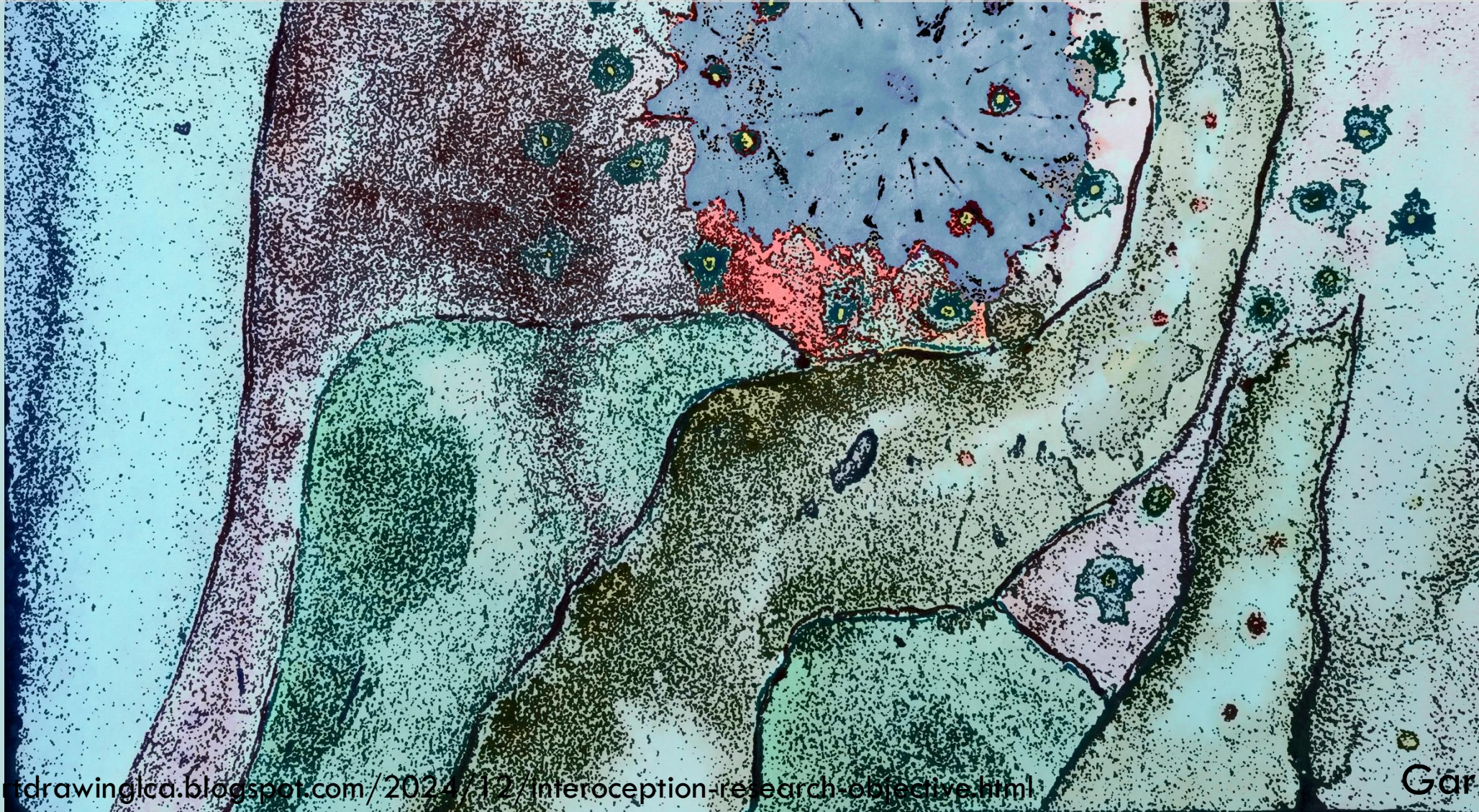


SENSATION & PERCEPTION: VISION



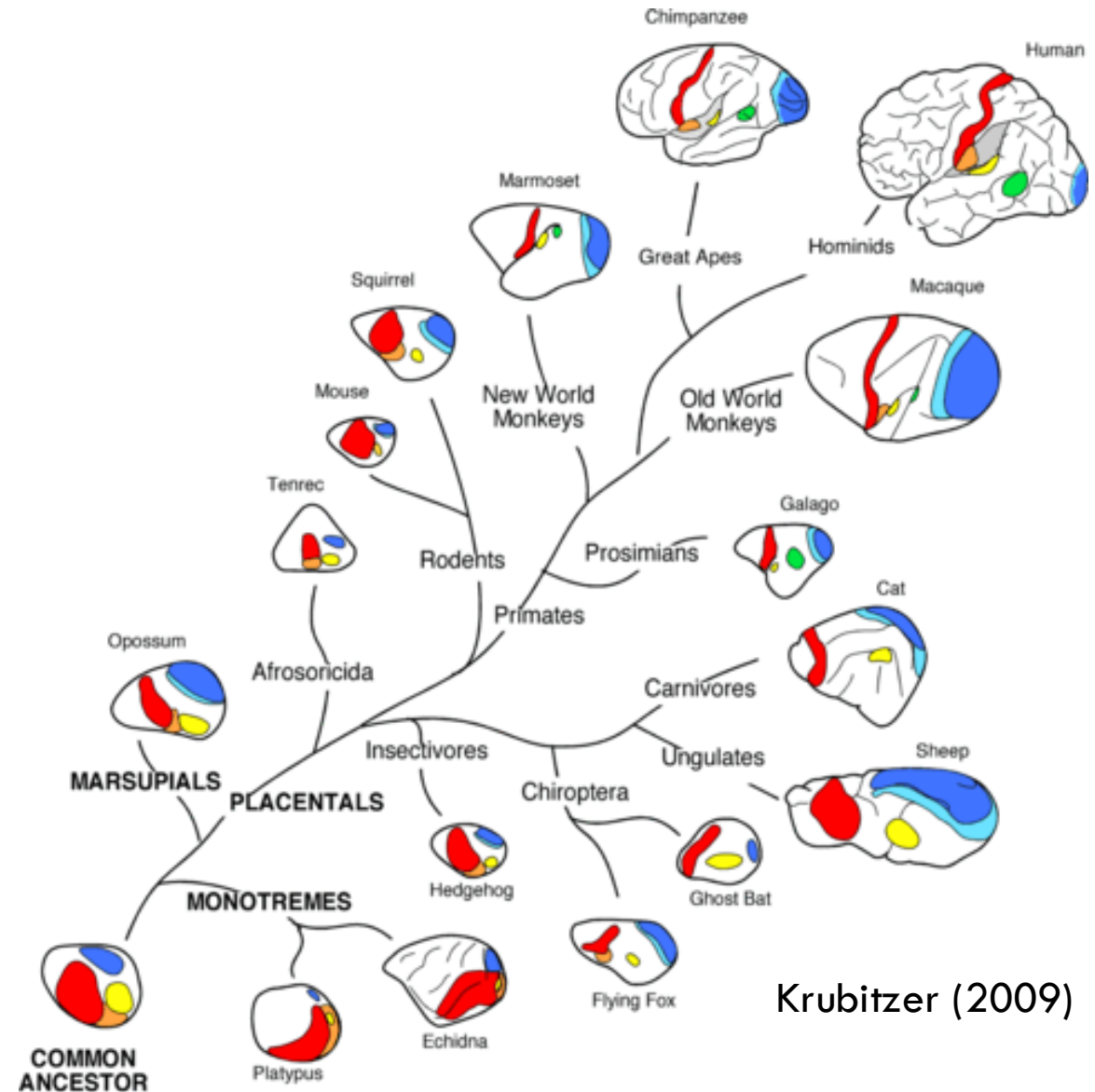
Reminders & Announcements

- Prelim 1 Tuesday – In Class
 - Does not include content from today on sensation & perception
 - Study guide is online
 - Bring your student ID and a dark pencil
- Extra credit advertisements on Canvas:
 - <https://canvas.cornell.edu/courses/74259/modules/items/2922859>
- Neurosynth Part 1 is graded

Brains Reflect Evolution

Minds and bodies evolved

- Unlike computers, animals are not designed
 - Engineered solutions may not correspond to biology
- Solutions build upon and subsume solutions (like reuse)
 - Bauplan
 - Cortical expansion
 - Incremental changes
 - Constrained



Movement in the wild



<https://www.youtube.com/watch?v=D3W4OCnHyCs&t=116s>

What are two behaviors evident in the starfish that are likely present in most animals?



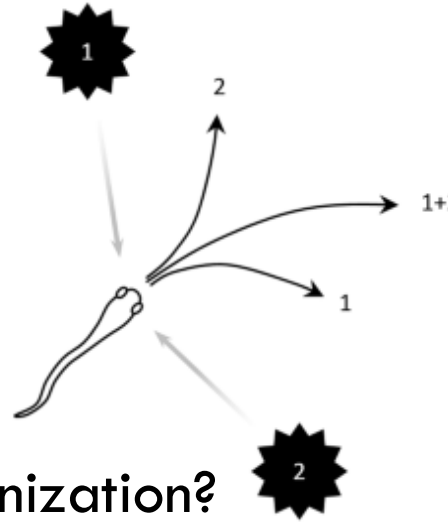
Nobody has responded yet.

Hang tight! Responses are coming in.

Foundational functions

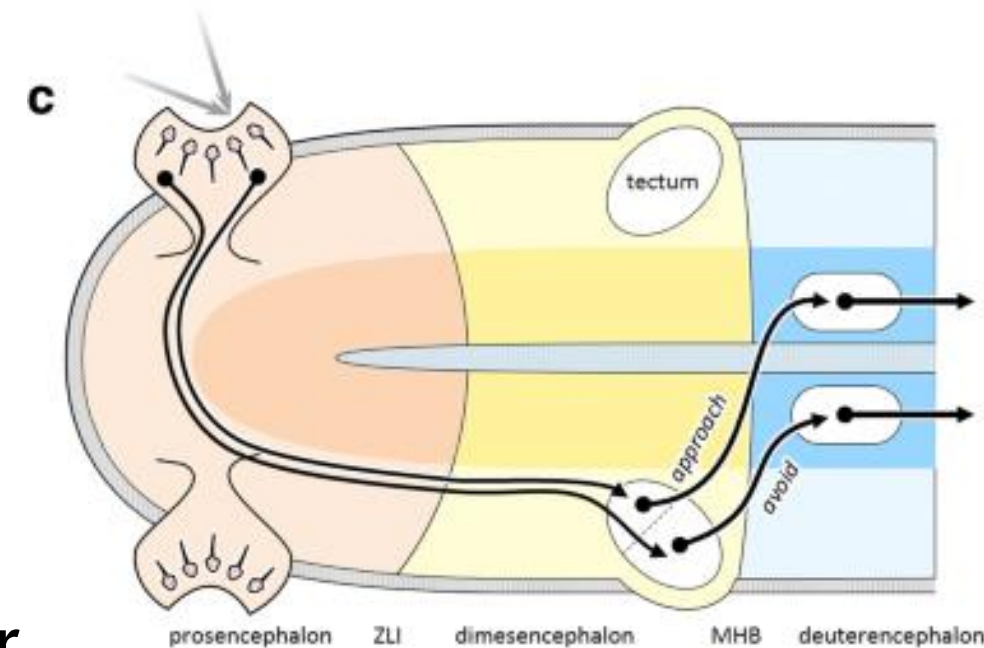
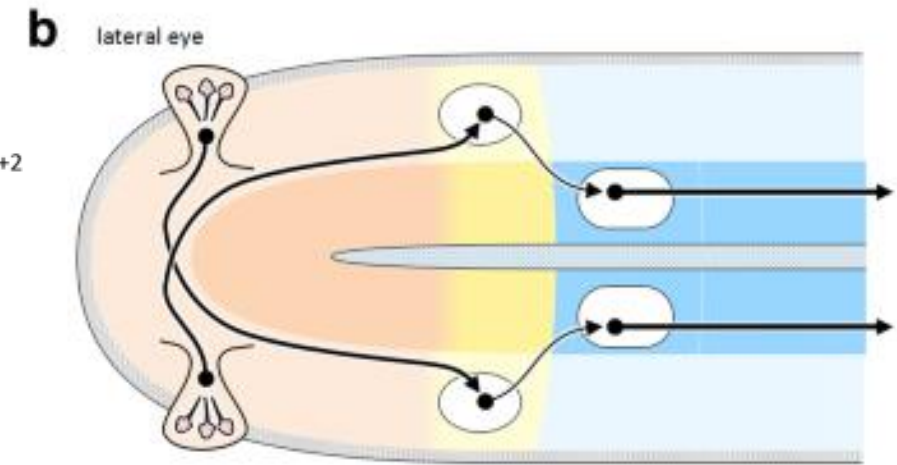
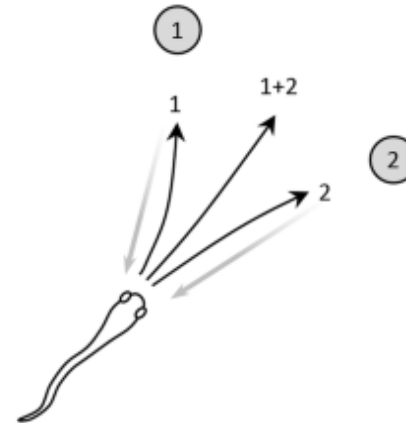
• Avoid

- Change in light on one side
- Turn the other way
- Explanation for contralateral organization?



• Approach

- Need to turn toward
- If several, need to select one
- Develop selection mechanism



- Elaborations improve control of behavior

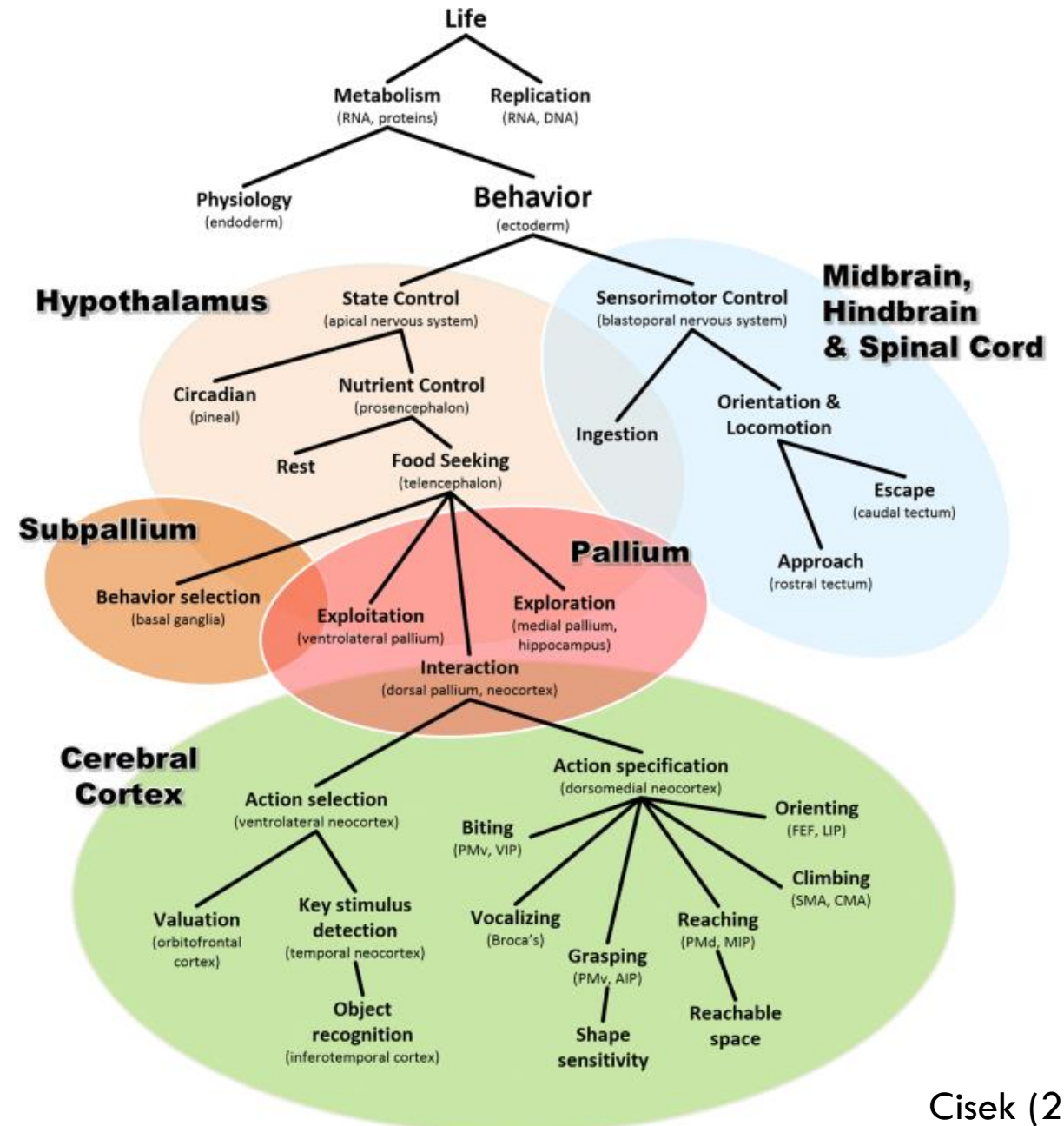
What are the parts?

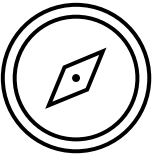
- Cisek's ontology of cognition

- State control ->
- Food seeking ->
- Exploration, Exploitation, Interaction ->
- Specification and Selection of Action ->
- Recognition and Value

- Parts of cognition are determined by evolution

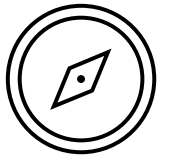
- More easily relate these to structure





Part 1: Foundations

- The mind is what the brain does (function)
- How function relates to structure
- Methods for characterizing both
- Neural systems balance segregation and integration
- How this works reflects context

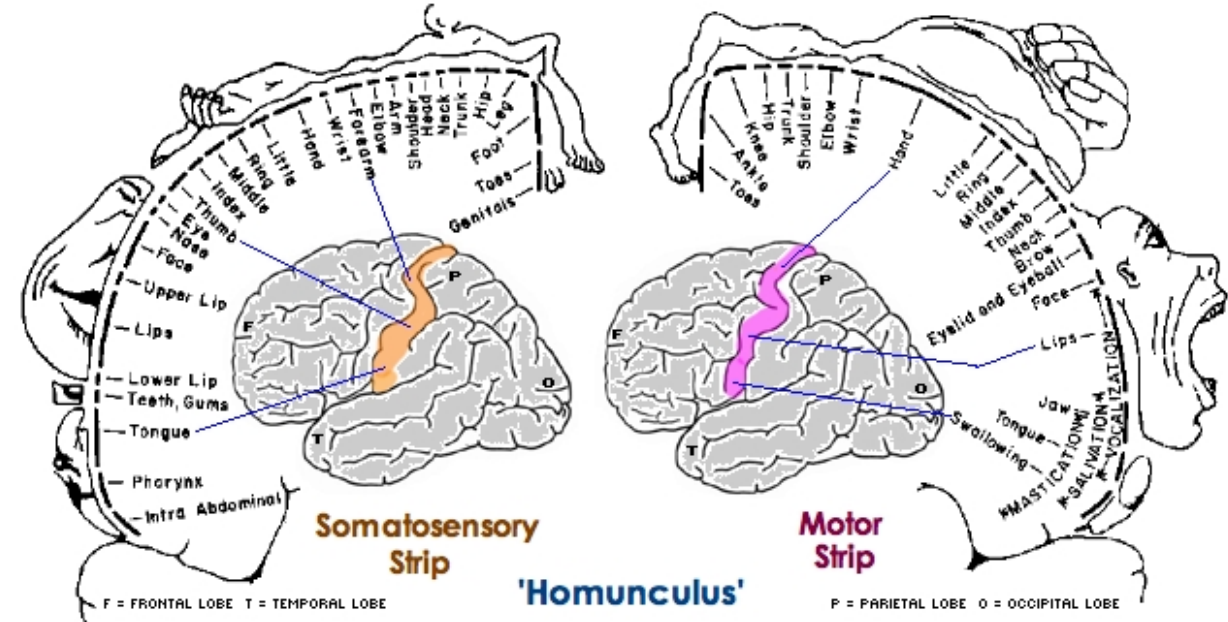


Part 2: Core Functions

- From sensation to object recognition
- Representing and navigating through space
- How we move
- Communicating through language
- Ways the brain remembers

Sensation

- Transformation of physical stimulus to neural signals
 - Should result in something useful
- Pull signals apart (segregate) to get different features of world
 - Maps
- Integrate with other signals
 - Perception
 - Within & across modalities
 - Knowledge



Species that have vision and audition presumably have some advantage over those that don't (at least above ground). What do you think that is?

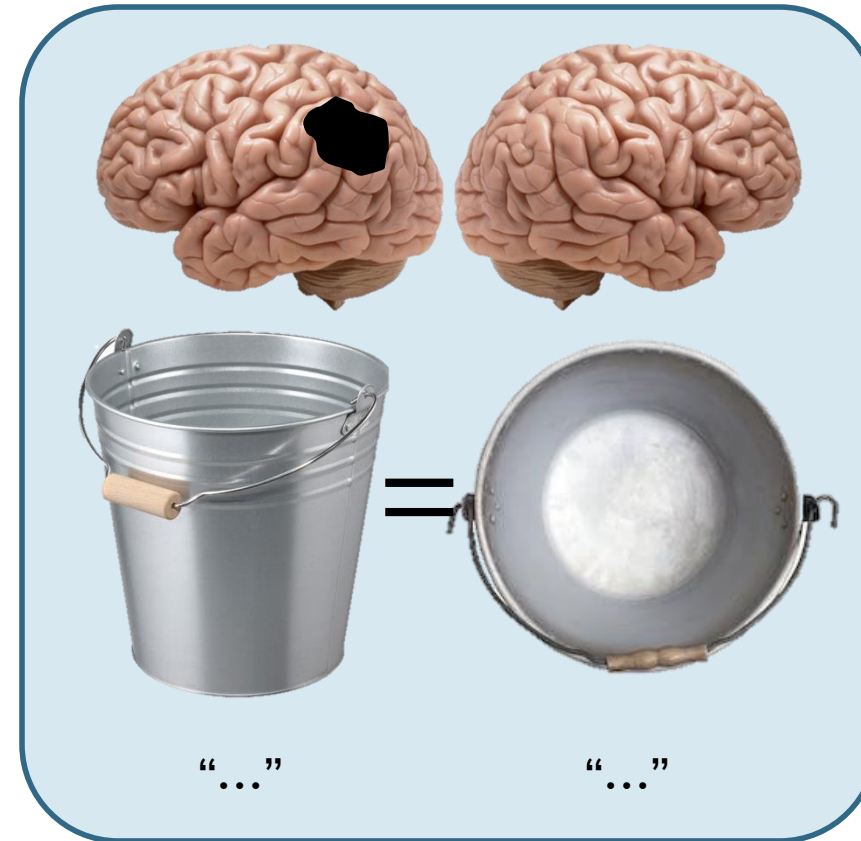
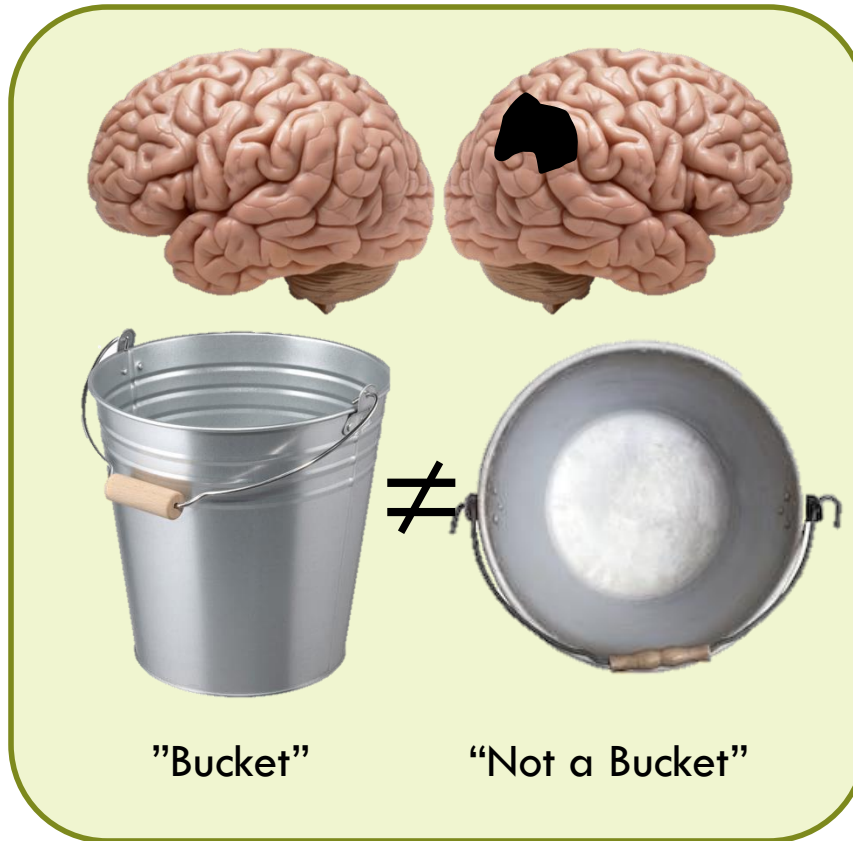
✓ 0

Nobody has responded yet.

Hang tight! Responses are coming in.



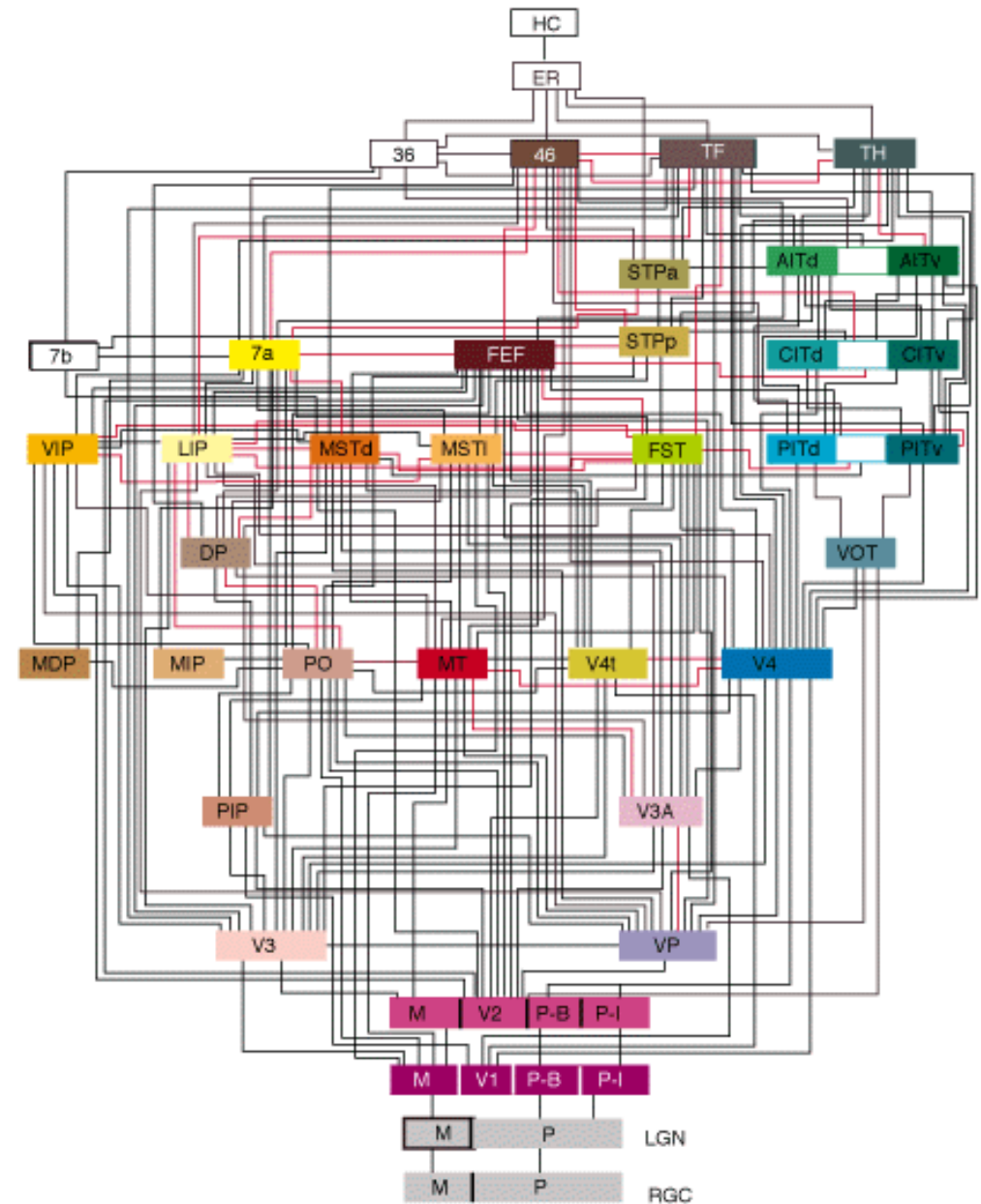
What is visual perception for?



- Marr: The computation vision performs is reconstruction of object in 3D for recognition
- Gibson: Eh....not so much

What does perception do?

- Recognizes & assigns value
- Guide action
- Close up and from a distance
- Turns out, this is not straightforward



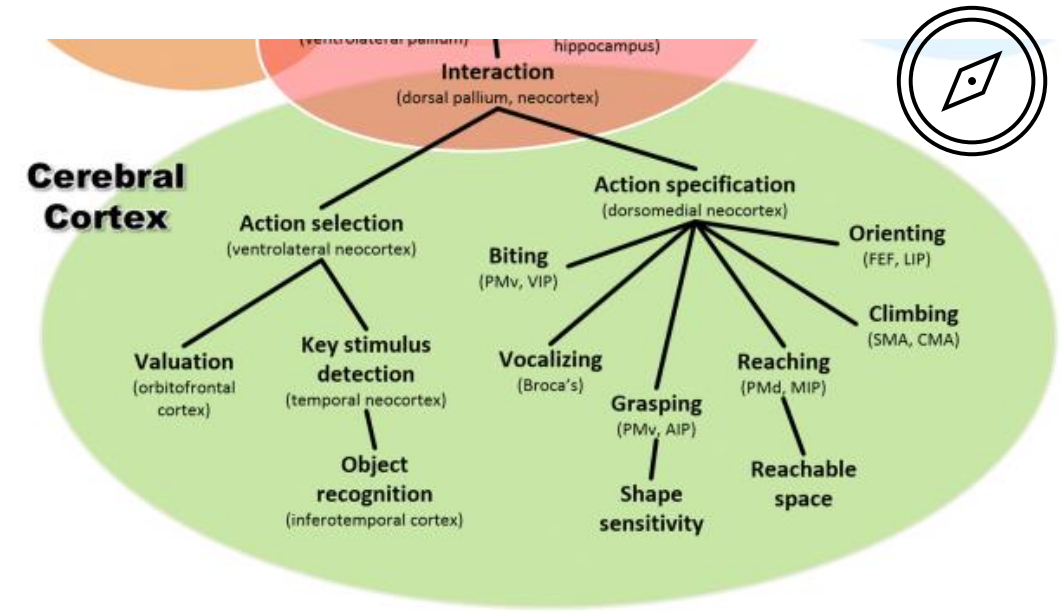
Sensation & Perception

- How does perception work?

- What's it for?
- What are the challenges?

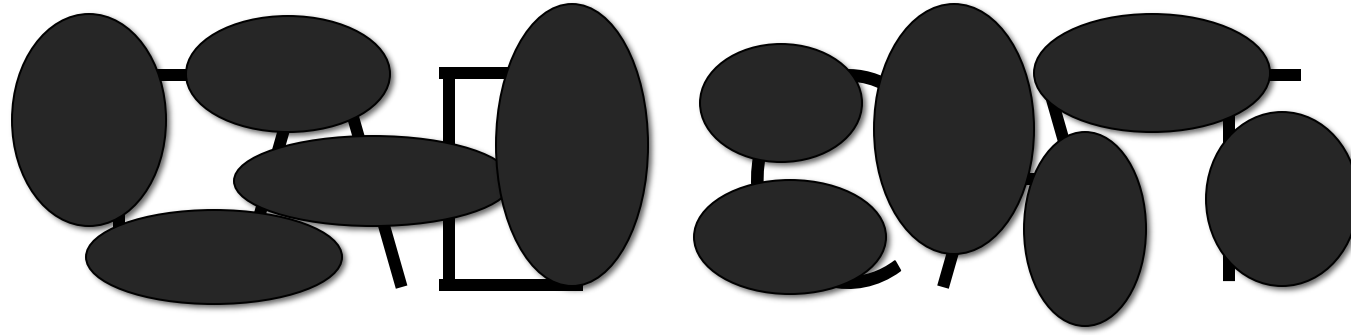
- From eye to cortex: The geniculostriate pathway

- Retina
- Early feature extraction
- Segregation of information
- Retinotopic maps



What's challenging about vision?

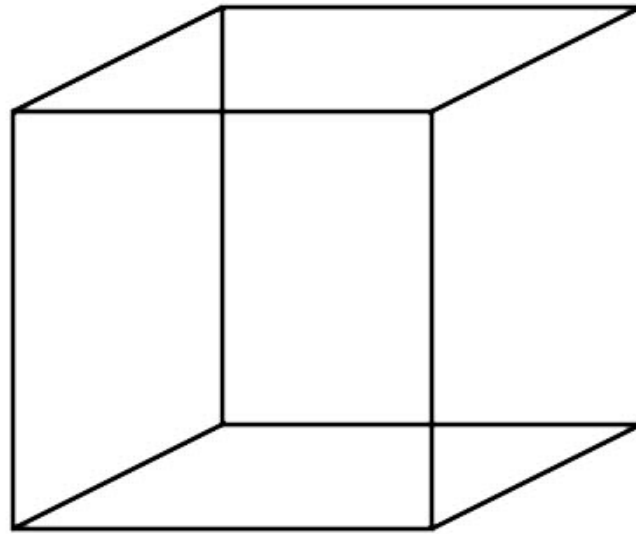
Challenges



- How do we categorize/recognize despite variability in how things look?
- How do we categorize/recognize despite ambiguity?
- How does context affect this?

The ambiguity challenge

- Sometimes an image can be interpreted many ways



The context challenge



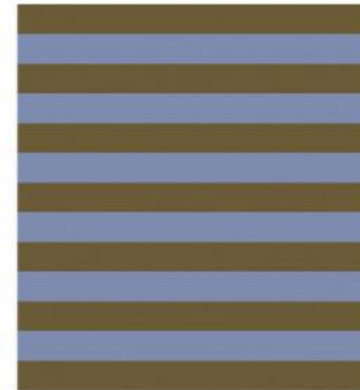
IS THE DRESS IN SHADOW?

If you think the dress is in shadow, your brain may remove the blue cast and perceive the dress as being white and gold.



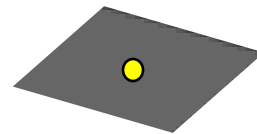
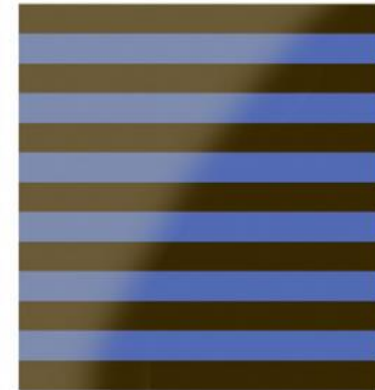
THE DRESS IN THE PHOTO

If the photograph showed more of the room, or if skin tones were visible, there might have been more clues about the ambient light.



IS THE DRESS IN BRIGHT LIGHT?

If you think the dress is being washed out by bright light, your brain may perceive the dress as a darker blue and black.



- The way we see an object or part of an image is influenced by its context

Invariance & selectivity challenges

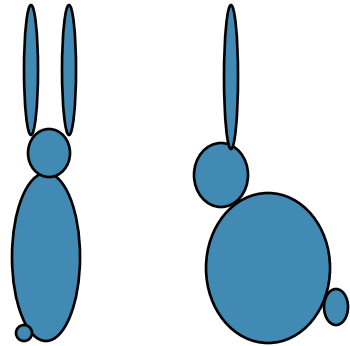


Invariance & selectivity challenges

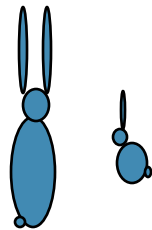
One to many: One object can produce many different images on the retina



Viewpoint

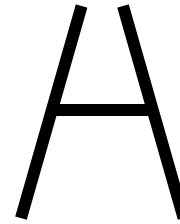


Distance/size



Many to one: Different objects can produce similar images on the retina

(Can give rise to ambiguity)



While sitting at a café, you notice a small green coiled thing in the dirt about five feet away. It could be a snake or a hose, reflecting the ____ challenge. Would you move your eyes or head around to try to figure out what it is?

Ambiguity; Yes

Ambiguity; No

Invariance; Yes

Invariance; No

While sitting at a café, you notice a small green coiled thing in the dirt about five feet away. It could be a snake or a hose, reflecting the ____ challenge. Would you move your eyes or head around to try to figure out what it is?

Ambiguity; Yes

0%

Ambiguity; No

0%

Invariance; Yes

0%

Invariance; No

0%

While sitting at a café, you notice a small green coiled thing in the dirt about five feet away. It could be a snake or a hose, reflecting the ____ challenge. Would you move your eyes or head around to try to figure out what it is?

Ambiguity; Yes

0%

Ambiguity; No

0%

Invariance; Yes

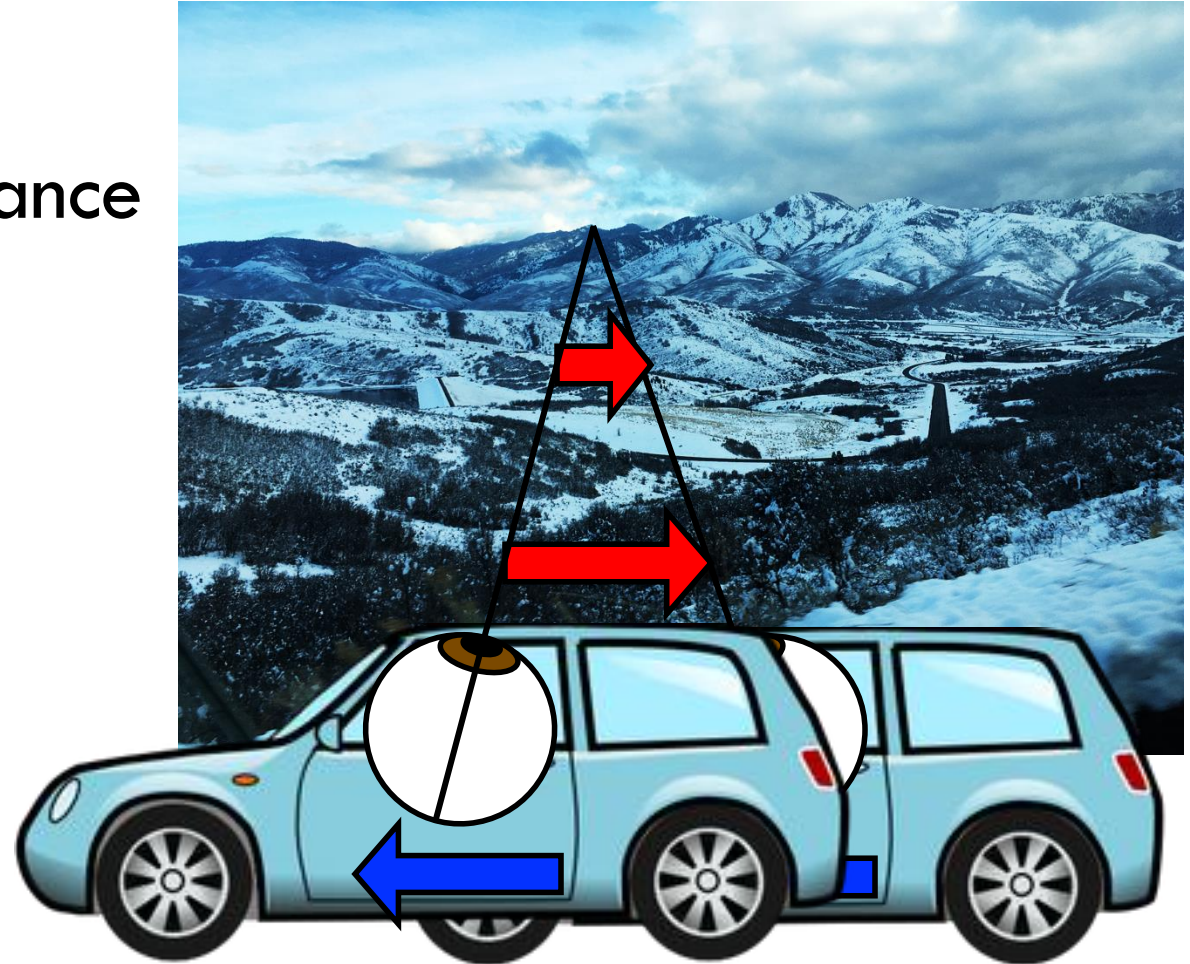
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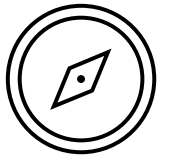
Invariance; No

0%

Perception from Action (Gibson)

- Move body, head, etc.
- Gives info on 3D shape and distance
- Invariants
- Motion Parallax
 - Motion is a depth cue





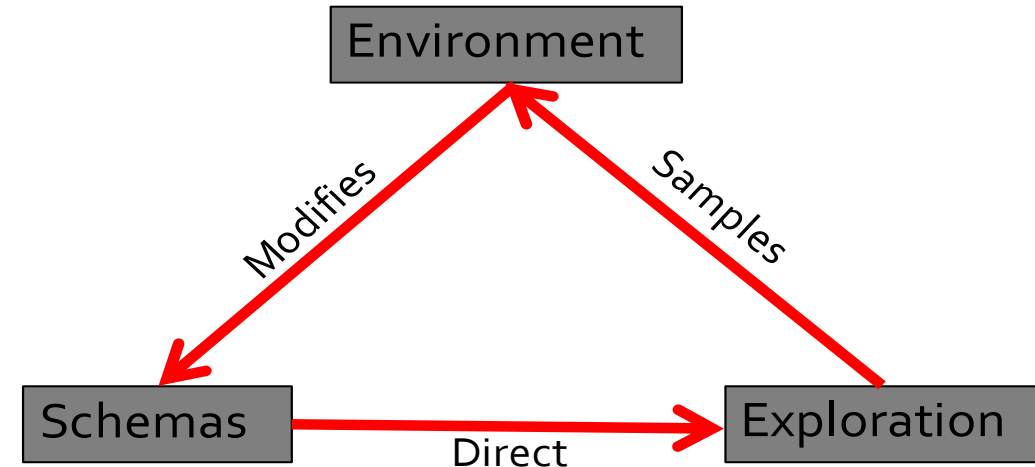
How does perception work?

- What are the challenges?

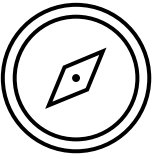
- Ambiguity
- Importance of context
- Invariance

- Movement

- gives additional info
- may help solve these challenges



- How does the brain process visual information?



How does perception work?

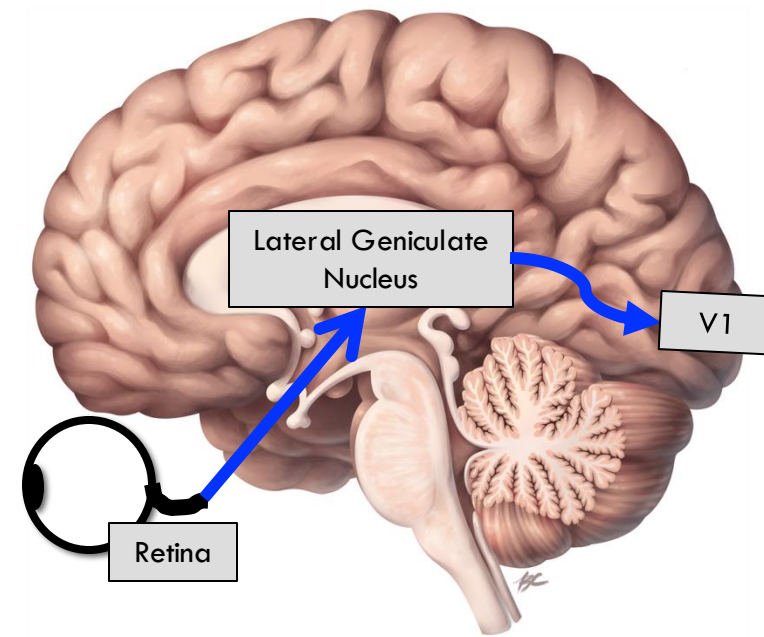
- How does the brain process visual information?

- The geniculostriate pathway

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

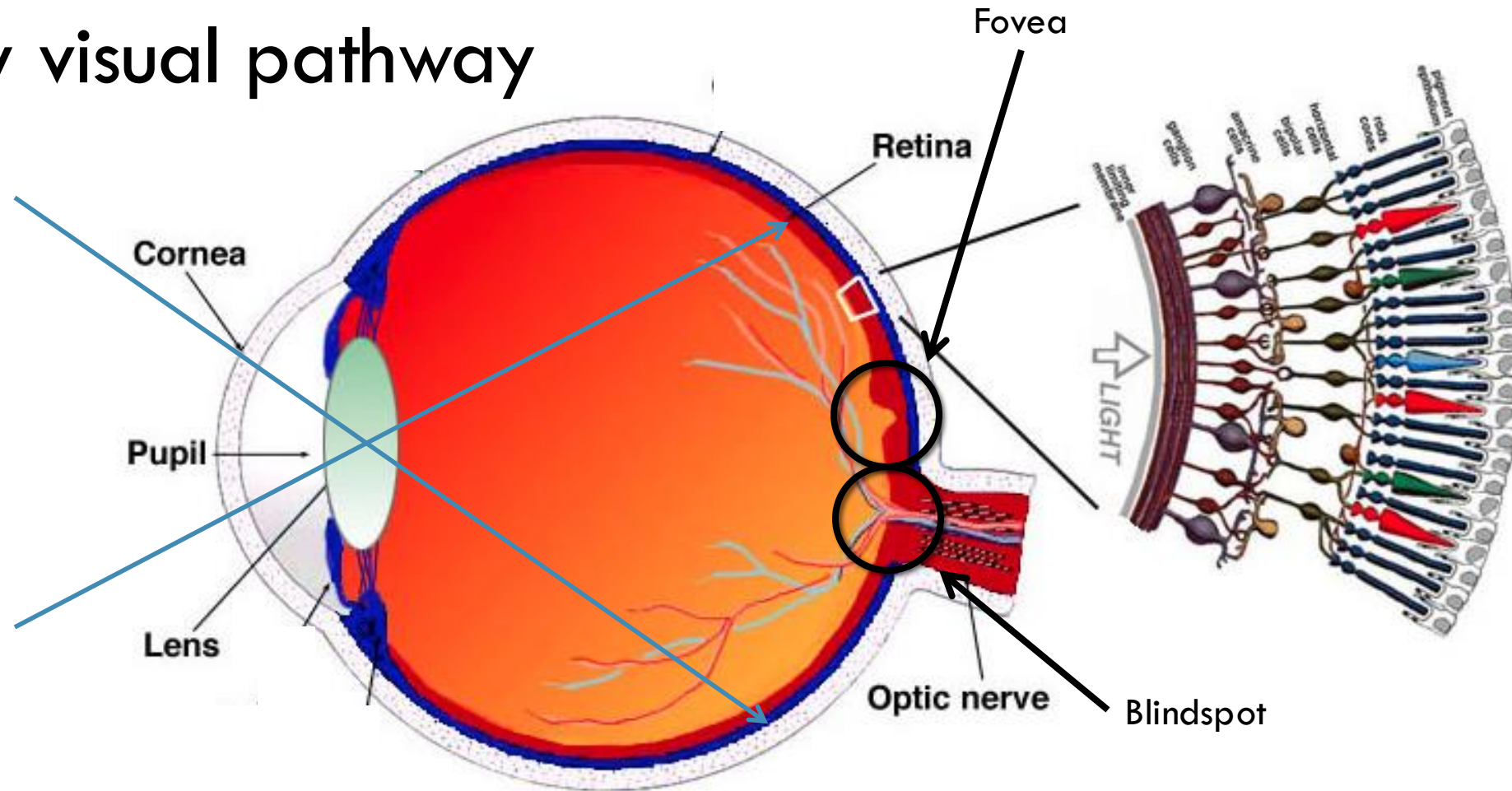
- The tectopulvinar pathway (later)

- Retina to pulvinar (in thalamus)
- Orienting



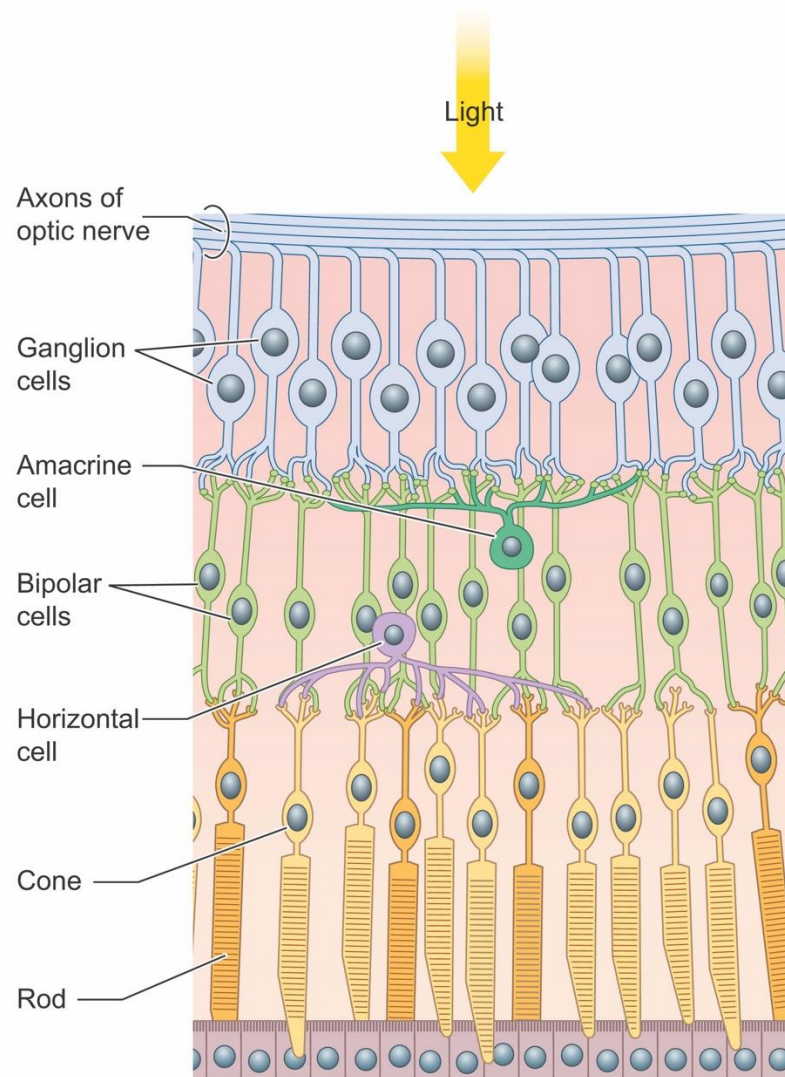
Transforming Electromagnetic Radiation into Visual Information

Early visual pathway



- Retina codes location and wavelength of light
 - Cones: Specific wavelengths (blue, green, red), more in fovea
 - Rods: Greater light sensitivity, more numerous, more in periphery

Retinal ganglion cells



- **Magnocellular (M) cells**

- Mainly rods
- Many inputs
- Light and motion sensitive, fast

- **Parvocellular (P) cells**

- Mainly cones
- Very few inputs
- Preserves detail and color, a bit slower