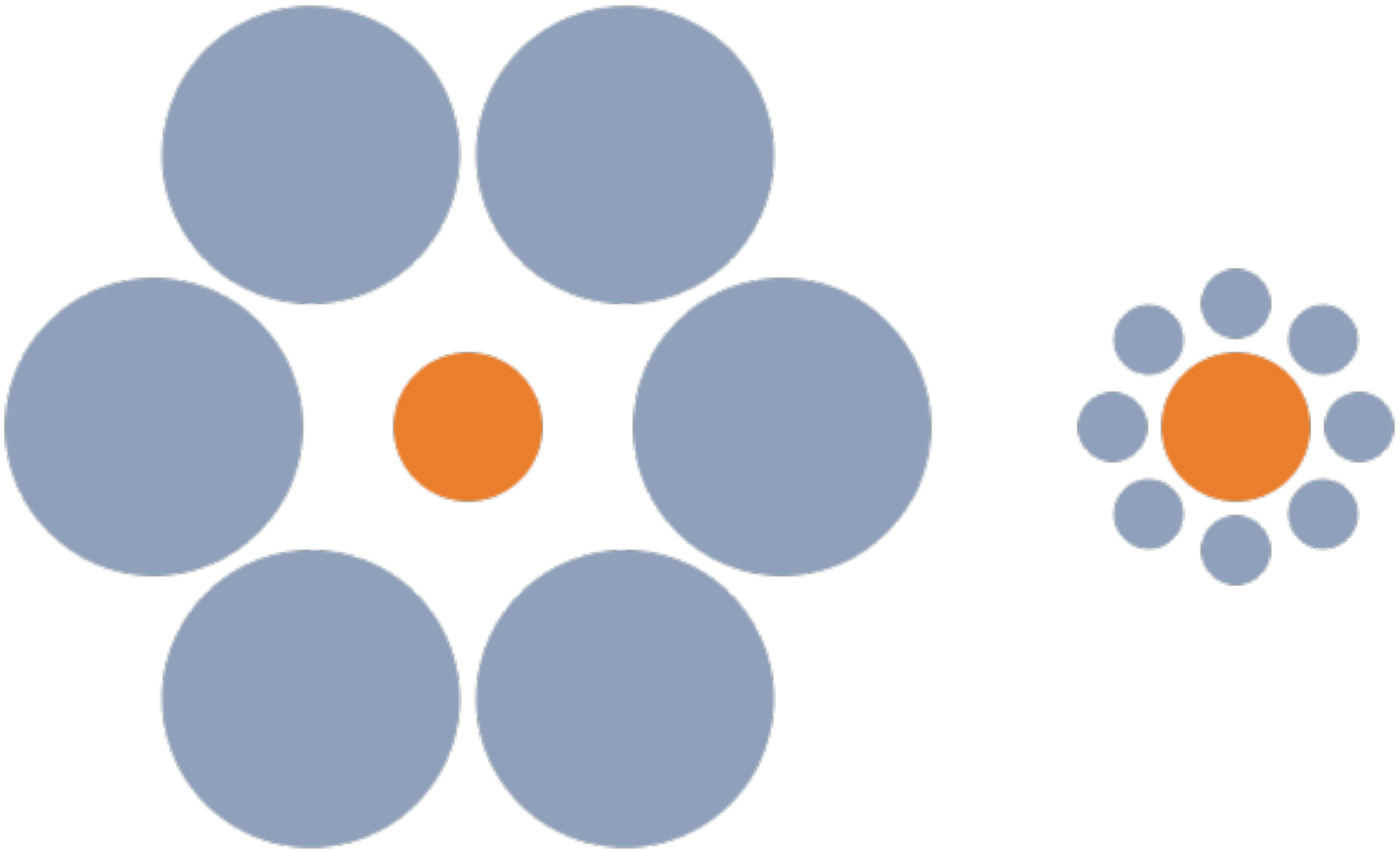


"Zollner illusion" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Zollner_illusion.svg#/media/File:Zollner_illusion.svg

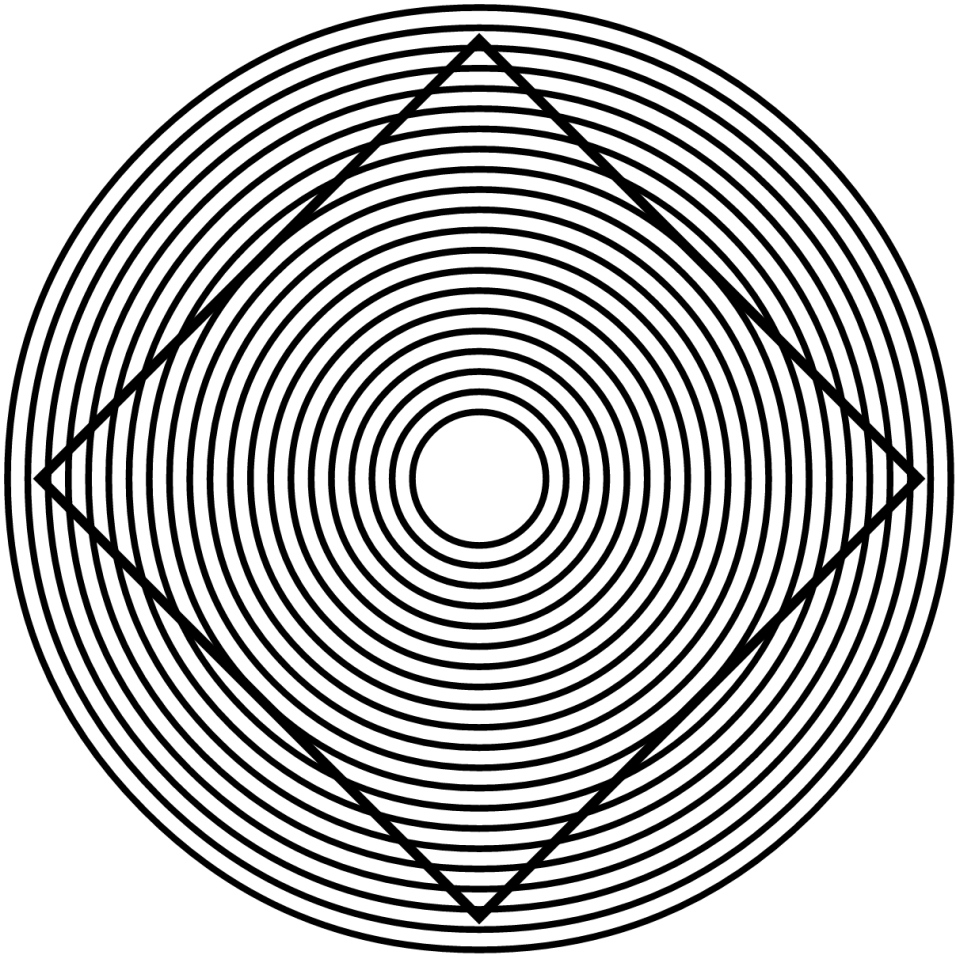


"Café wall" by Fibonacci - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Caf%C3%A9_wall.svg#/media/File:Caf%C3%A9_wall.svg

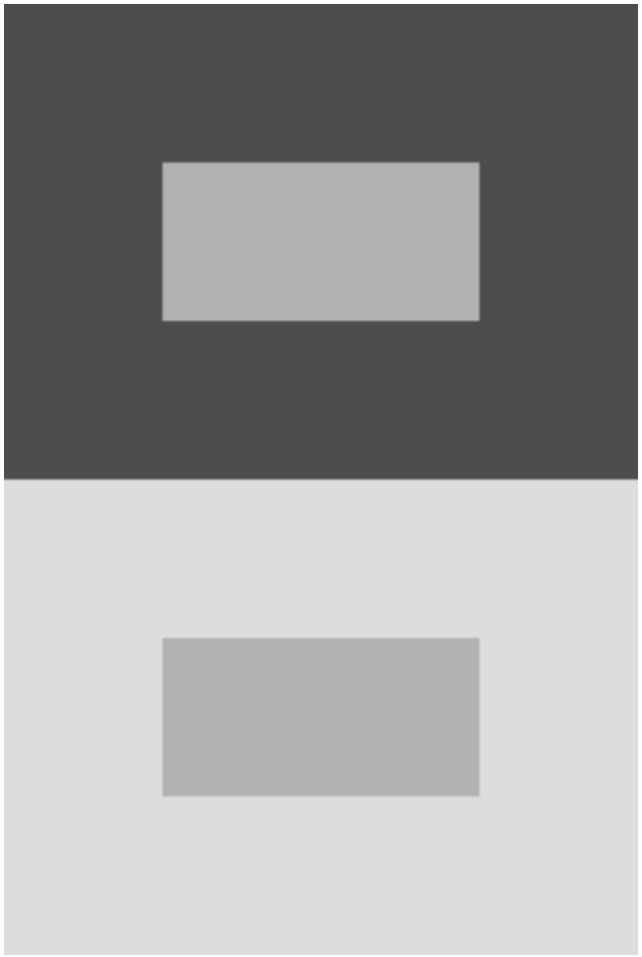
Ebbinghaus Illusion

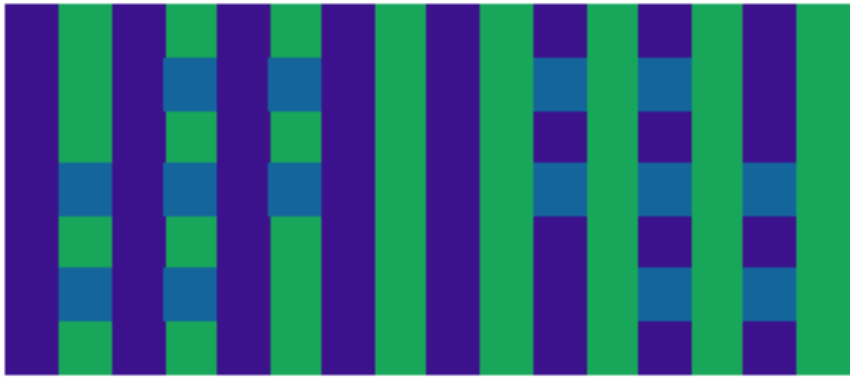


Ehrenstein Illusion

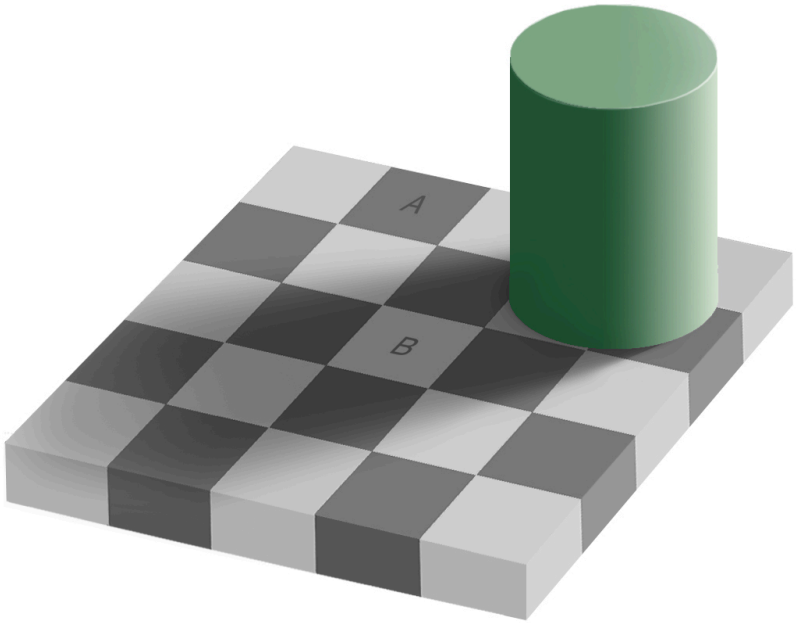


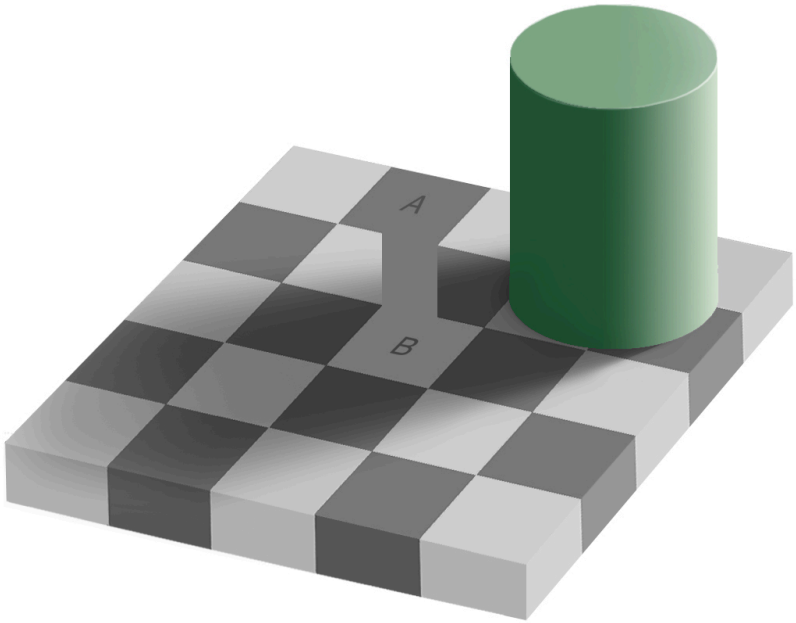
Simultaneous Contrast



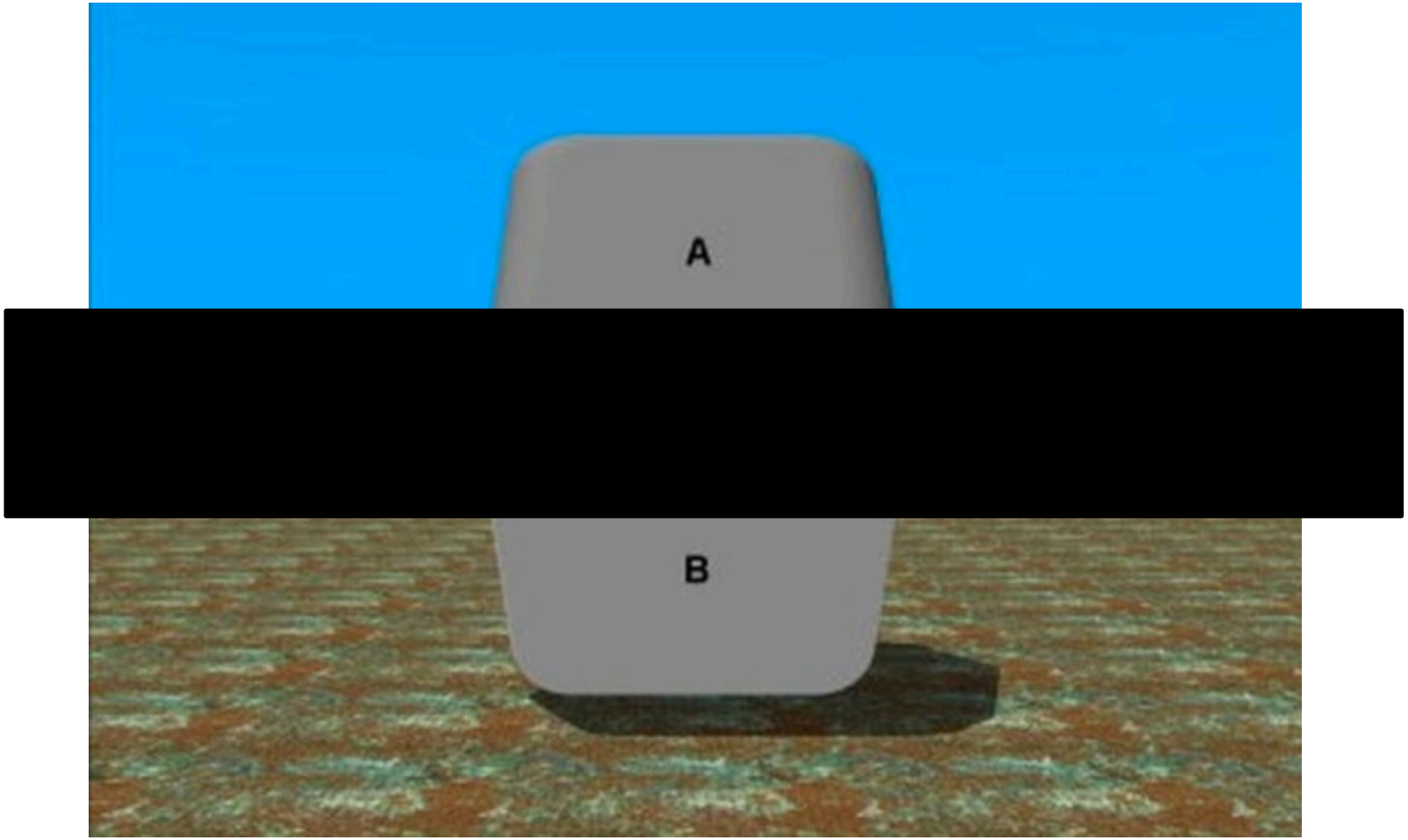


Adelson’s Illusion

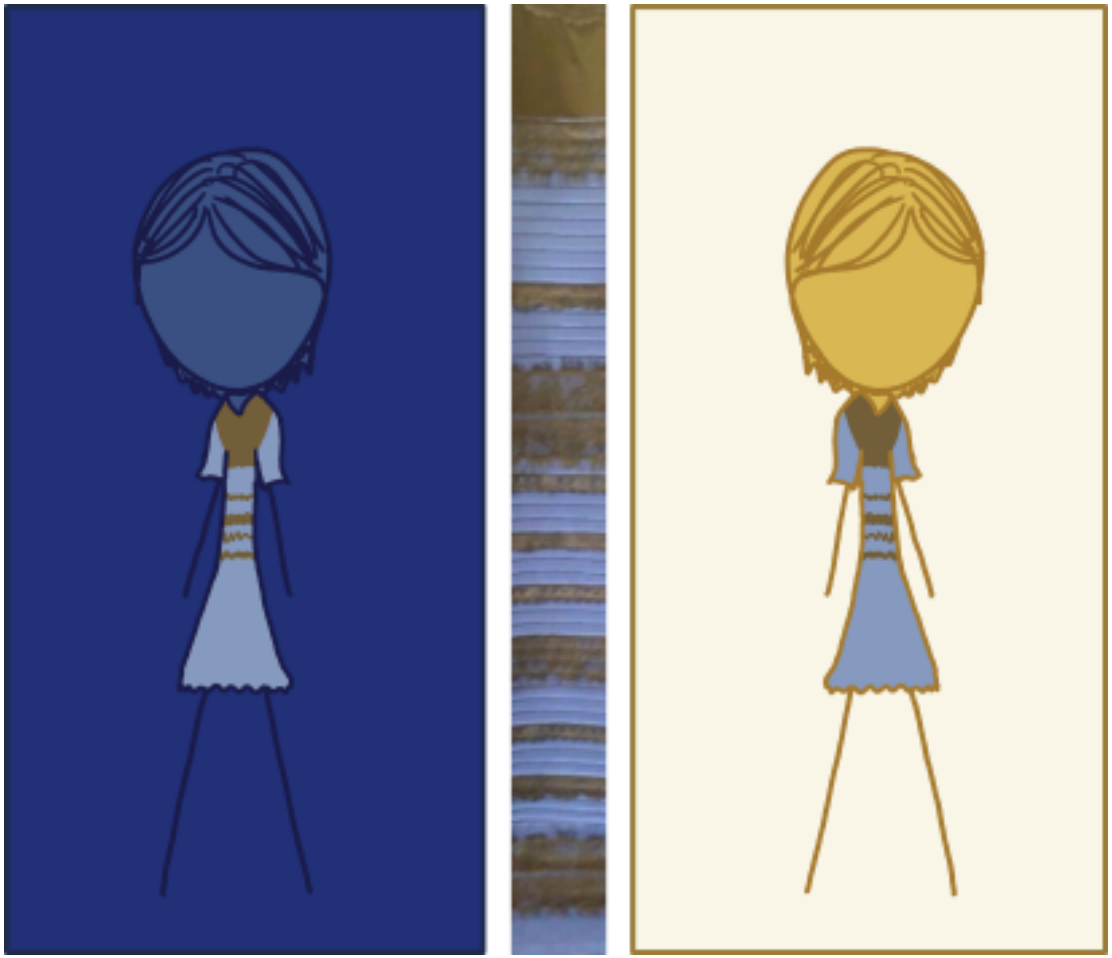




Context



Dress Color



Takeaway Messages

- Limiations of human vision system
- Exploits message brodcast at early stage of perception: preattemptive perception
- Avoid possible causes of biases