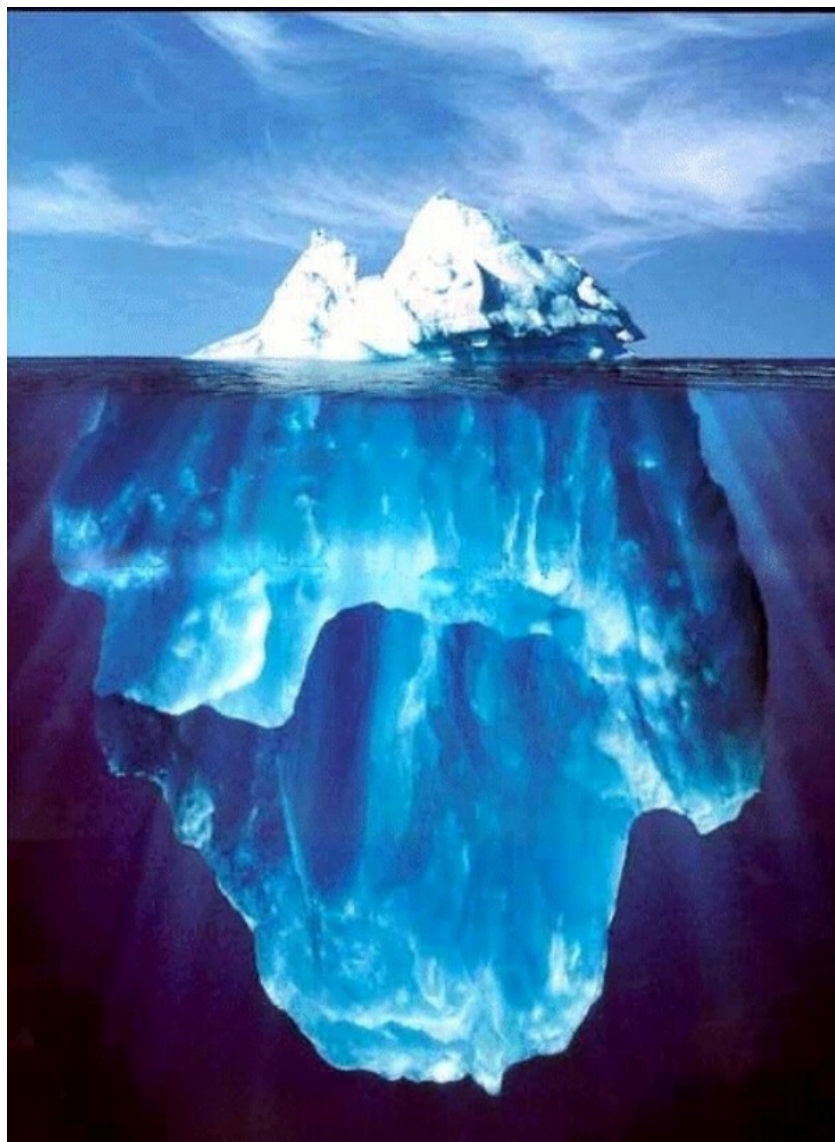


# Cognitive psychology

Introduction to information  
processing

Michaela Porubanova



# MIND

- A mysterious form of matter secreted by the brain. Its chief activity consists in the endeavor to ascertain its own nature, the futility of the attempt being due to the fact that it has nothing but itself to know itself with.
- Ambrose Bierce, *The Devil's Dictionary*

# Intro to cognitive $\Psi$



## ◎ *Cognition*

◎ - cognosco (Greek)

## ◎ *Assumptions of C $\Psi$ :*

- ◎ **a**, a human being is an individual, a subject that observes the world, anticipates, formulates hypotheses, plans, experiments, makes conclusions and via already acquired information adjusts to and forms it as well
- ◎ **b**, mental processes and external behavior depend on information we acquire
- ◎ **C**, an individual is influenced by information stored in long-term memory

# Goals and subjects of study in Cognitive psychology

⦿ to understand human cognition- how we process information (acquisition, storage, transformation, use of knowledge)

⦿ Subjects of study:

⦿ Perception

⦿ Attention

⦿ Memory

⦿ Thinking

⦿ Language

⦿ Reasoning and decision making

⦿ Consciousness

## History:

-Aristotle

-Wundt

-Ebbinghaus

-behaviorism

-gestalt

-information-processing approach

(comparison with PC)

# Keep in mind (before we start)

- ①. The cognitive processes are active, rather than passive.
- ②. The cognitive processes are remarkably efficient (what about accurate).
- ③. CP handle positive information better than negative.
- ④. CP are interrelated with one another, they do not operate in isolation.
- ⑤. Many CP rely on BOTH bottom-up (importance of info from stimuli) and top-down (role of concepts, expectations, memory) processing (e.g. recognition of a familiar person)

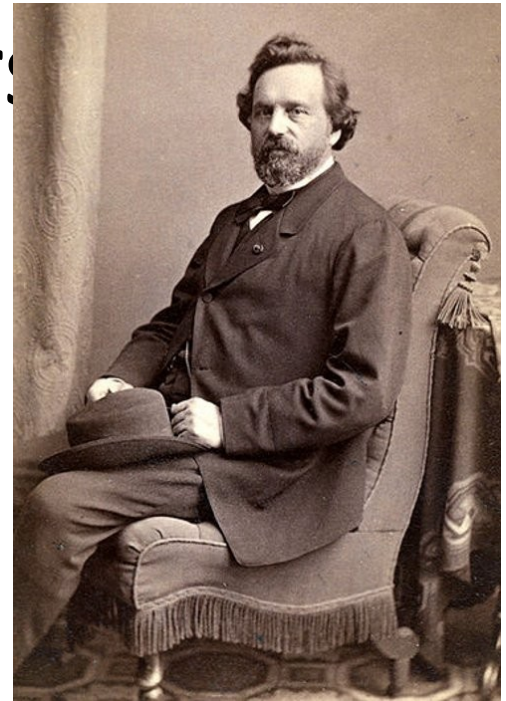
- Complexity of cognition.
- Why would you say cognition is complex?

# Brief history of CP

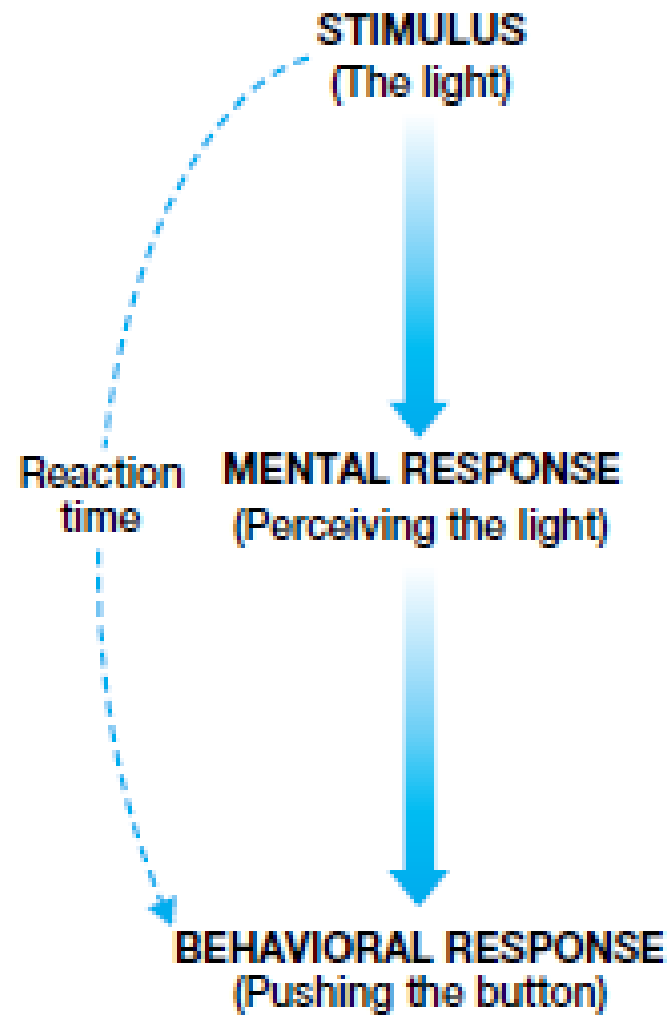
- Cognitive psychology/ cognitive science
- 19 century- F.Donders- mental chronometry
- 60<sup>th</sup> “real birth” of CS



# Franciscus Donders



- 1818-1889
- Ophthalmology
- Reaction time measures
  
- Simple RT
- [http://www.cogtest.com/tests/cognitive\\_int/crtflash1.html#top](http://www.cogtest.com/tests/cognitive_int/crtflash1.html#top)
  
- Choice RT
- [http://www.cogtest.com/tests/cognitive\\_int/crtflash1.html#top](http://www.cogtest.com/tests/cognitive_int/crtflash1.html#top)

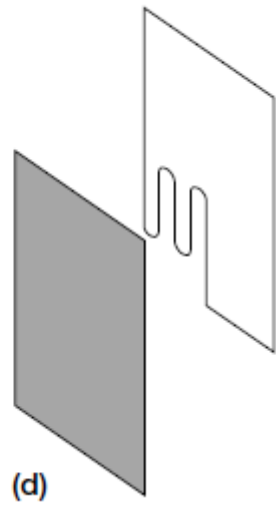
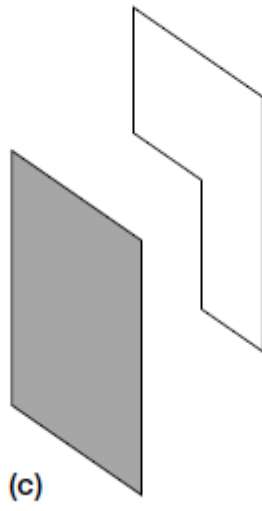
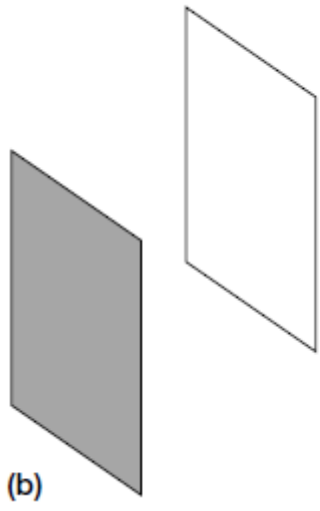
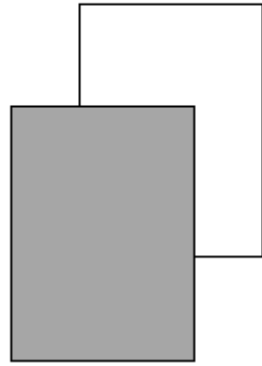


(a)

# Hermann von Helmholtz



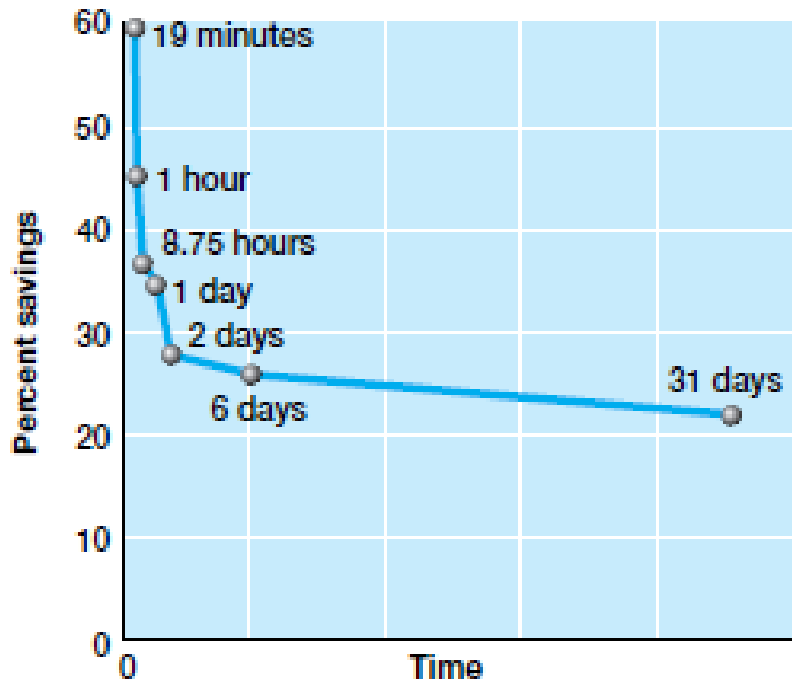
- 1821-1894
- perception
- theory of **unconscious inference**- role of  
experience in perception



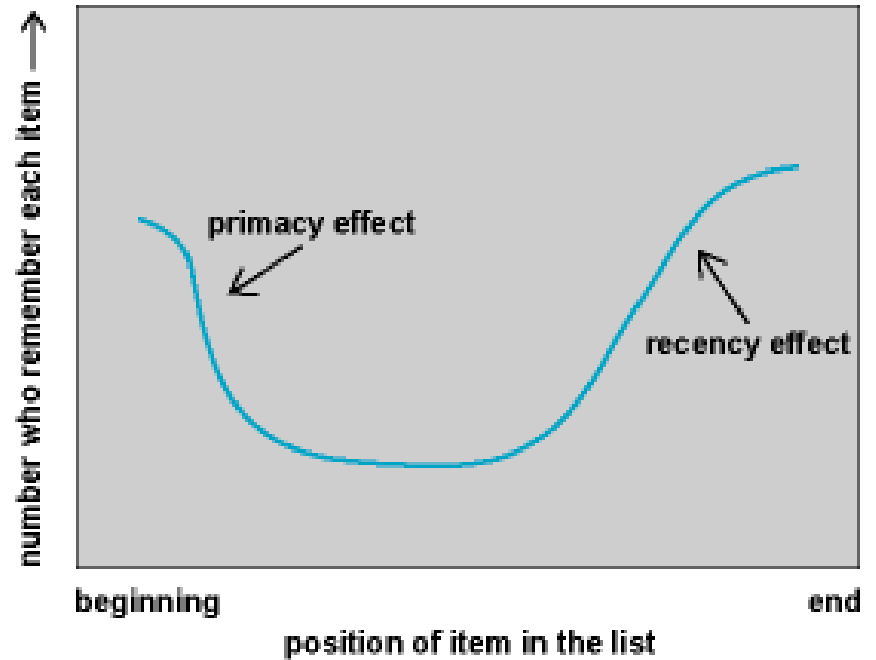
# Ebbinghaus

- 1850-1909
- Classical experiments on memory
- **serial position curve:**
- **1**, the *primacy effect*
- **2**, the *recency effect*





Ebbinghaus' s retention curve



Serial position curve

# Psychological Antecedents of Cognitive Psychology

## STRUCTURALISM



- Titchener (Phd under Wundt)
- understanding the structure of mind; influence of chemistry and physics; experience that is constituted from elements (for example: the taste of lemonade into elements of sensation : bitterness, sweetness)
- study of sensations through a method of introspection
- 4 different dimensions of sensations: quality, intensity, duration, and clarity
- problems with introspection

# Psychological Antecedents of Cognitive Psychology

## FUNCTIONALISM

---



- - William James (1842-1910)- critique of structuralism
    - purpose of mind (what does it serve for?), analysis of elements of consciousness should be disregarded, rather dynamic, unstable, changeable nature, core of the consciousness
    - how does mind serve for adaptation and functioning in the environment? (Darwin)
    - method of introspection, but also observation of behavior as a subject of study
    - theory of emotions- first theory of emotions (with Lange)  
physiological reactions cause emotions
  - **EXAMPLES**>Why do we dream -- what function does it serve?  
>Why do we have emotions -- what function do they serve?
  -
-



# Psychological Antecedents of Cognitive Psychology

## Gestalt psychology

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□ 1912

in the center of study was perception, how do we organize experience. what we see depend mainly on the stimuli in relation to the background and their organization (distance, proximity, similarity) laws of perception (Wertheimer).

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# Psychological Antecedents of Cognitive Psychology Behaviorism

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- - founded by J.B. Watson
  - - research based on results with animals mostly (influence of Darwin)- if humans are related to other species it might be useful to systematically study animal behavior and create implications for human mind functioning
    - bh refused to take into account existence of mind, or rather considered it to be the black box
    - similarly as emphasized in empiricism, a human is determined by education, upbringing
    - role of environment (compare to nativism)
-

# *Beginning of Cognitive Psychology*

## **Noam Chomsky**

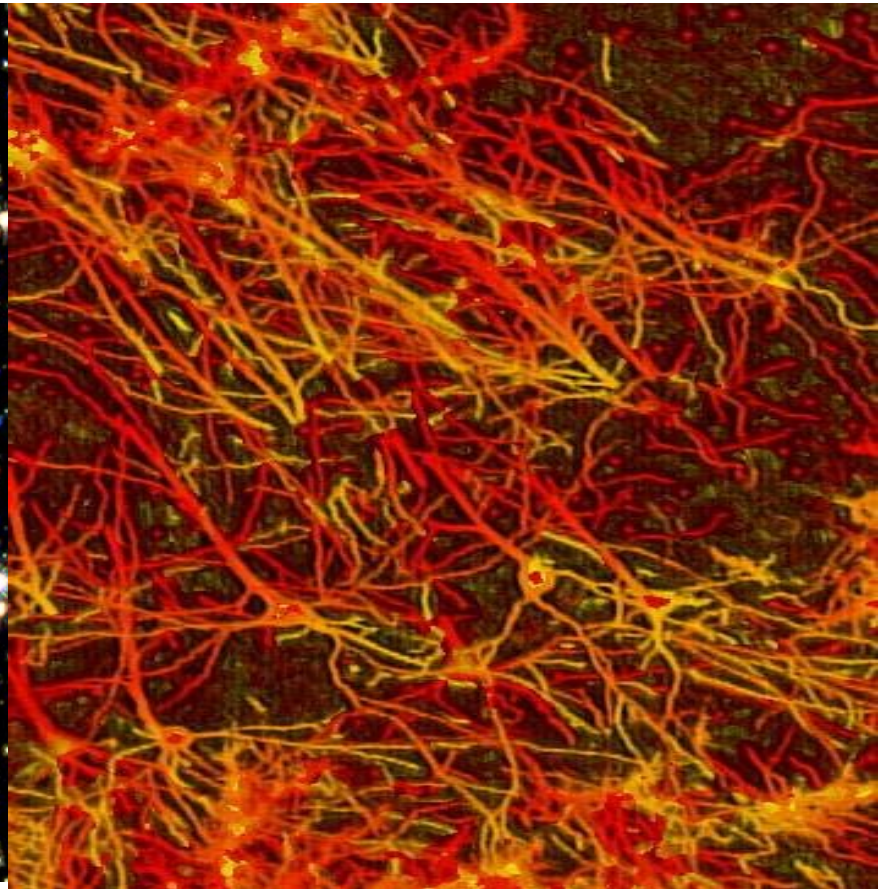
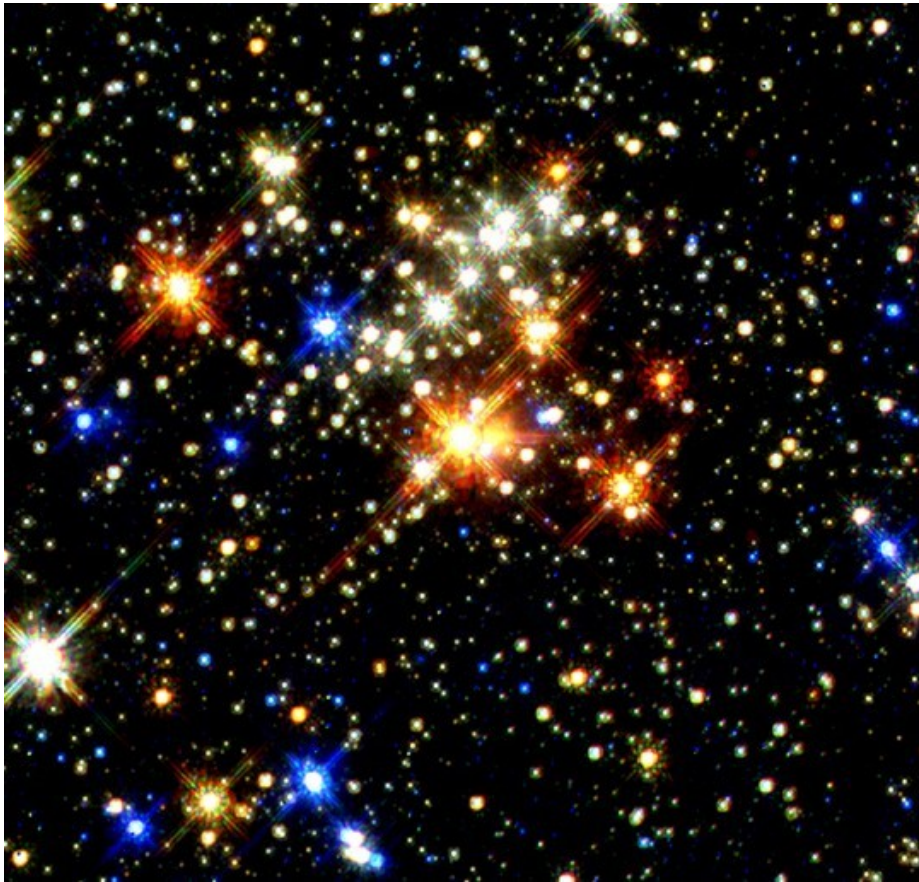
- Linguistic arguments against behaviorism
- Arguments from language acquisition
  - Behaviorists are not able to explain how children can produce newsentences they never heard
  - Generative grammar

# *Emergence of Cognitive Psychology*

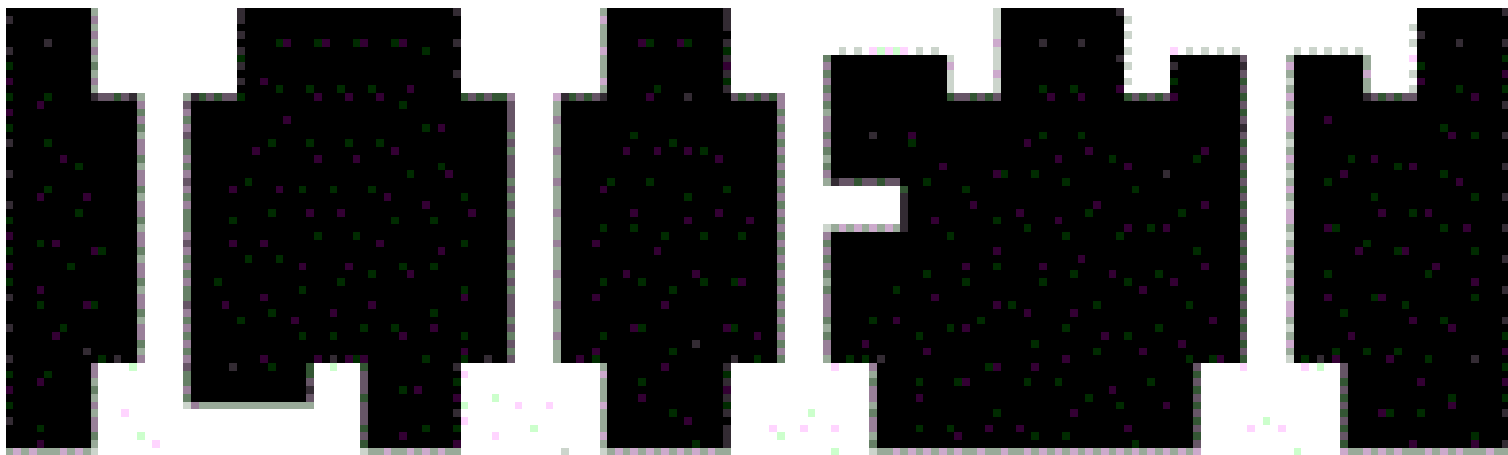
## **Alan Turing**

- Development of first computers
  - His “Colossus” computer helped break the German “Enigma” codes during the World War II
  - TURING machines- simple abstract computational devices intended to help investigate the extent and limitations of what can be computed
- Analogy between computers and human minds
  - Hardware (brain), Software (mind)
  - Thinking as a process of algorithmic manipulation of some information
  - These ideas helped to establish the information processing paradigm in psychology – thus, cognitive psychology

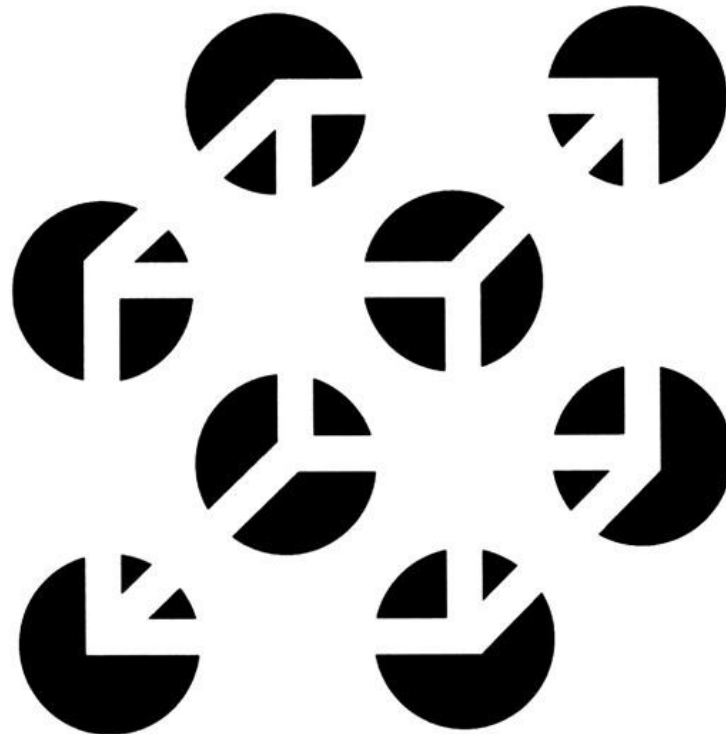
# Stars in Milky way vs. Neurons in brain





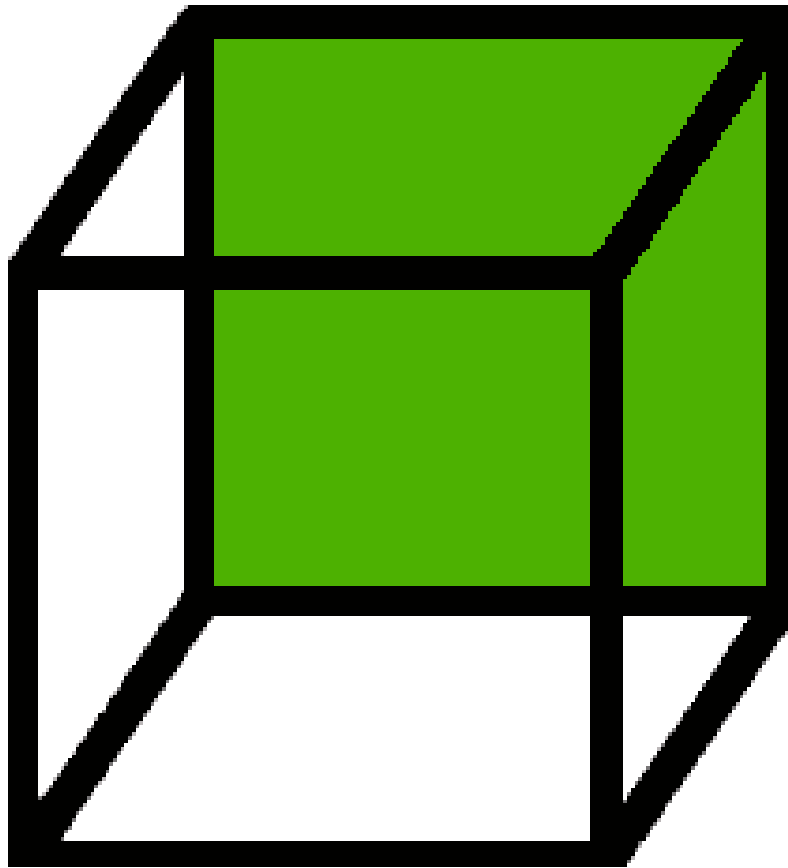


# Necker cube



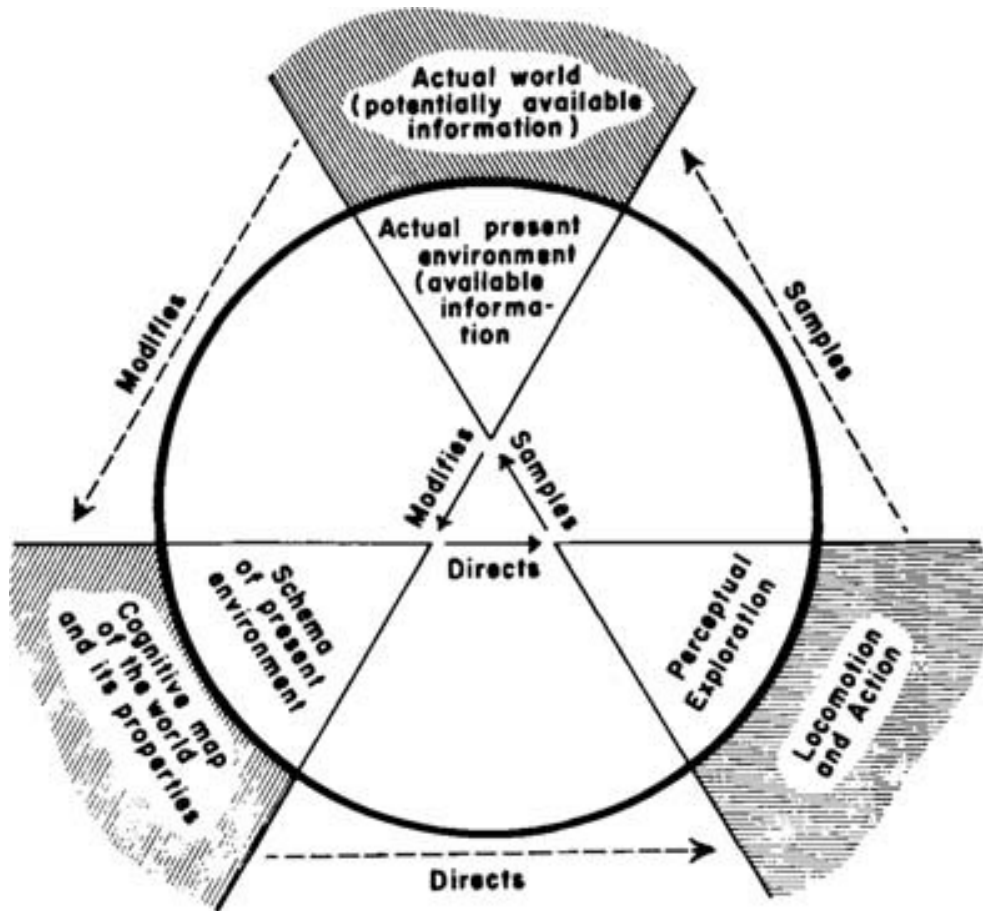


Necker cube



# Perception

- Object recognition
- Gibson (bottom-up information processing)
- Constructivism (top- down information processing)
- Gestalt principles
- Optical illusions



Ulric Neisser's perception cycle

The process  
of perception

- How does perception depend on incoming stimulation and existing knowledge?

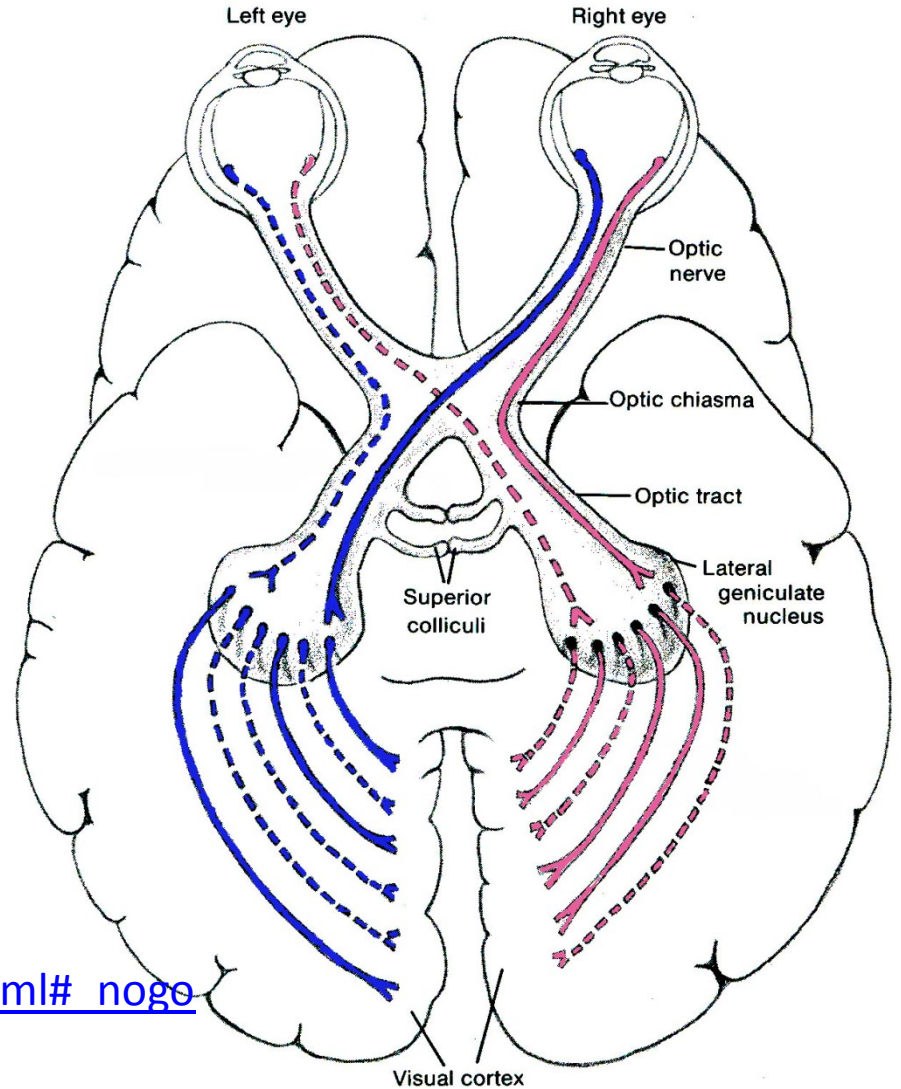
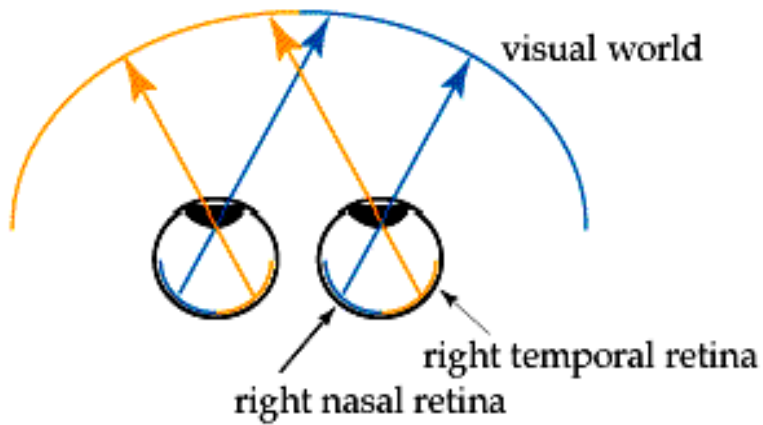
Perceiving  
objects

- How are objects analyzed into features early in the process of perception?
- How are elements in a scene organized into objects?

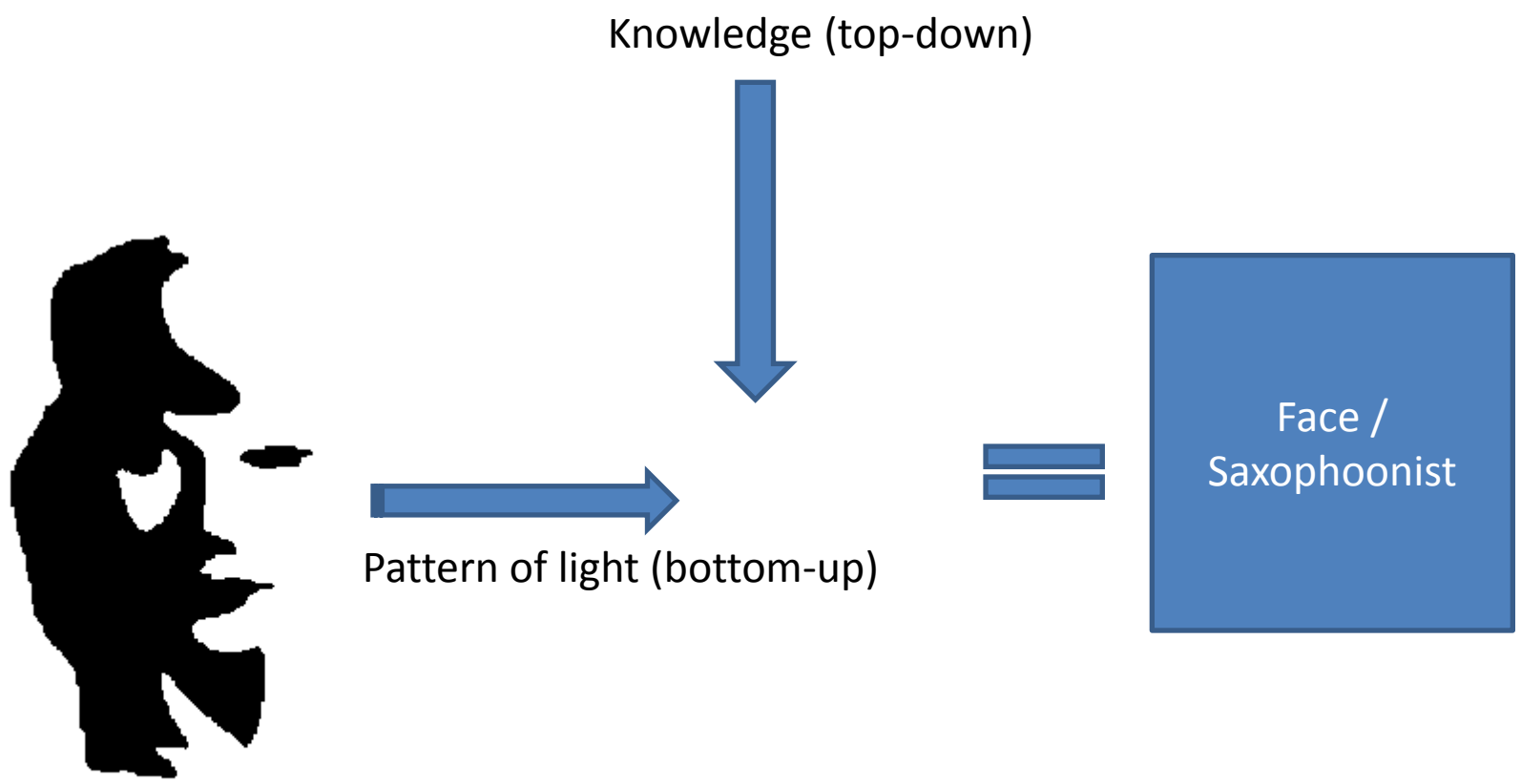
Perceptual  
intelligence

- How do humans use perceptual intelligence to perceive objects?

# Visual pathways



[http://iknow.net/phys\\_eye\\_education.html#\\_nogo](http://iknow.net/phys_eye_education.html#_nogo)



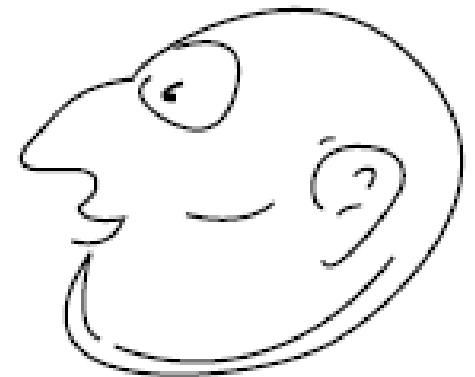
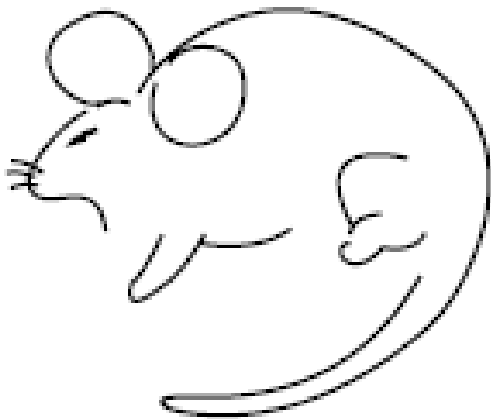
Knowledge (top-down)



Pattern of light (bottom-up)



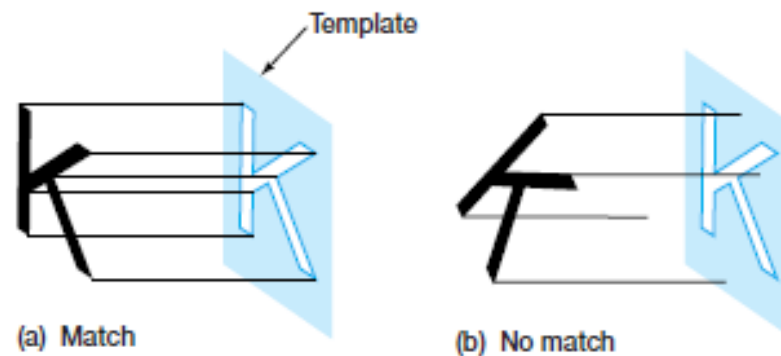
Face /  
Saxophonist



rat-man demonstration

# Object recognition- template matching

- Disadvantages?

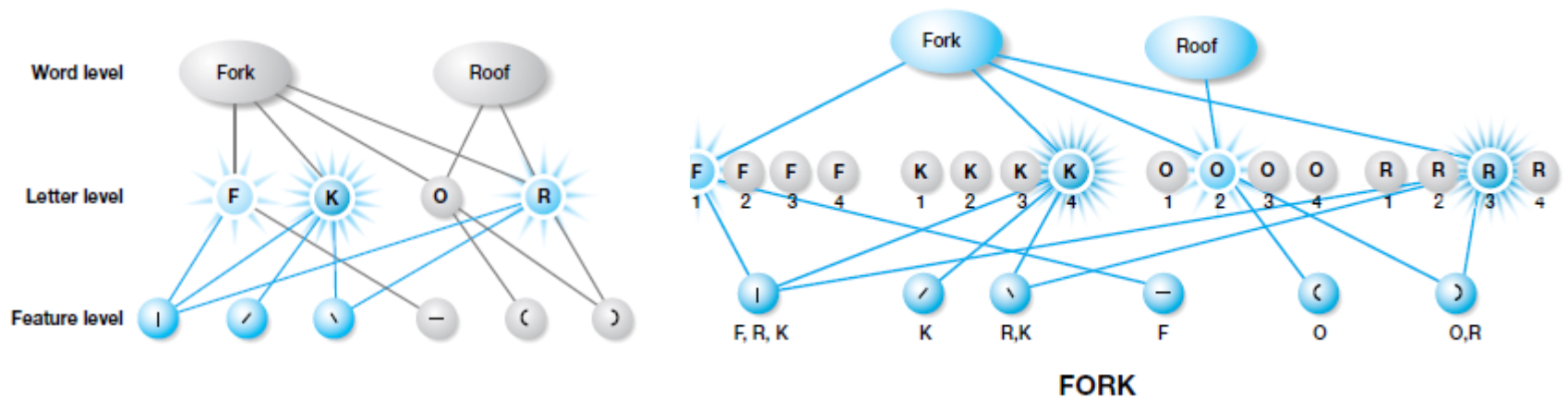


(c) Different kinds of K's that share features

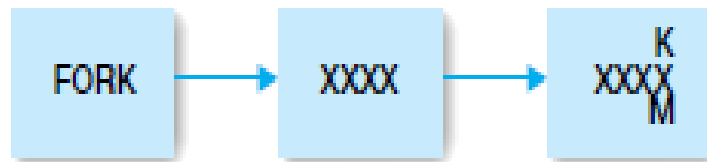


# Object recognition- Interactive activation model

- Rumelhart & McClelland



# Interactive activation model : Word Superiority Effect



(a)

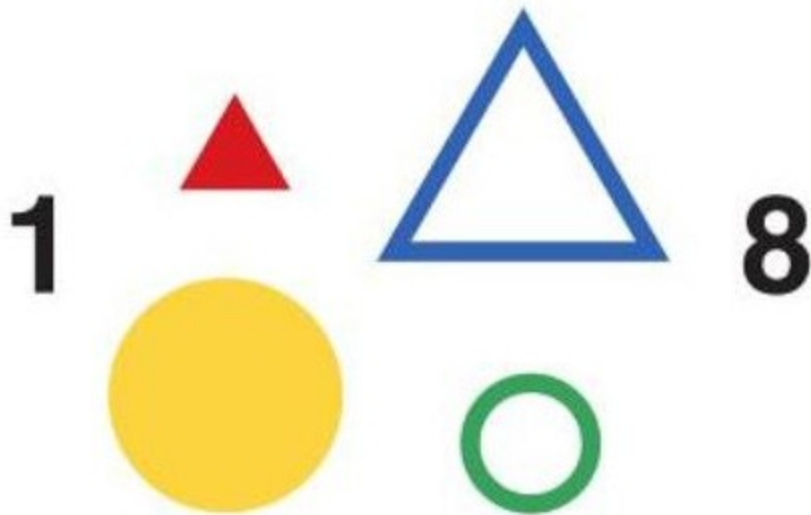


(b)

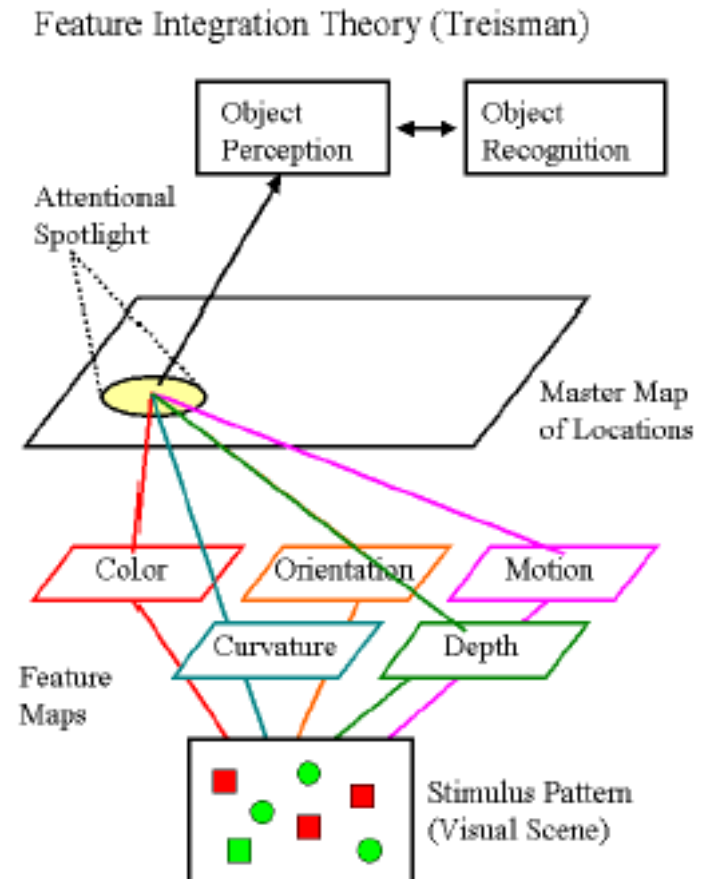


(c)

# Feature Integration Theory



illusory conjunctions occur because at the beginning of the perceptual process each feature exists independently of the others

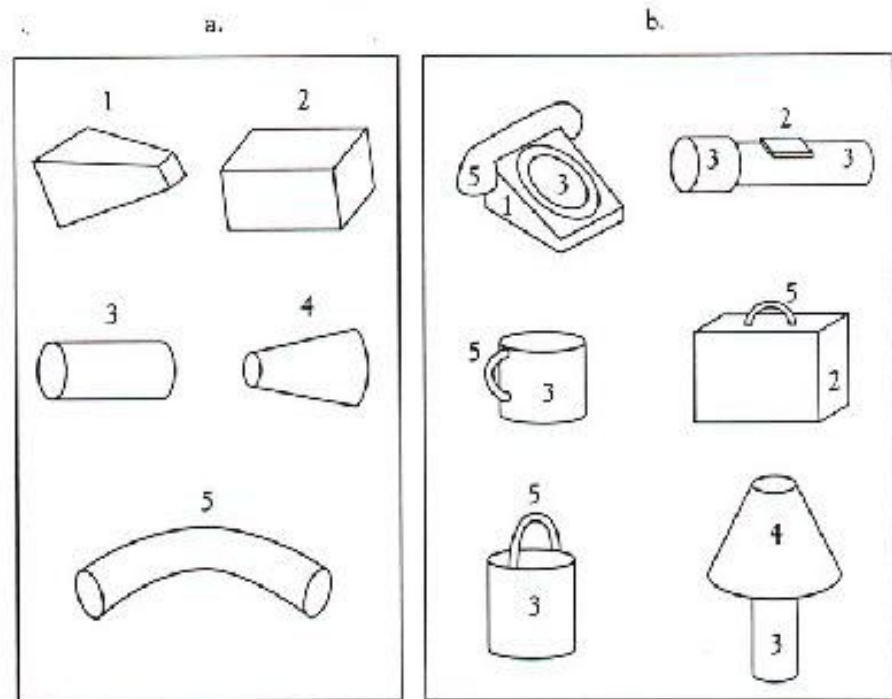


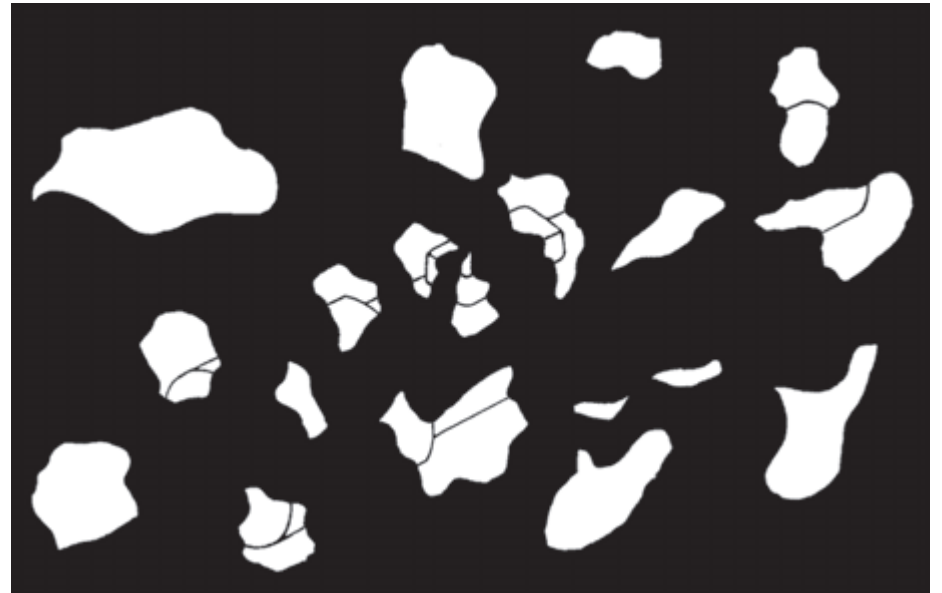
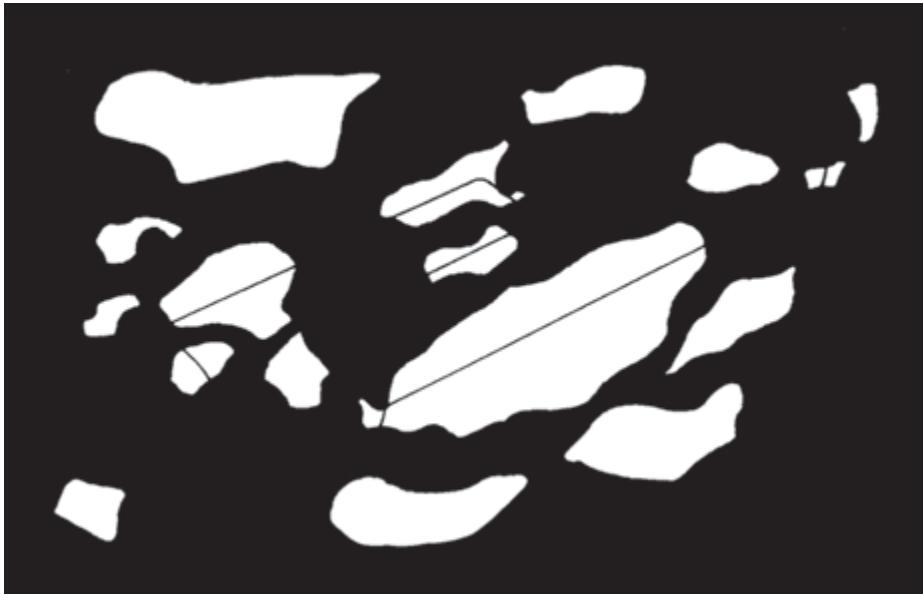


# Recognition-by-Components Theory

- Geons:
- -36
- -can be identified v angles
- -view invariance
- -discriminability
- - resistance to visu

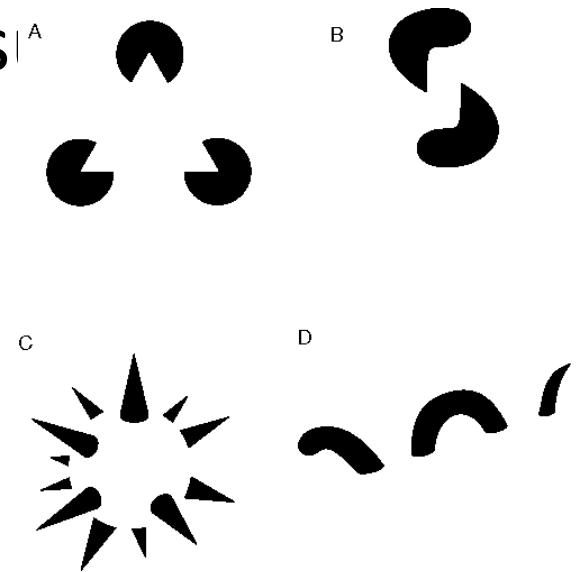
Examples of Geons (Left) and Representative Objects That Can Be Constructed from the Geons (Right). (From Biederman, 1990).





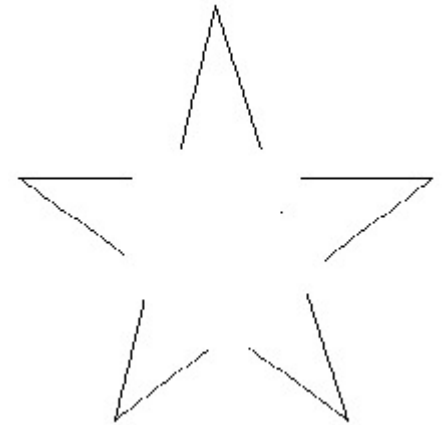
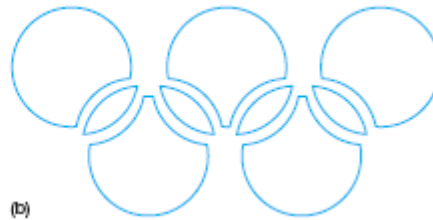
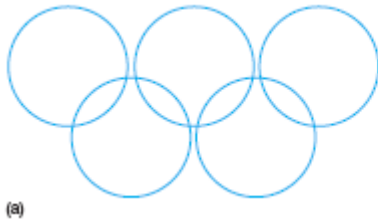
# Perceptual organization

- the organization of elements of the environment into objects
- Gestaltists
- “The whole is greater than the s|  
parts”



# *laws of perceptual organization*

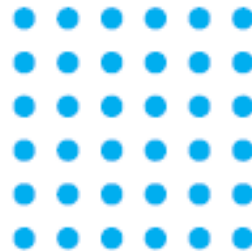
- Law of Pregnanz (good form/shape/figure)
- - every stimulus patterns perceived in the simplest possible form



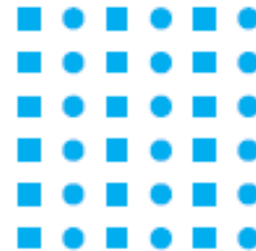


# *laws of perceptual organization*

- Law of similarity



(a)

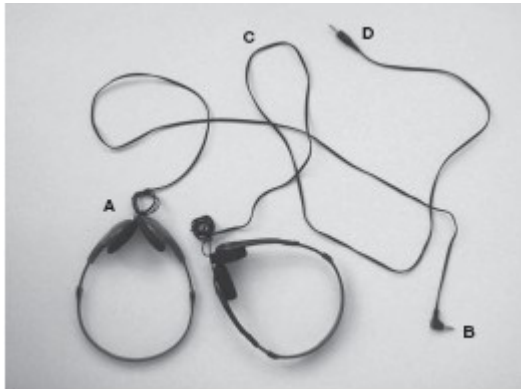


(b)



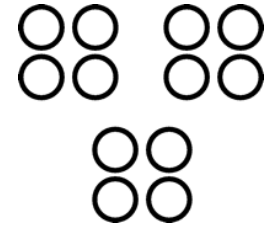
(c)

- Law of good continuation

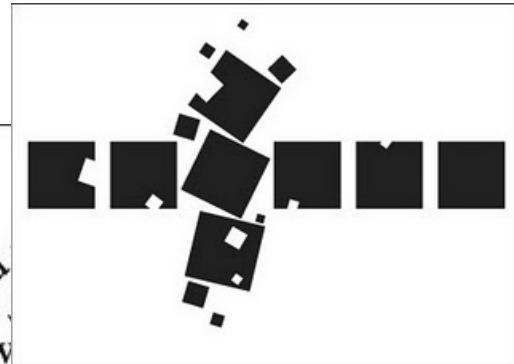
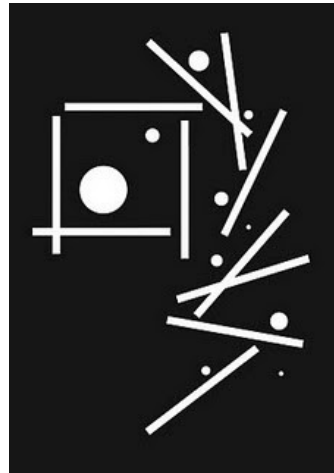


# *laws of perceptual organization*

- Proximity



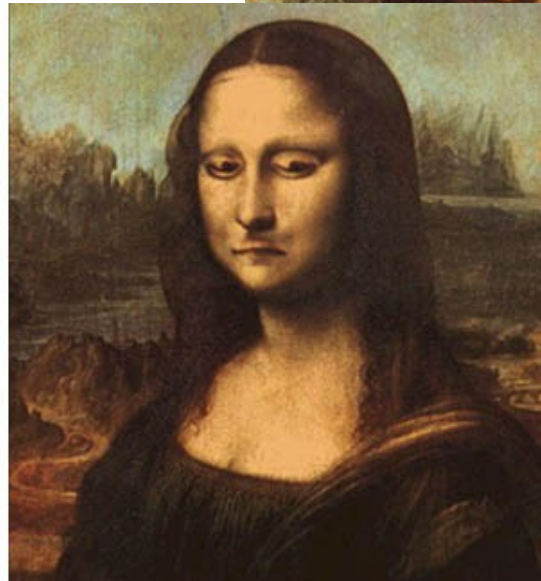
- Common Fate



- Familiarity



# Familiarity/ Meaningfulness



# Gibson's theory of direct perception

- ❖ ecological' theory: with background, horizons, other objects, etc. all playing a part.
- ❖ Gibson first developed his theory during WW2 when he was given the task of preparing training films for pilots. From this he developed a theory of optic flow patterns, based on a fixed point towards which the pilot is moving which appears motionless. The rest of the visual environment is moving away from that point, flowing over and around the viewer.
- ❖ **Affordance**
- ❖ This means attaching particular meaning to visual information. Gibson rejected the theory that long term memory provides meaning. Rather, he argued that the potential use of an object is directly perceivable - a ladder 'affords' climbing up or down, a chair 'affords' sitting.
- ❖ Gibson's theory was that of direct perception, which means that humans directly perceive their environment through stimulation of the retina. Traditionally, and especially by Gestalt psychologists, perception was believed to be indirect. According to this theory, humans do not directly perceive their environment. It is only through sensory stimulation over time that we learn what is in our environments, and that we perceive much more than mere sensory input.



# Constructivist theory of perception

- “Constructivists” such as Helmholtz, Rock and Gregory claim that incoming visual data are insufficient for perception to be achieved, and that the brain must supplement these data with top down processing
- process whereby the brain makes a series of hypotheses about the external world, stress the importance of central factors such as memory and expectation in determining the phenomenological content of perception



# Comparison between the theories

- Comparison of two theories to perception:
  - 1. Mental processes to pick up information or not
    - The constructivists see the stimulation reaching our senses as inherently insufficient necessitating an “intelligent” perceptual system that relies on inferential types of mechanisms to overcome this inherent equivocality of stimulation.
    - The ecologically oriented theorists argue that the information in the ambient environment suffices and is not equivocal and thus no “mental processes” are needed to enable the pick up of the relevant information.
  - 2. Direct or indirect perception
    - The constructivists see perception as multistage with mediational processes intervening between stimulation and percept, i.e., perception is indirect.
    - The ecological theorists see perception as a single-stage process, i.e., it is direct and immediate.
  - 3. Relying on stored information
    - For the constructivists, memory, stored schemata, and past experience play an important role in perception.
    - The ecologically oriented approach sees no role for memory and related phenomena in perception.
  - 4. Process versus stimulation
    - The constructivists excel at analyzing the processes and mechanisms underlying perception.
    - The ecological approach excels at the analysis of the stimulation reaching the observer.

# AMES ROOM

- <http://www.youtube.com/watch?v=Ttd0YjXF0no&feature=related>



# Architecture of Ames Room

