Perception

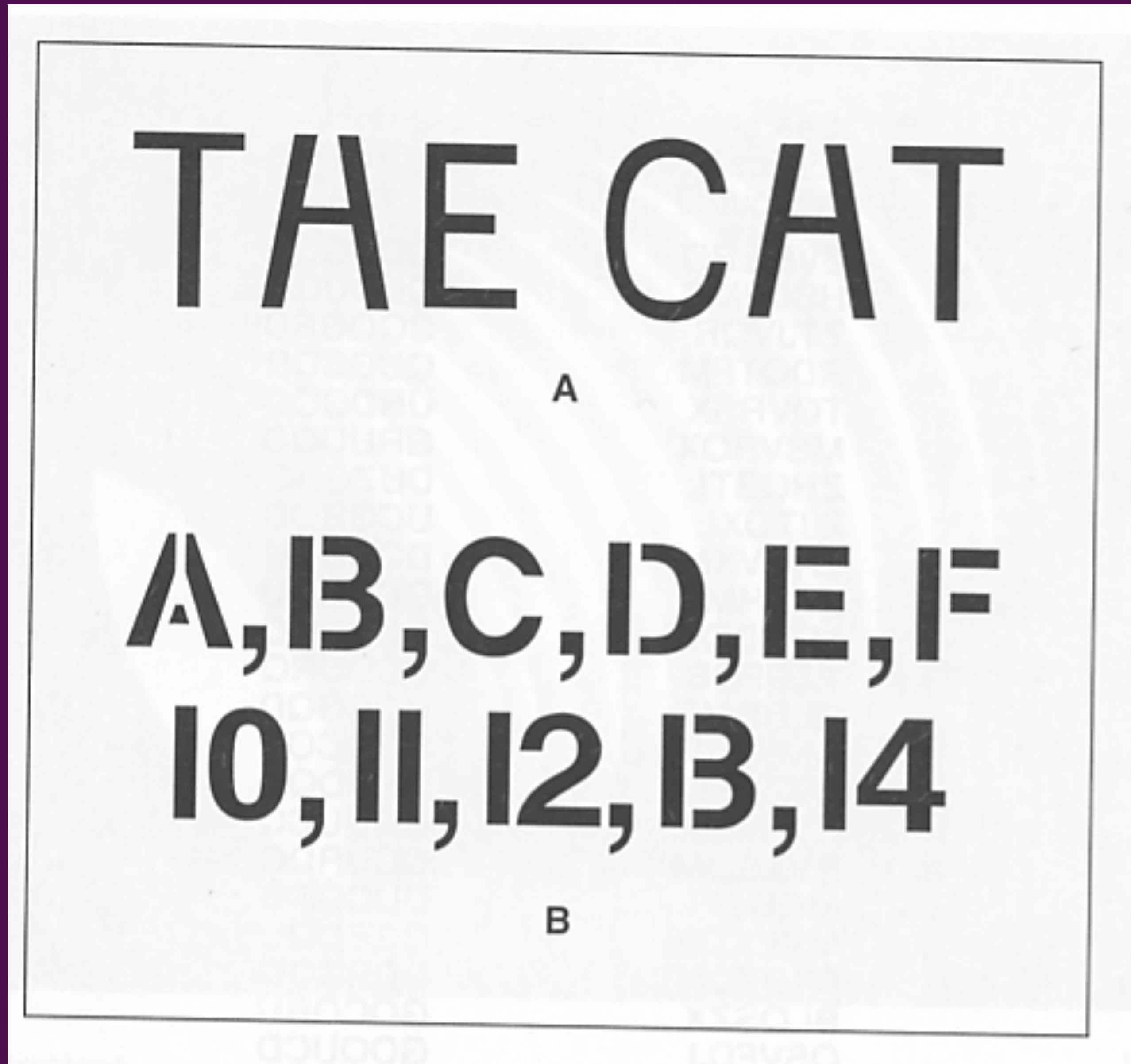
- Why is perception important for cognition?
  - Grounding for abstract thought
  - False dichotomy between perception and cognition
- Top-down and bottom-up perception
- Perception as observer-dependent

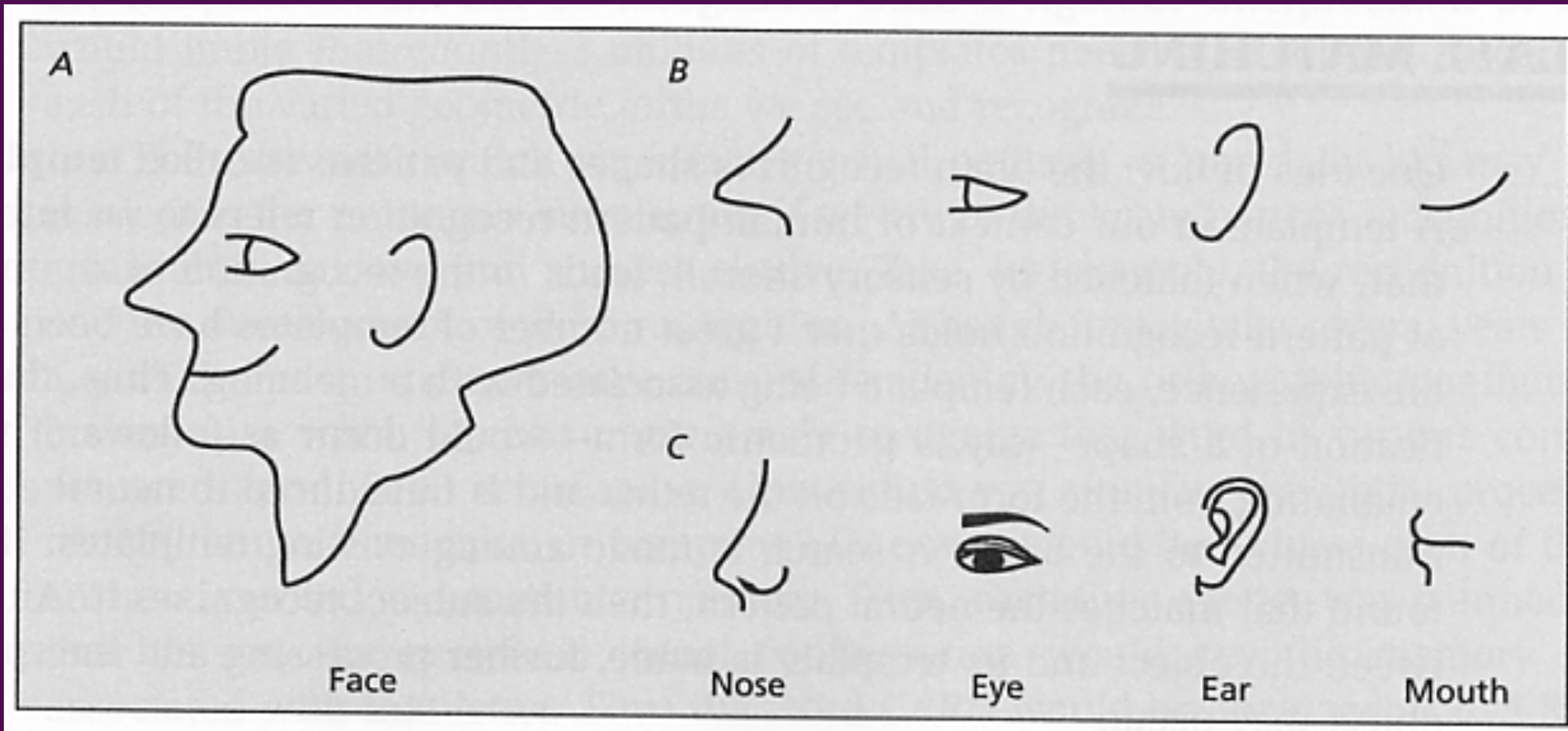
Bottom-up and Top-down Perception

- Bottom-up perception
  - Physical characteristics of stimulus drive perception
  - Realism
- Top-down perception
  - Knowledge, expectations, or thoughts influence perception
  - Constructivism: we structure the world
  - "Perception is not determined simply by stimulus patterns; rather it is a dynamic searching for the best interpretation of the available data." (Gregory, 1966)

Evidence for Top-down Perception

- Perception is context-sensitive
  - THE CAT, ABC 12 13 14
  - Face perception, Archimbaldo's Vegetable Head
  - McGurk Effect: auditory "ba" + visual "ga" -> heard "da"
  - The Word superiority effect
    - Easier to identify letter in word than by itself, or in non-word
    - Rumelhart and McClelland's Interactive Activation Model


A
B


A
B
C
Face
Nose
Eye
Ear
Mouth

Archimbaldo

McGurck Effect

Speech that is **heard** depends upon face that is **seen**

Auditory	Ba	Ga	Ba	Ba	Ba	Ba	Ba	Ba	Ba	Ba	Ba
Visual	Ba	Ga	Ba	Ga	Ba	Ga	Ba	Ga	Ba	Ga	Ba
Heard	Ba	Ga	Ba	Da	Ba	Da	Ba	Da	Ba	Da	Ba

Word Superiority Effect

WORK / XXXK

---K
Or ?
---D

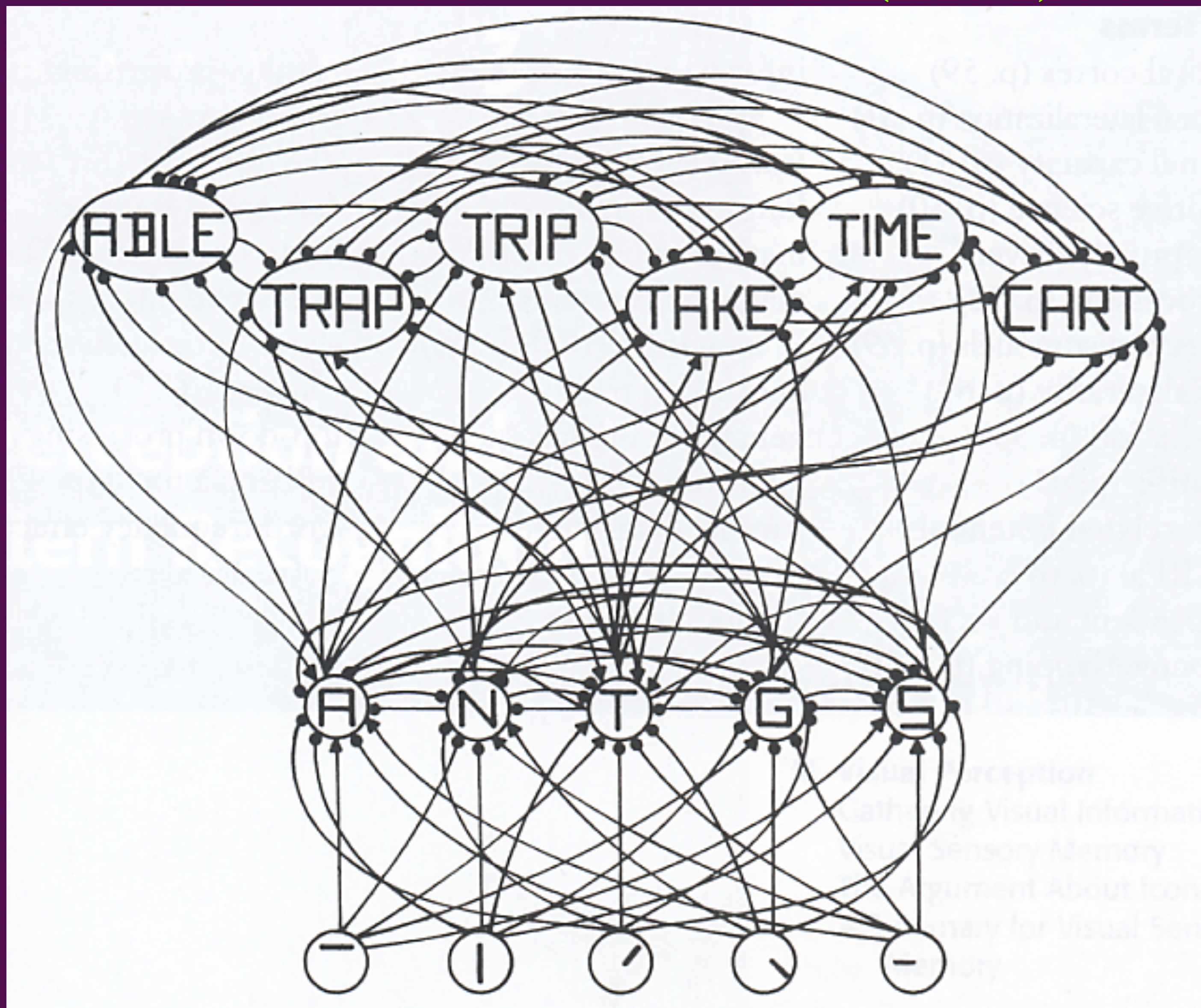
XXXK

---K
Or ?
---D

Subjects are more likely to choose the correct letter when it is in the context of a word than when it is isolated or in a non-word.

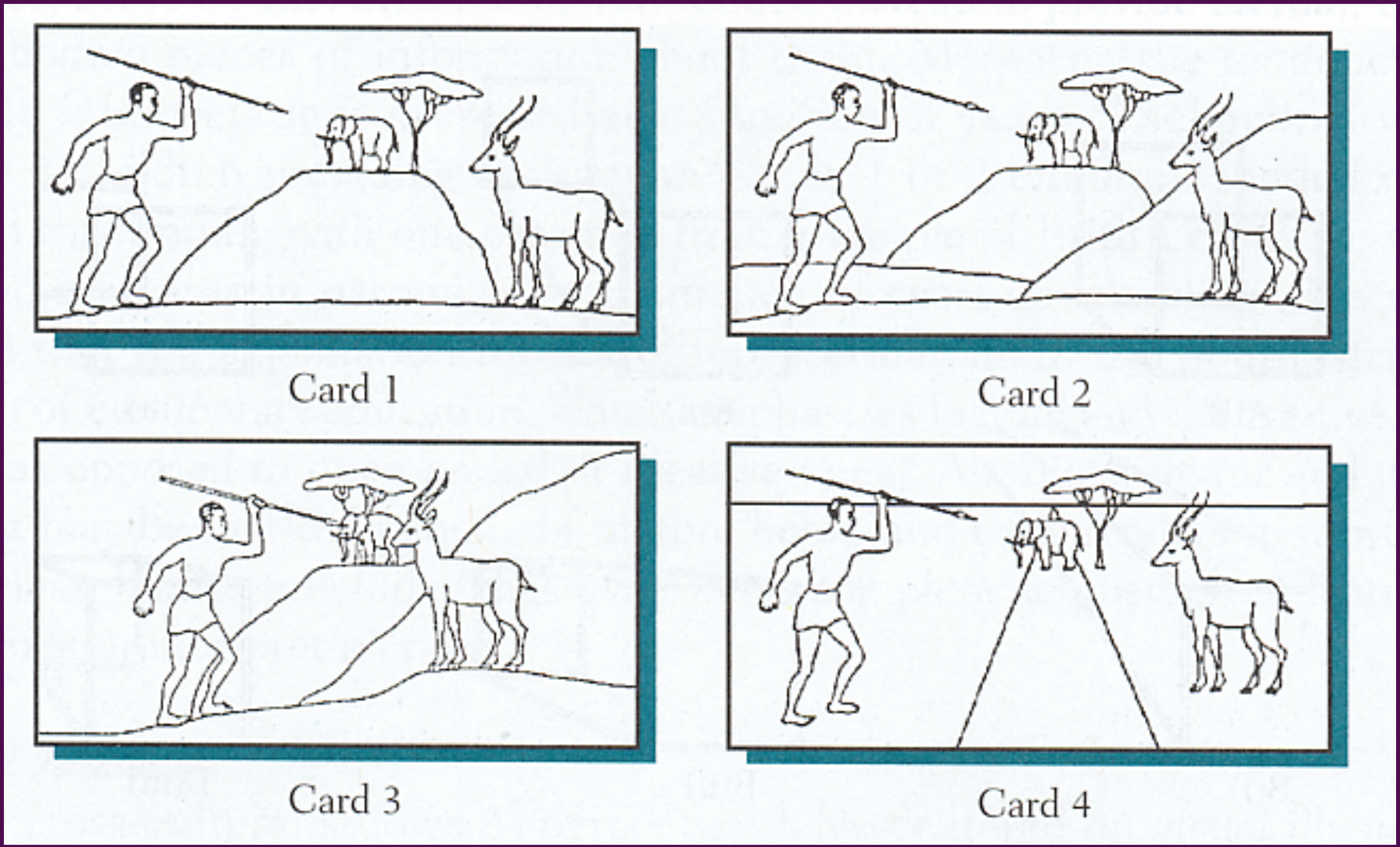
Context improves people's sensitivity, not just bias

Interactive Activation Model
McClelland & Rumelhart (1981)



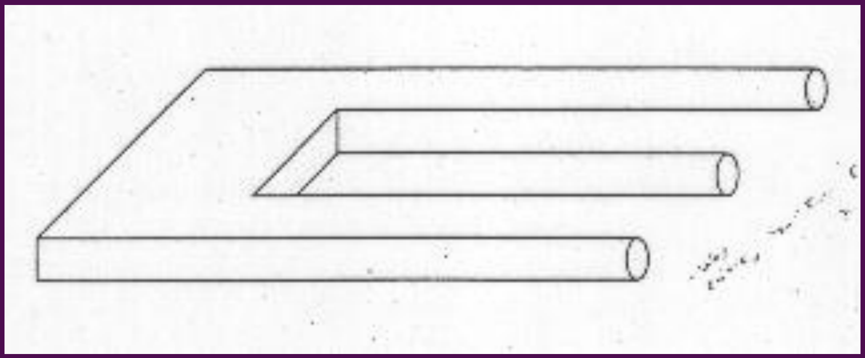
Evidence for Top-down Perception

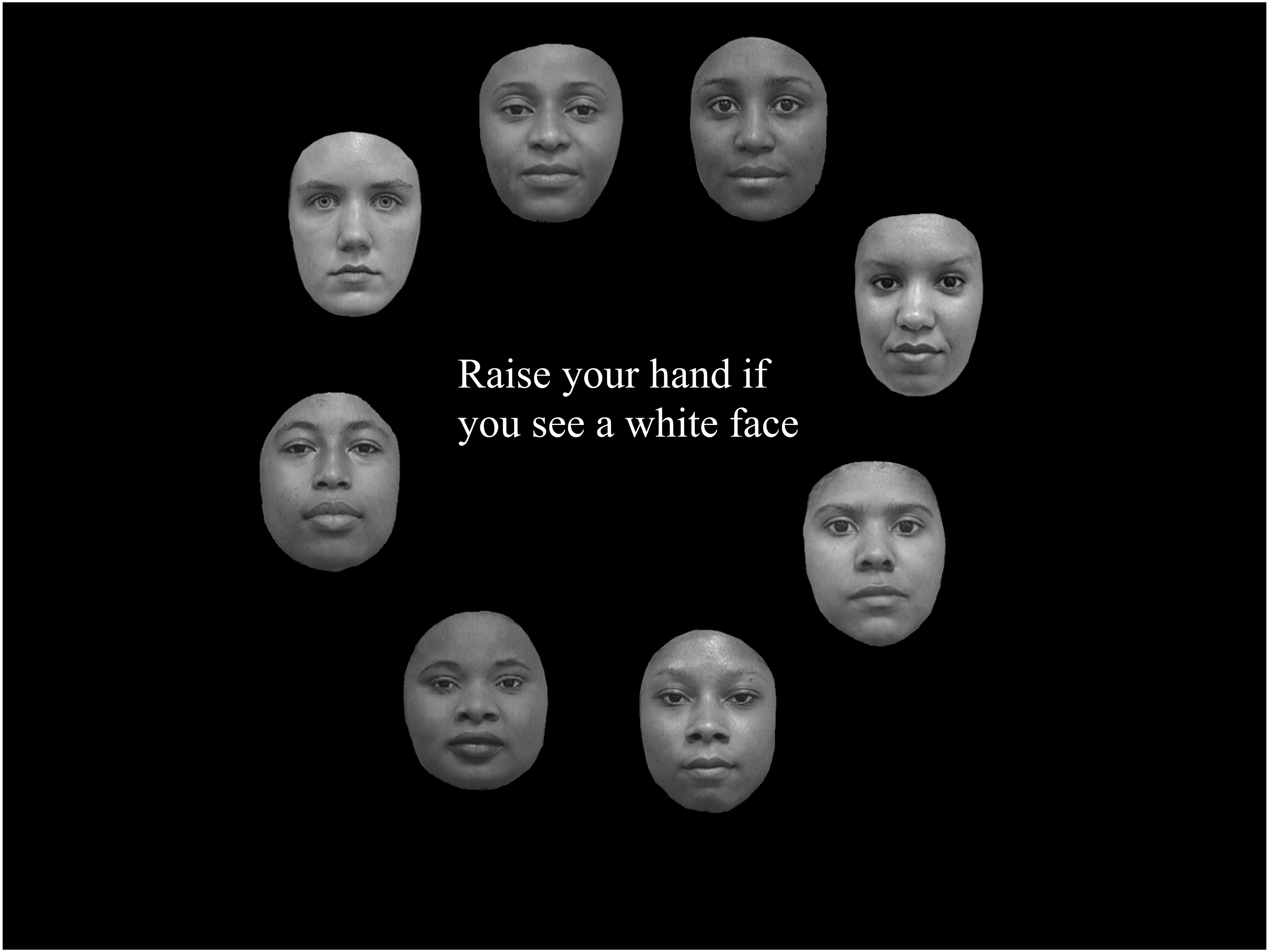
- Race Perception
  - People can learn names for faces of their same race better than faces of another race (O'Toole, 1996)
  - People can categorize <u>by </u>race people of another race faster than their own race
  - For white subjects, a black face among white faces is more quickly spotted than a white face among black faces (Levin, 2000)

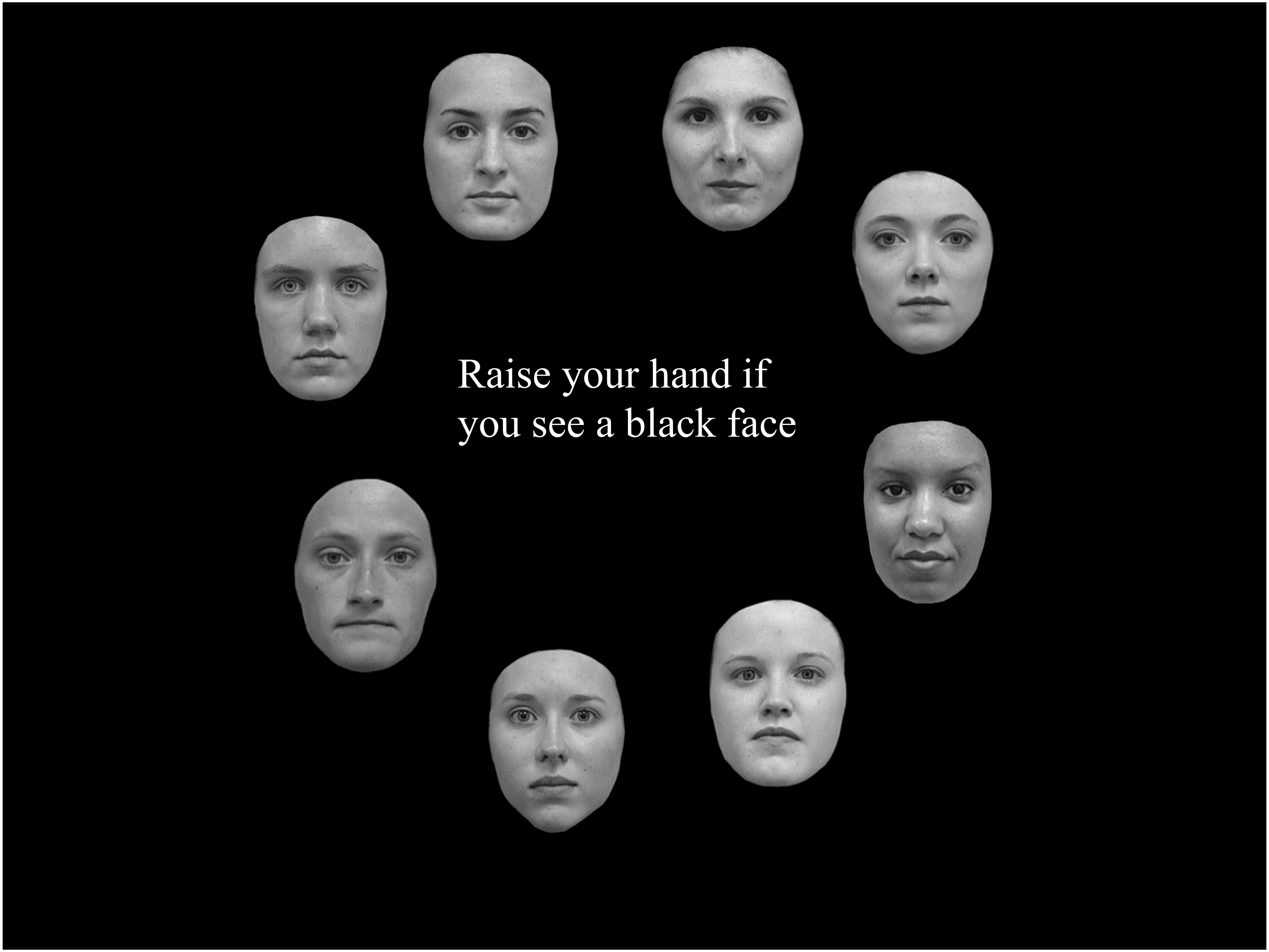


Zambians believe the hunter is about to spear the elephant (Deregowski, 1972)

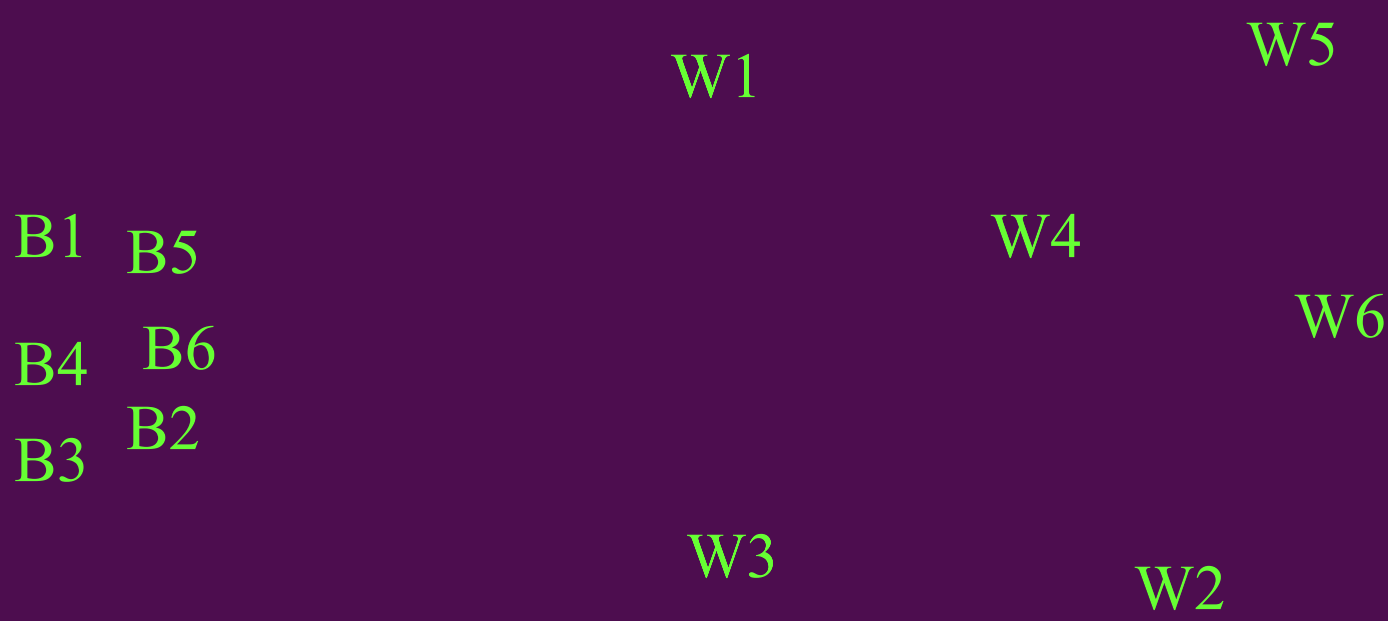
Zambians require less inspection time to copy drawing




Raise your hand if
you see a white face


Raise your hand if
you see a black face

The similarities of faces for a white subject



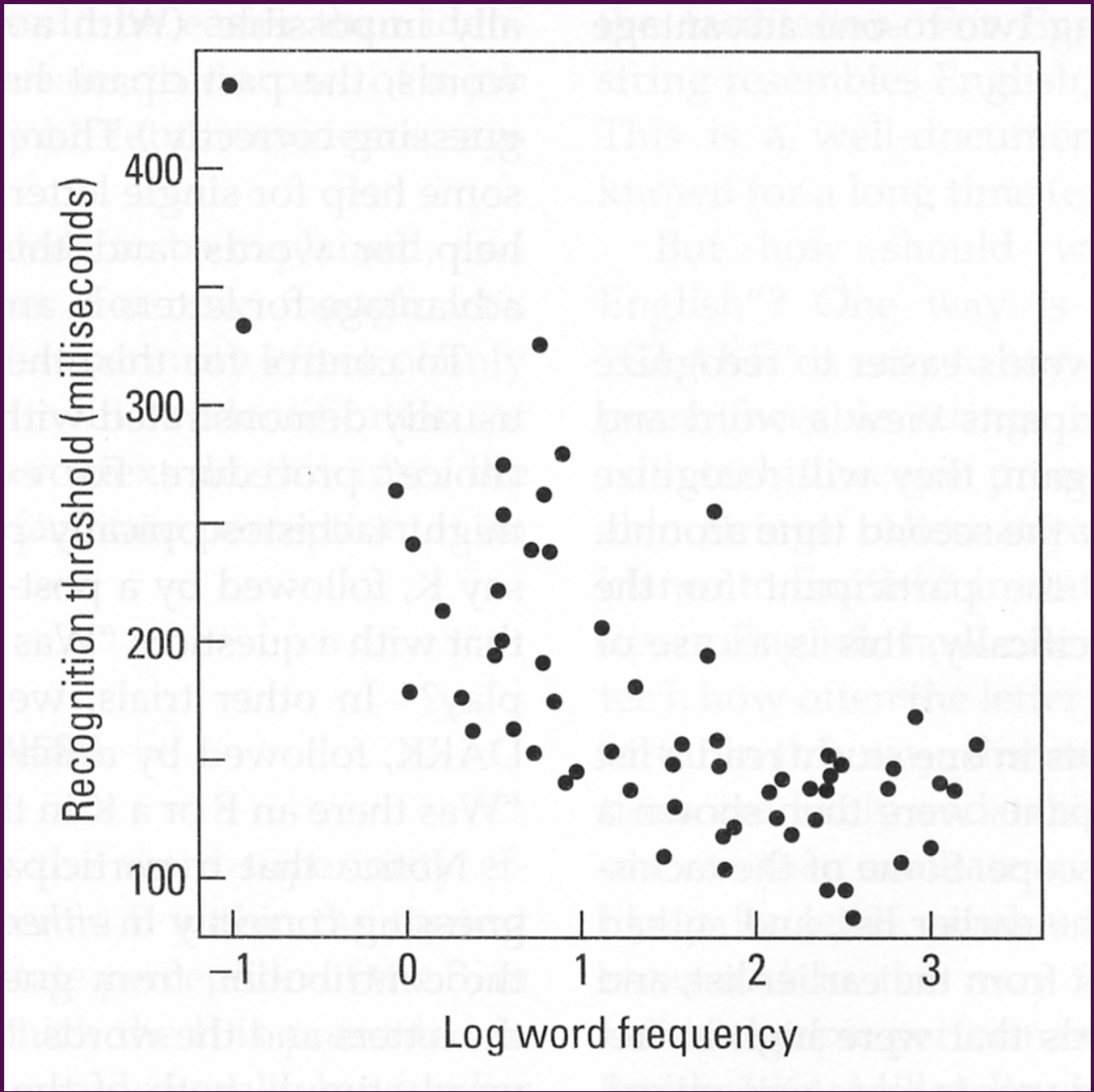
Black faces hard to identify (e.g. as “John”) because they seem similar.

Categorizing a face as “black” is easy because black faces seem similar.

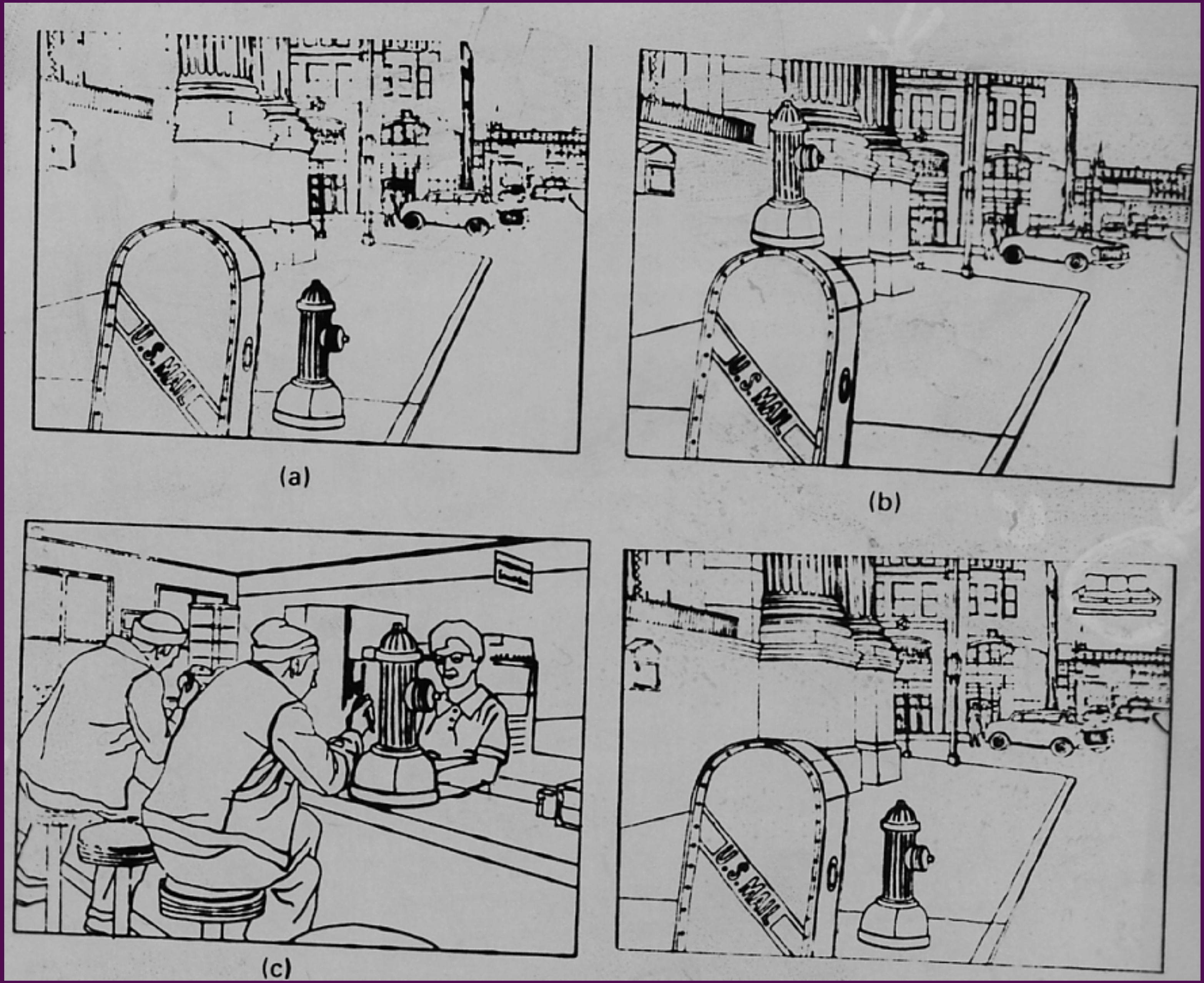
Evidence for Top-down Perception

- Perception is biased by observer's expectations
  - Influence of object on color perception (Delk & Fillenbaum, 1965; Hansen et al., 2006)
  - Recognition time for unexpected events (e.g. red ace of spades)
  - Object identification in scenes (Biederman et al, 1982)
  - "Aha" effect with degraded object perception

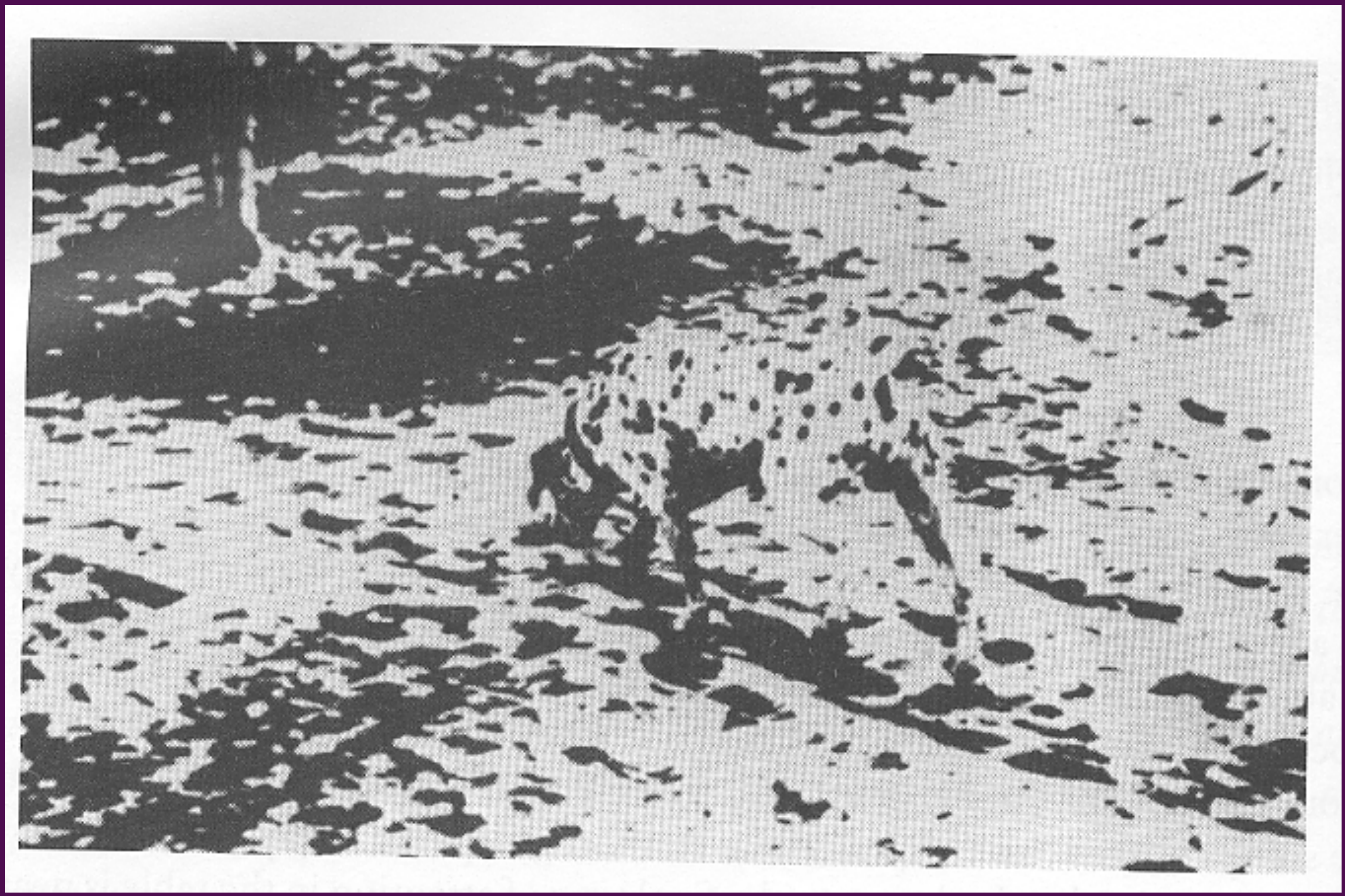
As word become rarer, takes longer to recognize it



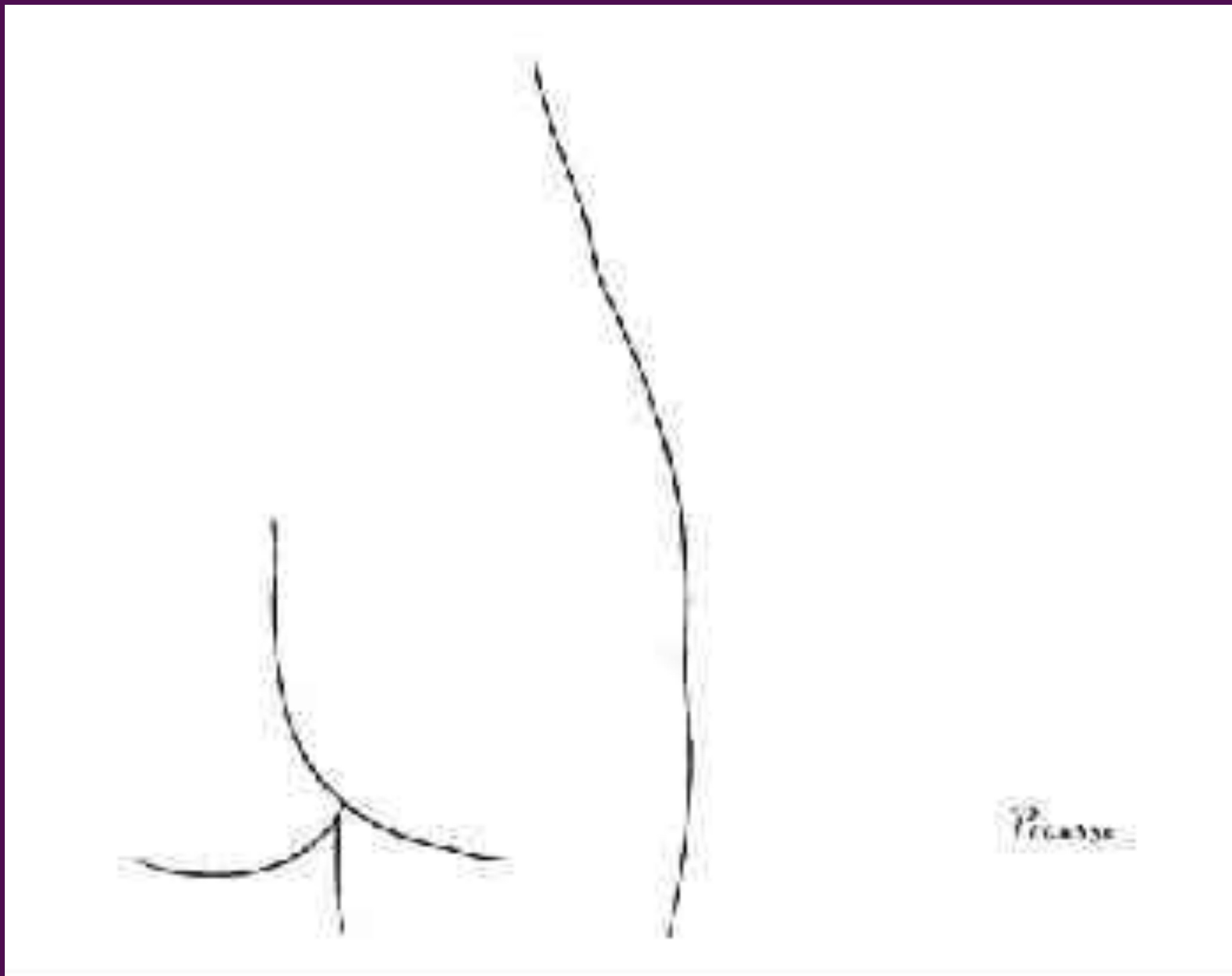
If an object is unexpected, it is hard to see



Knowing where an object is can make an otherwise invisible object appear



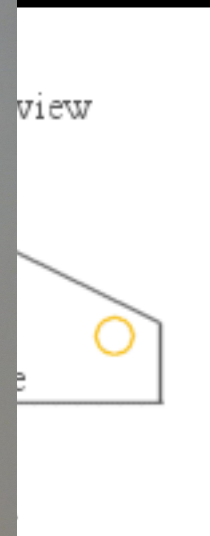
Matisse



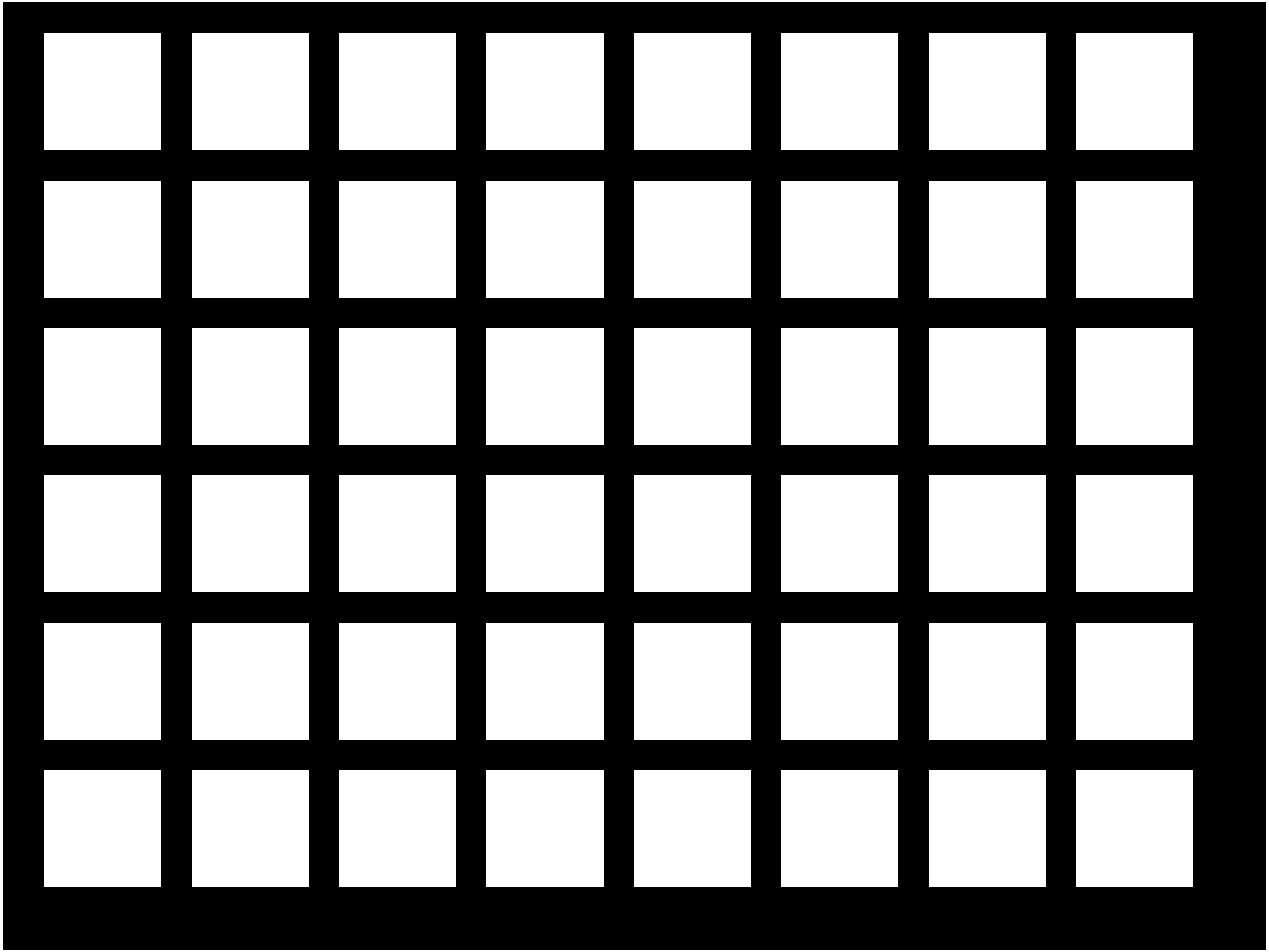
Perceptual Illusions

- Why study illusions?
  - Illusions reveal constraints/biases on perception
    - Constraints are perceptual assumptions that we make
      - Usually correct but occasionally wrong
      - When wrong, illusion results
    - Illusions come from helpful processes
      - Without constraints, no perception at all!
      - Our perceptual system is biased to emphasize important aspects
        - » Hermann's Grid and lateral inhibition
        - » We are built to detect contrast
  - Explore human contribution to perception by dissociating real world from our perception of it

Ames Room



We naturally assume that the room is rectangular, not trapezoid

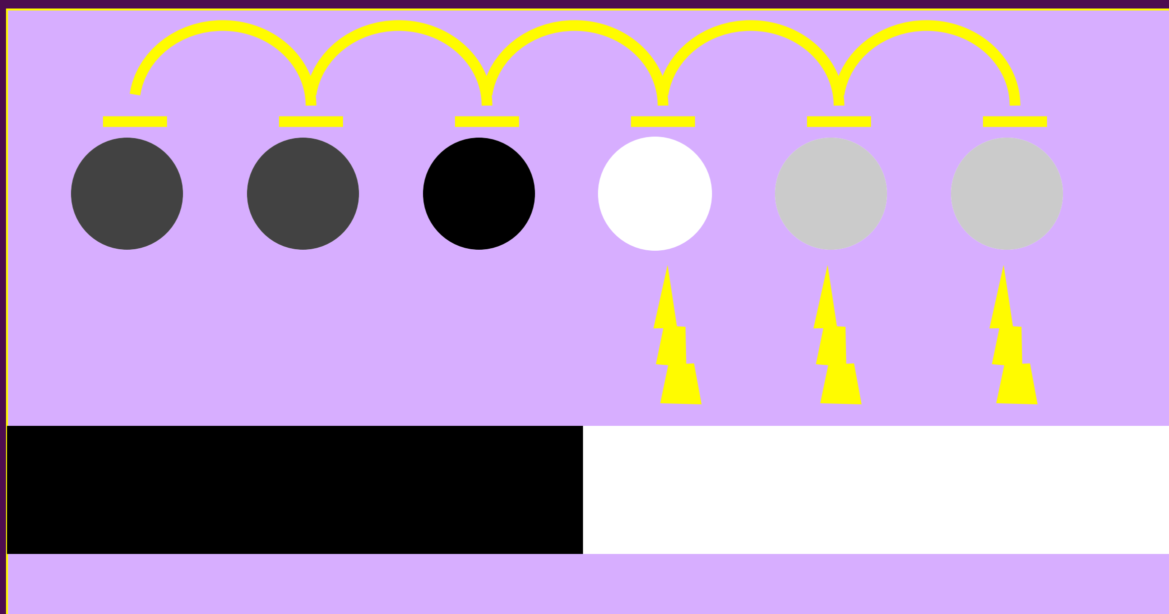


Lateral Inhibition

Neighboring neurons inhibit each other

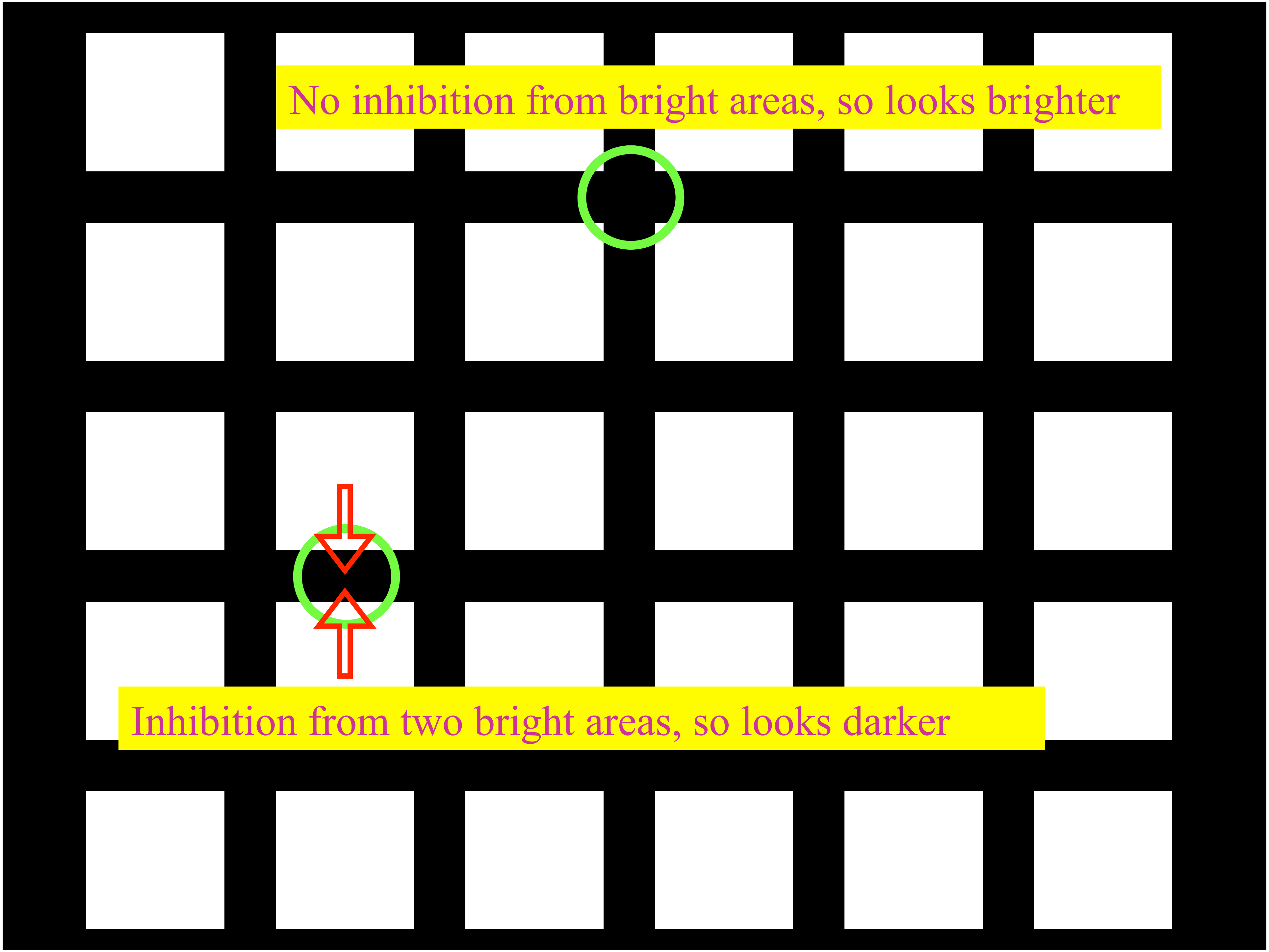
Inhibition: if a neuron is on, it will turn off its neighbors

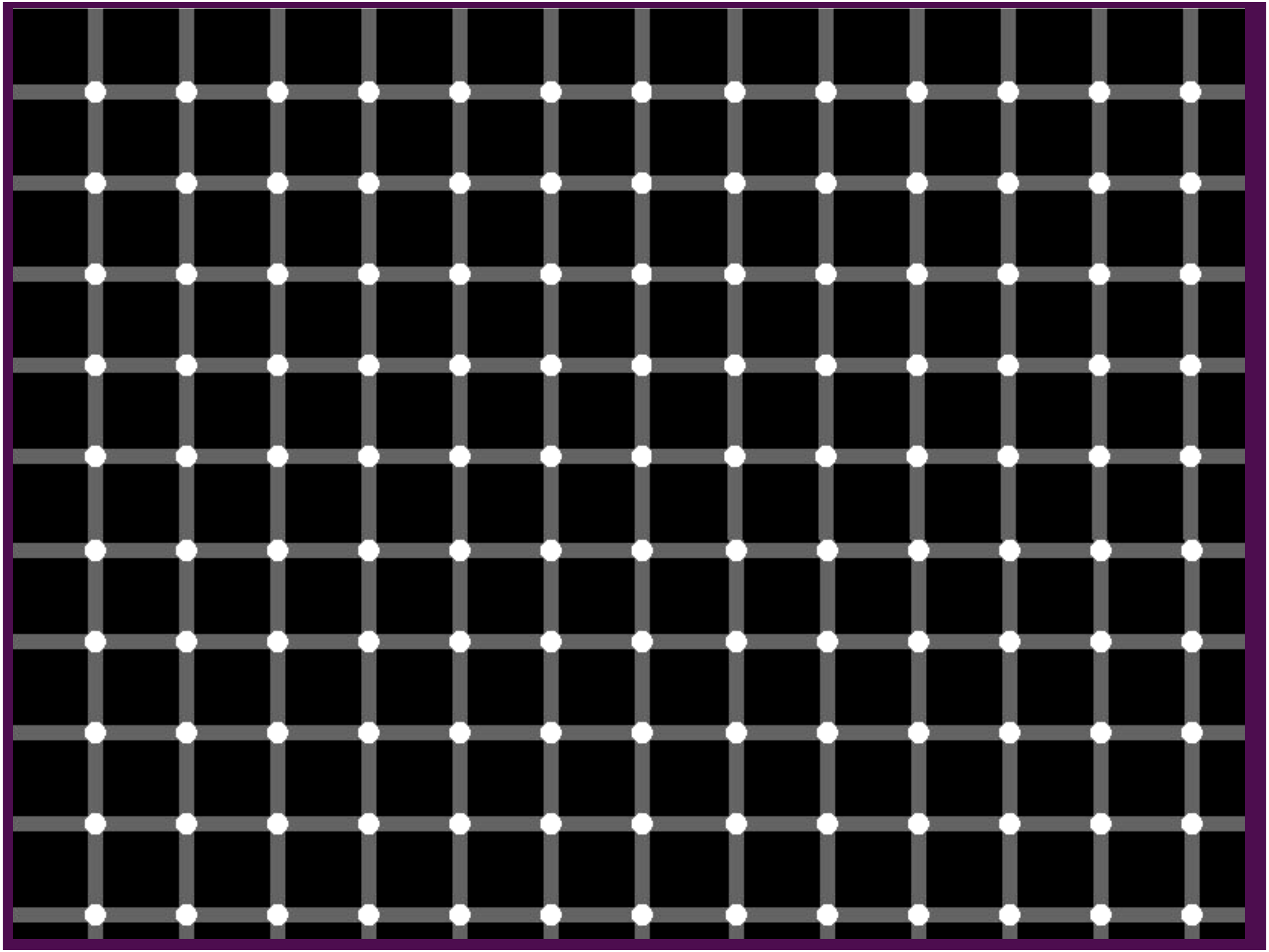
Brightness activates neurons more than darkness



Bright next to dark seems particularly bright

Dark next to bright seems particularly dark


No inhibition from bright areas, so looks brighter
Inhibition from two bright areas, so looks darker



Lateral Inhibition enhances edges

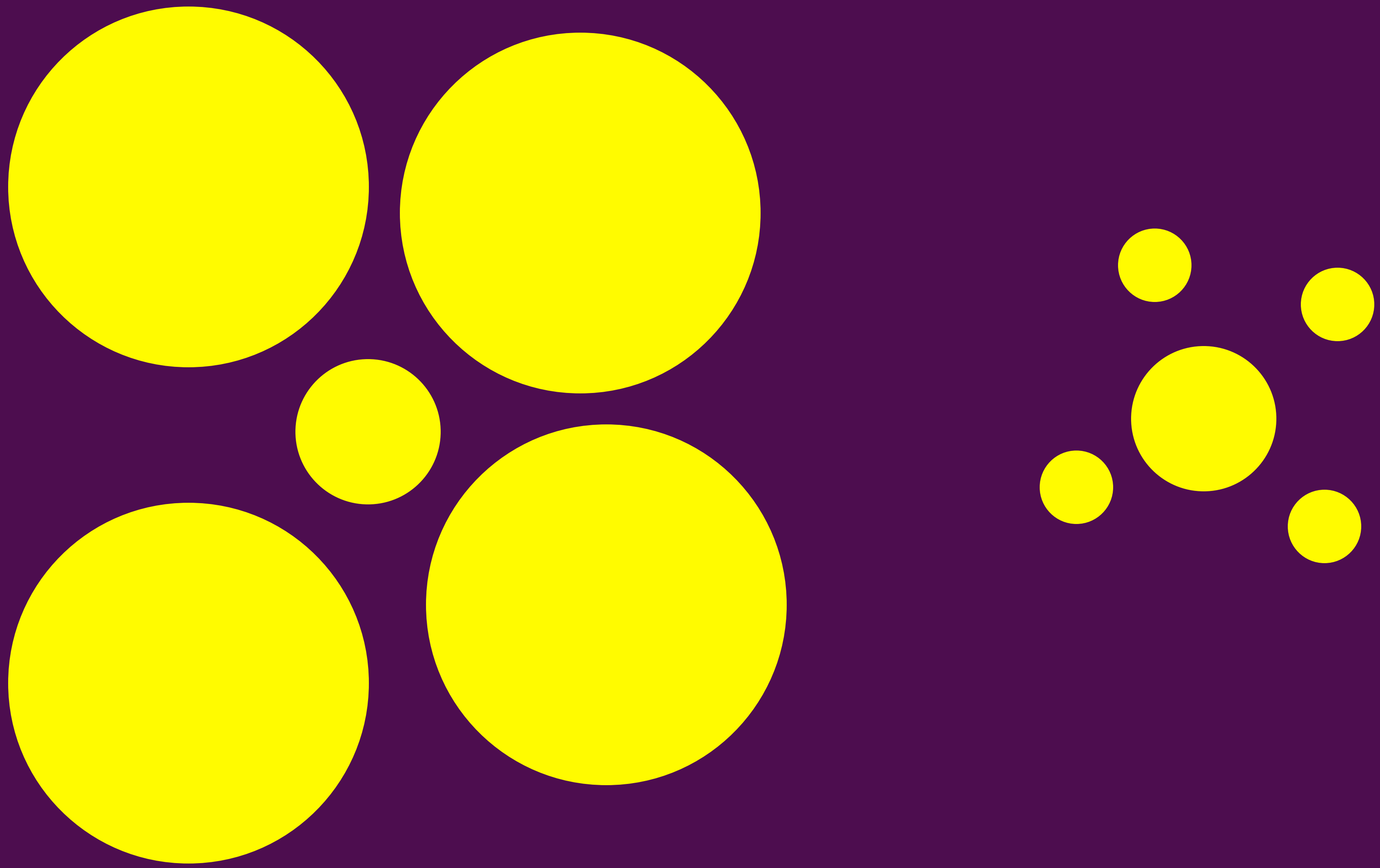
Edges are important because they contain a lot of information. They show the regions of <u>change</u> in an image.

Silhouettes show that edges are sufficient for object recognition

Humans are Contrast Detectors

- We are more sensitive to change and relative values than absolute values
  - We represent objects relative to the other nearby objects
  - We adapt to one object, and other objects are evaluated with respect to that object
- Lateral inhibition – Hermann's grid
- Ebbinghaus Illusion
- Color adaptation and afterimages
- Face adaptation: Shape and blur
- Motion adaptation

Ebbinghaus Illusion



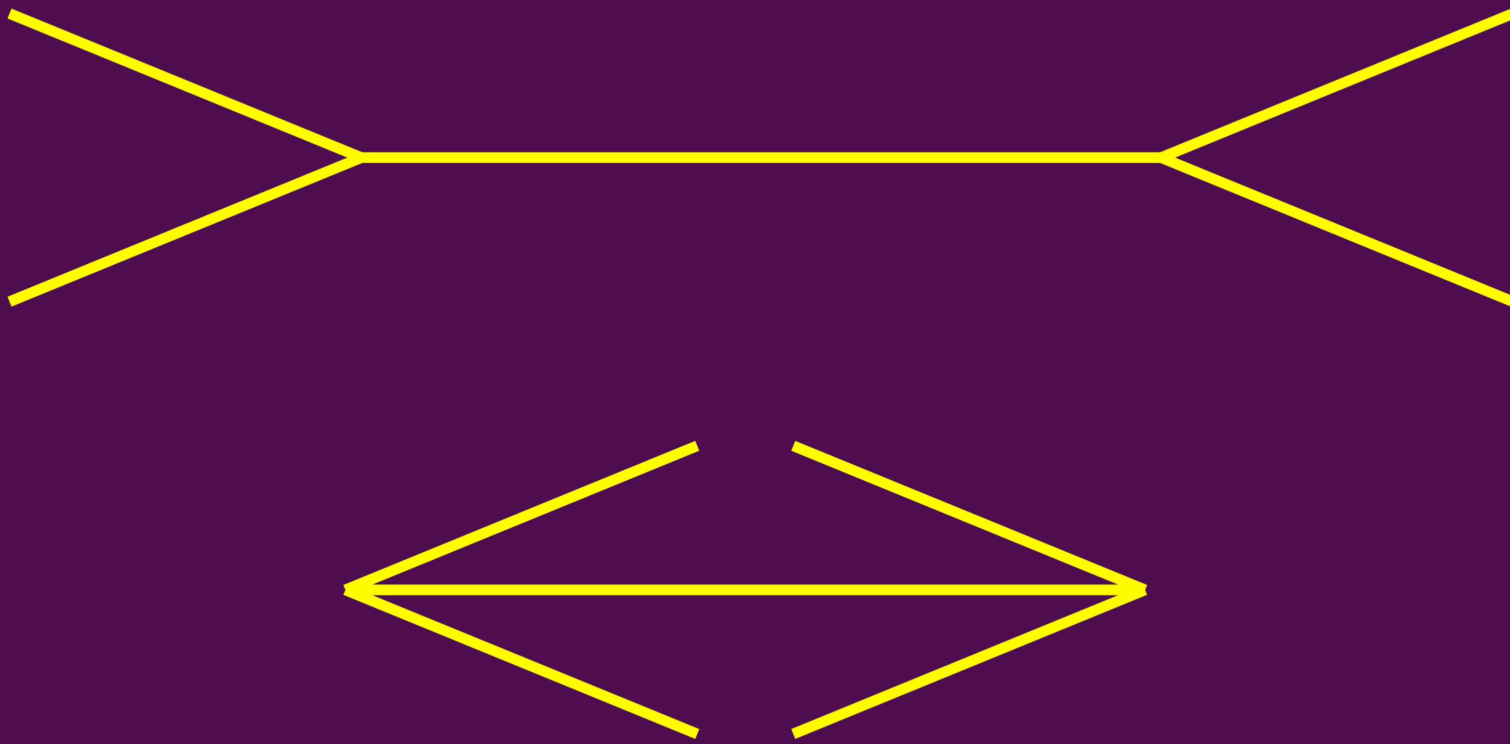
Sizes of middle circles is perceived relative to their surrounding circles



Illusions

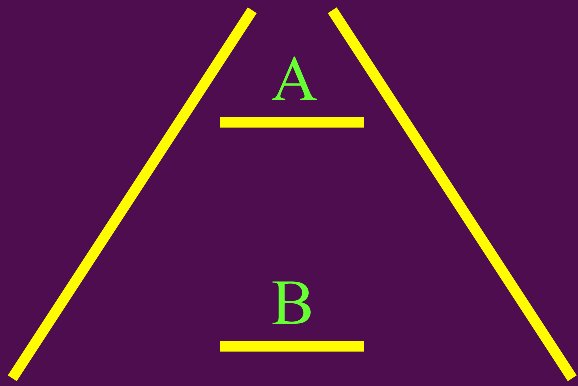
- Cognitive impenetrability - perception is resistant to strategies and knowledge
  - Impenetrability implies an isolated perceptual module
  - So, perception is not completely influenced by experience, thoughts, and knowledge
  - Perception is constrained
- Three case studies
  - The railroad track illusion
  - The Tau effect
  - Apparent motion

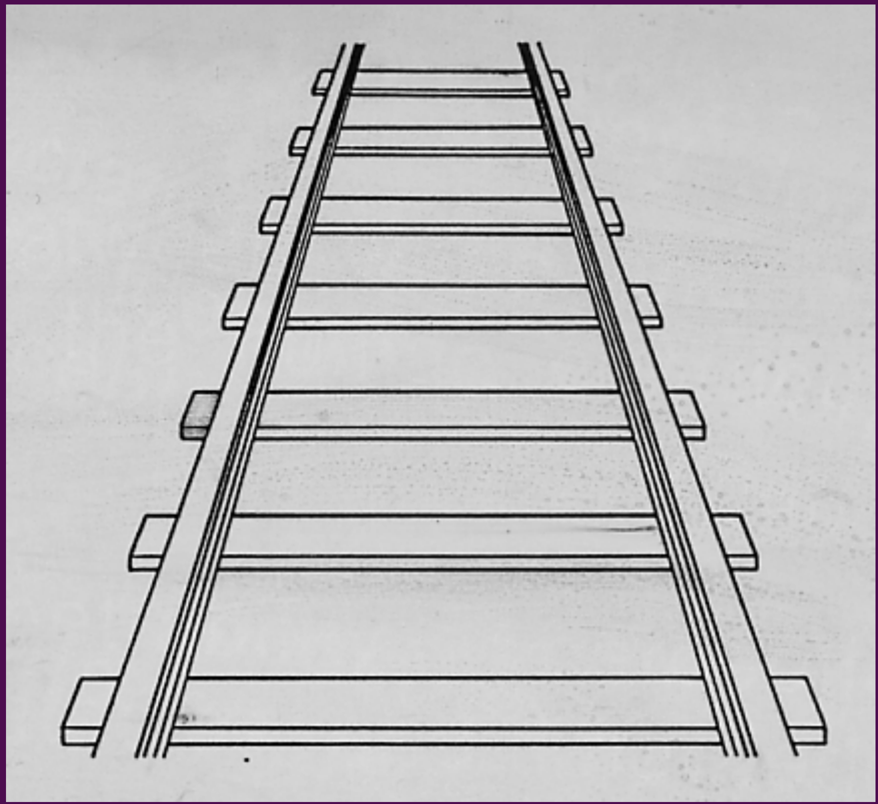
The Mueller-Lyer Illusion



Cognitive Impenetrability

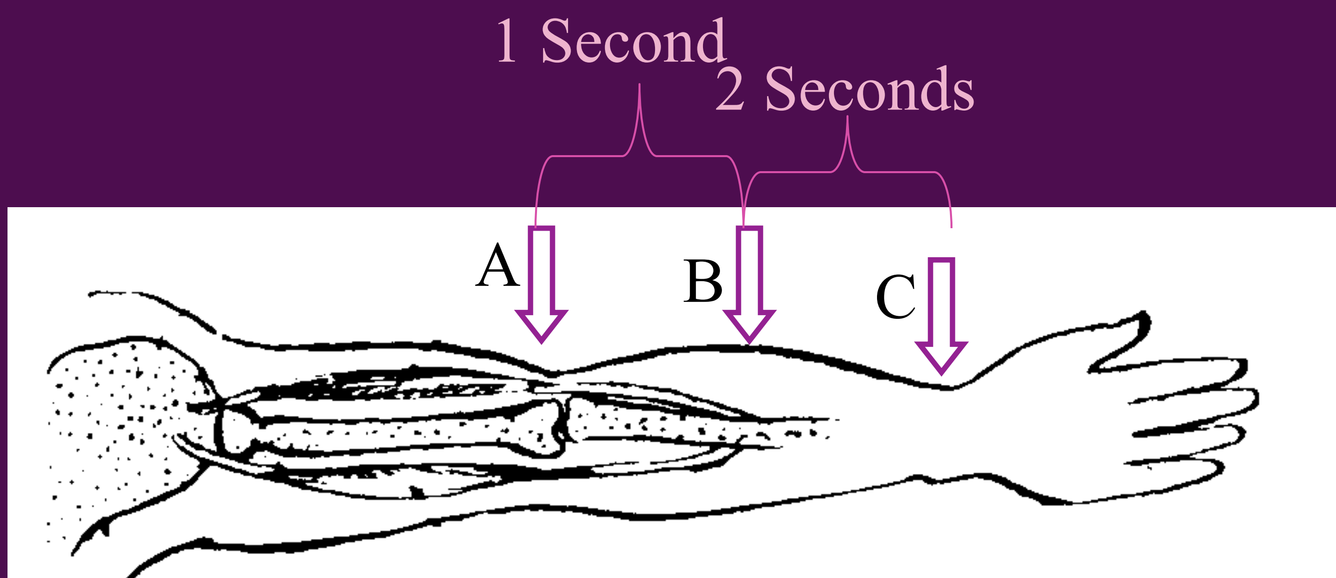
The Railroad Tracks Illusion



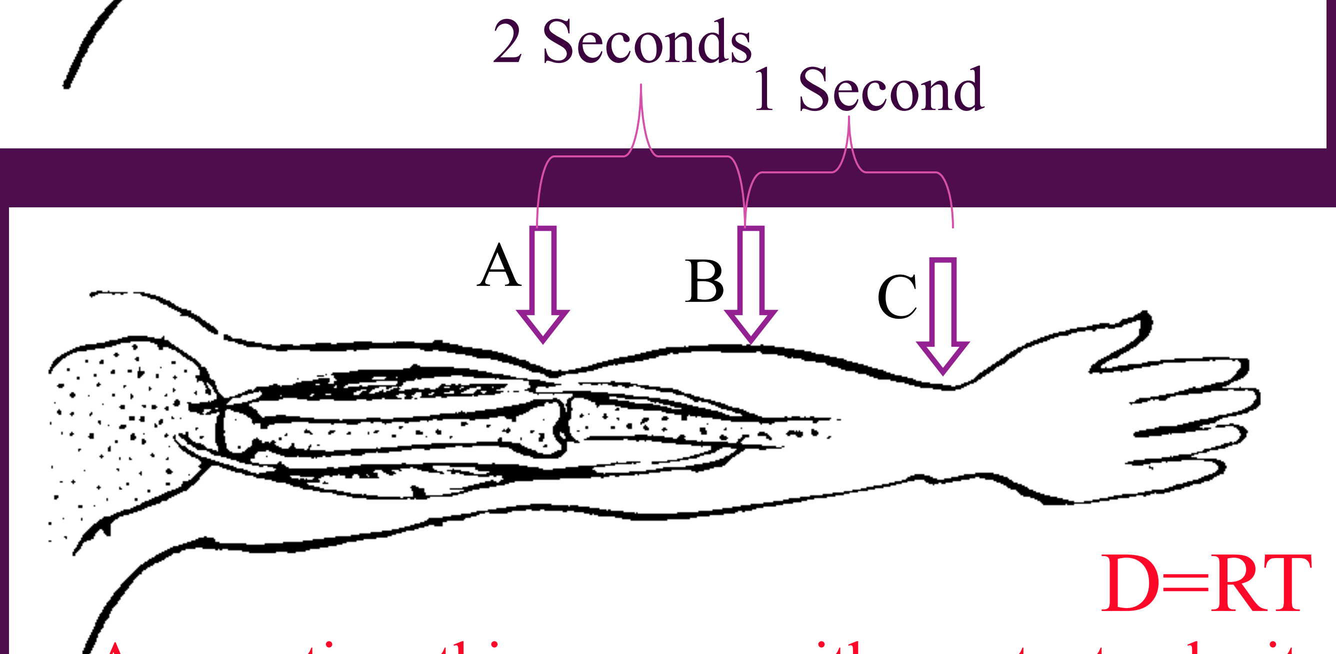


Assumption: the scene is taken from a 3-D world

The Tau effect



A-B distance seems shorter than B-C distance



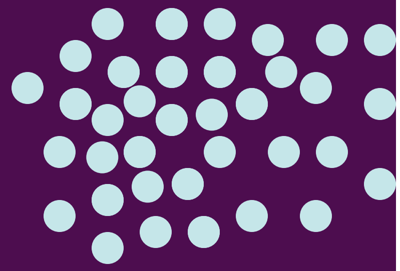
A-B distance seems greater than B-C distance

D=RT

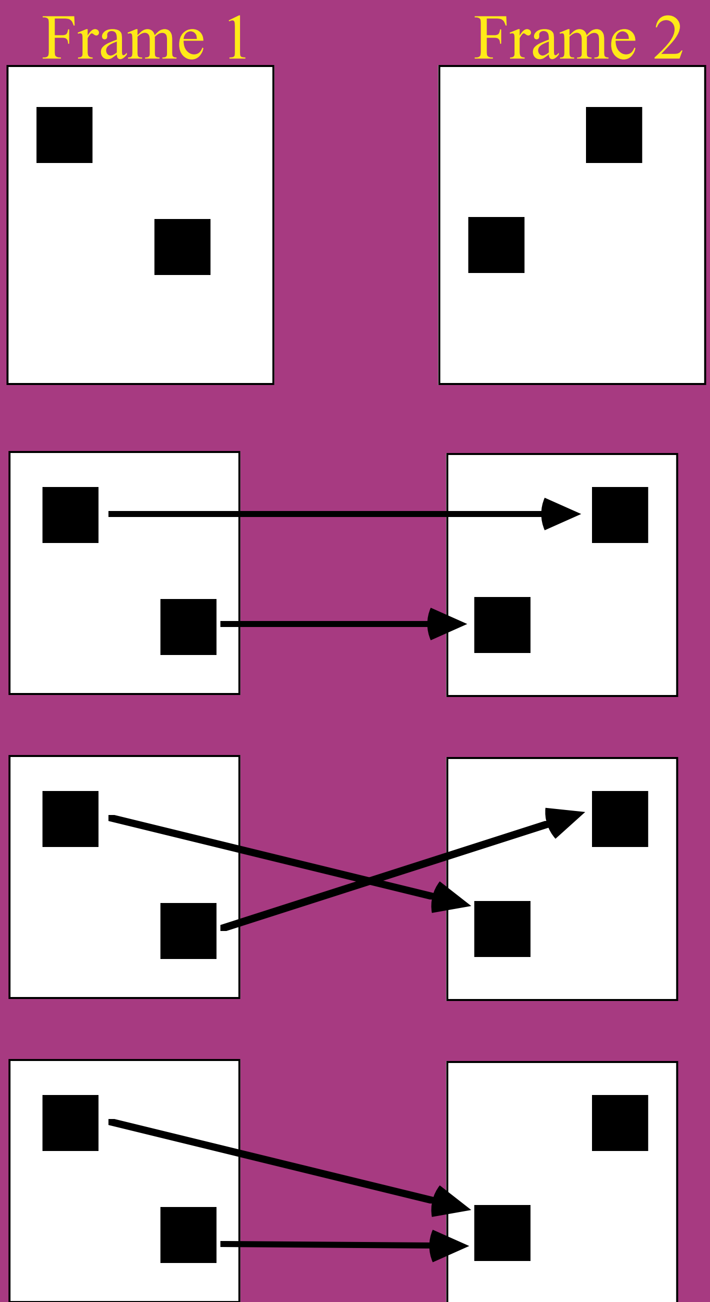
Assumption: things move with constant velocity

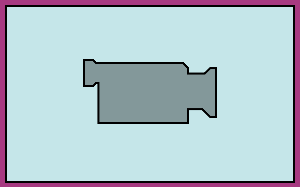
Case Study 3: Apparent Motion

- Motion Perception
  - Importance for perceptual organization
  - Dedicated brain areas
- Apparent Motion
  - Motion from sequentially presented still frames
  - Assume objects in one frame are the same as those in the other frame, just moved
  - Challenge: How to determine which objects correspond to each other across frames



One-to-one Mapping Constraint





Yes, horizontal motion

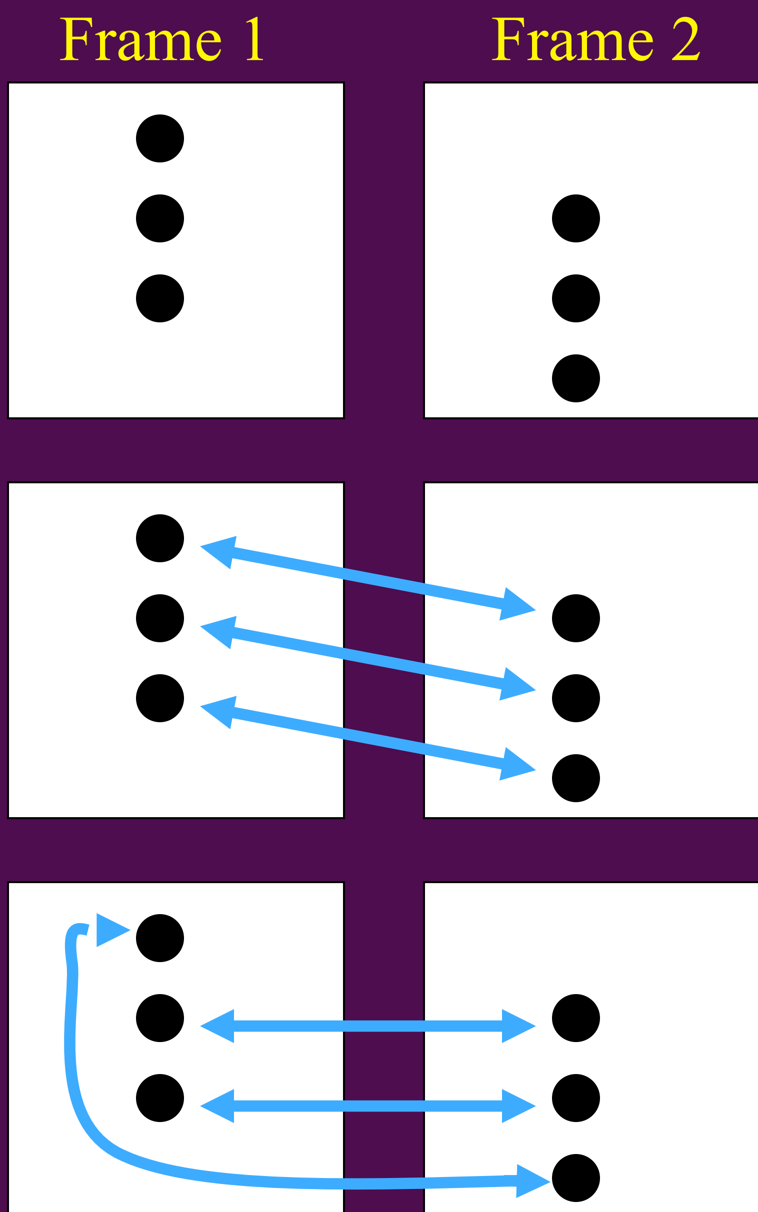
Yes, vertical motion

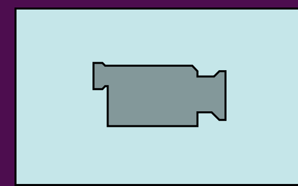
No, violates 1-to-1 mapping

Constraints on Motion Perception

- Proximity
  - Parts A and B tend to be the same object if they are close
- Shape similarity
  - Parts A and B tend to be the same object if they are similar in their shape
- Color and size similarity
- One-to-one mapping constraint
  - Two parts at Time T should not correspond to one part at Time T+1
  - Global coherence: Correspondences all influence each other

Ternus Effect

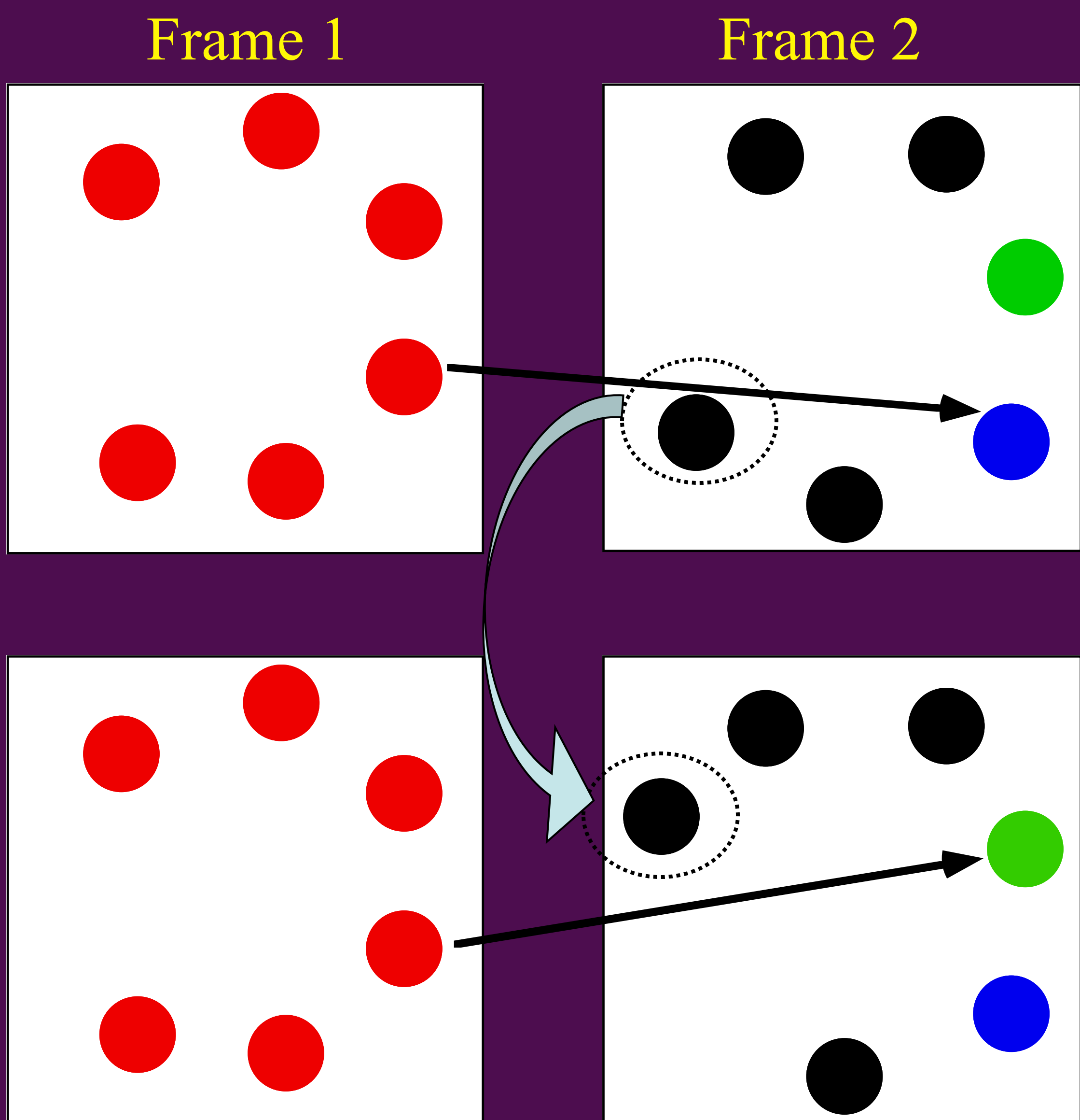




Globally coherent correspondences (Long pause)

Locally determined correspondences (Short pause)

Globally Coherent Motion



Correspondences depend on distantly related correspondences

Automatic tendency to find globally consistent solutions