# RECOGNITION & SPATIAL COGNITION

https://flic.kr/p/7hkbHH

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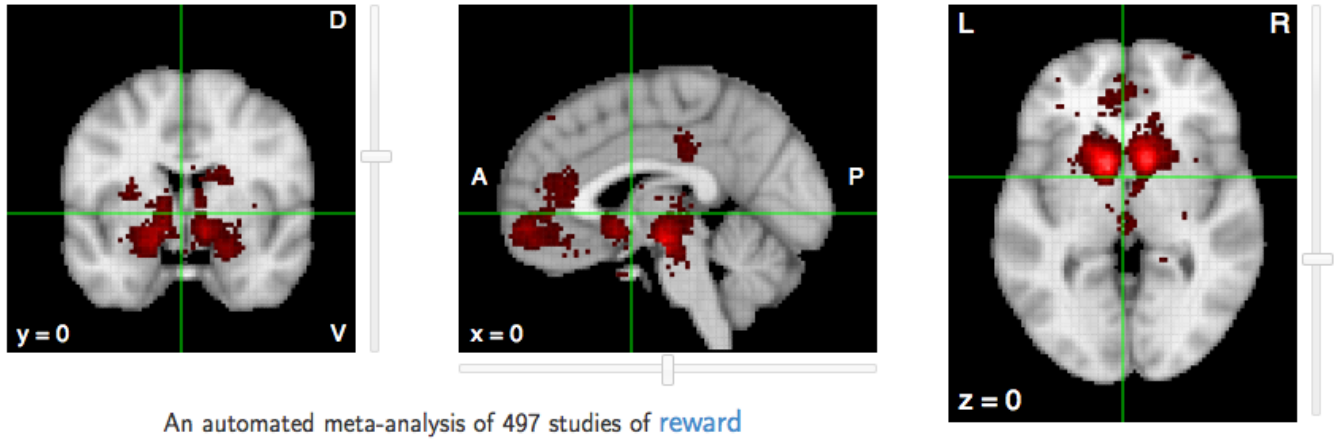
# Neurosynth Part 2 (Due 3.18.25 @ 11:59 pm)

## neurosynth.org

Neurosynth is a platform for large-scale, automated synthesis of functional magnetic resonance imaging (fMRI) data.

It takes thousands of published articles reporting the results of fMRI studies, chews on them for a bit, and then spits out images that look like this:

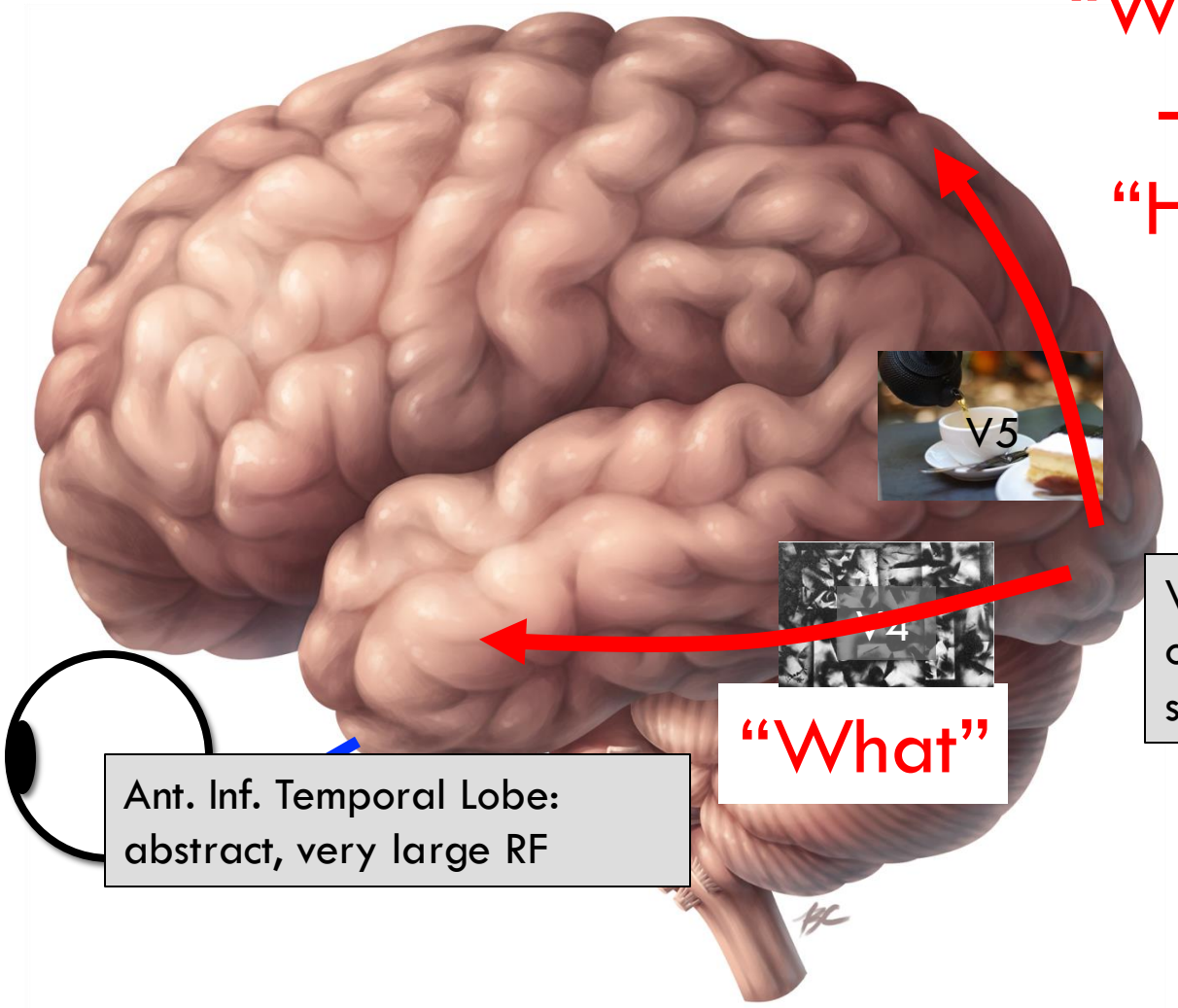



An automated meta-analysis of 497 studies of reward

Focus: Understanding structure-function relationships in terms of brain activation and functional localization

Review critical concepts from earlier in the course

# Two Visual Processing Streams




RF: Receptive Field

## If the receptive fields of neurons increase in size along the ventral visual processing stream, what do you think might happen to spatial resolution?

It should become more precise

It should become less precise

It should be unchanged

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

# If the receptive fields of neurons increase in size along the ventral visual processing stream, what do you think might happen to spatial resolution?

It should become more precise

0%

It should become less precise

0%

It should be unchanged

0%

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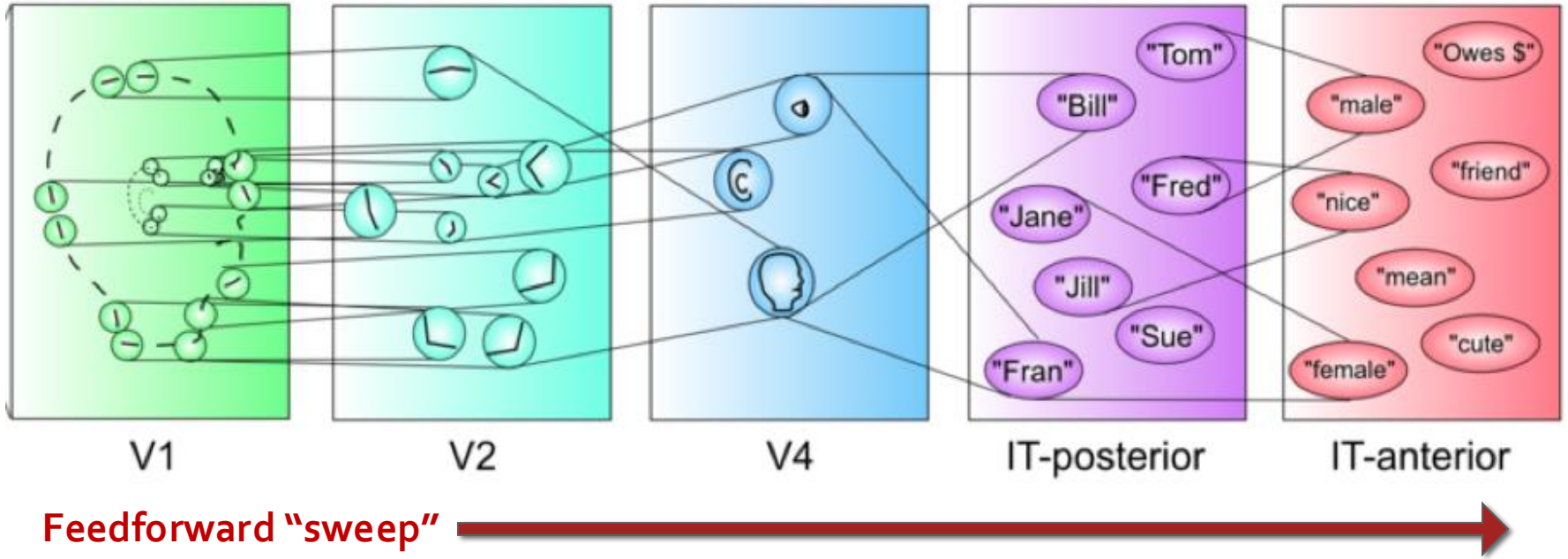
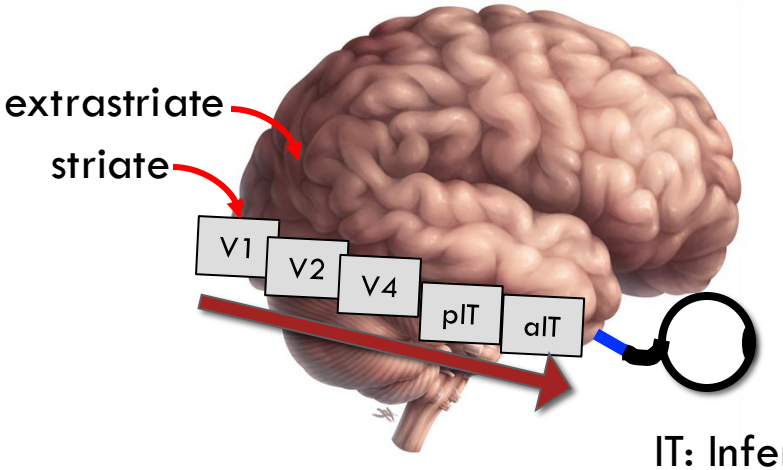
# Vision for Recognition

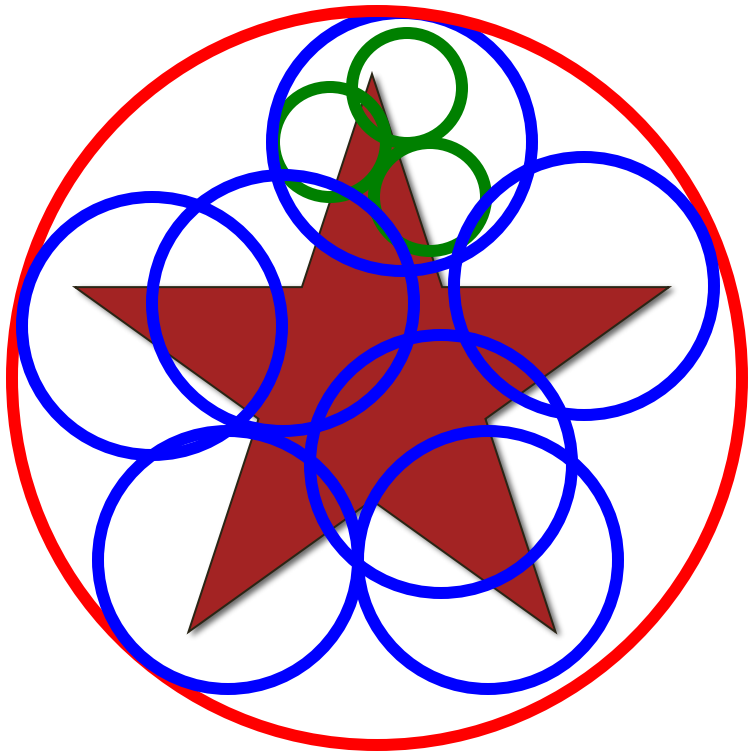
# Ventral Visual Processing Stream




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



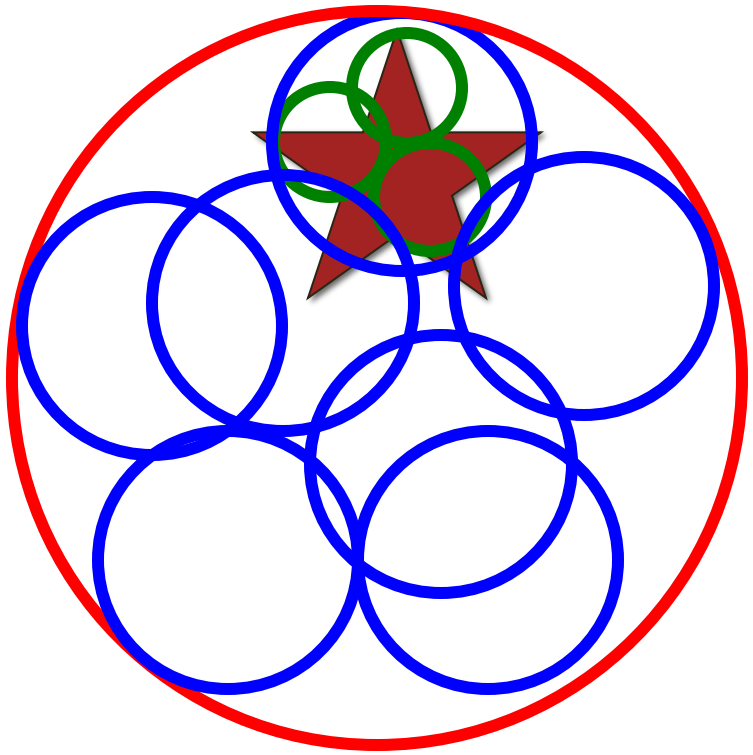

IT: Inferotemporal



V1: Small RF; Line orientation

V2: Bigger RF; Intersections & Junctions

V4: Large RF; Complex Shapes



V1: Small RF; Line orientation

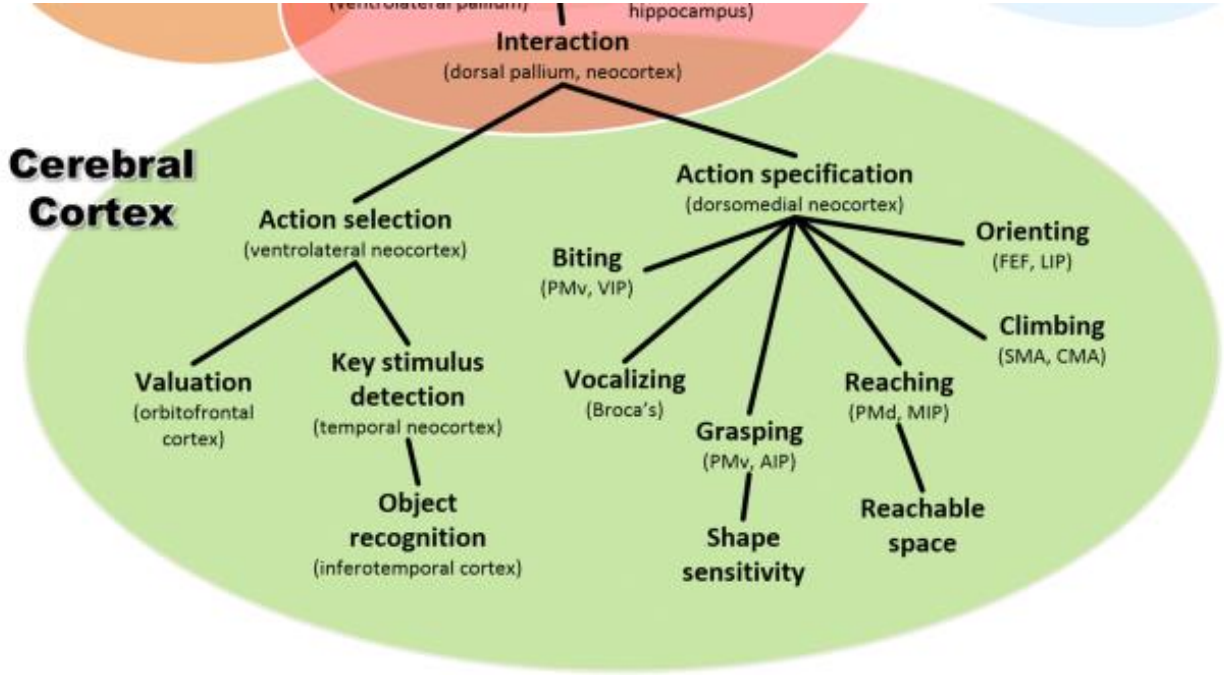
V2: Bigger RF; Intersections & Junctions

V4: Large RF; Complex Shapes

# How does perception work?

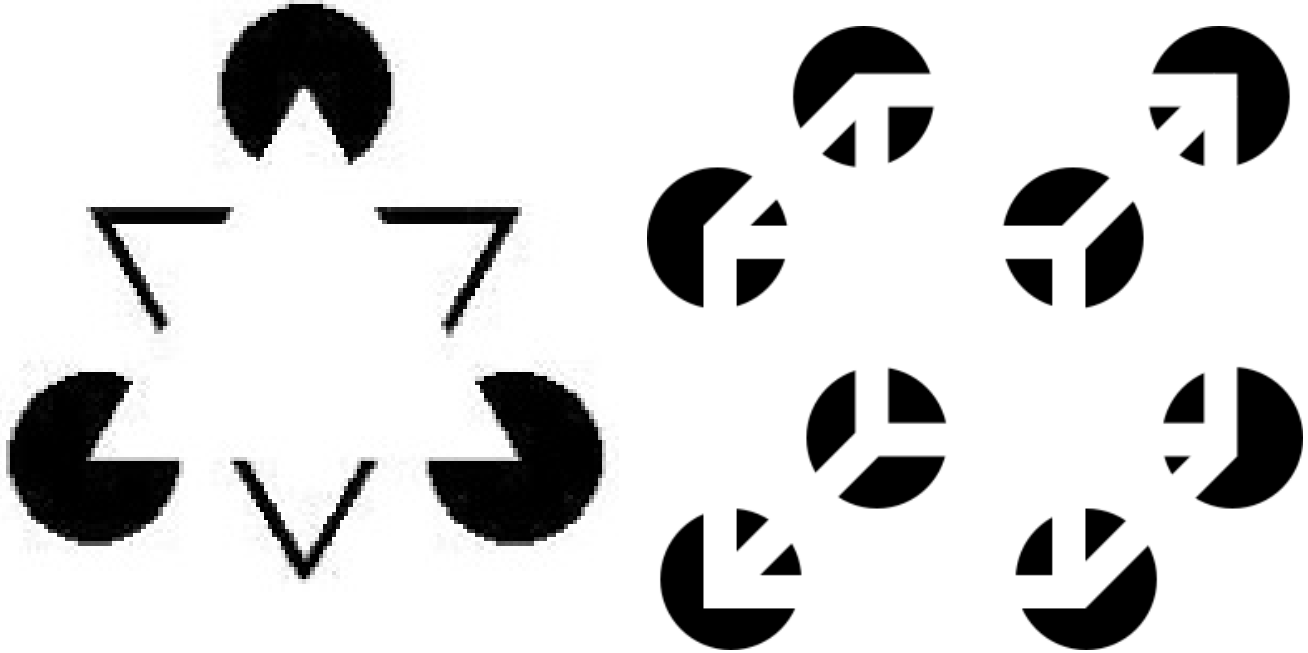
- Challenges: Invariance, ambiguity, importance of context

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

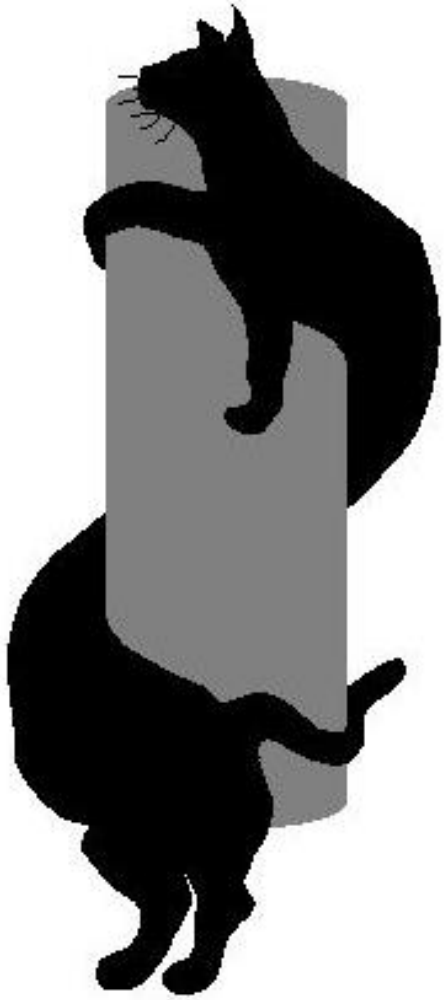



- Vision involves
  - Feedforward processing
  - Feedback processing
  - Hierarchical processing
  - Experience based inference

# Vision as inference

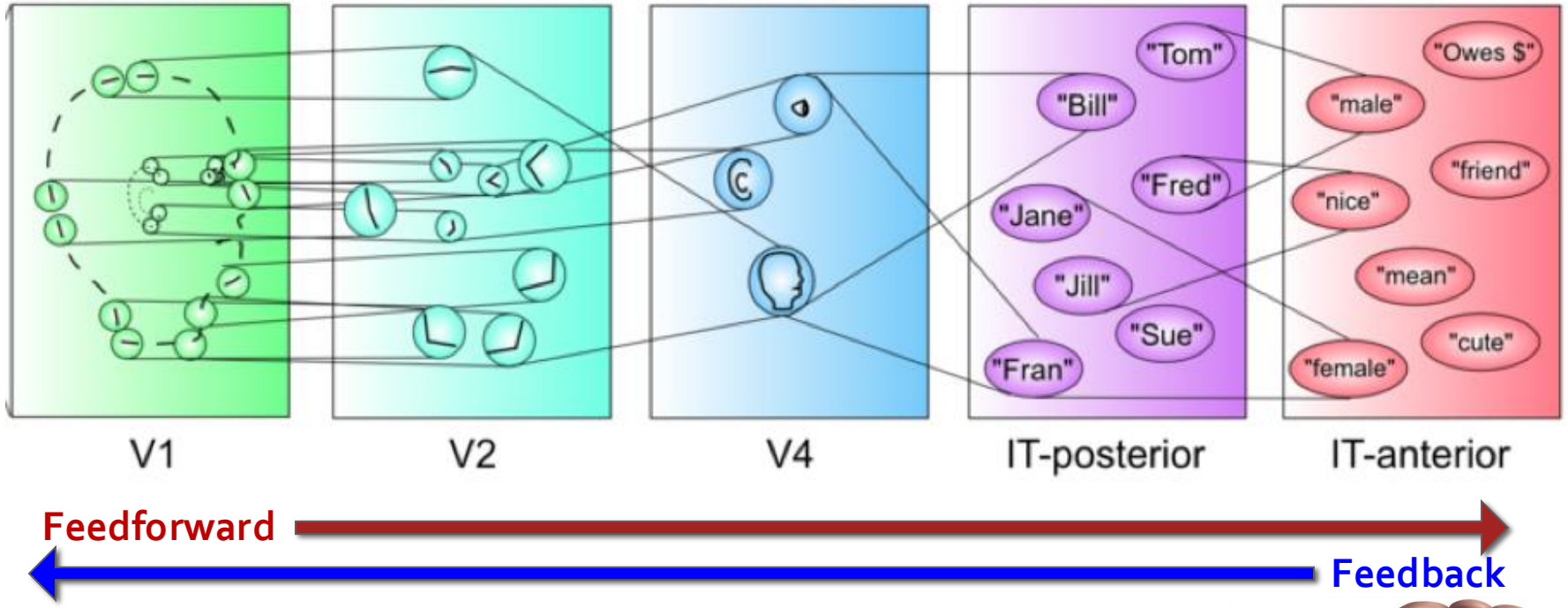


Illusory Contours

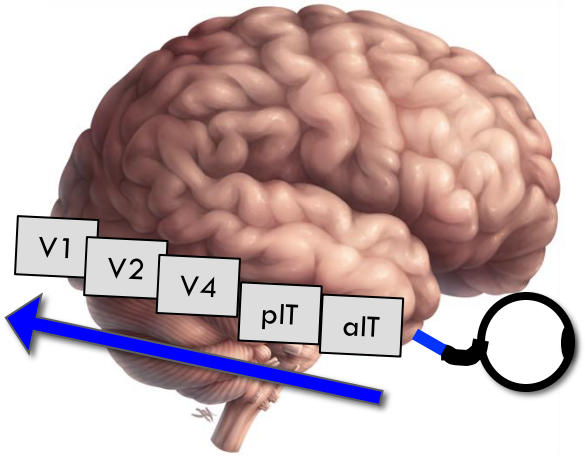


Amodal Completion

# Ventral Visual Processing Stream

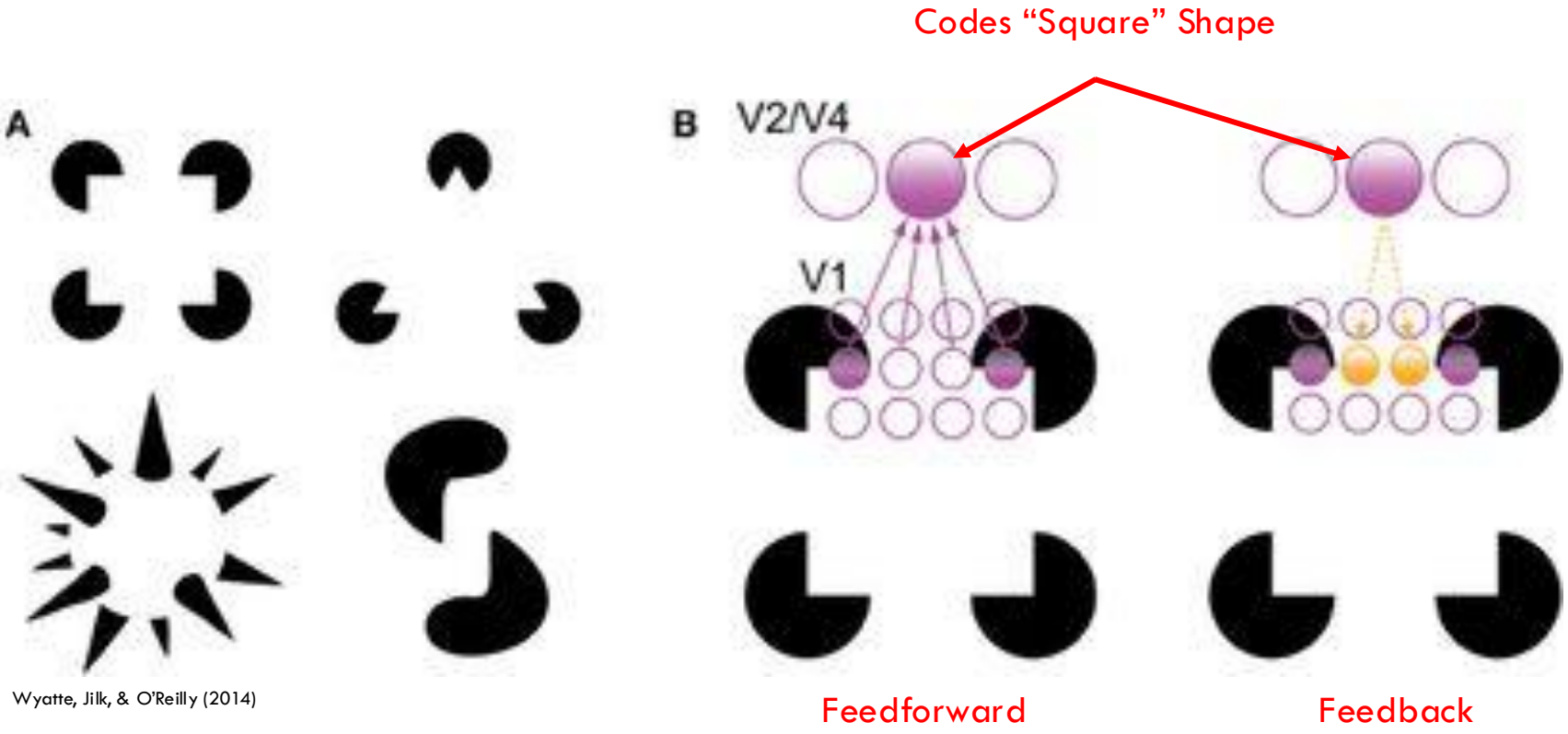



- Feedback
  - Inferences about what can't be seen
  - Resolves ambiguity
  - Provides context info
  - Starts right away



# Feedback

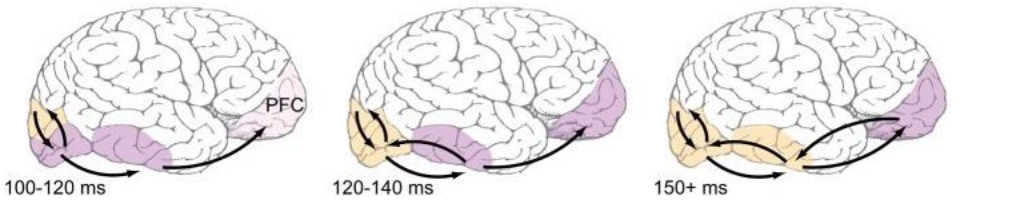
- Visual processing reflects internal info as well
  - Shape




Wyatte, Jilk, & O'Reilly (2014)

# Feedback

- Visual processing reflects internal info as well
  - Shape
  - Context
- Reflects experience
  - Scene statistics
  - Perceptual learning
- Starts within ~100 ms




Wyatte, Jilk, & O'Reilly (2014)

Next time, you'll spot it faster

# Take-aways (Ventral Visual Stream)

- Sorts out "what" is being looked at

- Initially processing is feedforward
  - Simple features -> Complex/Abstract
  - Small receptive field -> Large receptive field (lose spatial precision)
  - Contributes to invariance

- Feedback sharpens and fills in information
  - Helps resolve ambiguity
  - Context and knowledge contribute
  - Starts early

# Perception for Action

https://staticg.sportskeeda.com/editor/2021/10/7bd5b-16350049142782-1920.jpg

https://gray-wowt-prod.cdn.arcpublishing.com/resizer/v2/JGNHB3N5A3GKBBPB2B5RXRV3TA.jpg?auth=2a7474e098c3d209676b98f7fe50746e75b2b7738bf2fff7274413dd82377340&width=1600&height=900&smart=true

# What "computations" do you think are needed for these passes?

0

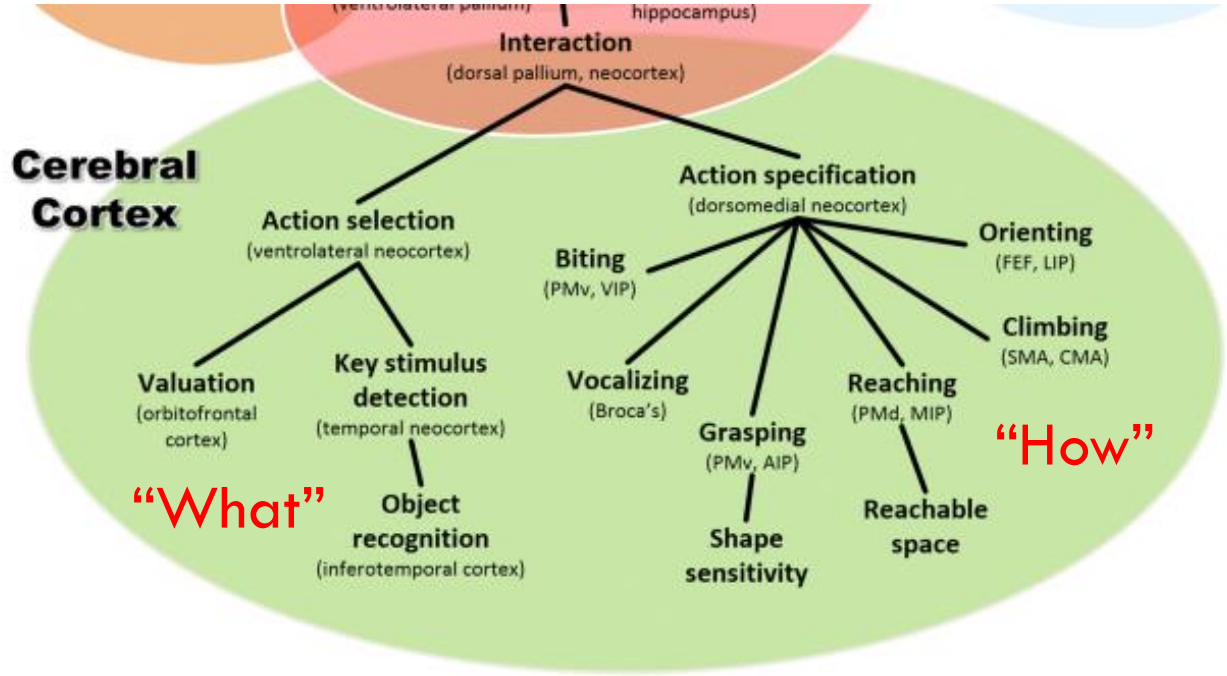
Nobody has responded yet.

Hang tight! Responses are coming in.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

# How does perception work?

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



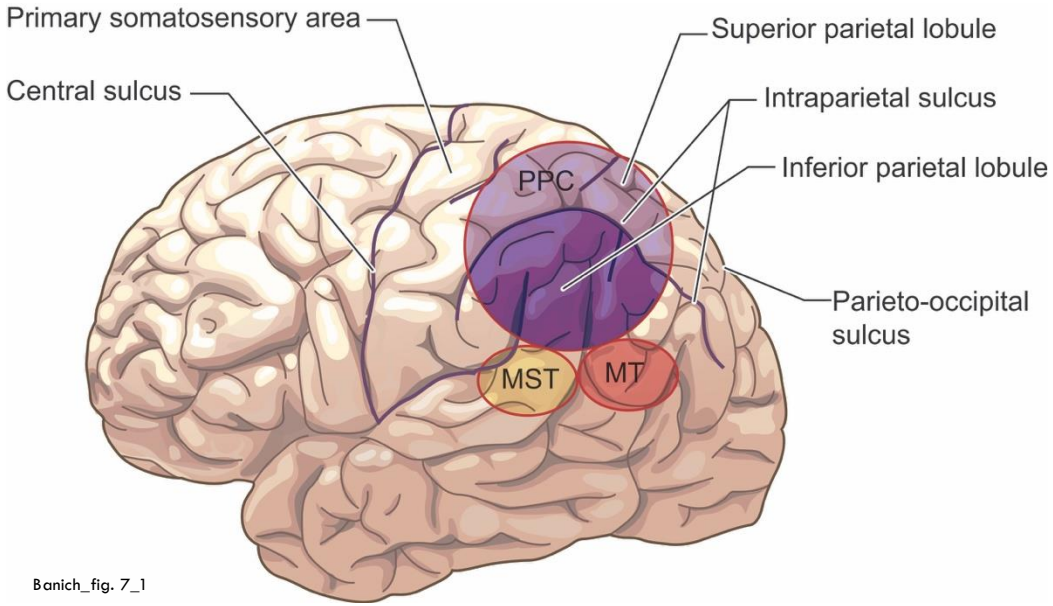
# What is needed for action?

- Self representation
  - Body, how it can move, where it is
  - (And, actual control of the body)

- Spatial location
  - Direction, movement
  - Near vs far
  - But, relative to what?

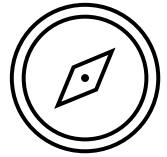
- How external world relates to self
  - Multiple sensory modalities

## These converge in parietal cortex

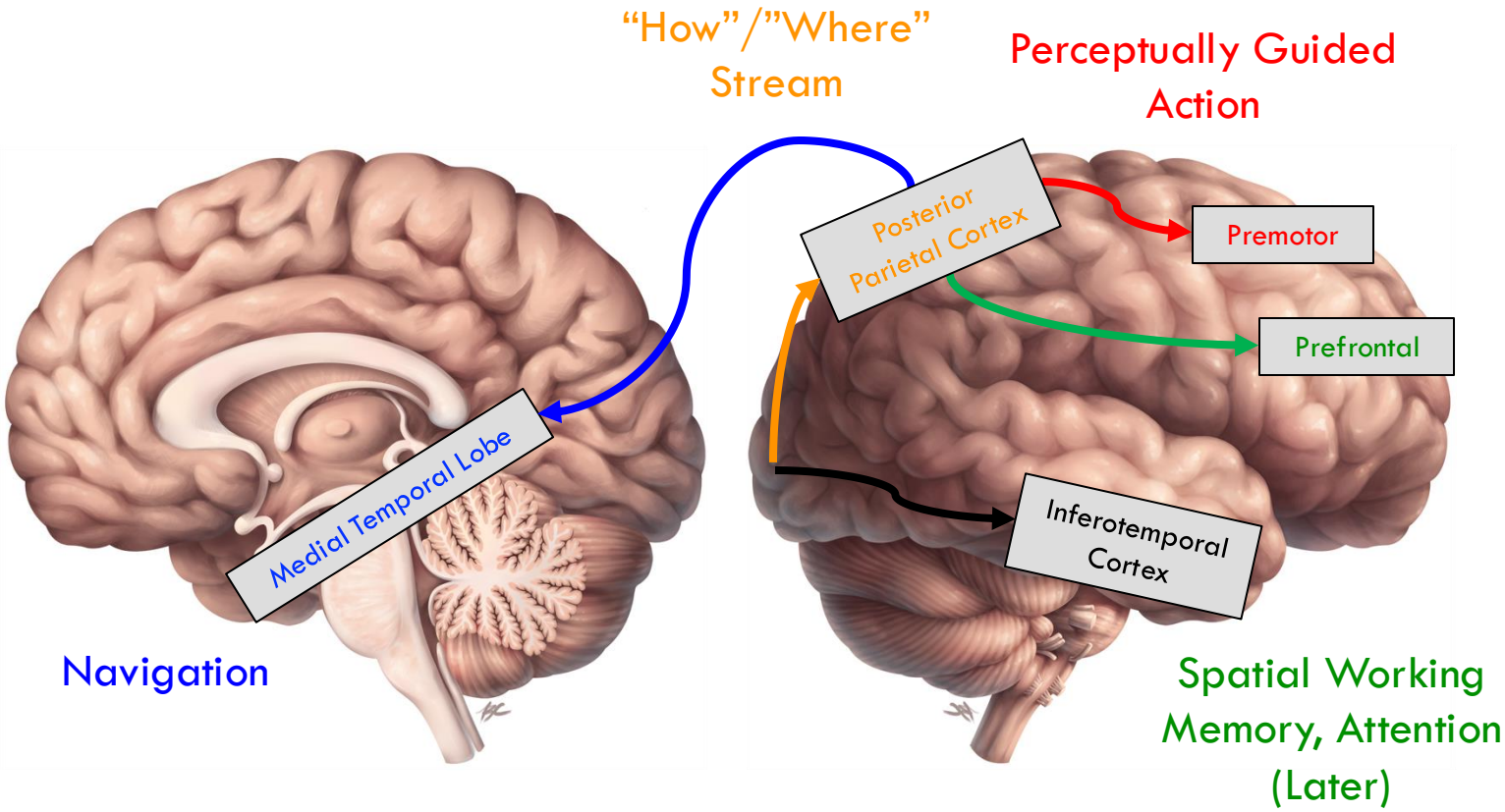



Banich_fig. 7_1

# From Perception to Action



- The "How"/"Where" stream
  - Action-oriented representations
  - Optic Ataxia
- Reference Frames
  - What coordinates are used?
- Integration of…
  - Sensory modalities
  - Action
- Navigation



# The “How” or “Where” Pathway

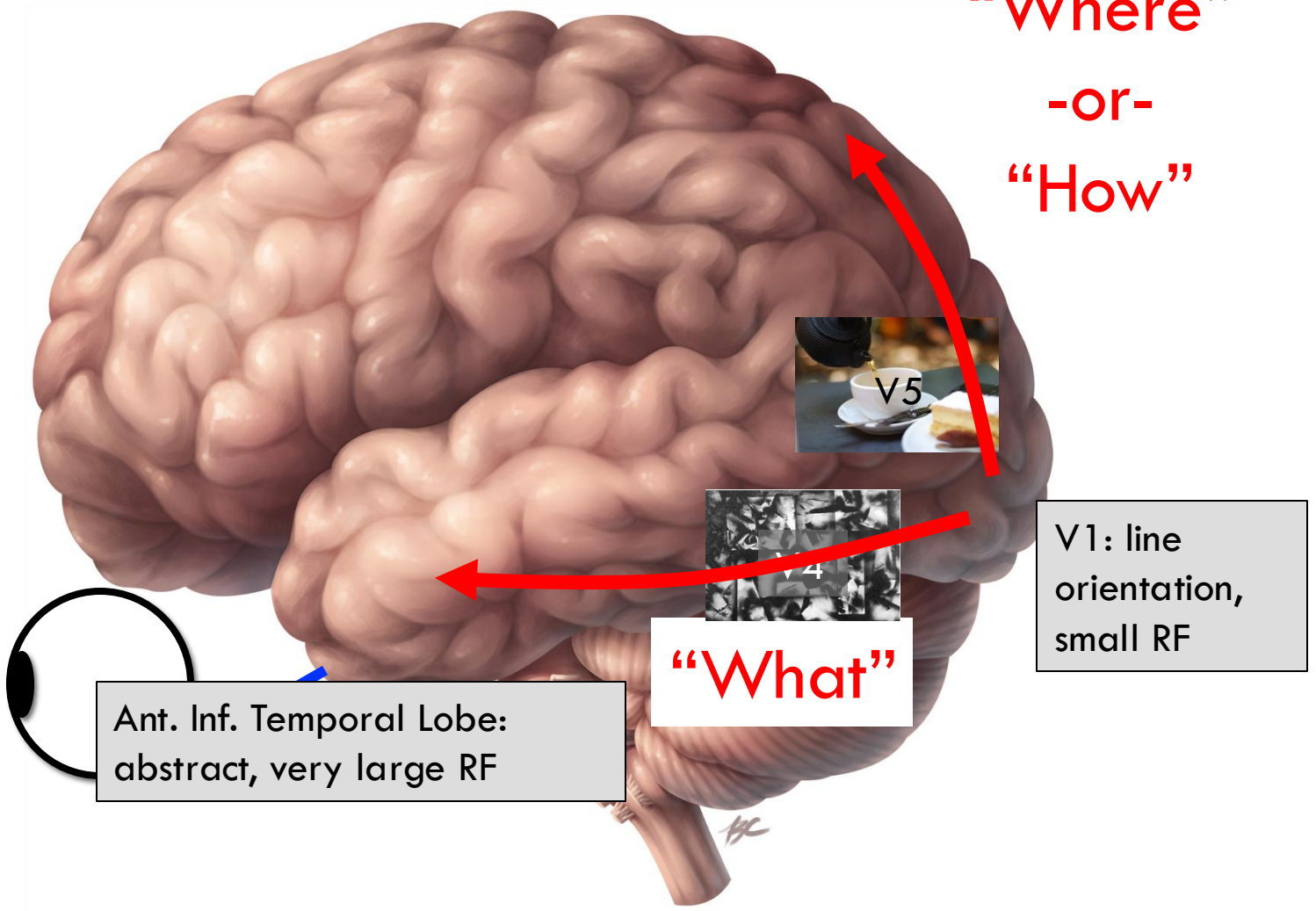
# What is perception for, anyway?

"If the goal of perception and reason is to guide action (and it surely is, evolutionary speaking), it will often be simpler to represent the world in ways rather closely geared to the kinds of actions we want to perform."

-Andy Clark, *Where Brain, Body, and World Collide*, p. 266

Action-Oriented Representations

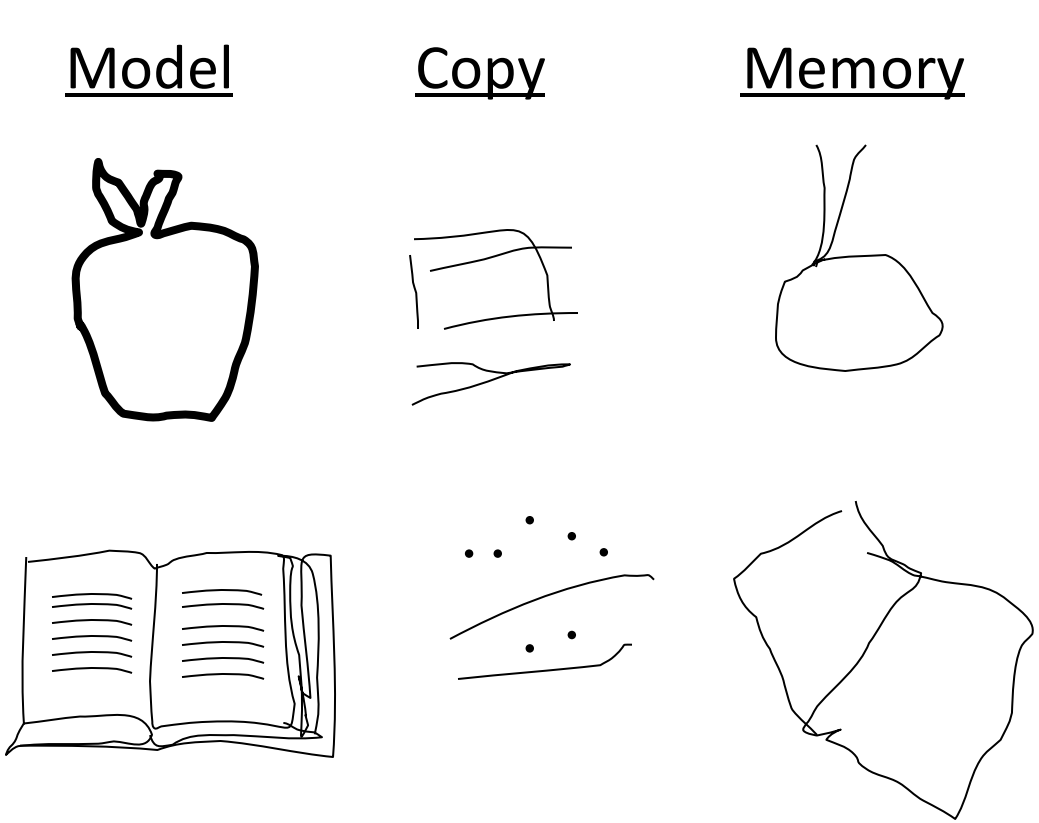
# Two Visual Processing Streams

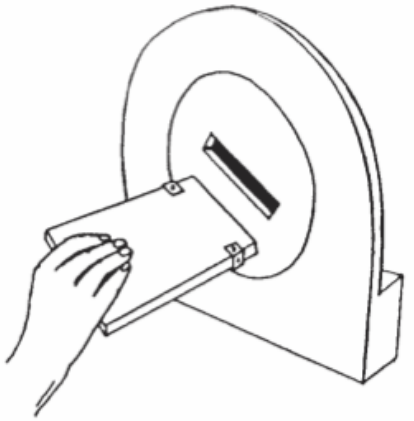



RF: Receptive Field

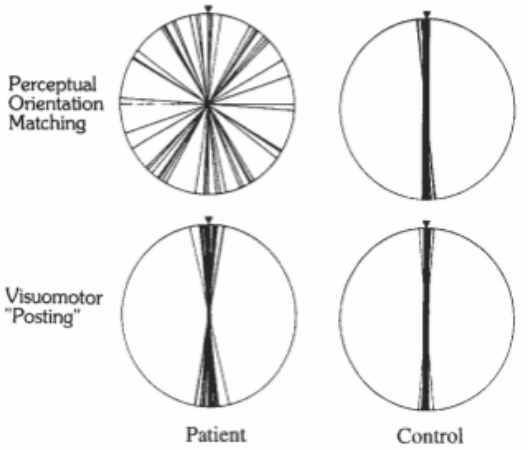
# Knowing what is not knowing how

- Patient DF: Apperceptive agnosia from damage to ventral stream



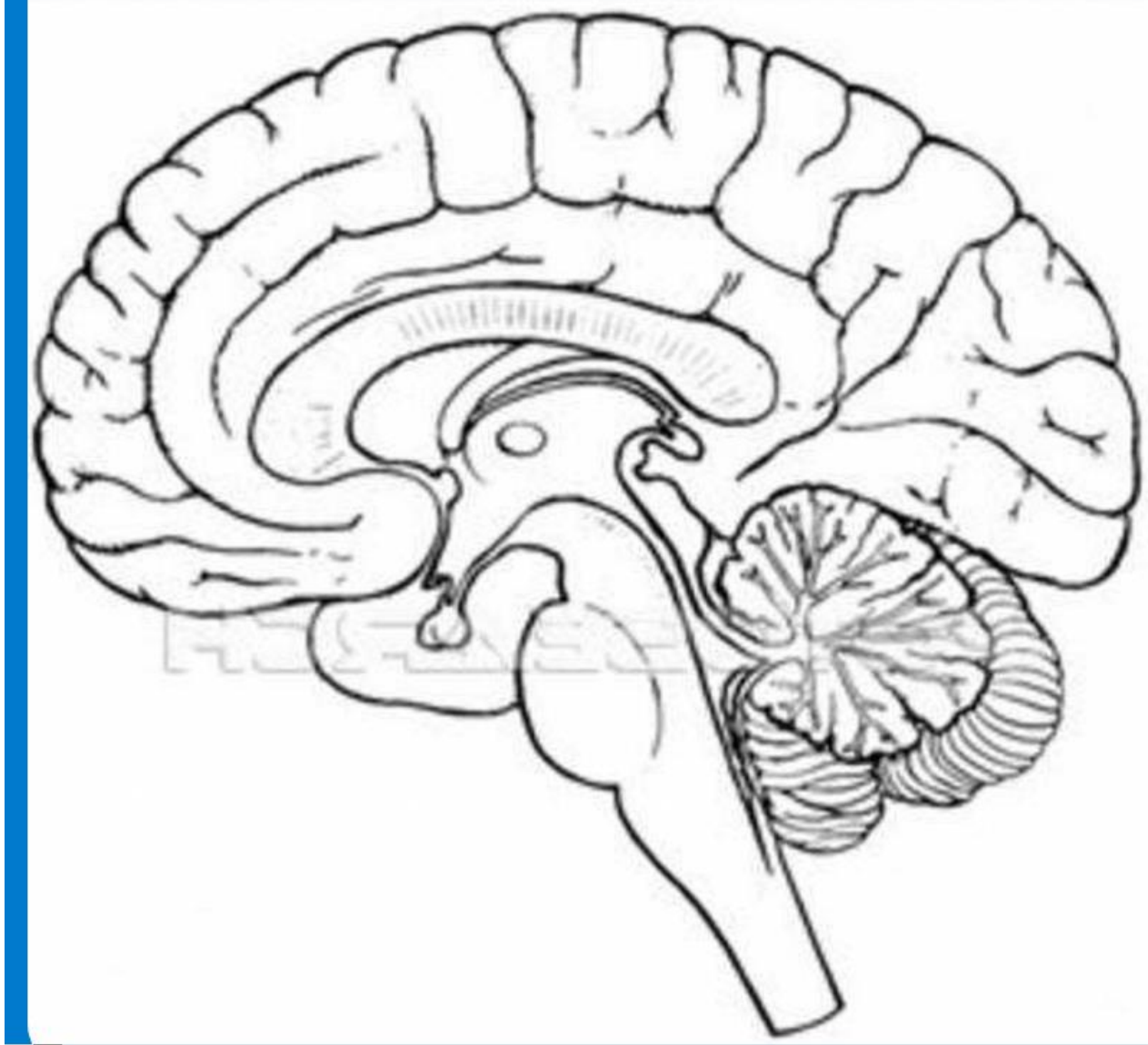
Posting Task

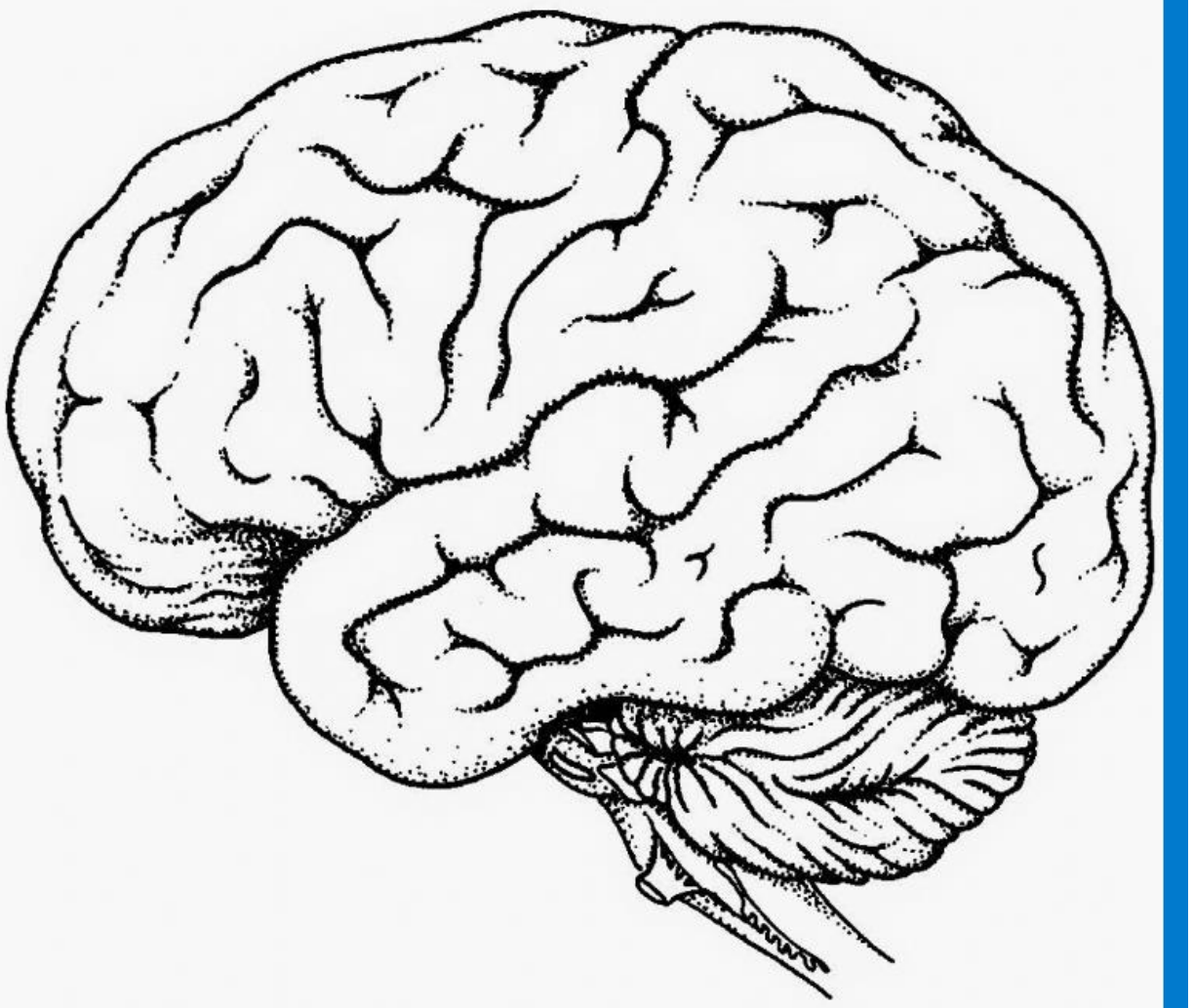



Milner & Goodale (2008)

# Click to indicate: Where might damage impair performance on the "posting task"?

0





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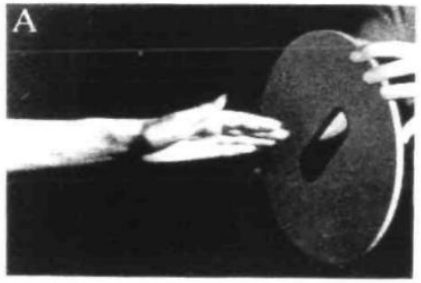
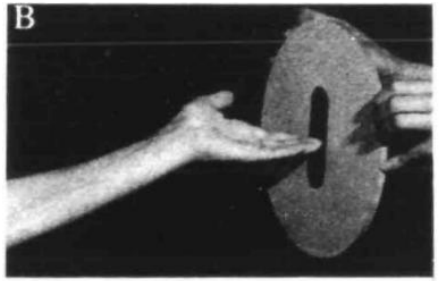
# Knowing what is not knowing how

- Damage to the dorsal stream does something different

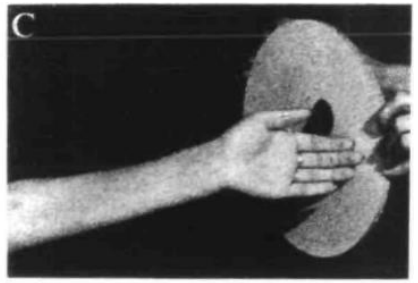
Right Parietal Lesion:
Left visual field errors



Left Hand, Right Visual Field



Left Hand, Left Visual Field



Left Hand, Left Visual Field

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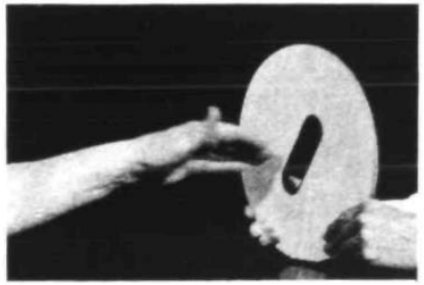

Left Hand, Left Visual Field

Right Hand, Right Visual Field

Right Hand, Right Visual Field

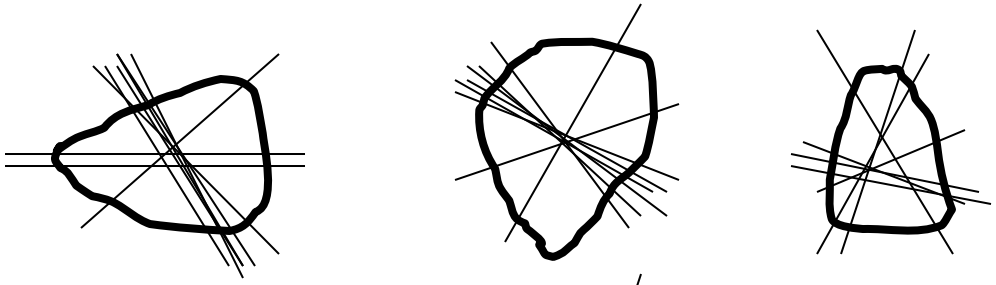
- <u>Optic Ataxia</u>: breakdown in visually guided reaching, pointing

Perenin & Vighetto (1988)

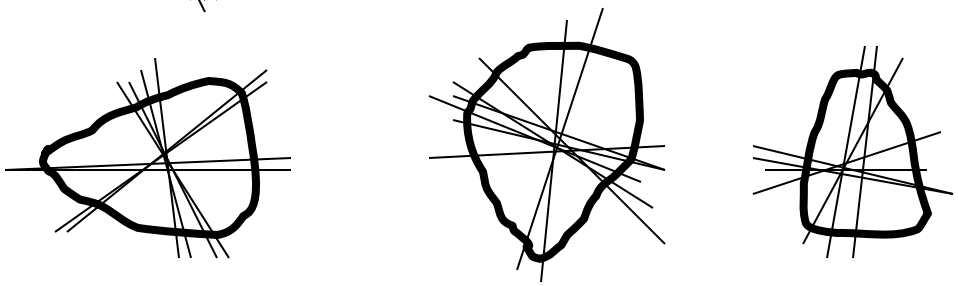
# Knowing what is not knowing how

- Patient RV: Optic ataxia from damage to the dorsal stream

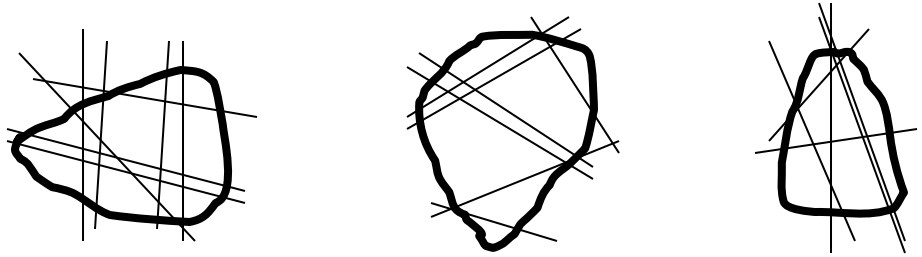
Normal controls



Patient DF (agnosia)



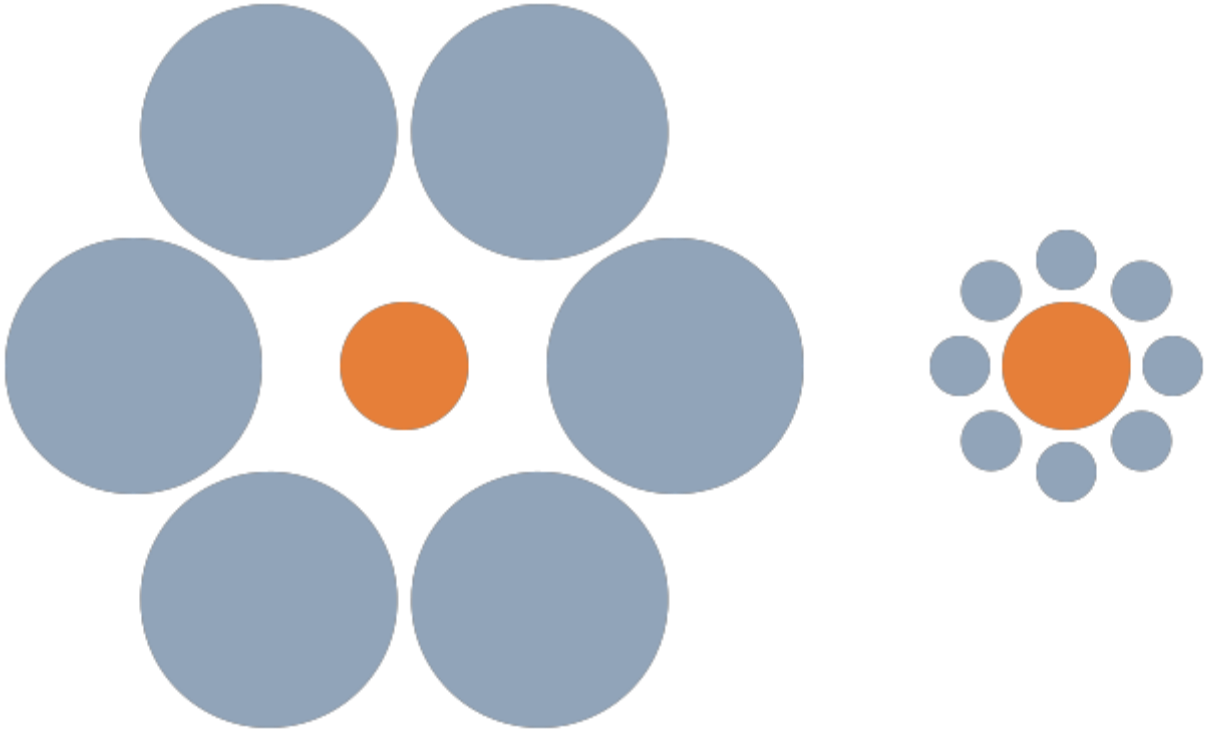
Patient RV (optic ataxia)



Milner & Goodale (2008)

# Knowing what is not knowing how

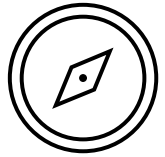
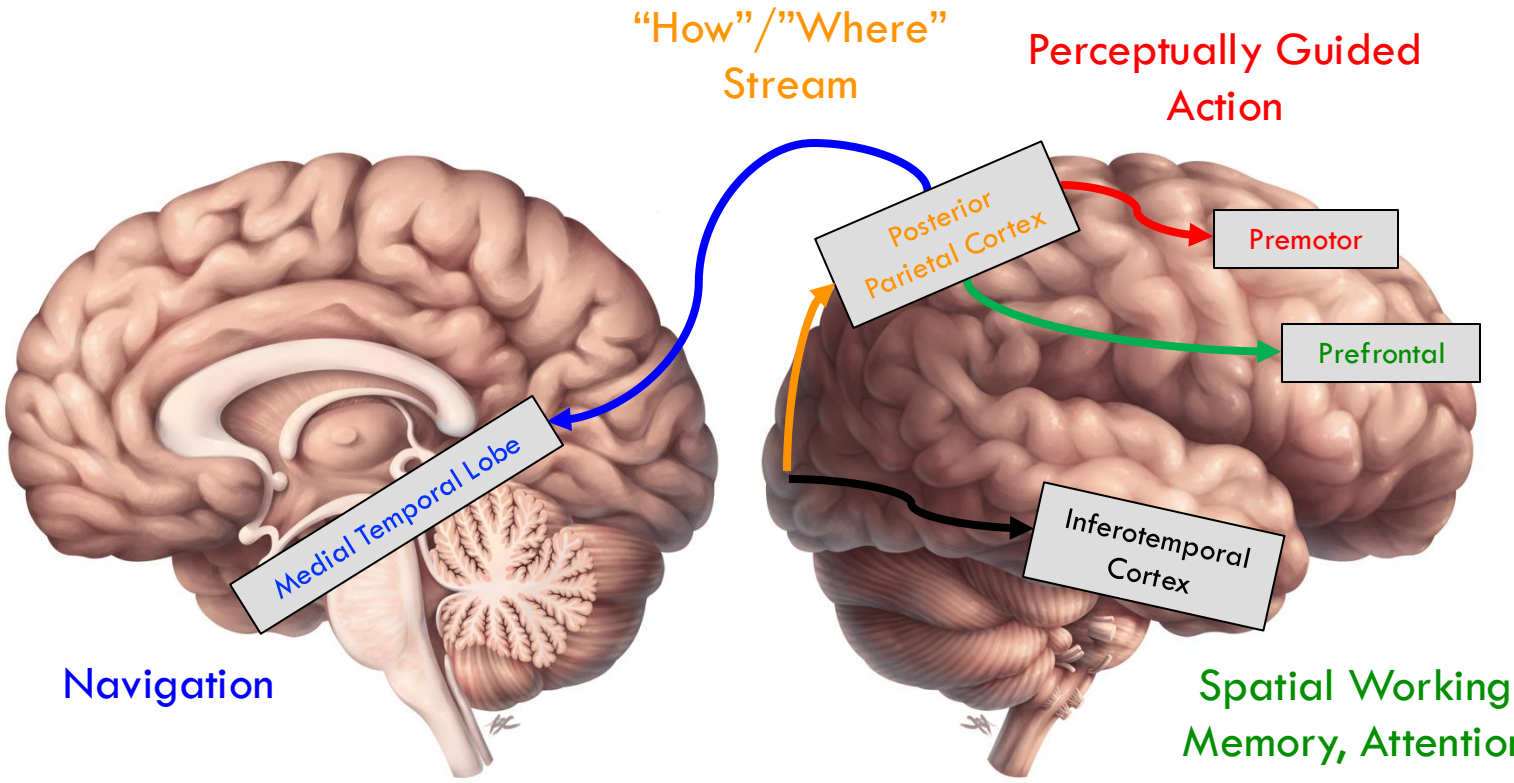
## Ebbinghaus Illusion



- Open hand the same amount when grabbing the orange circles, despite differences in perceived size
- Aware of ventral but not dorsal?

Haffenden, Schiff, & Goodale (2001)

# From Perception to Action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