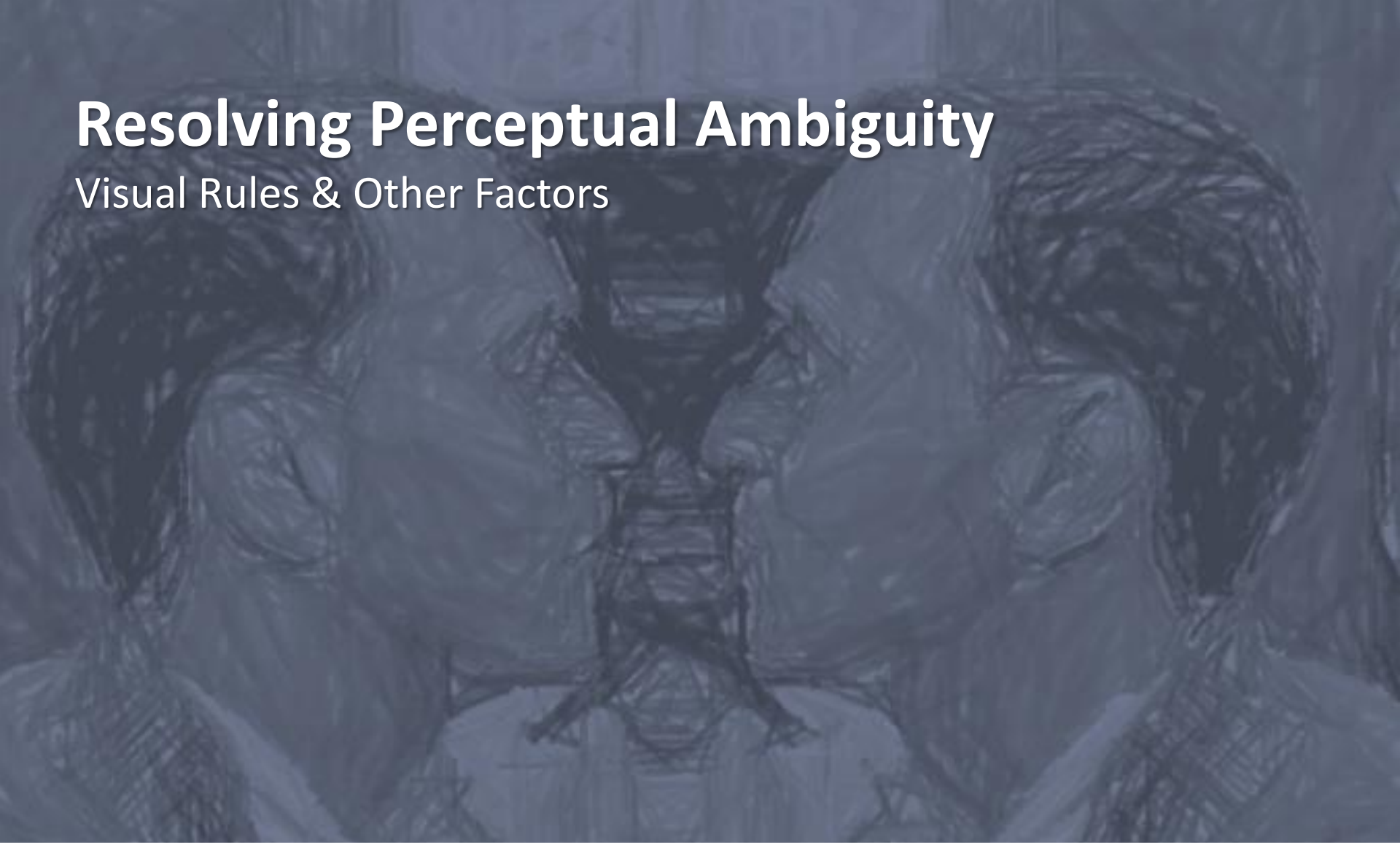
Resolving Perceptual Ambiguity

Visual Rules & Other Factors



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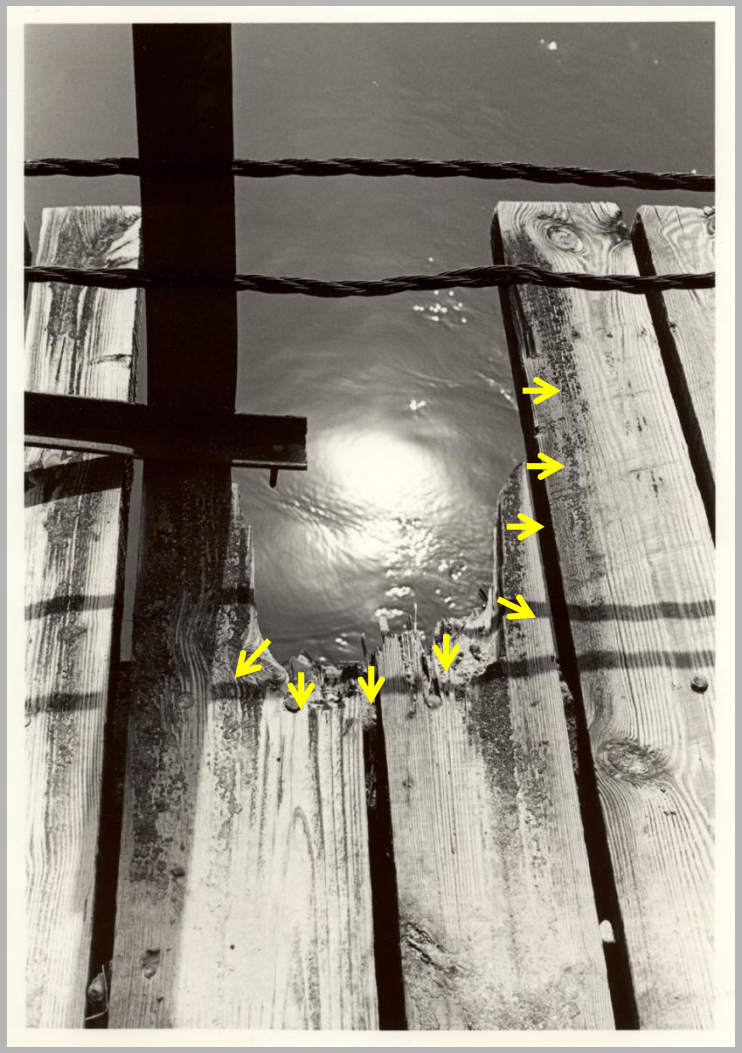
What do you see?

Depth ambiguity can strongly affect our perception of shapes in the world

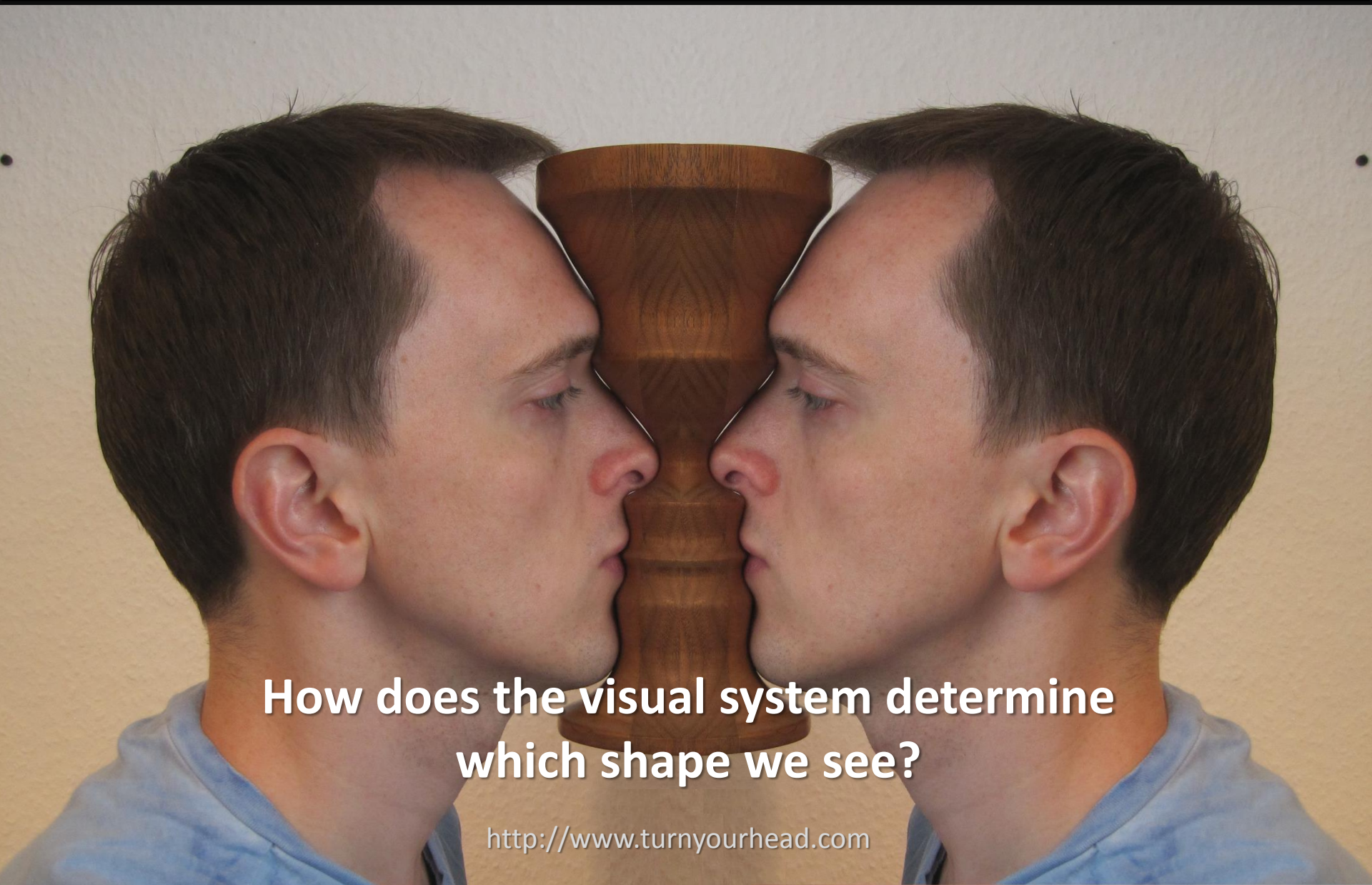
Shape depends on edge-assignment (a.k.a figure-ground org)



Perceived depth and shape have consequences for how we act on the world

Rubin's Faces Vase

The Rubin Vase is a classic example of shape ambiguity



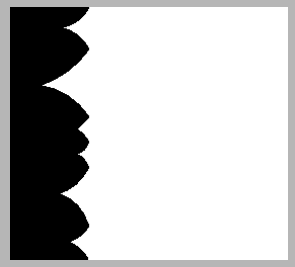
How does the visual system determine which shape we see?

http://www.turnyourhead.com

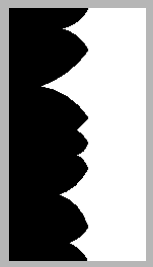
Visual/Image-Based Influences

Figure-ground organization is affected by visual properties of the edge and adjacent regions

Contrast
Rubin (1915/21)

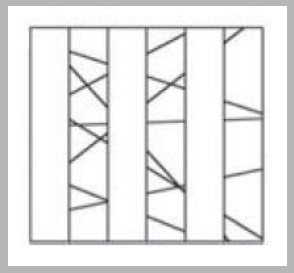


Relative Area
Rubin (1915/21)

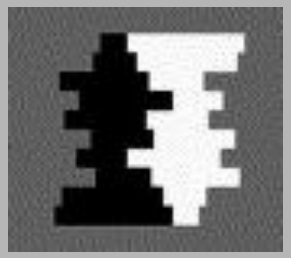


Convexity
Kanizsa & Gerbino (1976)

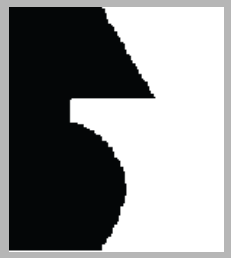
Symmetry
Kanizsa & Gerbino (1976)



Entropy
Gillam & Grove (2011)

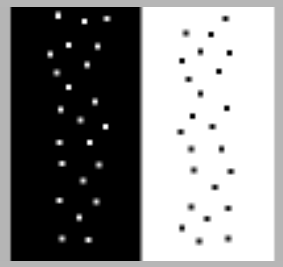


Top-Bottom Polarity
Hulleman & Humphreys (2004)



Familiarity
Peterson(1994)

Lower Region
Vecera et al. (2002)

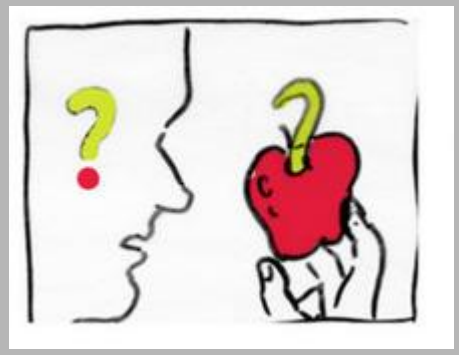


Edge-Region Grouping
Palmer & Brooks (2008)
Brooks & Driver (2010)
Brooks, et al (2012)

Visual Rules & Computer Vision

- **Discovering new visual cues/rules helps us to:**
  - Basic Science: Understand how human visual perception works
  - Applied Science: Improve computer vision algorithms
  - Applied Science: Design better visual displays

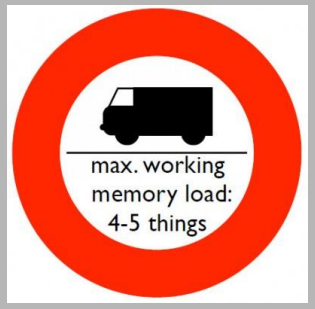
  - Stroke/agnosia: problems with some visual rules.
    - understand their problems
      Brooks, et al. 2012
    - develop treatment protocols
      Brooks, et al., 2015



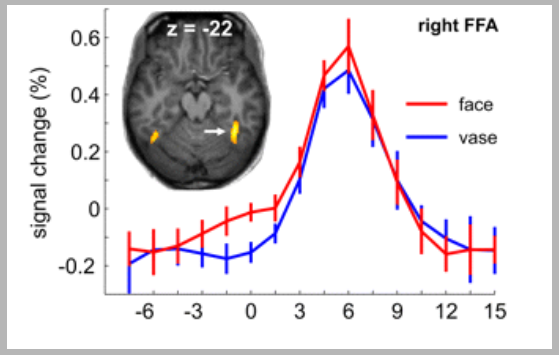
Not all cues/principles are “visual”

Attention
Vecera et al. (2004)

Reward/Punishment
e.g., Rock & Fleck (1950)
Brooks et al (in prep)



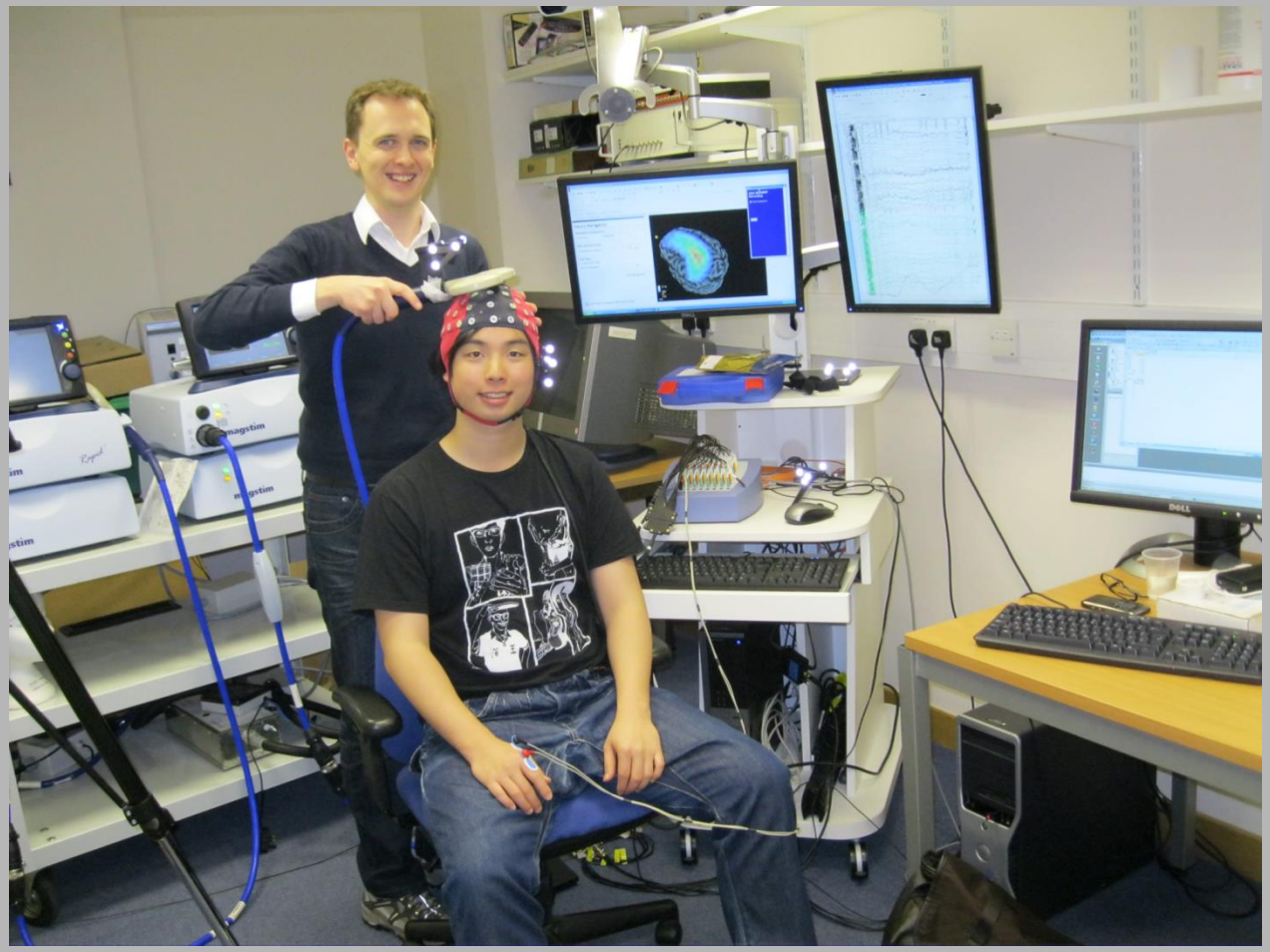
Cognitive Load



Random Brain Fluctuations
Hesselmann et al. (2008)
Brooks et al (in prep)

These “top-down” factors can combine with bottom-up visual information

Controlling Perception with Brain Stimulation?



Transcranial Magnetic Stimulation (TMS) can be used to experimentally CHANGE activity in these brain areas and AFFECT perception

Controlling Perception with Brain Stimulation

STIMULATE 14Hz Low	STIMULATE 14 Hz High	STIMULATE 14 Hz Low	STIMULATE 14 Hz High
↓	↓	↓	↓
See Faces	See Vase	See Faces	See Vase

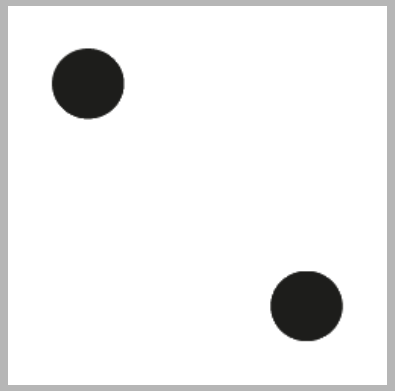
TMS induces brain activity which can then affect perception/behaviour

Not necessarily a DISRUPTION. Can be used to ENHANCE function

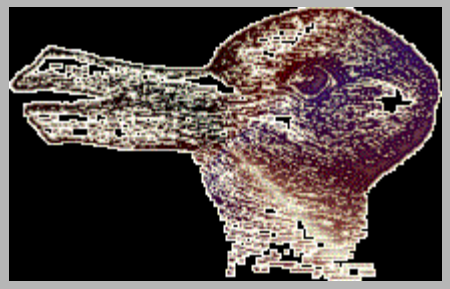
Effect depends on parameters

Other Types of Perceptual Ambiguity

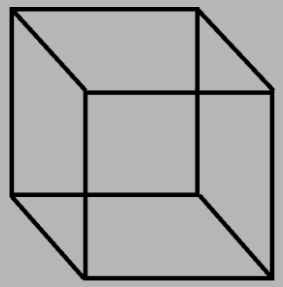
"The" Dress



Vertical or Horizontal Motion?



Duck or Rabbit?



Necker Cube

My Question: How does our visual system come to an "answer"?

Thank you!

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wellcome trust

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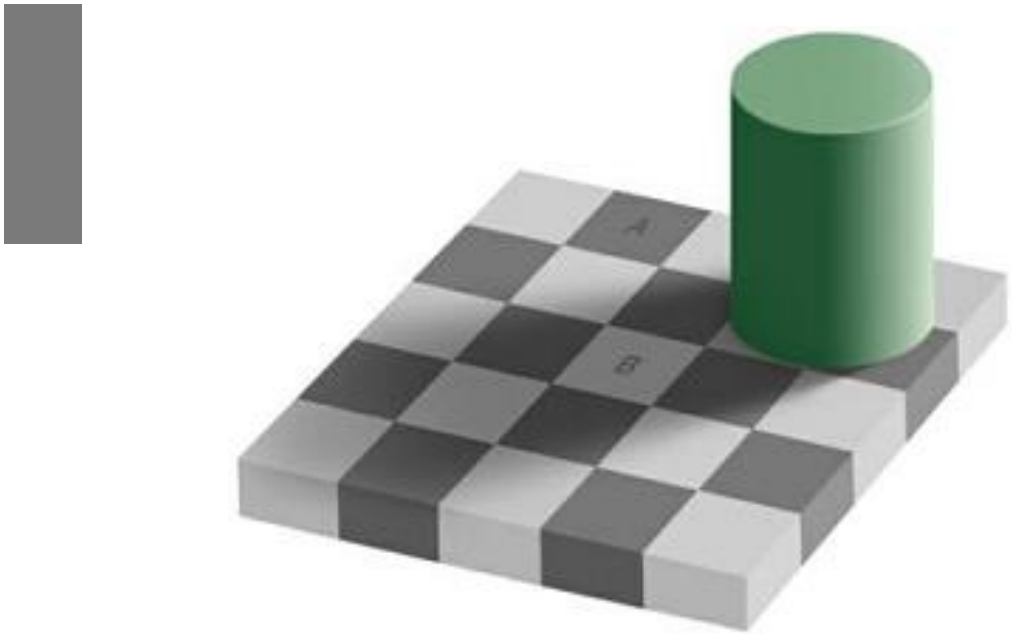
The Dress: Partial Explanation

- Light reaching your eyes is affected by
  - Colour of light in light source
  - Reflectance of the object
- Your eye/brain has no way of separating the influence of light source from reflectance
- Your brain needs to GUESS
- If you think that light in the room is yellowish, then you will attribute gold tones to the light source
- However, if you think that light is not yellowish, then the yellow tones on dress must be a PROPERTY OF THE DRESS

Lightness Constancy

Brain makes inferences based on context



Which is darker?
A or B?

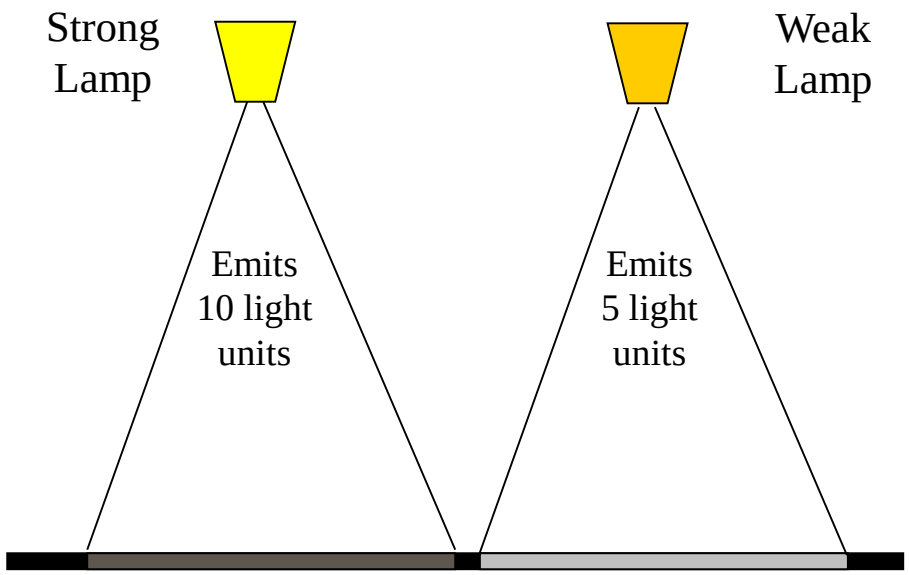
The actual paint in squares A and B is the same

Why do they look different?

The process of lightness constancy

Illumination

Lamps of different strengths shine on two patches



Distal Stimulus

2 Different paints reflect different amounts of light

Proximal Stimulus

Amount of light reflected and falling on the eyes

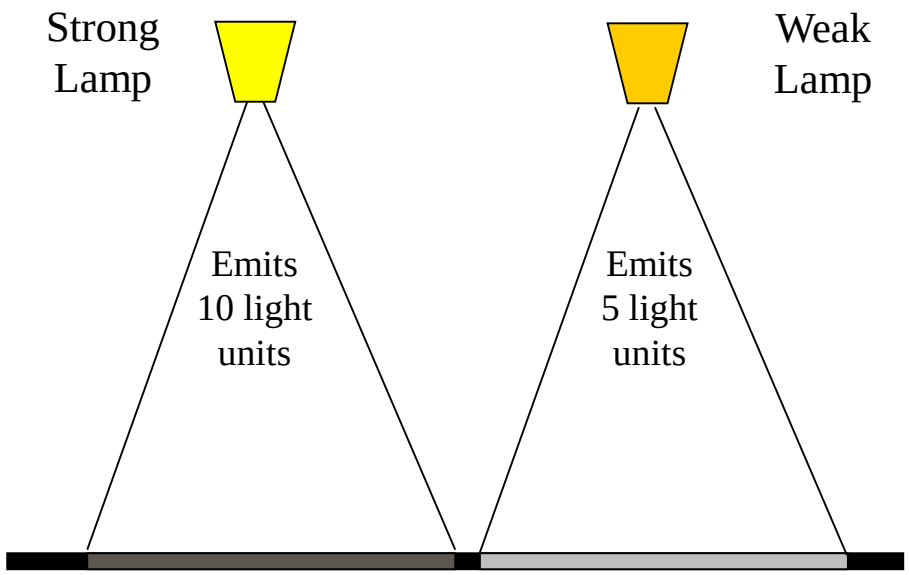
25% of 10 light units = **2.5 light units**	50% of 5 light units = **2.5 light units**

Raw proximal stimulus suggests that the two patches are the same…

Is this what we see?

No! We see paints of two different lightnesses

Illumination
Lamps of different strengths shine on two patches



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Actual Perception

We take the illumination difference into account

Even though light falling on eyes is the same, we adjust our calculations to pick up the true features of the distal stimulus