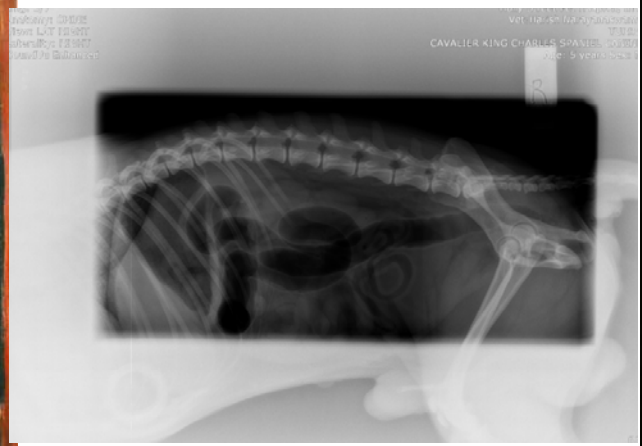
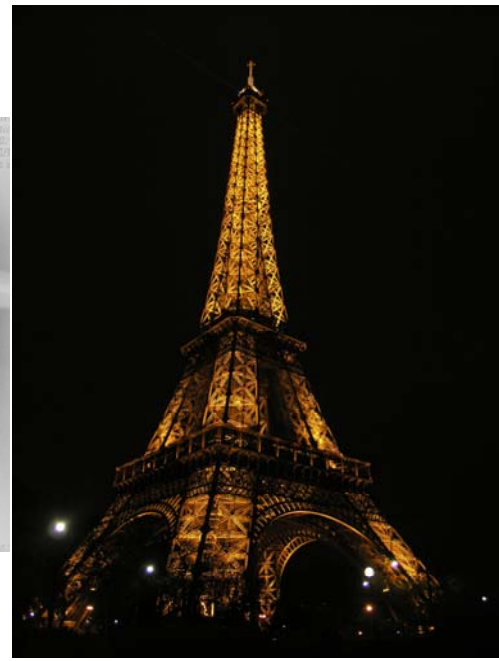
Perception

Perception

What do you see?





Perception

What do you see?

J.F. K

A black and white portrait of a man

The picture of the 35th president of the US

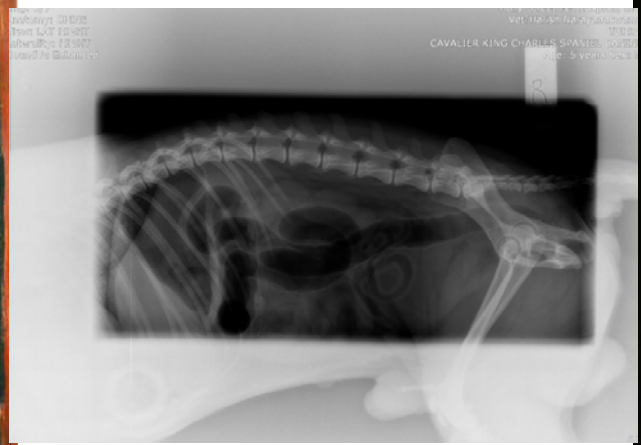
The picture of the man who said “I am a Berliner”

The Scream by Edward Munch

A person screaming

A painting

A representation of anxiety



My dog

An X-ray

The bone structures and the internal organs of an animal

a photo of the Eiffel Tower.
a photo of a famous Paris landmark.
a photo of the Seine Paris by night
a color photo taken in Paris, France.

Sensation & Perception

Sensation: transduction (conversion) of physical energy (electromagnetic radiations, sound waves…) into an other kind (i.e. electrical, chemical)

Vision:

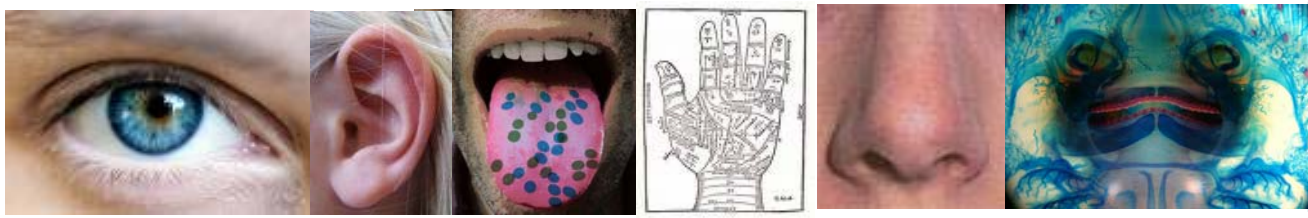
Electromagnetic energy electrical signal in neurons

Perception

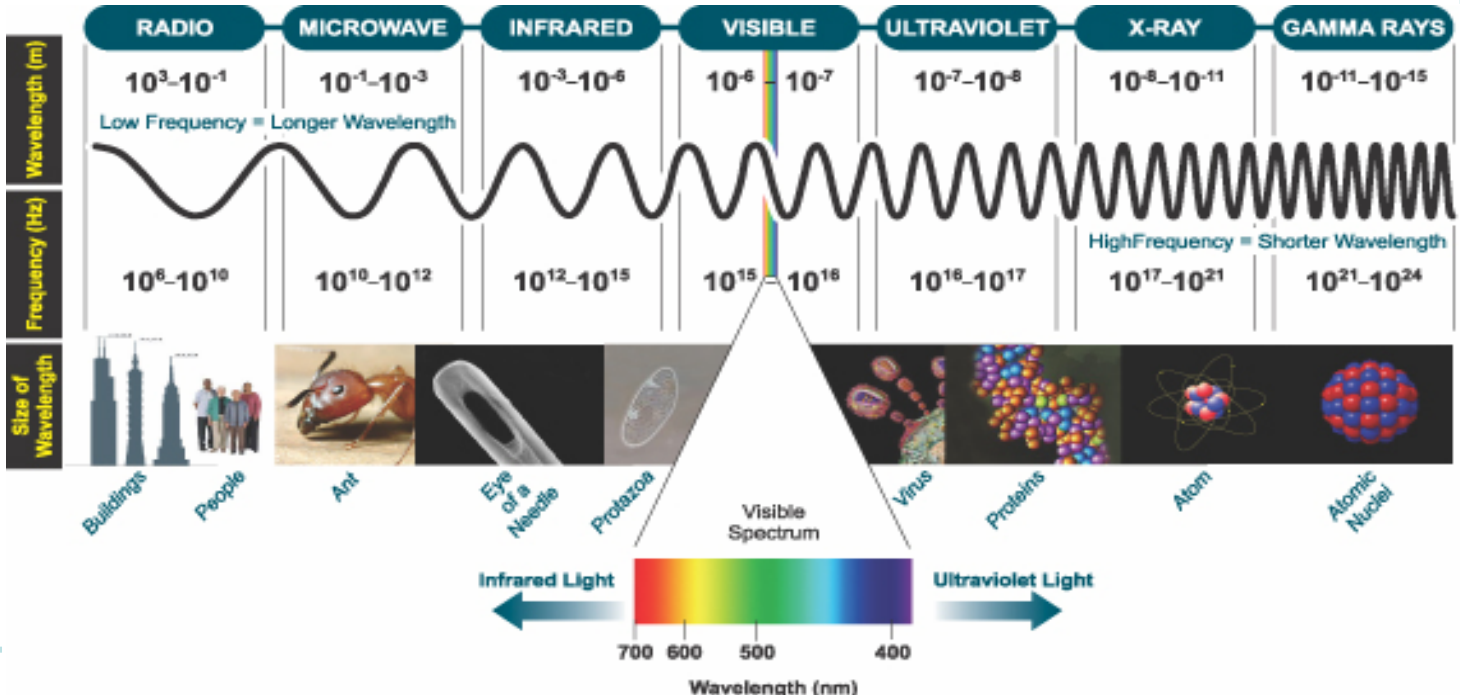
Visual Consciousness/ Perceptive experience is limited

For each specie, the perception of the outside world depends both on the **sensory organs** and the way the **brain integrates the sensory and motor events**.

- **Captors modality**



- **Sensory selectivity**

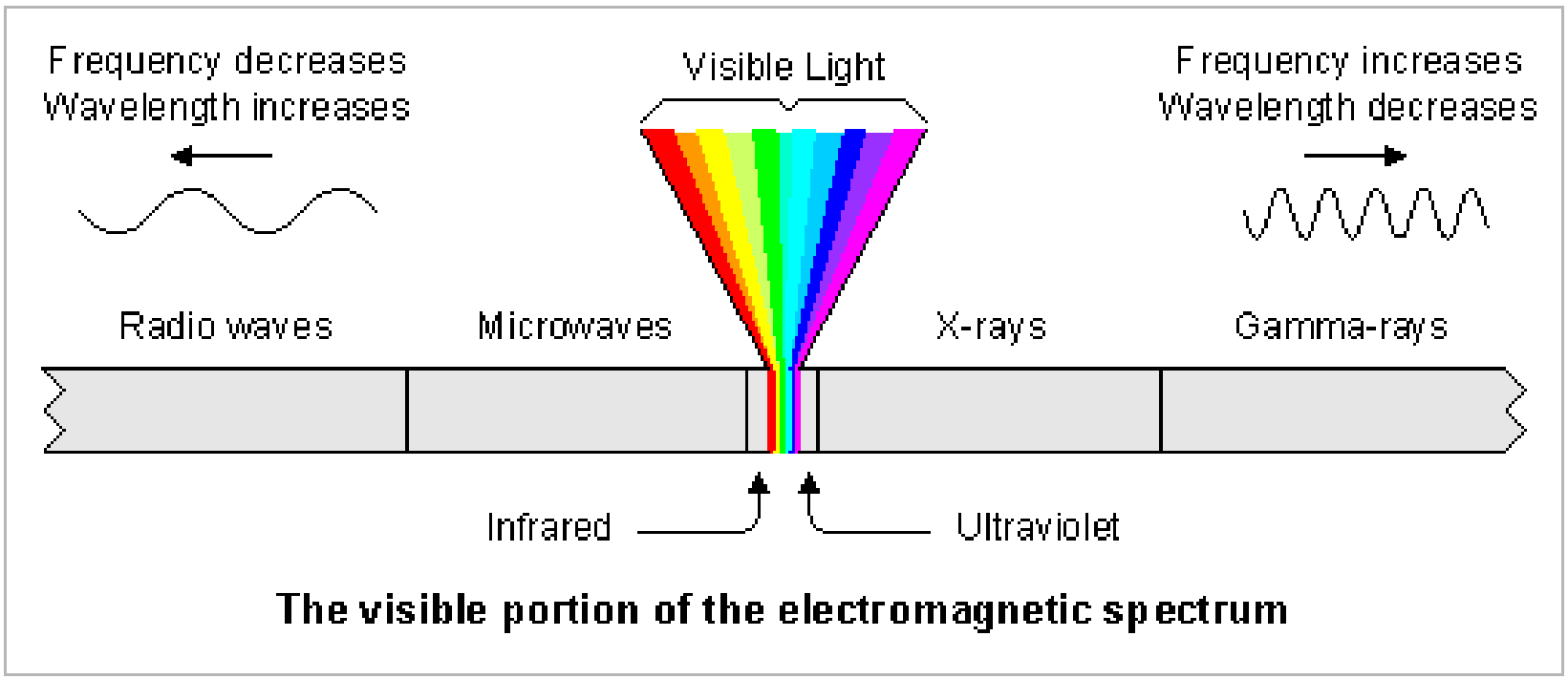


- **Brain organization**

Vision begins in the eye/ Light is the stimulus for vision

Light: portion of the ***electromagnetic spectrum*** that our eyes can see (detect and process), ranging from violet at one end to red at the other (photon-wavelength).

The energy in the spectrum can be described by its ***wavelength***, i.e. the distance between 2 peaks of the electromagnetic waves.

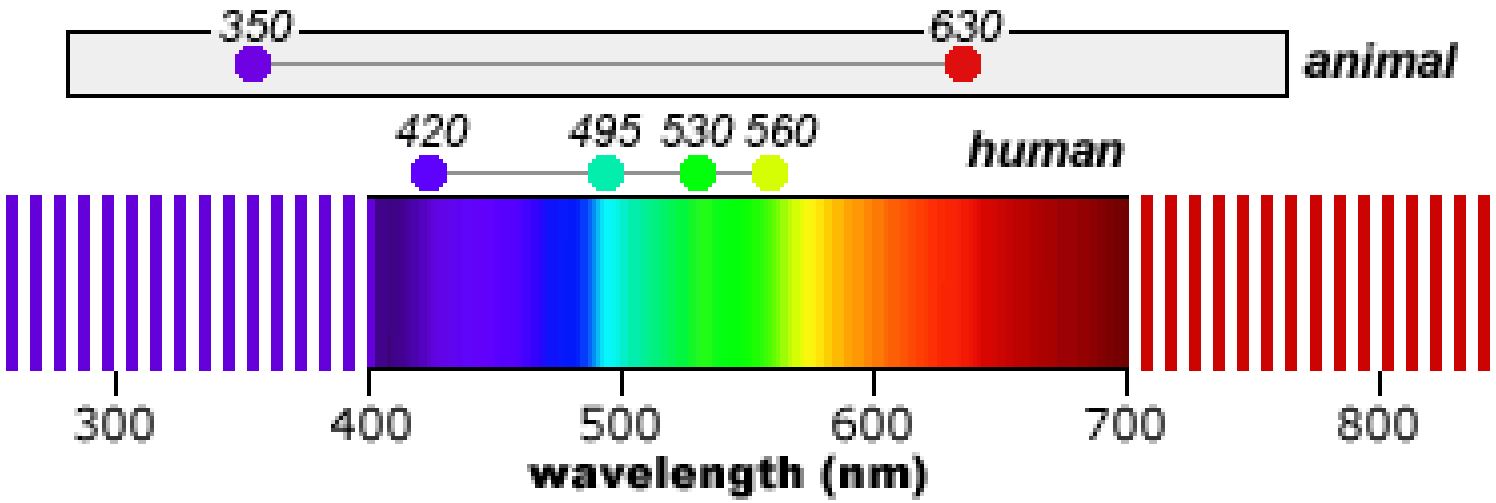


The visible portion of the electromagnetic spectrum

Vision begins in the eye/ Light is the stimulus for vision

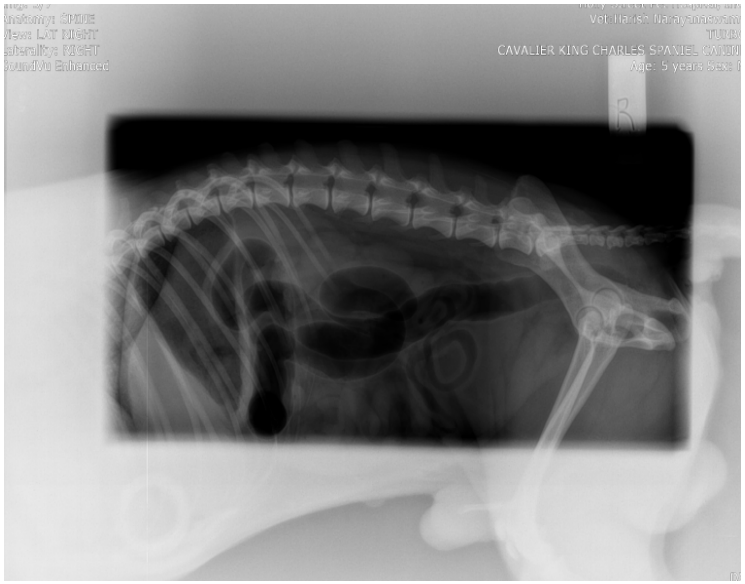
Visible light (humans): 400-700 nanometers (10-9 meters).

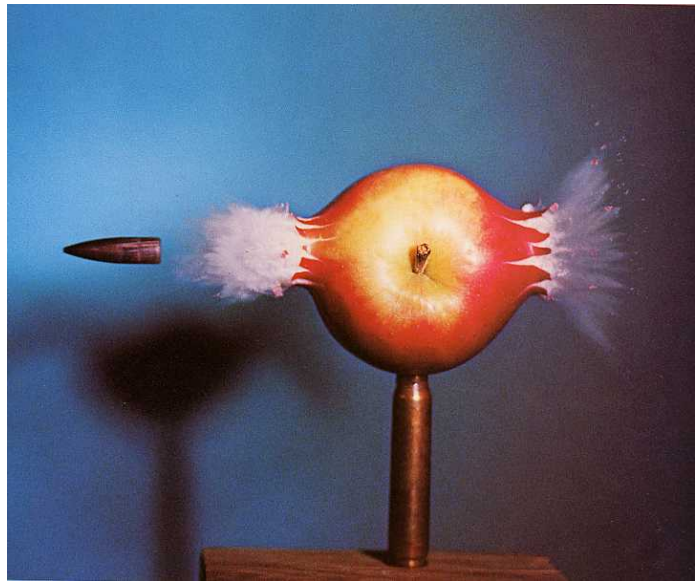
The wavelengths of visible light are associated with the different color of the spectrum.

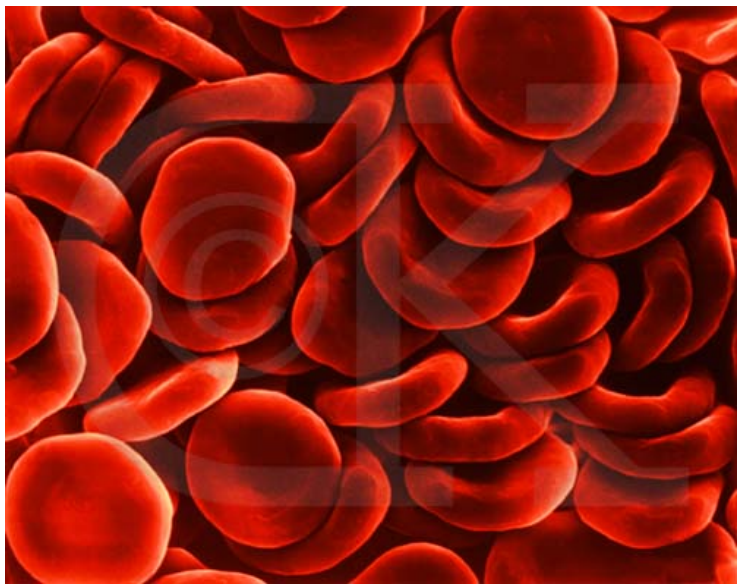


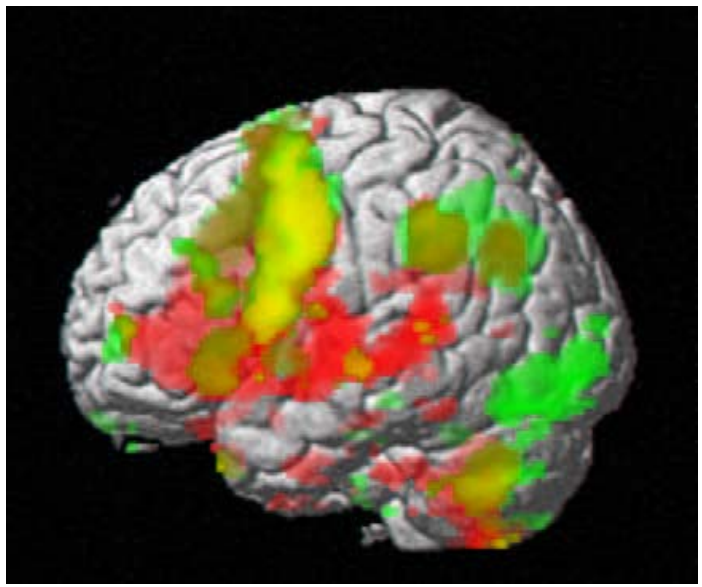
Radio Infrared Visible Ultraviolet

PSYC 158 PERCEPTION/ Course 1: Introduction to Perception









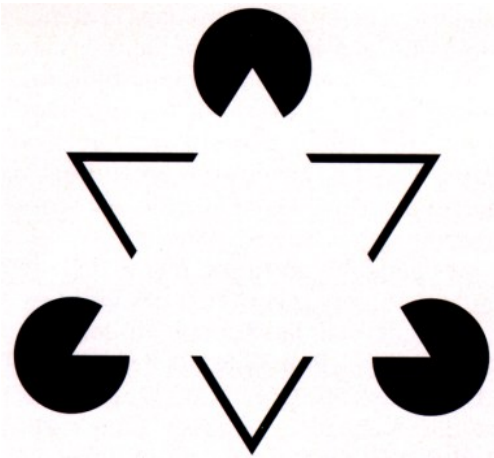
Visual consciousness

•The sensory perception can be insufficient or suppressed (confusion, coma) and doesn't lead to integration of the sensory information

•The sensory perception can be inexact, when the object of perception is inaccurate, misperceived (mirages false recognition): sensory illusion

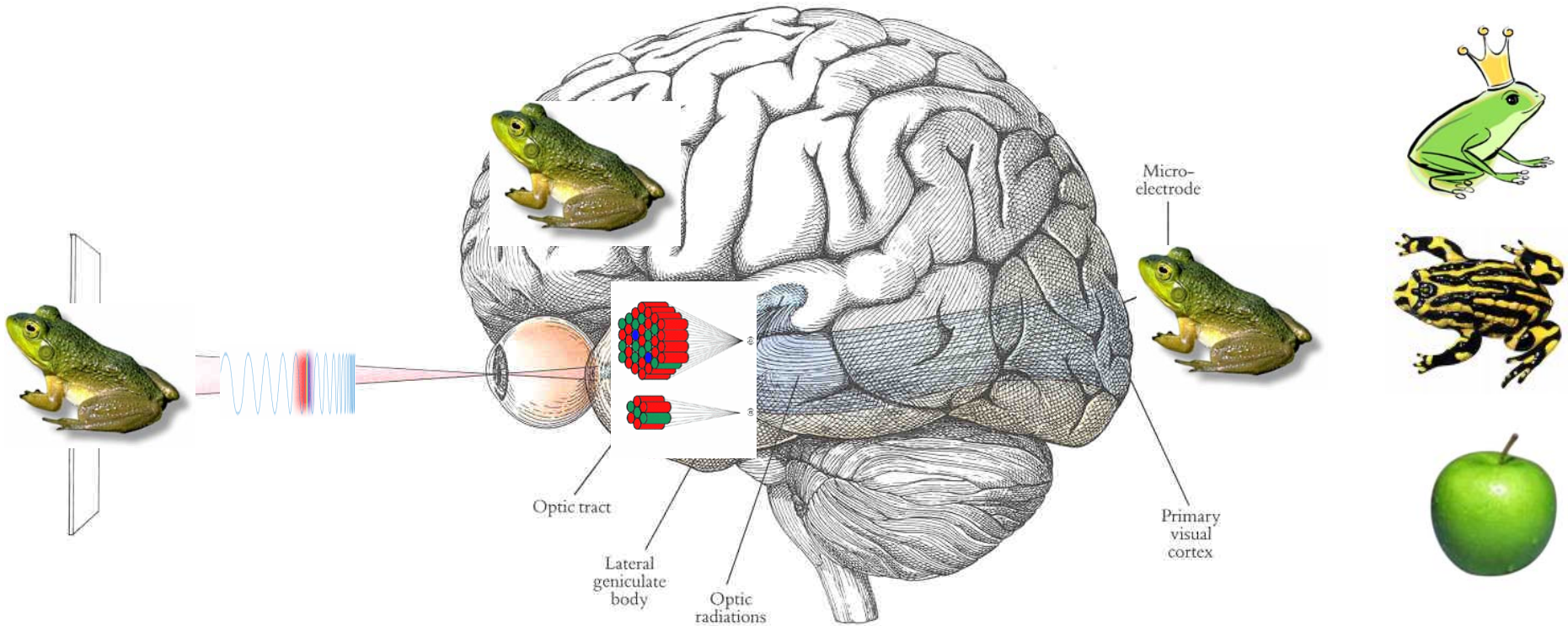
•Perception without physical object: objects are seen, felt or heard without external stimulus, without external cause: hallucination.

J. Baillarger (1855): *"hallucination is a phenomenon that goes from inside to outside, while normal perception goes from outside into inside".*



Perception

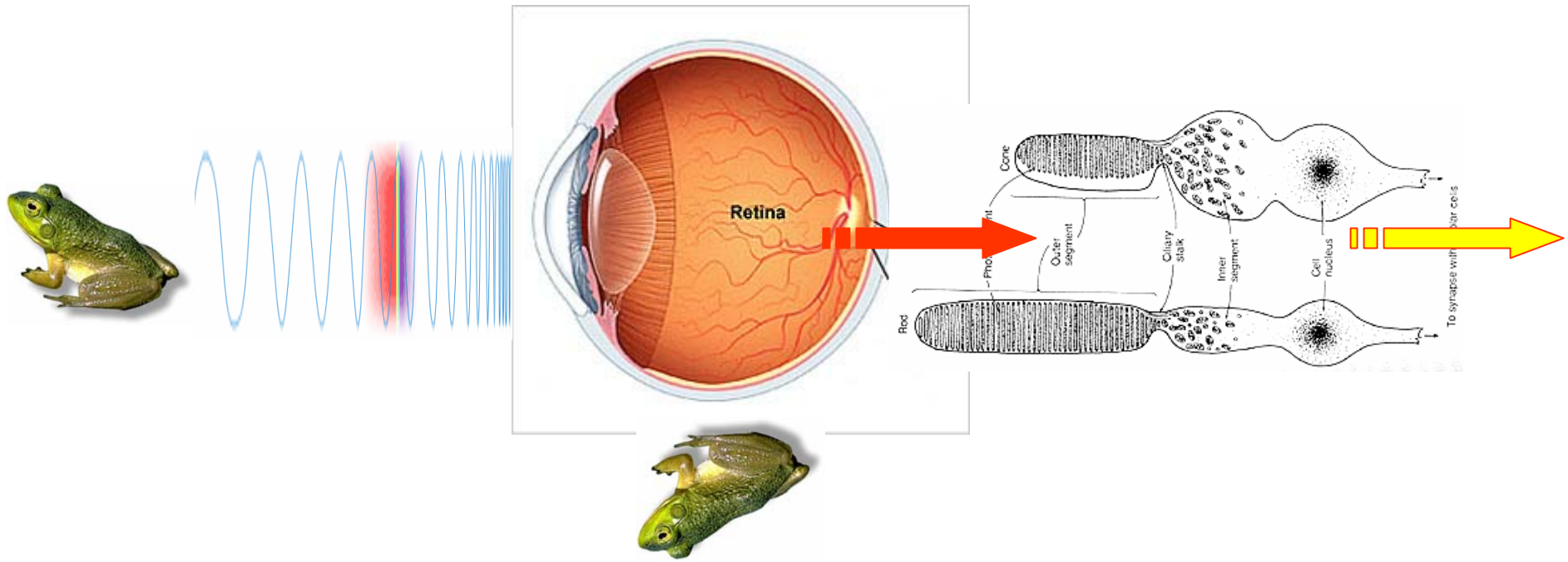
Sensory System



Stimulus Signal Sensation Reception Transduction Amplification Transmission Integration Perception Recognition Action

Sensory System/ Transduction (Peripheral processing)

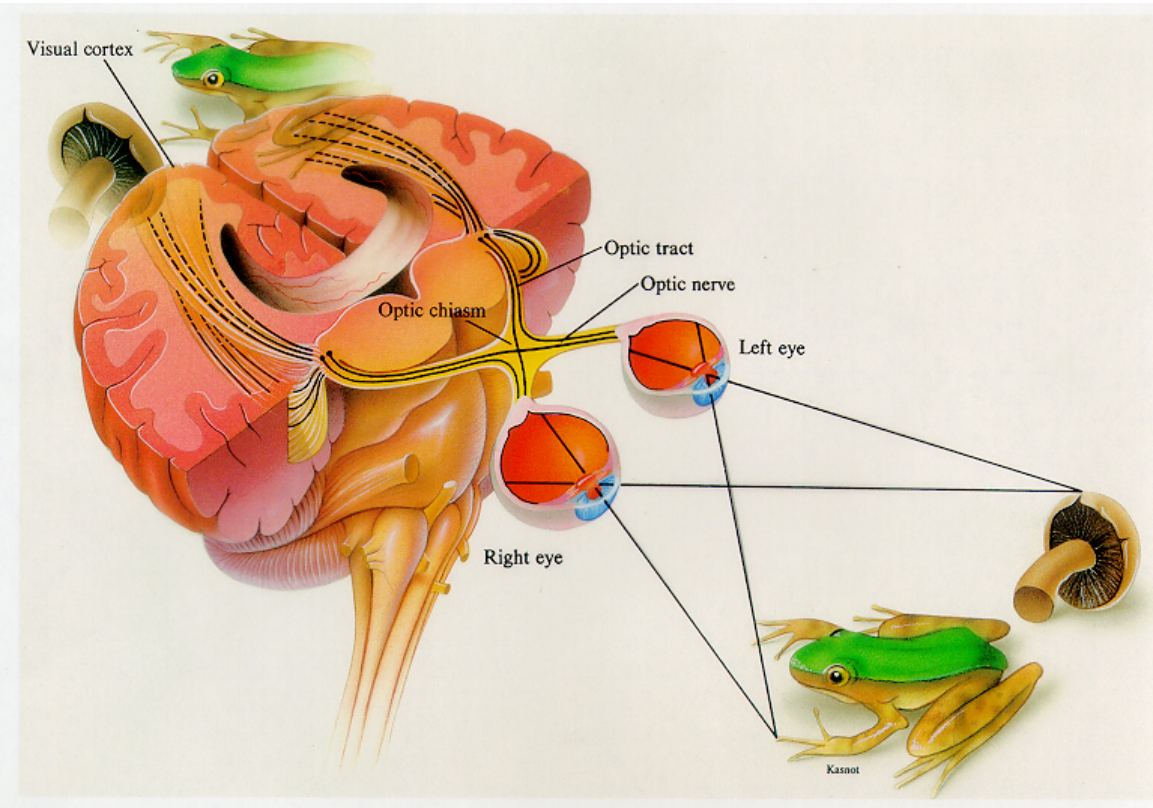
Sensation: ***transduction*** (conversion) of physical energy (electromagnetic radiations, sound waves…) into an other kind (i.e. electrical, chemical)

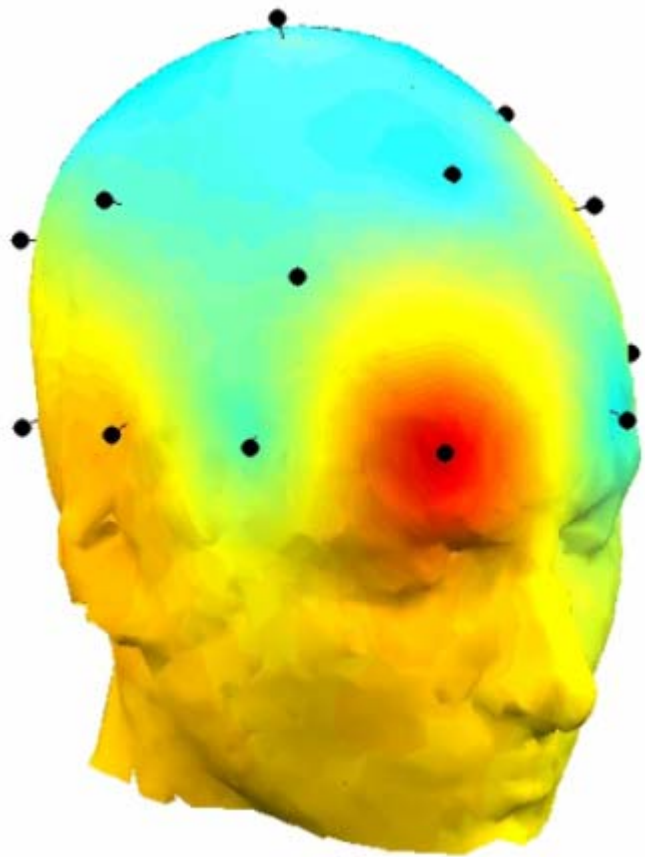


Stimulus Signal Sensation Reception Transduction (Amplification)
Transmission Integration Perception Recognition Action

Perception

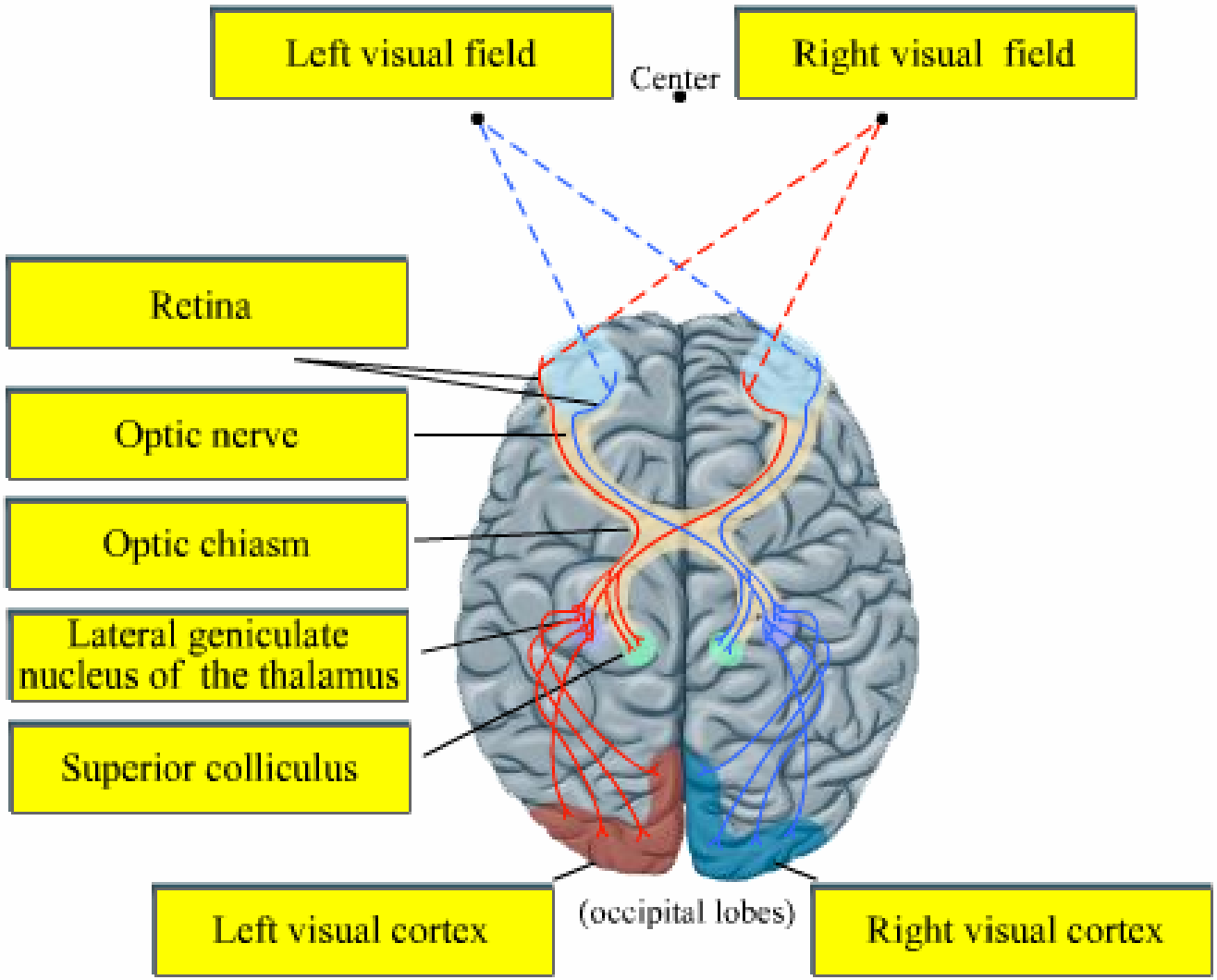
Central Processing

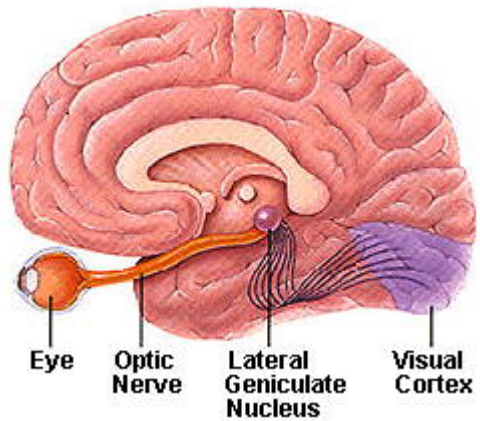




Stimulus Signal Sensation Reception Transduction Amplification
Transmission Integration Perception Recognition Action

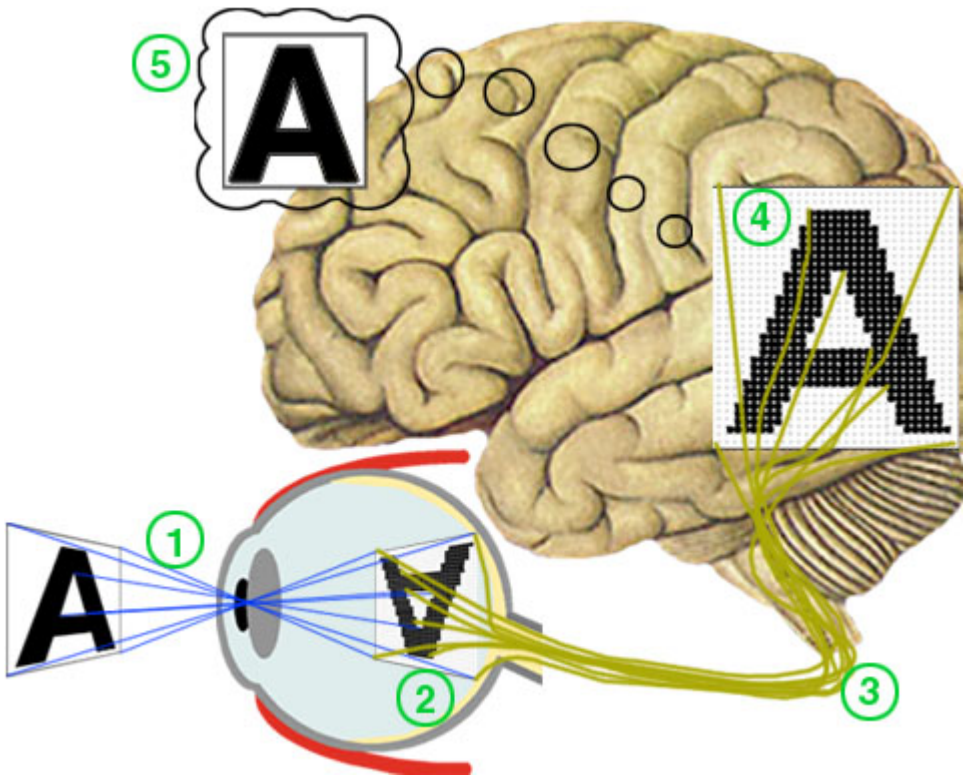
The visual pathways: from the eyes to the brain





The Visual Cortex: from the eyes to the brain

The retina alone can’t perceive anything



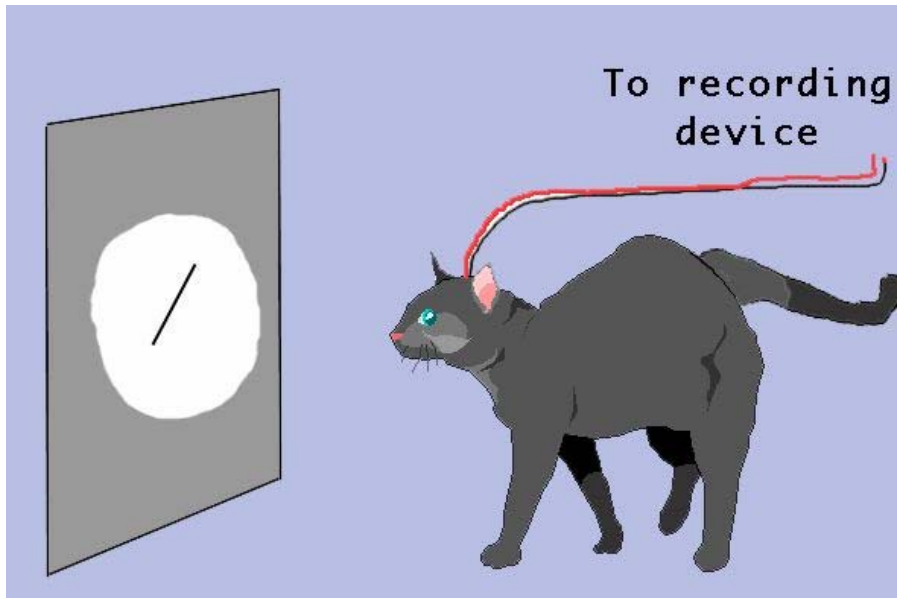
The Visual Cortex: from the eyes to the brain

Blakemore & Cooper, 1970: The cortex is necessary for visual consciousness

Showed how important early visual experience is in developing normal visual skills. They reared some kittens in the dark, except for periods when the kittens were placed inside large drums that were painted on the inside.

Some cats were in a drum with ***vertical black and white stripes***, while the other drum had ***horizontal black and white stripes.***

The kittens could not recognize anything with edges that were different from the one they had seen inside their drums.



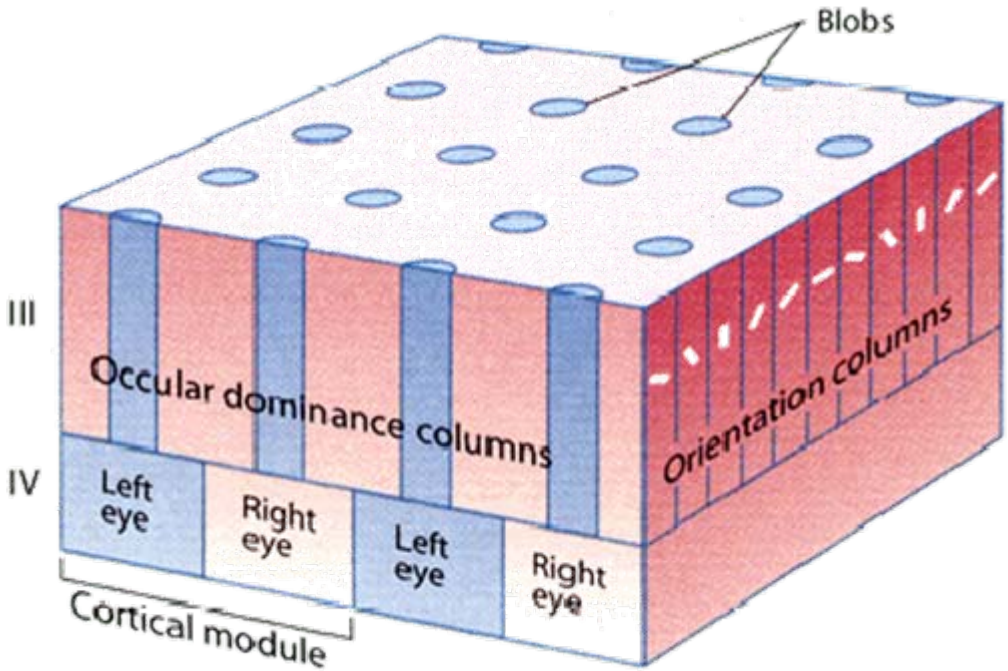
The Visual Cortex:

Hypercolumn (hubel & wiesel)

The cells in V1 are organized in an array of ***hypercolumns***, each of which corresponds to a point on the retina

Each column in the ***hypercolumn*** responds to a *particular orientation*; adjacent columns manage information from adjacent retinal locations

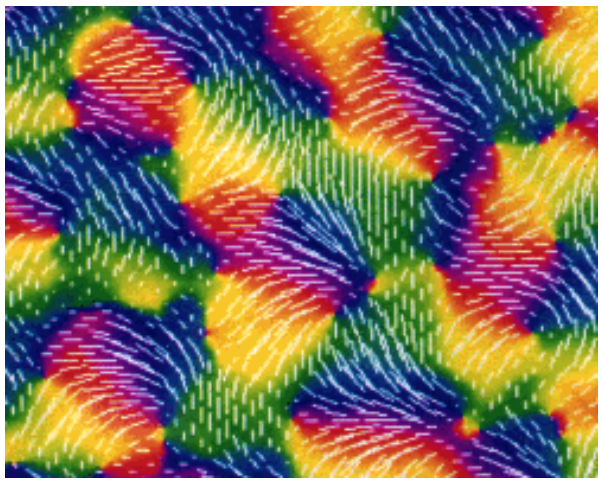
Blobs and *interblobs:* perception of color.

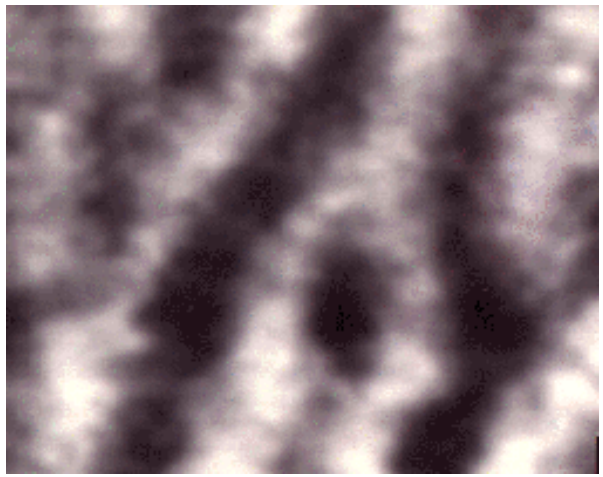


(Aus Gazzaniga et al., 1998)

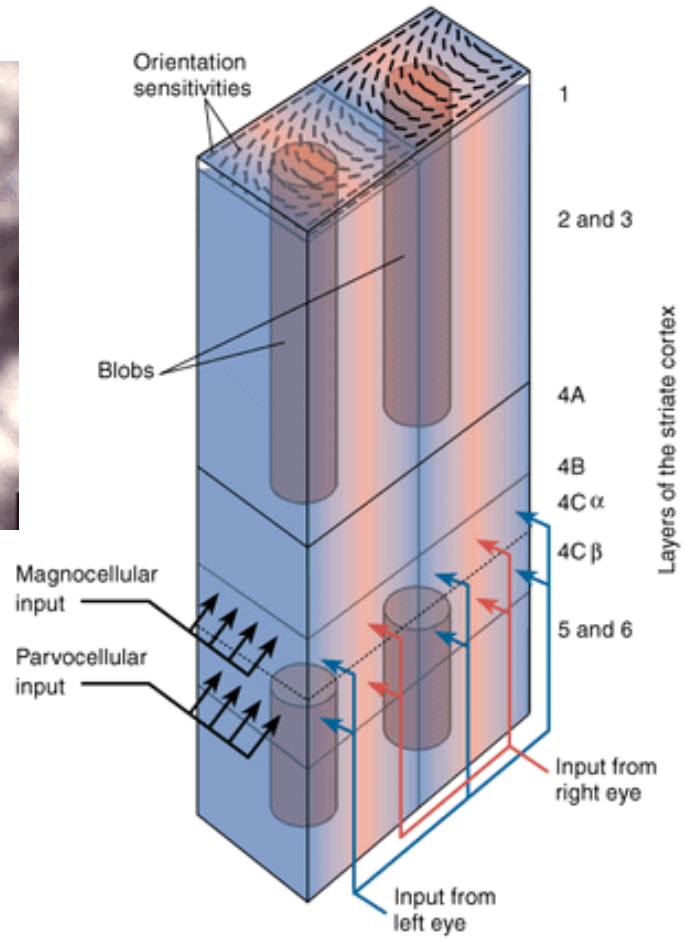
The Visual Cortex

Primary Visual Cortex V1 or Striate Cortex:





Orientation *and* ***ocular dominance*** *columns in a patch of the monkey visual cortex visualized with modern imaging techniques (Blasdel and Salama 1992).* red to violet indicate orientation preference of cells varying from zero to 180 degrees from exclusive left to binocular to exclusive right



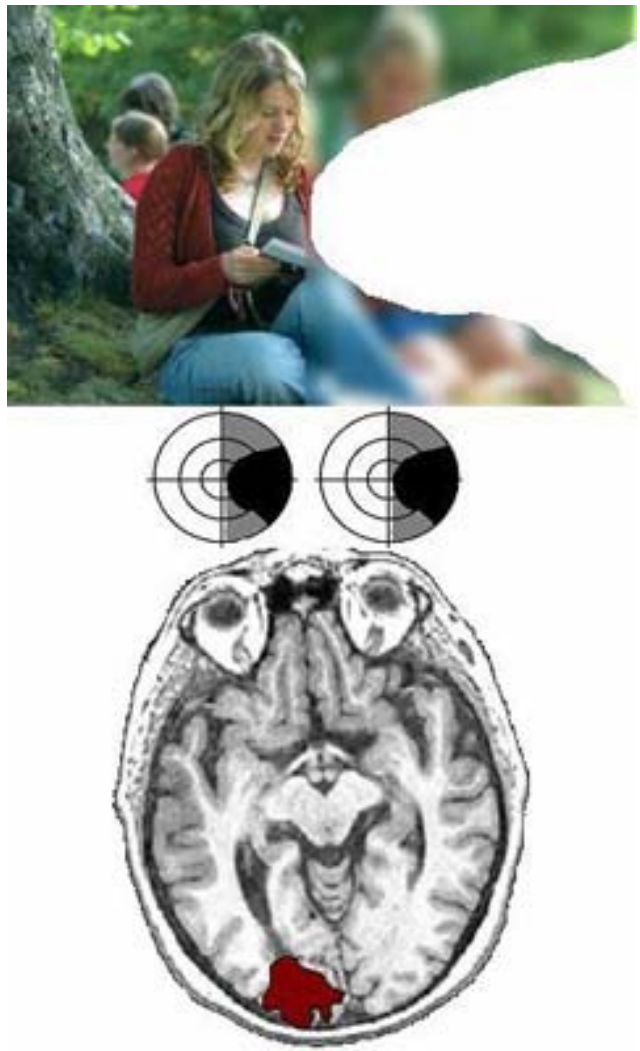
The Visual Cortex: from the eyes to the brain

What is blindsight?

The visual functions that can be elicited in response to stimuli presented within fields of cortical blindness have become known as ***blindsight.***

The ‘blind’ in blindsight reflects the patients' claims not to see the stimuli at all, while the ‘sight’ refers to their residual or recovered ability to localize, detect and discriminate between such unseen stimuli.

This divorce between blindness and visual performance is captured in the term blindsight coined by Lawrence Weiskrantz and colleagues in 1974, and makes the phenomenon intriguing to psychologists, cognitive neuroscientists, and philosophers.

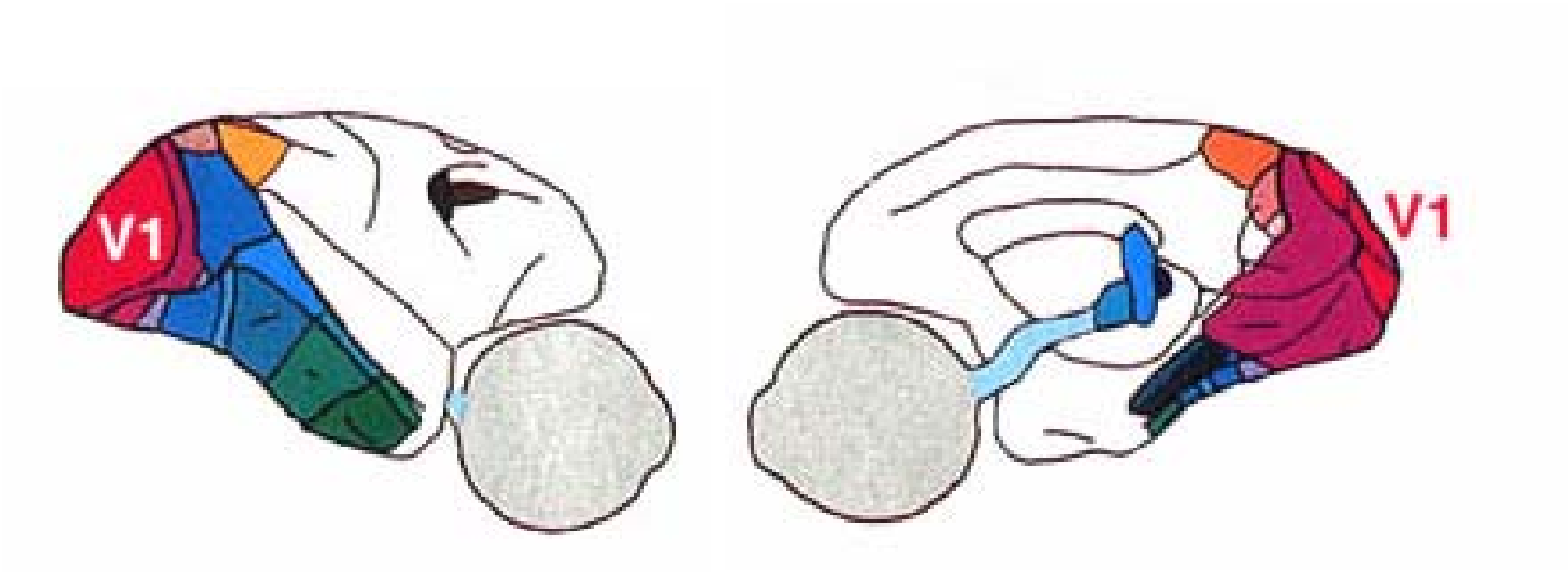


Vision/ PNS/ Neurons & Perception

- ***Interactions between neurons***

Processing past the retina

Extra-Striate Visual Cortex: nearby visual areas where further image analysis takes place. Areas specialized for processing different aspects of vision, e.g., motion, color, form, etc.



Sensation & Perception

- Perception is rapid and effortless (500ms)
- Perception involves multiple stages and transformations of mental representations
- Perception is the result of processes that construct mental representations of the information available in the environment: visual stimulus + stored representations + attentional state + emotional state +…
- Perception is always driven by expectations of how the world ought to look or sound based on our knowledge's.

Sensation & Perception

Sensation without perception: the plants

Perception involves Sensation

Illusory perception: the perceptual process construct a mental representation that does not accurately mirror the object in the environment

Perception without Sensation: hallucination

Pattern Recognition

Refers to the step between the transduction and the perception of a stimulus in the environment and its categorization as a meaningful object.

Visual Agnosia

Apperceptive Agnosia: object recognition fails as a result of difficulties in identifying the visual features that define a perceptual category

Associative Agnosia: object recognition fails because of difficulties in identifying the functional features that define a semantic category.

Object Recognition and Perceptual Organization

225 221 216 219 219 214 207 218 219 220 207 155 136 135
213 206 213 223 208 217 223 221 223 216 195 156 141 130
206 217 210 216 224 223 228 230 234 216 207 157 136 132
211 213 221 223 220 222 237 216 219 220 176 149 137 132
221 229 218 230 228 214 213 209 198 224 161 140 133 127
220 219 224 220 219 215 215 206 206 221 159 143 133 131
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211 208 223 213 216 226 231 230 241 199 153 141 136 125
200 224 219 215 217 224 232 241 240 211 150 139 128 132
204 206 208 205 233 241 241 252 242 192 151 141 133 130
200 205 201 216 232 248 255 246 231 210 149 141 132 126
191 194 209 238 245 255 249 235 238 197 146 139 130 132
189 199 200 227 239 237 235 236 247 192 145 142 124 133
198 196 209 211 210 215 236 240 232 177 142 137 135 124
198 203 205 208 211 224 226 240 210 160 139 132 129 130
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211 210 217 218 214 227 244 221 162 140 139 129 133 131
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255 235 230 249 253 240 228 193 147 139 132 128 136 125
250 245 238 245 246 235 235 190 139 136 134 135 126 130
240 238 233 232 235 255 246 168 156 144 129 127 136 134

Object Recognition and Perceptual Organization

Problems with object perception

The Gestalt Theory

Perceptual segregation

Contemporary approaches on object perception

- ***Structural description models***
- ***Image description models***

Object Perception

Problems with object perception

There is no "object neuron" (cf. face neuron)

The stimulus on the receptor is ambiguous

Seeing objects from just on viewpoint result in an ambiguous information on the receptor

Inverse projection Problem: a particular image on the retina can be caused by different objects

Objects can be hidden or blurred

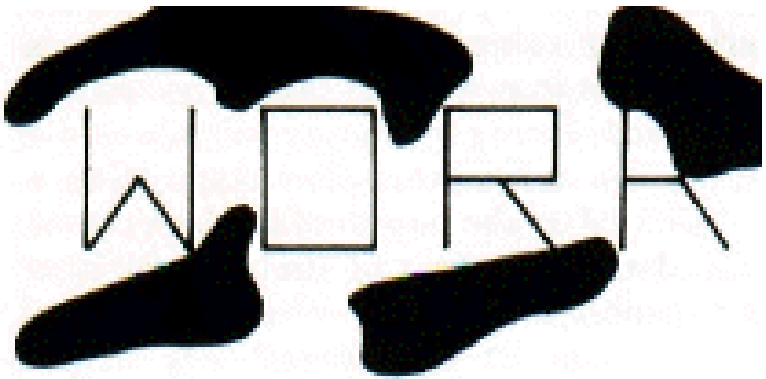
Objects look different from different viewpoints

Object Perception

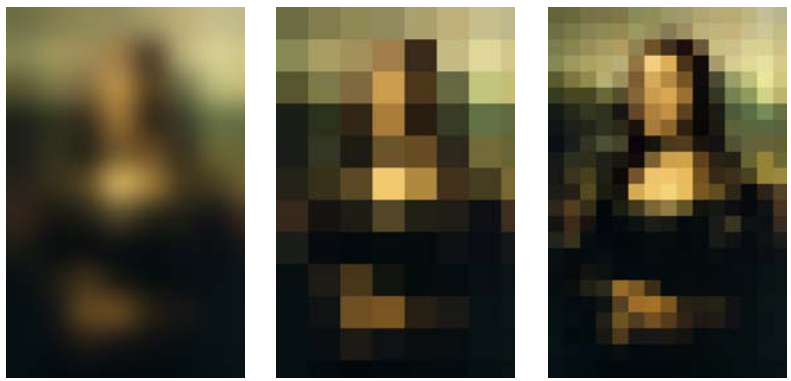
Problems with object perception

Objects can be hidden or blurred

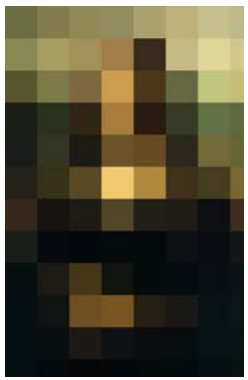
Occlusions

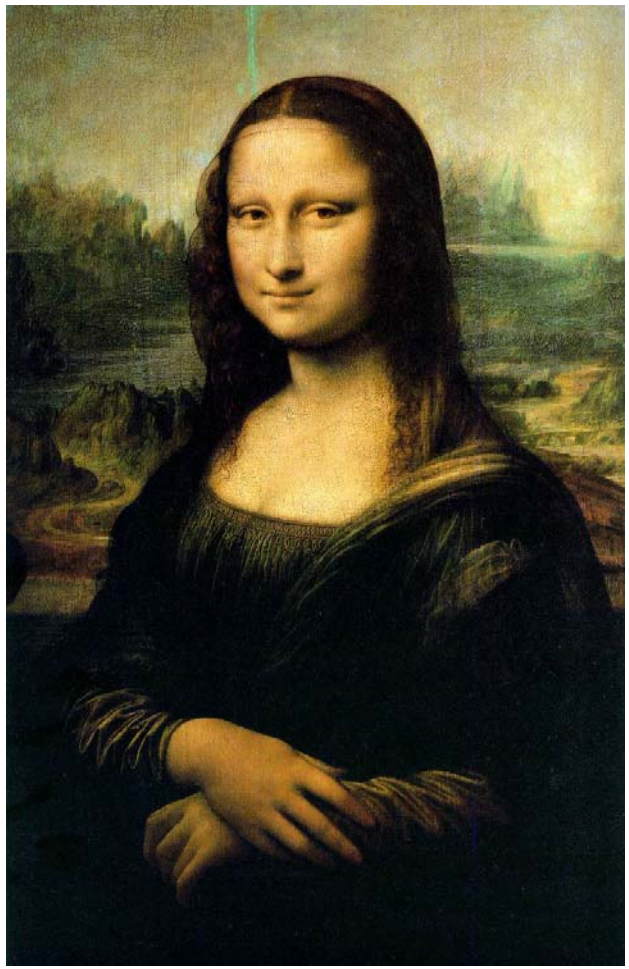


Blurred images



Object Perception

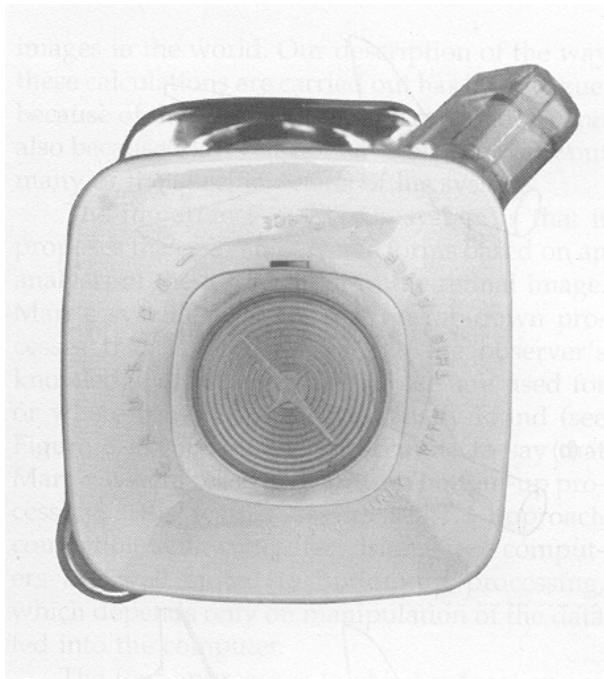




Object Perception

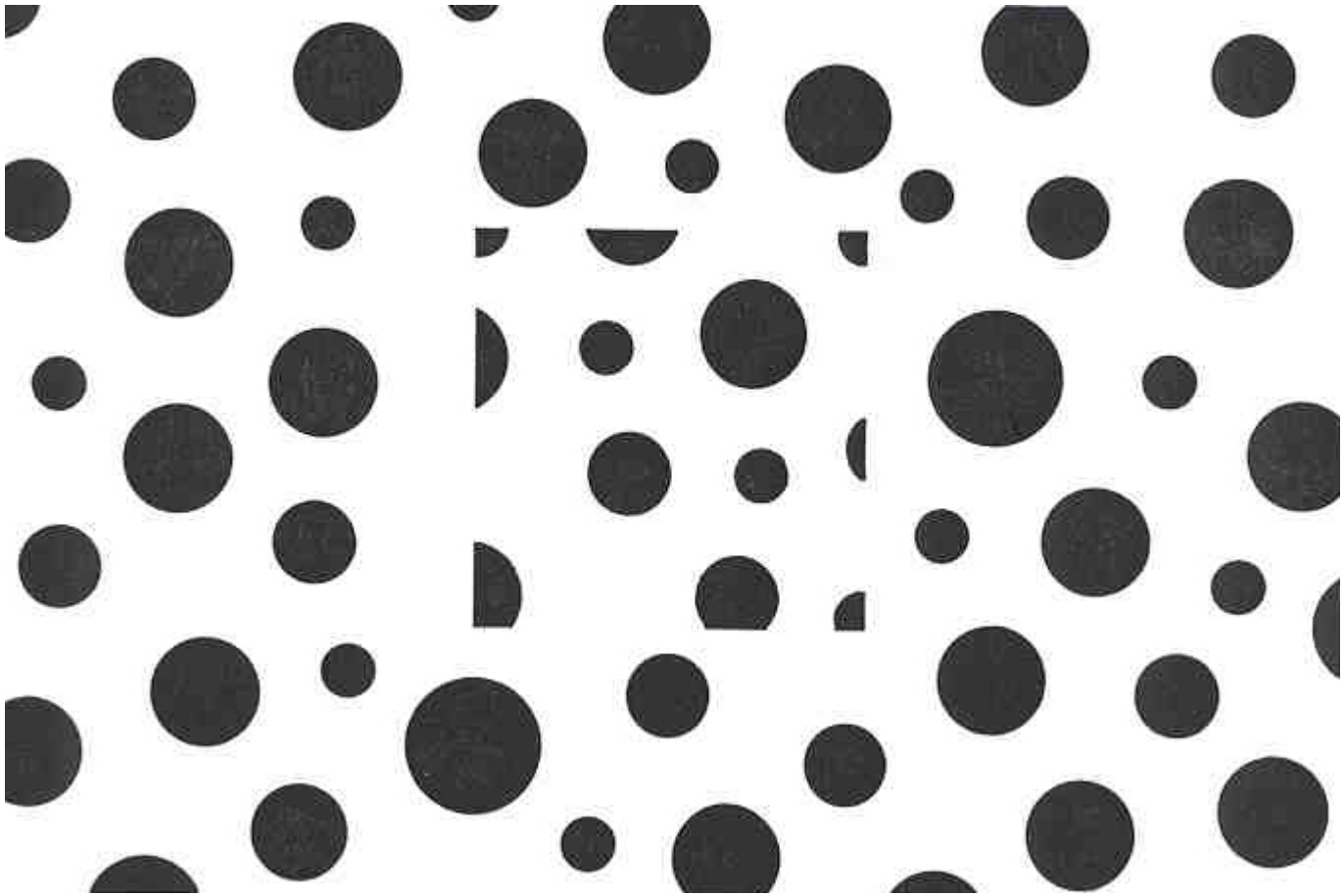
Objects look different from different viewpoints

Viewpoint invariance: ability to recognize an object seen from different viewpoints or different captors



Object Perception

The Gestalt approach to object perception



Kanizsa's Subjective Contour Dot Window (Kanizsa, Organization in Vision, 1979)

Object Perception

The Gestalt Theory

Wilhelm Wundt: first laboratory of scientific psychology (1879)

Founder of the ***Structuralism***:

Perception is created by combining elements called ***sensations***

Gestalt Psychology:

Max Wertheimer (1911): Apparent movement illusion (two stationary objects presented successively (50 ms ISI) in slightly different positions. No stimulation between in space between the 2 stimuli and therefore no sensations to explain the movement

M. Wertheimer, K. Koffka, I. Kohler: the Gestalt Psychologists: reject the idea that perception is build up on sensations

The whole differs from the sum of its parts

Perceptual Organization:

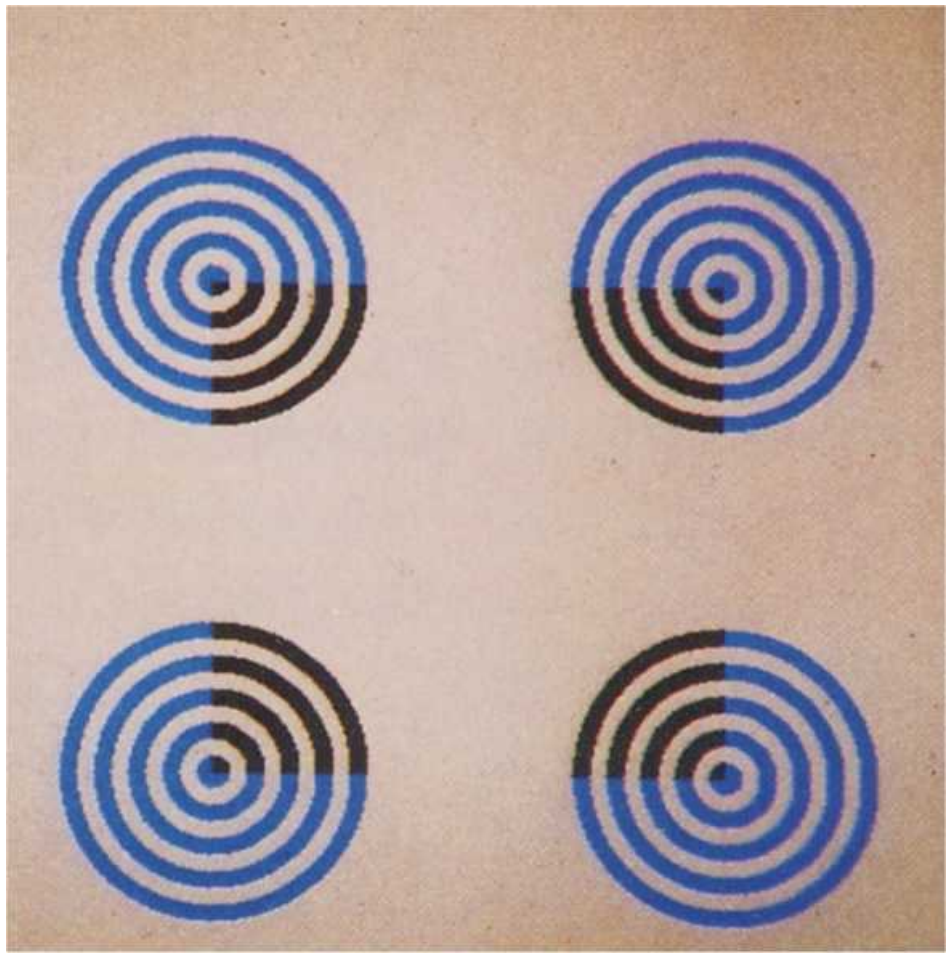
How small elements become grouped into larger objects

B. Doolittle

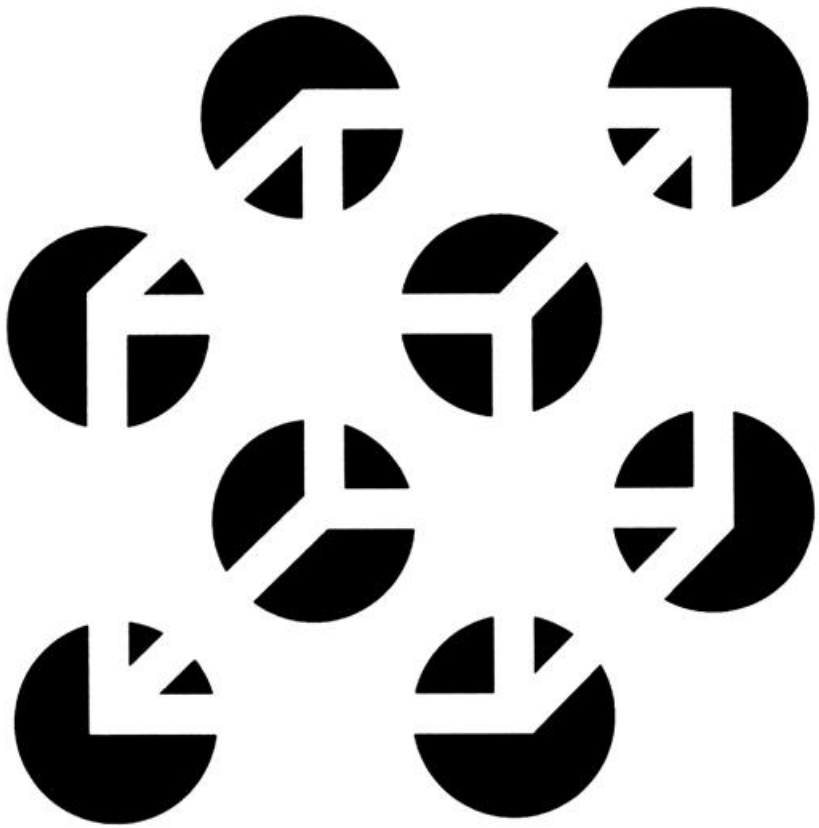
R. C. James

PERCEPTION

Perceptual Organization:



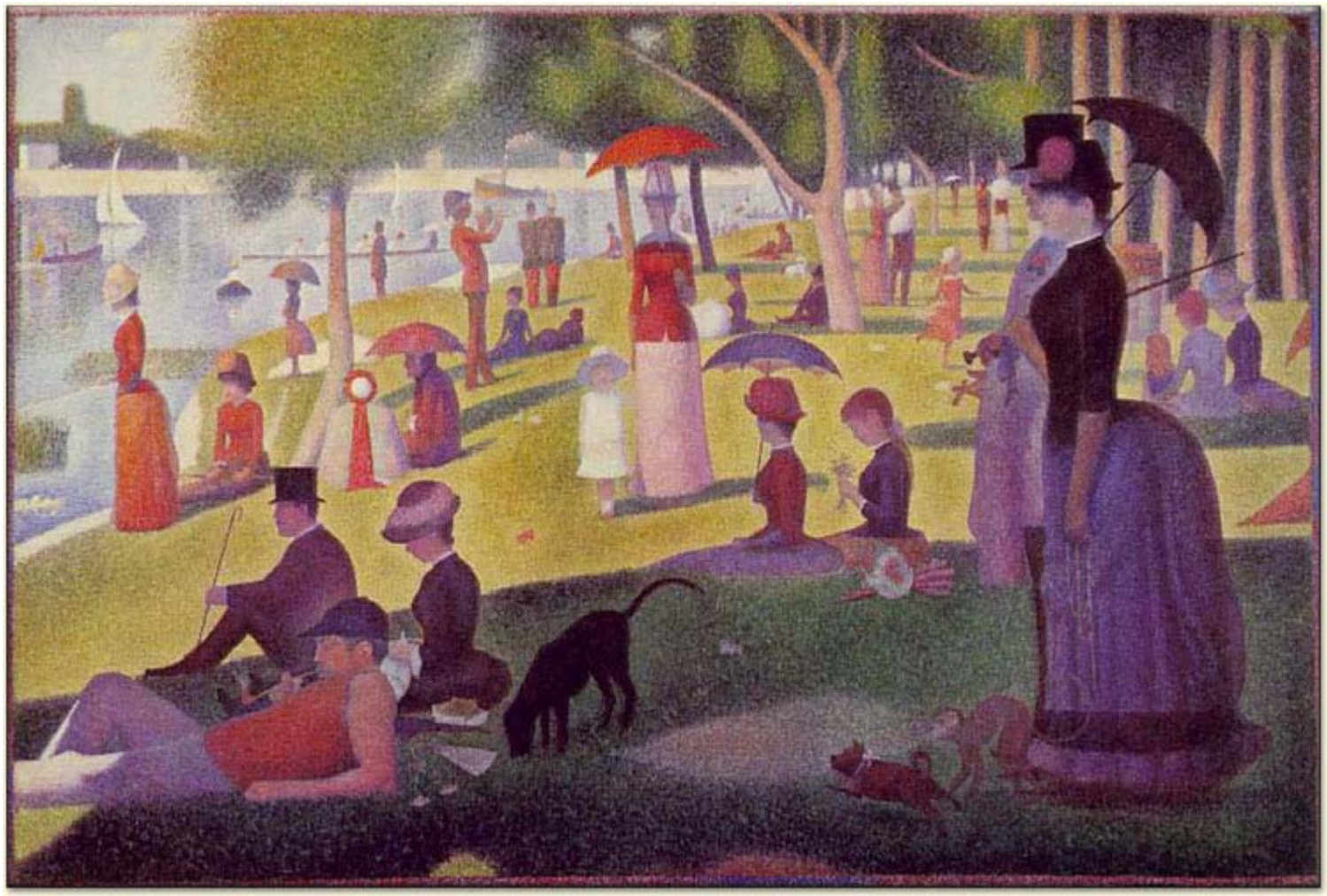
Perceptual Organization:



Subjective Necker Cube (Bradley, Dumais, and Petry, 1976)

PERCEPTION

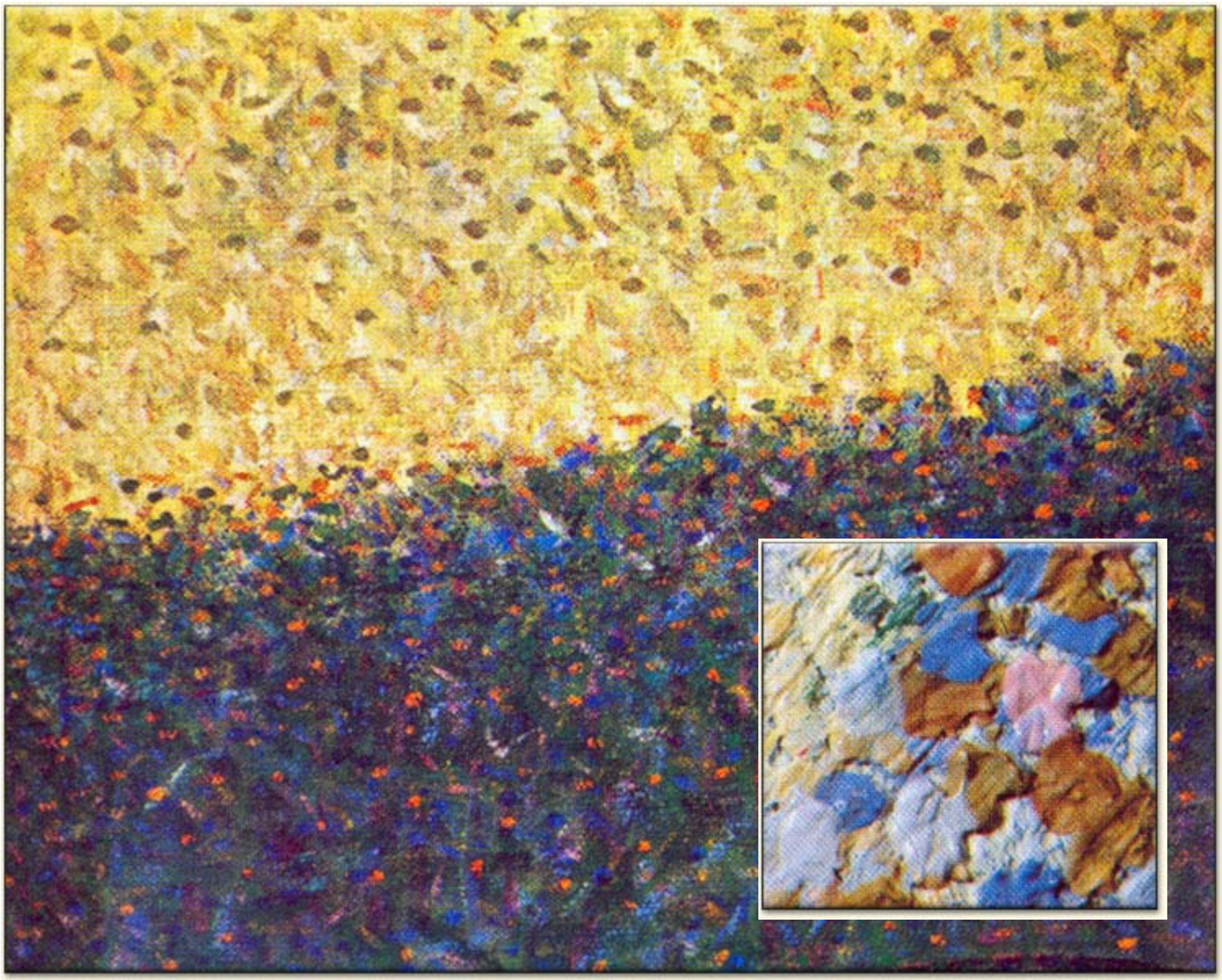
Perceptual Organization:



Sunday Afternoon on the Island of La Grande Jatte (*Un dimanche après-midi à l'Ile de la Grande Jatte*), Georges Seurat, 1884-1886.

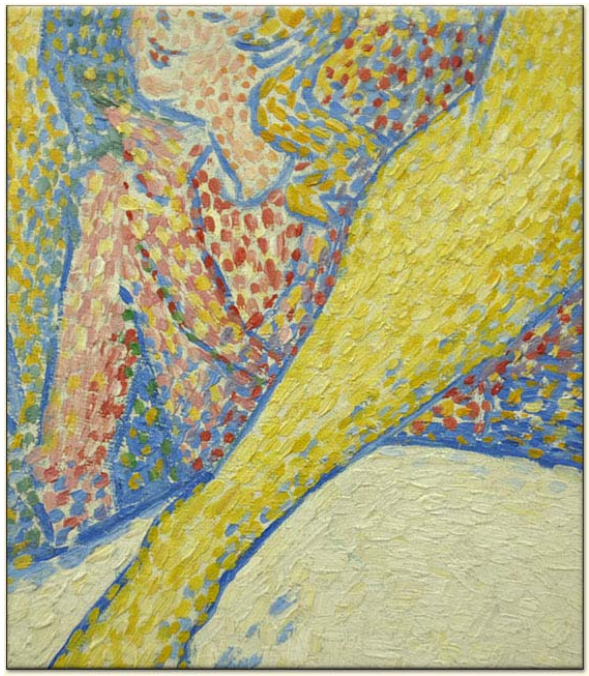
San José State UNIVERSITY

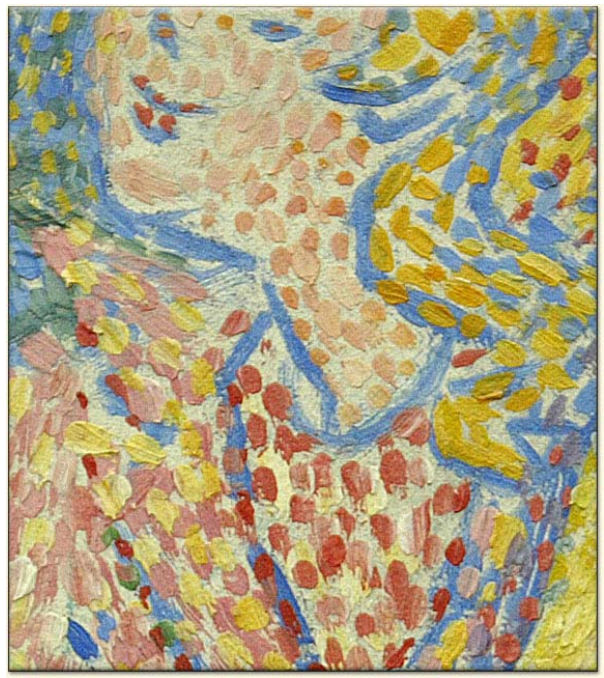
PERCEPTION



Perceptual Organization:

Divisionism (neo-impressionnism) is a broader term meaning that it is possible to obtain brighter hues of color such as green, orange and purple, by a series of dots (or blobs) of both primary colors so that they are optically intermingled in the spectator's eye (rather than being pre-mixed).





The Circus, Georges Seurat, 1890-91

PERCEPTION

Perceptual Organization:

Untitled, Larry Poons, 1960s.

PERCEPTION

The Gestalt Laws of Perceptual Organization:

A

similarity

B

proximity

C

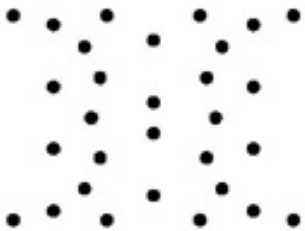
good continuation

D

closure

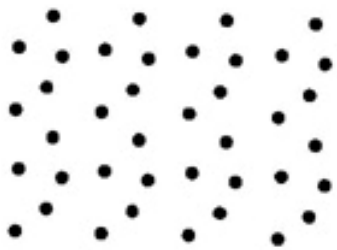
E

symmetry



F

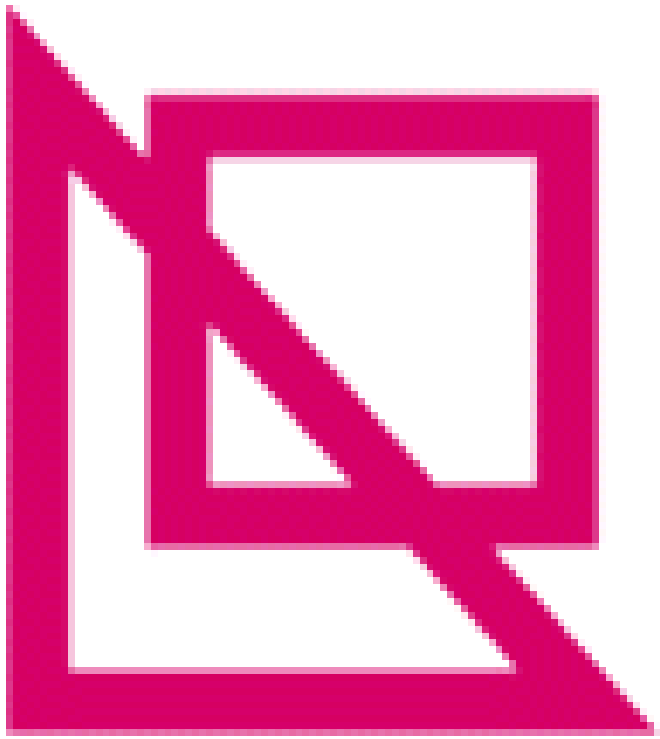
periodicity



Perceptual Organization:

•***Low of Good figure*** *(pragnanz or law of simplicity) :* central law of Gestalt psychology.

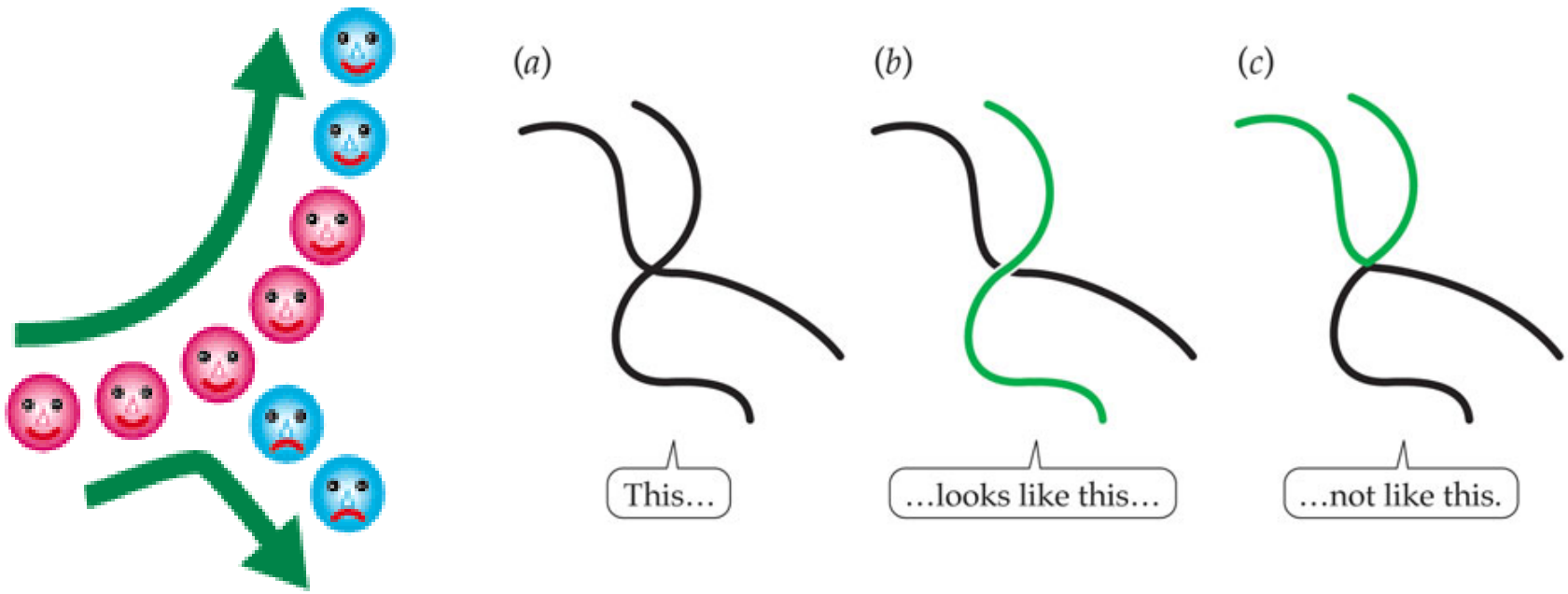
"Every stimulus pattern is seen in such a way that the resulting structure is as simple as possible".



Perceptual Organization:

- ***Law of Good Continuation:***

  " Points that, when connected, result in straight or smoothly lines are seen as belonging together and the lines tend to be seen in such a way as to follow the smoothest path".



SENSATION AND PERCEPTION, Figure 4.7 © 2006 Sinauer Associates, Inc.

Perceptual Organization:

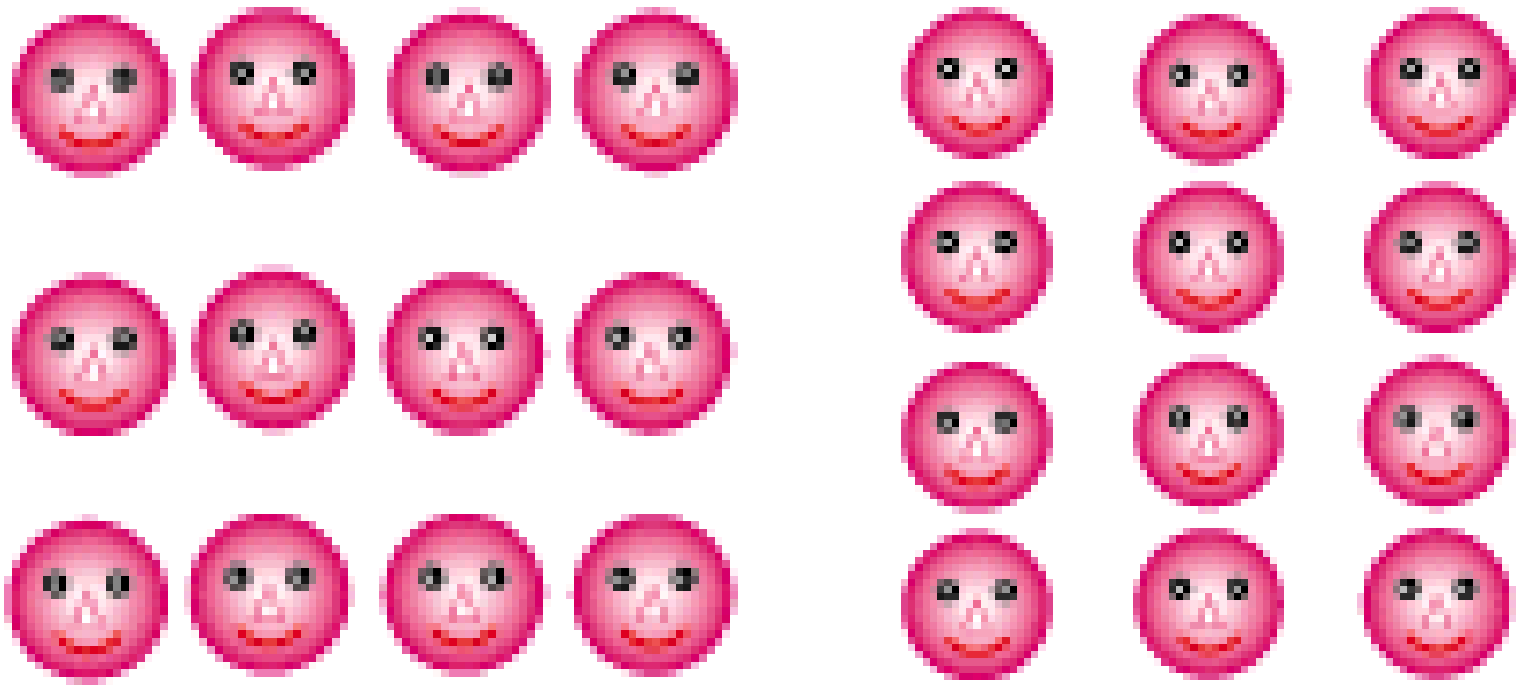
•***Law of Closure:***

"We tend to enclose a space by completing a contour and ignoring gaps in a figure ".

Perceptual Organization:

- ***Law of Proximity (nearness):***

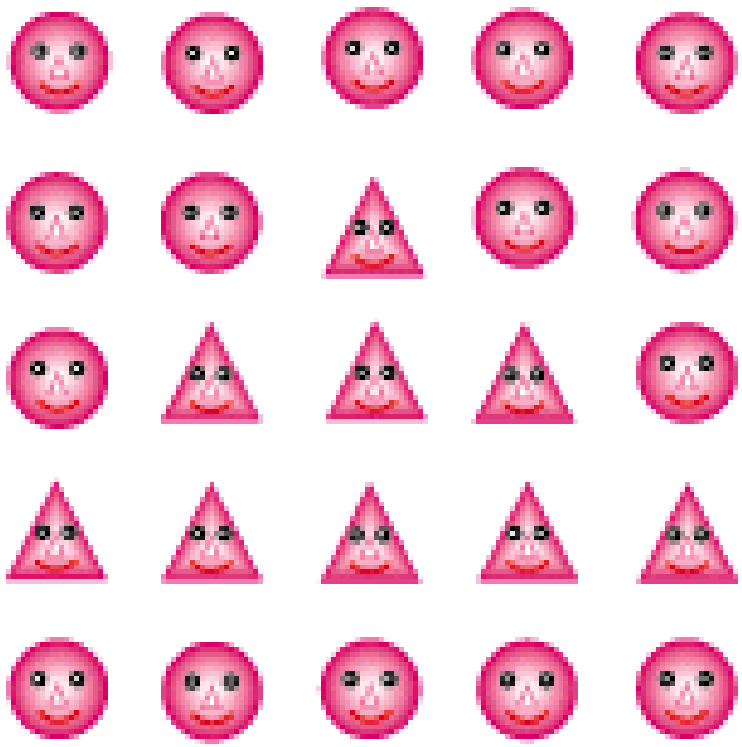
  "Things that are near to each other appear to be group together"



Perceptual Organization:

- ***Law of Similarity:***

  "Similar things appear to be group together".



Perceptual Organization:

- ***Law of Similarity:***

  "Similar things appear to be group together".

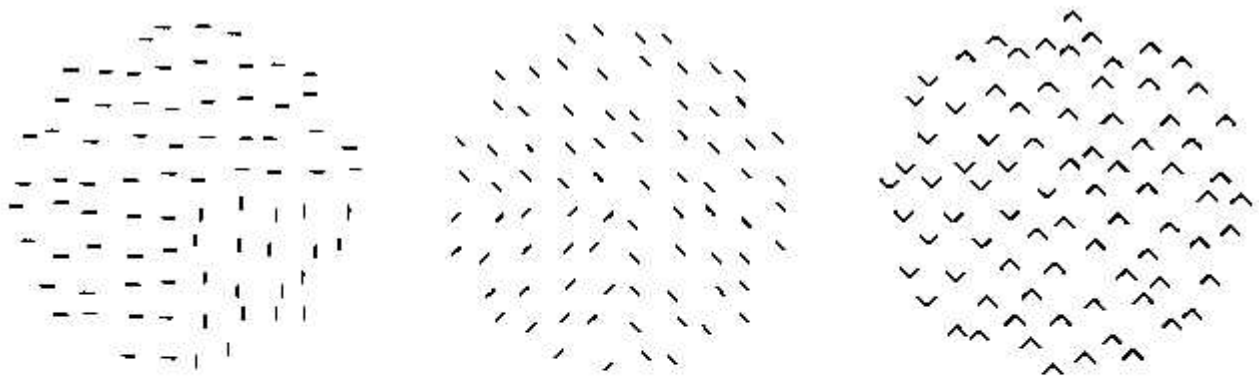


FIG. 6.6. The task is to locate the region of the field containing the disparate elements. These panels show how elements group on the basis of similar line slope to make the task easy in Panels A and B but difficult in Panel C. (Adapted from Olson & Attneave, 1970.)

Perceptual Organization:

Physiological validation of Gestalt Theory:

- Neurons that respond to grouping.

From laws to heuristics:

Rules that provide a best-guess solution to a problem

Algorithms

Procedure that is guaranteed to solve a problem

Perceptual Organization:

Perceptual segregation: How objects are separated

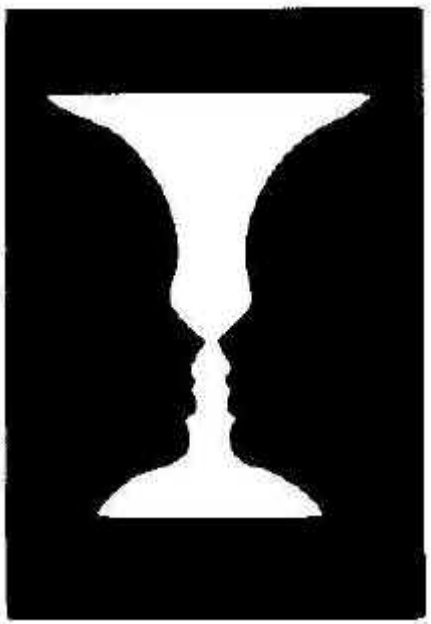
Figure-Ground segregation

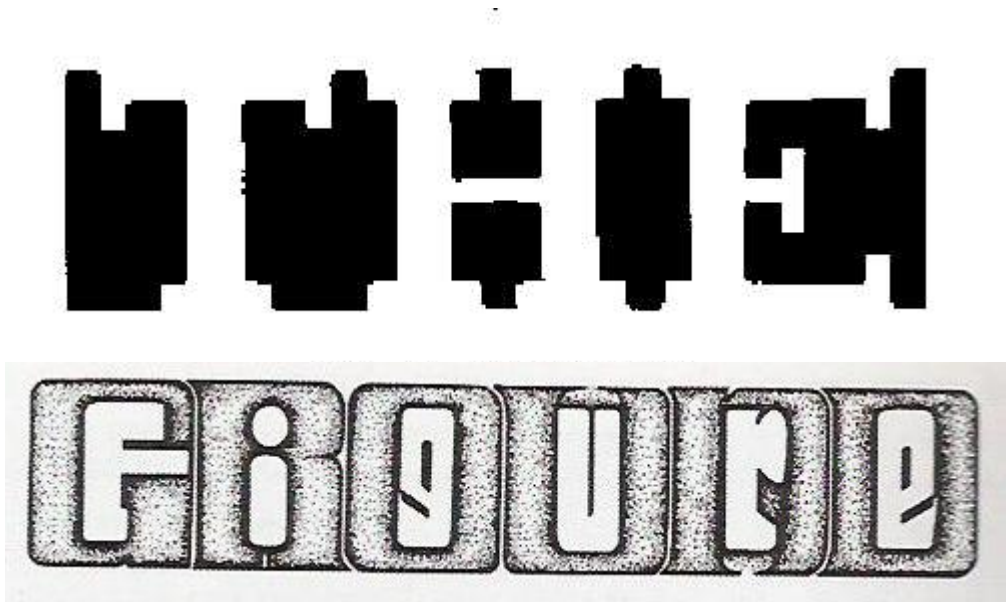
Properties of figure-ground segregation:

-Thinglike

- Border ownership

Reversible figure-ground





Perceptual Organization:

Perceptual segregation:

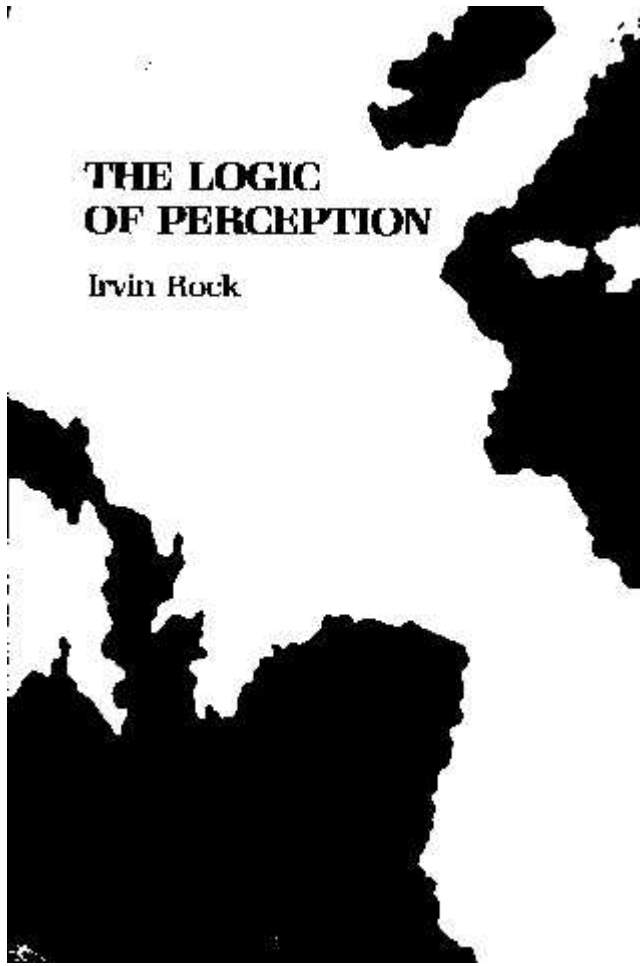
Figure-Ground reversal

What factors determine which area is Figure?

The lower region of a display tends to be seen as

Figure

Symmetry, Size, Orientation and meaning



Perceptual Organization:

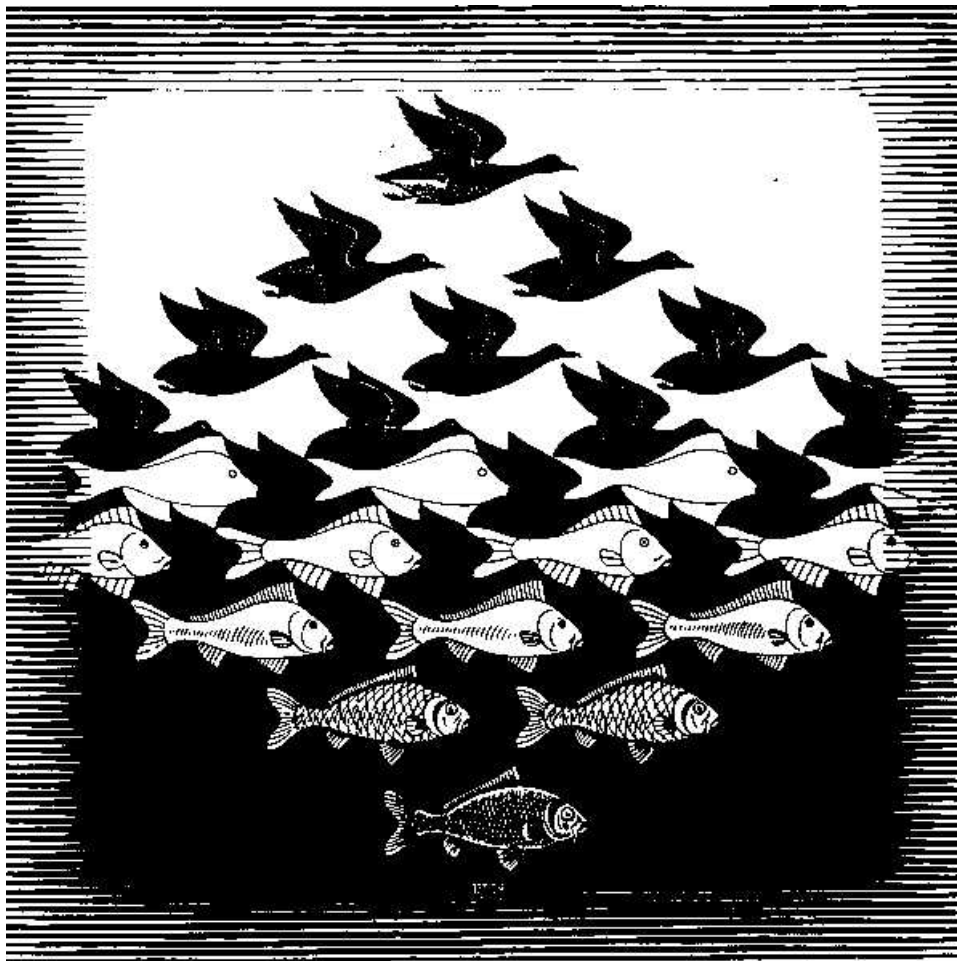
Perceptual segregation:

Figure-Ground reversal

Perceptual Organization:

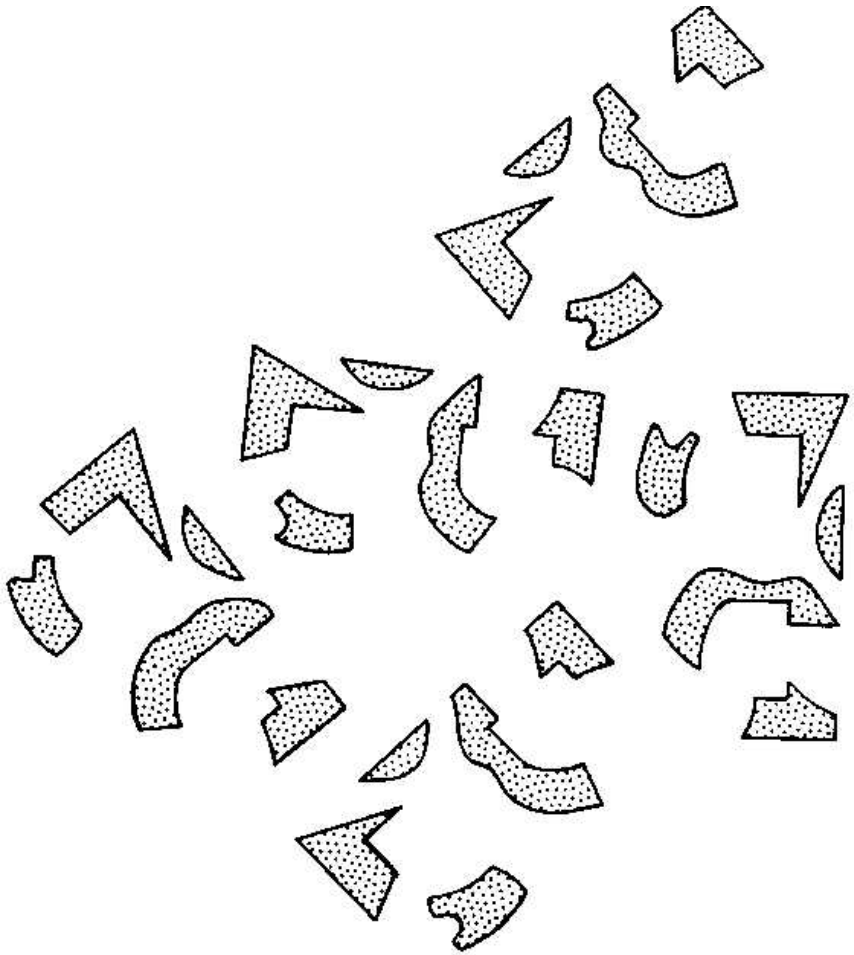
Perceptual segregation:

Figure-Ground segregation



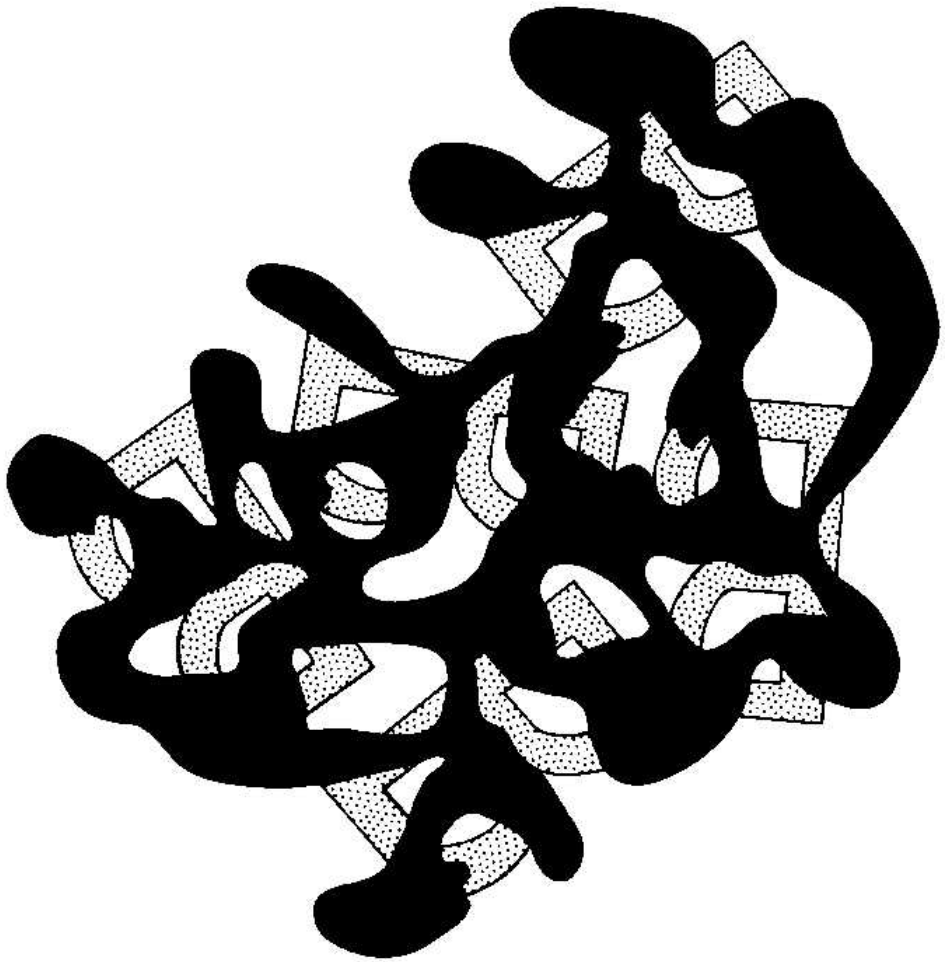
Perceptual Organization:

Depth edges vs. occlusion edges



Perceptual Organization:

Bregman's letters



Perceptual Organization:

Modern research on object perception

Recognizing objects from different viewpoints

Structural-description models

Volumetric features: D. Marr (1982)

Recognition by components RBC theory: I. Biederman (1987)

Geons: geometric ions: view-invariant properties.

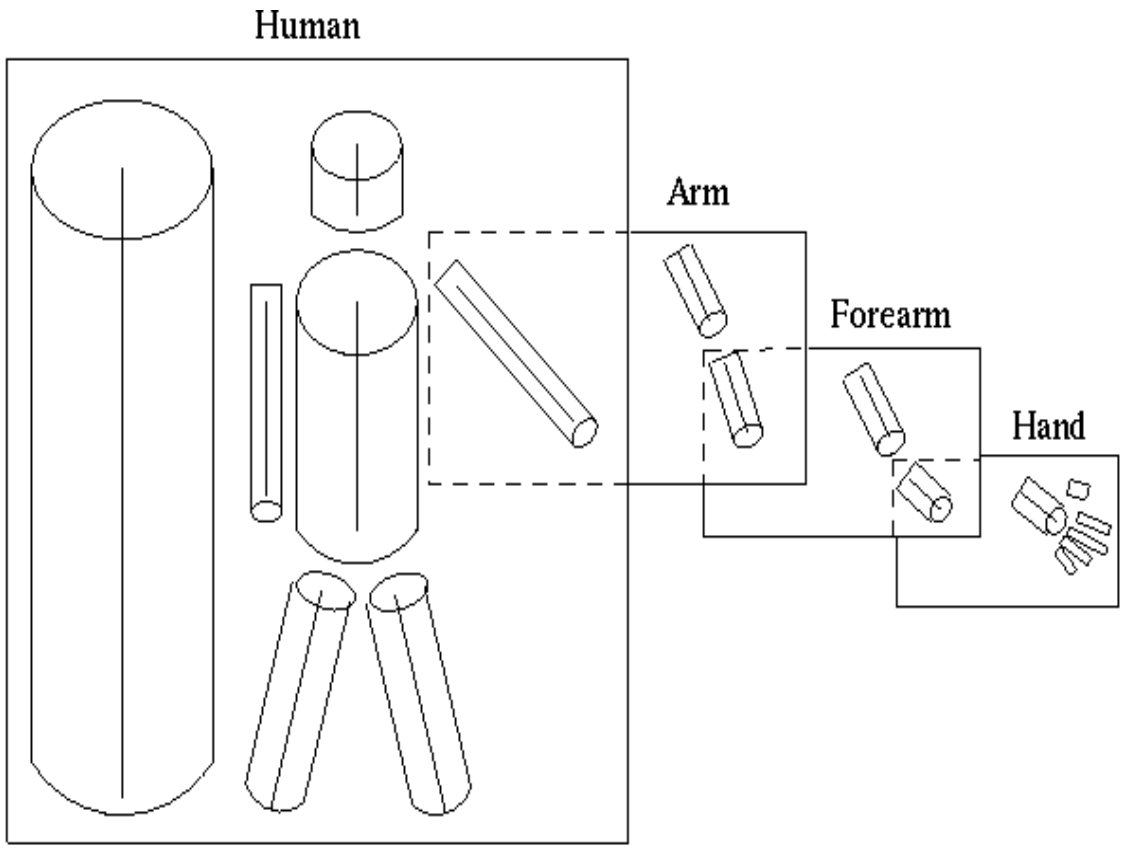
Principal of componential recovery

Image-description models:

Perceptual Organization:

Structural-description models

Volumetric features: D. Marr (1982)



Perceptual Organization:

Structural-description models

Volumetric features: D. Marr (1982)

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Marr (1982): *Vision*

A Computational Investigation into the Human Representation and Processing of Visual Information

- Marr proposed 4 "stages" of representation:
  - » Image
  - » Primal Sketch
  - » $2^1/_2$-D Sketch
  - » 3-D Model
- Each representation has its own set of primitives

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Image

- Represents: Light Intensity

- Primitives: Intensity values

Perceptual Organization:

Structural-description models

Volumetric features: D. Marr (1982)

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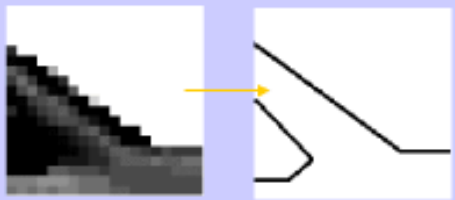
Primal Sketch

- Represents: Intensity **changes** (zero crossings)

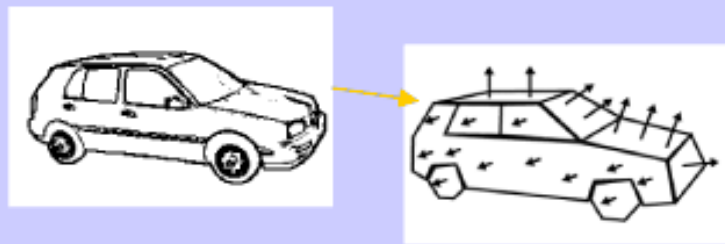


- Primitives: Edges

9

$2^1/_2$-D Sketch

- Represents: Visible surfaces



- Primitives: Oriented surfaces

Perceptual Organization:

Structural-description models

Volumetric features: D. Marr (1982)

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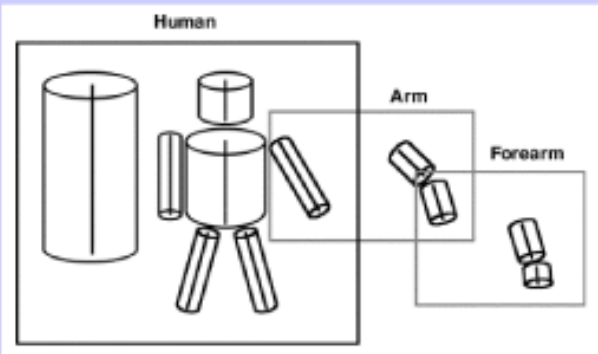
3-D Model

- Represents: 3-D Structure



- Primitives: Oriented cylinders

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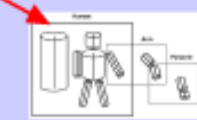
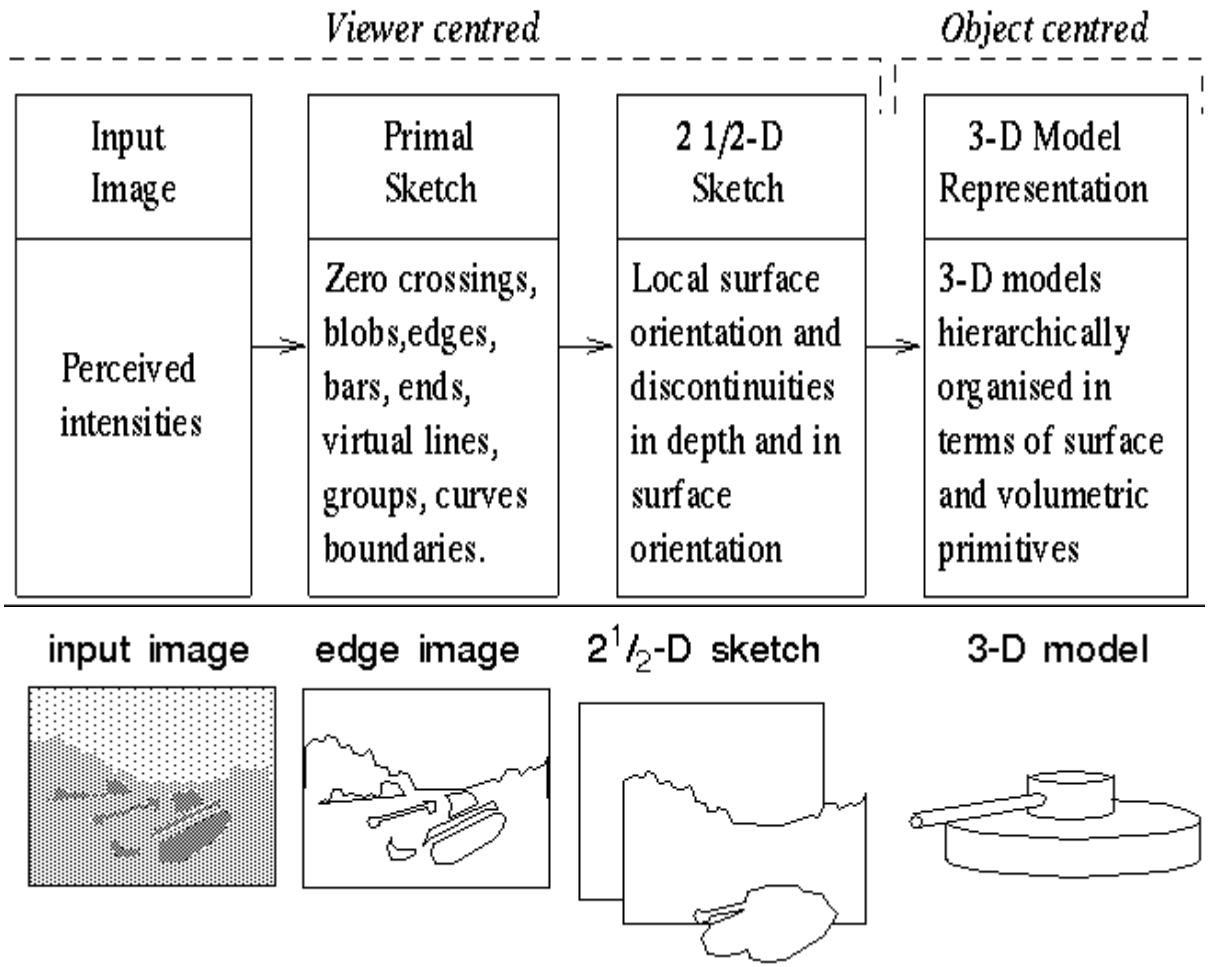
Marr's Theory: 4 Stages of Representations

- Image
- Primal Sketch
- 2^1_2 -D Sketch
- 3-D Model



Perceptual Organization:

Structural-description models: Volumetric features: D. Marr (1982)



Perceptual Organization:

Structural-description models: Volumetric features: D. Marr (1982)

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Representing 3D Structure

- If we can represent the full 3D structure of an object, we have solved the problem of object constancy: The same representation will be extracted from any viewpoint

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The Problem with Marr's Theory

- Computationally intractable:
  - » Not clear how 2 1/2-D sketch can be computed (Marr himself died just before his book was published)
  - » Impossible to fully represent 3-D structure from one view

Perceptual Organization:

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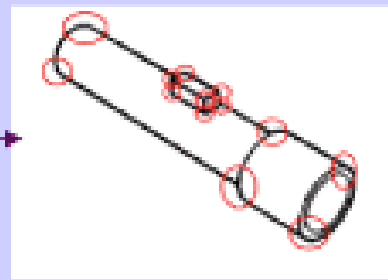
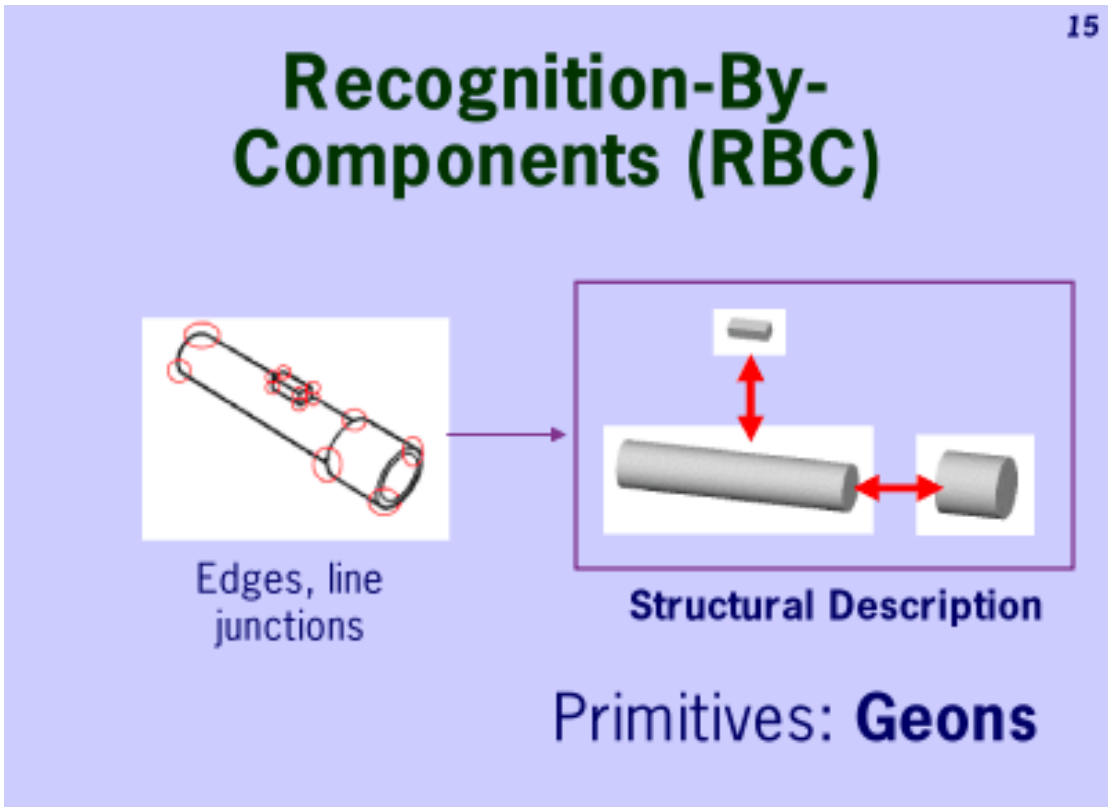
Recognition-By-Components (RBC; Biederman, 1987)

Image

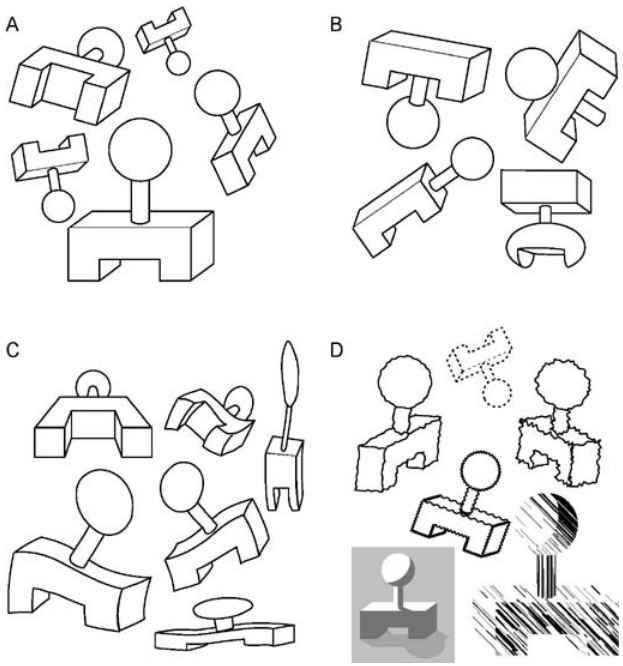


Edges, line junctions

Perceptual Organization:



Perceptual Organization:



Perceptual Organization:

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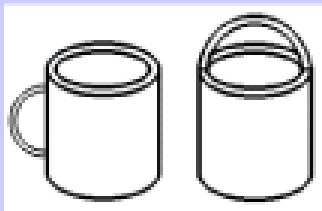
More About RBC

- Geons constitute an "alphabet" of primitives
- Structural descriptions code both geons and relations between geons



- Structural descriptions (partially) represent 3D structure

Perceptual Organization:

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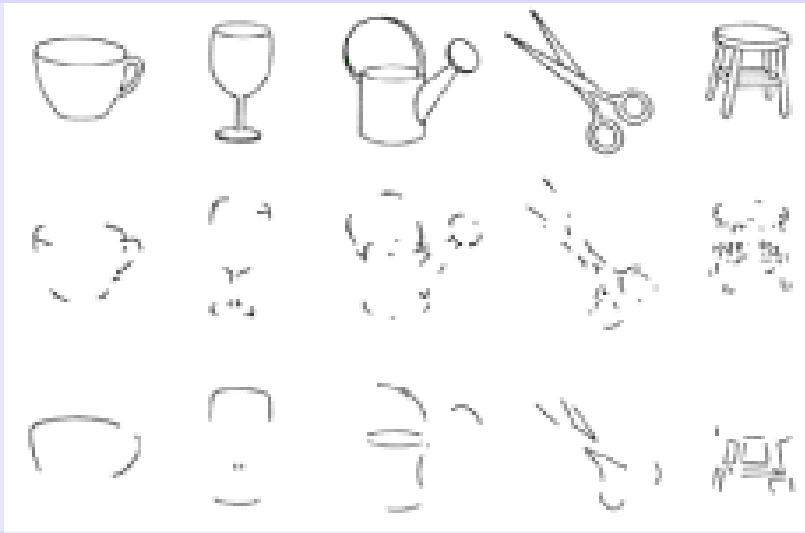
Support for RBC: Contour-Deletion Experiments



<- Complete

<- Recoverable

<- Non-recoverable

Perceptual Organization:

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Strengths of RBC

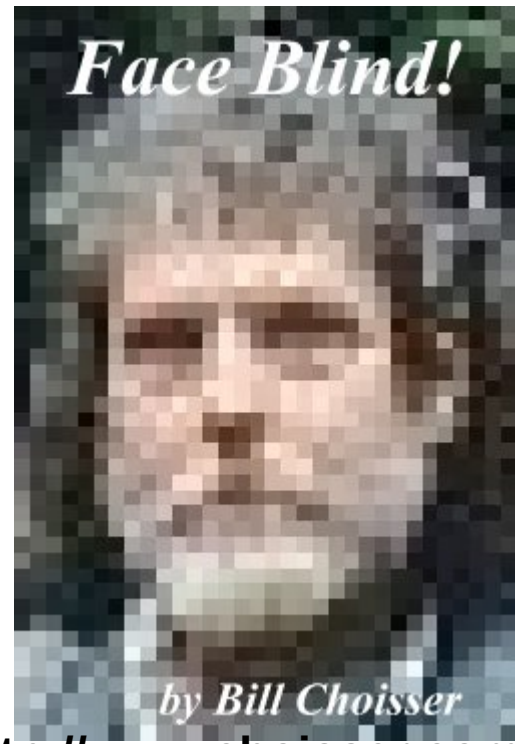
- Achieves partial object constancy
- Relatively few steps in object recognition process
- Efficient object representations
- Intuitively appealing

Face Perception

Modularity/ Face Perception

Specialized module for face recognition (Farah, 1990, 1998)

Prosopagnosia: Face blindness, i.e. selective inability to recognize faces.



http://www.choisser.com/faceblind/

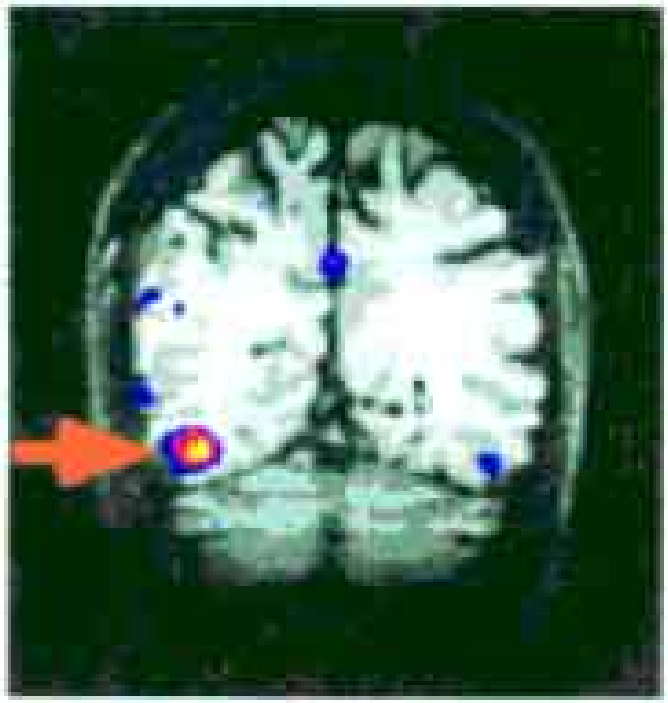
PERCEPTION

Prosopagnosia A prosopagnosic might not even be able to recognize his/her face in a mirror.

"Is Self Special? A critical review of Evidence from experimental psychology and cognitive neuroscience". Gillihan & Farah, 2005

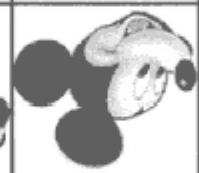
Some rare cases have been reported of prosopagnosic not being able to recognize human faces but able to recognize the faces of their farm animals (McNeil & Warrington, 1993).

Modularity/ Face Perception/ FFA or Fusiform gyrus



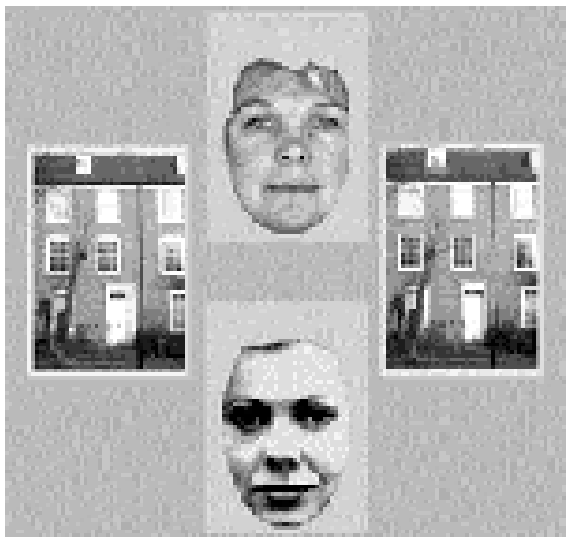
FFA

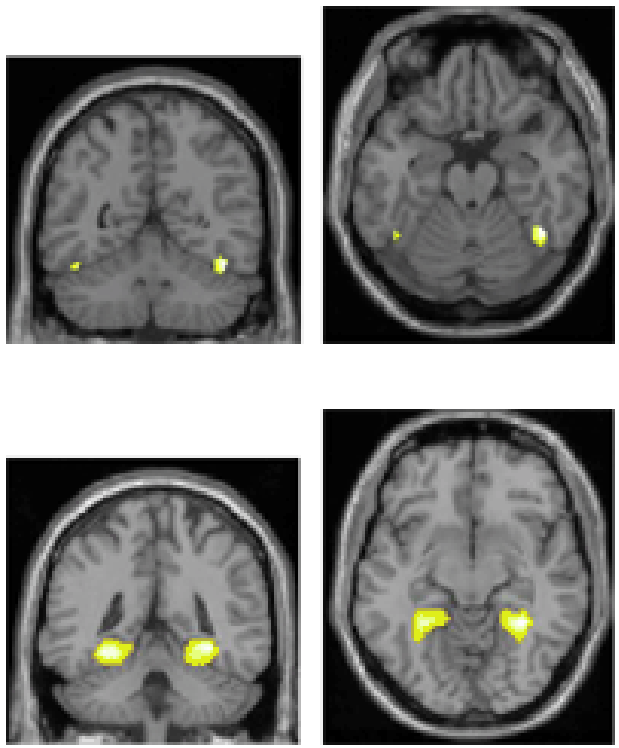
	Faces	No Eyes	Eyes	Houses
				
% MR Signal	1.8	1.7	1.3	0.6

	Faces	Upright Cartoons	Inverted Cartoons	Objects
				
% MR Signal	1.7	1.7	1.4	0.7

Modularity/ Face Perception/ FFA vs. PPA

A module for the faces, a module for the places

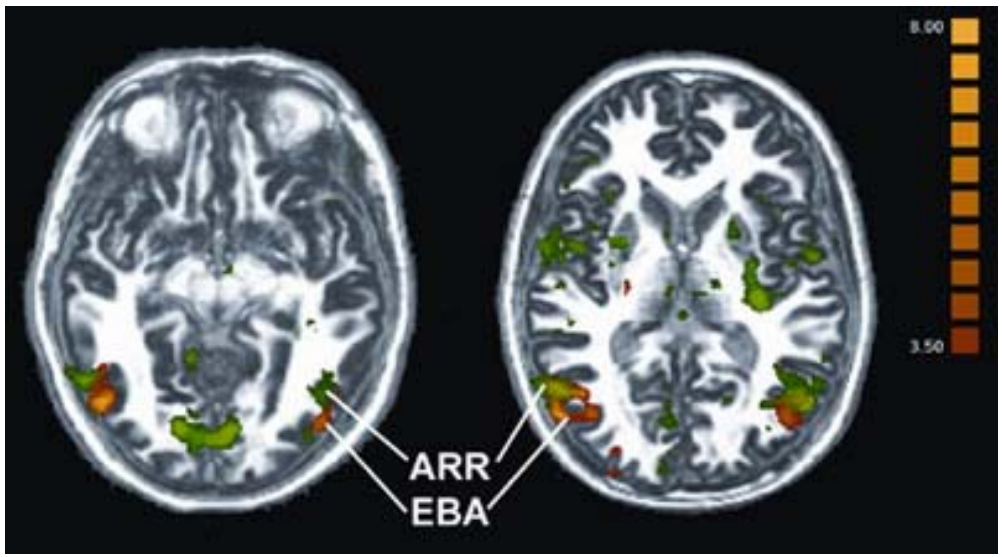




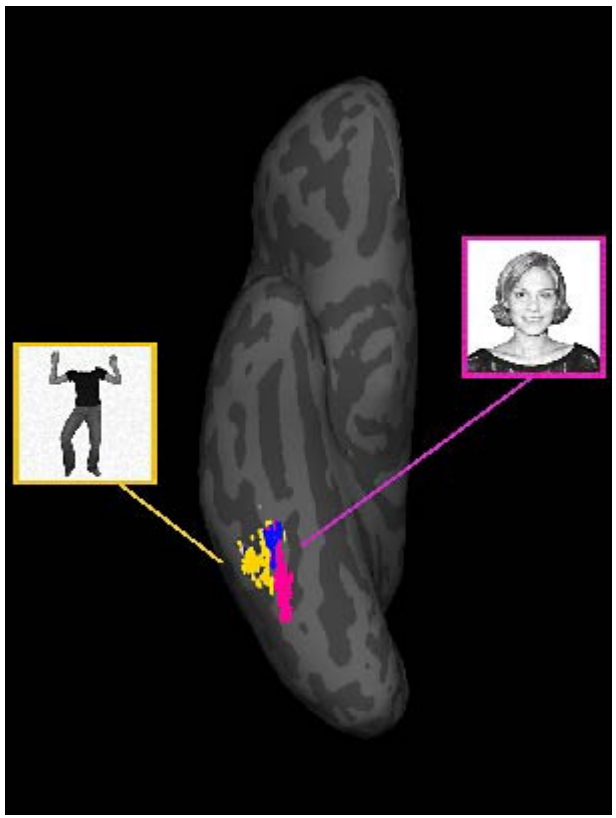
P. Vuilleumier et al., 2001

Modularity/ EBA & ARR

A module for the body, a module for the actions



Extrastriate Body area EBA
Action Related Region ARR



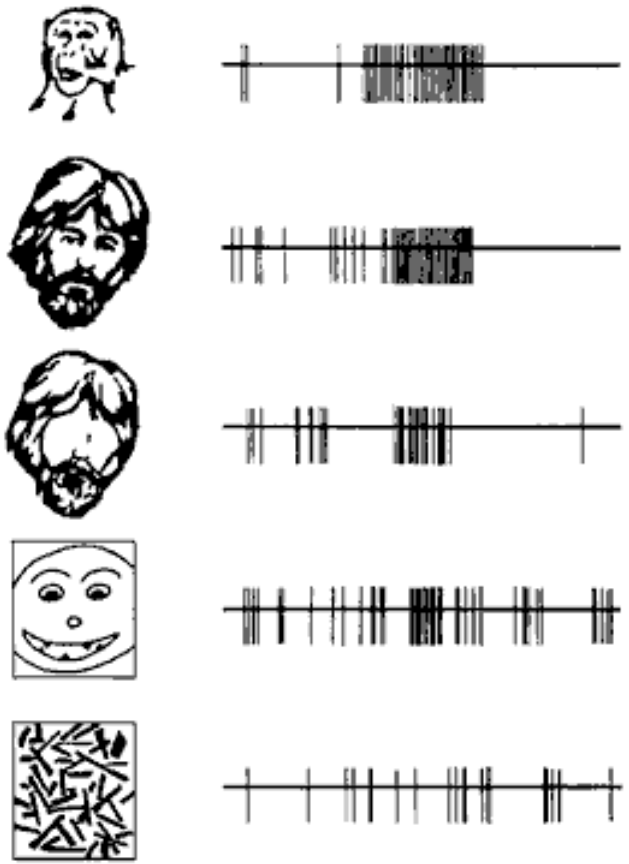
N. Kanwisher et al., 2005

Nature Neuroscience **8**, 125 (2005) doi:10.1038/nn0205-125a
Is the extrastriate body area involved in motor actions? Marius V. Peelen & Paul E. Downing

Modularity/ Face Perception

Inferotemporal cortex:

E. Rolls & M. Tovee (1995) Monkey



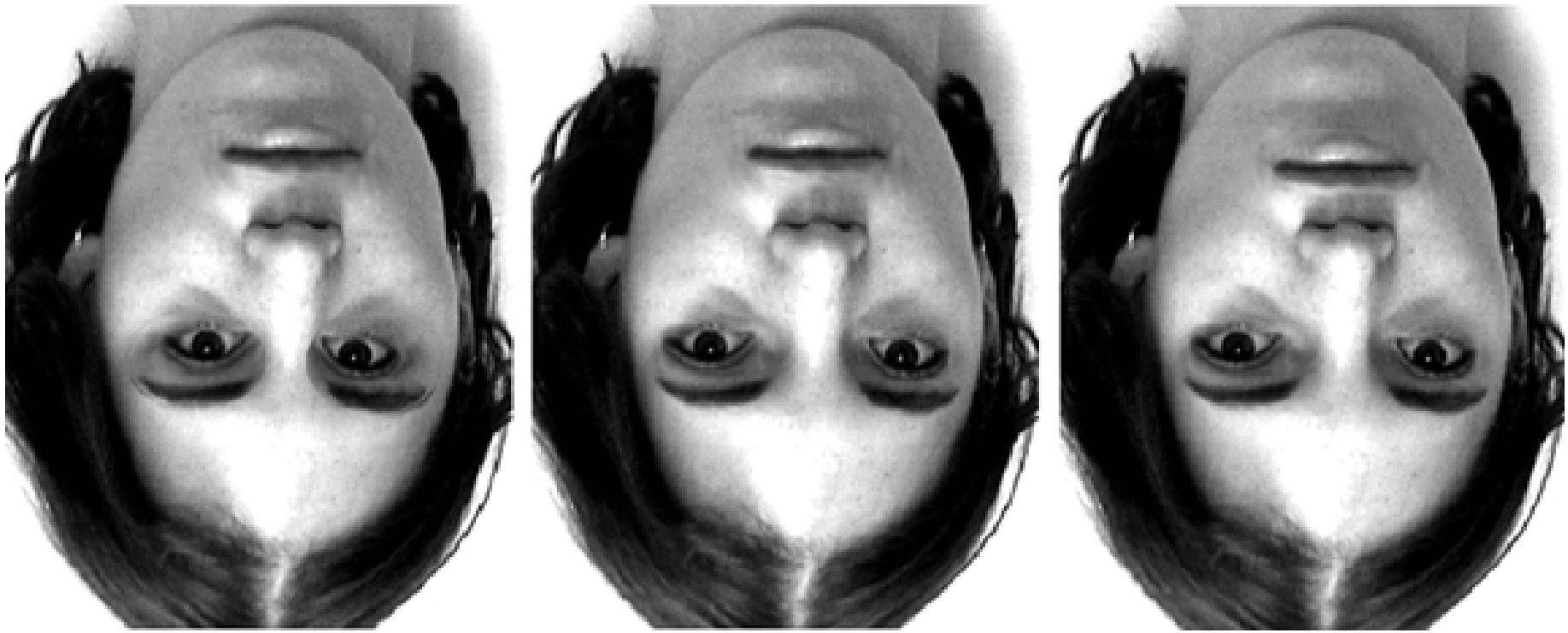
Responses of a neuron in a monkey's area IT to various stimuli. This neuron responds best to a full face, as shown by its response to monkey and human faces in the top two records. Removing the eyes or presenting a caricature of a face reduces the response. This neuron does not respond to a random arrangement of lines. (From Bruce, Desimone, & Gross, 1981.)

Modularity/ Face Perception

Ex: inverted vs. upright faces

Modularity/ Face Perception

Ex: inverted vs. upright faces



Because the most faces we see during this 'training' period are upright, the expertise we gain is orientation-specific. Contrasting perceptual skills during processing of upright faces with those during processing of inverted faces should reveal something about the nature of expert face processing mechanisms.

San José State UNIVERSITY

PERCEPTION

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PERCEPTION

Modularity/ Face Perception

Evidence for modular processing:

Holistic vs. Analytic processing:

Object vs. part recognition task:

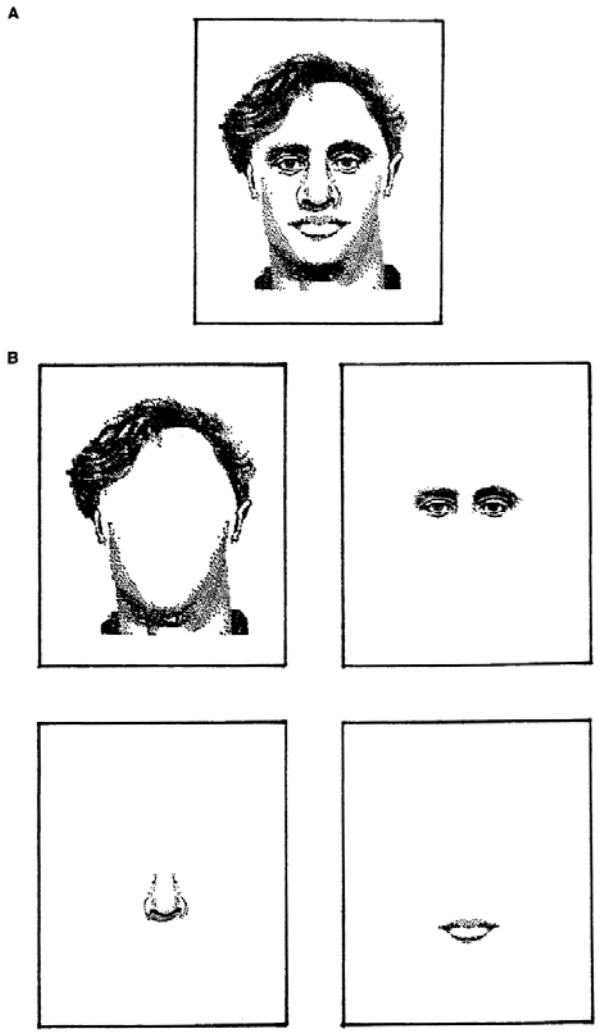
Phase 1: learning the name of upright faces and objects.

Phase 2: recognizing faces or objects in the whole condition.

Phase 3: recognizing parts of faces or objects.

Analytic face recognition < analytic object recognition.

Diamon & Carey, 1986: to recognize objects, we need *first-order relational information.* To recognize a face, the authors proposed the existence of a *second-order relational information process.*



PERCEPTION

Speech Perception

Phoneme: speech sound or phonological segment that makes a difference in meaning

Speech spectrogram: physical acoustic energy of an utterence as a function of frequency and time

Formants: