

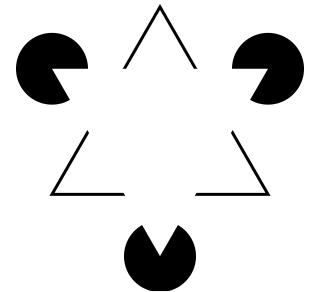
# Human Segmentation: Insights for Computer Vision

Michelle R. Greene, Ph.D  
CS 131  
11-10-14



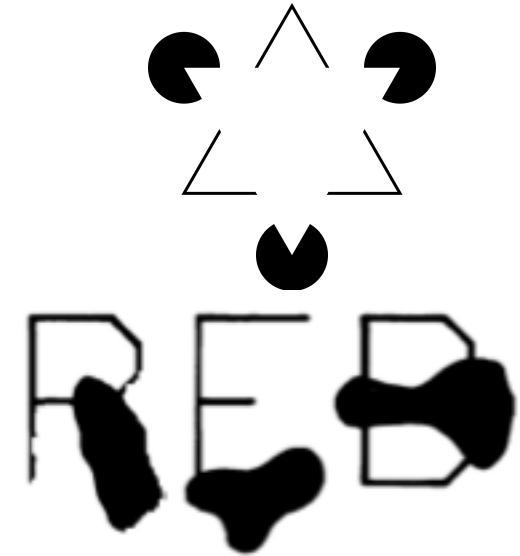
# Today's Agenda:

- Edges are not enough!
- Human perceptual organization is a bag of heuristics.
- Gestalt laws
- Figures and ground
- Texture segregation



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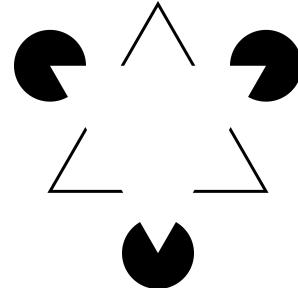
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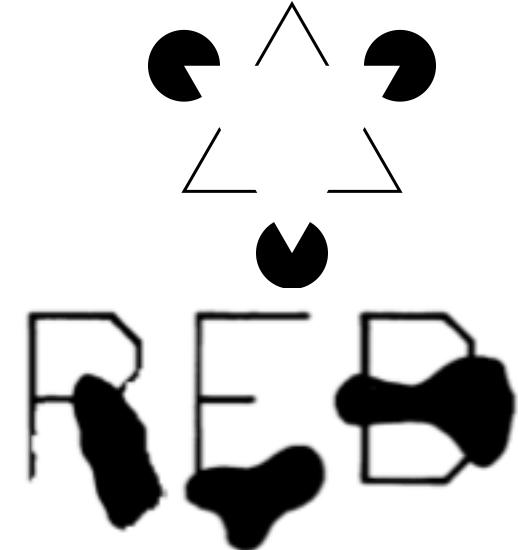
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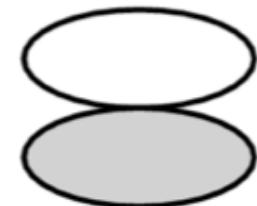
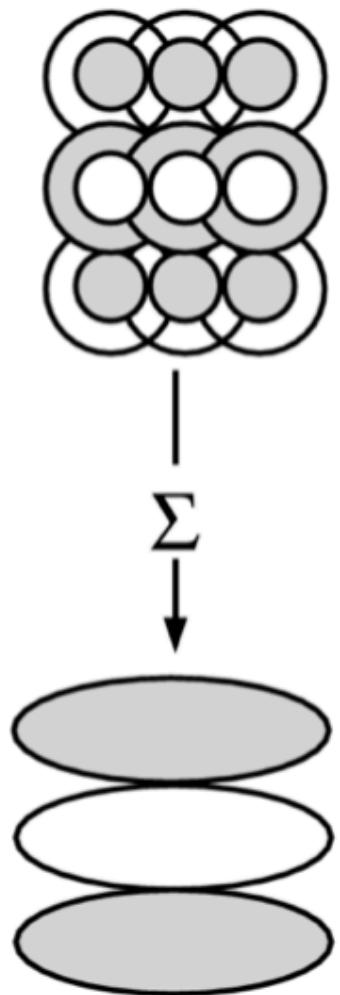
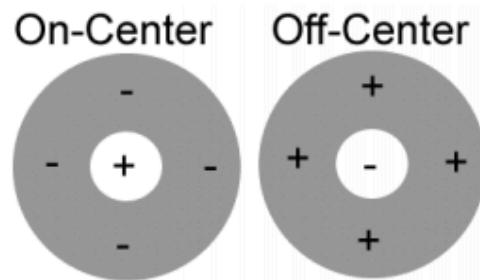
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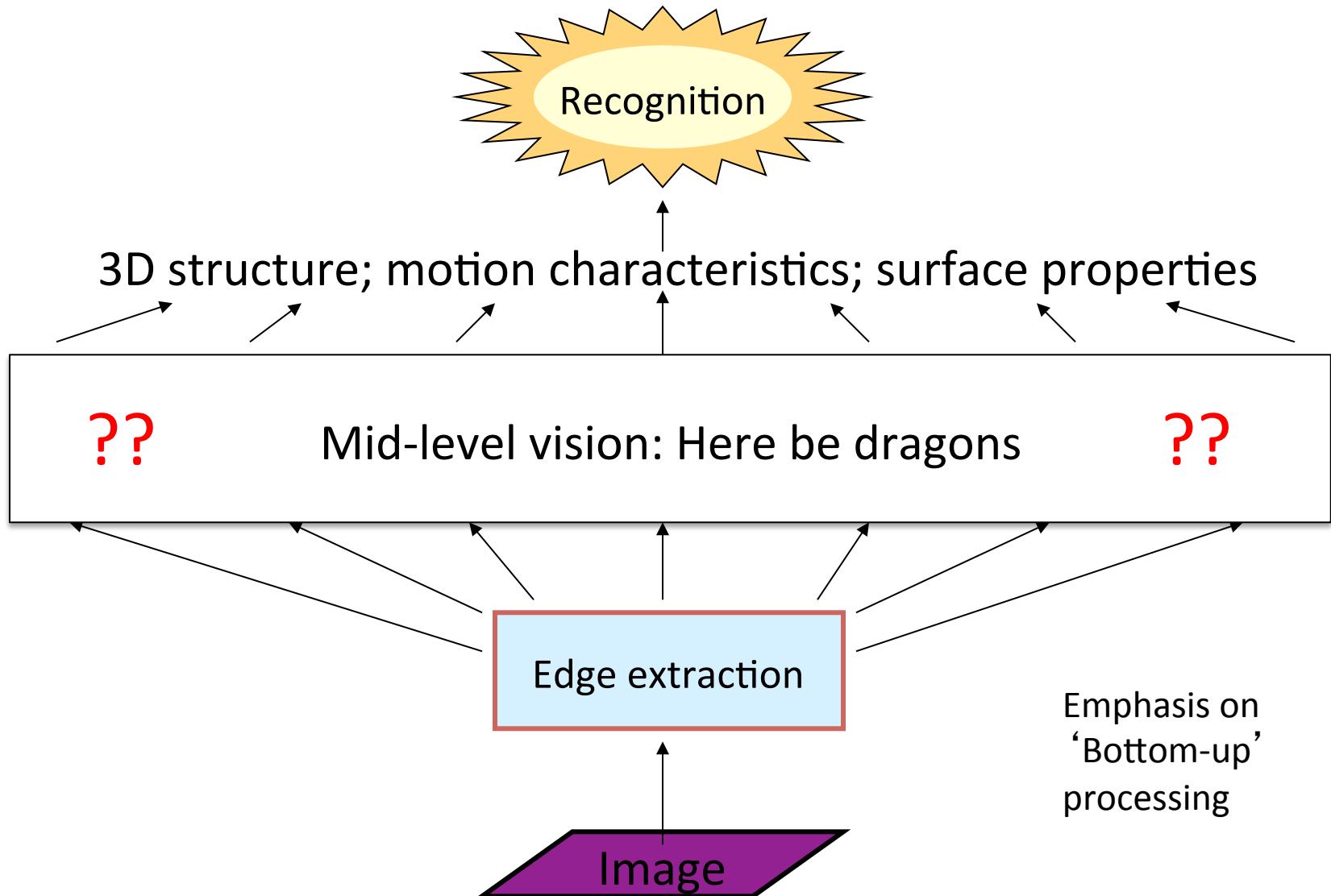
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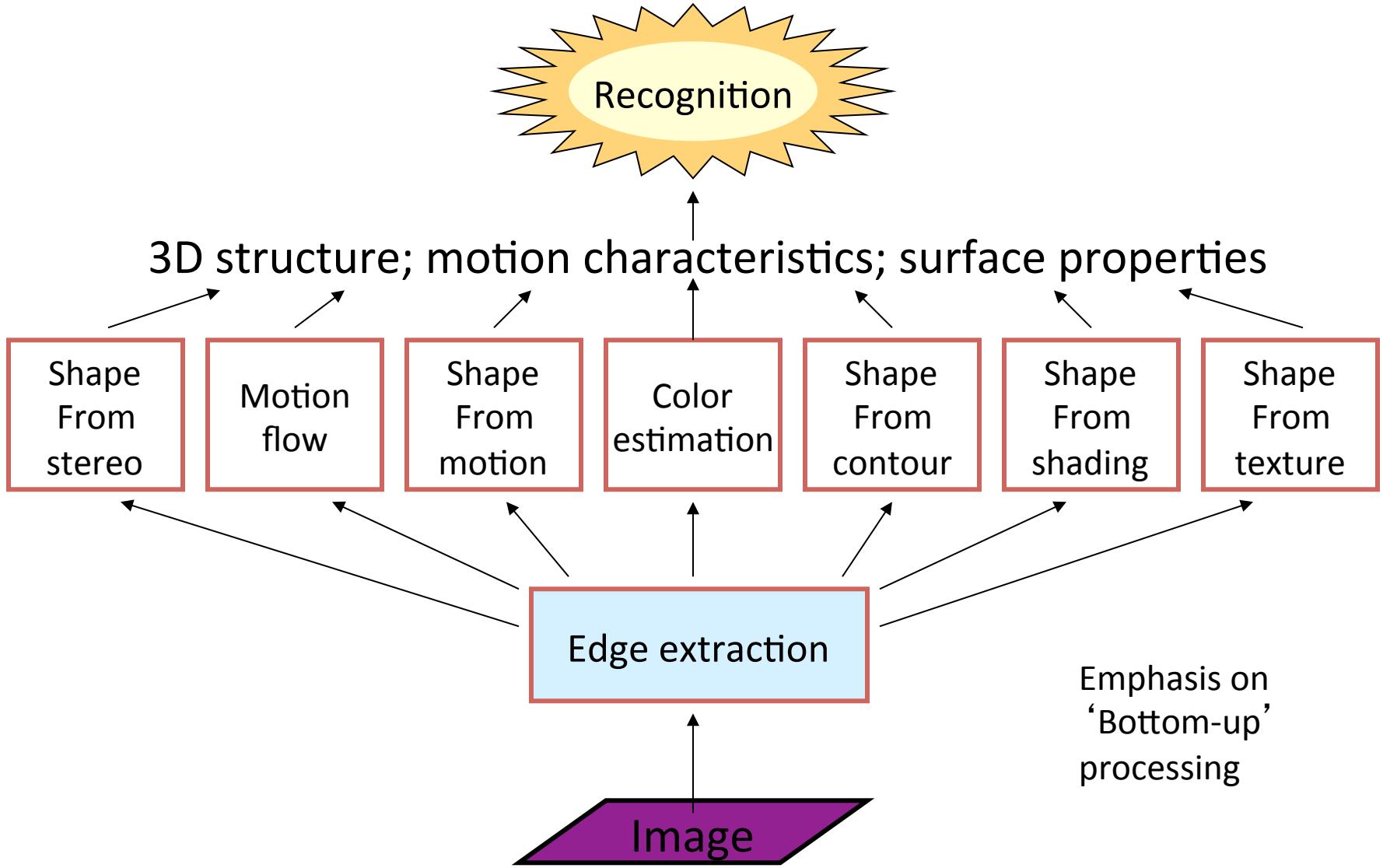
# Types of V1 cells

simple cells



Hubel & Wiesel (1962)

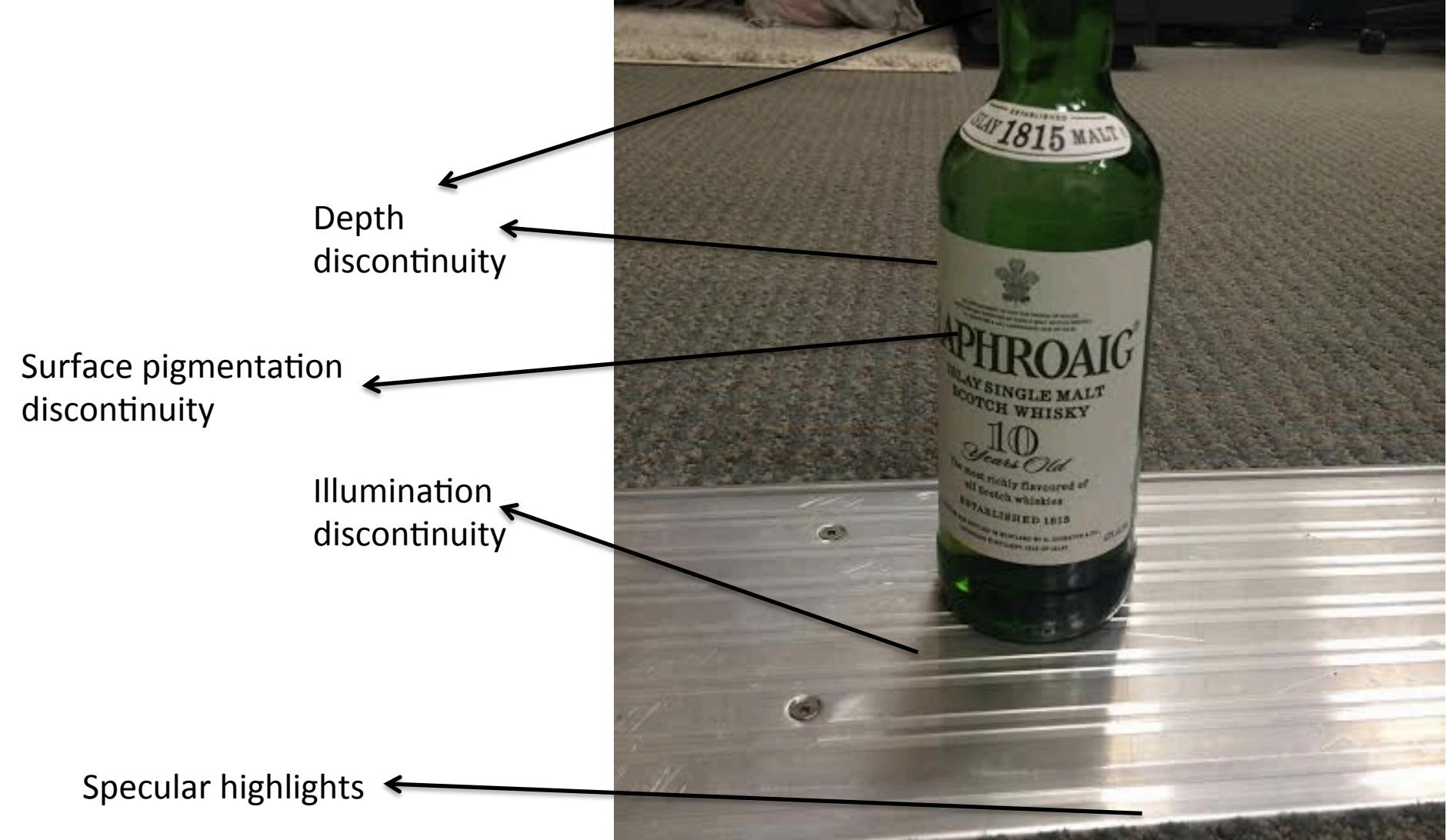




# Edges are not enough!



# Edges are not enough!



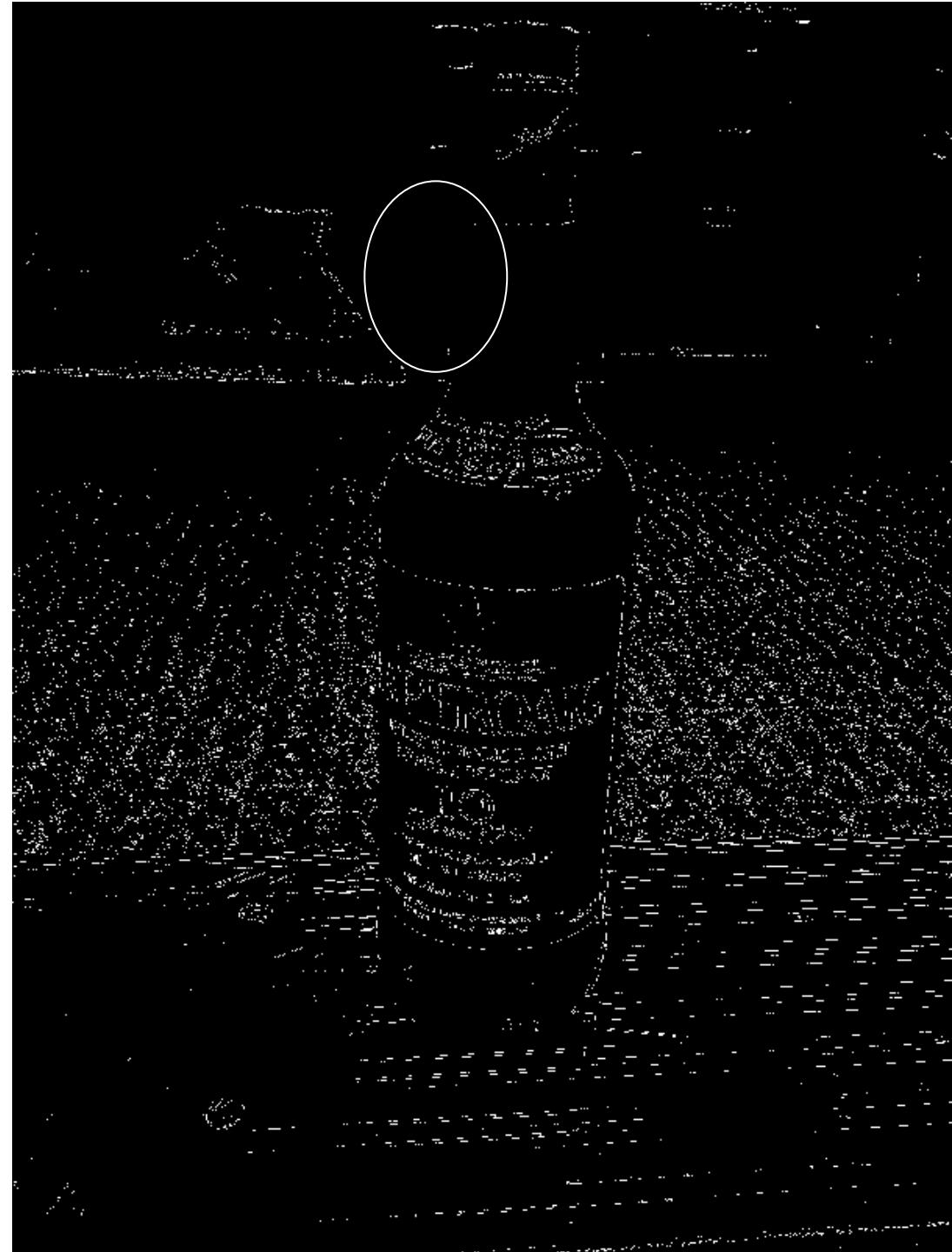
# Edges are not enough!

Depth  
discontinuity

Surface pigmentation  
discontinuity

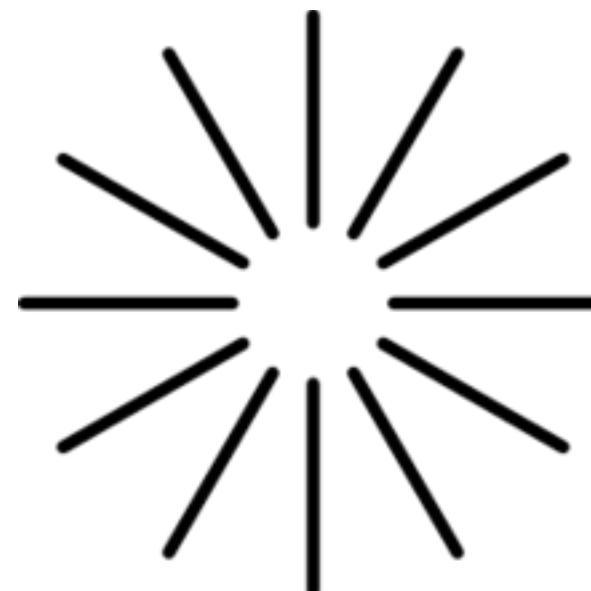
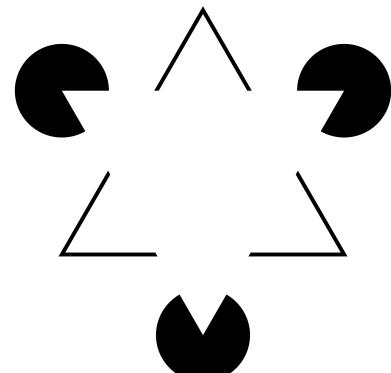
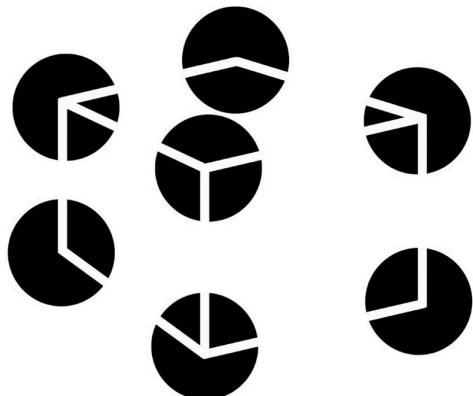
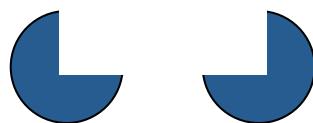
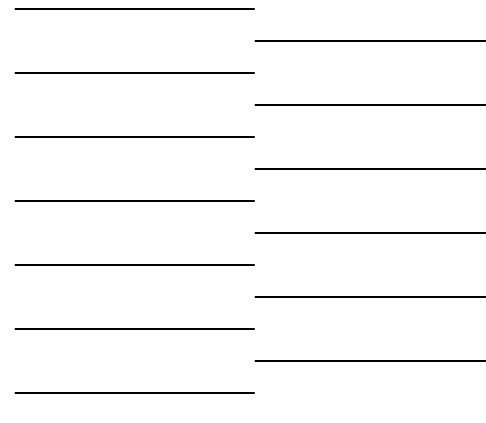
Illumination  
discontinuity

Specular highlights



Where do conventional edge-detectors fail?

## Detecting illusory contours



jolyon.co.uk

No luminance difference across  
long sections of the perceived contours

# Properties of Illusory Contours:

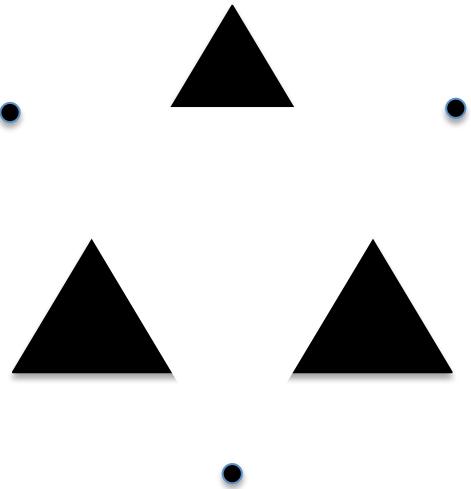


Need not be based in prior experience

# Properties of Illusory Contours:



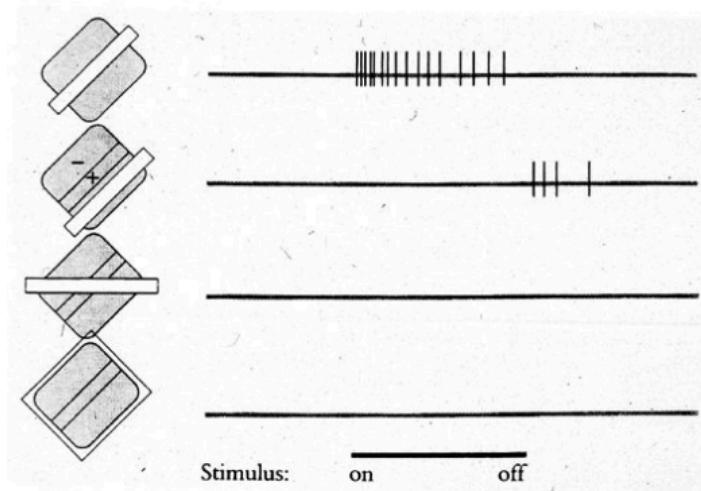
Need not be based in prior experience



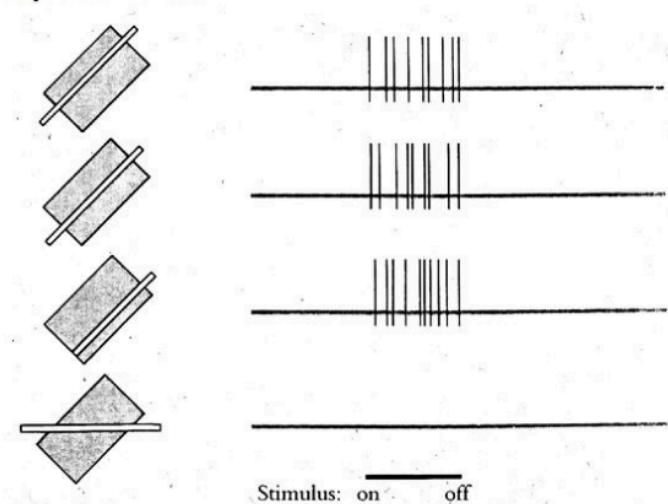
Can be induced with minimal stimulus

# In class exercise:

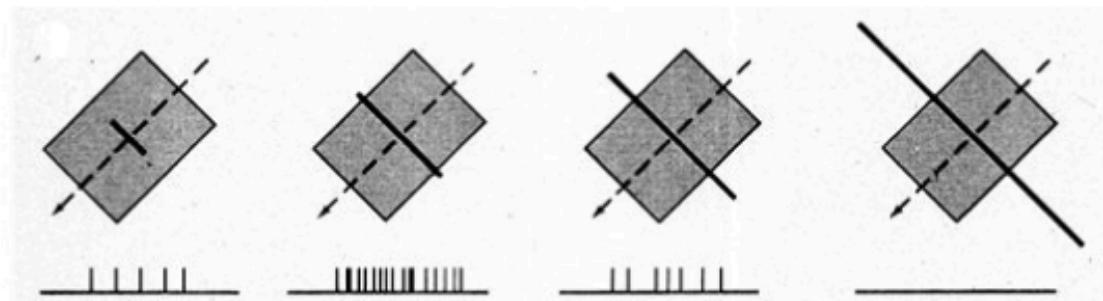
Simple cell



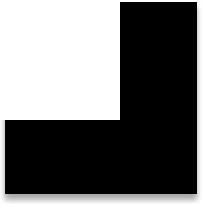
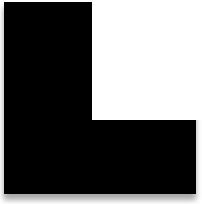
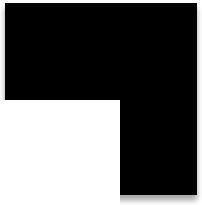
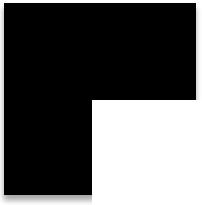
Complex cell



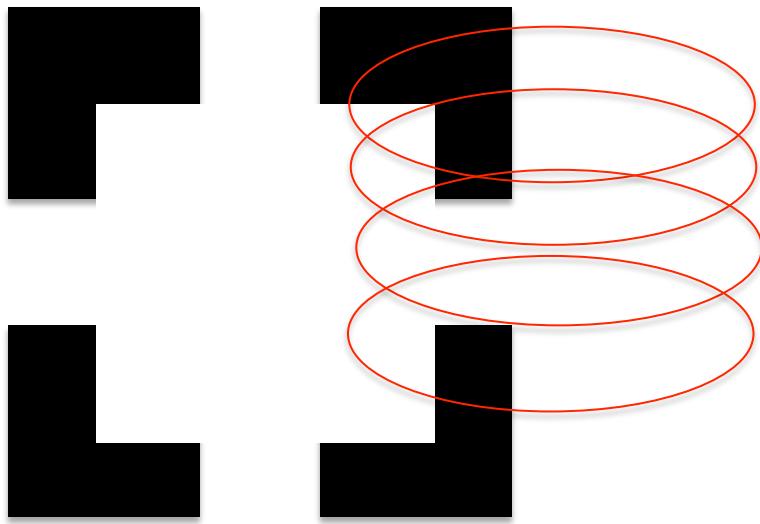
Hypercomplex cell



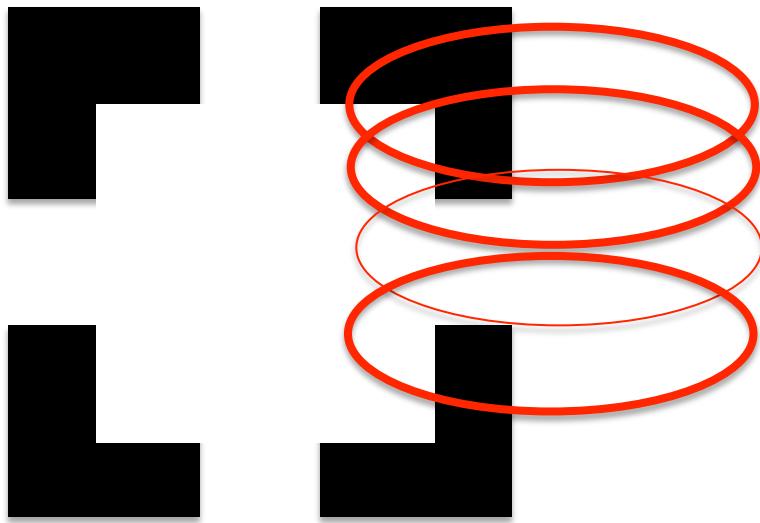
# End-stopped cells could “see” illusory contour



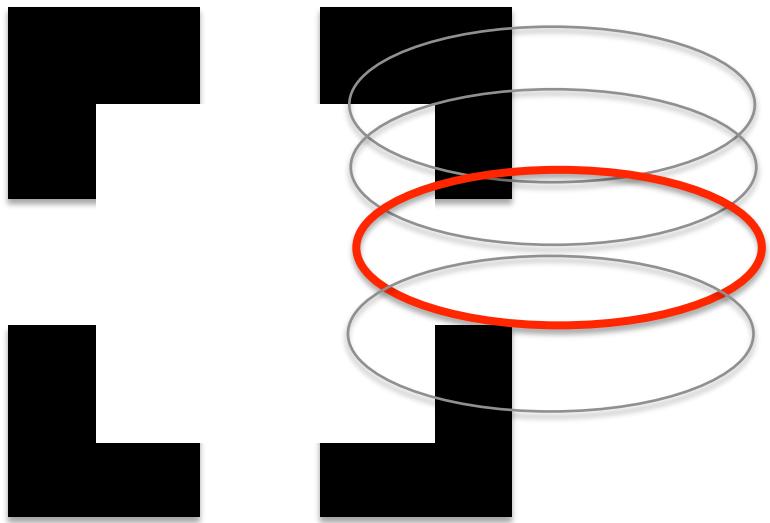
# End-stopped cells could “see” illusory contour



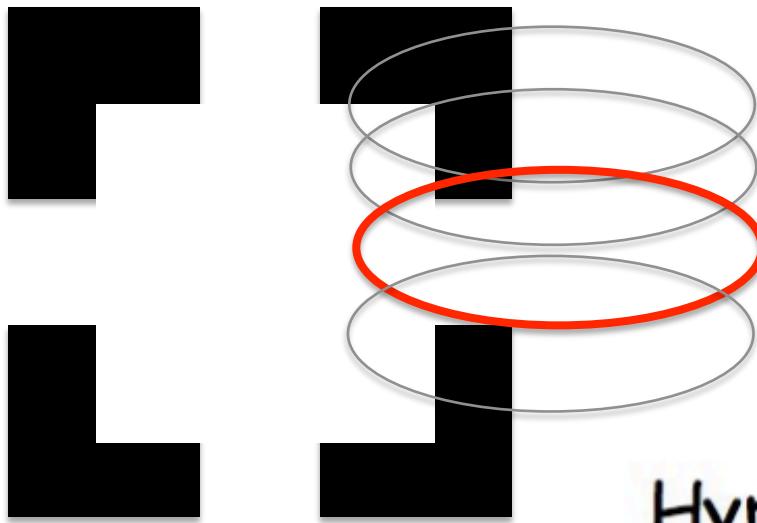
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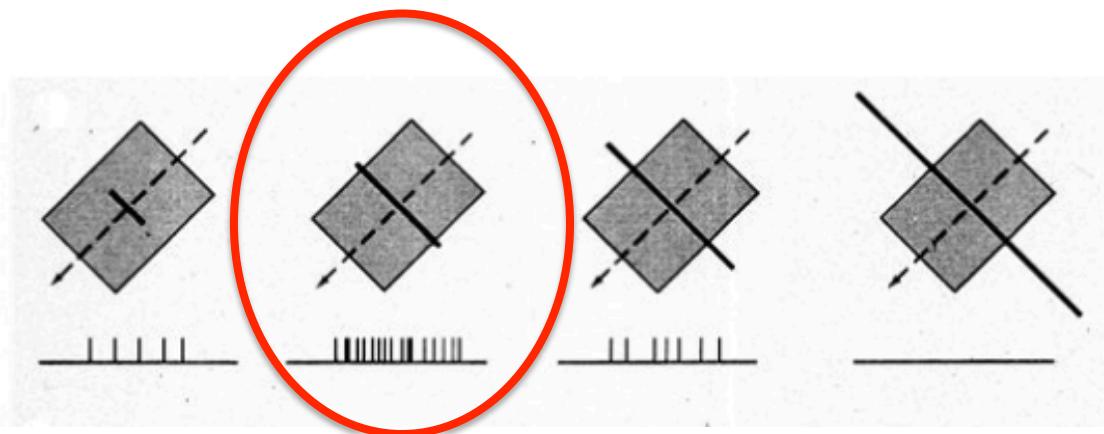
# End-stopped cells could “see” illusory contour



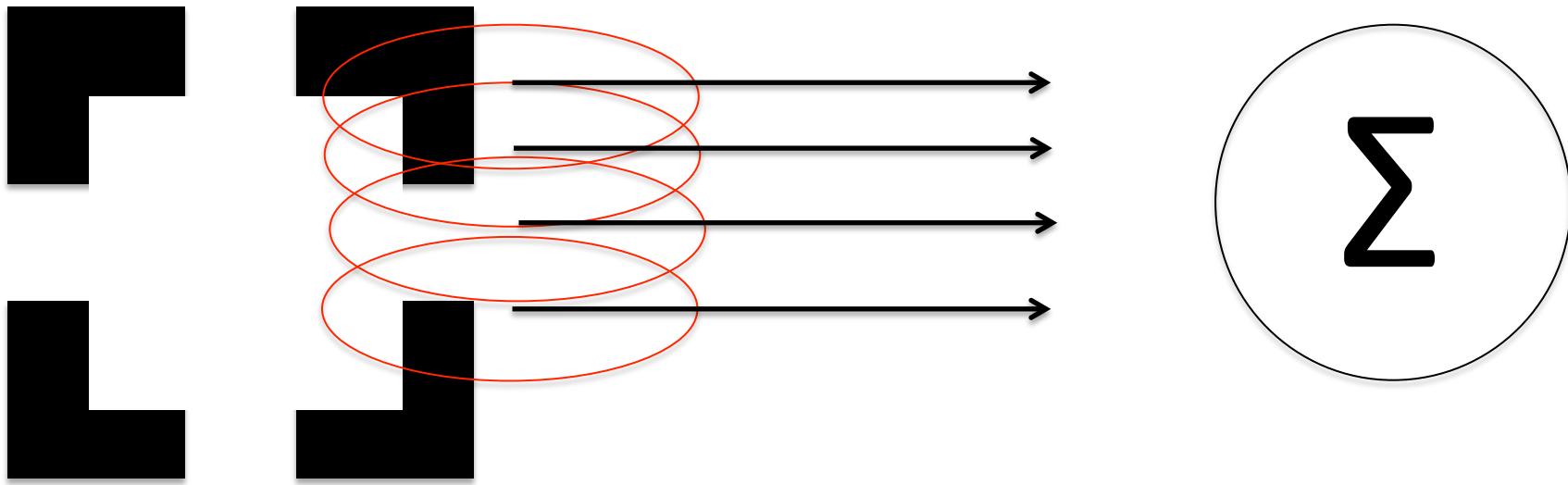
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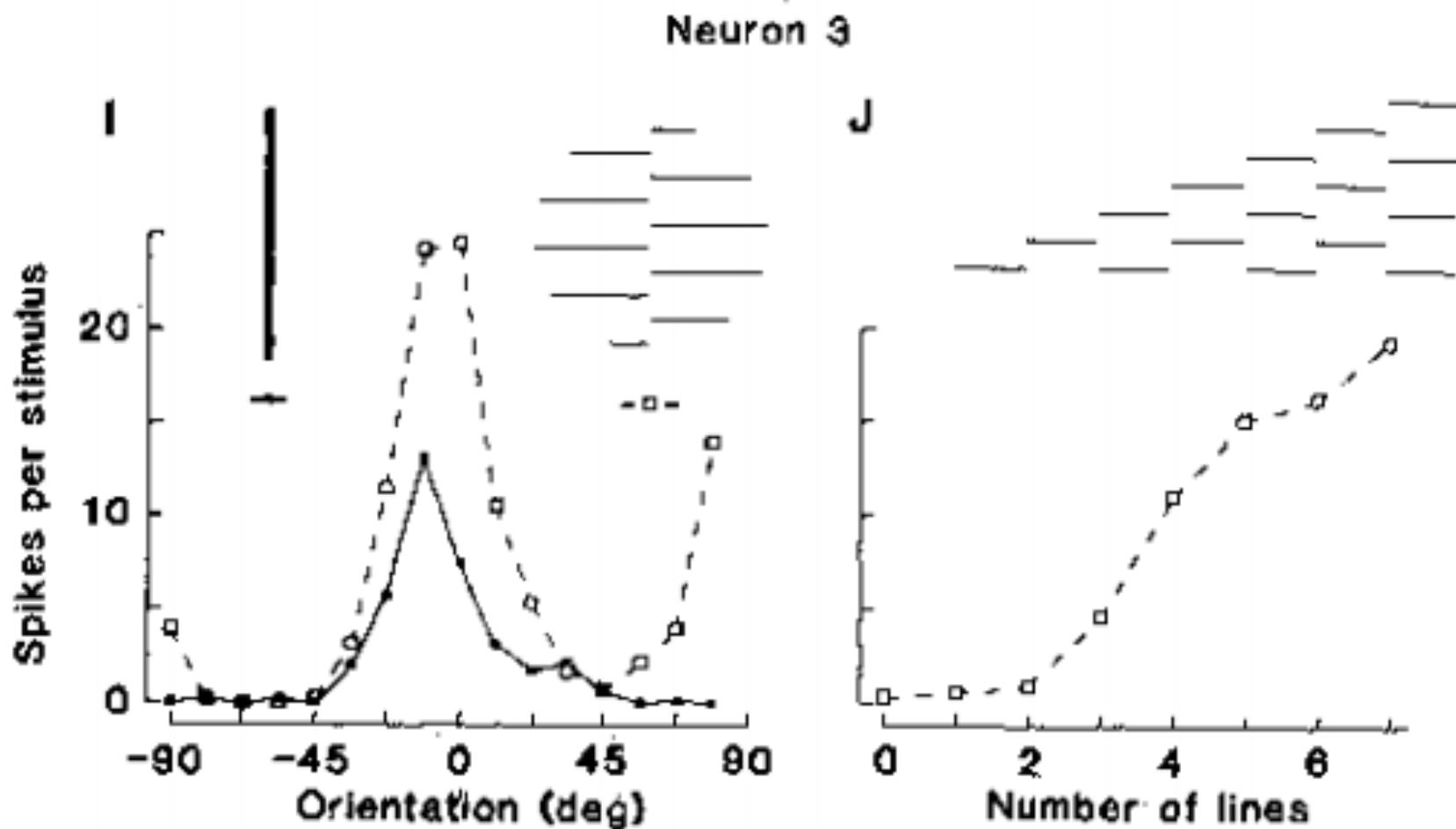
Hypercomplex cell



# End-stopped cells could “see” illusory contour

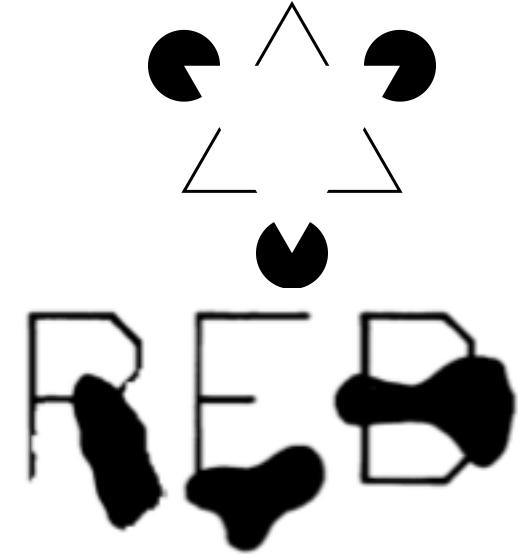


# V2 “sees” illusory contours:

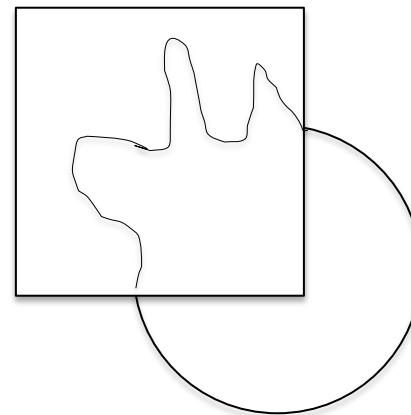
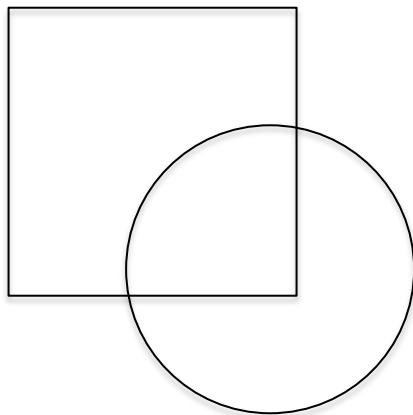
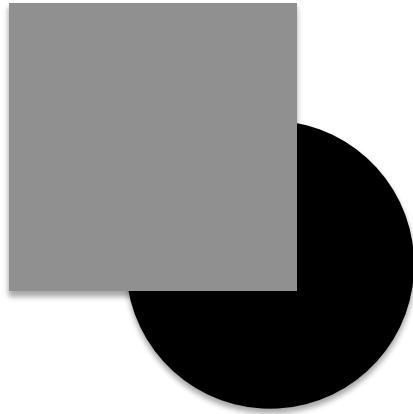


# Today's Agenda:

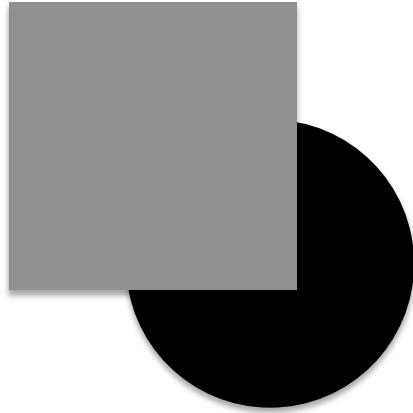
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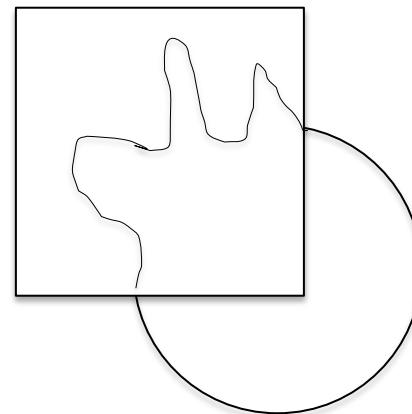
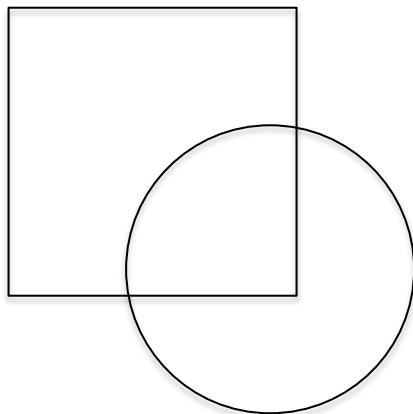
# Priors: simplicity and context



# Priors: simplicity and context



Pragnanz



Priors: simplicity  
and context

TAE CAT

R E B

S R O T

E I S H

D E B T

Priors: simplicity  
and context



TAE CAT

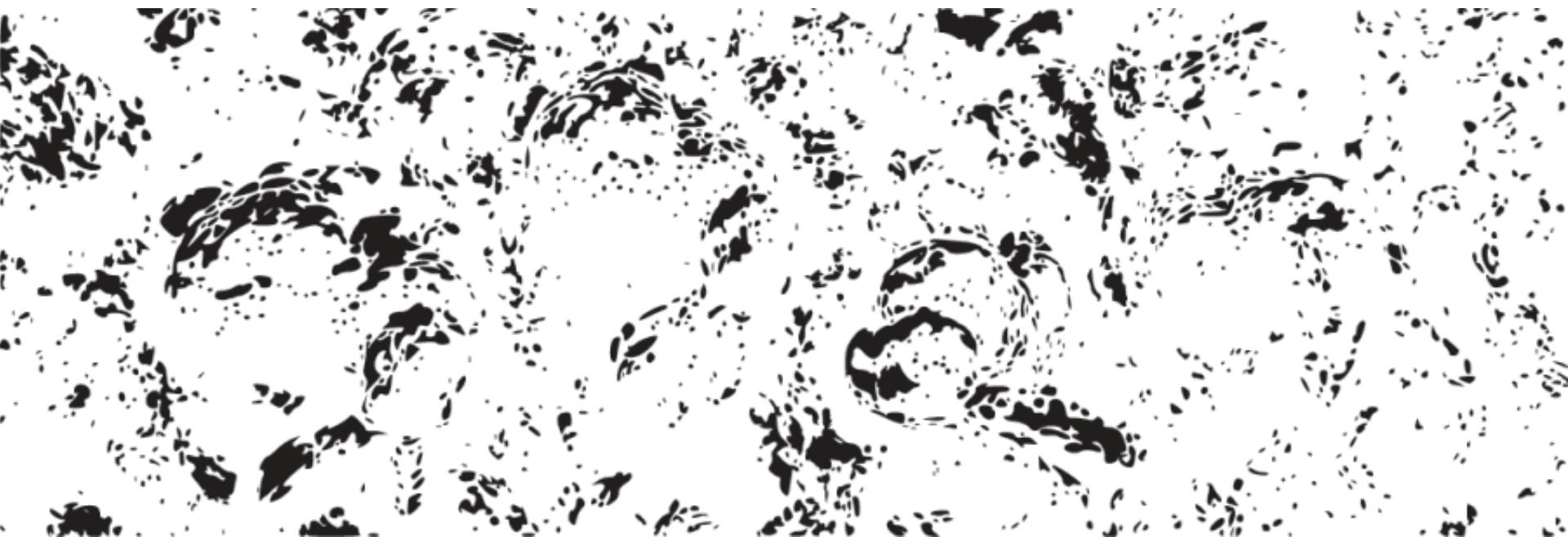
R E B

S R O T

E I S H

D E B T

# Priors: simplicity and context



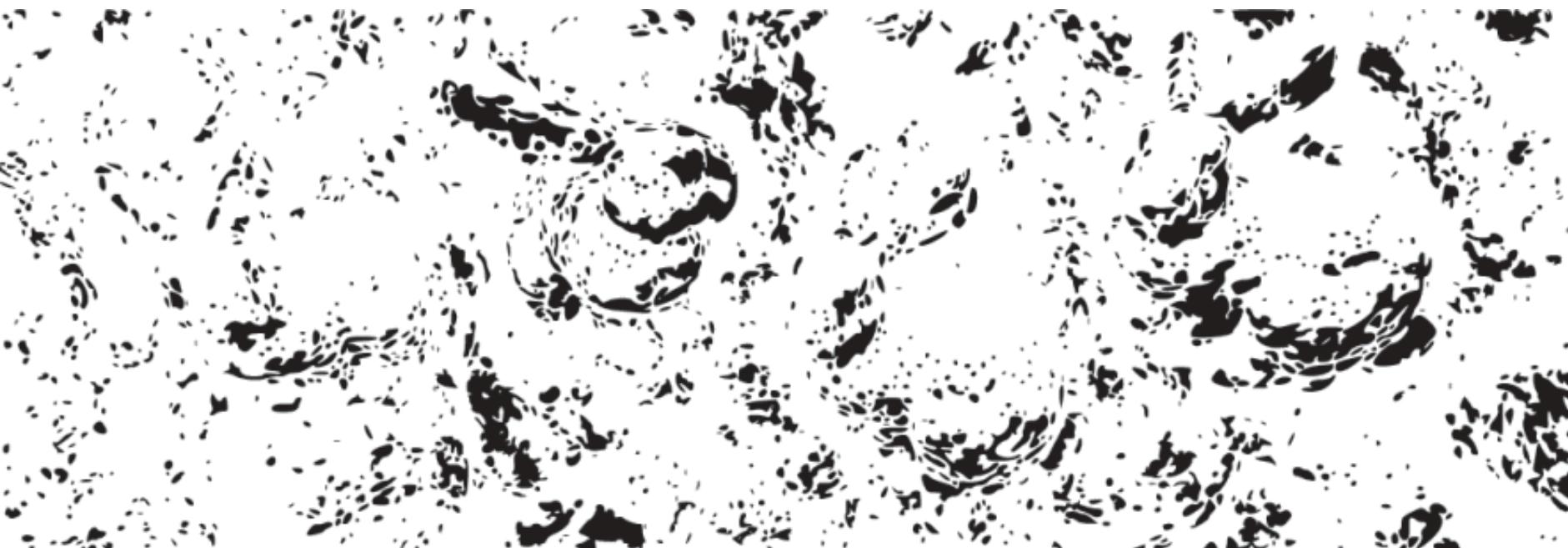
Demo from Stanford Graphics Group

# Priors: simplicity and context



Demo from Stanford Graphics Group

# Priors: simplicity and context



Demo from Stanford Graphics Group

# Photographs have accidental viewpoints



# Motion helps disambiguate grouping



Pawan Sinha



# Motion helps disambiguate grouping

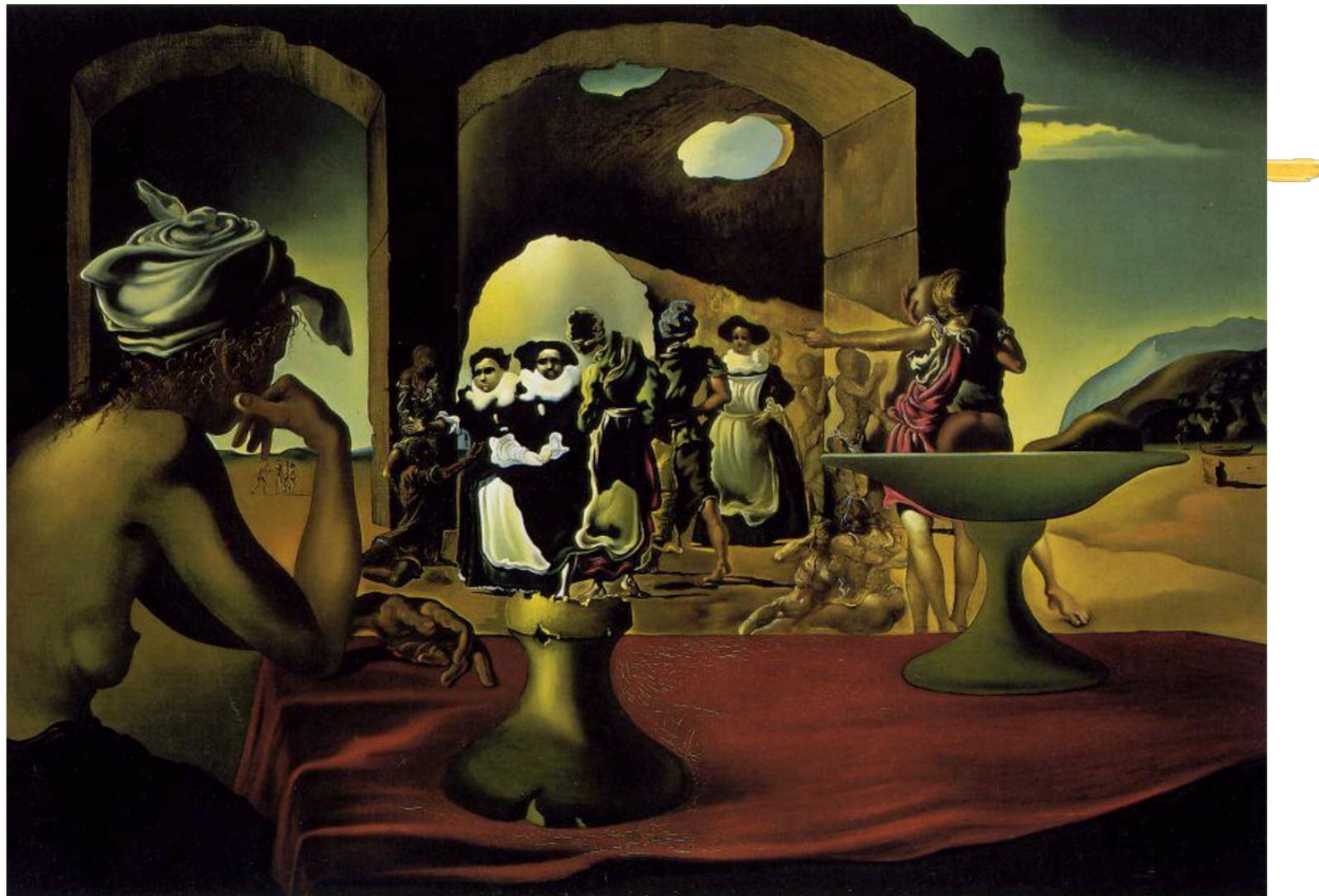


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# Perceptual Organization





Octavio Ocampo

**"The whole is greater than the sum of the parts"**  
This phrase is often used when explaining Gestalt principles.

# Gestalt Laws: Proximity



# Gestalt Laws: Proximity



## Law of Continuity

Objects will be grouped as a whole if they are co-linear, or follow a direction



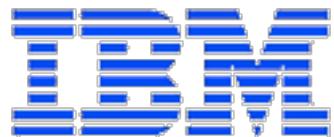
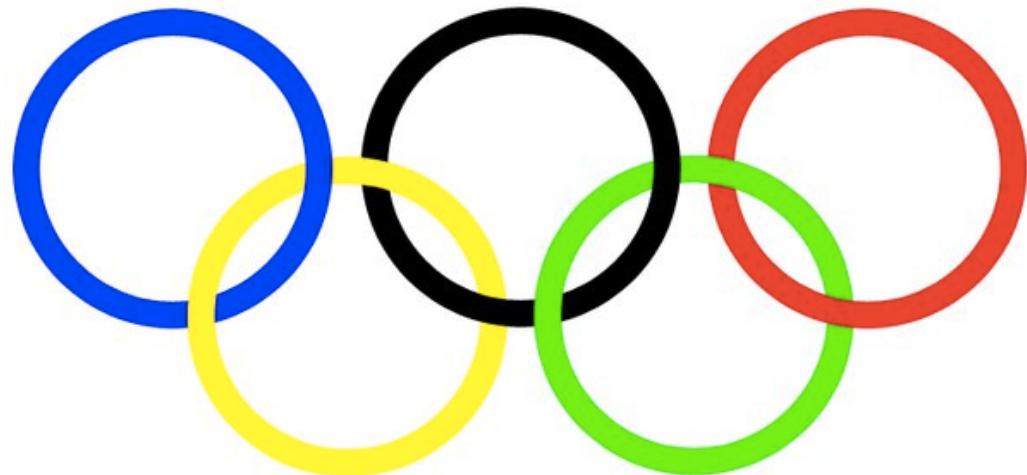
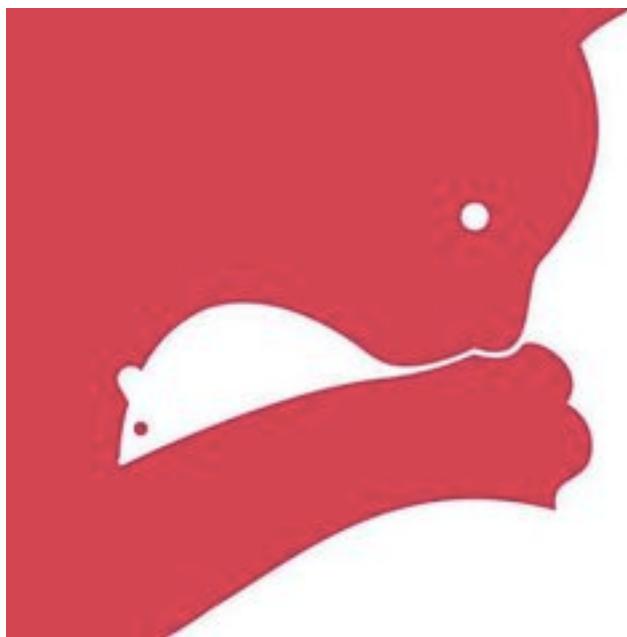
# Gestalt Laws: Similarity



# Gestalt Laws: Common Fate



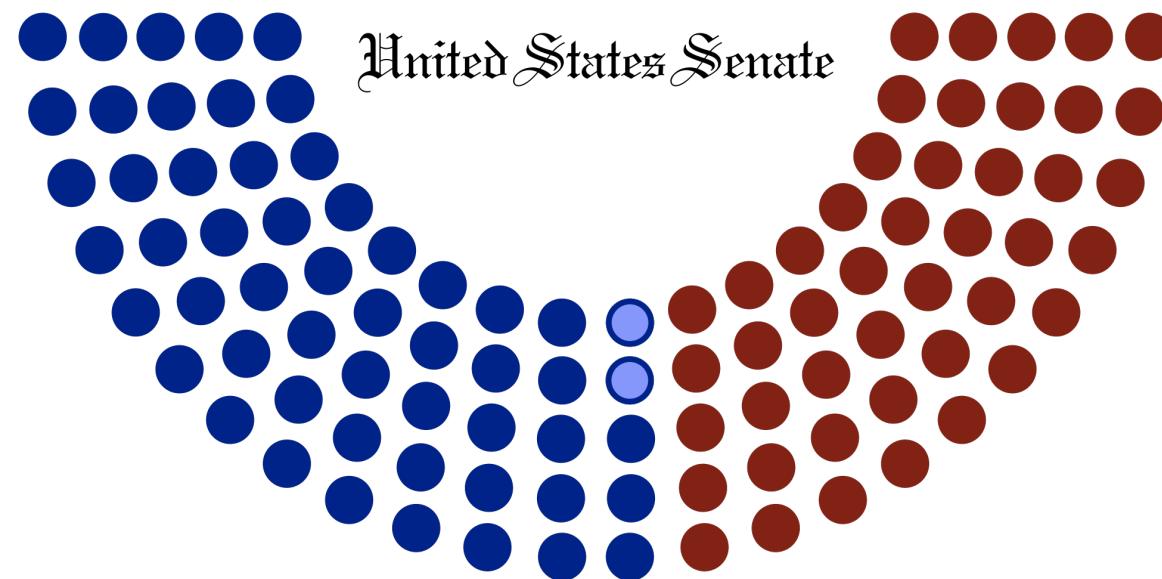
# Gestalt Law of Closure



# Grouping by Synchrony



# Grouping by Common Region



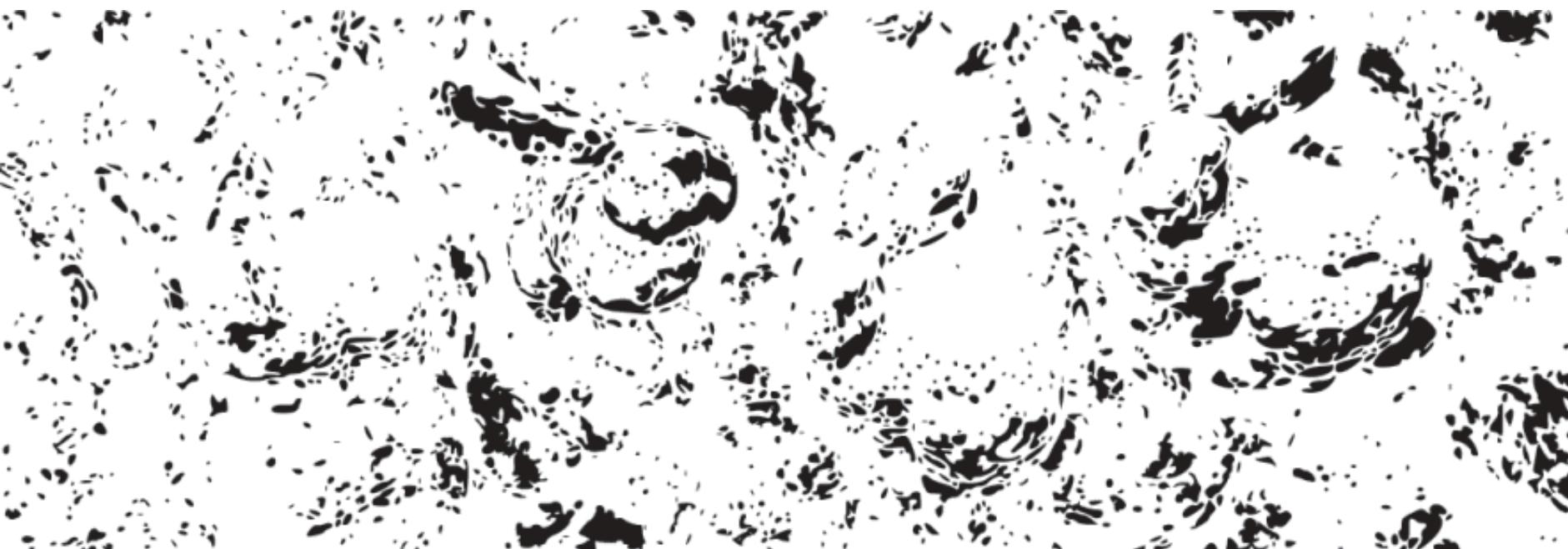
# Grouping by Continuation



# Grouping by Continuation

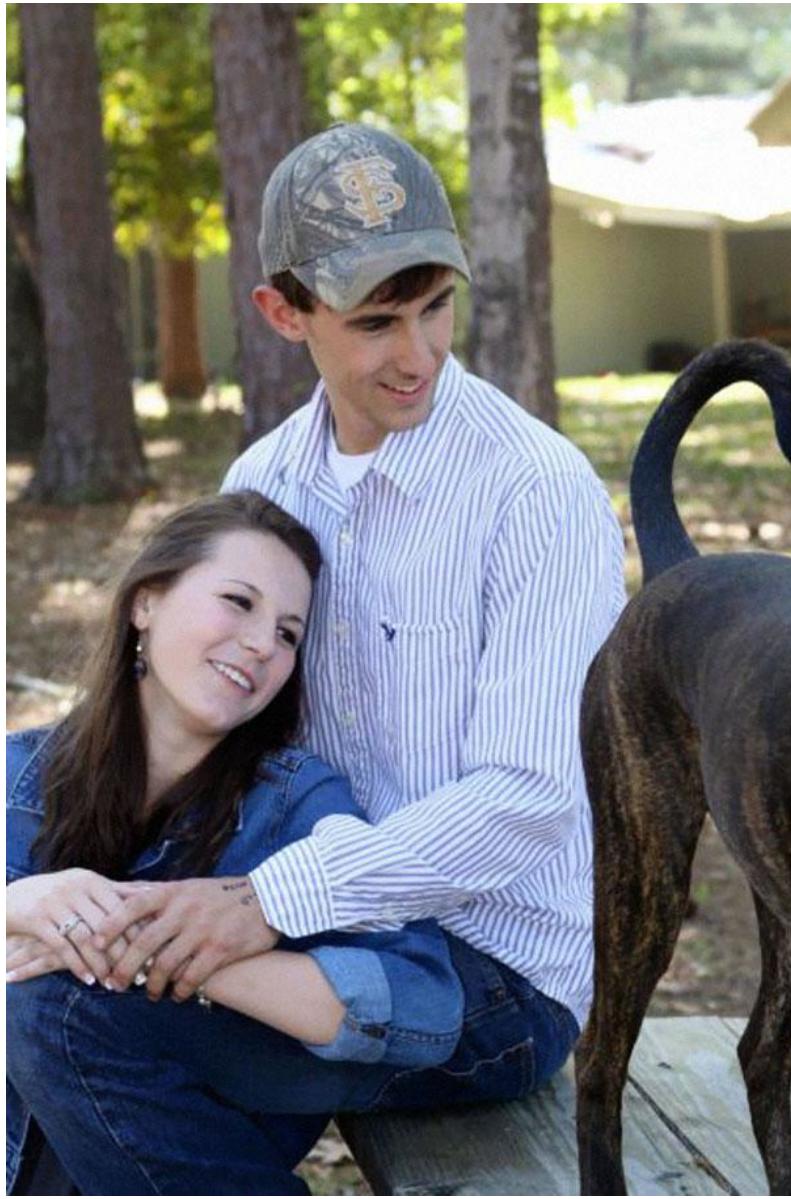


# Grouping from Past Experience



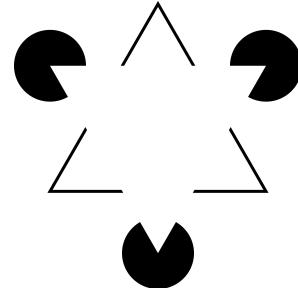
Demo from Stanford Graphics Group

# Grouping by Social Cues?

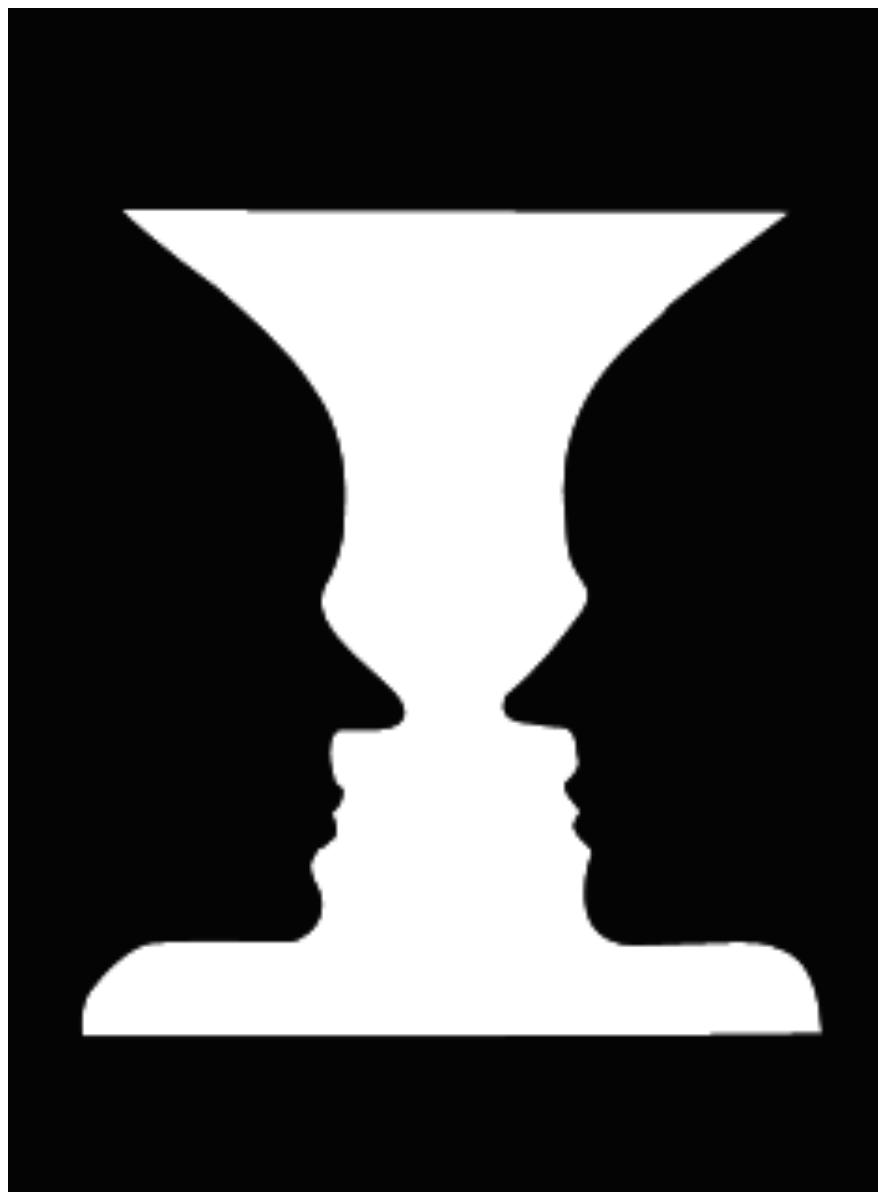


# Today's Agenda:

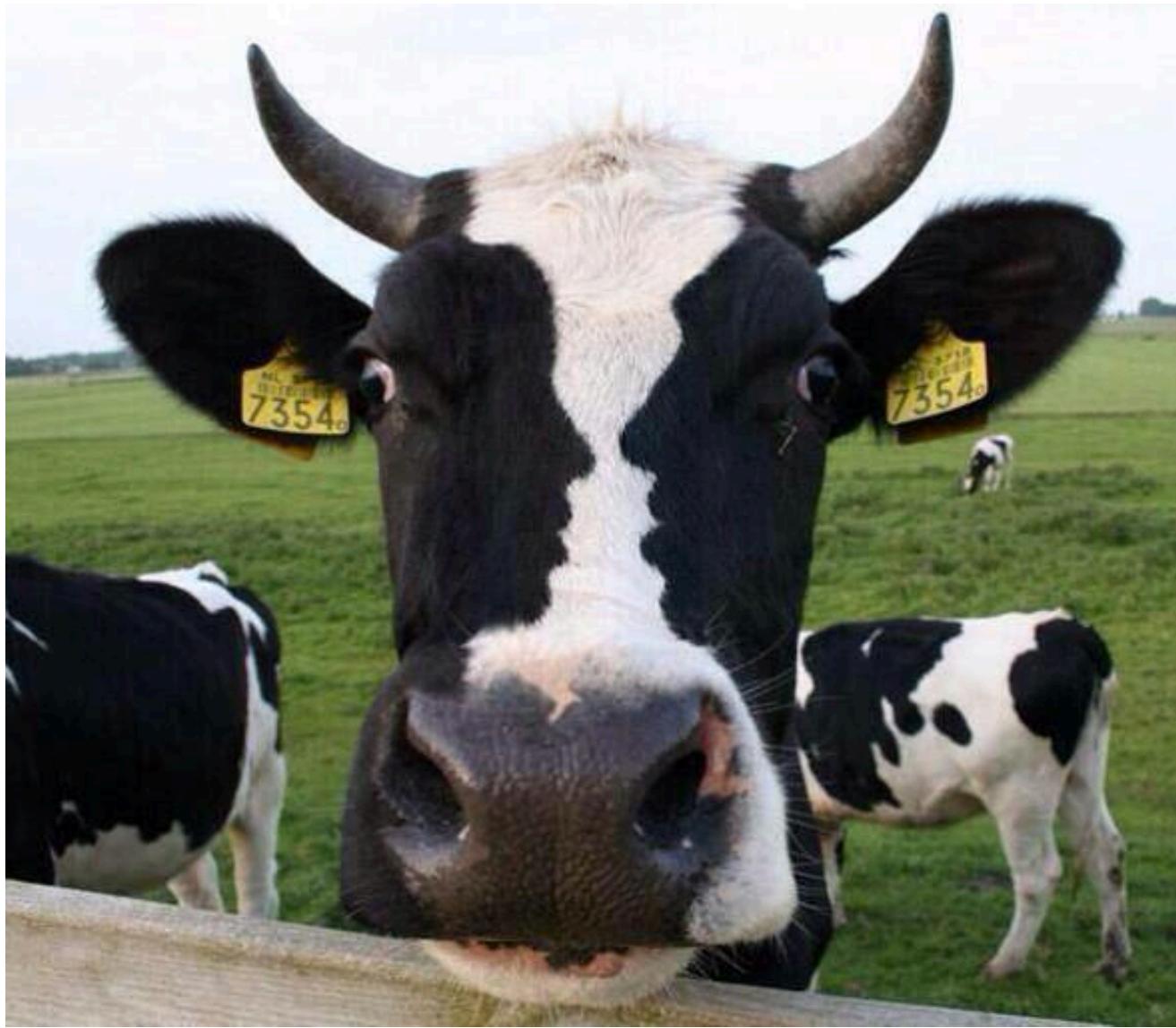
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# Law of Figure and Ground



# Law of Figure and Ground



# Properties of Figures:

**Nearer to observer**

Bounded by contour

Convexity

Parallelism

“Thinglike”



Which building is in front? Are you sure?  
See more at: [www.eyewonderbooks.com](http://www.eyewonderbooks.com)

# Properties of Figures:

Nearer to observer

**Bounded by contour**

**Convexity**

Parallelism

“Thinglike”



# Properties of Figures:

Nearer to observer

**Bounded by contour**

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# Properties of Figures:

Nearer to observer

Bounded by contour

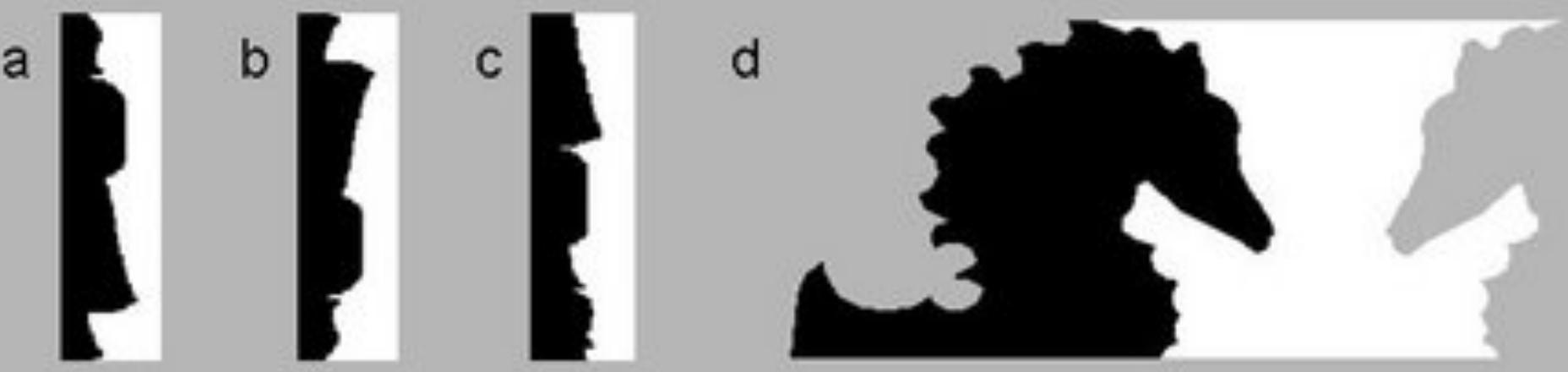
Convexity

**Parallelism**

“Thinglike”



# Prior experience



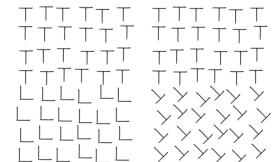
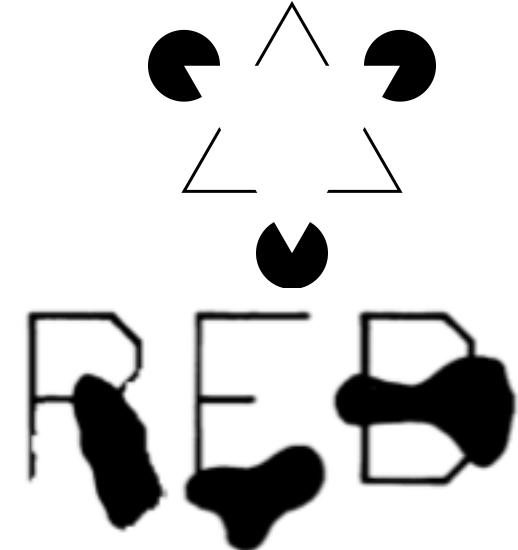
# Ambiguous Figures:



Figure by Roger Shepard

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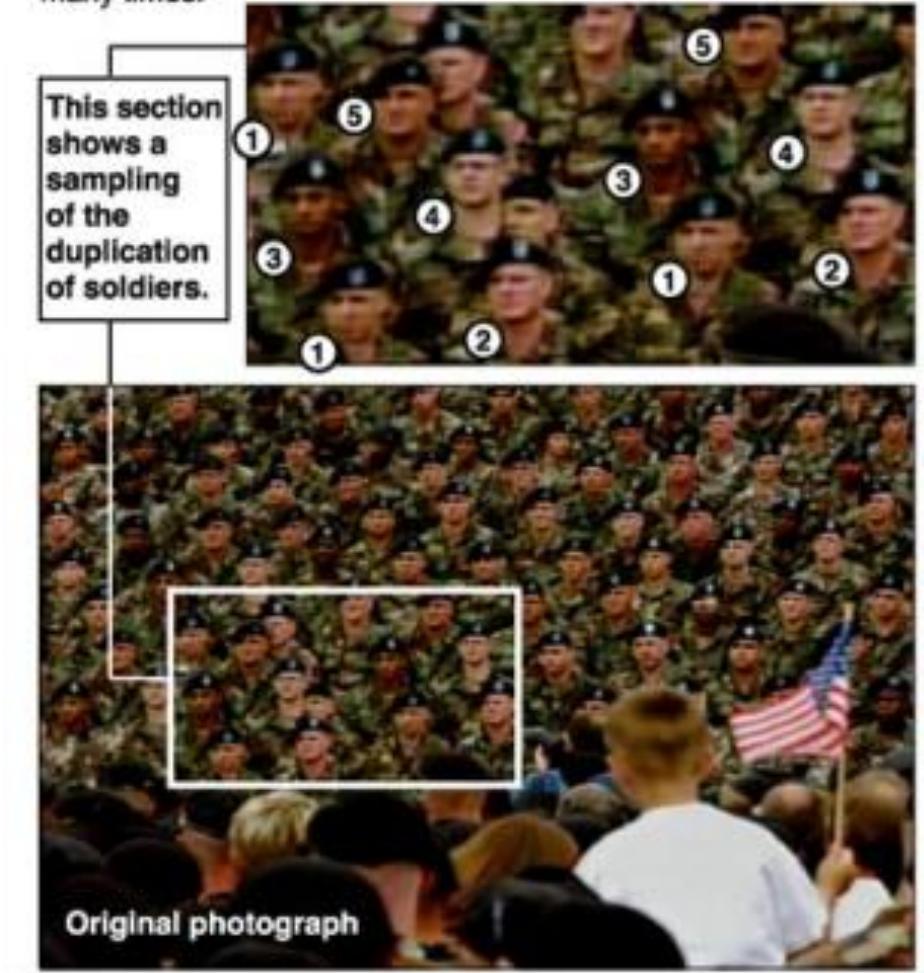
# Texture Segmentation



# Texture Segmentation

## Bush campaign digitally altered TV ad

President Bush's campaign acknowledged Thursday that it had digitally altered a photo that appeared in a national cable television commercial. In the photo, a handful of soldiers were multiplied many times.



# Texture Segmentation





NATIONAL  
GEOGRAPHIC

Photograph by Graham McGeorge

NATIONAL GEOGRAPHIC TRAVELER PHOTO CONTEST 2013

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# High resolution only at fovea



# High resolution only at fovea

**A**

+

**A**

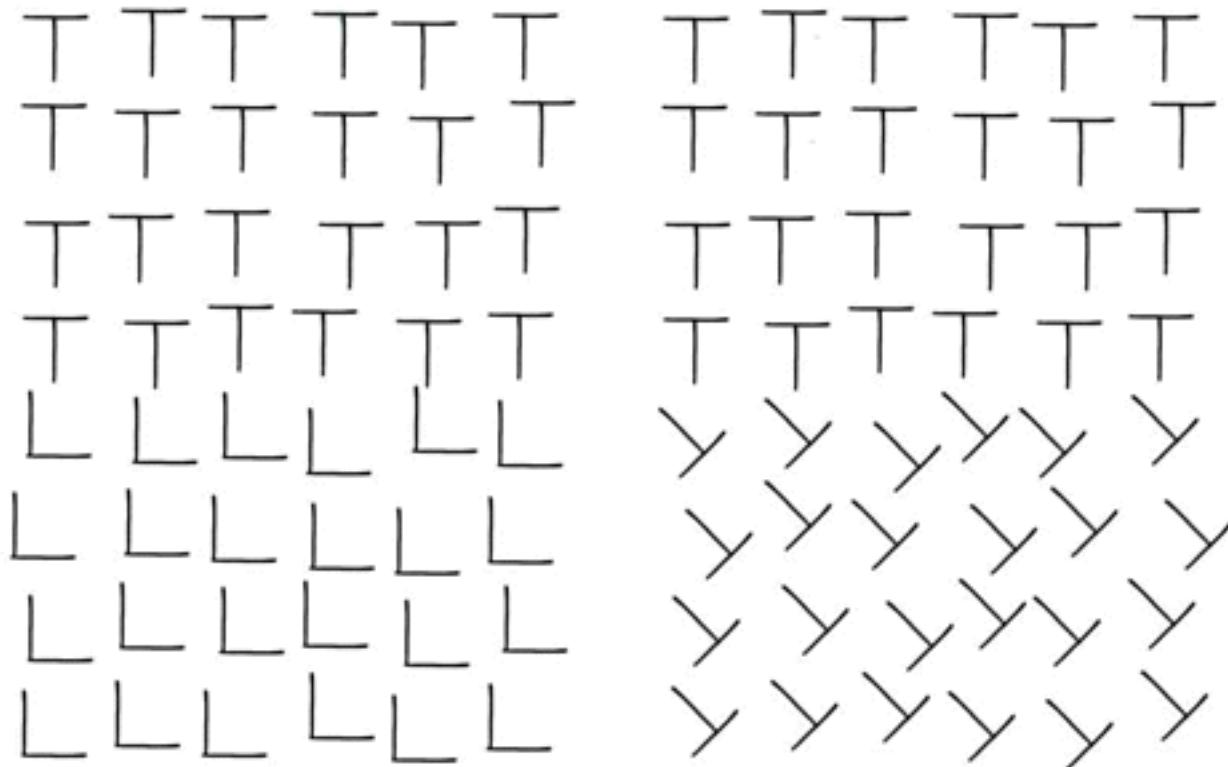
“Crowding”

# High resolution only at fovea

A + BOARD

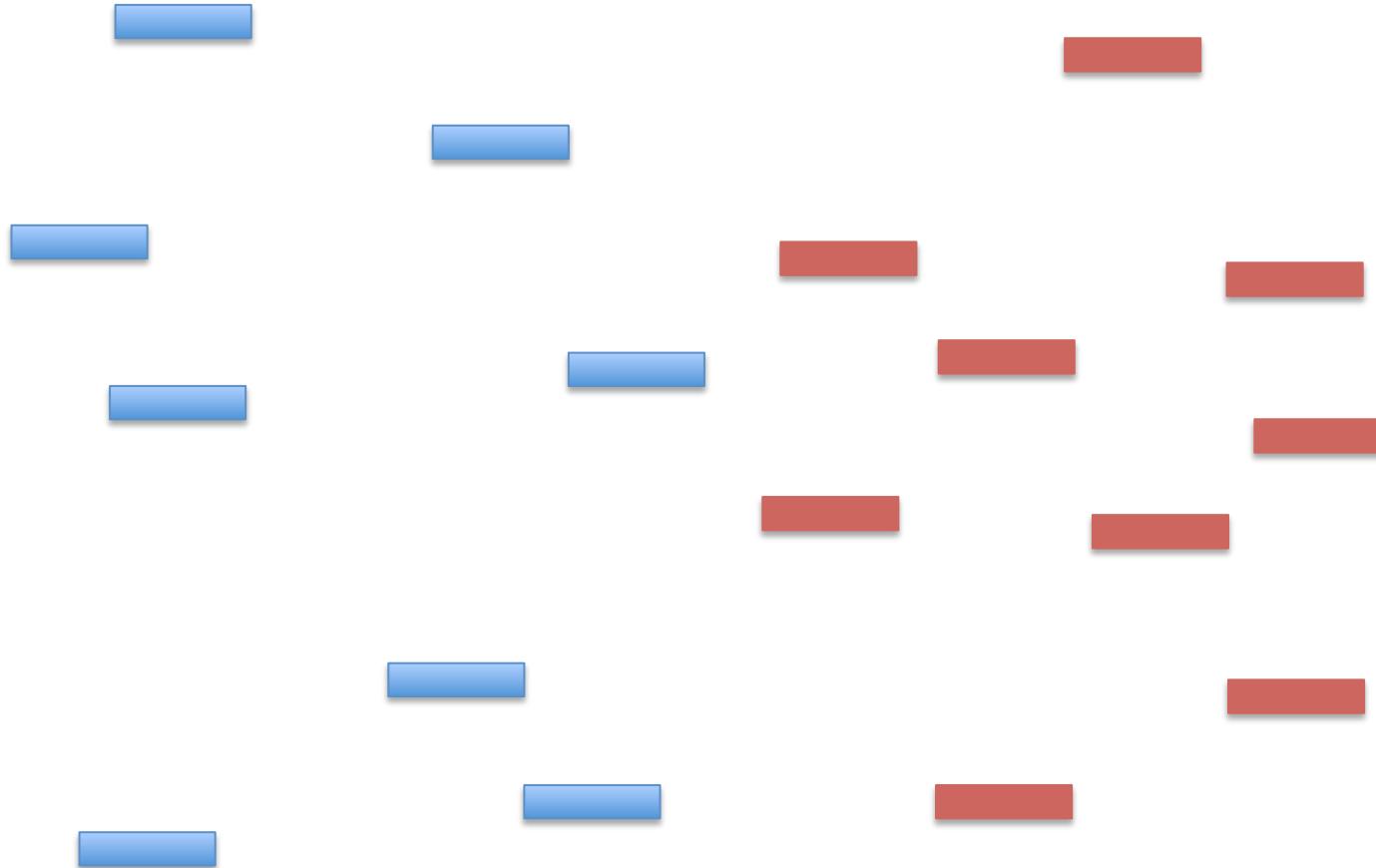
“Crowding”

# Texture Segmentation



Summary statistics of orientation, not binding of elements

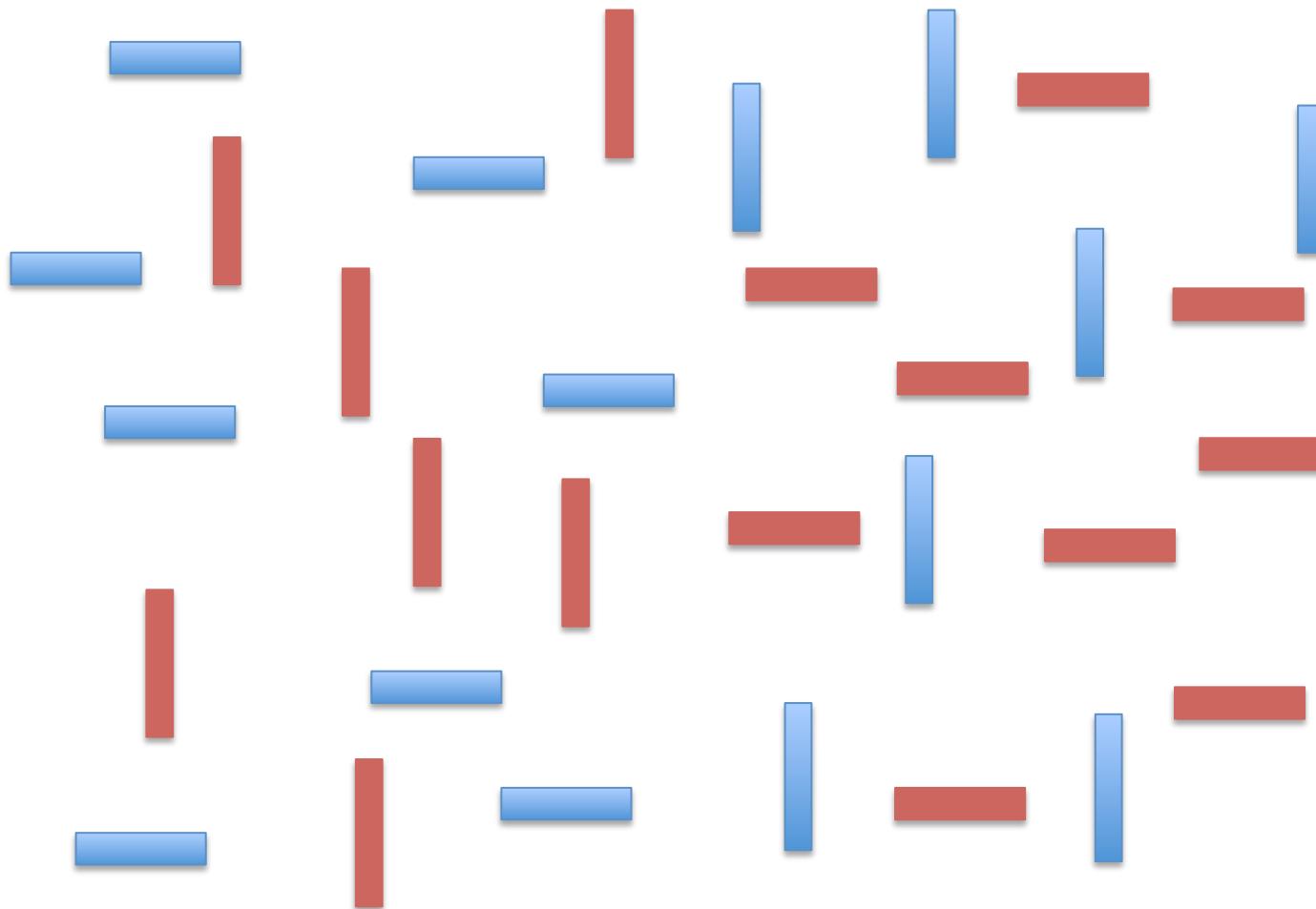
# Texture Segmentation



# Texture Segmentation



# Texture Segmentation



Original patches

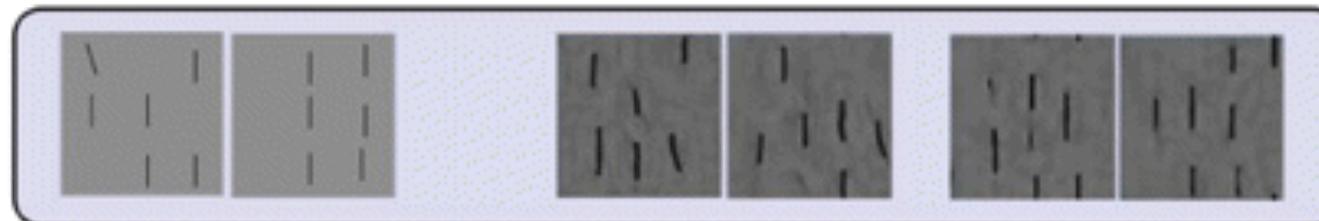
Mongrels

Target +  
distractors      Distractors  
only

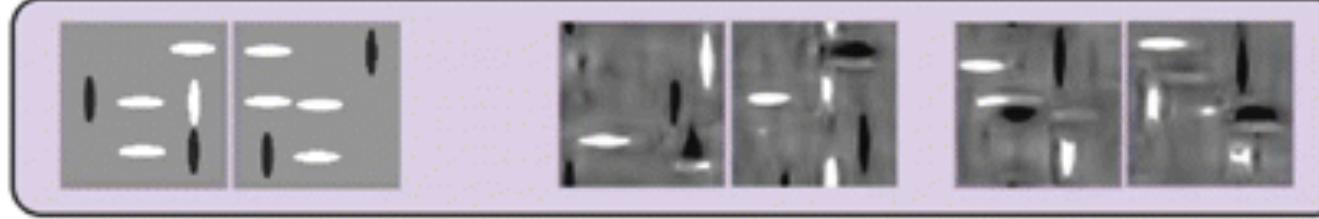
Target + distractors

Distractors only

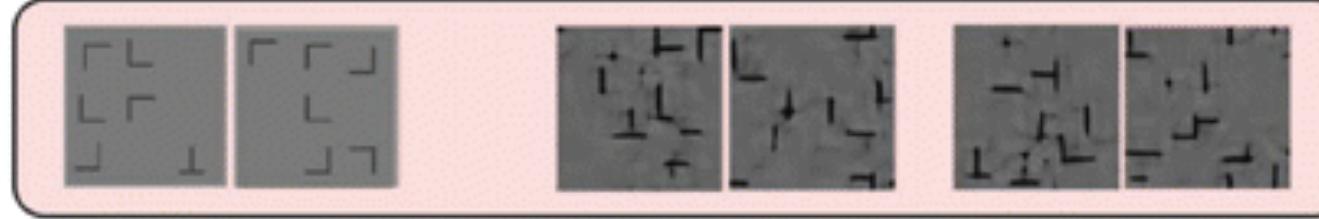
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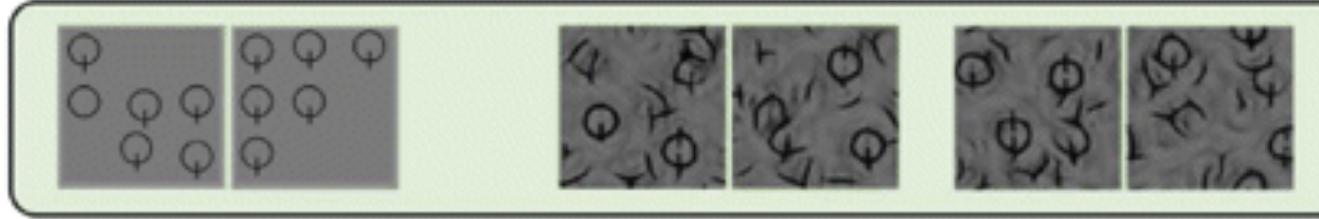
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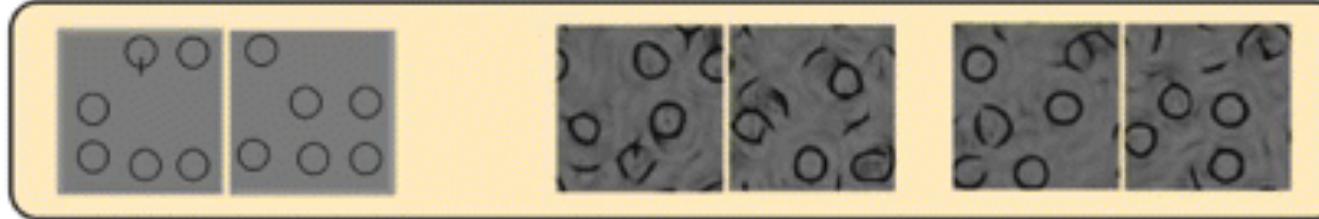
c



d



e



Rosenholtz et al,  
*Journal of Vision*,  
2012

These images are seen as the “same”

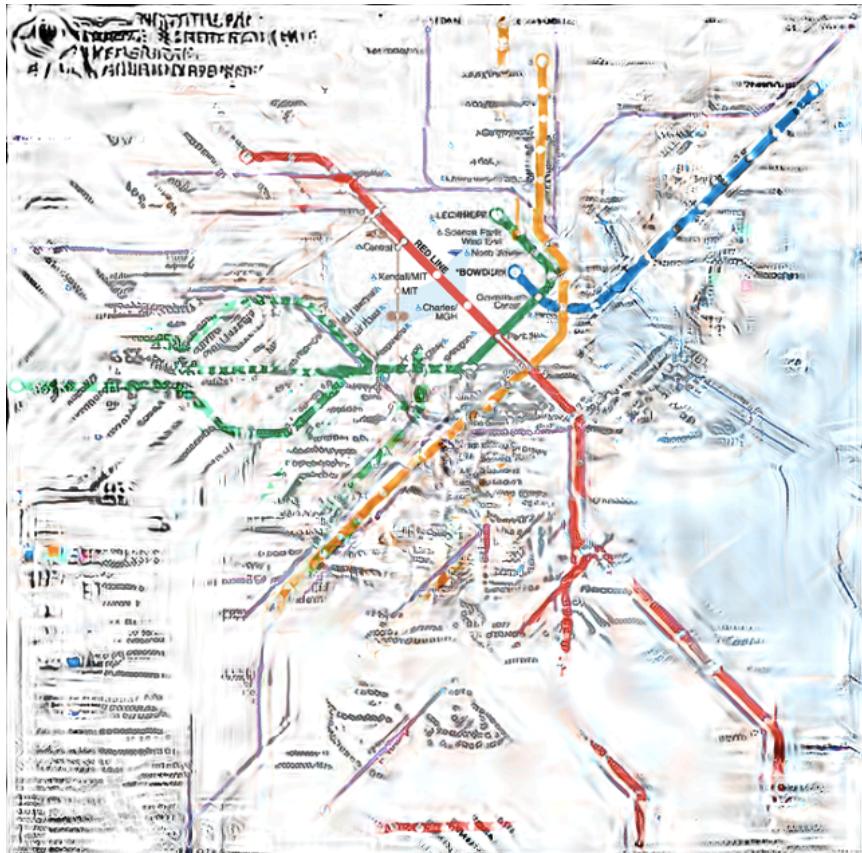
C



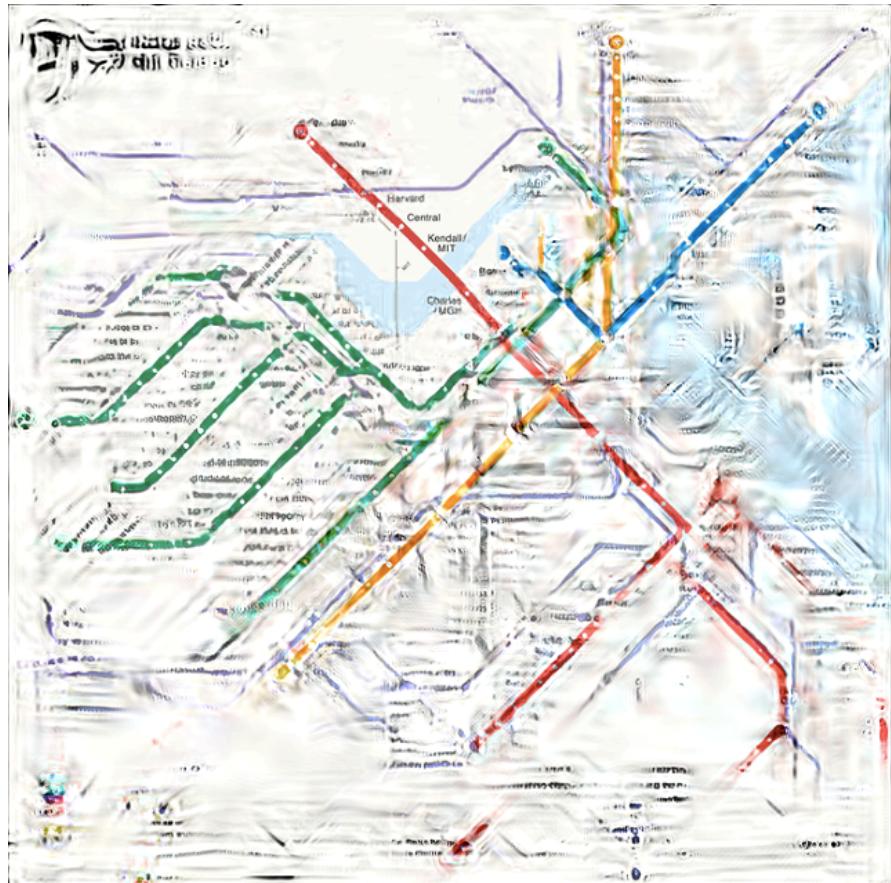
D



# Application: Designing better subway maps

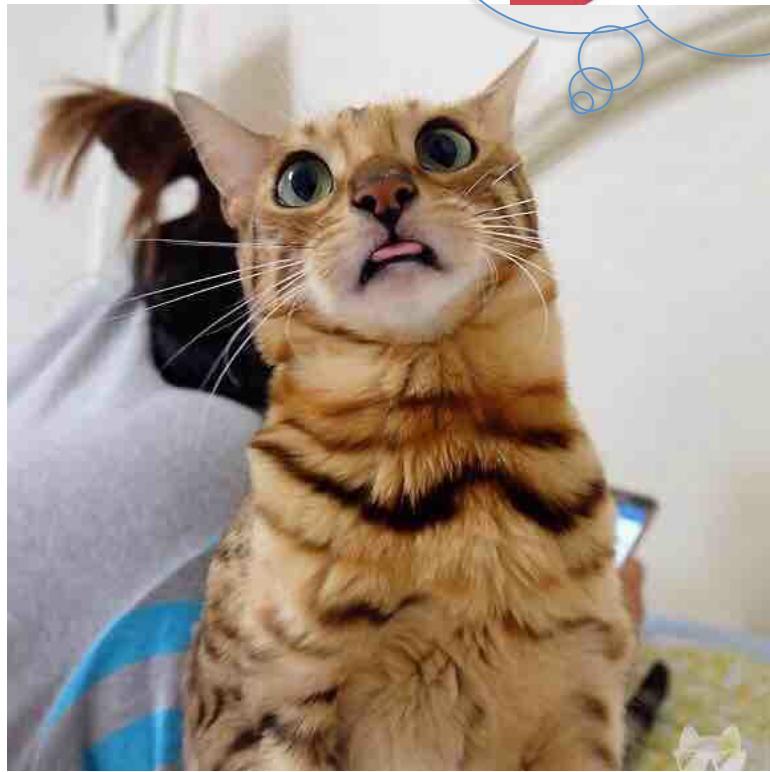


# Application: Designing better subway maps



# Application: Designing better subway maps





mrgreene@stanford.edu