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Guest Lecture ISTA 352
September 24, 2012

How does the brain determine which pieces go together to form an object?

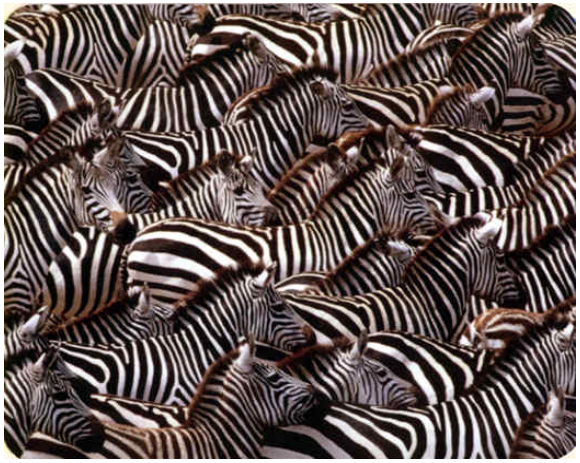
How are objects segregated from one another?

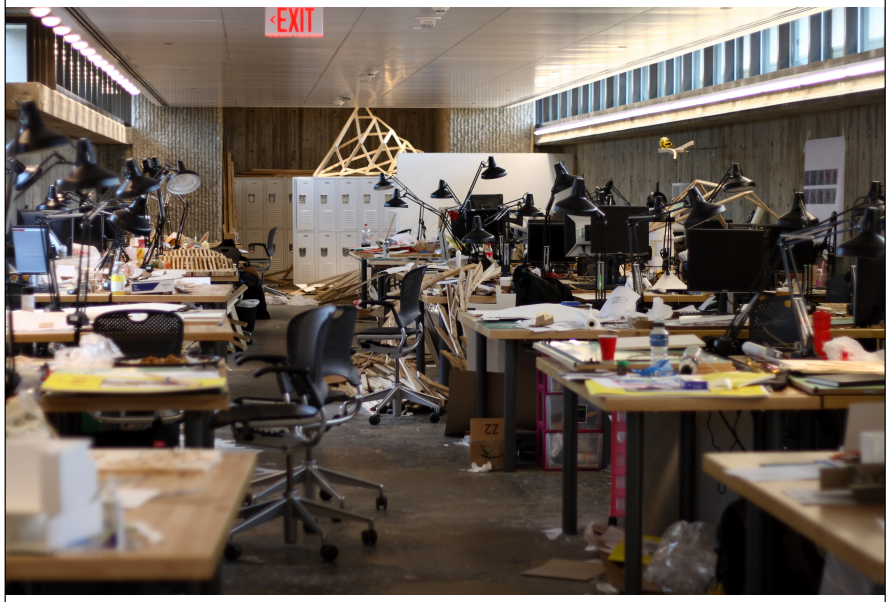
Daunting task

- You do it so easily, hard to see there's any problem
- Yet computers can't do it -- **not even Watson!**

http://en.wikipedia.org/wiki/Watson_(computer)

A few examples to try to give you insight that it's hard





There are no pictures in the head

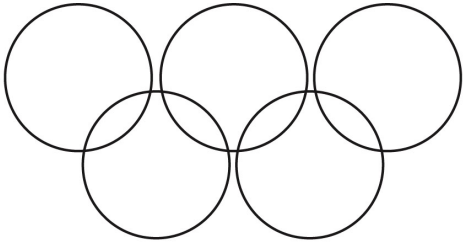
Light rays hit the retina
Transduced into electrical signals
Electrochemical signals from there on in

How do these internal electrical signals produce percepts?

What do you see?

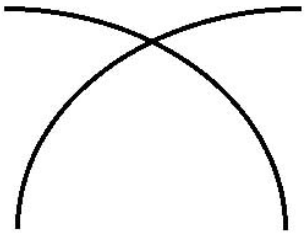
The brain uses a variety of "heuristics" (rules of thumb) to find objects in a scene

An important problem; lots of heuristics



(a)

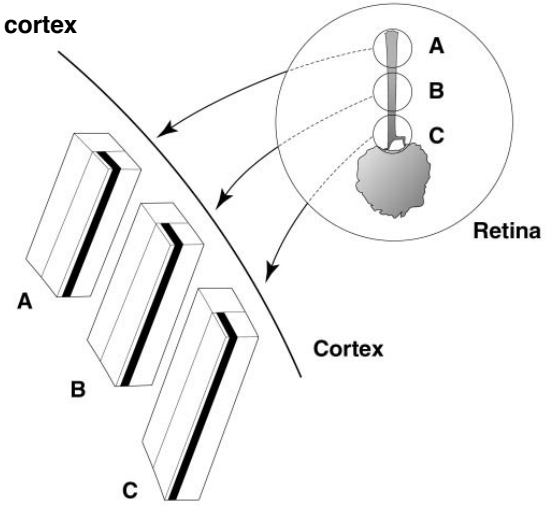
Good continuation: contours continue along smoothly curving paths



Representation of tree in cortex

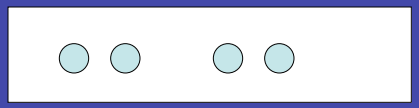
Non-trivial.

what representation of a tree trunk is like in cortex.

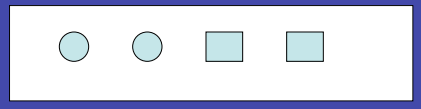


Grouping Principles

2. Proximity (close together)

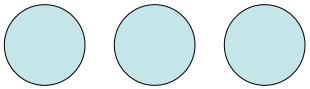


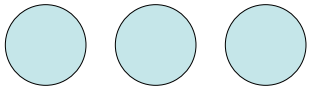
3. Similarity



Grouping Principles

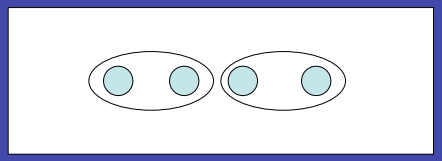
4. Common fate: things that change at the same time appear to be grouped together



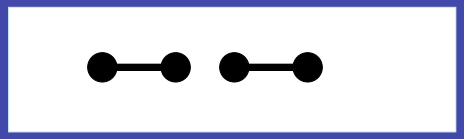


Recent additions:

5. Common region



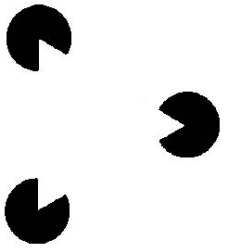
6. Connectedness

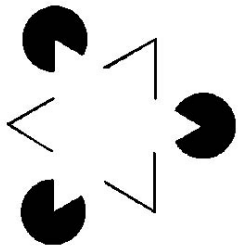


Context Matters

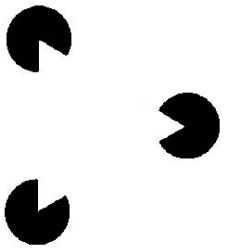
The whole is different from the sum of the parts

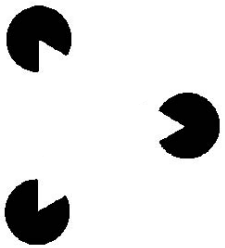
e.g., subjective contour triangle



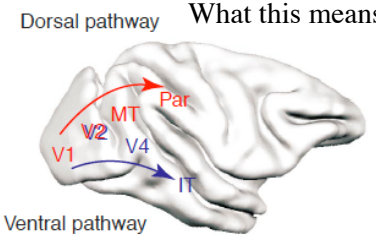


Kanizsa





What this means in terms of the brain:



A Neuron's Receptive field (RF):
The portion of the retina that when stimulated affects its response

RF size increases with
level in the visual hierarchy

Context effects imply that perception is not simply being assembled/ built up (e.g., no subjective contours at low levels). Higher levels influence lower levels– can see subjective contour response in low-level neurons.

What do you see?

What grouping heuristics operate?

Good continuation?
Proximity?
Similarity?
Common Fate?
Common Region?
Connectedness?

Examples of whole different from sum of parts?

Is past experience necessary?

What do you see?

Separating Objects from one another

FIGURE-GROUND SEGREGATION

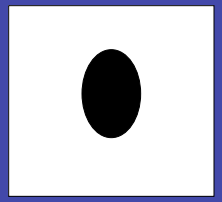
Determining where shape/object lies relative to an edge

Two regions share an edge

Figure = region to which edge is assigned; has a definite shape

Ground = shapeless near shared edge

Gestalt heuristics for figure assignment



- relatively smaller area
- symmetric (around a vertical axis) vs. asymmetric
- enclosed vs. surrounding
- convex vs. concave

A brief Experiment:

1. **Which region stands out as the "figure"**
(i.e., the one shaped by the border)

2. **What object(s) does the black region portray?**

3. **What object(s) does the white region portray?**

Which region stands out as the "figure"
(i.e., the one shaped by the border)

What object(s) does the black region portray?

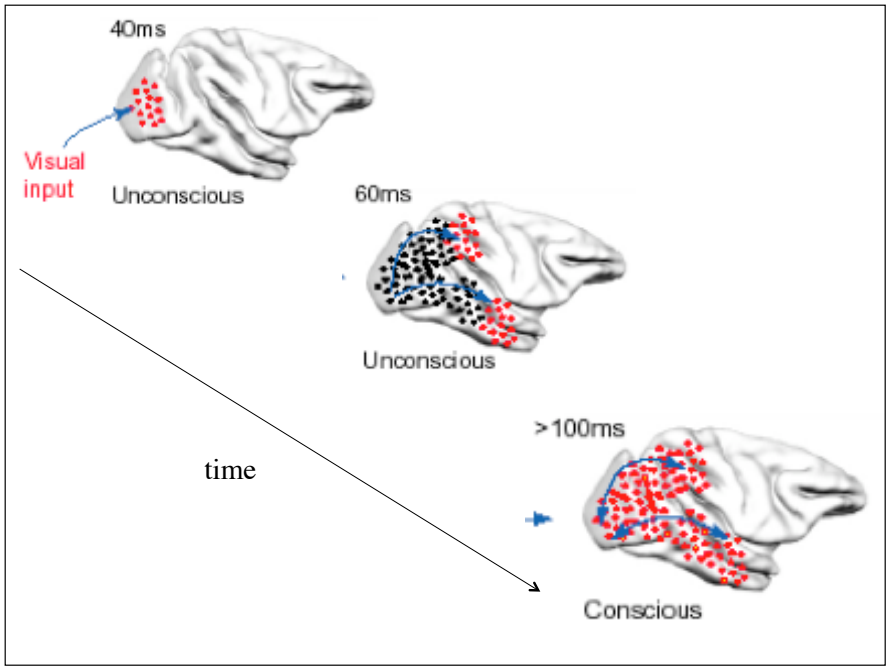
What object(s) does the white region portray?

Brief masked exposures: Which region is figure?

INV 61%

UP 76%

More past experience upright than inverted.
Past experience (memory) is an object cue too!



Massive feed-back connections
from high to low levels in the brain,

Wherever there are feed-forward connections,
there are feedback connections

Perceptual organization into groups and figures
is of primary importance.

makes sense to use both
feed-forward (bottom-up) information
and
feed-back (top-down) information
to accomplish these tasks

Top-down is past experience/object memories

Object recognition
and
object perception
(grouping & segregation)
are intertwined.

And context matters!