Announcements

http://www.youtube.com/watch?v=URLRdonUHk&feature=related

Cortical visual processing & form vision

1. V1 responses to natural images & the binding problem
2. Perceptual grouping
3. Perceptual segregation
4. Neural mechanisms of grouping and segregation

Early visual analysis is **LOCAL**

visual input is analyzed at different spatial scales (i.e., spatial frequency bands)

---

Early visual analysis is **LOCAL**

---

Early visual analysis is **LOCAL**

---

Early visual analysis is **LOCAL**
Early visual analysis is LOCAL

What’s the binding problem?

The “Humpty Dumpty” Problem:
How are local, spatially distributed image descriptions linked to achieve meaningful representations of objects?

Solution(s)?

Gestalt = organized whole, complete pattern
Gestalt psychology = Studies how are local, spatially distributed image descriptions linked to achieve meaningful global representations of objects and events.
Key message: “the whole is more than the sum of its parts”
Vision exploits regularities in the environment and knowledge from experience to “solve” the binding problem

We see objects and not spatial frequencies, contrasts, etc.

How are local, spatially distributed image descriptions linked to achieve meaningful representations of objects?

The “binding” problem

What’s the binding problem?
Solution(s)?

“What we actually perceive are entities such as things, figures… This demonstrates the operation of processes in which the content of certain areas is unified and, at the same time, segregated from its environment… [this] organization depends upon relations among local stimuli.”

unified = grouping
segregated = figure/ground segmentation

Cortical visual processing & form vision

1. V1 responses to natural images & the binding problem
2. Perceptual grouping
3. Perceptual segregation
4. Neural mechanisms of grouping and segregation

What Promotes Perceptual Grouping?

Gestalt principles of grouping:
• Similarity
• Proximity
• Common region
• Element connection
• Good continuation
• Symmetry
• Closure
• Simplicity
• Common fate

Visual grouping from:
similarity - proximity - common region - connection - symmetry - continuation - closure - simplicity

LIGHTNESS
COLOR
ORIENTATION
Visual grouping from:
similarity - proximity - common region - connection - symmetry - continuation - closure - simplicity
Visual grouping from:
similarity - proximity - common region - connection - symmetry - continuation - closure - simplicity
Grouping from dynamic visual input: “Common Fate”

“One can easily show that the factors on which grouping depends in time are about the same as those on which it depends in space.”

Wolfgang Köhler
Role of Learning in Grouping

Grouping Cues At Work
similarity - proximity - common region - connection - symmetry - continuation - closure - simplicity

Cortical visual processing & form vision
1. V1 responses to natural images & the binding problem
2. Perceptual grouping
3. Perceptual segregation
4. Neural mechanisms of grouping and segregation

Solution(s)?
“What we actually perceive are entities such as things, figures... This demonstrates the operation of processes in which the content of certain areas is unified and, at the same time, segregated from its environment... [this] organization depends upon relations among local stimuli.”

unified = grouping
segregated = figure/ground segmentation

Figure/Ground Segmentation
Figure/Ground Segmentation

• Figure-ground segregation - determining what part of environment is the figure so that it "stands out" from the background

• Properties of figure and background
  – The figure is more "thinglike" and more memorable than ground.
  – The figure is seen in front of the ground.
  – The ground is more uniform and extends behind figure.
  – The contour separating figure from ground belongs to the figure (border ownership).

• Factors that determine which area is figure:
  – Elements located in the lower part of displays
  – Elements that are symmetrical
  – Elements that are convex
  – Elements that are small
  – Elements that are oriented vertically
  – Elements that have meaning, etc...

Stimuli and results from Vecera et al. (2002)
1. V1 responses to natural images & the binding problem
2. Perceptual grouping
3. Perceptual segregation
4. Neural mechanisms of grouping and segregation
BUT,

how are grouping, segmentation, etc. implemented in the brain?

Visual grouping from:
- similarity
- proximity
- common region
- connection
- symmetry
- continuation
- closure
- simplicity

Contextual modulation - stimuli outside of a neuron’s receptive field can affect neural firing

Figure/Ground Segmentation in V1

How a neuron in V1 responds to oriented lines presented to the neuron’s receptive field (shown as a pink circle).

(a) The neuron responded when the bars on the receptive field are part of a figure, but there is less response when
(b) the same pattern is not figure.

Adapted from Lamme (1995)