VISUAL RECOGNITION

Reminders & Announcements

- How I "curve"…
  - Exams only (not course grade)
  - Add enough points to have a median of 80
  - If median is 80 or above, I do nothing

- Lots of extra credit opportunities!
  - SONA: https://canvas.cornell.edu/courses/74259/pages/sona-study-advertisements

- Tzu-Yen's guest lecture on spatial cognition will be 3/6

Do you want to visit the MRI facilities on campus? This would be another extra credit opportunity, and not during class.

Yes

0%

No

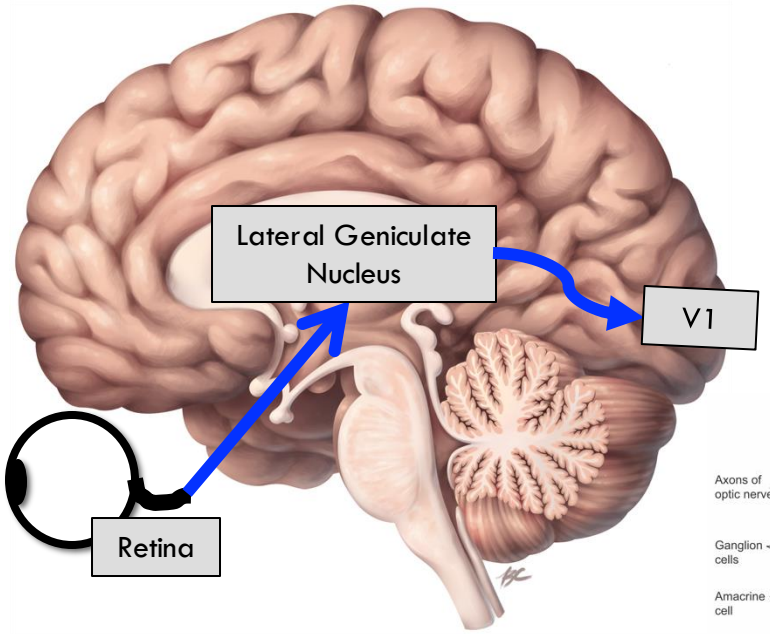
0%

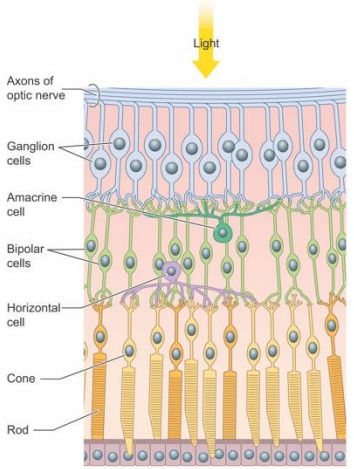
How does perception work?

- How does the brain process visual information?

- The geniculostriate pathway
  - Retina to primary visual cortex
  - Segregation of information
  - Early feature extraction
  - Organization

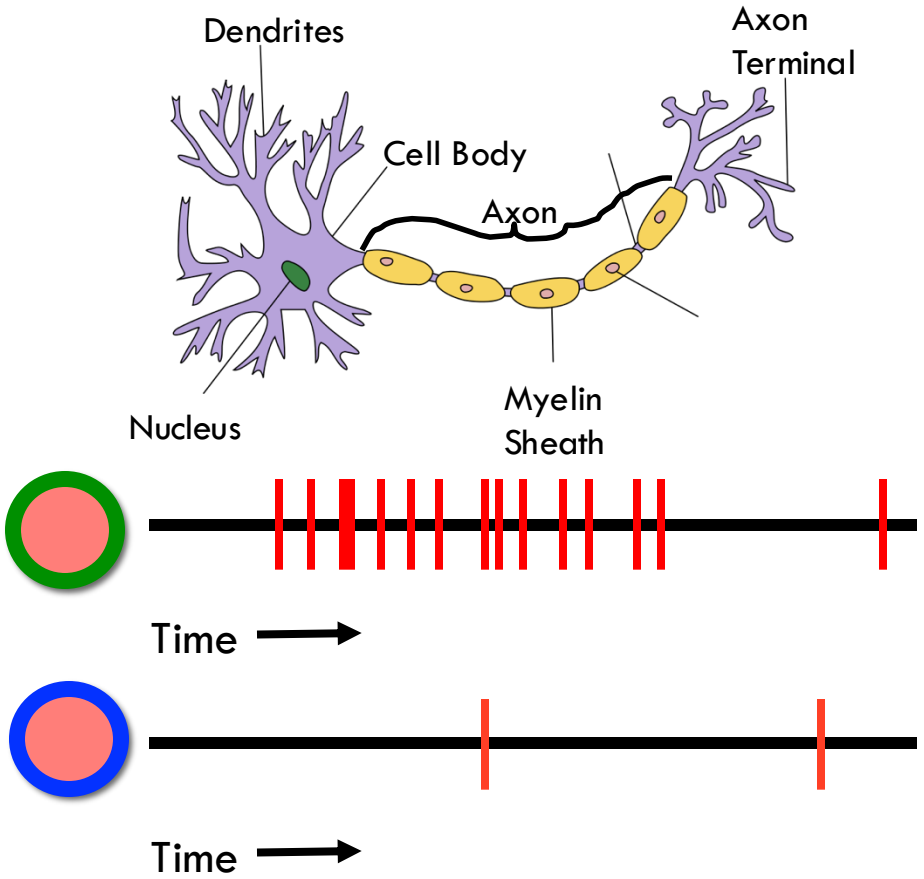
- The tectopulvinar pathway (later)
  - Retina to pulvinar (in thalamus)
  - Orienting





Receptive Fields (RF)

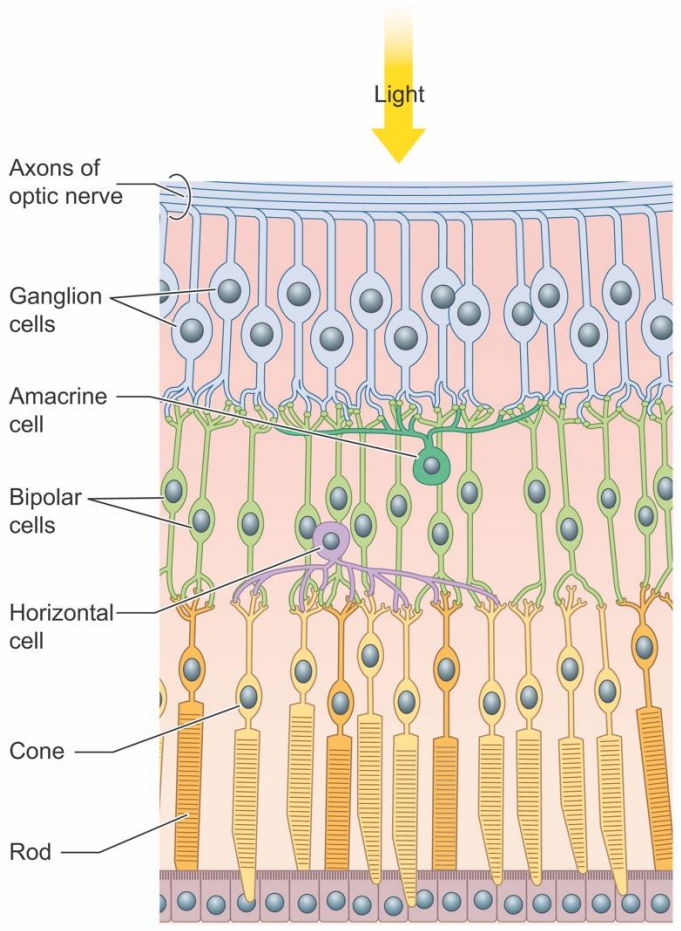
- The part of the visual field that is coded by a neuron
- Tuned to specific types of info (e.g., longer wave lengths)



https://www.vanityfair.com/culture/photos/2013/10/dog-costumes-photos

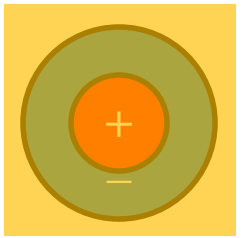
Early Visual Feature Detection

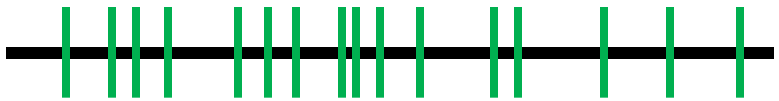
- Retinal ganglion cells code contrast



Center-Surround (On-Center)

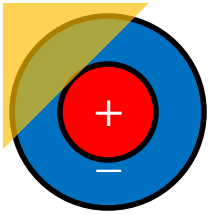
Uniform
Net = 0





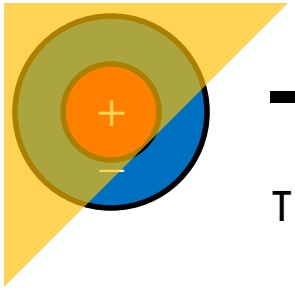
Time →

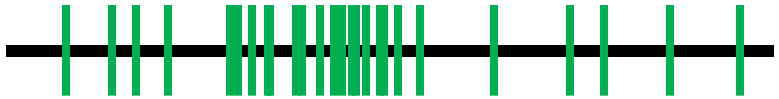
Surround Only
Net = -



Time →

Center+Some Surround
Net = +



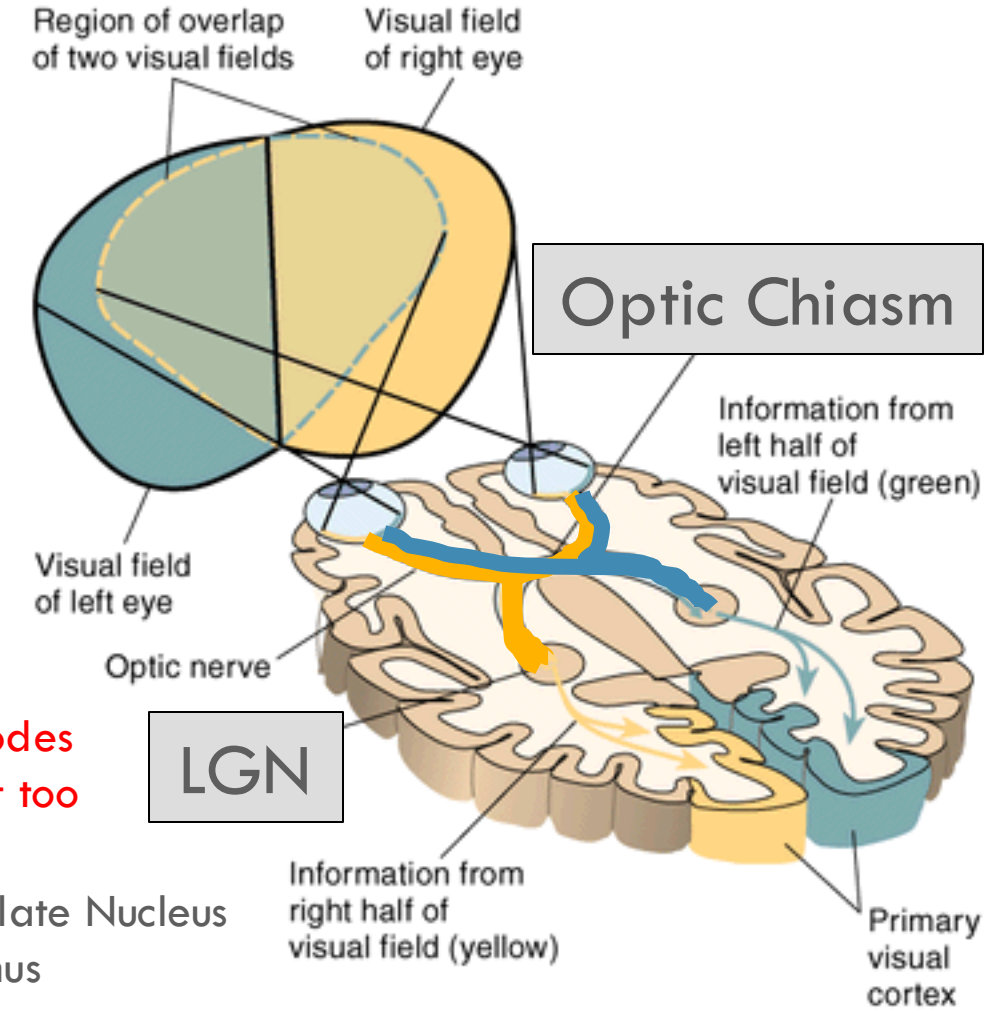


Time →

http://grey.colorado.edu/CompCogNeuro/index.php?title=File%3Afig_on_off_rfields_edge.png

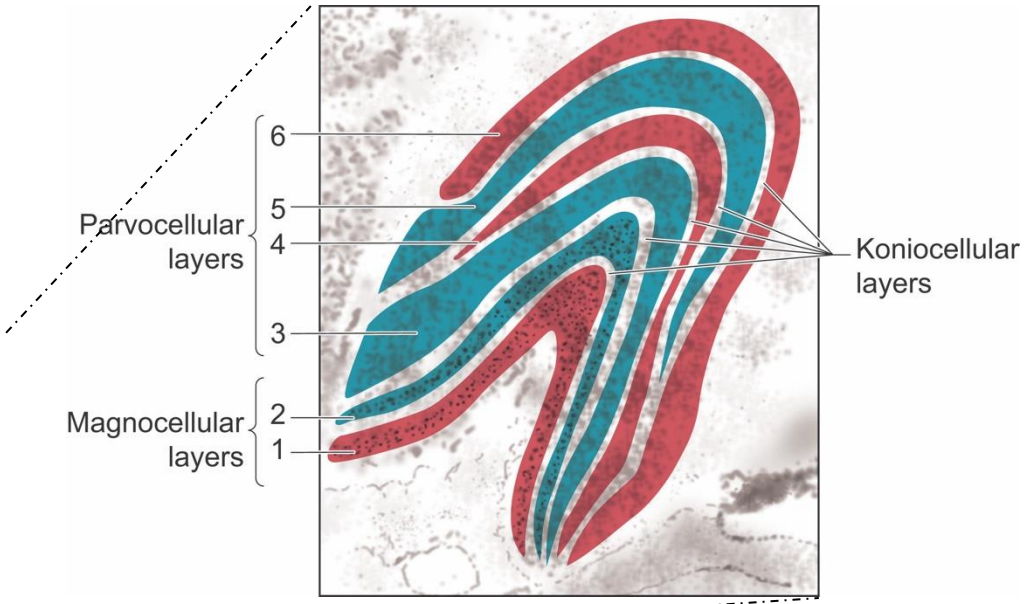
Early visual pathway

- Geniculostriate Pathway



LGN Codes Contrast too

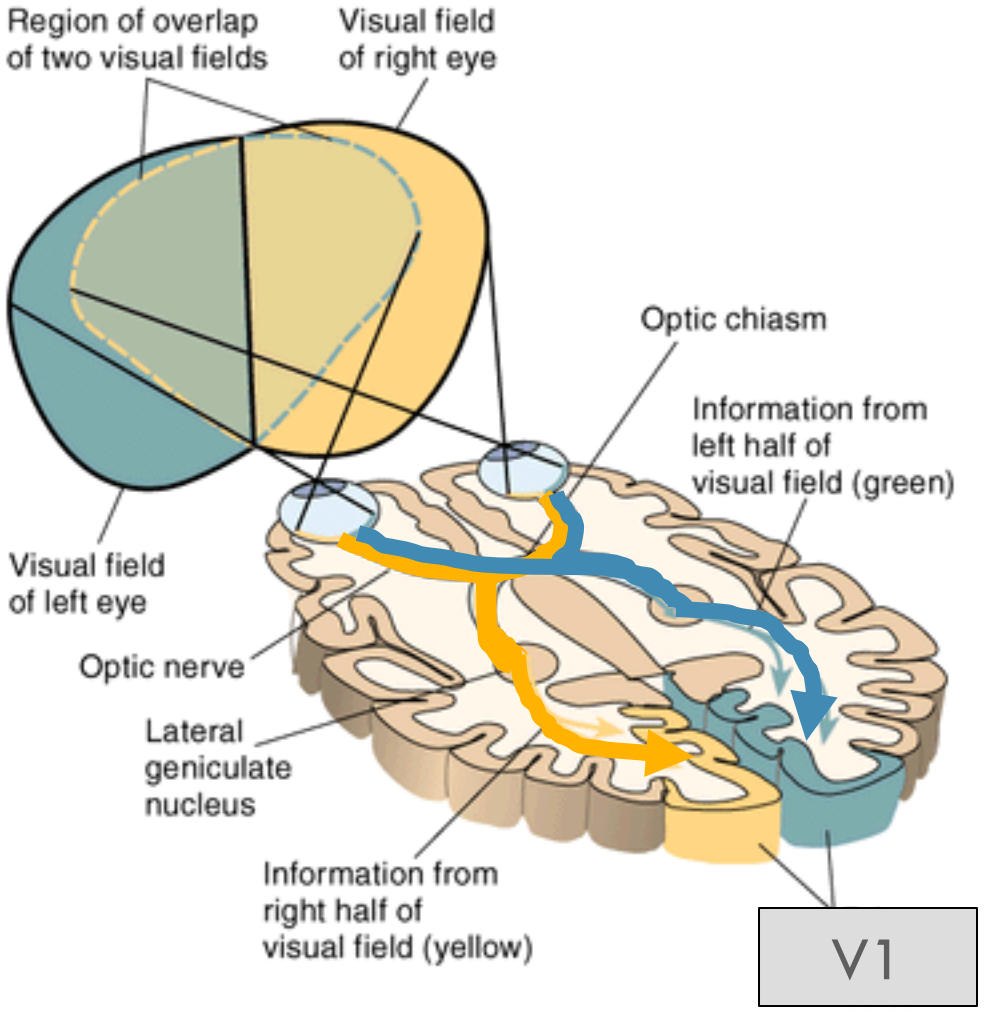
LGN = Lateral Geniculate Nucleus
In the thalamus



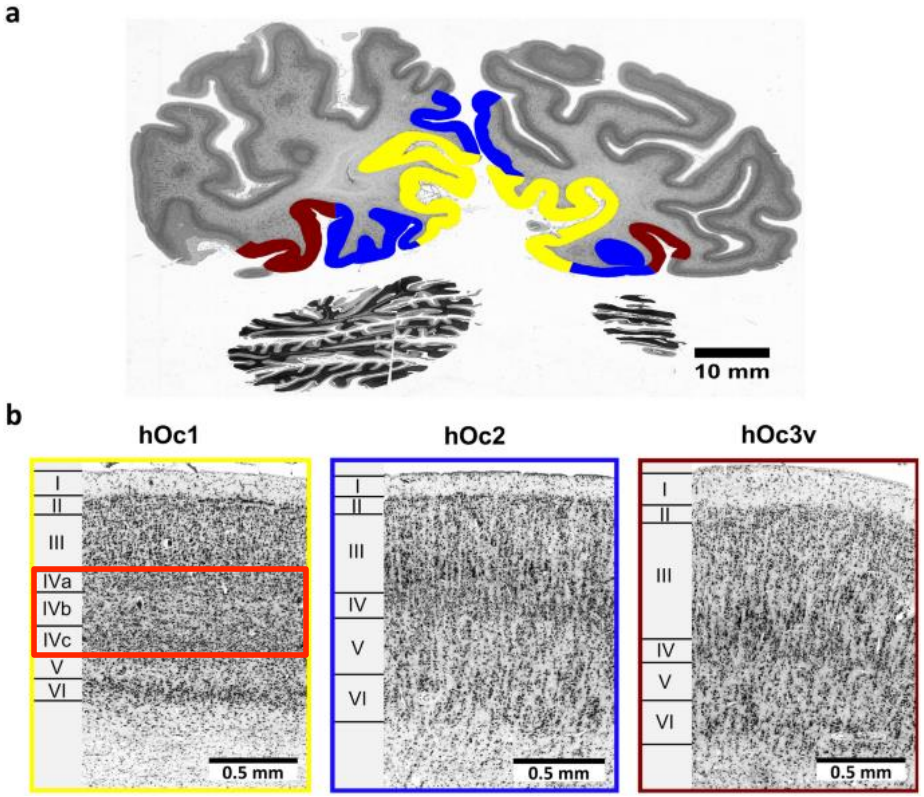
- Each eye goes to a different layer
- Magno- and Parvo- are separate
- Each layer is *retinotopic map*

Early visual pathway

- Geniculostriate Pathway



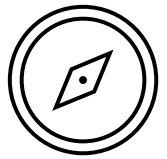
https://www.nature.com/articles/s41598-020-78638-y



Striate Cortex
aka:
V1
Primary Visual Cortex
BA 17

What does V1 do?

Primary Visual Cortex (V1)

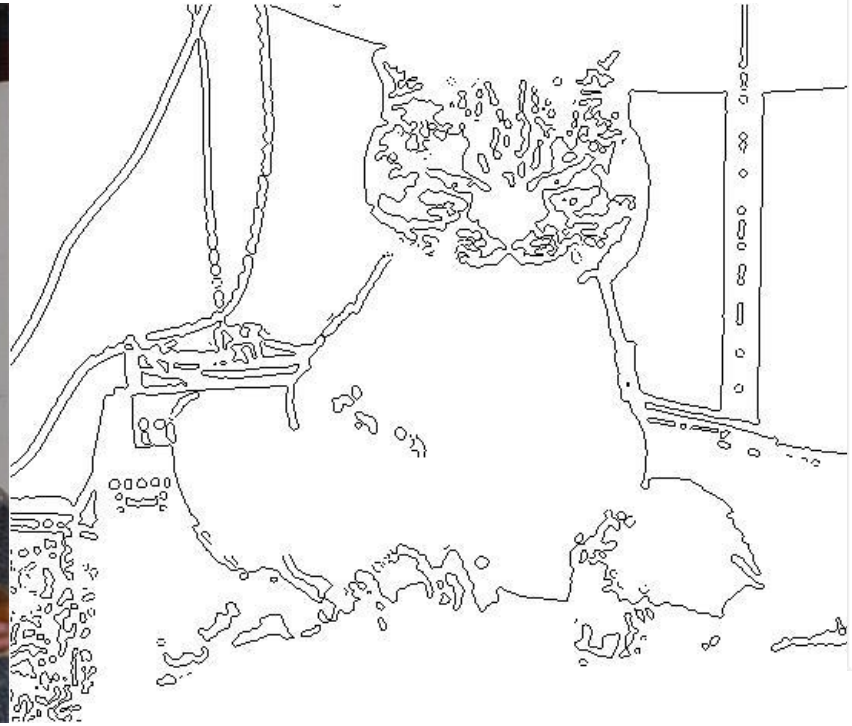


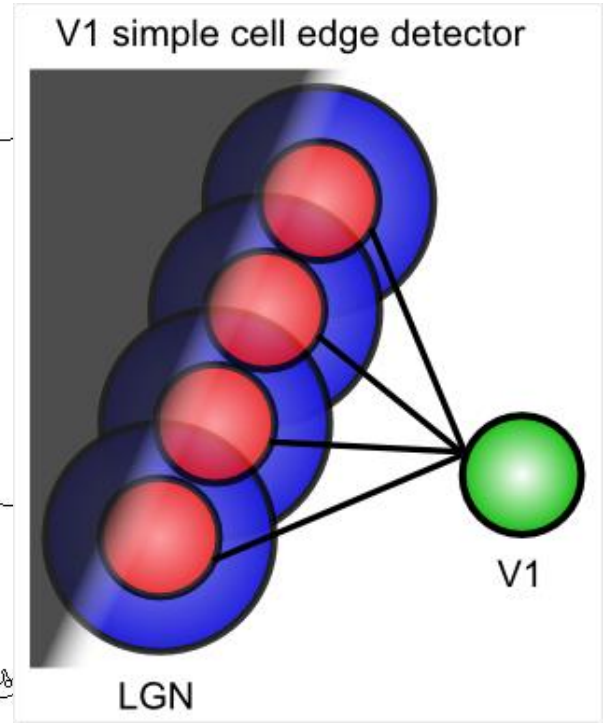
- What features does it pull out? How?

- How is it organized?

Simple Cell

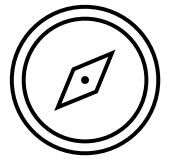
Primary Visual Cortex (V1)





- Edge identified by combining contrast info from LGN
- Simple cells in V1 sensitive to location and orientation of edge
- Complex cells sensitive to direction of motion

Primary Visual Cortex (V1)

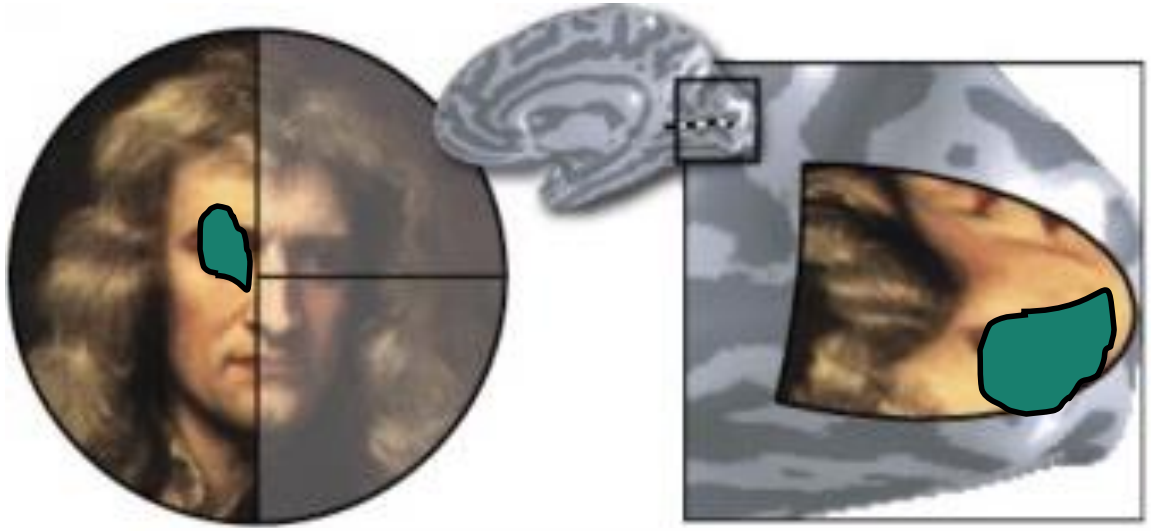


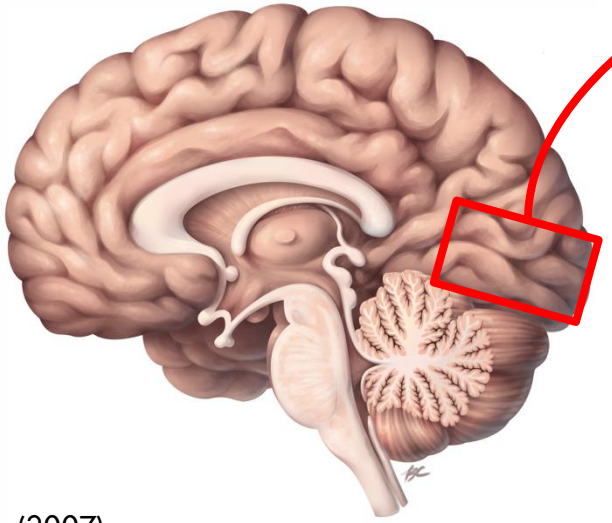
- What features does it pull out? How?
  - Edges, Orientation, Motion

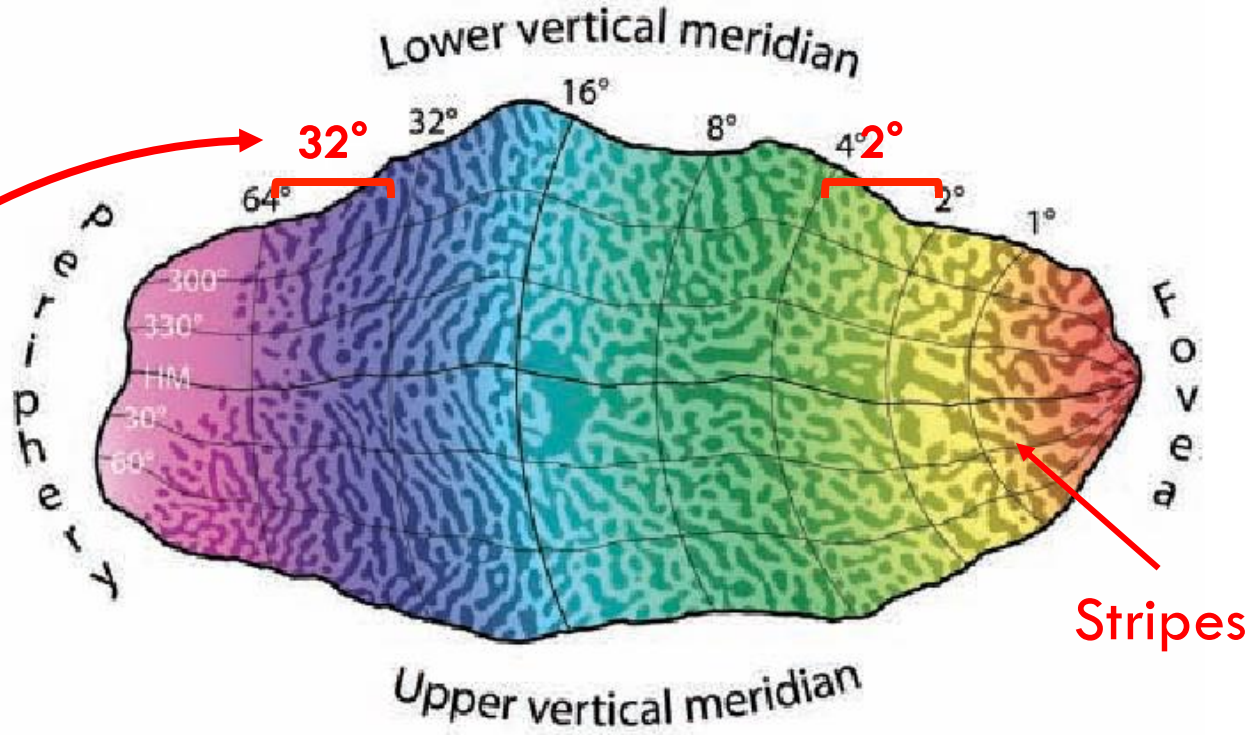
- How is it organized?

Visual Map in V1

- The V1 retinotopic map
  - Medial occipital (calcarine sulcus)
  - Upside down and contralateral
  - Over-representation of fovea
  - Cortical magnification
  - Ocular dominance columns
  - Scotoma

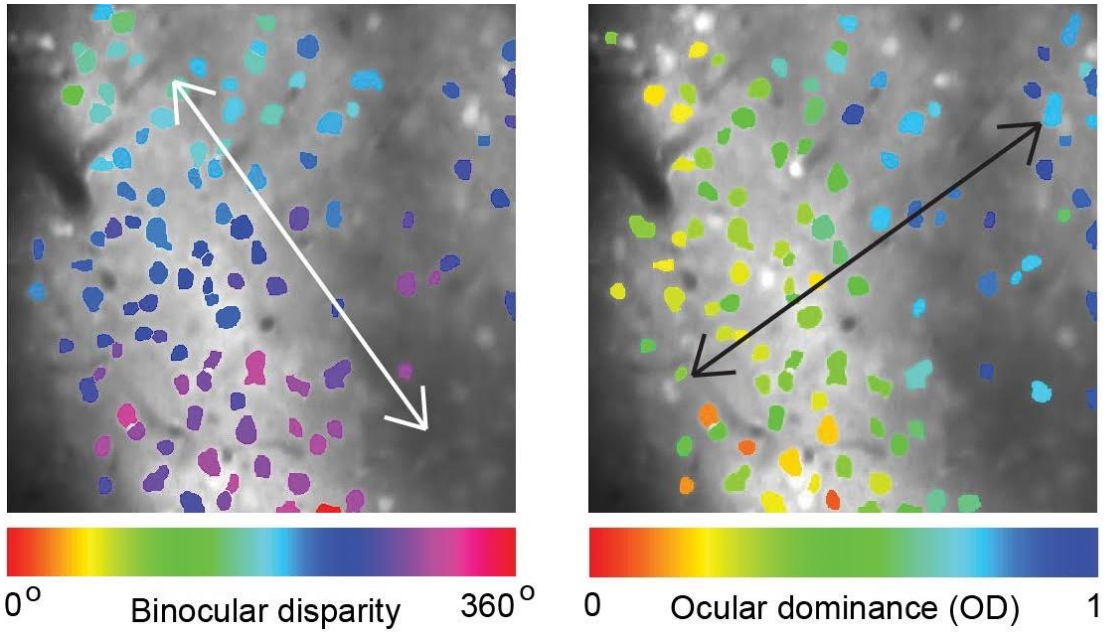






Adams & Horton (2009); Wandell, et al. (2007)

Depth from binocular disparity

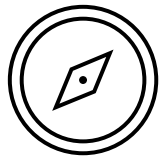


- Stereopsis
- Binocular disparity
  - Integration across the eyes

https://www.karalab.org/binocularvision

https://www.google.com/url?sa=i&url=https%3A%2F%2Flwlies.com%2Farticles%2Fthe-history-of-3d-cinema%2F&psig=AOvVaw2mcUwx6W-xC9k8ke-dETCI&ust=1708496345635000&source=images&cd=vfe&opi=89978449&ved=0CBMQjRxqFwoTCPjd4IyjuYQDFQAAAAAdAAAAABAc

Primary Visual Cortex (V1)



- What features does it pull out? How?
  - Edges, Orientation, Motion
  - Depth

- How is it organized?
  - Retinotopic Map
  - Ocular Dominance Columns
  - Neurons coding similar orientations are also near each other (columns)

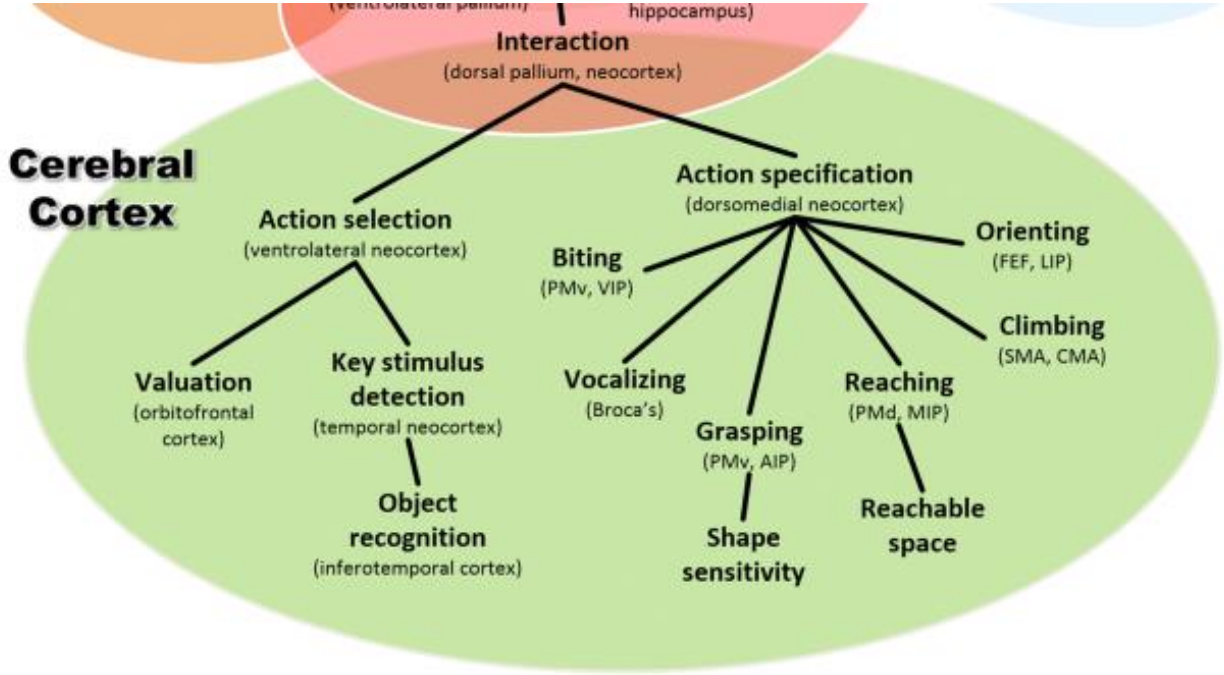
Take-aways (Eye to V1)

- The retina transforms light into visual information
- Visual processing pulls out information useful for cognition, behavior
  - Segregation of signals early on
  - Integration to generate more complex, abstract info
- Cells representing nearby info are physically near each other
  - Maps
  - Location, orientation, motion, depth
- V1 is important for conscious visual perception

How does perception work?

- Challenges: Invariance, ambiguity, importance of context

- Different computations for different purposes (segregation)
  - Starting at the eye
  - Recognition and categorization
  - Action and location



- Vision involves
  - Feedforward processing
  - Feedback processing
  - Hierarchical processing
  - Experience based inference

If visual processing involves segregated functions, what are we likely to find from lesion studies?

- Functional connectivity
- Reuse
- Double Dissociation
- Distributed processing

If visual processing involves segregated functions, what are we likely to find from lesion studies?

Functional connectivity

0%

Reuse

0%

Double Dissociation

0%

Distributed processing

0%

If visual processing involves segregated functions, what are we likely to find from lesion studies?

Functional connectivity

0%

Reuse

0%

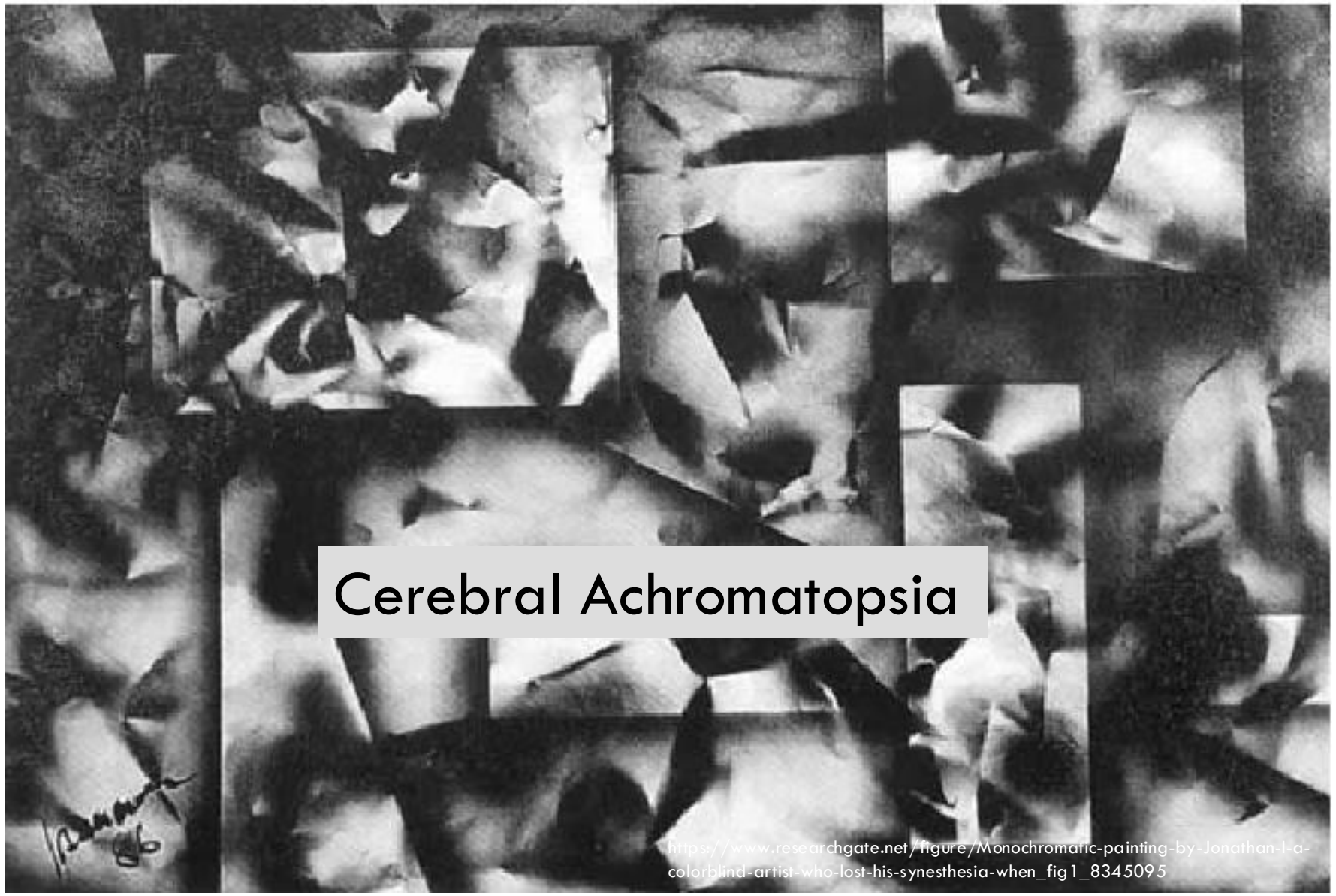
Double Dissociation

0%

Distributed processing

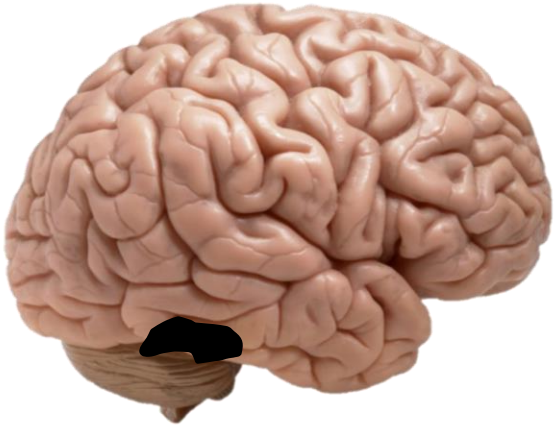
0%

The Case of the Color-Blind Painter



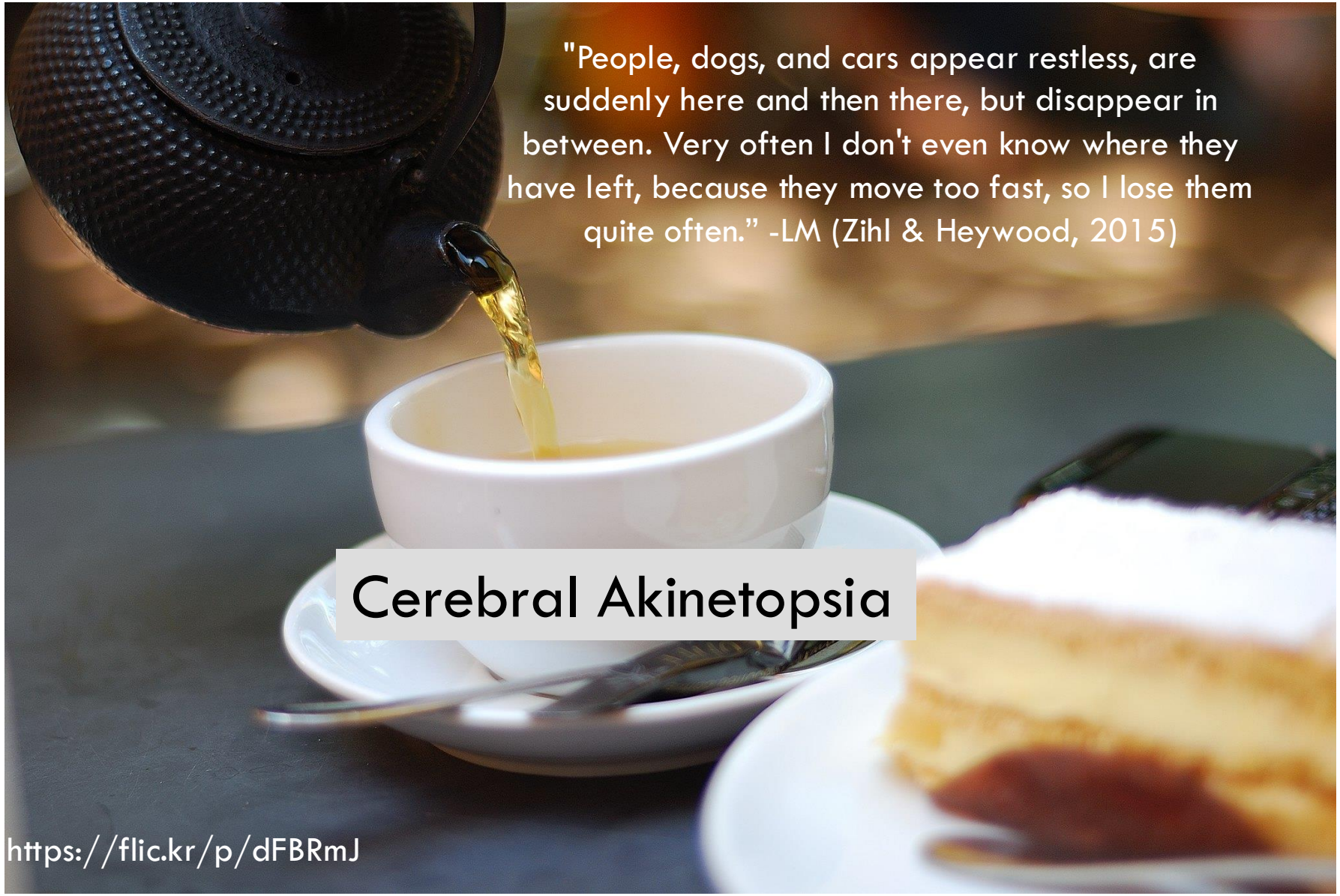
https://www.researchgate.net/figure/Monochromatic-painting-by-Jonathan-I-a-colorblind-artist-who-lost-his-synesthesia-when_fig1_8345095

Area V4: achromatopsia, not akinetopsia

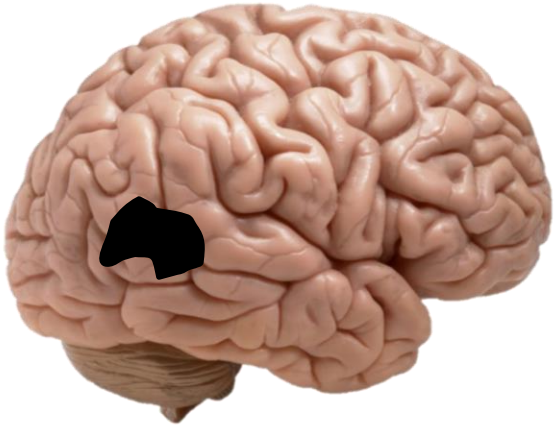


Sacks & Wasserman

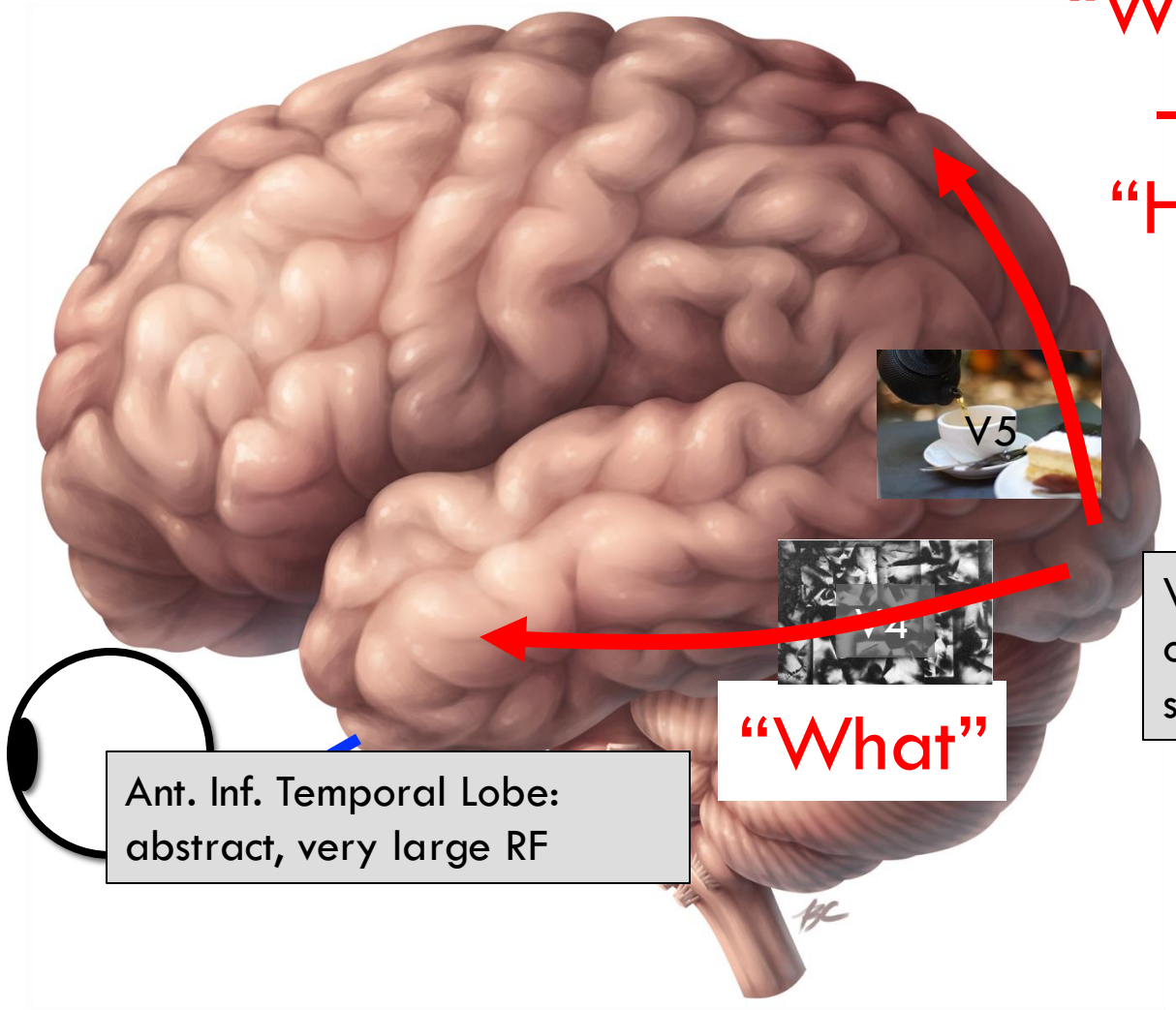
Patient L. M.



Area V5: akinetopsia, not achromotopsia



Two Visual Processing Streams



RF: Receptive Field

Vision for Recognition

Which of the following do you think best characterizes the deficit this man is showing?

0

- Unable to perceive shape
- Unable to name objects
- Unable to perceive spatial configurations
- Unable to perceive affordances

Which of the following do you think best characterizes the deficit this man is showing?

0

Unable to perceive shape

0%

Unable to name objects

0%

Unable to perceive spatial configurations

0%

Unable to perceive affordances

0%

Which of the following do you think best characterizes the deficit this man is showing?

0

Unable to perceive shape

0%

Unable to name objects

0%

Unable to perceive spatial configurations

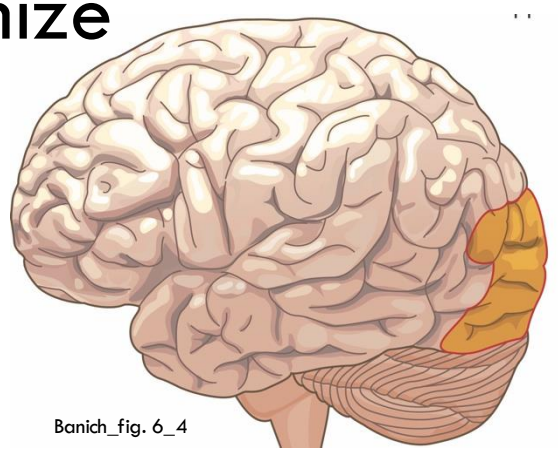
0%

Unable to perceive affordances

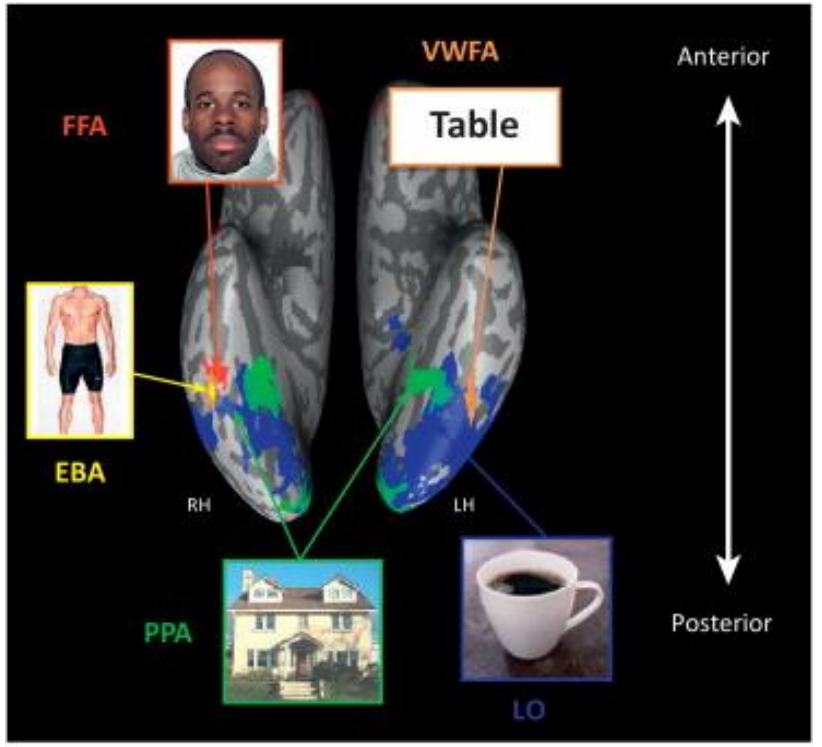
0%

Recognition break down patterns

- Agnosia: failure to recognize
  - Apperceptive Agnosia
  - Associative Agnosia
  - Prosopagnosia
  - Topographical disorganization

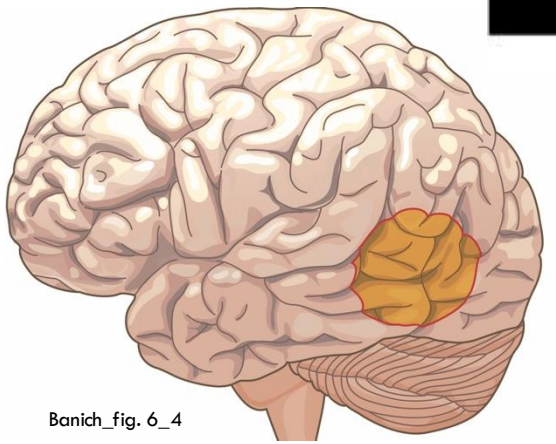


Banich_fig. 6_4



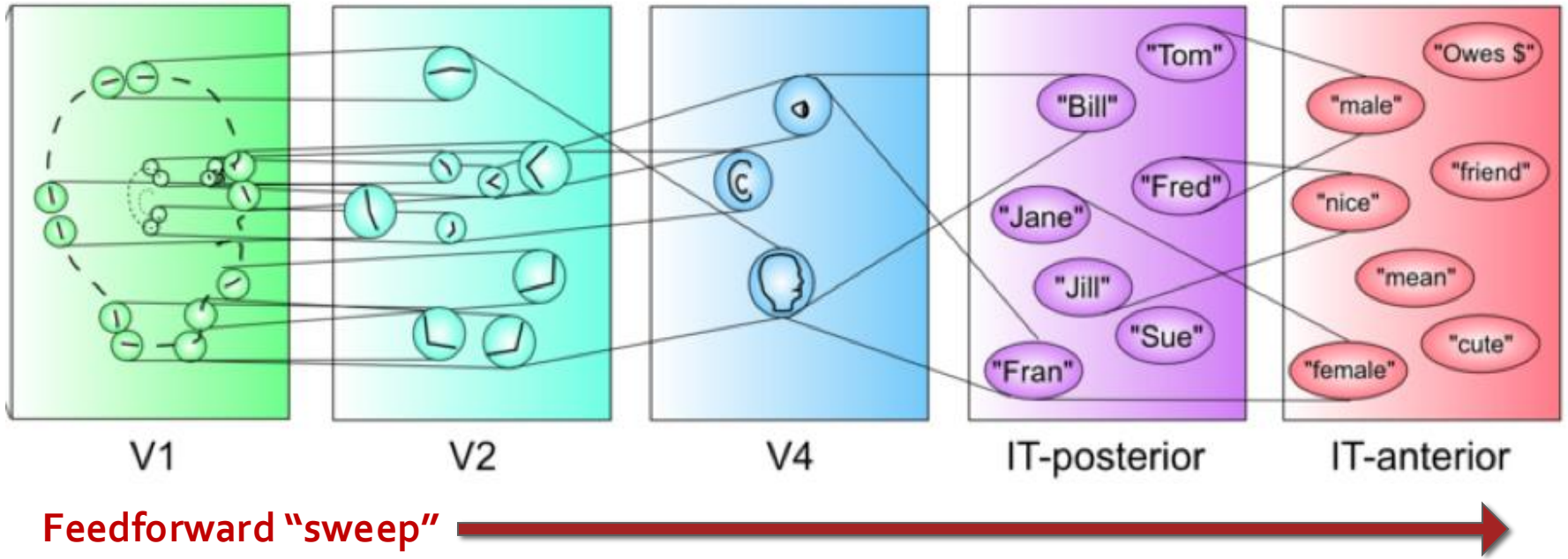
TRENDS in Cognitive Sciences

- Why does it get more specific with more anterior lesions?



Banich_fig. 6_4

Ventral Visual Processing Stream



- Hierarchically organized
  - RFs in later areas integrate earlier RFs in maps
  - Combinations increase in complexity and abstraction
  - Contributes to invariance