

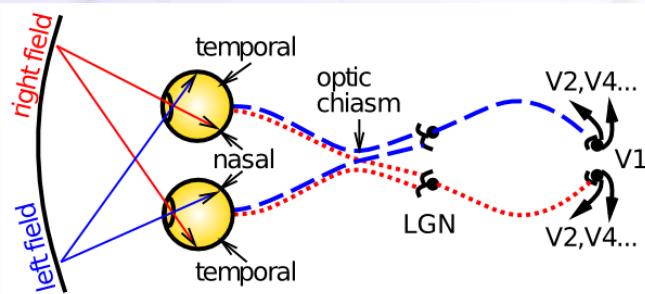
Perception & Attention

Computational Cognitive Neuroscience
Randall O'Reilly

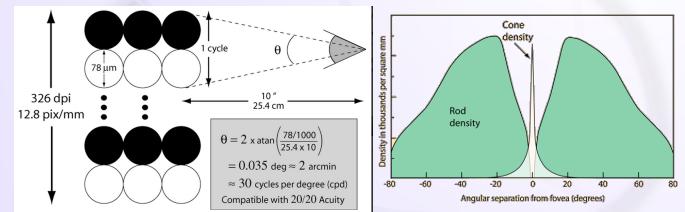
Perception Overview



Optic Pathway

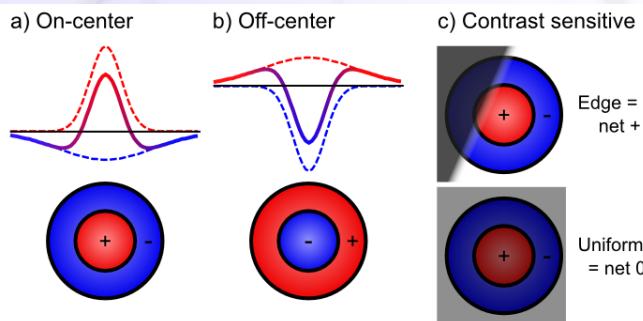


How Many Megapixels??

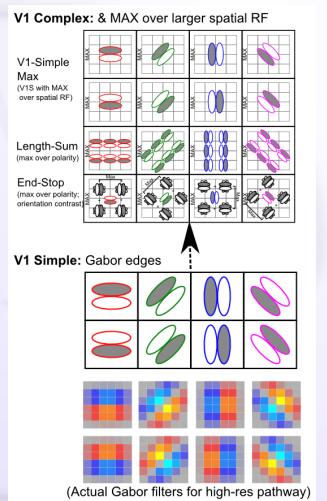
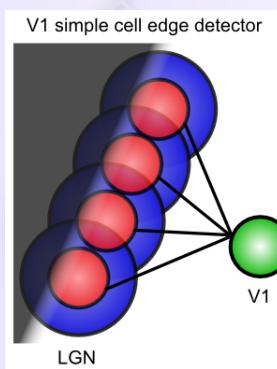


- Retina has ~100 mega-rods, only ~5-7 mega-cones
- Fovea can resolve about 30 cycles-per-degree (requires cone spacing of ~.3 arcmin) = ~300 dpi at 10° (close!)
- Focal length of human eye is ~22mm, max ISO about 800

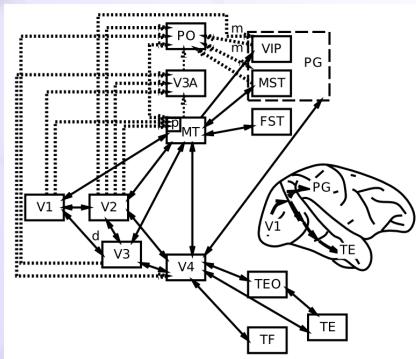
Retinal Contrast Filtering



V1

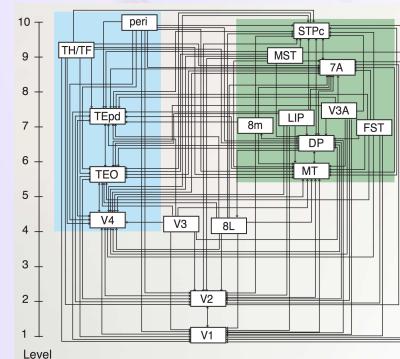


Visual Hierarchy: What vs Where



7

“Van Essen” Hierarchy

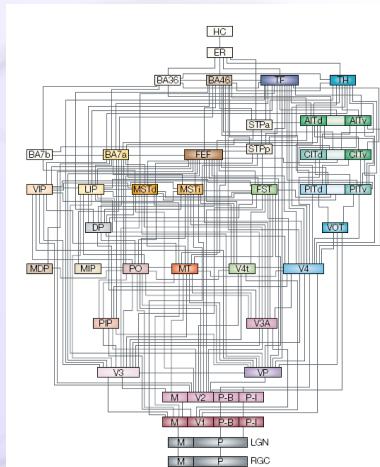


Markov et al., 2014

TE.. = Temporal
LIP, DP.. = Parietal
8L = Frontal Eye Field

To hippocampus:
TH/F = Parahippo
peri = Perirhinal

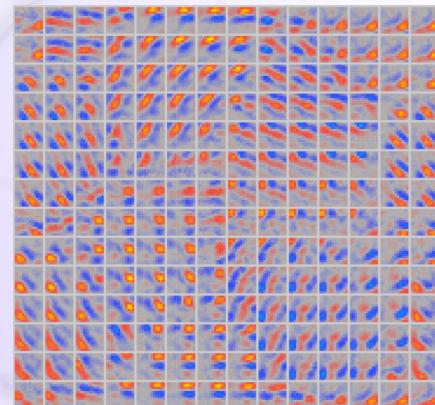
8



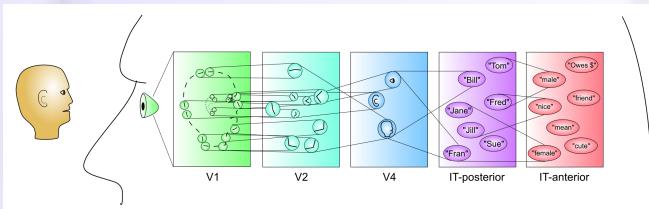
What is Common?



Self-Organized Topography

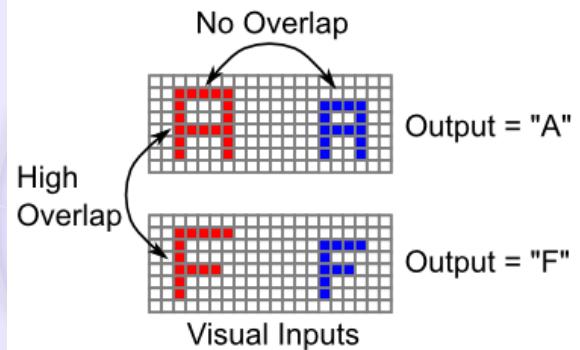


Invariant Object Recognition

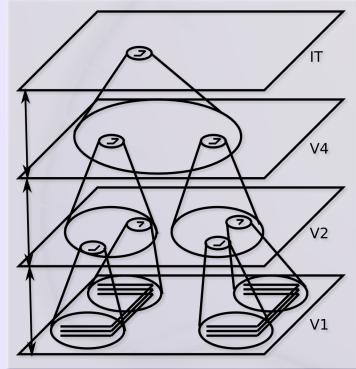


15

It's Hard



Invariant Object Recognition

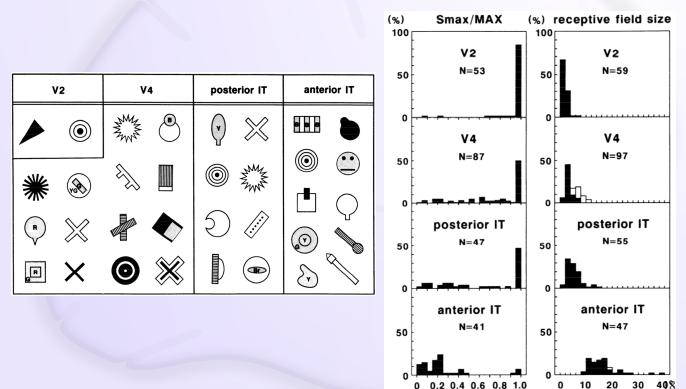


- Hierarchy of increasing:
 - Feature complexity
 - Spatial invariance
- Strong match to RF's in corresponding brain areas

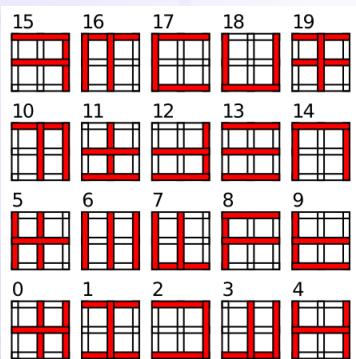
(Neocognitron, HMAX, SLF, Pinto/DiCarlo, etc.)

17

Biological Data



Simple Textbook Test



3D Object Recognition Test

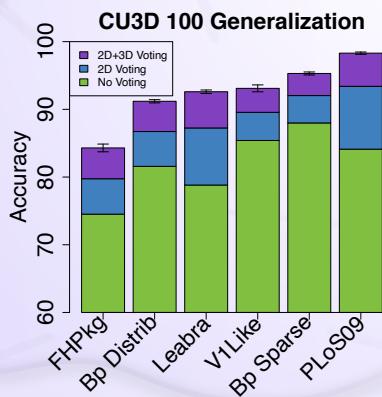


- 3D models from Google SketchUp
- 100 categories
- 9-10 objects per category
- 2 objects left out for testing
- +/- 20° horiz depth rotation + 180° flip
- 0-30° vertical depth rotation
- 14° 2D planar rotations
- 25% scaling
- 30% planar translations

<http://grey.colorado.edu/CompCogNeuro/index.php/CU3D>

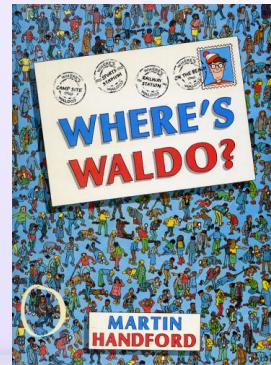
20

Generalization to Novel Category Exemplars – Better than 90%

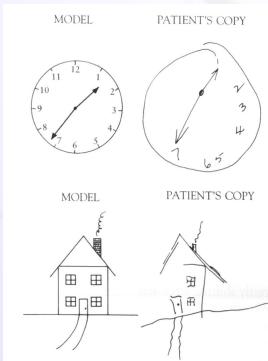


21

Spatial Attention and Neglect



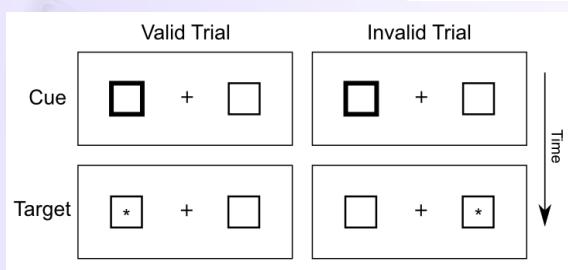
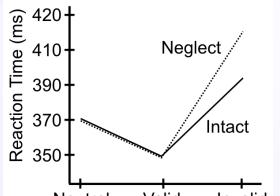
Hemispatial Neglect



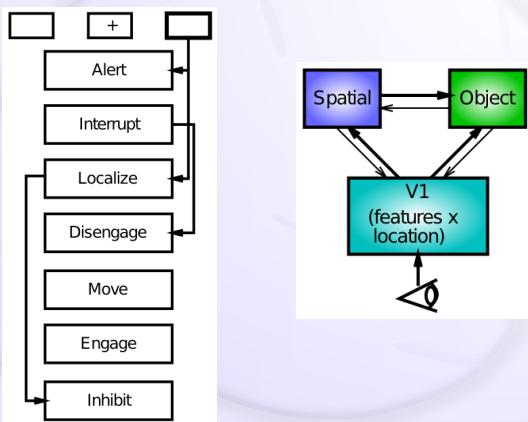
Test paper
(with horizontal lines on it)

Patient bisections
(Vertical lines)

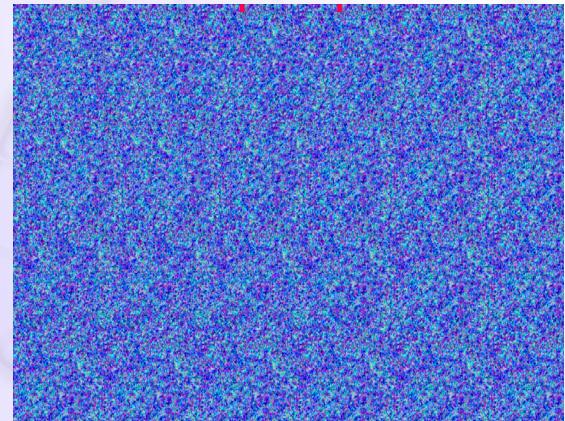
Posner Task



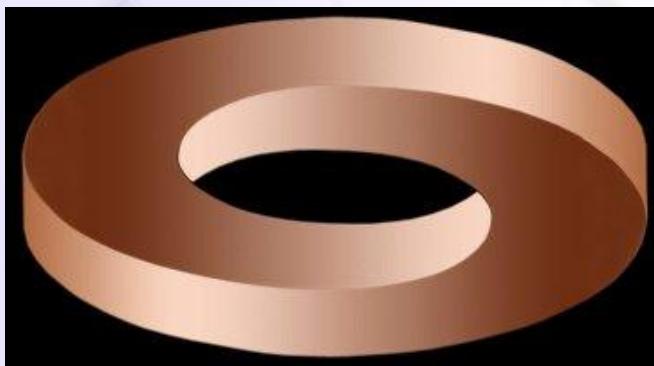
Boxology vs. Biology



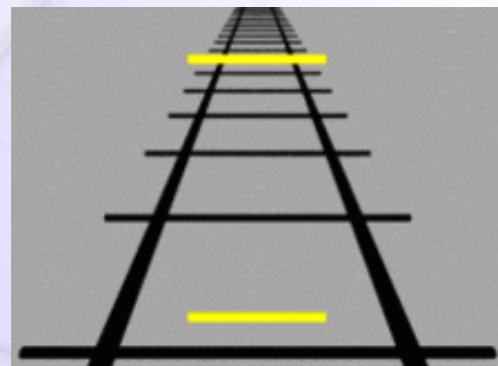
What's Missing? Lacking Depth..



Shape from Shading



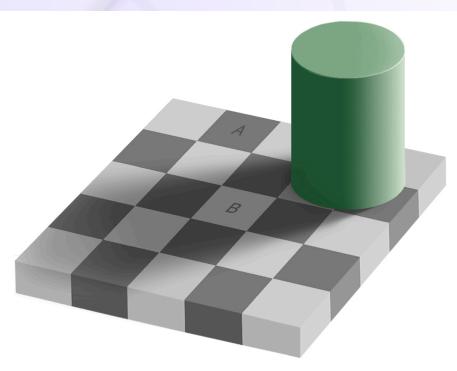
Depth Cues



Depth Cues



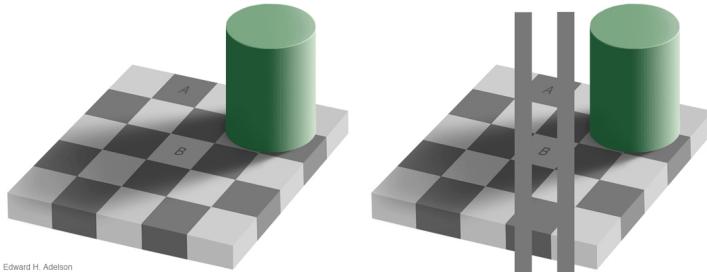
Contrast Illusions



A = B??

No Way!

Contrast Illusions



Edward H. Adelson

Way!

Breakdown in Color Constancy



- What do you see?
- A. Blue and Black
 - B. White and Gold
 - C. Blue and Brown

Edge Detectors Revealed...

