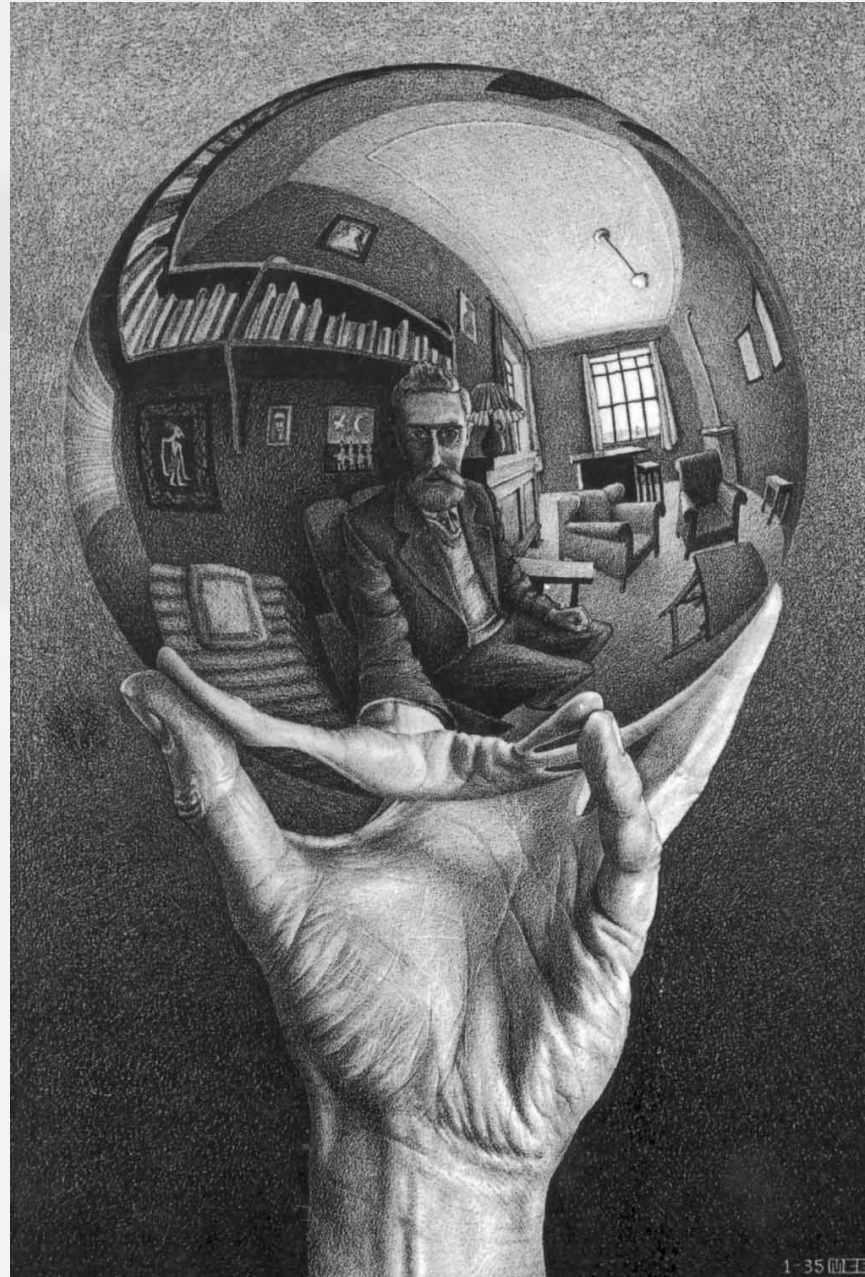
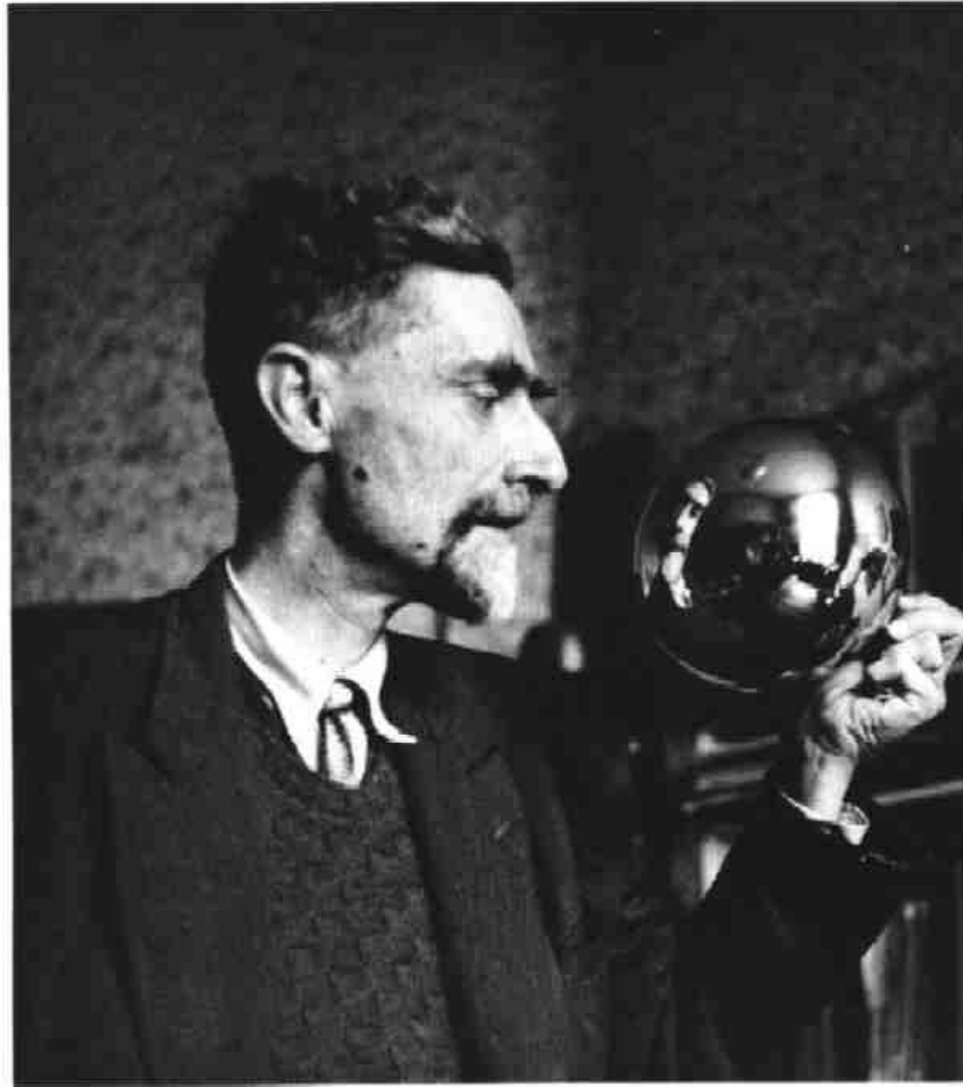


Chapter 5: Perceiving Faces and Objects



M.C. Escher

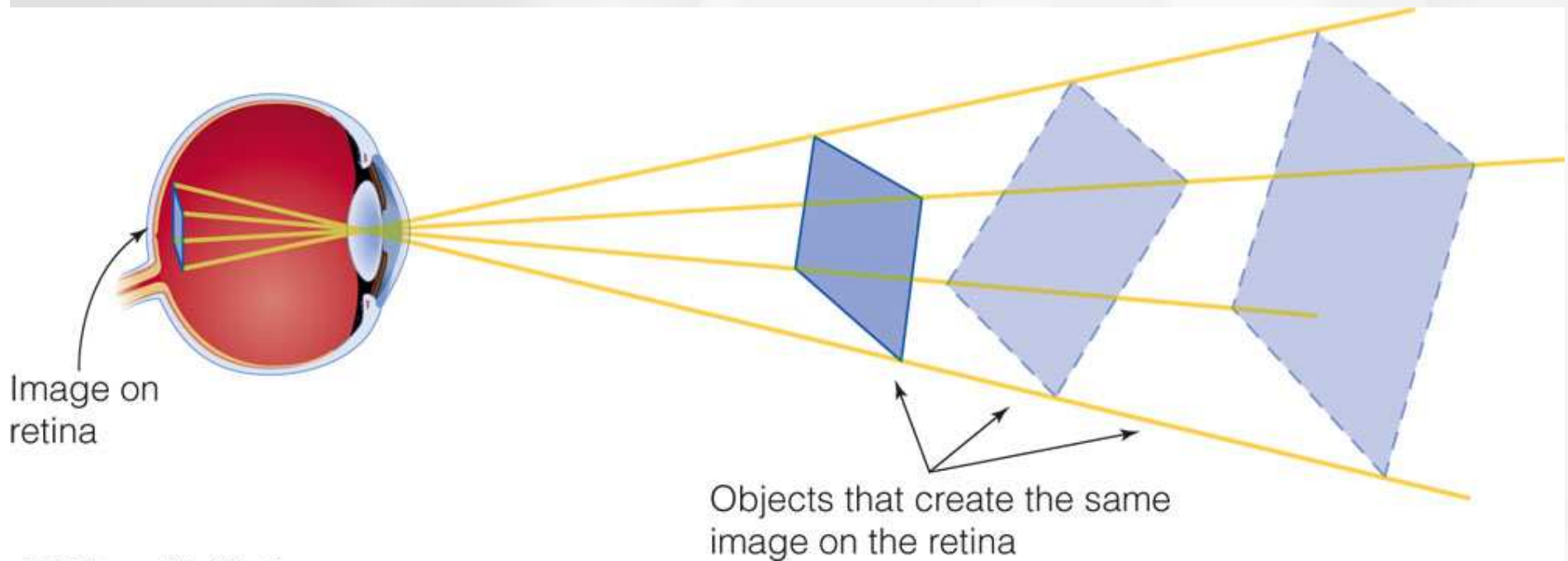
Chapter 5: Perceiving Faces and Objects



M.C. Escher

The Challenge of Object Perception

- The stimulus on the receptors is ambiguous
 - Inverse projection problem: an image on the retina can be caused by an infinite number of objects



The Challenge of Object Perception

- 1) Gestalt laws of perceptual organization
- 2) Figure-Ground segregation
- 3) Face perception



The Challenge of Object Perception

- Objects can be hidden or blurred
 - Occlusions are common in the environment



The Challenge of Object Perception

- The reasons for changes in lightness and darkness in the environment can be unclear – shadows cause huge differences in illumination



The Structuralist Approach

- Approach established by Wundt (1830-1920)
 - States that perceptions are created by combining elements called sensations
 - Popular in mid to late 19th century

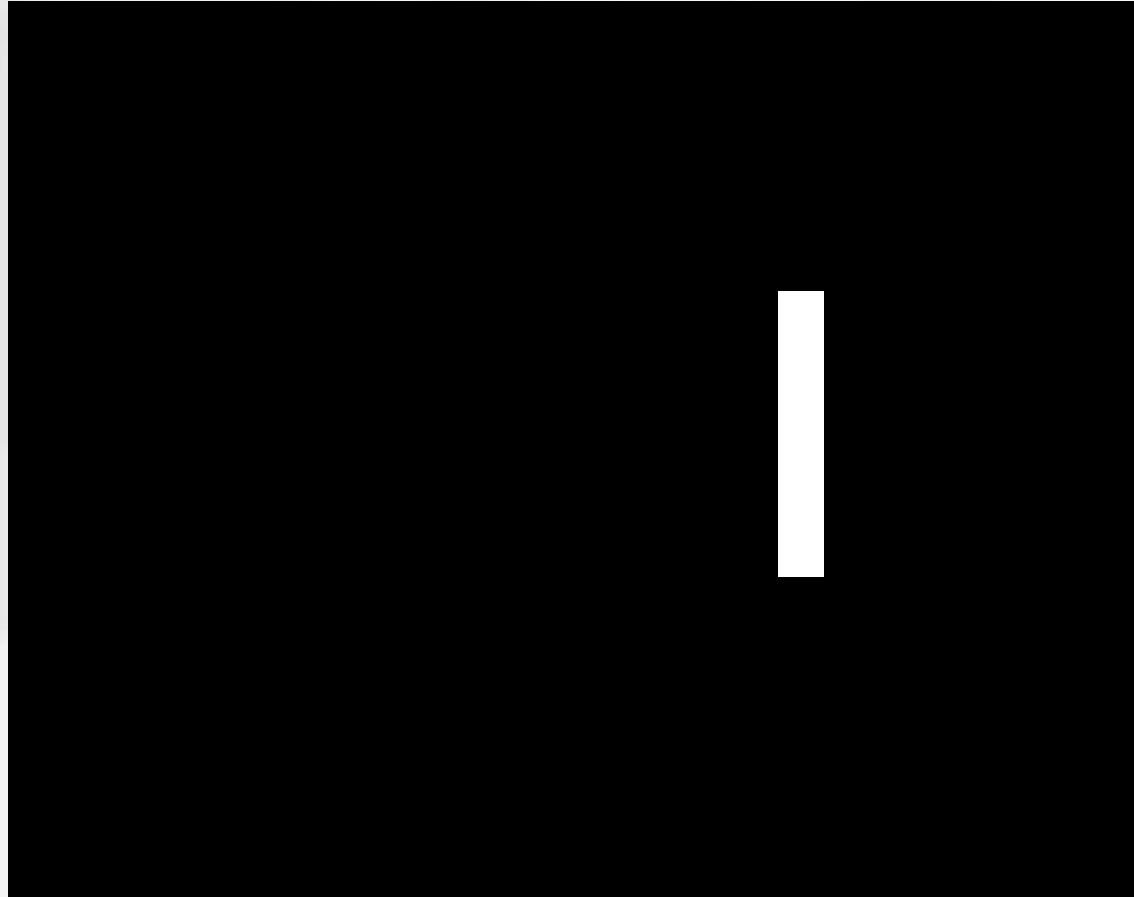


Wundt studied conscious experience by examining its *structure* or components parts (sensations, feelings) using individuals who were trained in *introspection*. This "school of psychology" became known as *structuralism*.

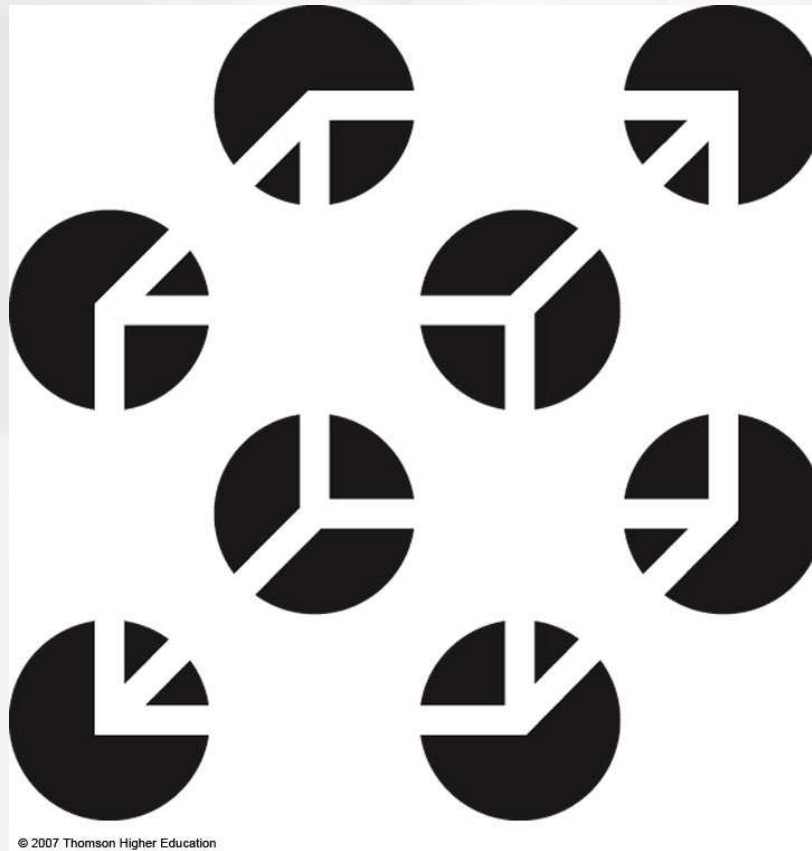
–Structuralism could not explain ‘apparent motion’



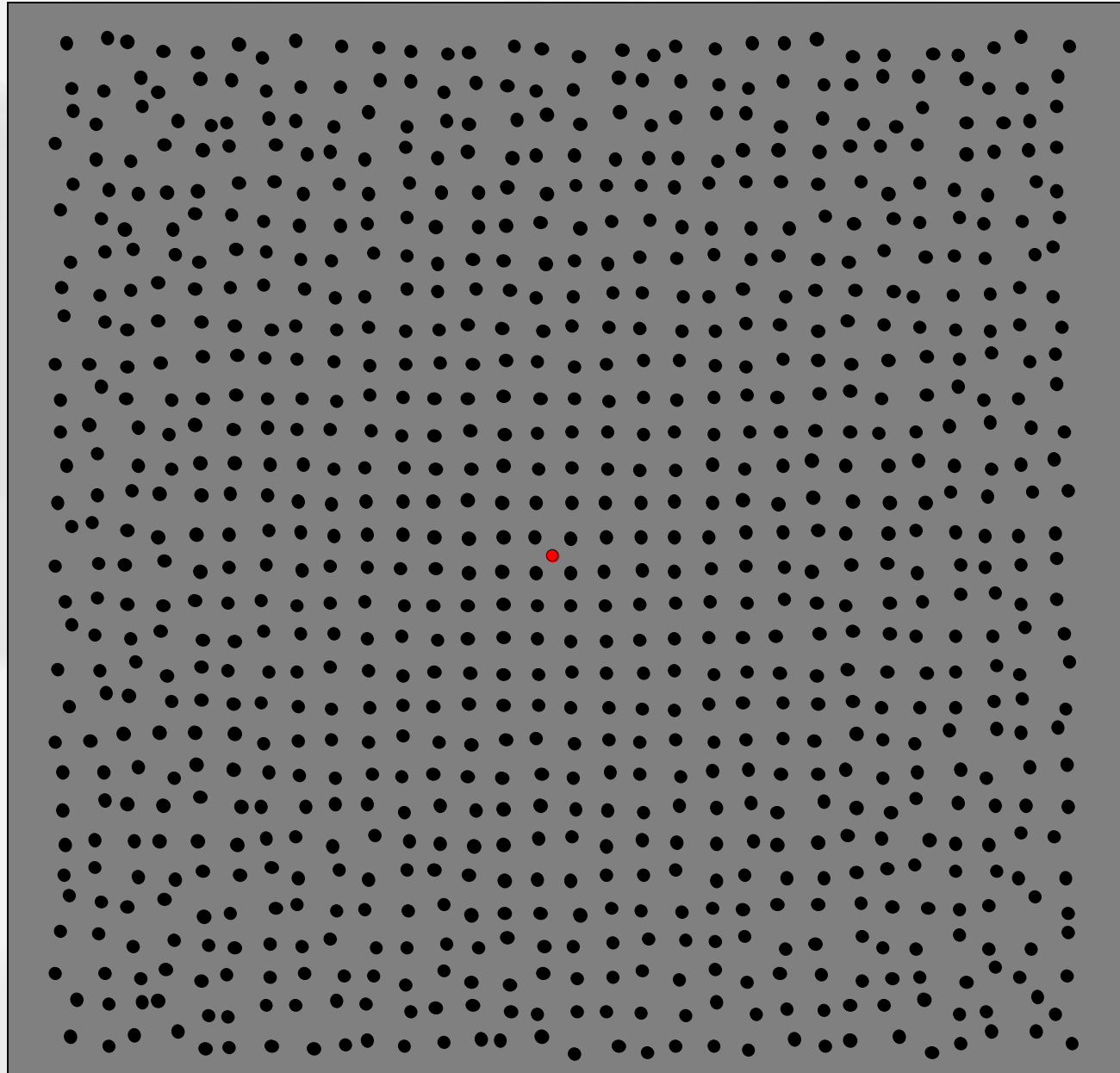
–Structuralism could not explain ‘apparent motion’



–Structuralism could not explain ‘illusory contours’ either.



It seems that the visual system 'looks' for regularity and patterns.
We often 'see' or infer structure when it's not actually there.



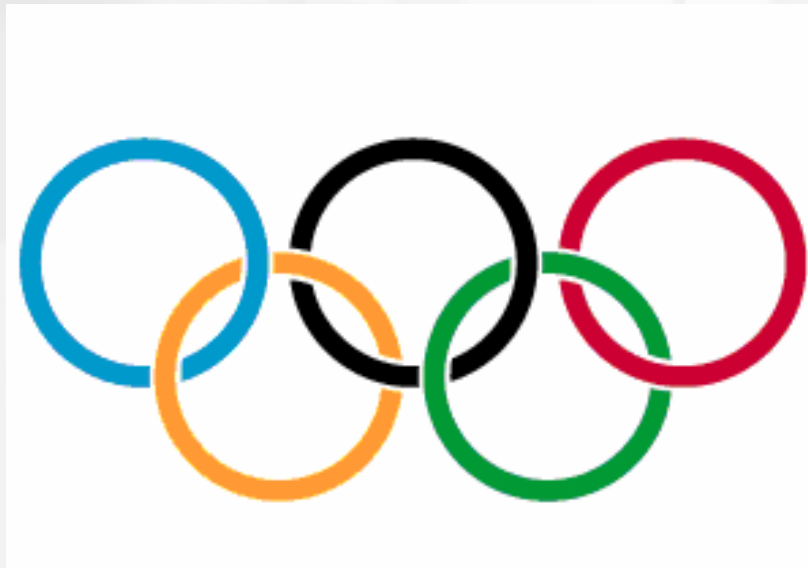
The Gestalt Approach

- According to Gestalt psychologists, the whole is different than the sum of its parts. Gestalt is a German word meaning configuration or pattern.
- Perception is **not** built up from sensations but is a result of *perceptual organization*
- Gestalt principles do not make strong enough predictions to qualify as “laws”
 - They are better thought of as *heuristics* - “best guess rules”

The following ‘laws’ describe heuristics for how elements in a scene tend to group together.

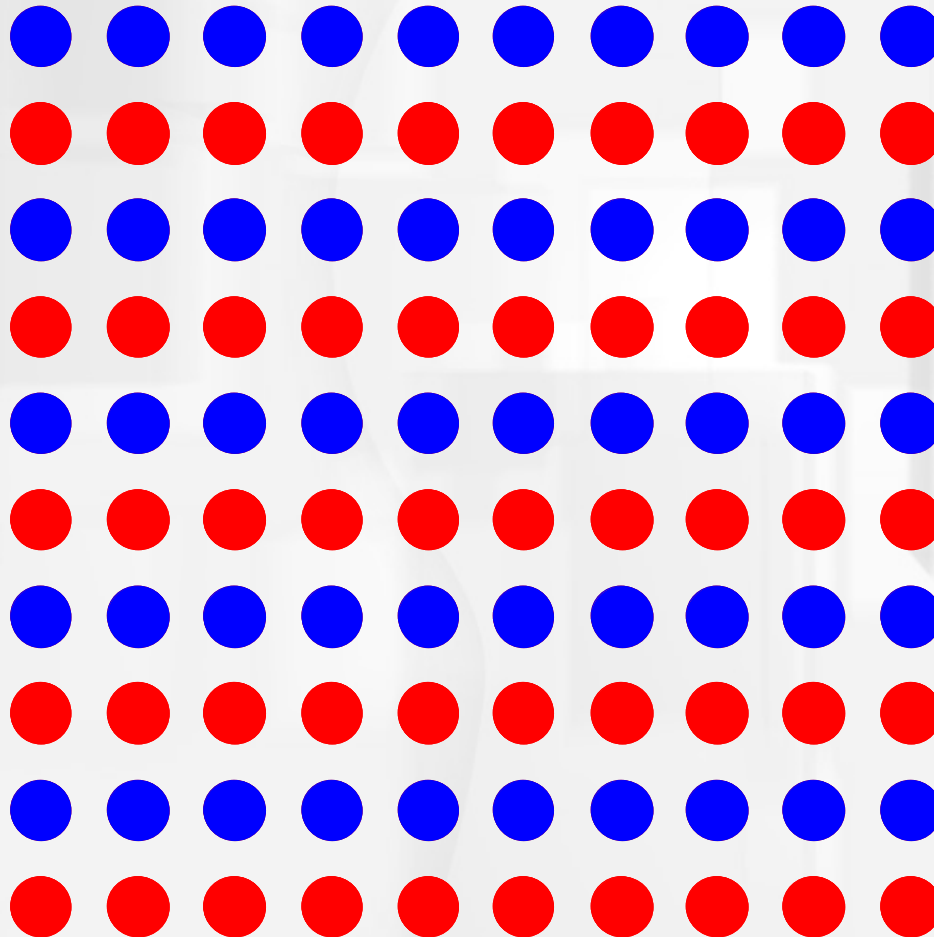
The Gestalt laws of perceptual organization

Pragnanz: Every stimulus pattern is seen in such a way that the resulting structure is as simple as possible.



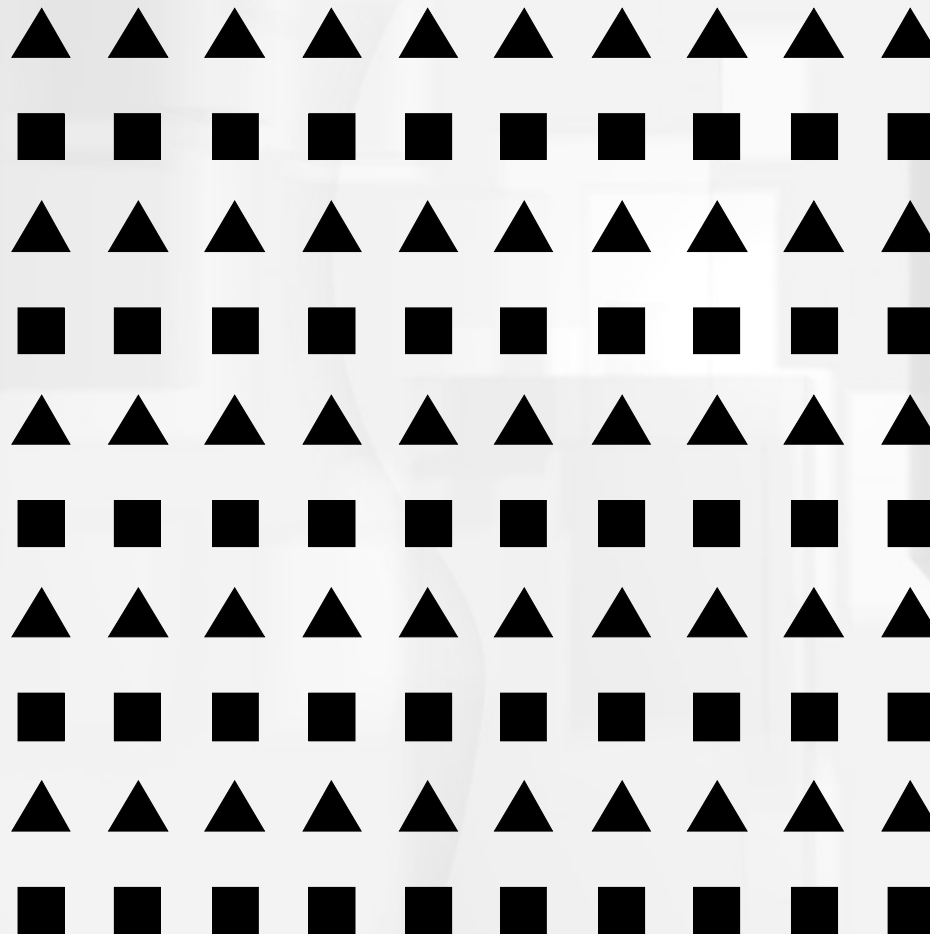
The Gestalt laws of perceptual organization

Similarity: Similar things appear to be grouped together.



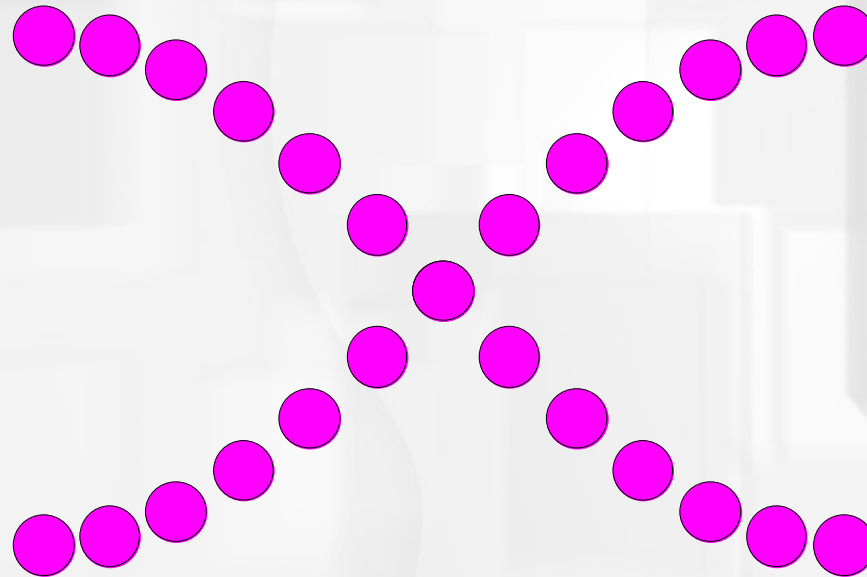
The Gestalt laws of perceptual organization

Similarity: Similar things appear to be grouped together.



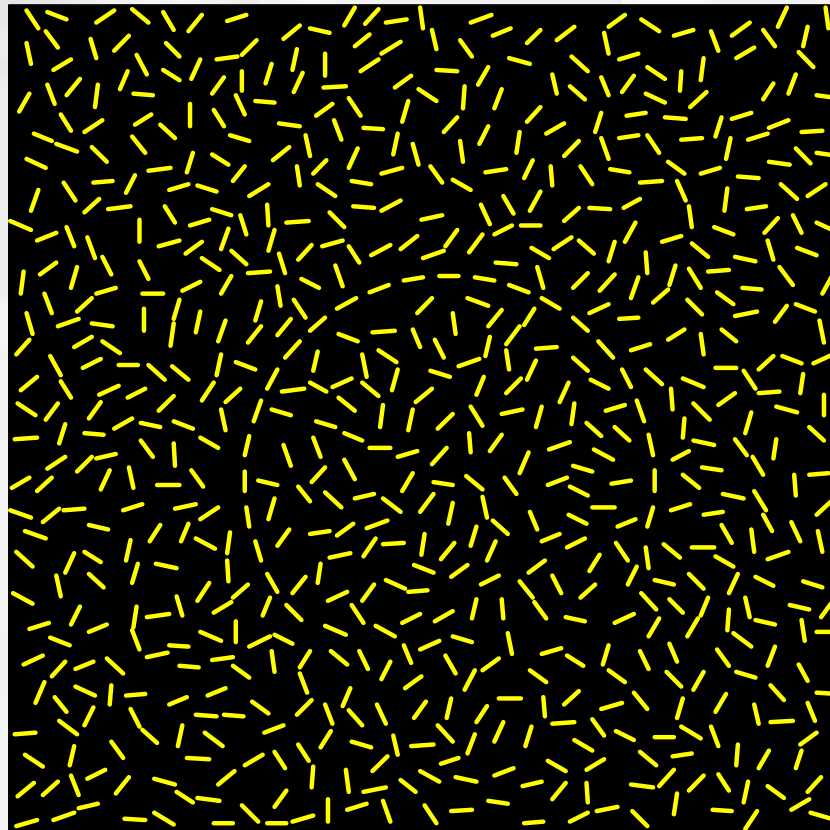
The Gestalt laws of perceptual organization

Good continuation: Points that, when connected, result in contours. These contours follow the smoothest path.



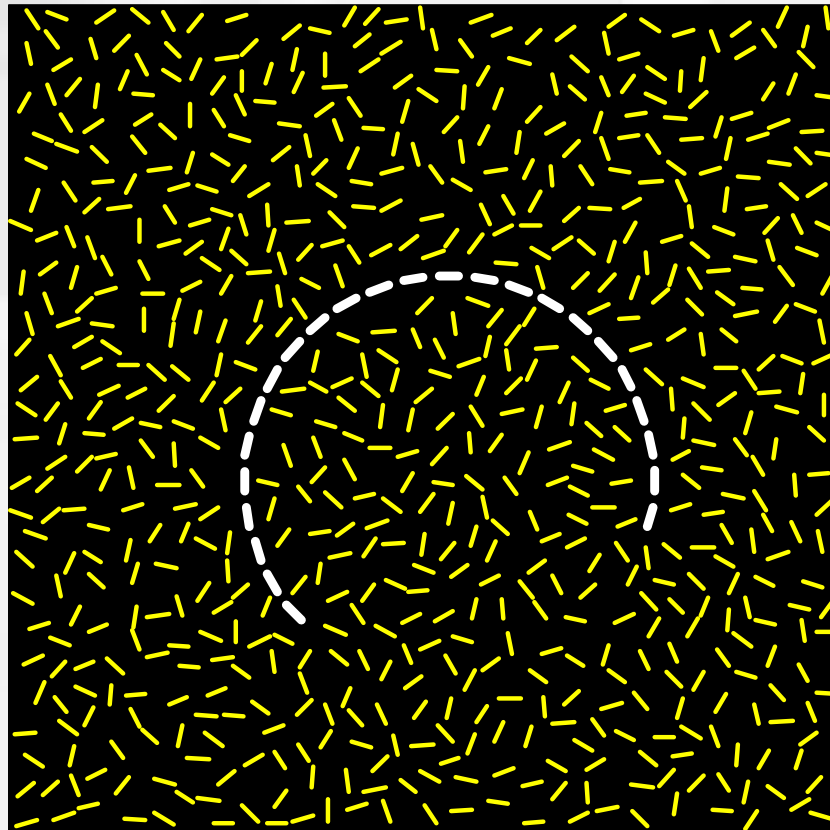
The Gestalt laws of perceptual organization

Good continuation: Points that, when connected, result in contours. These contours follow the smoothest path.

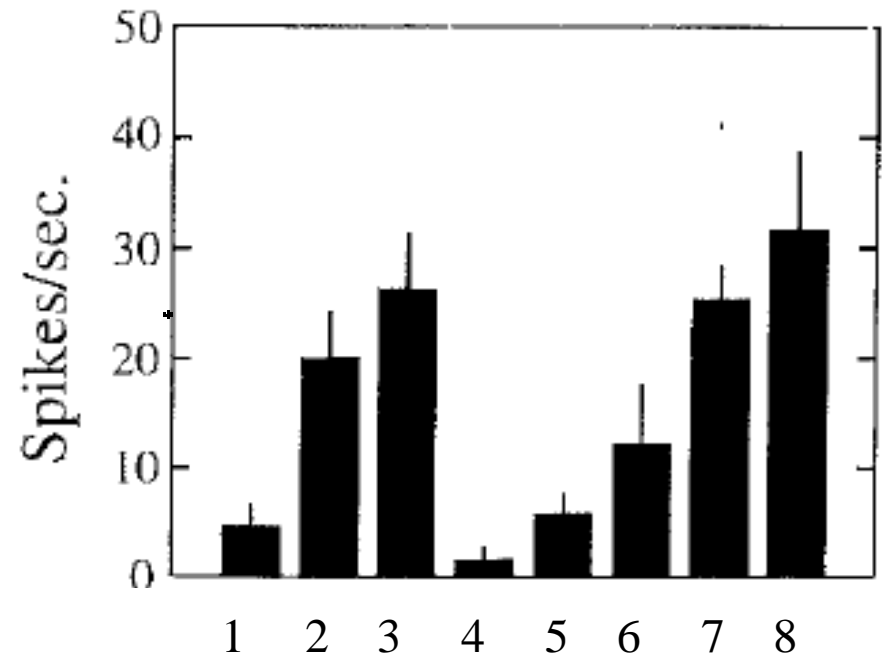
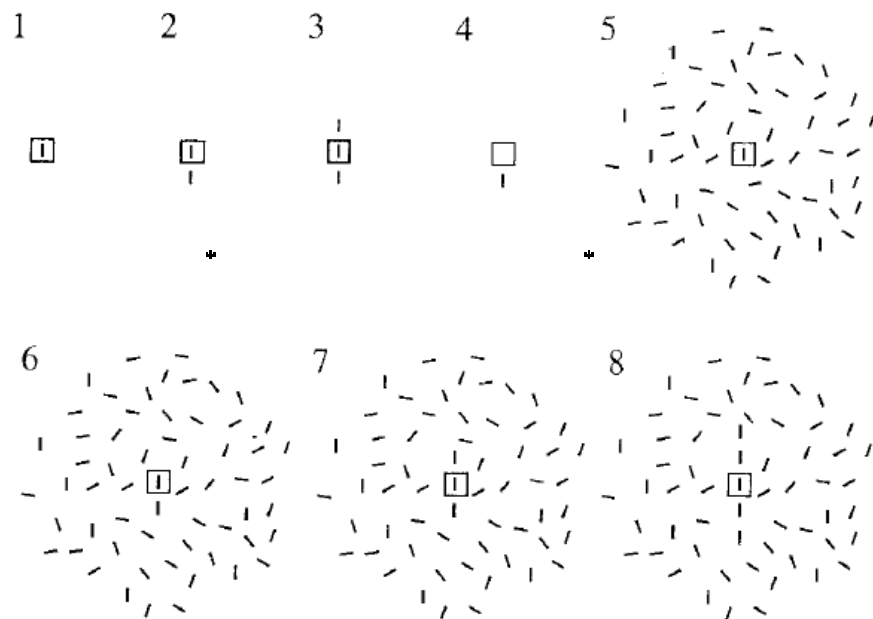


The Gestalt laws of perceptual organization

Good continuation: Points that, when connected, result in contours, and these contours follow the smoothest path.



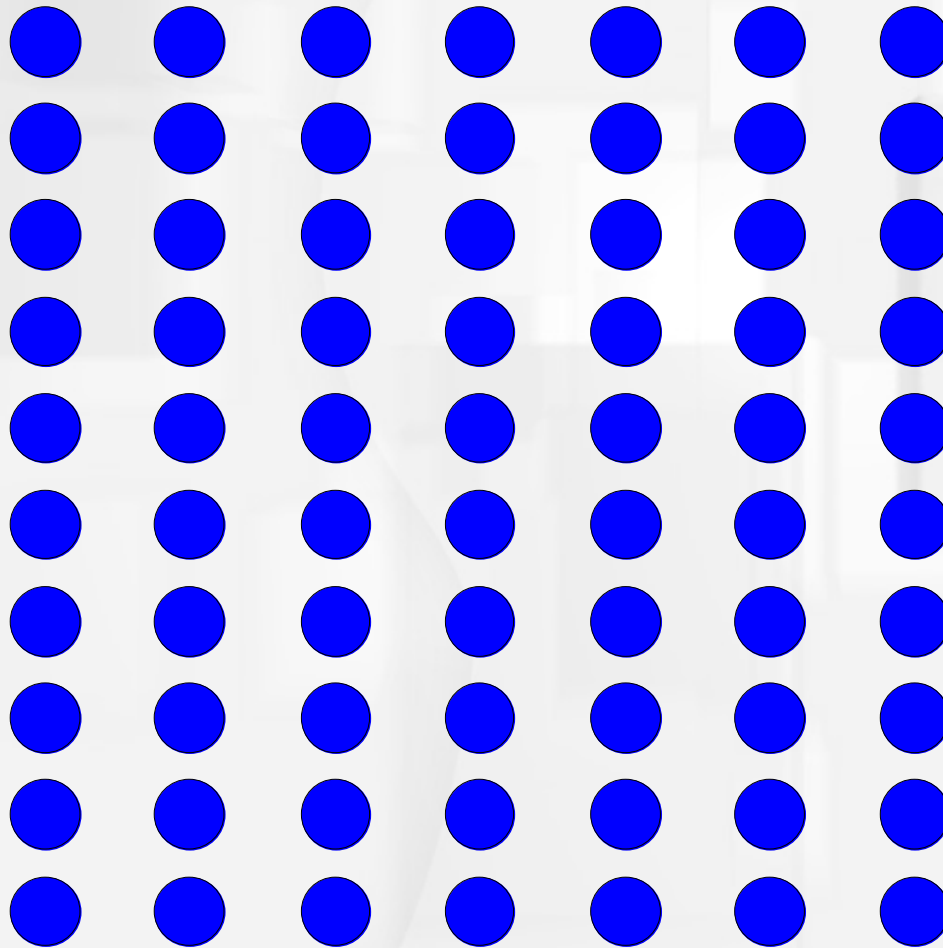
Neurons in V1 seem to support ‘good continuation’



Improvement in visual sensitivity by changes in local context: Parallel studies in human observers and in V1 of alert monkeys Kapadia, Ito, Gilbert, and Westheimer Neuron, 1995

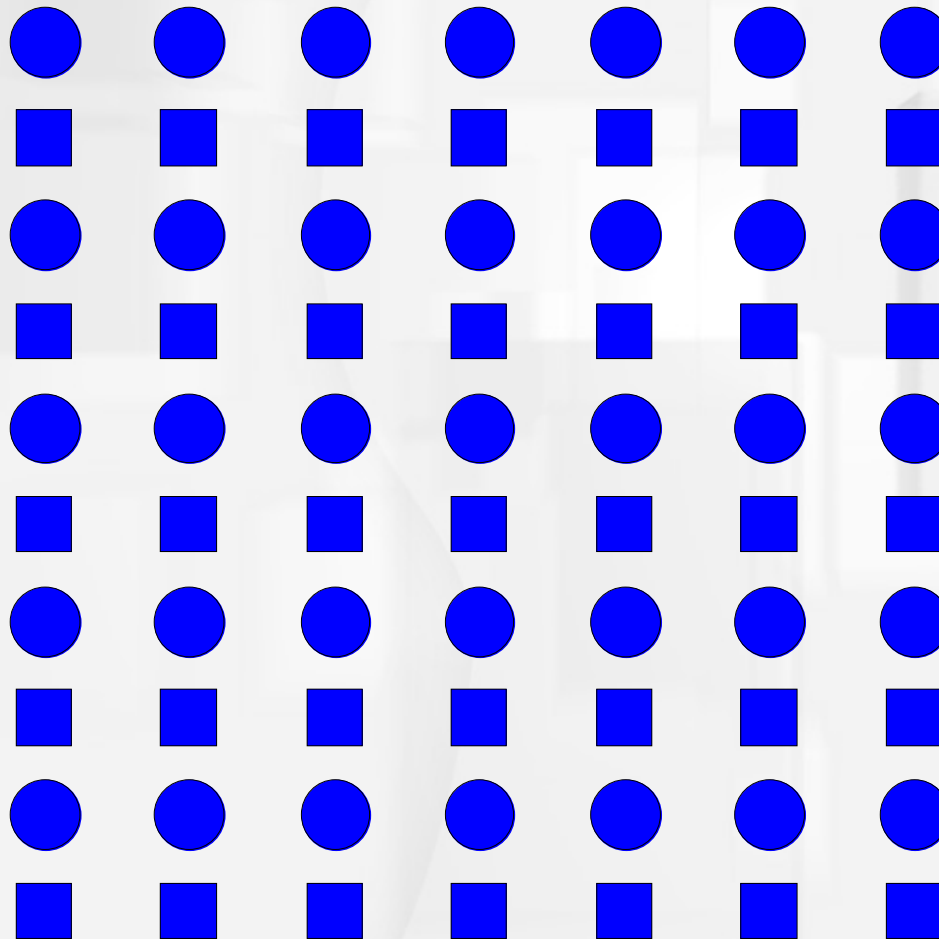
The Gestalt laws of perceptual organization

Proximity – (nearness) things that are near to each other are grouped together



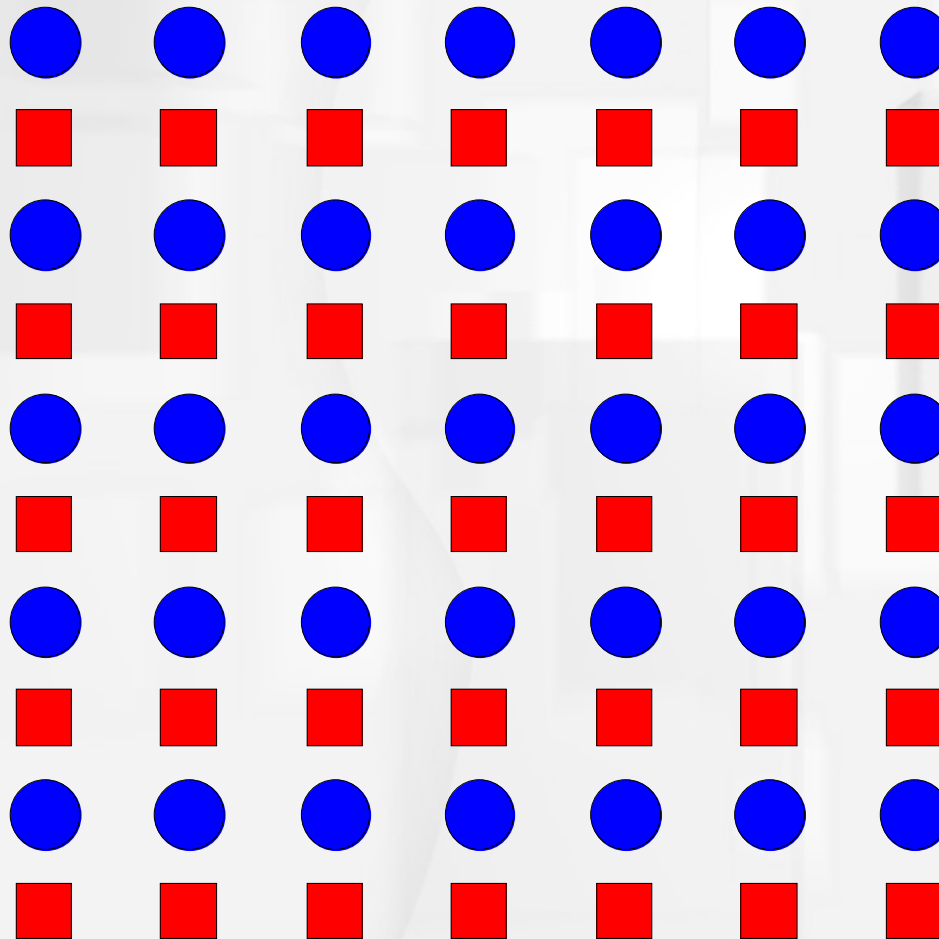
The Gestalt laws of perceptual organization

Proximity vs. Similarity Which one wins?



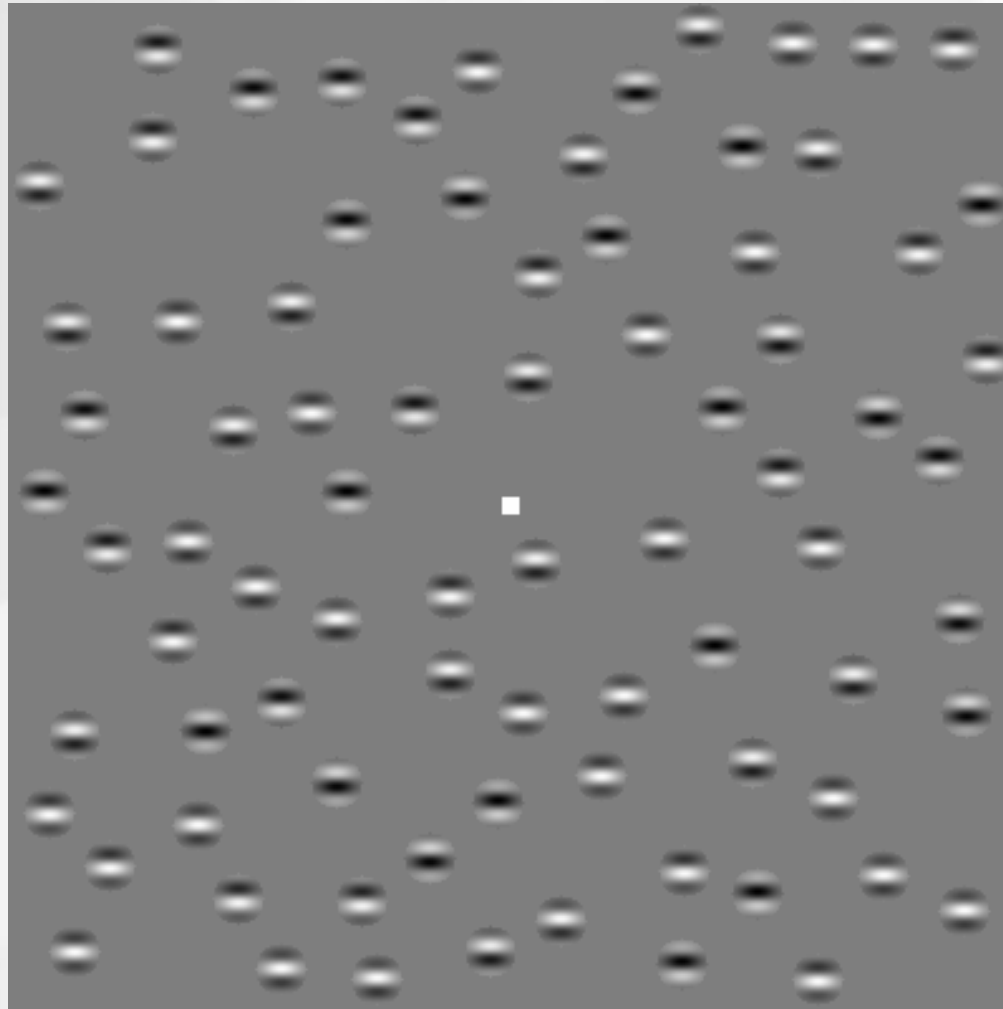
The Gestalt laws of perceptual organization

It depends...



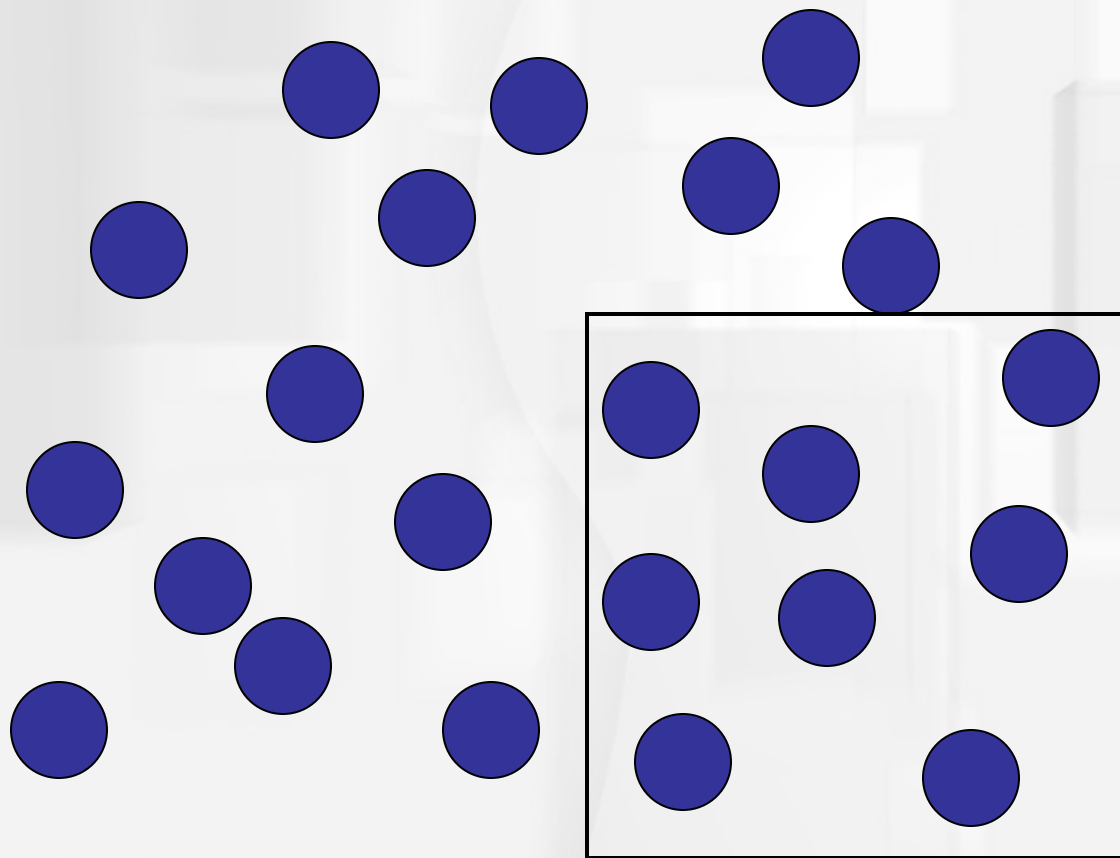
The Gestalt laws of perceptual organization

Common Fate – things that move together belong together



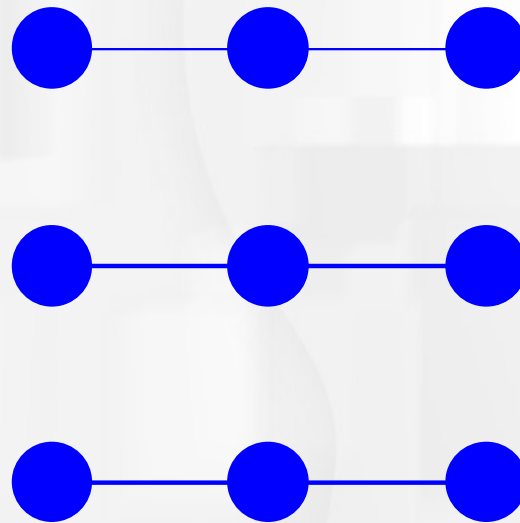
The Gestalt laws of perceptual organization

Common region - elements in the same region tend to be grouped together



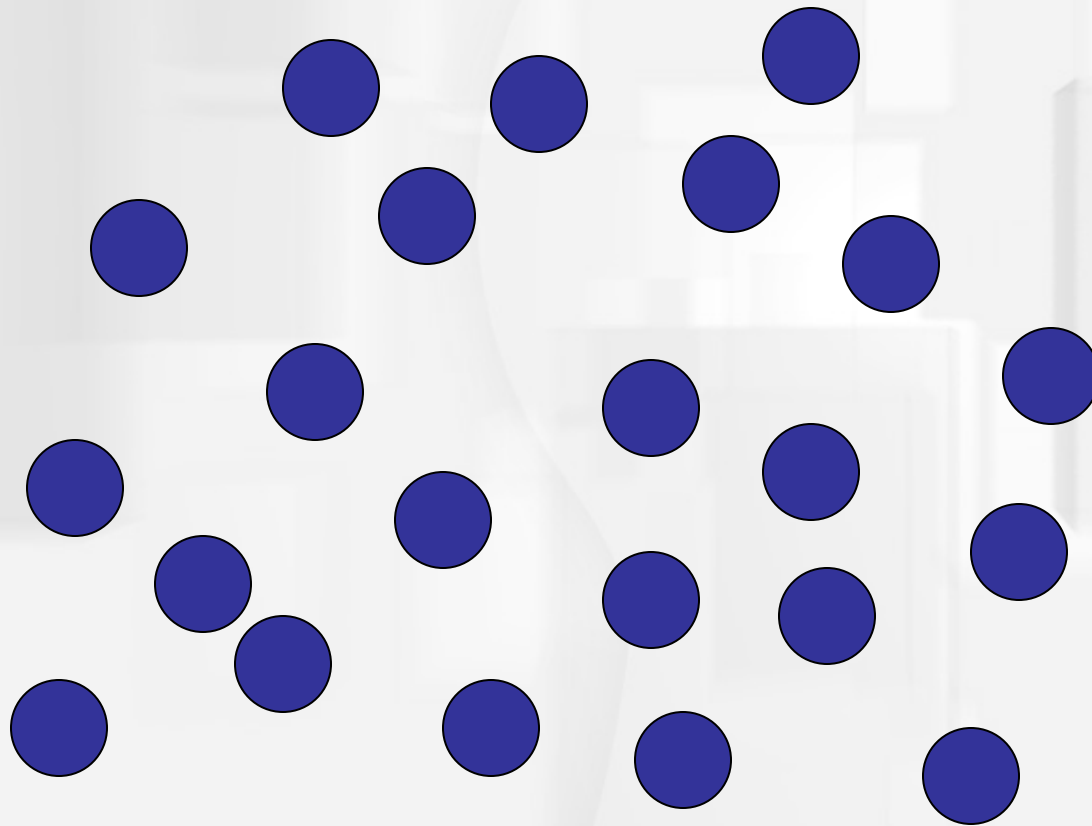
The Gestalt laws of perceptual organization

Uniform connectedness – a connected region of visual properties is perceived as single unit



The Gestalt laws of perceptual organization

Synchrony - elements occurring at the same time are seen as belonging together.



The Gestalt laws of perceptual organization

Meaningfulness or Familiarity- Things are more likely to form groups if the groups appear meaningful or similar.



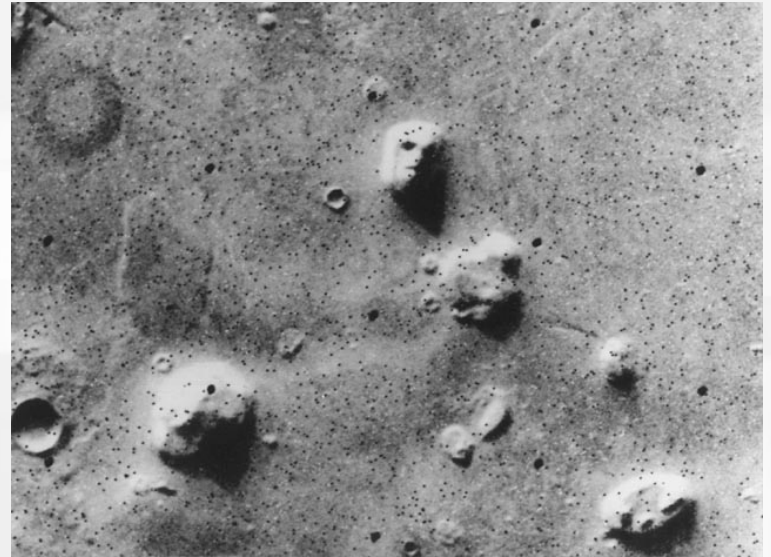
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Bev Doolittle (1985)

Pareidolia (payr.eye.DOH.lee.uh) *n.* The erroneous or fanciful perception of a pattern or meaning in something that is actually ambiguous or random.



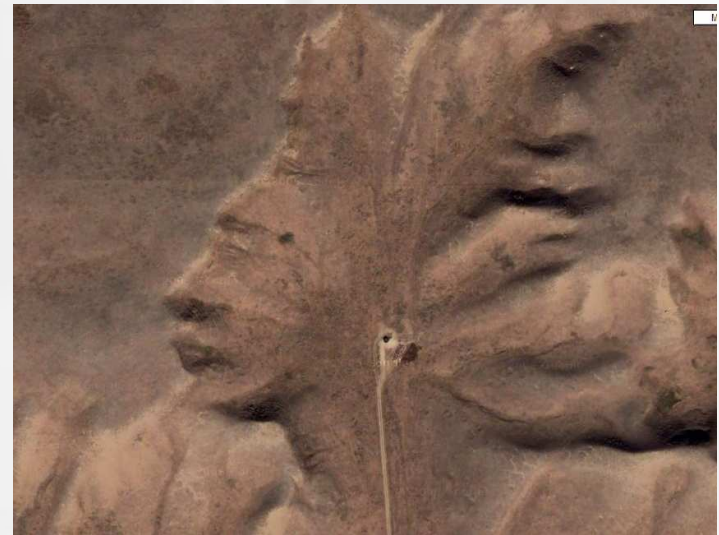
On Mars



On the Moon



On (Google) Earth



In smoke and fire and snow



In smoke and fire and snow

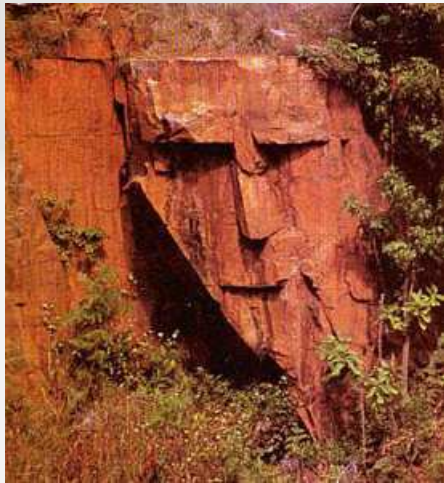


October 16, 2007: Is this Pope John Paul II waving from beyond the grave? Vatican TV director says yes

This fiery figure is being hailed as Pope John Paul II making an appearance beyond the grave.

The image, said by believers to show the Holy Father with his right hand raised in blessing, was spotted during a ceremony in Poland to mark the second anniversary of his death.

In rocks



On food.



Do cars have faces?

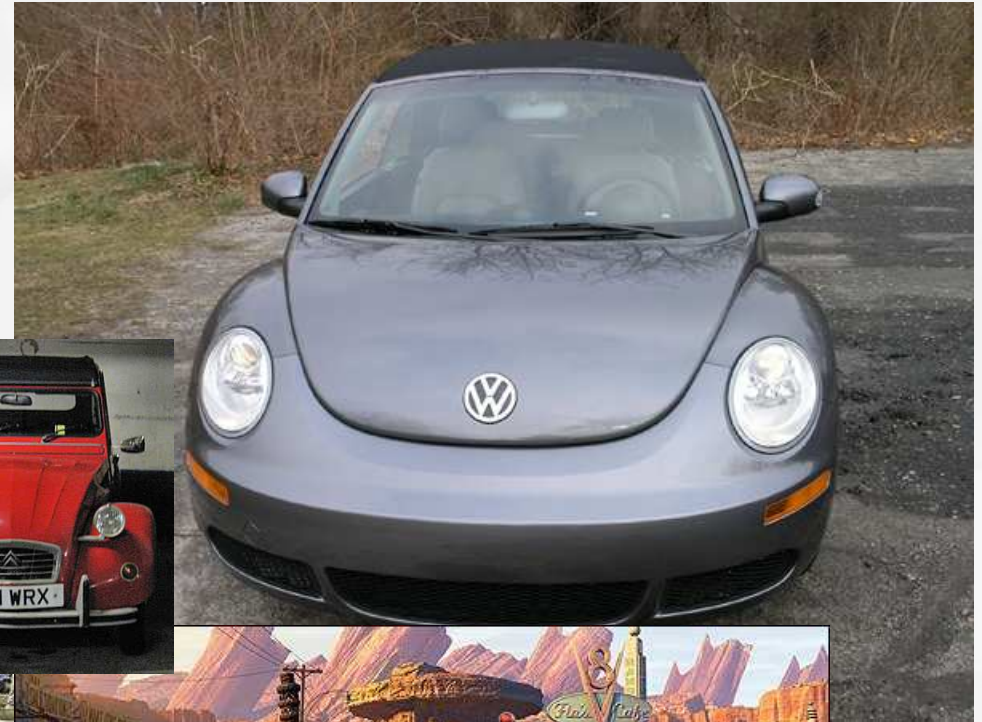


Figure-Ground Segregation

- Determining what part of environment is the figure so that it “stands out” from the background



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Figure-Ground Segmentation

Figure is usually:

In the lower part of the display

Symmetric

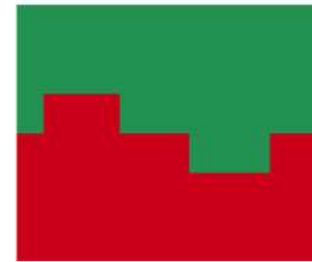
Convex

Relatively small in area

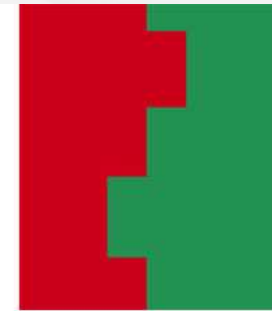
Oriented vertically rather than obliquely

Figure-Ground Segregation

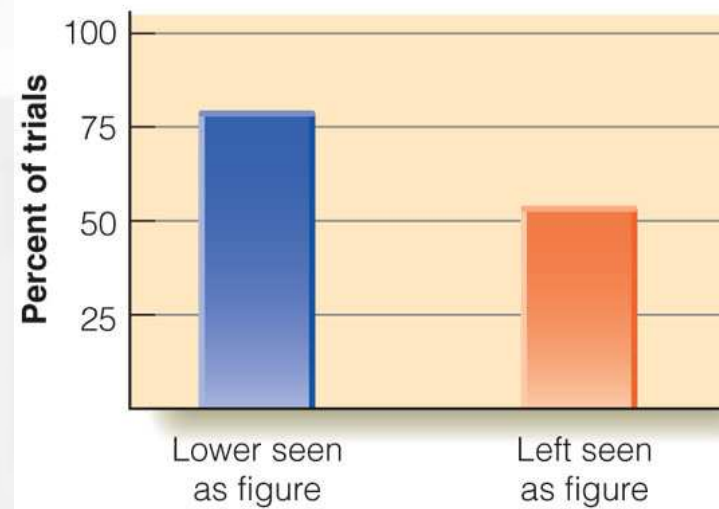
Elements located in the lower part of displays tend to be seen as figure.



(a)

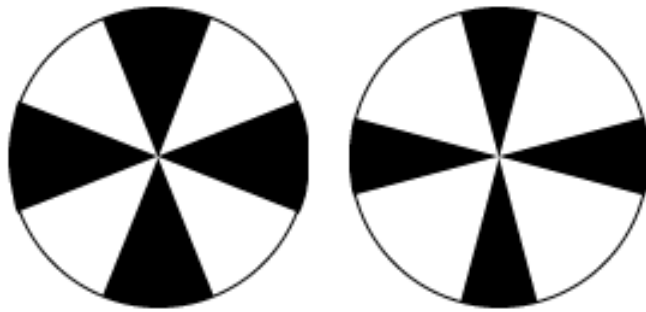


(b)



(c)

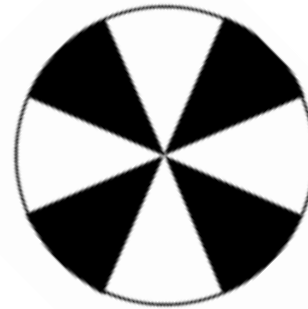
Area



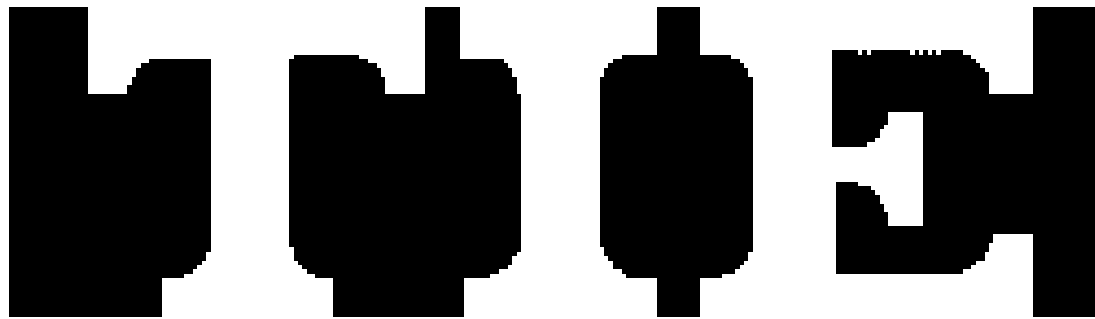
Smaller areas tend to be perceived as figure.

Orientation

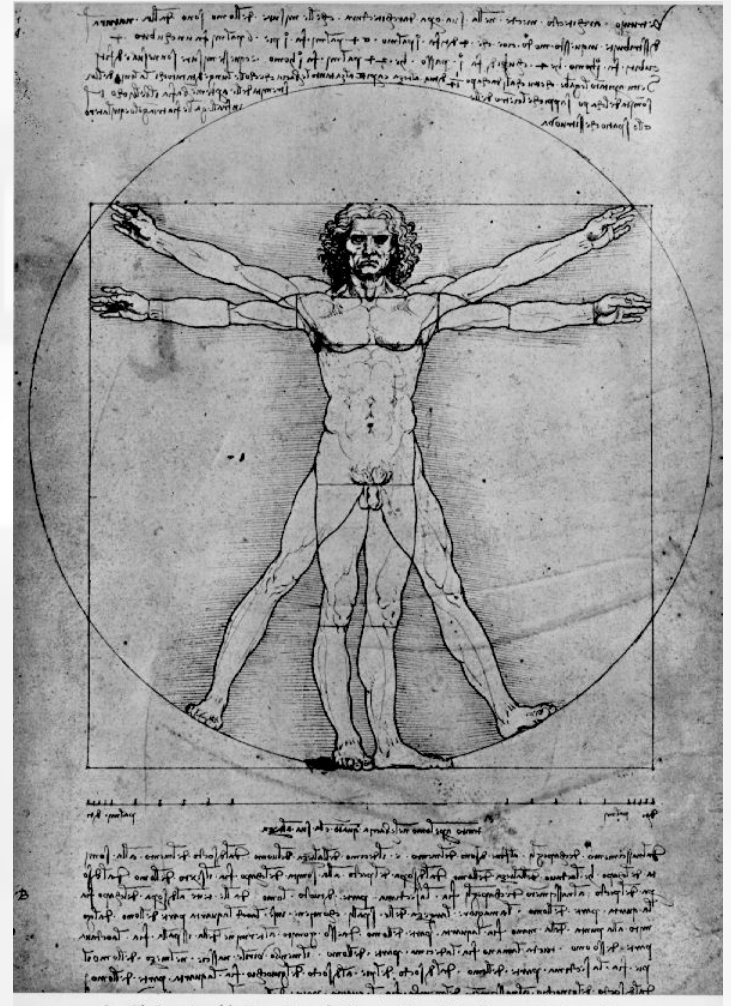
Vertical and horizontal components tend to be perceived as figure.



Smaller areas (the black shapes) tend to be perceived as figure.

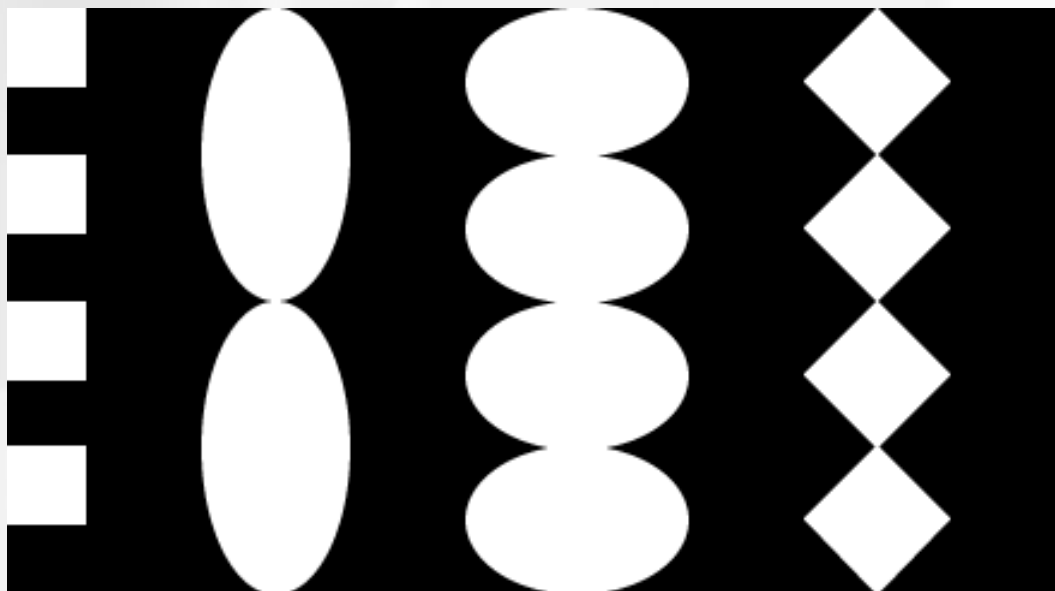


Symmetry



*Fig. The Dimensions of the Human Figure, after Vitruvius, from the original, by Leonardo da Vinci.

Convexity



Symmetry vs. Convexity

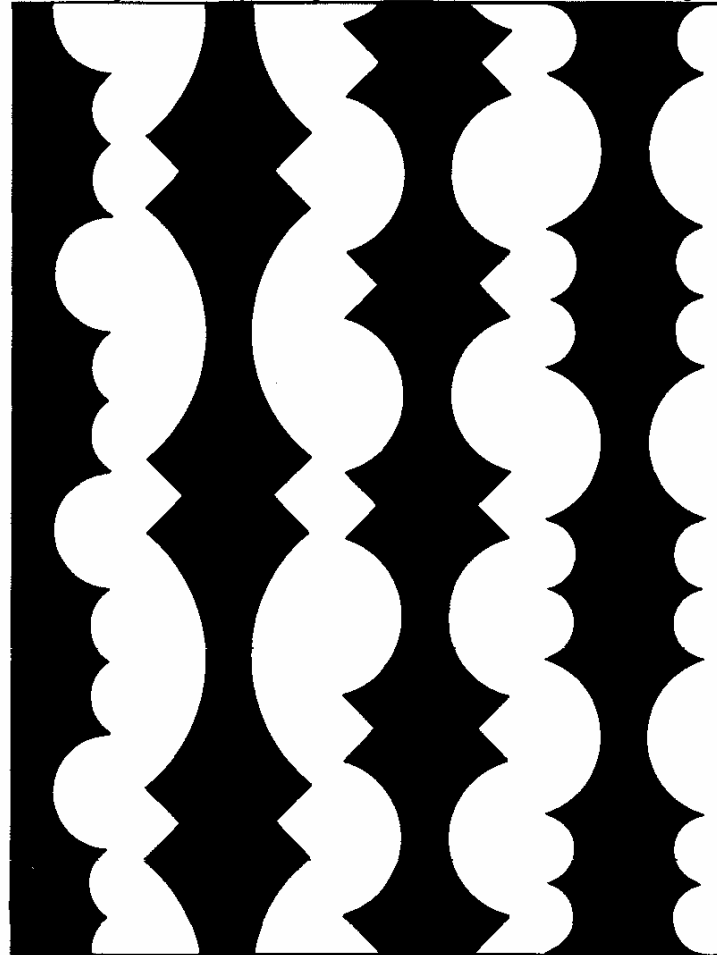
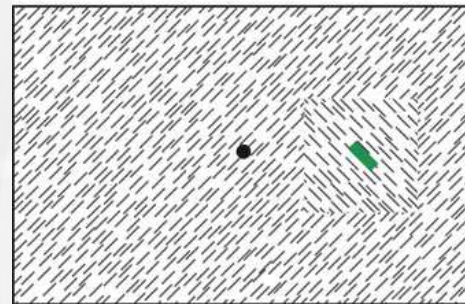


Figure 5.27

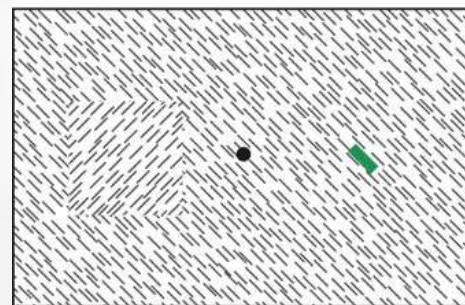
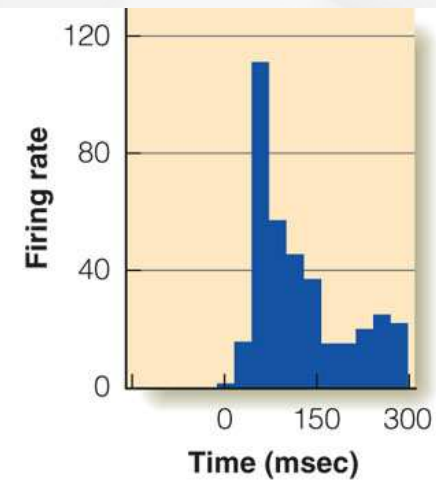
The black columns are symmetrical and the white columns are convex. Which are seen as figure (Kanizsa, 1979)?

Figure-Ground Segregation - Neural Evidence from V1.

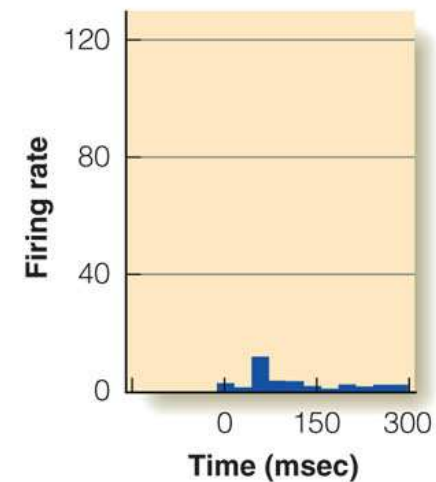
- Recordings from V1 in the monkey cortex show:
 - Response to area that is figure
 - No response to area that is ground



(a)



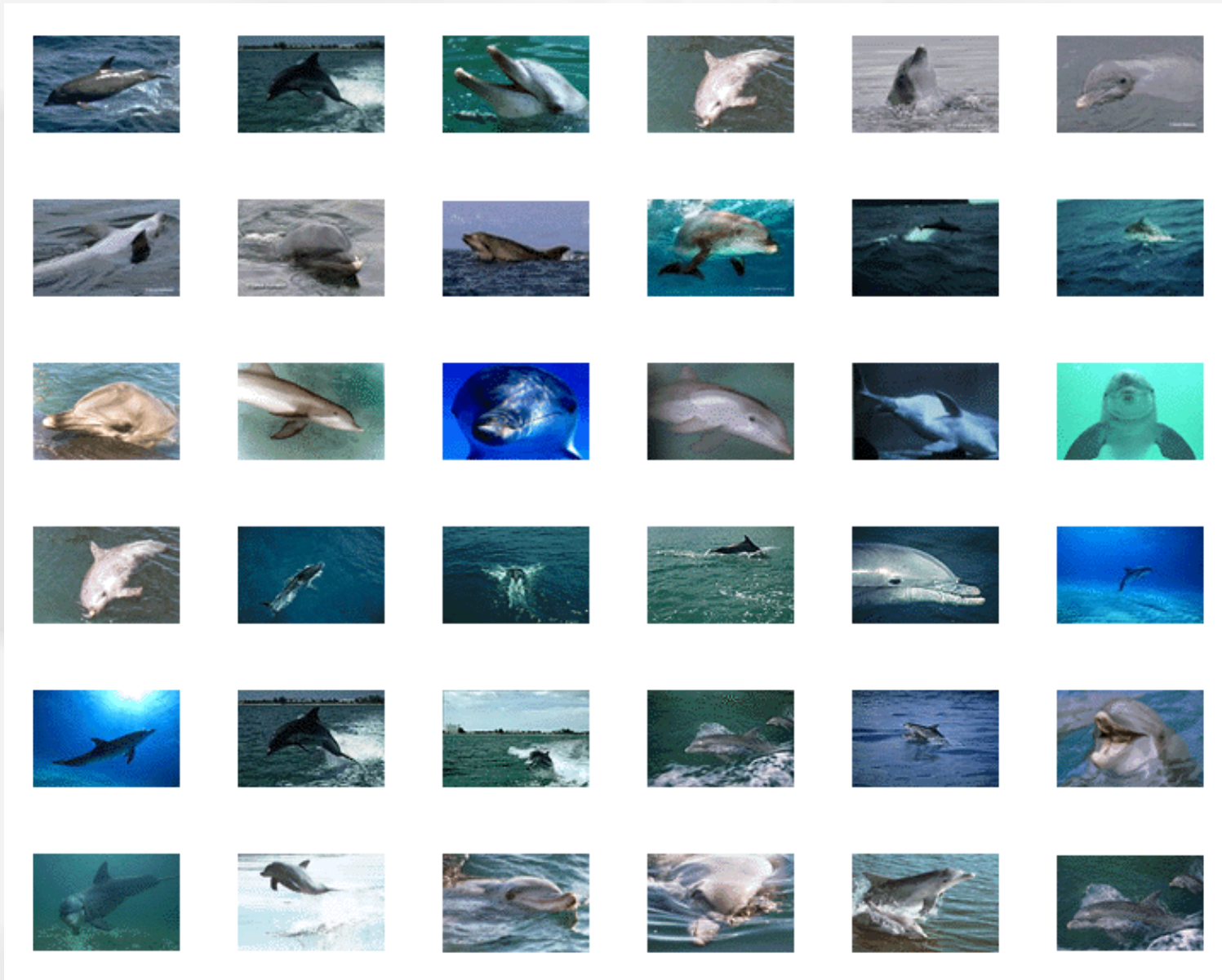
(b)



Shape and object perception



Visual input is extremely variable



Shape space is virtually infinite



How Do We Recognize Objects From Different Viewpoints?

Two competing theories:

- Structural description models
- Image description models

Structural-Description Models:

Recognition by Components (RBC)

Biederman (1985)

Geons (“Geometric Ions”)

Each geon is uniquely identifiable from most viewpoints (*viewpoint invariant*).

Only 36 geons needed to make thousands of objects.

Objects can be identified if the geons can be identified:

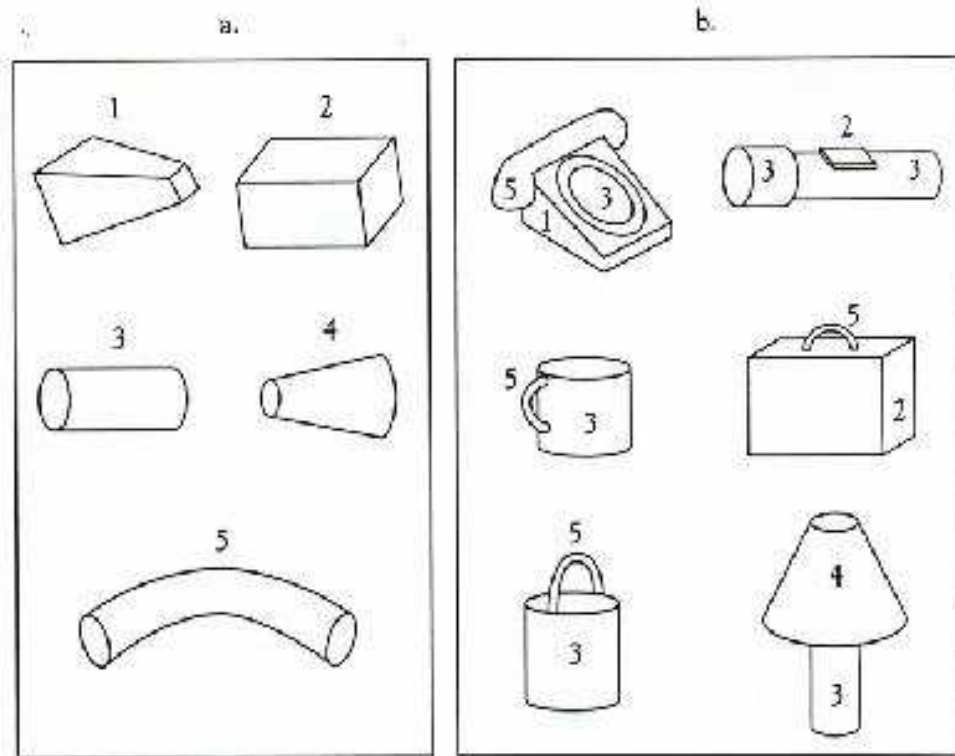
- which geons are present?

- what is the spatial relation among geons?

Structural-Description Models

Recognition by Components (RBC)

Examples of Geons (Left) and Representative Objects That Can Be Constructed from the Geons (Right). (From Biederman, 1990).





(a)
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(b)

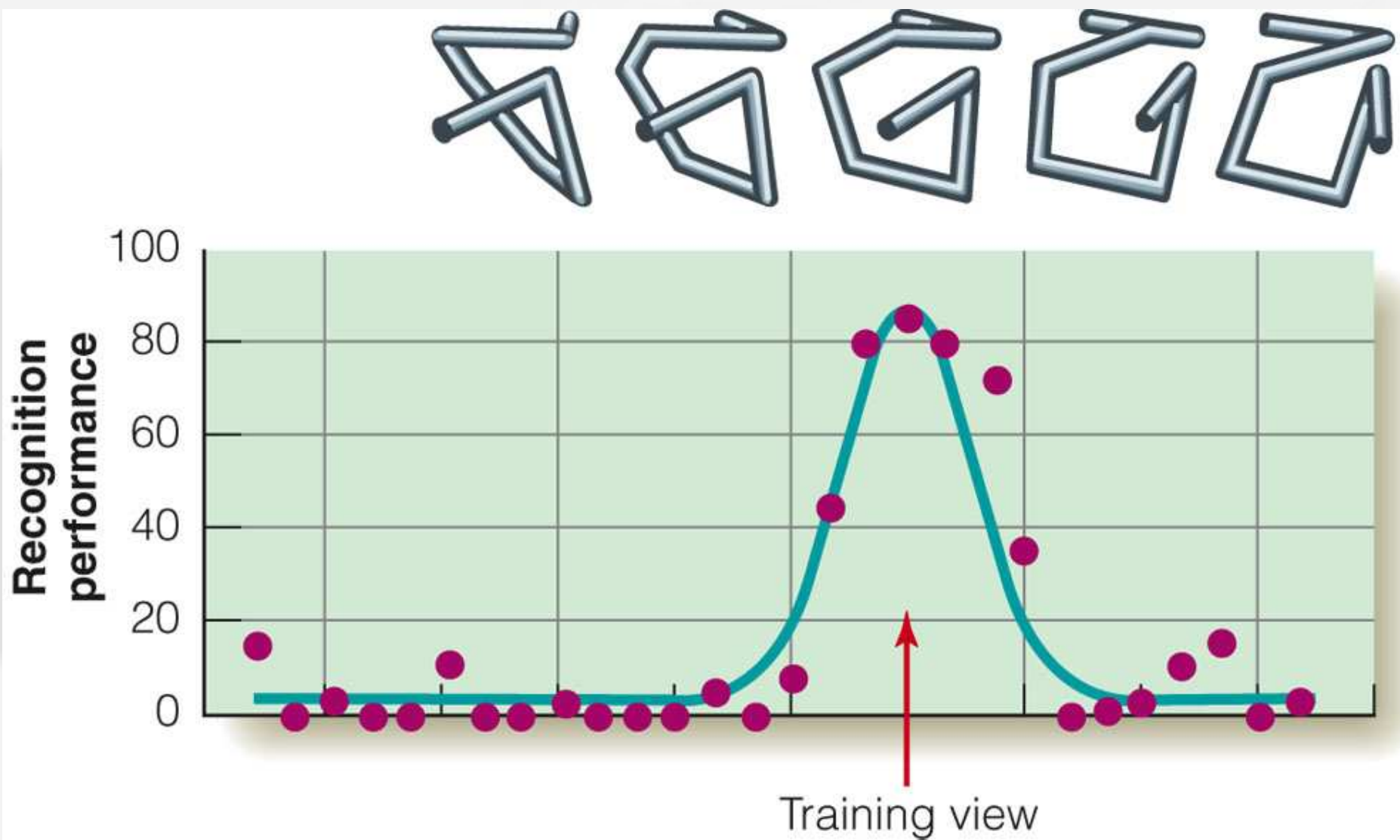
Figure 5.35 (a) It is difficult to identify the object behind the mask because its geons have been obscured.
(b) Now that it is possible to identify geons, the object can be identified as a flashlight.

Recognition by Components

- Strengths
 - Viewpoint invariant
 - Parts-based
 - May be able to deal with partial occlusion via feedback
 - Represent 3-D structure
- Weaknesses
 - Complexity of representation
 - Doesn't easily represent subtle metric differences (e.g., distance between eyes)
 - Recognition is at the level of categories (chair vs. table) rather than individuals (my office chair vs. my kitchen chair)

Image-Description Models

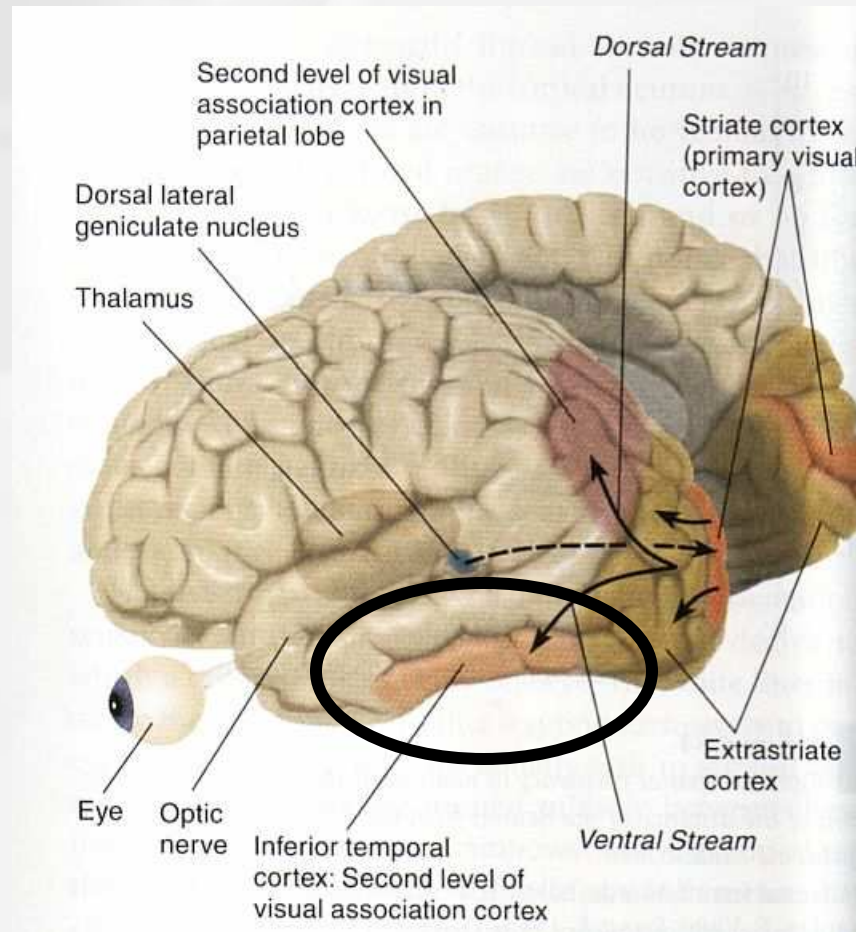
- Ability to identify 3-D objects comes from stored 2-D viewpoints from different perspectives
 - For a familiar object, view invariance occurs
 - For a novel object, view invariance does not occur
 - This shows that an observer needs to have the different viewpoints encoded before recognition can occur from all viewpoints



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Figure 5.37 Psychophysical curve showing that a monkey is better at identifying the view of the object that was presented during training (arrow). The drop-off in performance for other viewpoints is an example of a lack of view invariance.

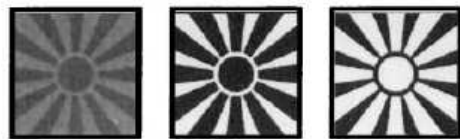
How Does the Brain Process Information About Objects?



Neurons in IT tend to reflect to what you consciously see.

Experiment by Sheinberg & Logothetis (1997)

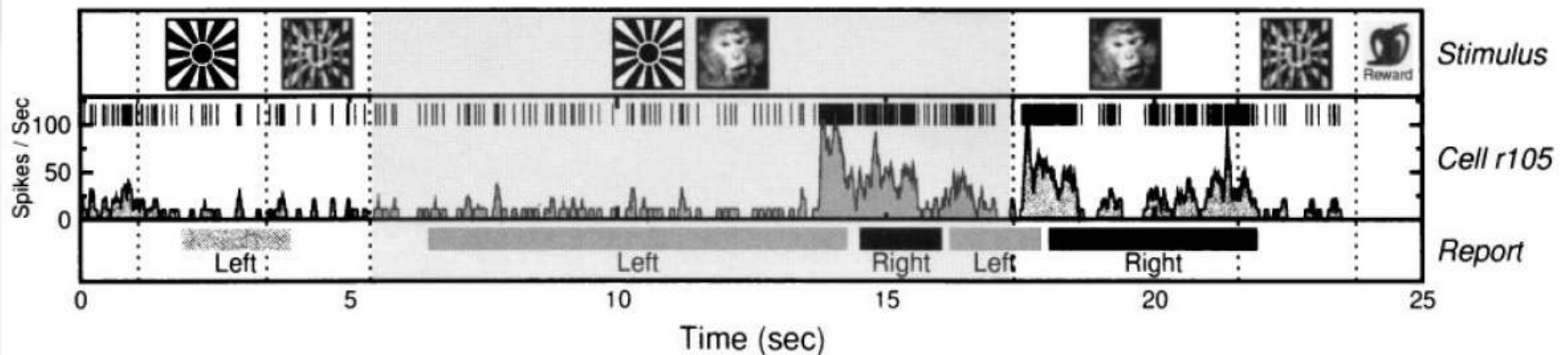
- Binocular rivalry was used - one picture shown to each eye
- Monkey was trained to pull a lever for a sunburst or an object
- Neuron in the IT cortex was monitored
- Firing was vigorous for only when the monkey saw the object



"Left" Objects



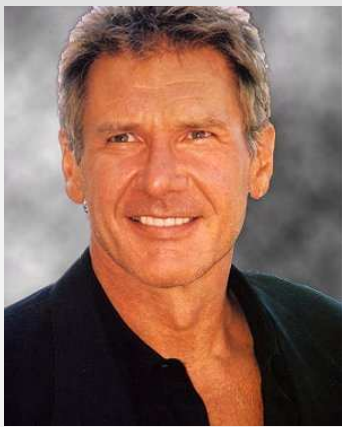
"Right" Objects



Neurons in FFA also reflects to what you consciously see.

Grill-Spector et al. (2004)

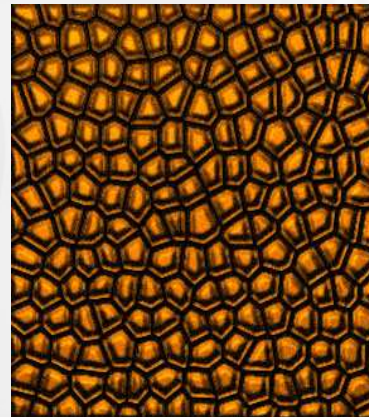
- Fusiform Face Area (FFA) in each participant was identified with fMRI.
- On each trial, participants were shown either:
 - A picture of Harrison Ford's face
 - A picture of another person's face
 - A random texture
 - All stimuli were shown for 50 ms followed by a random-pattern mask
 - Participants were to indicate what they saw (Harrison Ford, another face, or a texture pattern).



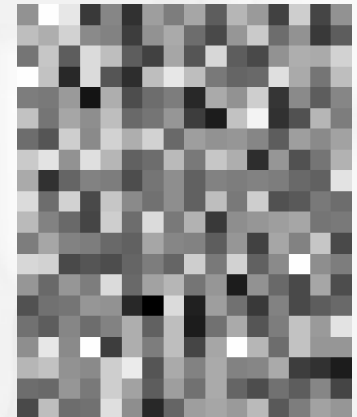
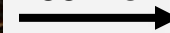
or



or

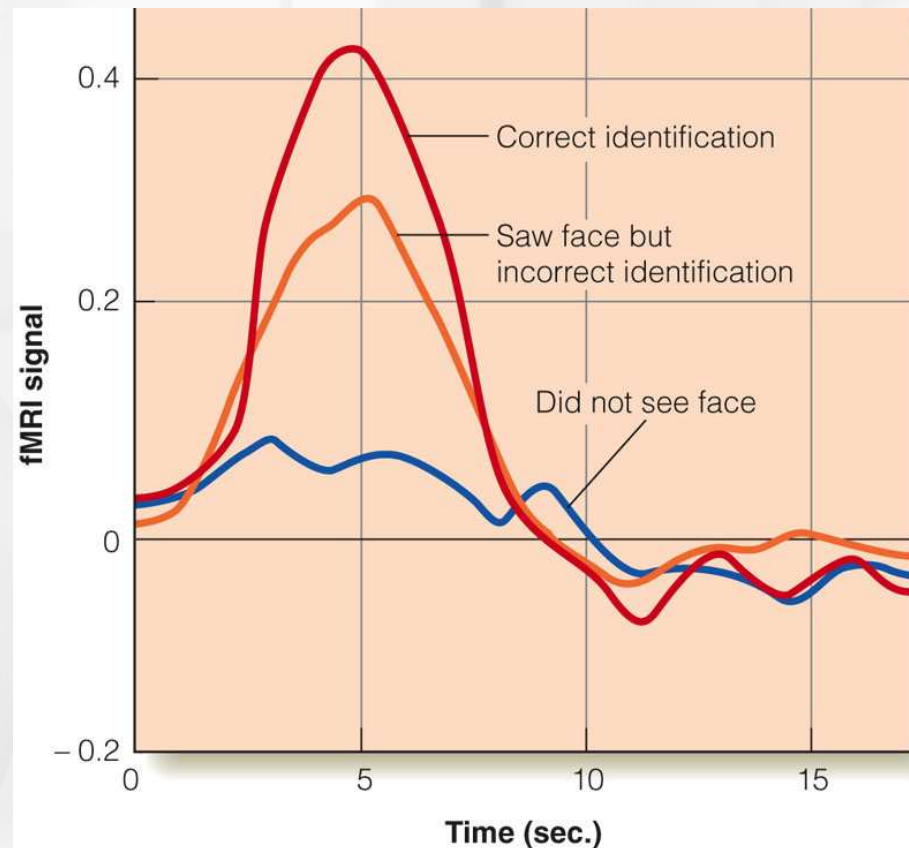
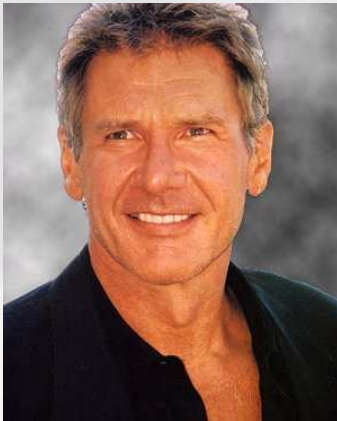


33 ms

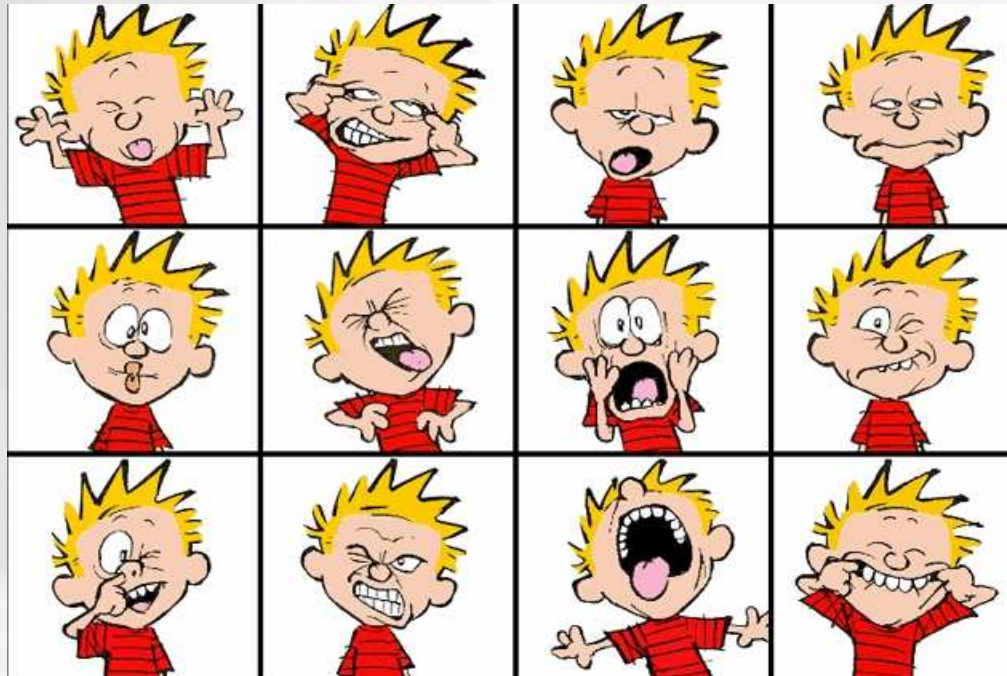


Grill-Spector Experiment - continued

- For trials that only included Harrison Ford's face, results showed that FFA activation:
 - Was greatest when picture was correctly identified as Ford
 - Was less when picture was identified as other object
 - Showed little response when there was no identification of a face



Face Perception



The hollow face illusion



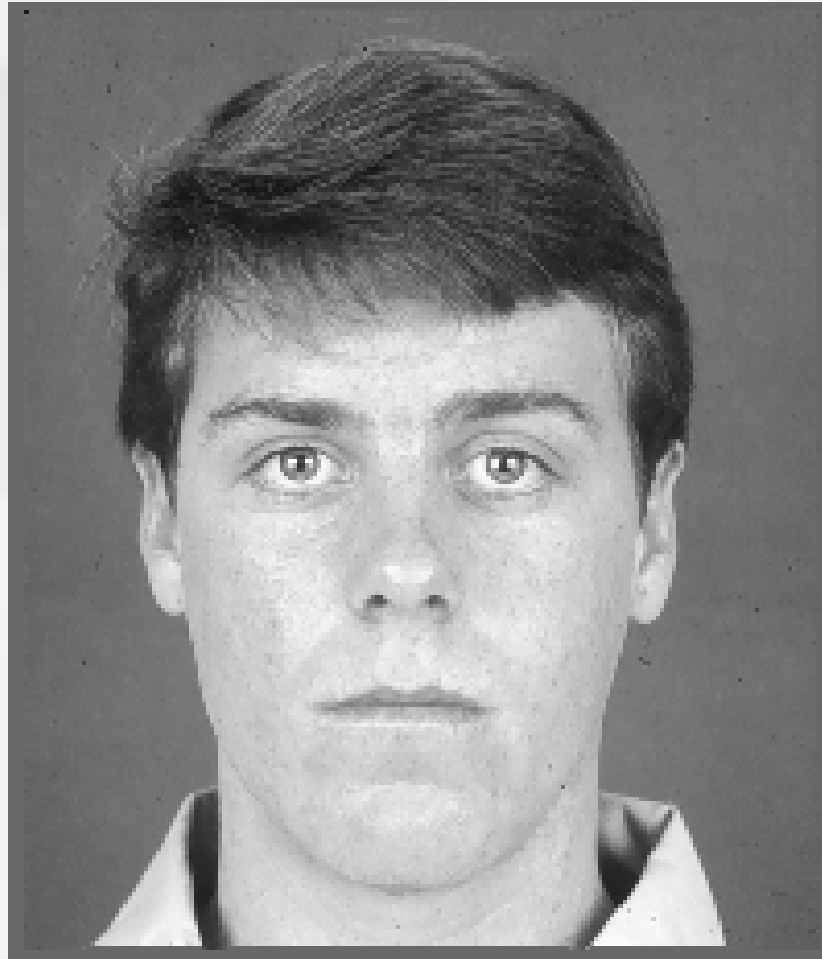
<http://www.richardgregory.org/experiments/index.htm>

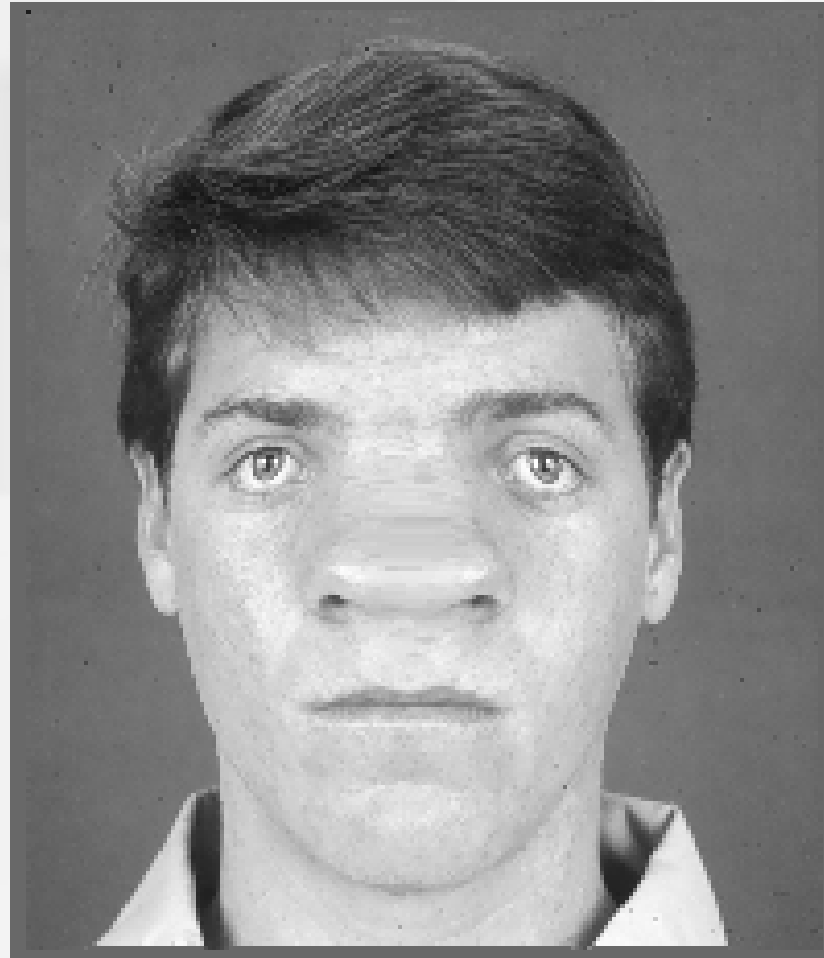
The Margaret Thatcher Illusion



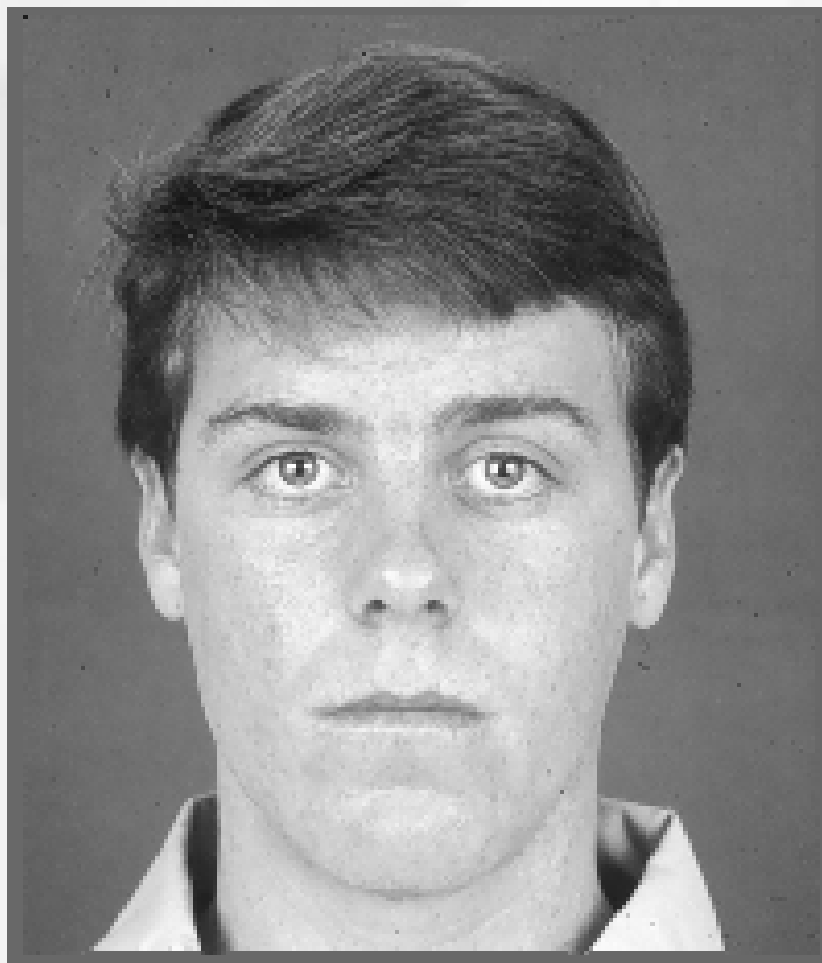


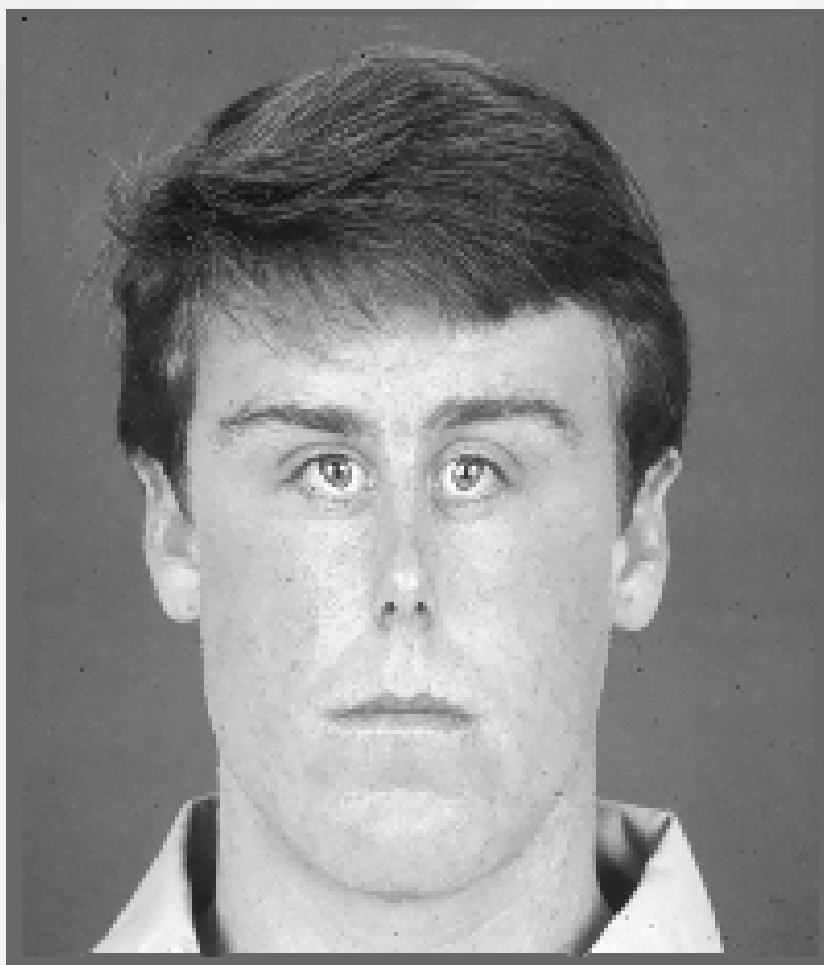
Adaptation to faces



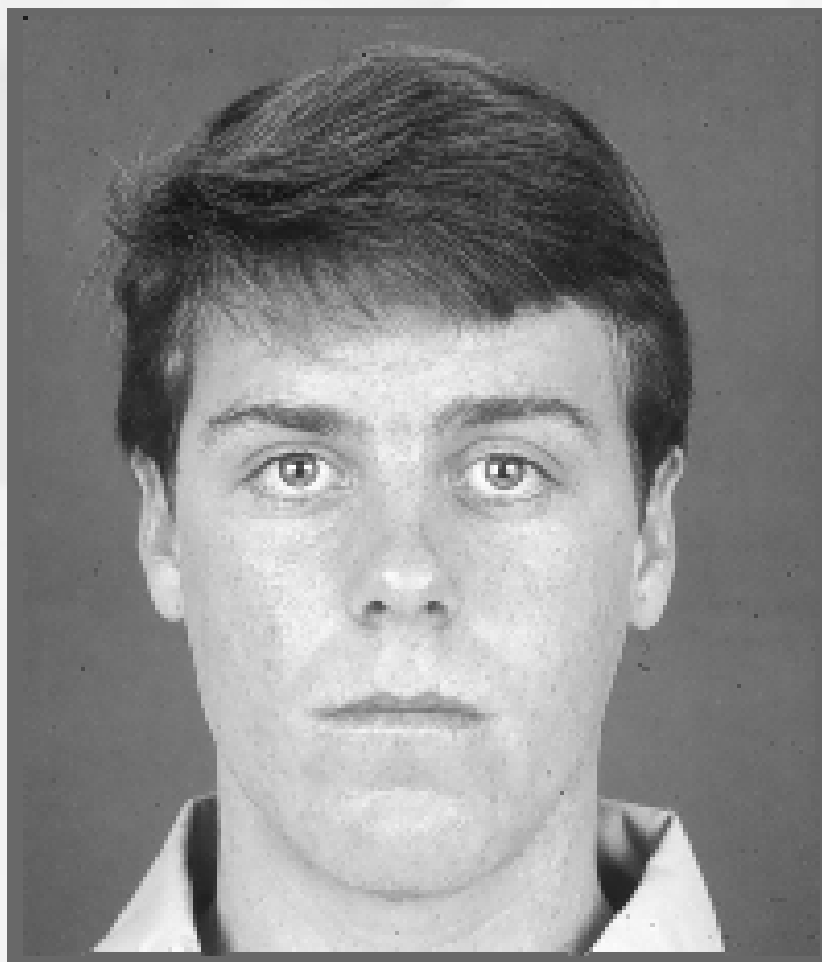


Adaptation to faces



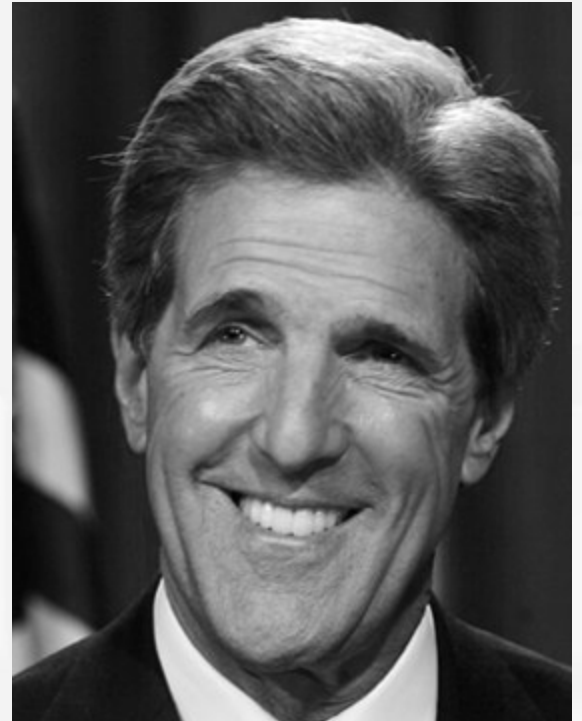


Adaptation to faces



Identity Aftereffects

The identity of the middle image is ambiguous



pre-adapt



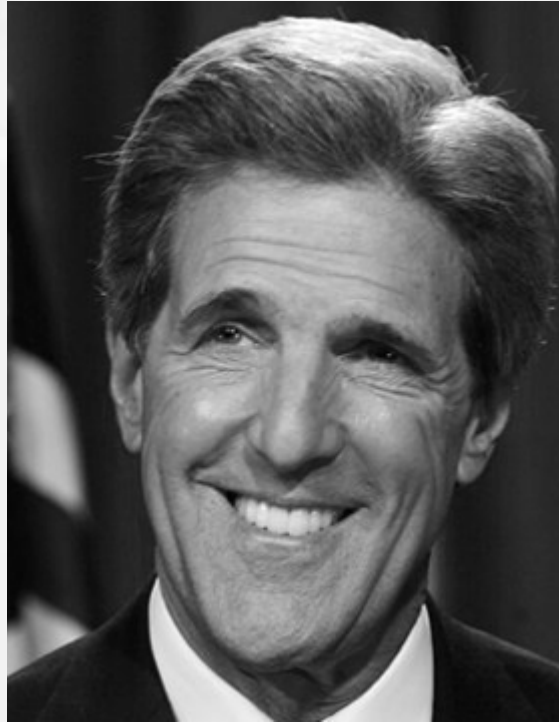
adapt



post-adapt



adapt



post-adapt



Adaptation to gender



Adaptation to gender



Adaptation to ethnicity



Adaptation to expression



These adaptation effects show that there are neurons in the brain that are selective to gender, ethnicity and expression.

The way a face looks to us depends on who we've been looking at recently!

There are large individual differences in face processing, including people with prosopagnosia.



For more on prosopagnosia, see <http://www.faceblind.org/>