Extensive childhood experience with Pokémon suggests eccentricity drives organization of visual cortex

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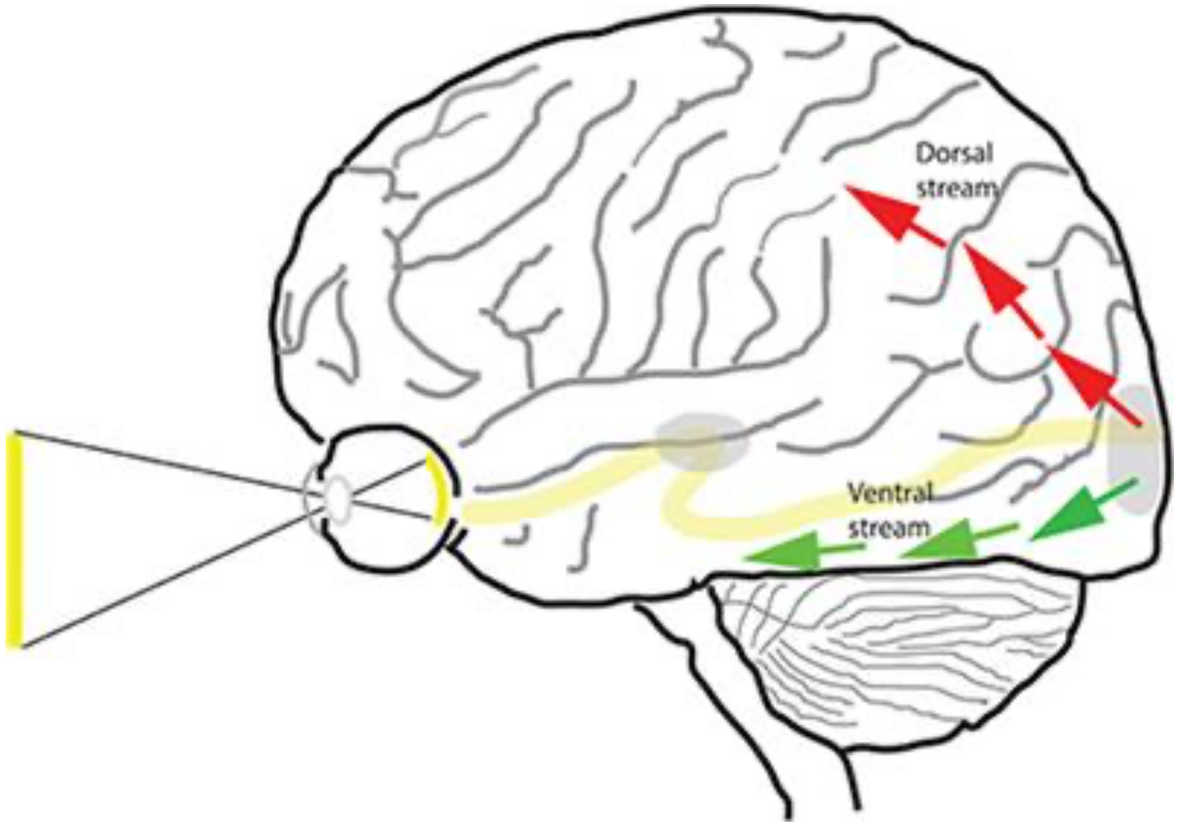
?
Pokémon

(Brief!) Introduction!

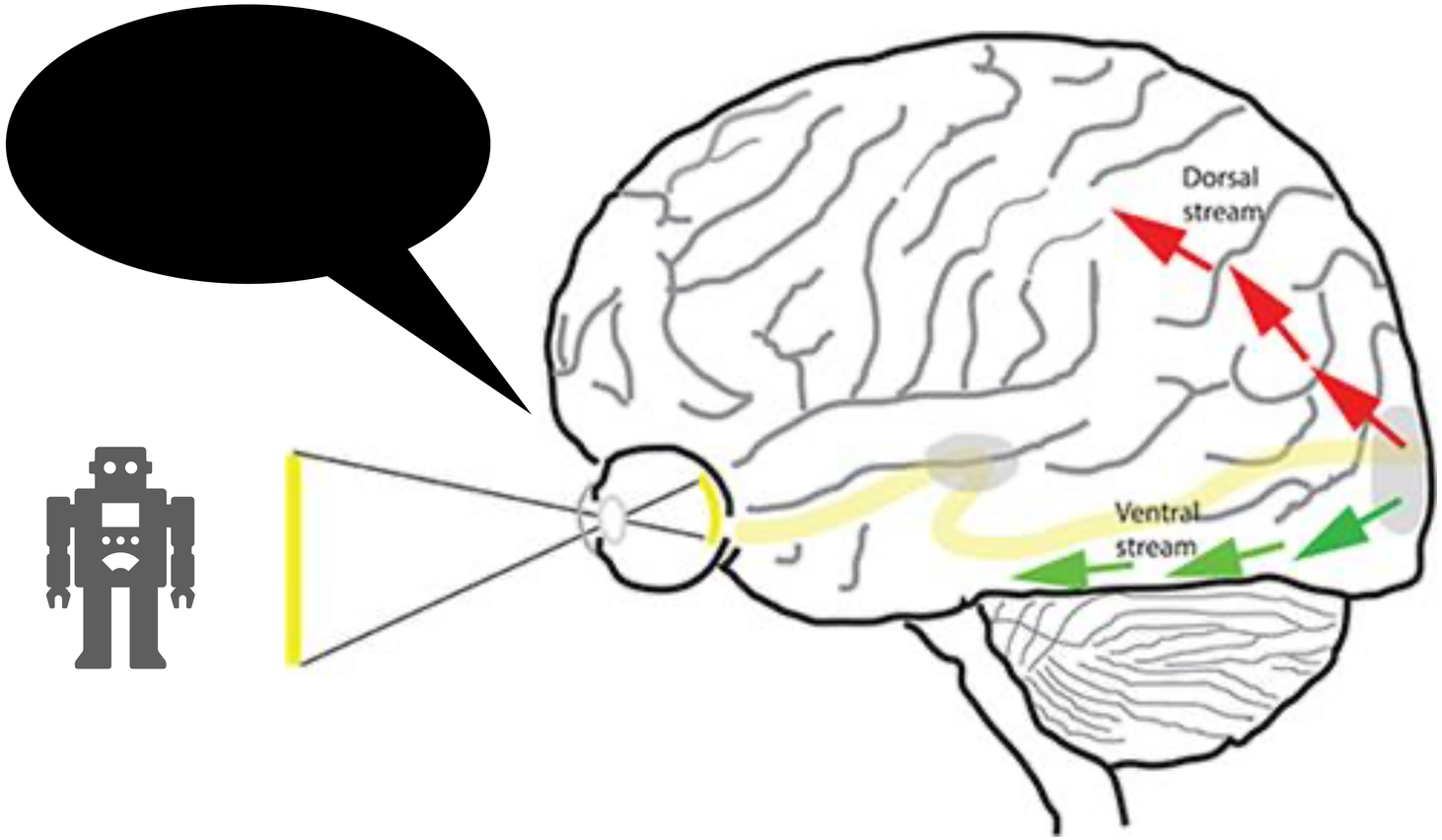
Ventral Visual Stream

Recall that when we process visual stimuli, this information gets processed by retinal ganglion cells —> LGN —> to our primary visual cortex (V1).



Ventral Visual Stream

We also have an extraordinary ability to recognize a range of stimuli quickly, thought to be the result of rapid cortical computations that occur within our visual stream (from V1 up to the ventral temporal cortex; VTC)



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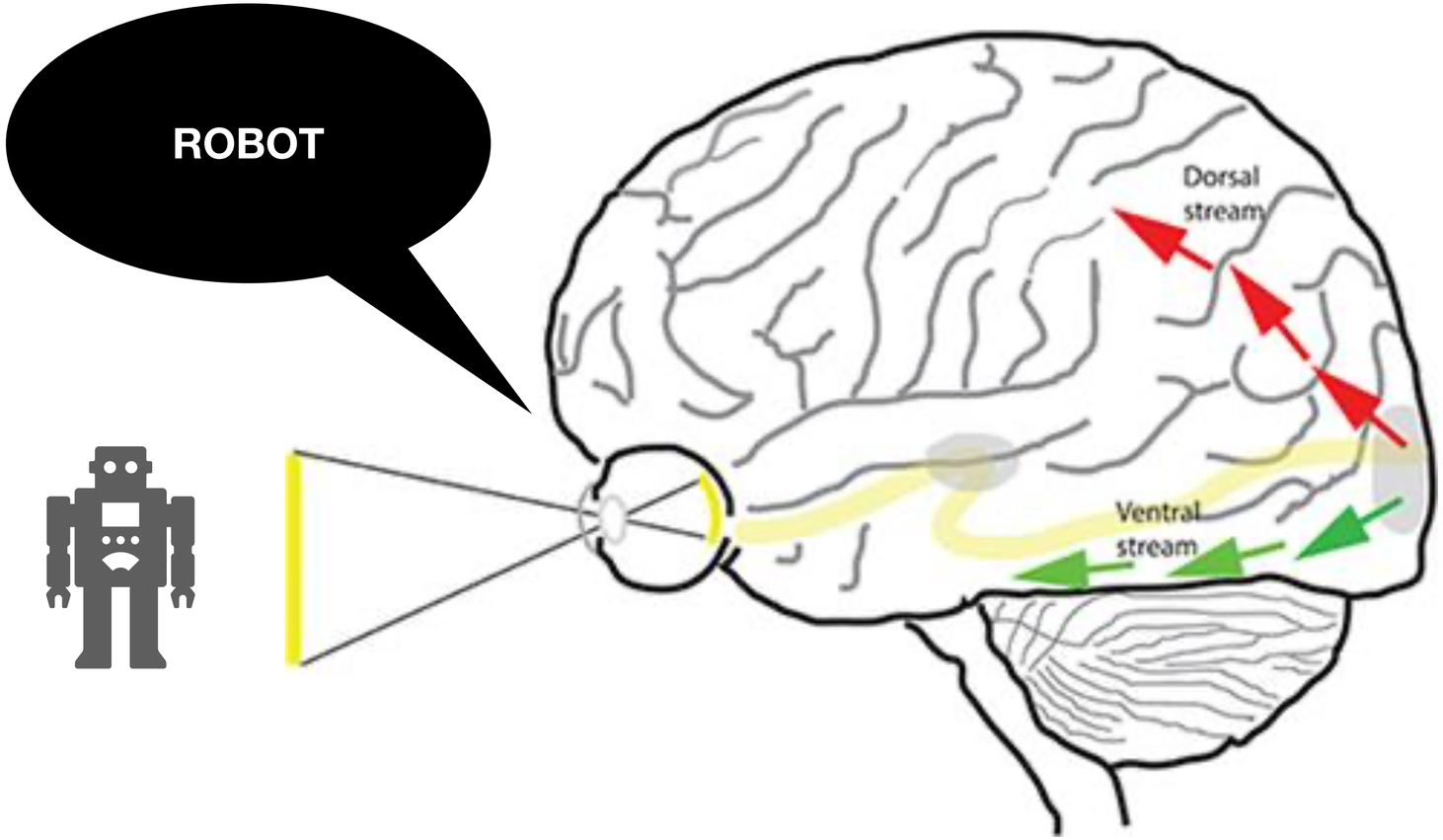

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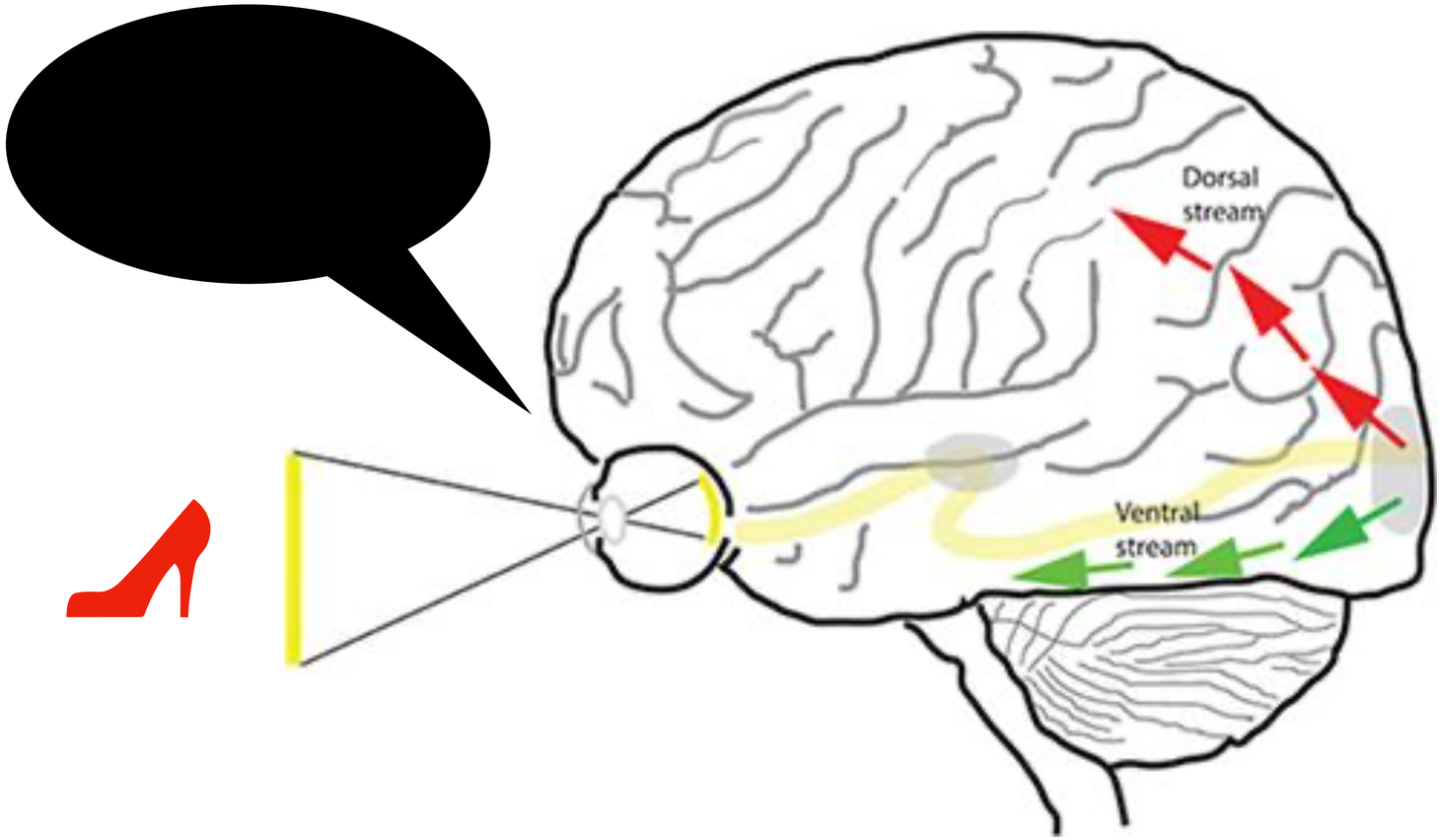

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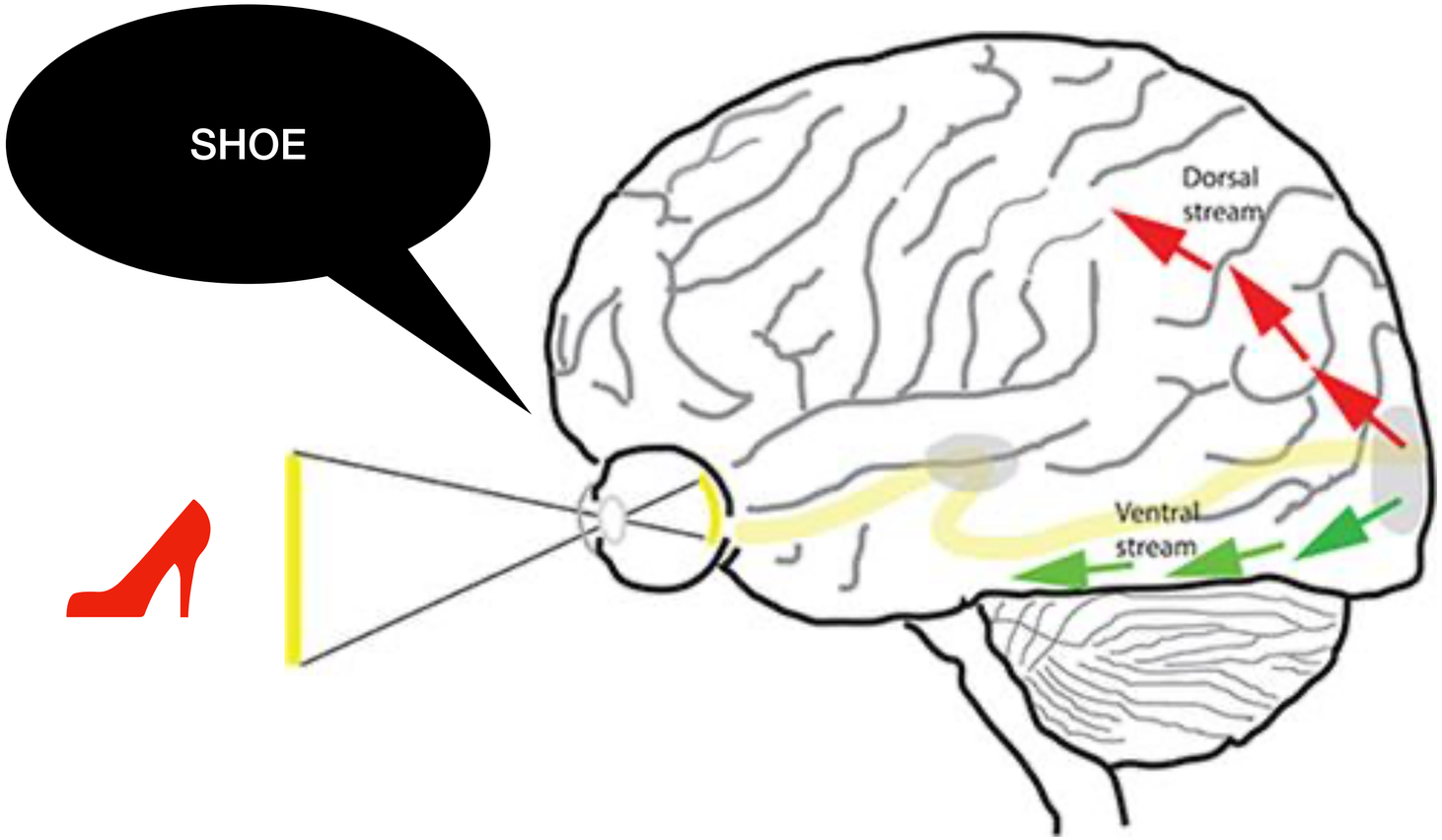

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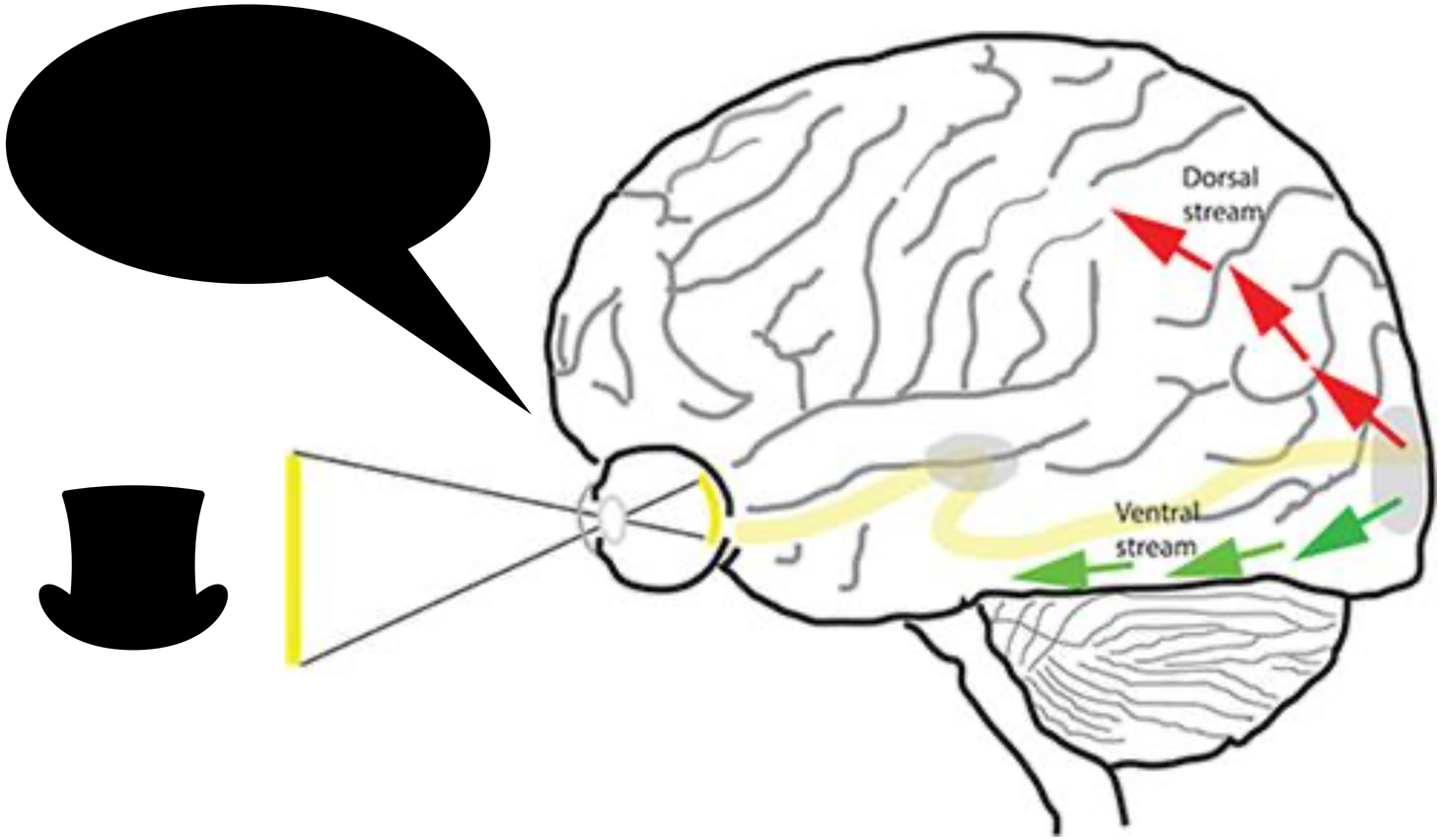

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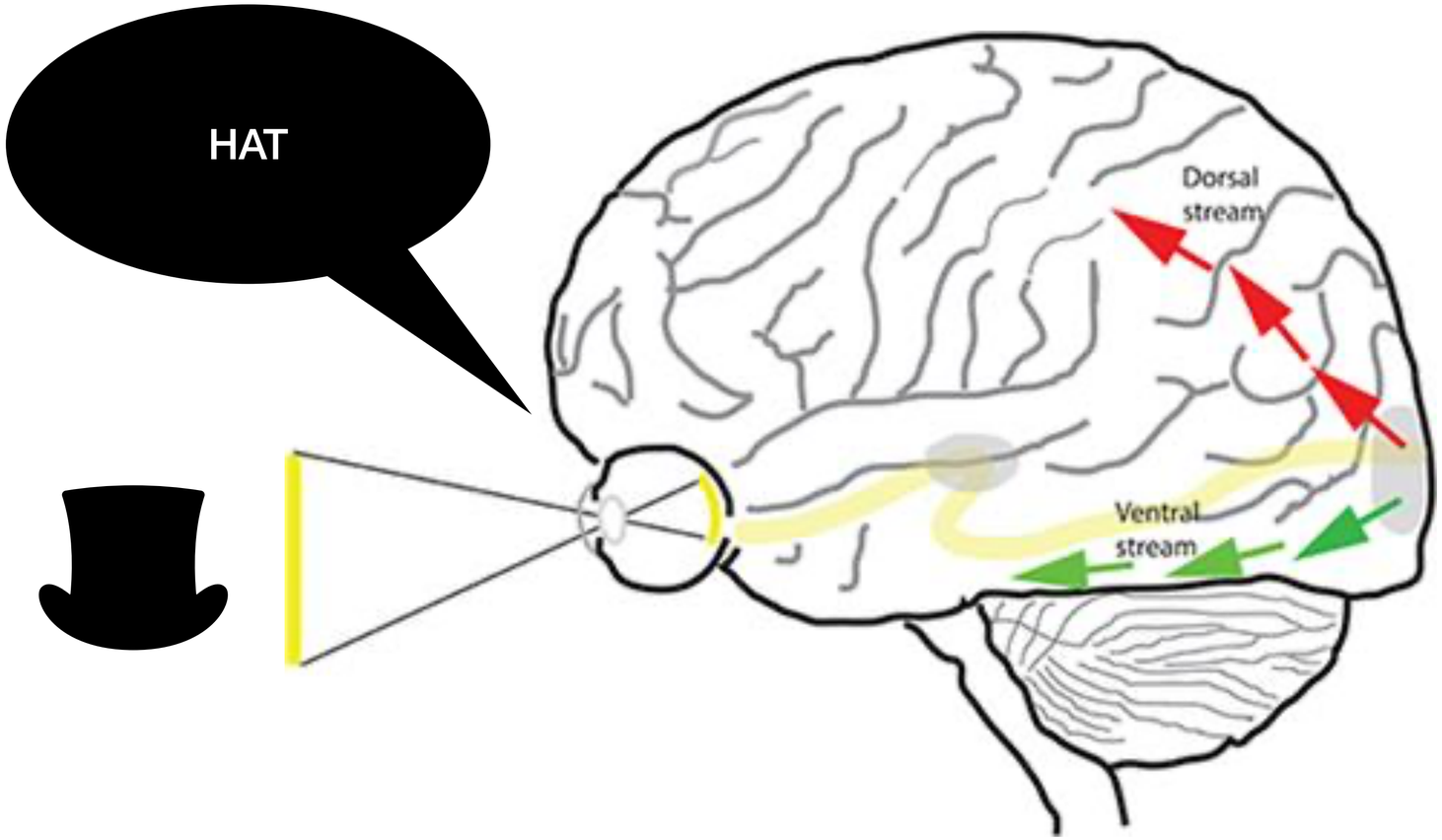
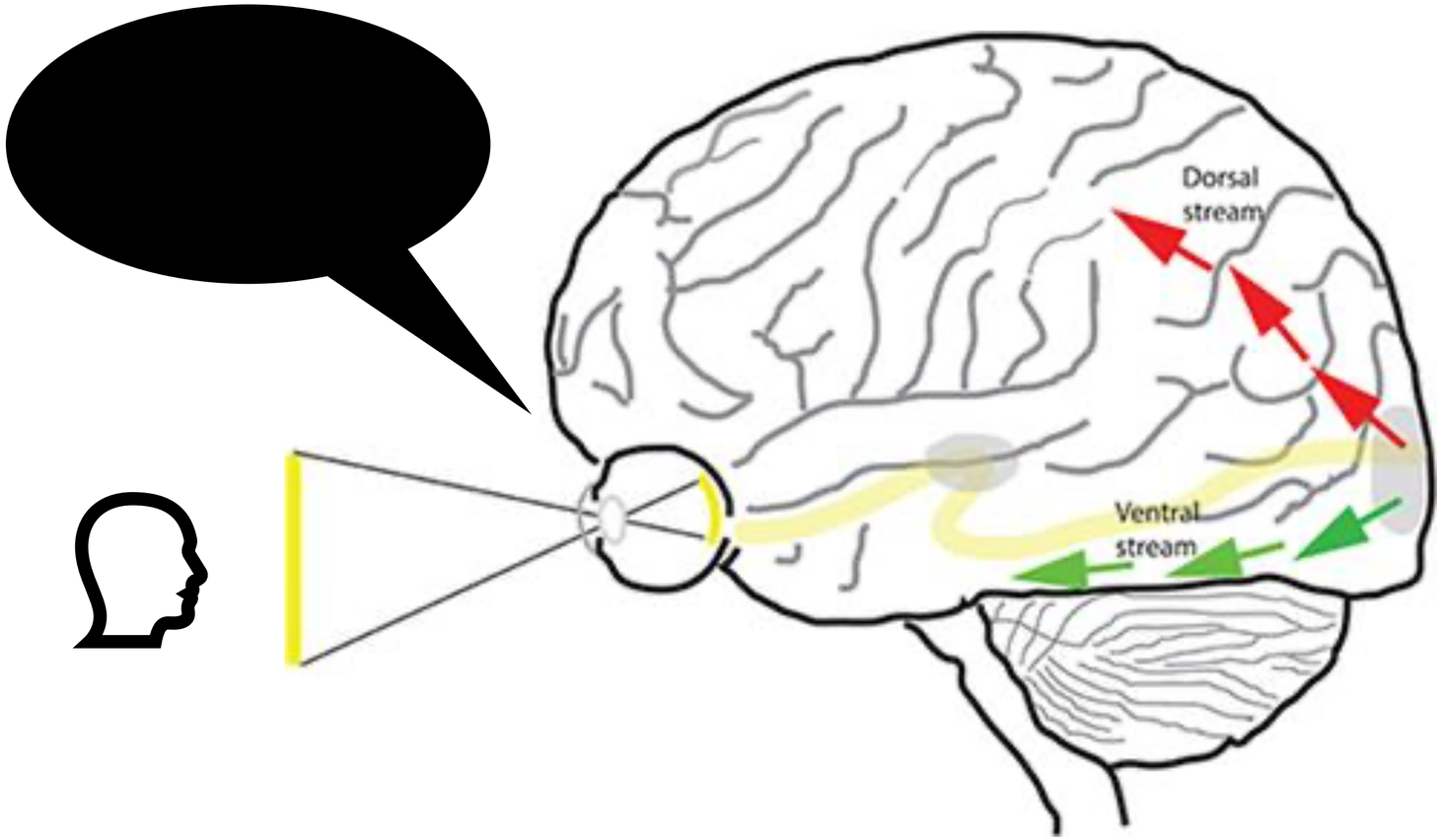


Ventral Visual Stream

This rapid visual recognition is thought to be facilitated by the VTC thanks to its distinct visual categories that are arranged with remarkable spatial consistency across people



FACE

BODY

WORD

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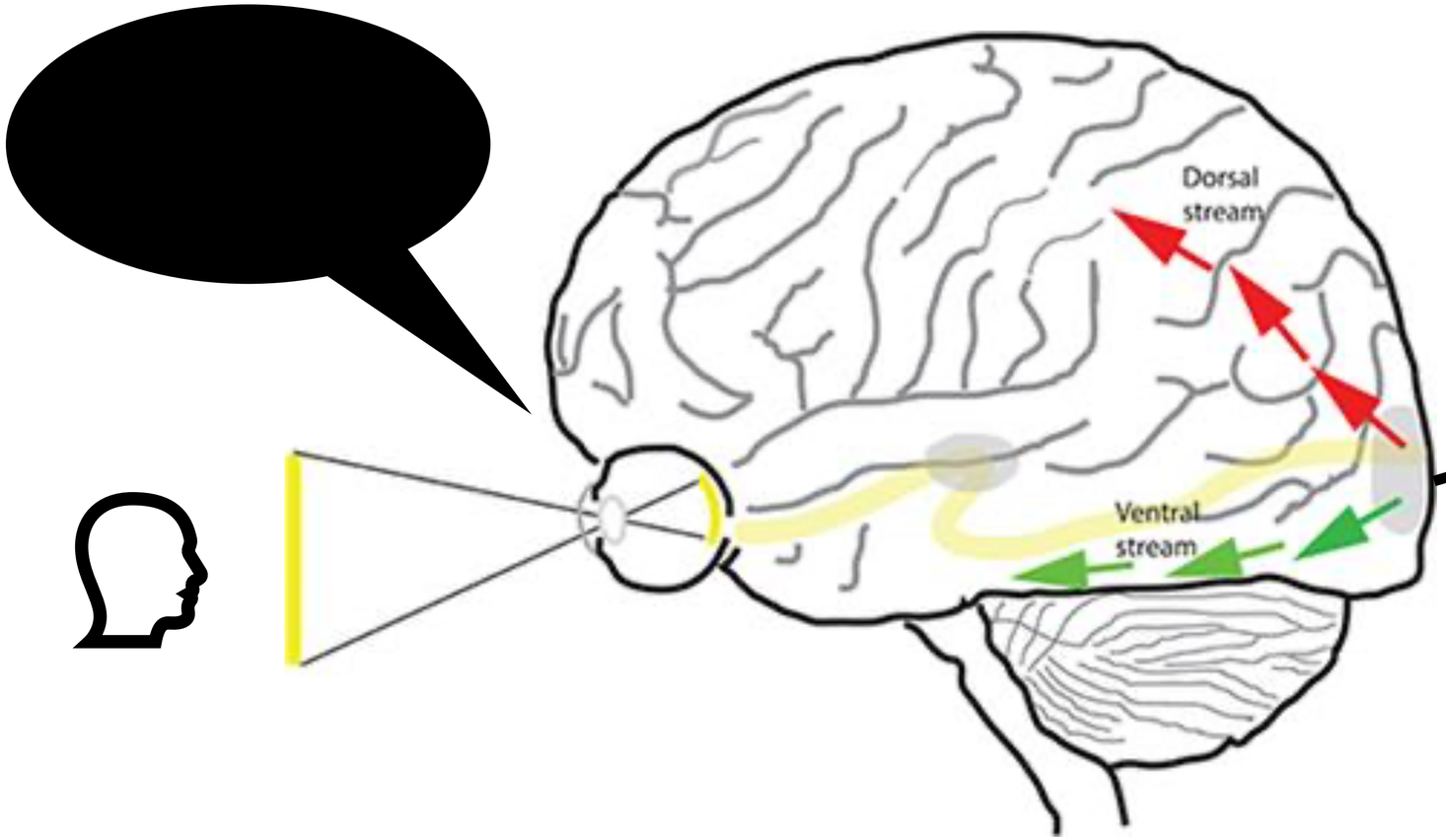

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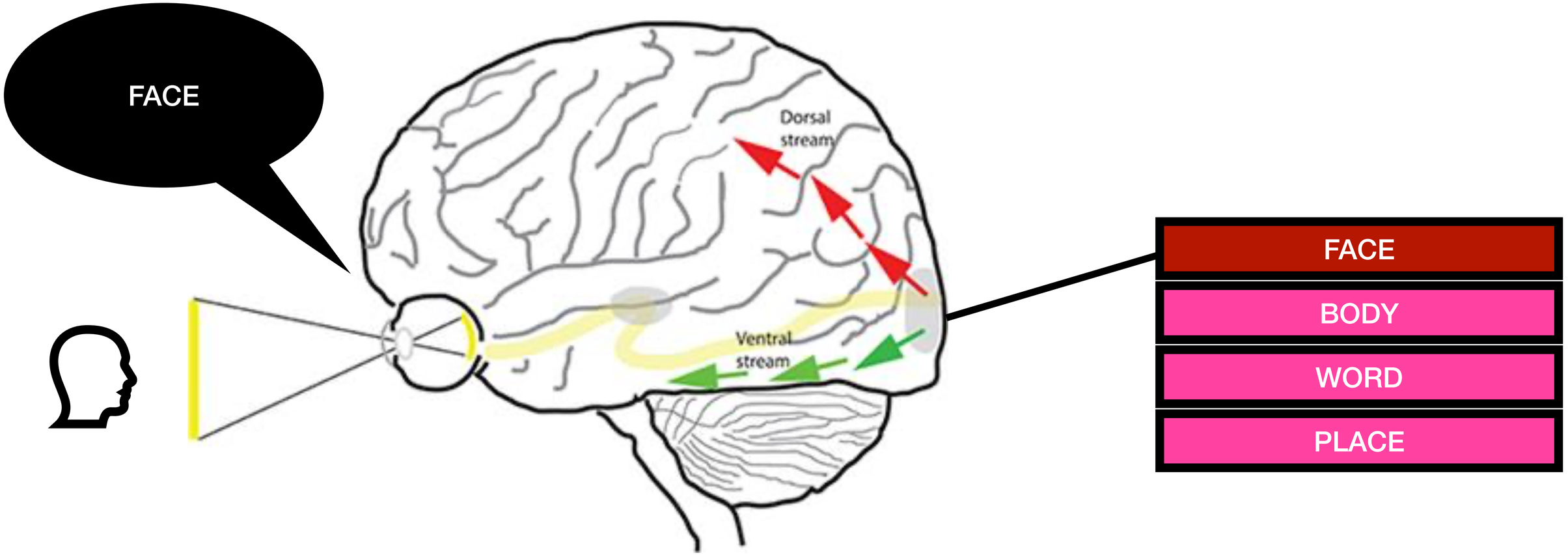

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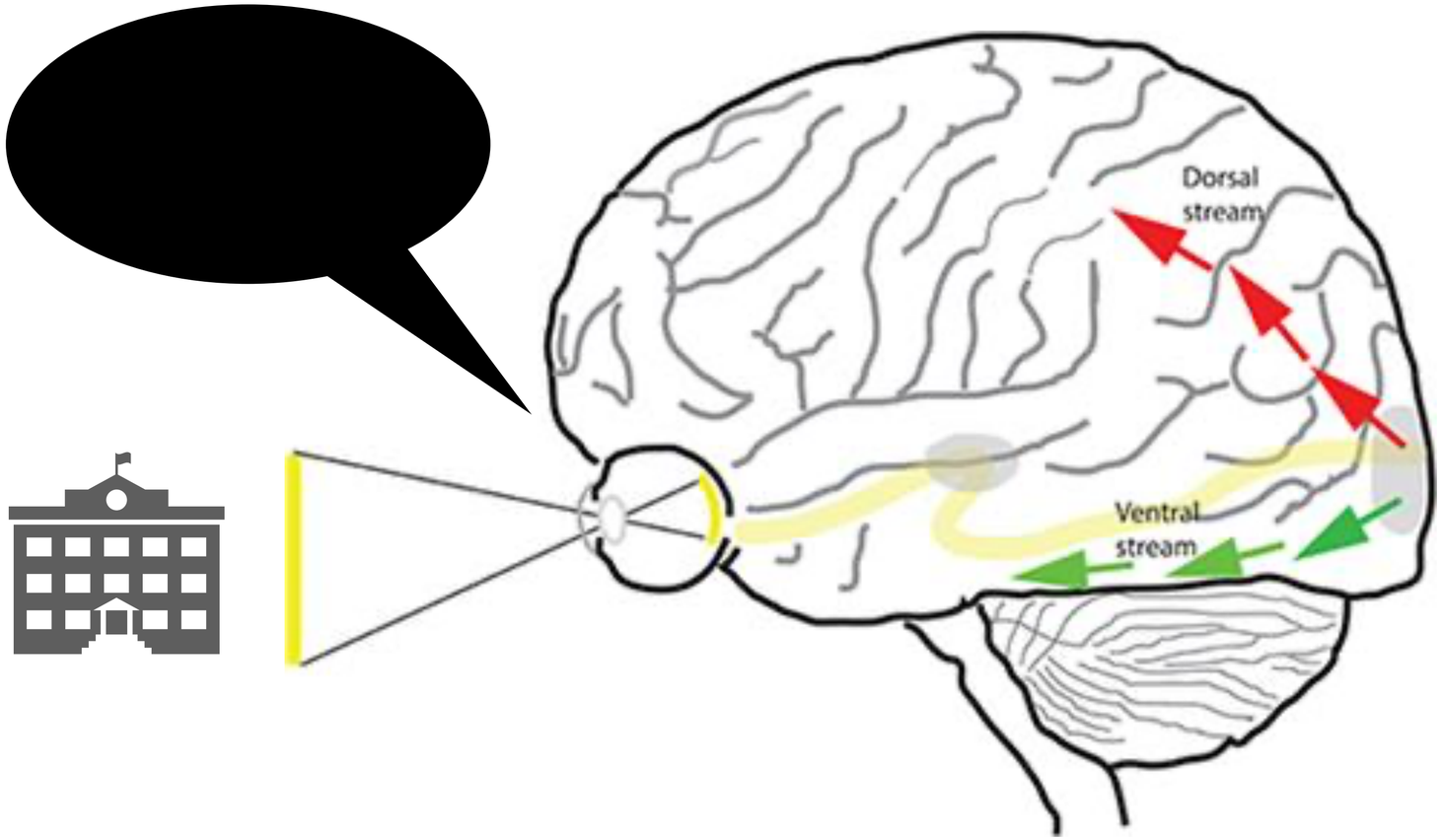

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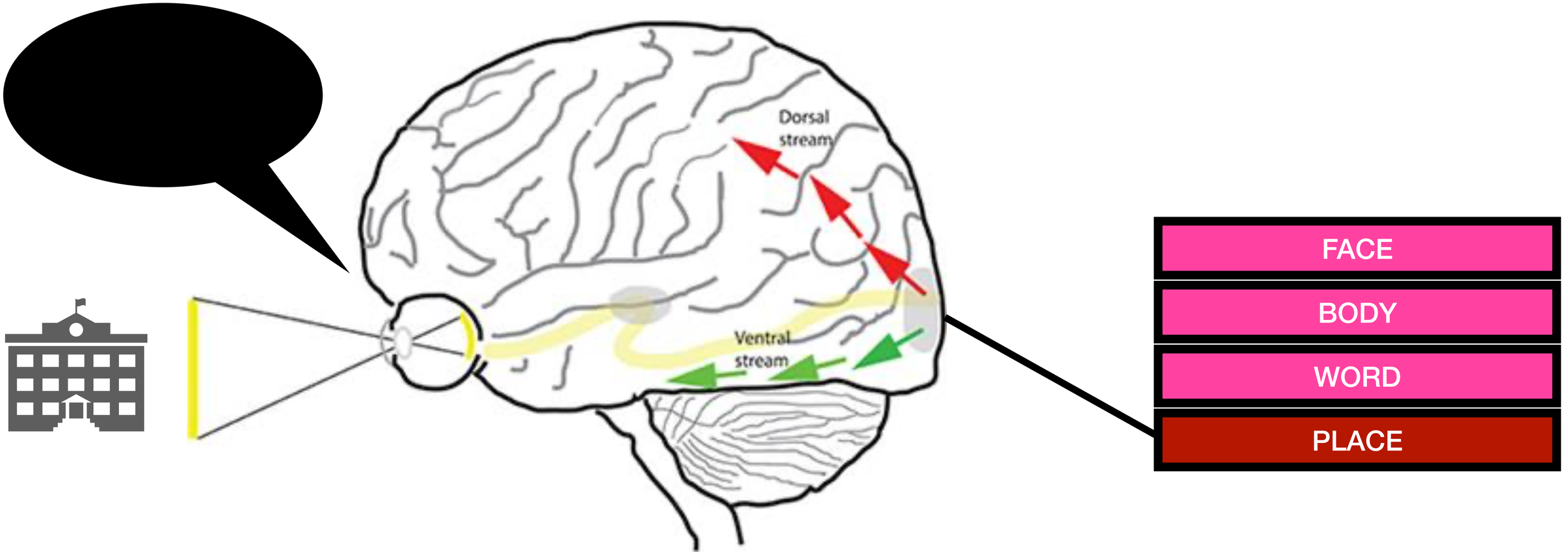

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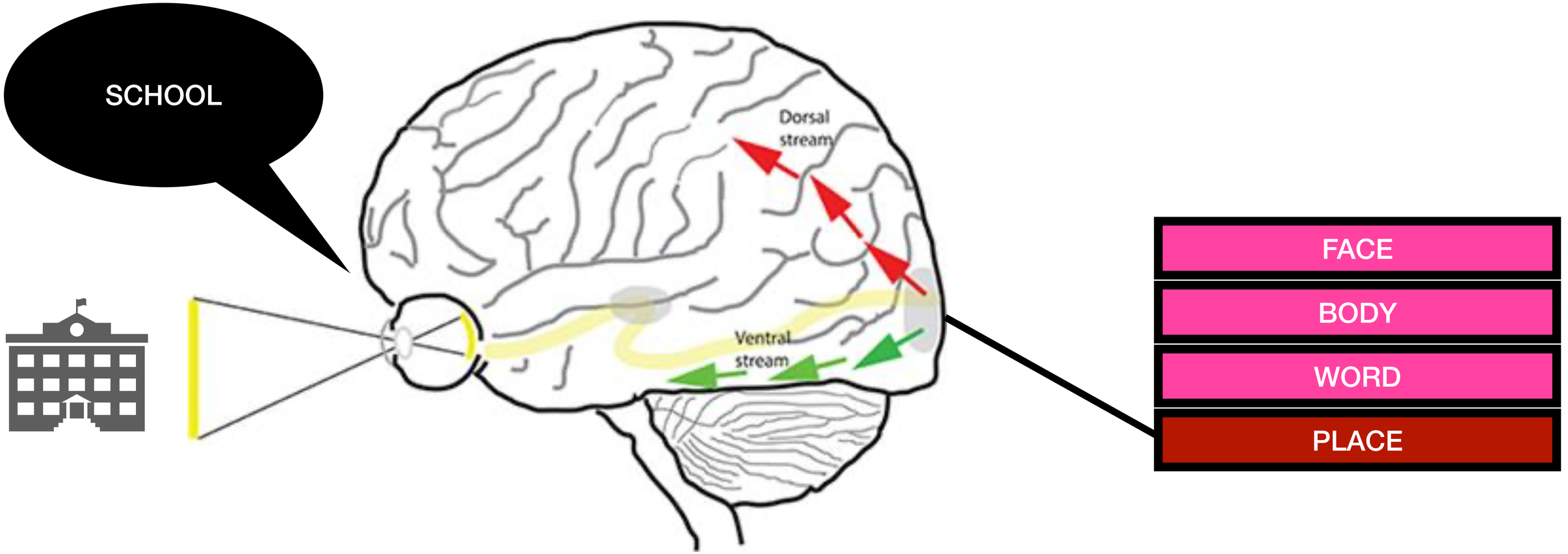

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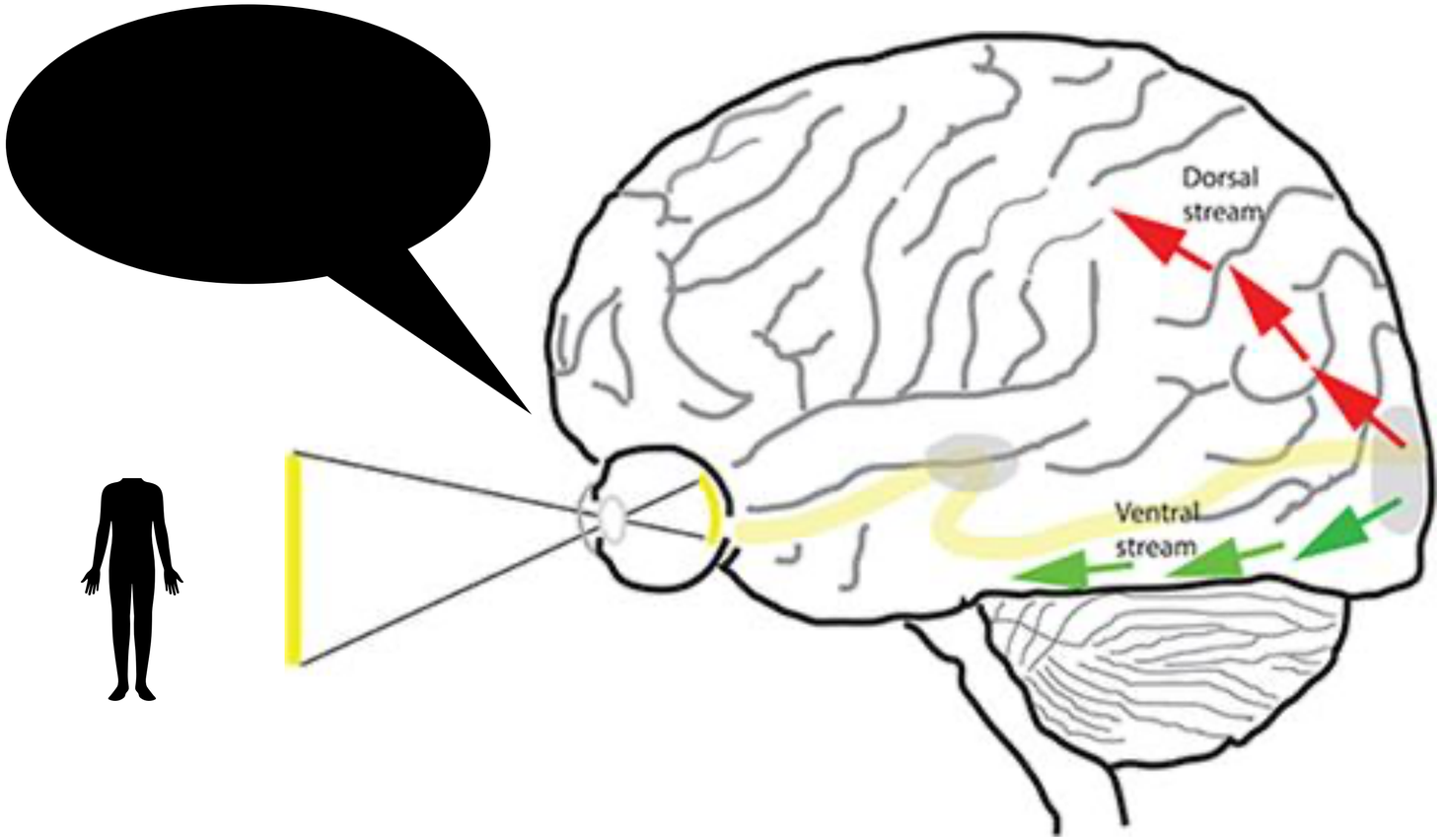

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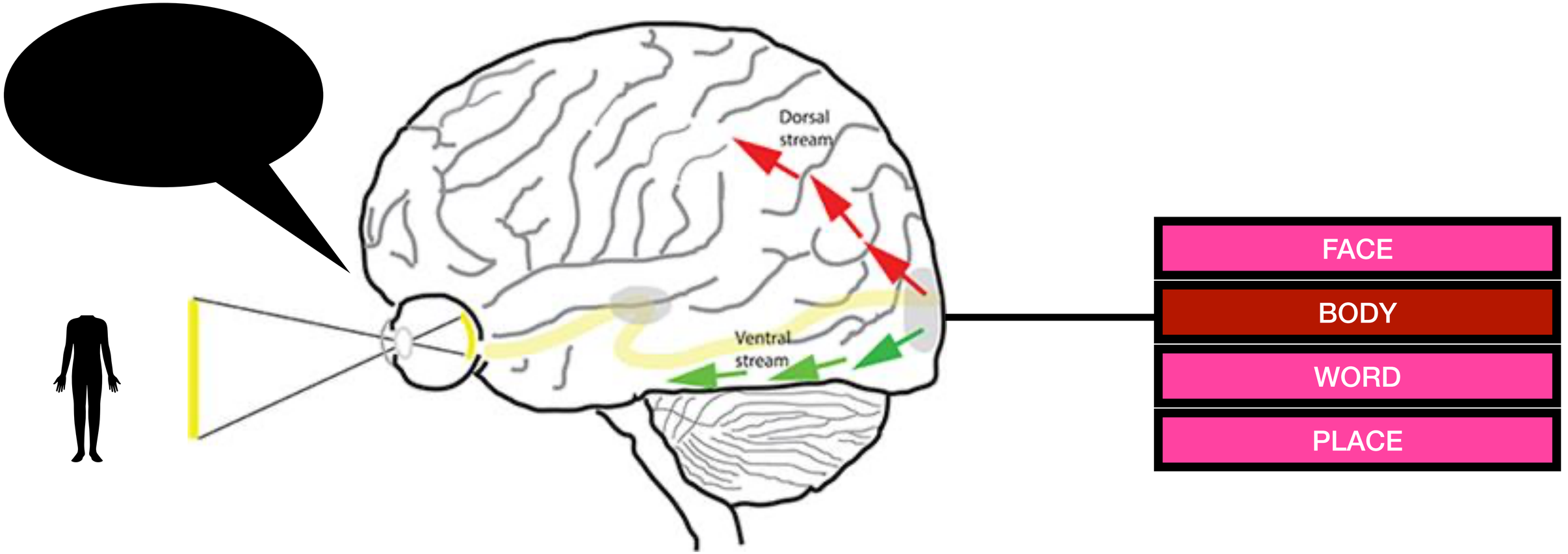

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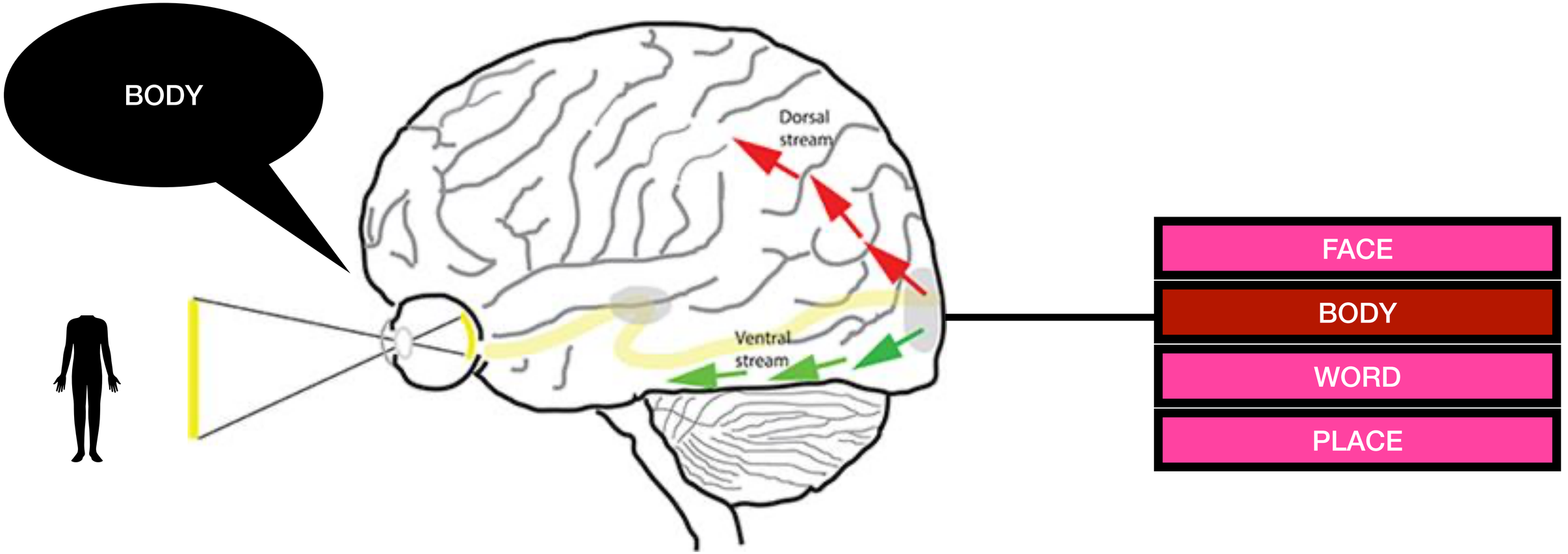


What experiences in childhood leads to the consistent spatial functional topography of the VTC? Is it the way we *see* images OR is it image-level details of the stimuli itself?

The Present Study

Questions they aim to address:

1

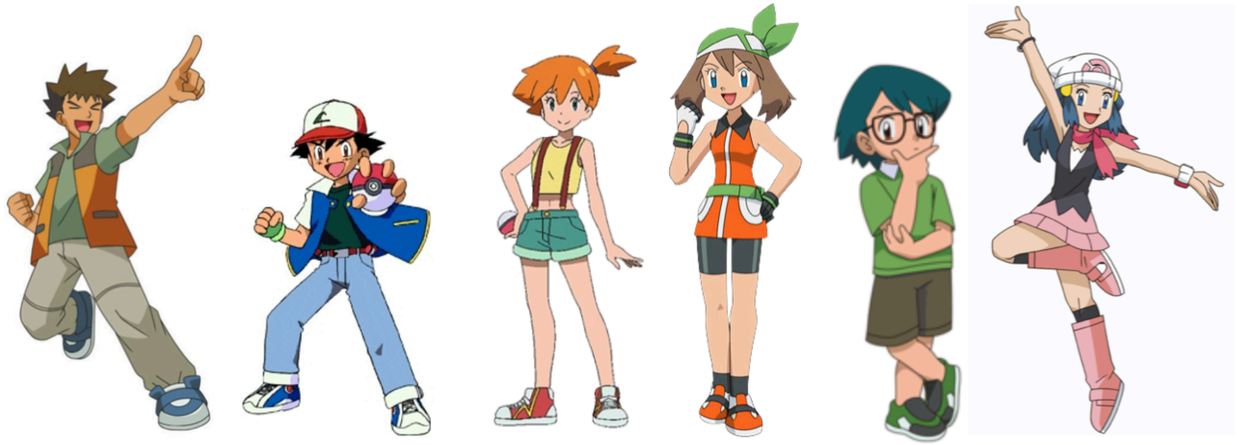
Does extensive experience with Pokemon from early childhood to adulthood result in novel representation in the visual cortex?

2

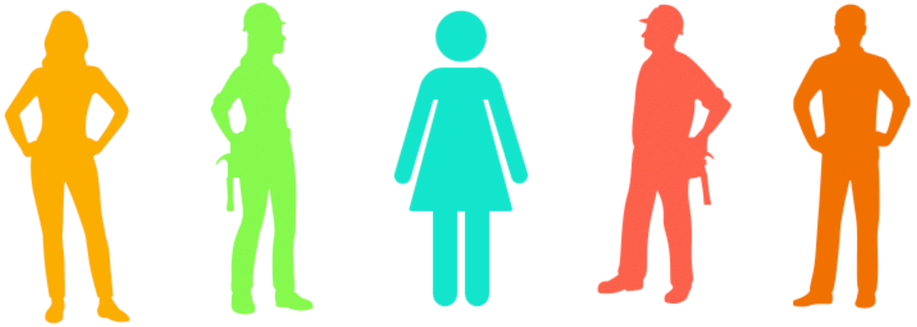
Does the features of Pokemon help us theorizes which features of visual stimuli drives the development and topographical organization in high-level visual cortex?

The Participants

11 Pokemon Masters!



11 Novices

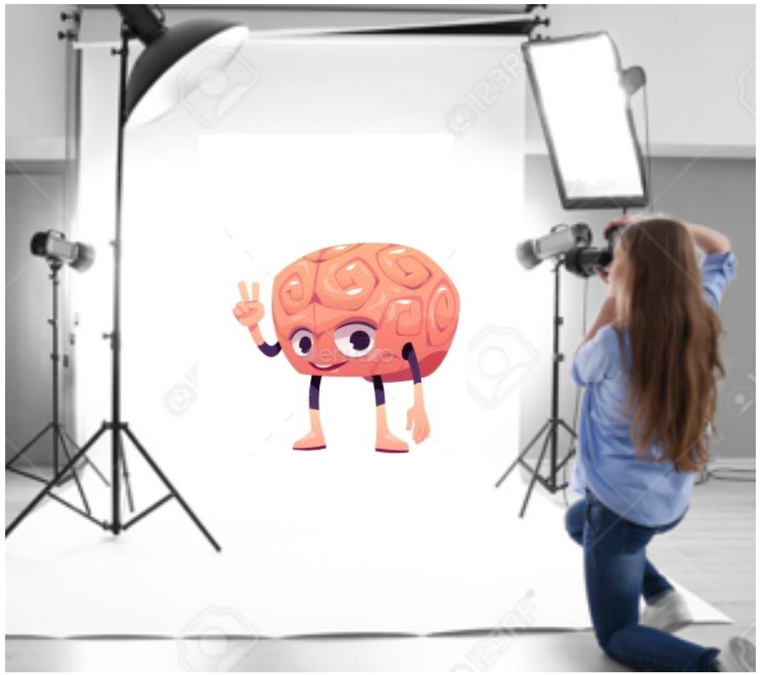


DISCUSSION QUESTION(S)!

How would you describe an "experienced" Pokemon participant? Is it the video game? Or is extensively watching of the cartoon show and/or card games a component to consider as well?

Experimental Design

Participants → MRI Scanner → Extract images!



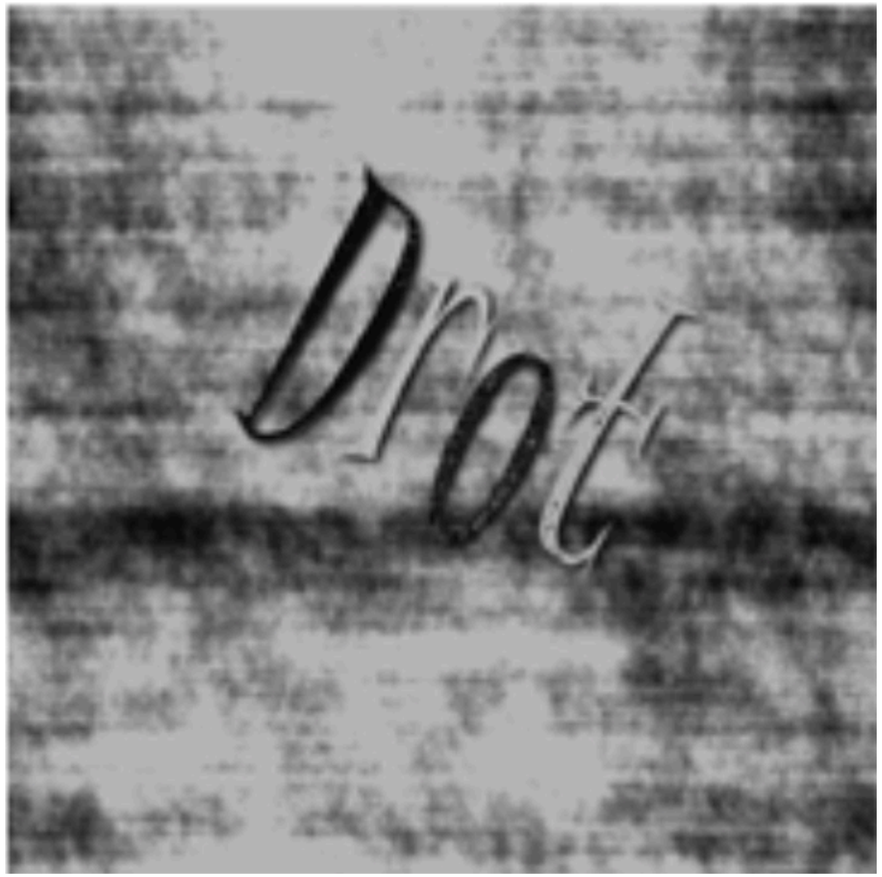
POKEMON

CARTOON

ANIMAL

FACE

BODY



WORD

CAR

CORRIDOR

Potential Outcomes: What could they see?

1

Null Hypothesis: Pokemon will not elicit a consistent response pattern in the VTC in any group and will not correlate with any other category

2

Animate Hypothesis: Pokemon will correlate with animals, faces, and bodies since they bear some resemblance to these categories

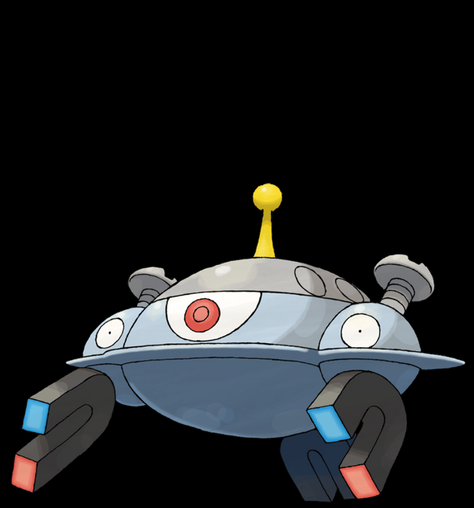
3

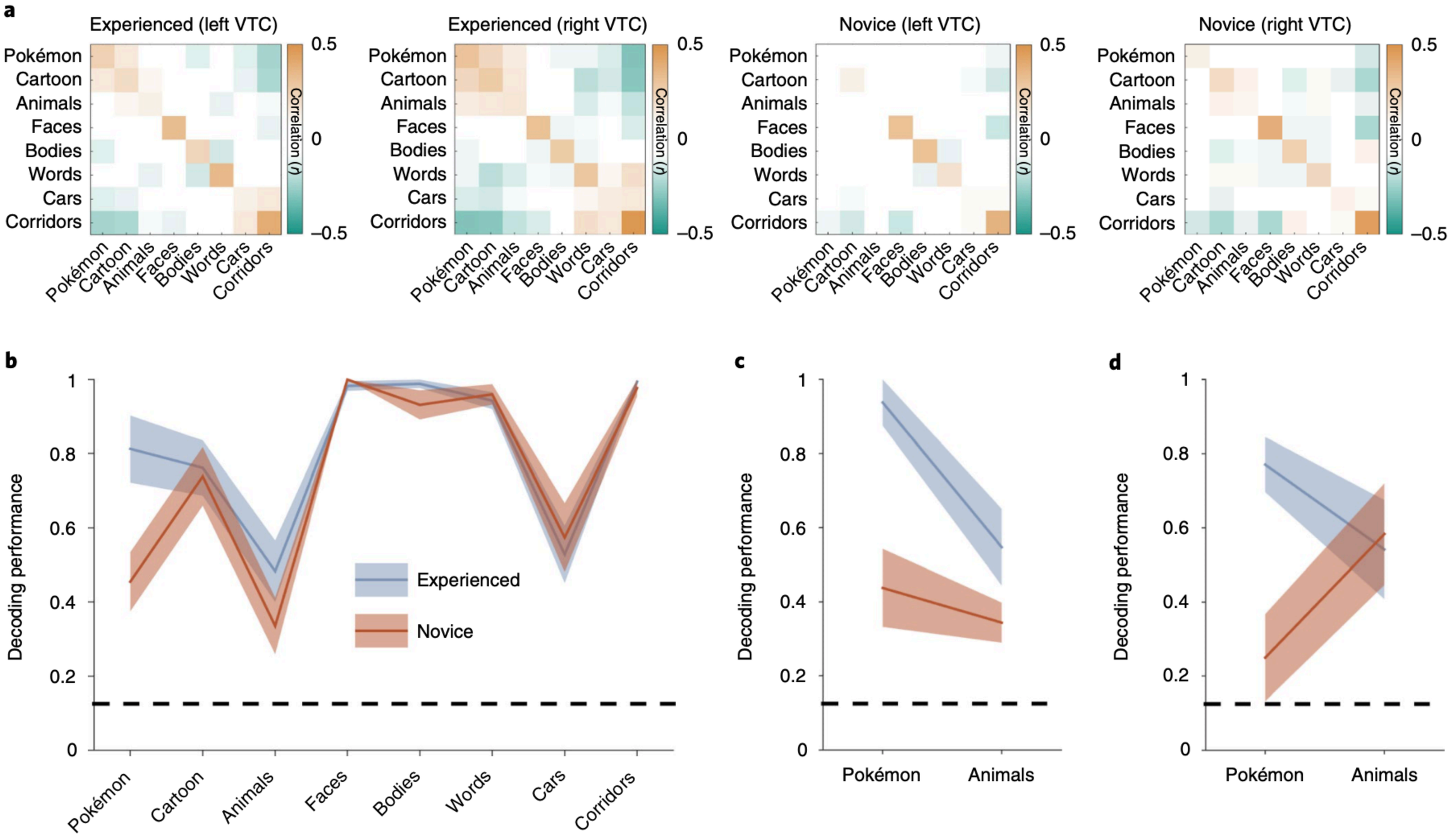
Expertise Hypothesis: Stimuli someone acquires expertise on will be processed in face-selective regions (re: Greeble study)

4

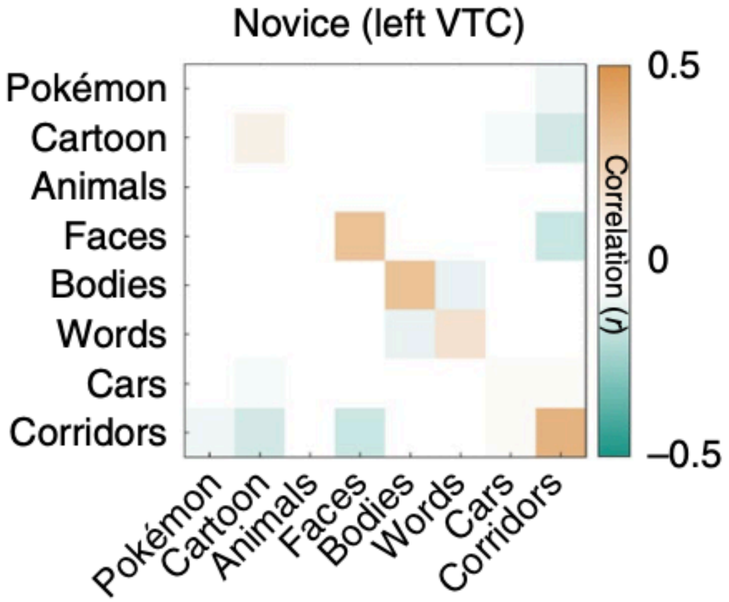
Distinctiveness Hypothesis: Pokemon constitute their own category and will elicit a unique response pattern

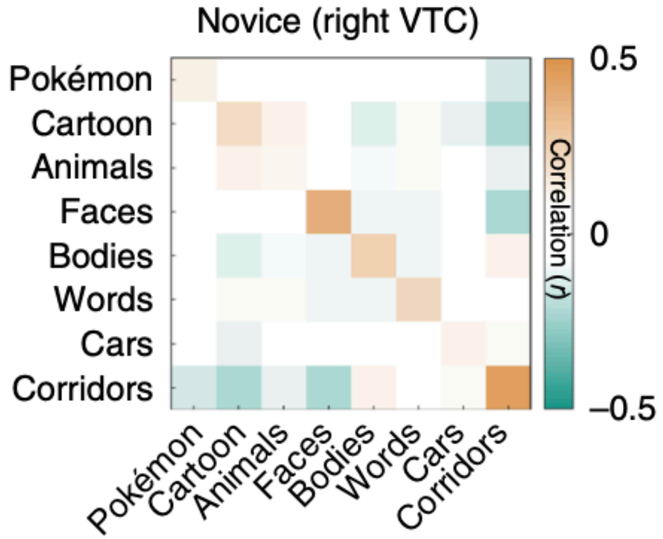
Results




a
Experienced (left VTC)
Experienced (right VTC)
Novice (left VTC)
Novice (right VTC)
Pokémon
Cartoon
Animals
Faces
Bodies
Words
Cars
Corridors
Correlation (r)
0.5
0
−0.5
b
Decoding performance
Experienced
Novice
c
d
Pokémon
Animals

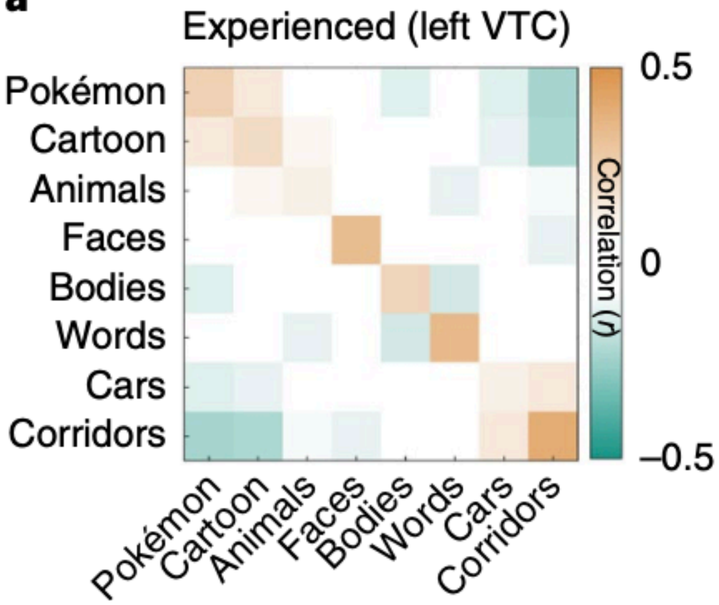
Pokemon Novices

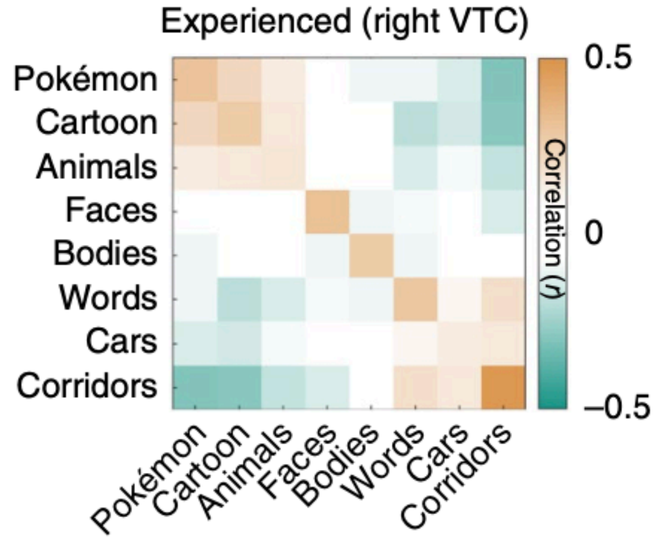




Pokemon Experts

a





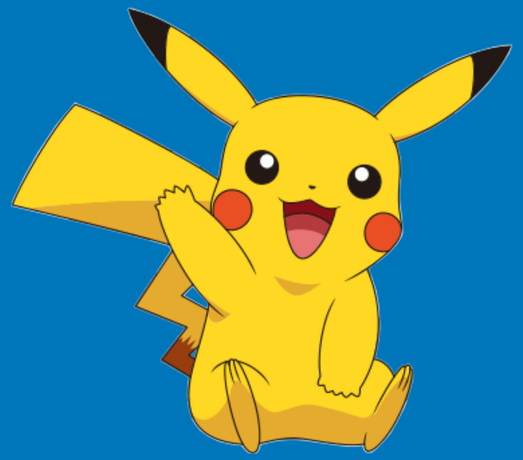
~~Null Hyp… Pok… …t elicit a consiste… …ttern in the VTC i… …p and t… …elate… …with any other categor…~~

~~An… …thesis… …will correlate … …aces, and h… …they … …blance to these cate…~~

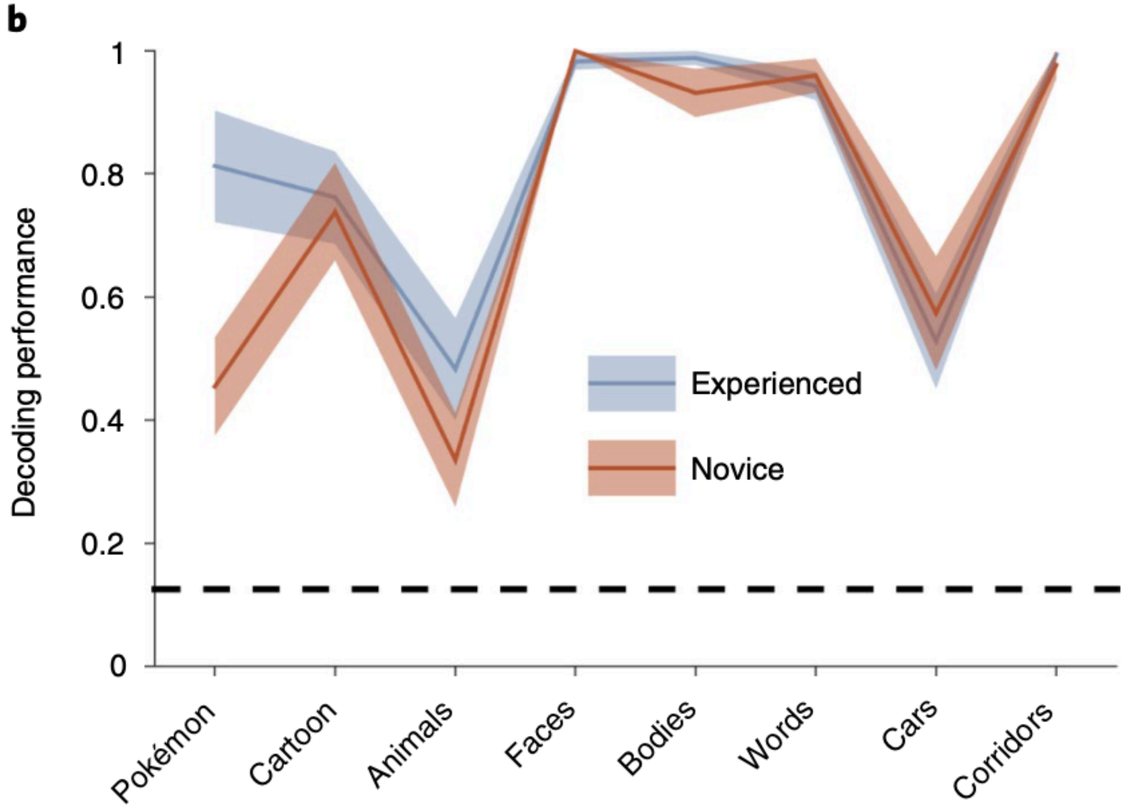
~~Expe… …thesis: S… …cone acquires exp… …e processed in fac… …reg… …eeble study)~~

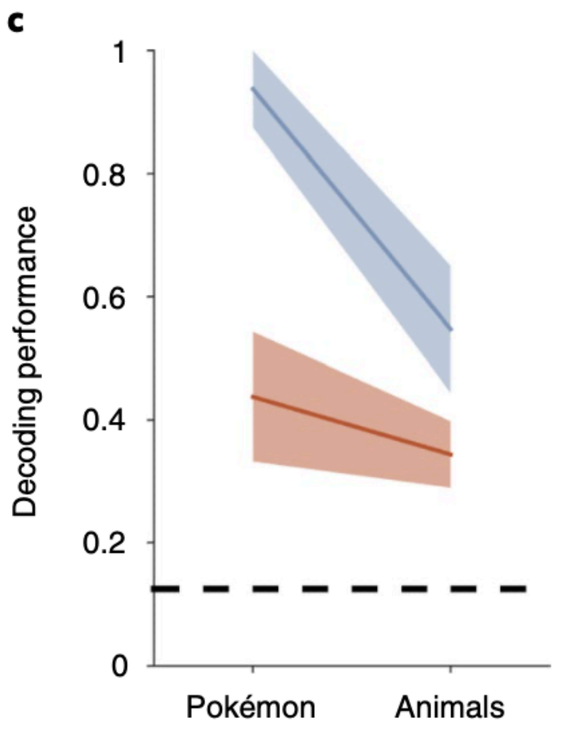
Distinctiveness Hypothesis: Pokemon constitute their own category and will elicit a unique response pattern

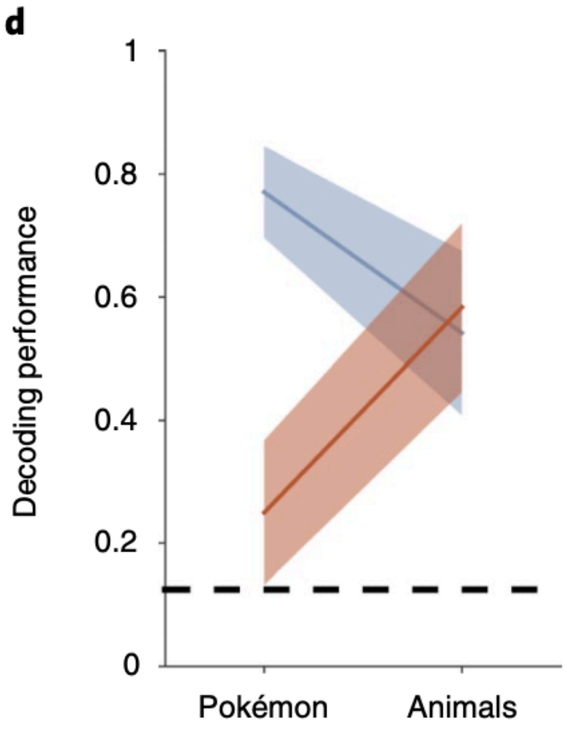
Distinctiveness hypothesis supported! Pokemon elicit their own unique response in experienced participants!



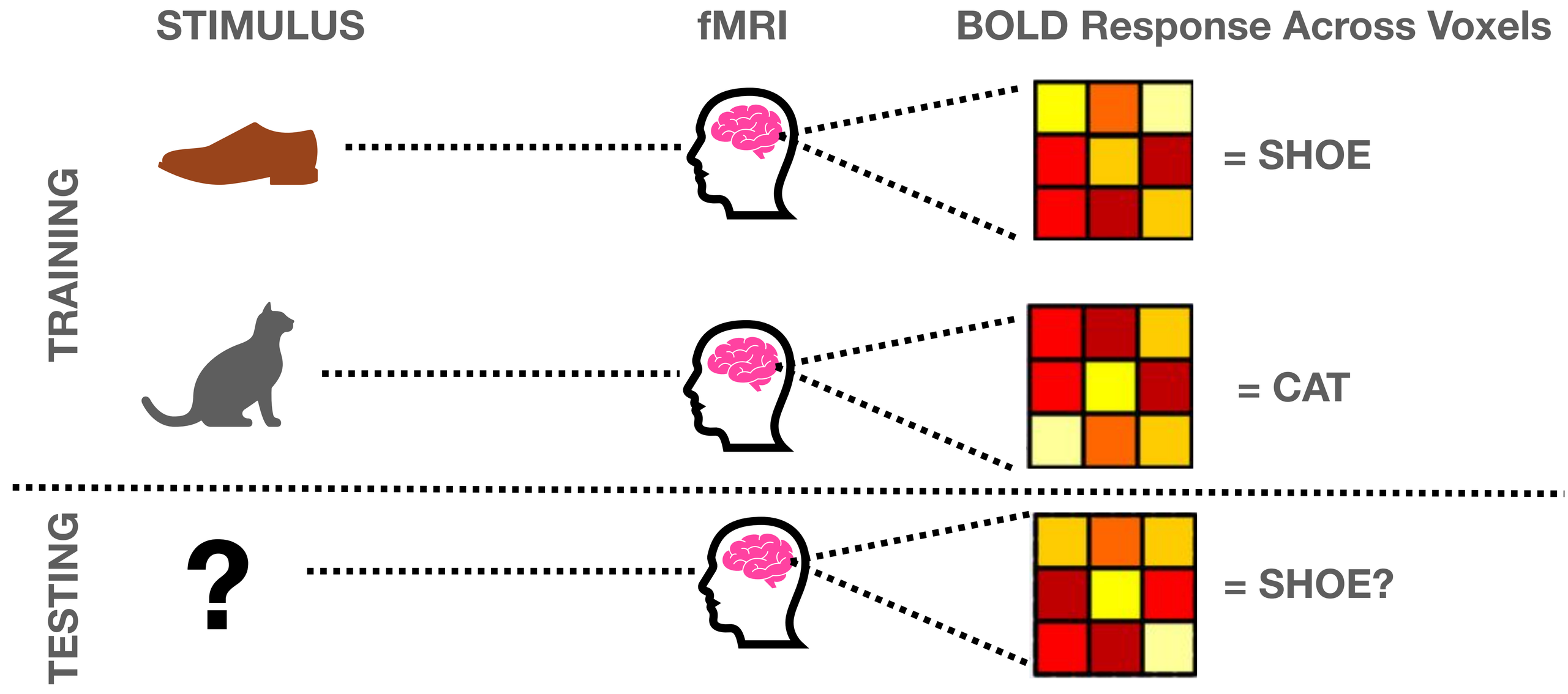
What does this figure mean?







What does neural decoding mean?



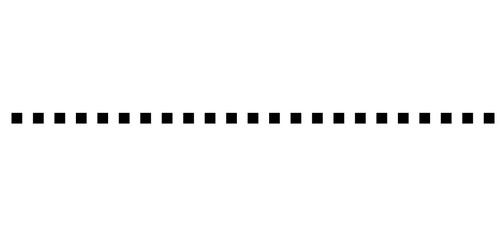
Can you decode Pokemon stimuli?

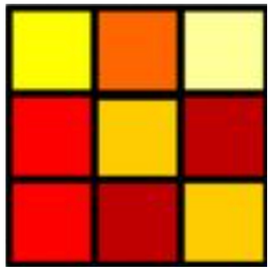
STIMULUS

fMRI

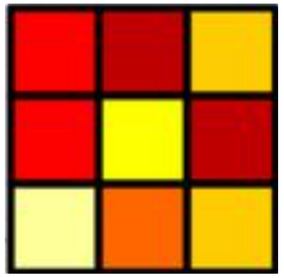
BOLD Response Across Voxels

EXPERIENCE



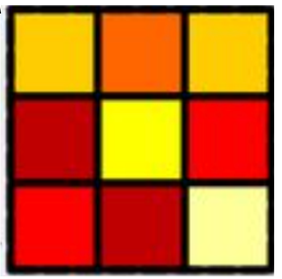


= POKEMON



= ANIMAL

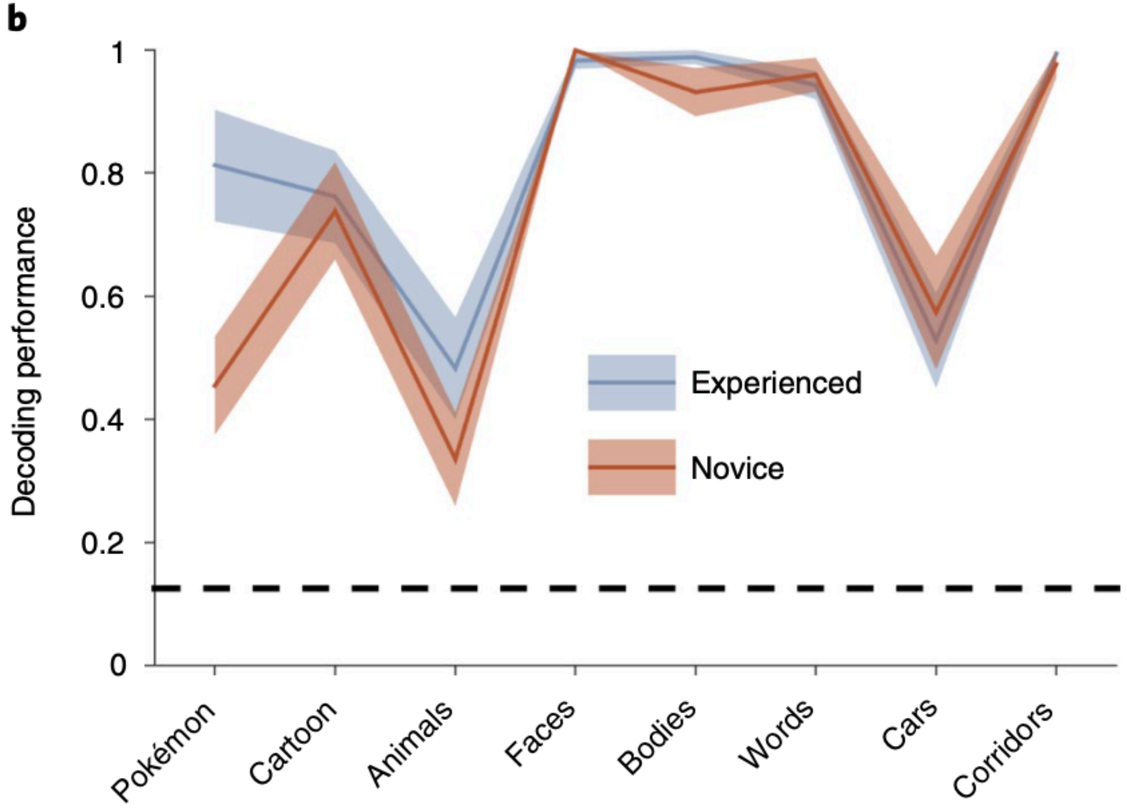
TESTING



= POKEMON?

Figure 2 — Decoding Performance

The decoder is able to accurately detect stimuli based on voxel patterns from the participants!



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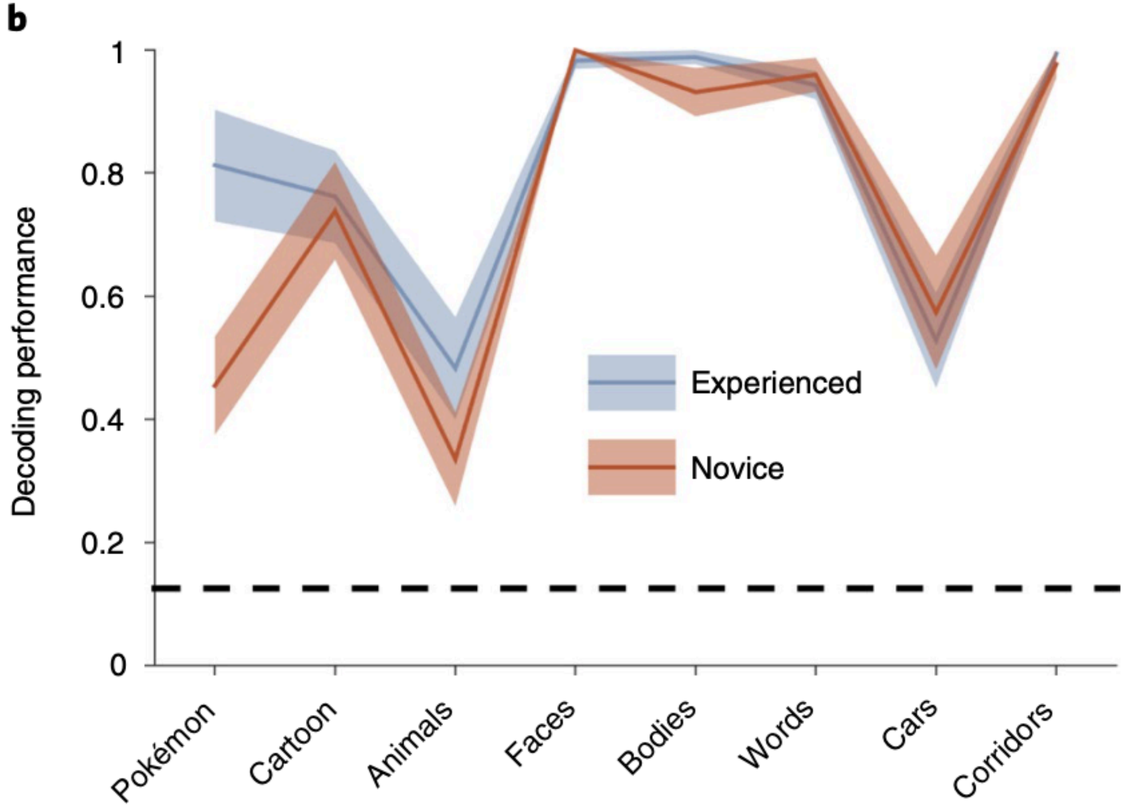
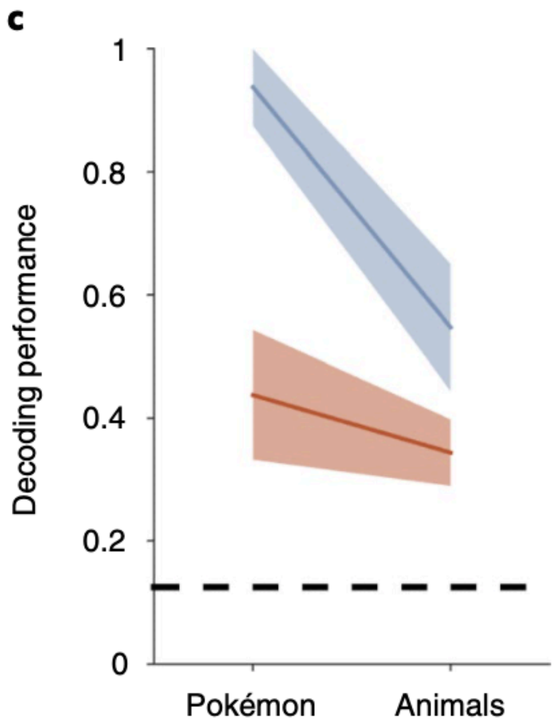
No significant differences between higher performances





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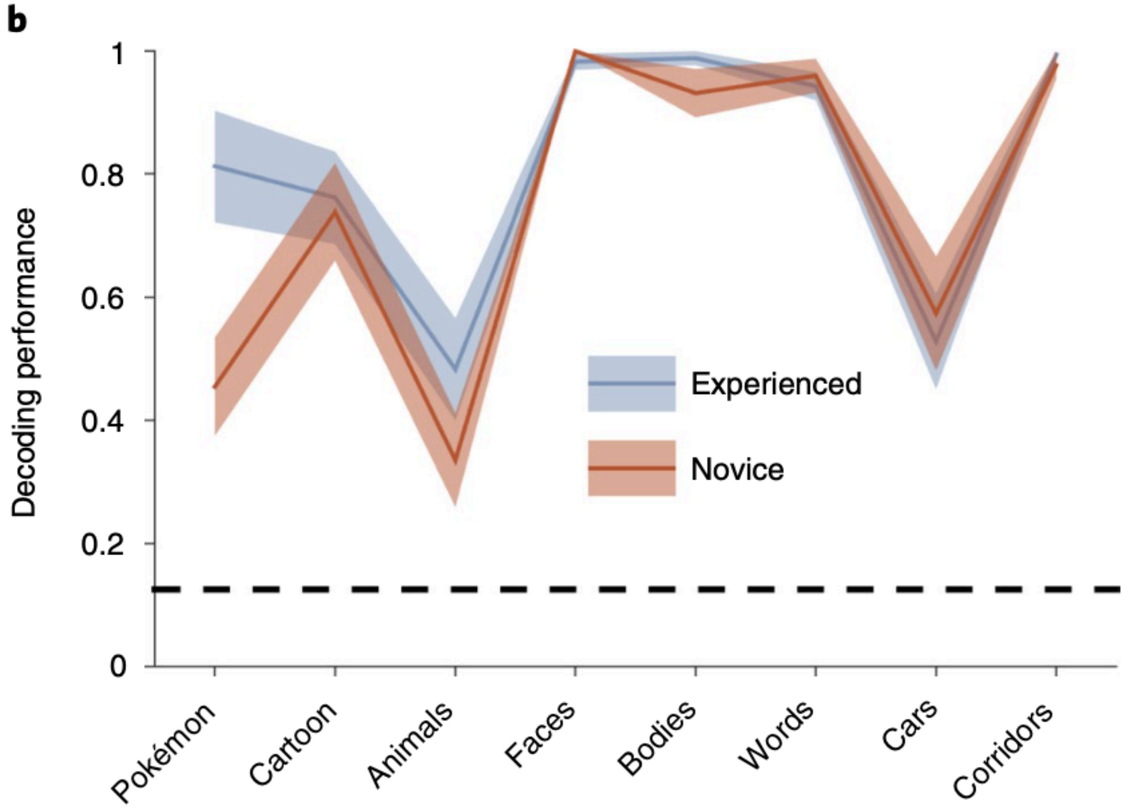
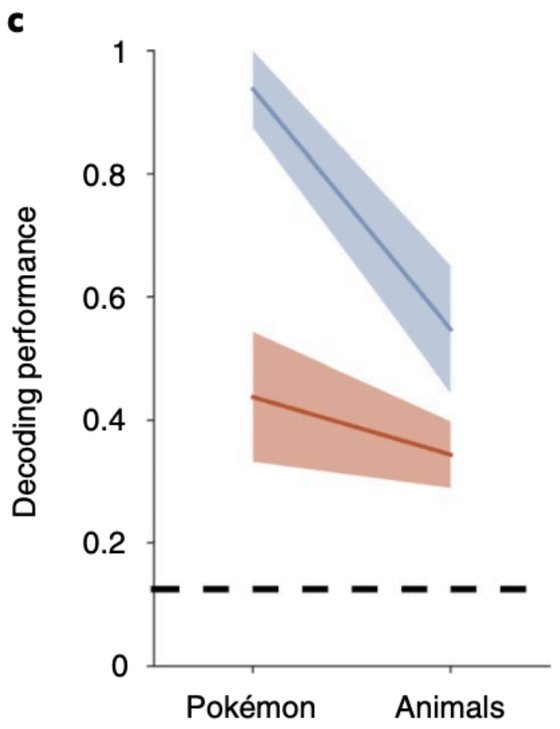
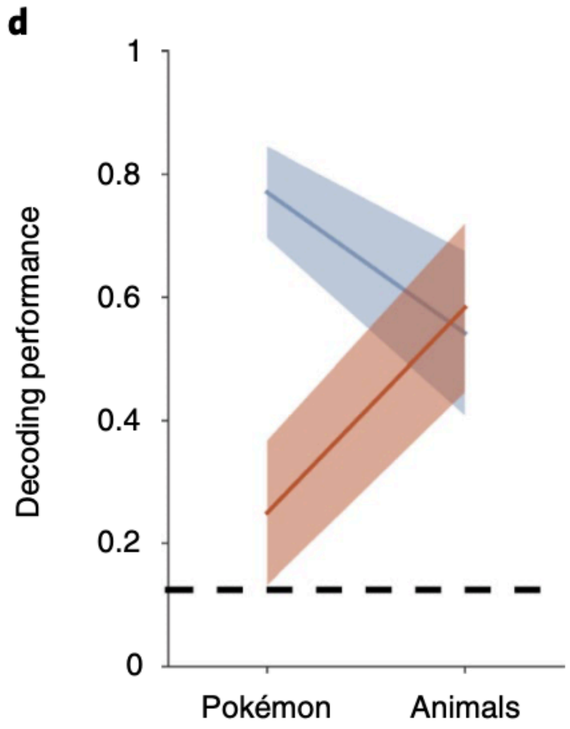






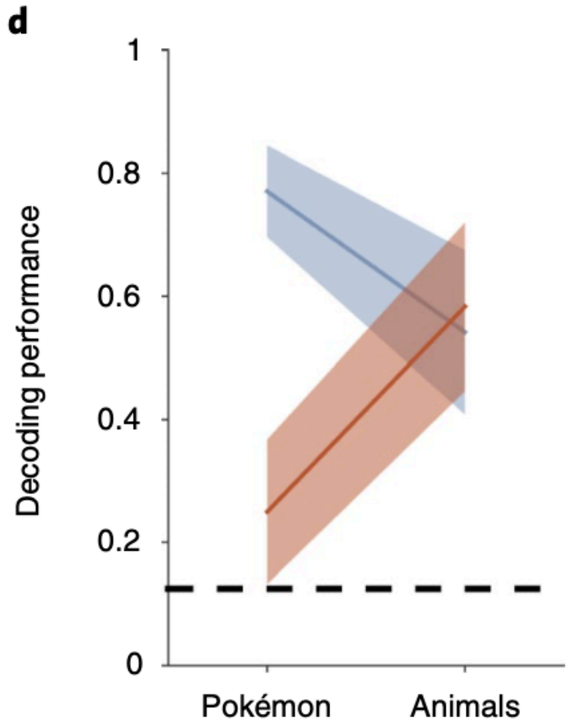
Is attention driving results?

Is it possible that the boost in the pattern of results found merely be a result of attention?

Argued that attention can boost signals to the category of expertise (Harel et al., 2010)

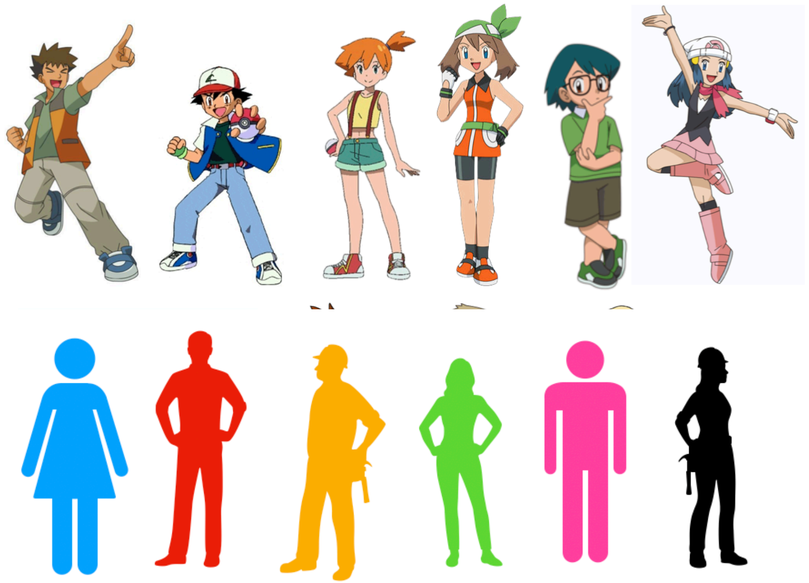
Replicate study — but with a more demanding attention task as well.

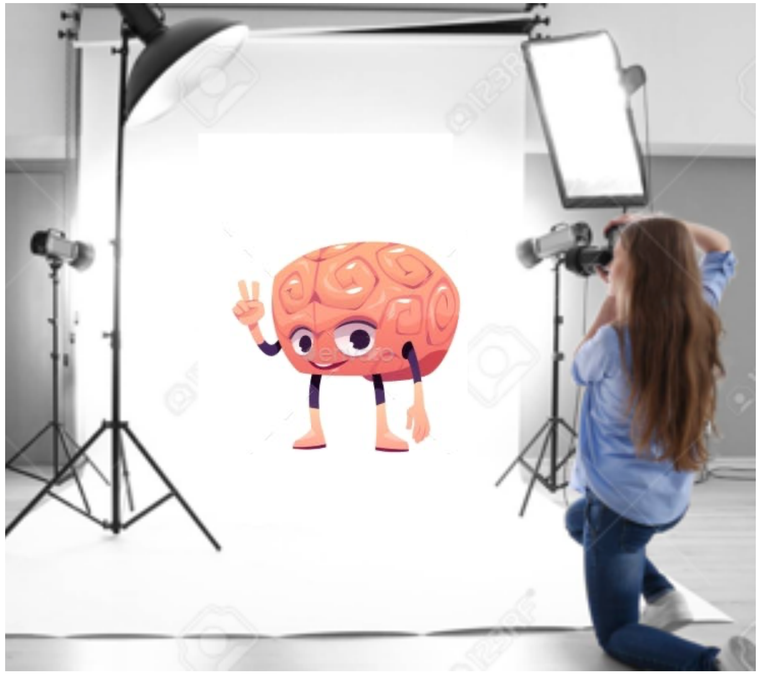
So what's going on here?



Experimental Design #2

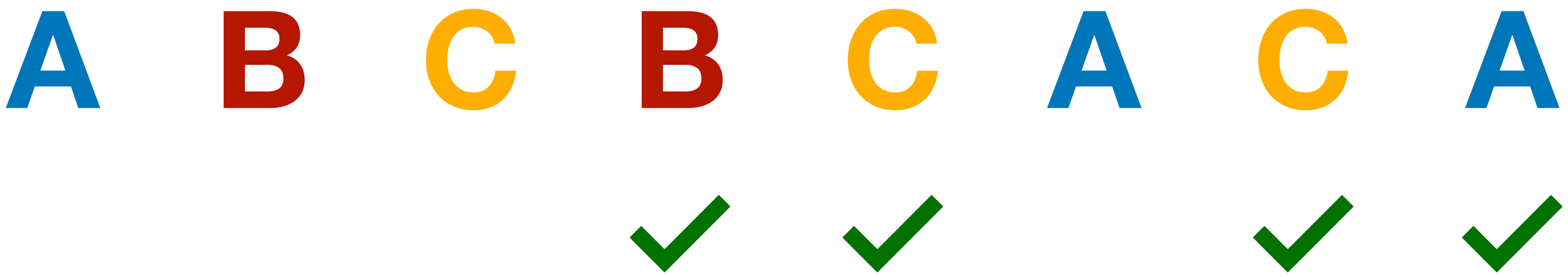
Participants → MRI Scanner → Extract images!





Experimental Design #2

In this task, participants need to determine whether the same image was sandwiched between another image



POKEMON

CARTOON

ANIMAL

POKEMON

ANIMAL

FACE

Is attention driving results? — NO!

Is it possible that the boost in the pattern of results found merely be a result of attention?

Argued that attention can boost signals to the category of expertise (Harel et al., 2010)

Replicate study — but with a more demanding attention task as well.

Attention is not driving results

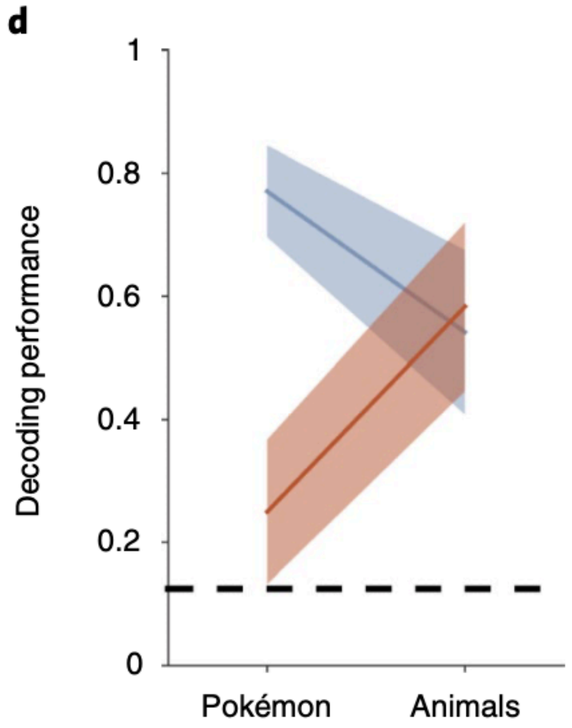
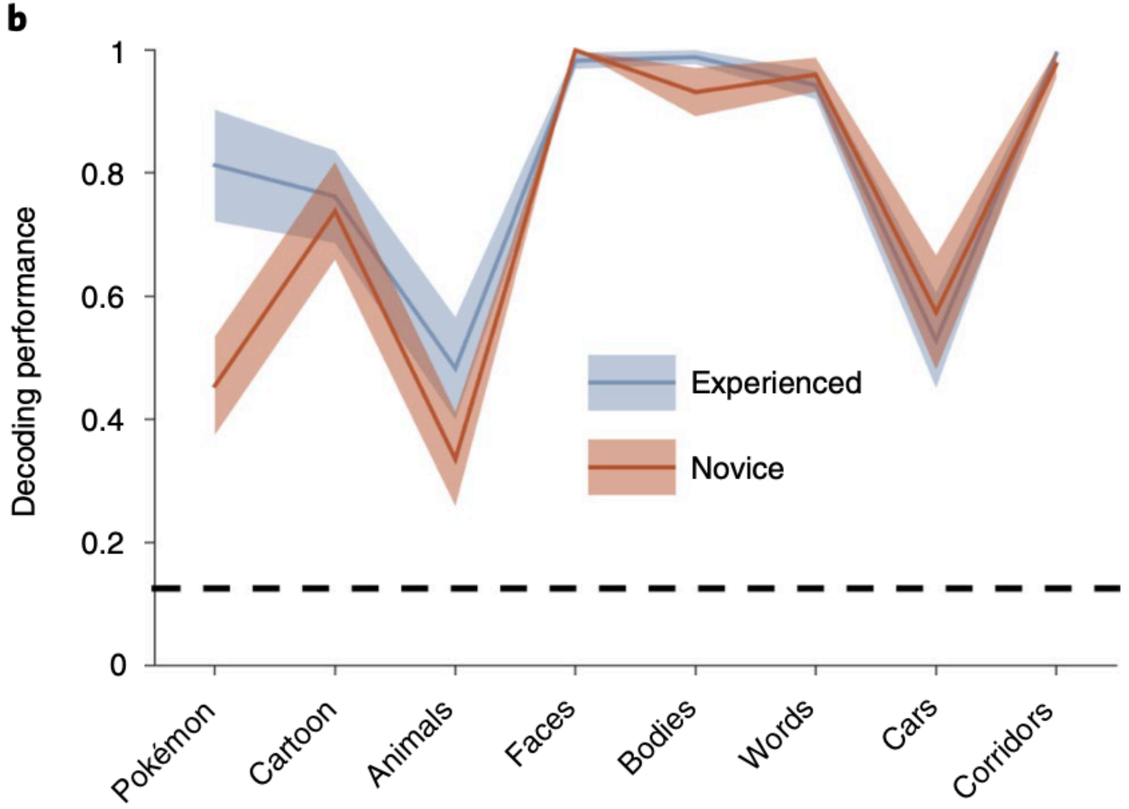


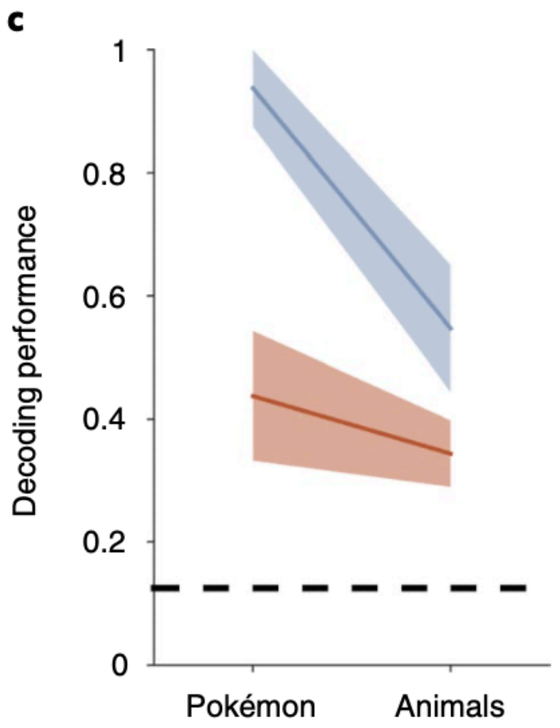
Figure 2 — Decoding Performance

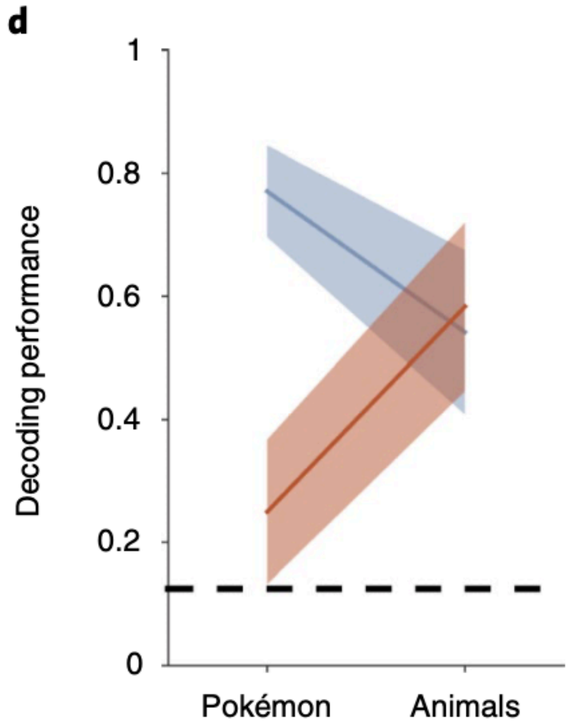
The decoder is able to accurately detect stimuli based on voxel patterns from the participants!

No significant differences between higher performances

Attention is not driving results





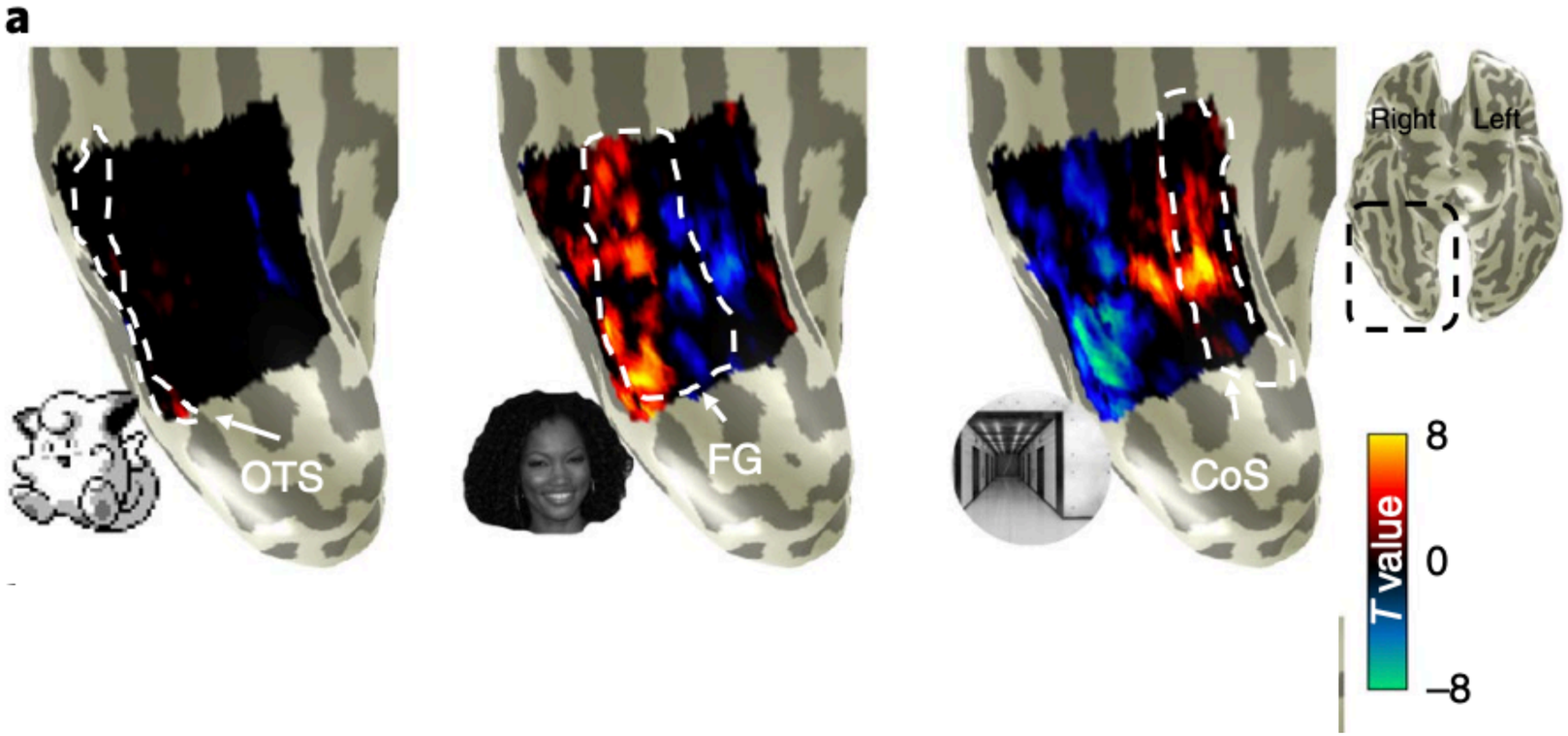


DISCUSSION QUESTION(S)!

Do you think there are other stimuli that could find similar results and add contextual information — like Yu-Gi-Oh!, for example? How would this help the purpose of this study?Would these have their own region or share space with Pokemon?

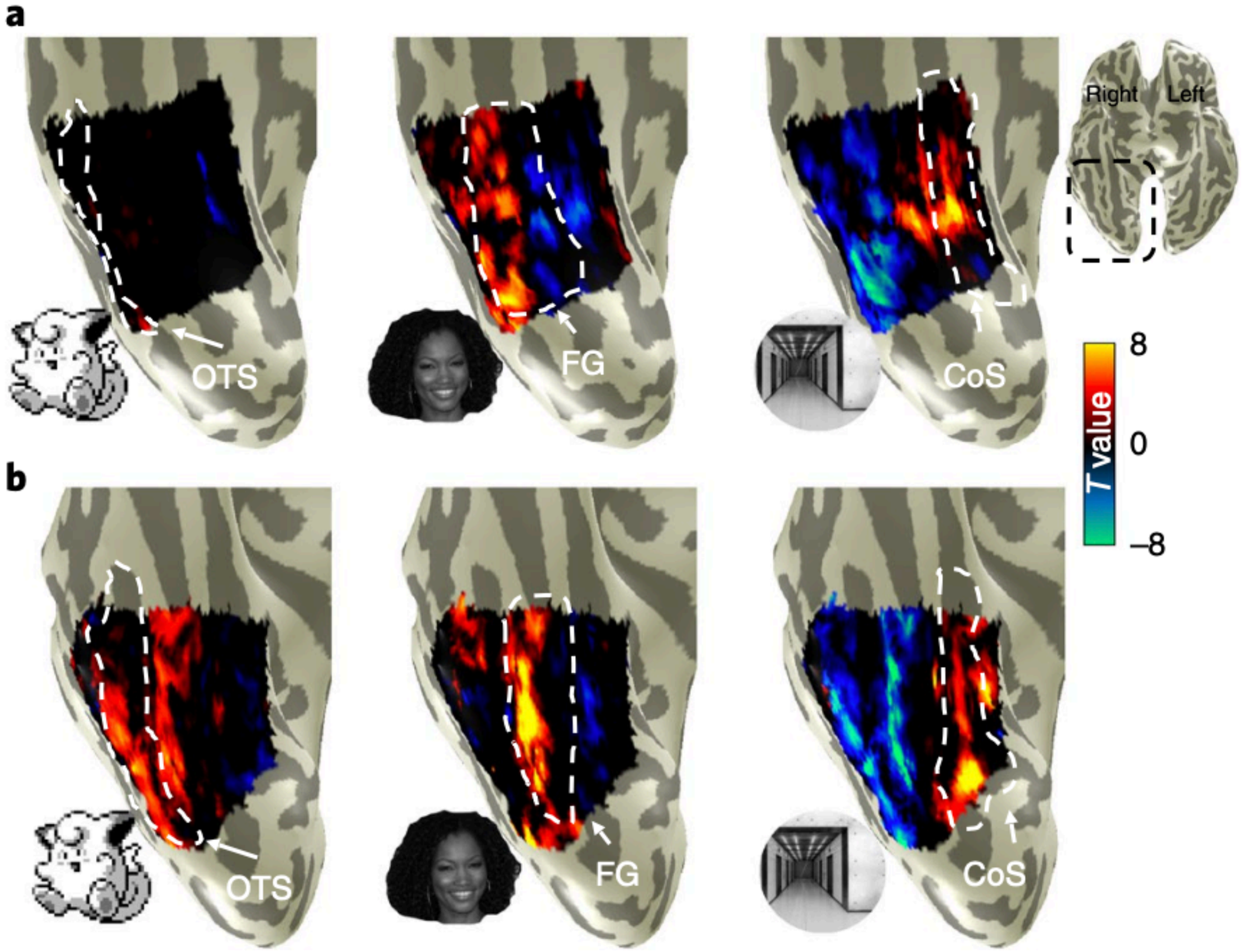
Does Pokemon generate distributed response patterns with similar topographies across experienced participants?

Pokemon Novices



Pokemon Novices

Pokemon Experts



Questions they aim to address:

1

Does extensive experience with Pokemon from early childhood to adulthood result in novel representation in the visual cortex?

2

Does the features of Pokemon help us theorizes which features of visual stimuli drives the development and topographical organization in high-level visual cortex?

Given that Pokemon stimuli from childhood experience resulted in spatially consistent topographical representation across participants, what attributes of Pokemon *DRIVES* the topography?

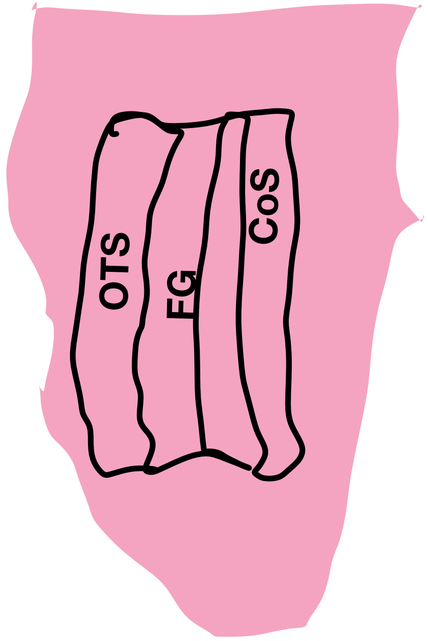
Attributes that affect topography in visual cortex

- Eccentricity
- Rectilinearity
- Perceptual Physical Size
- Perceived animacy

Attributes that affect topography in visual cortex

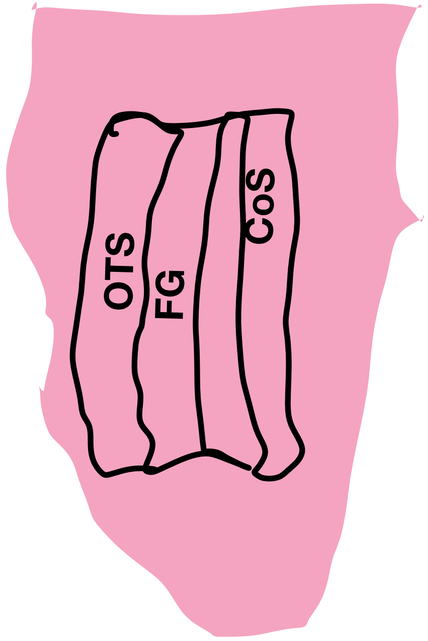
Eccentricity

L ⟷ M



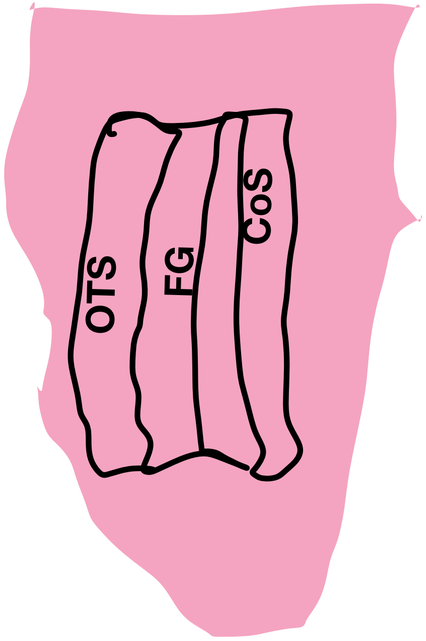
Rectilinearity

L ⟷ M



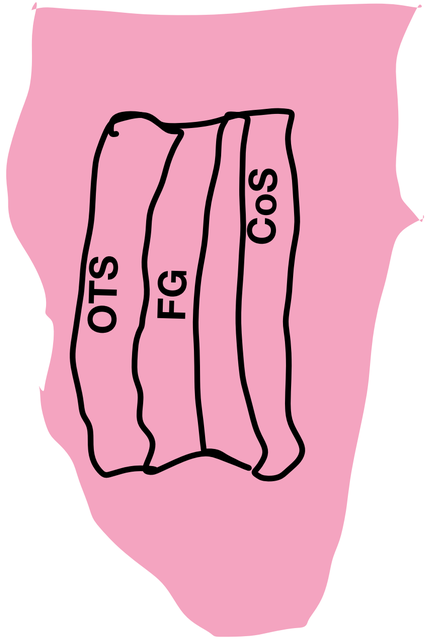
Perceptual Physical Size

L ⟷ M

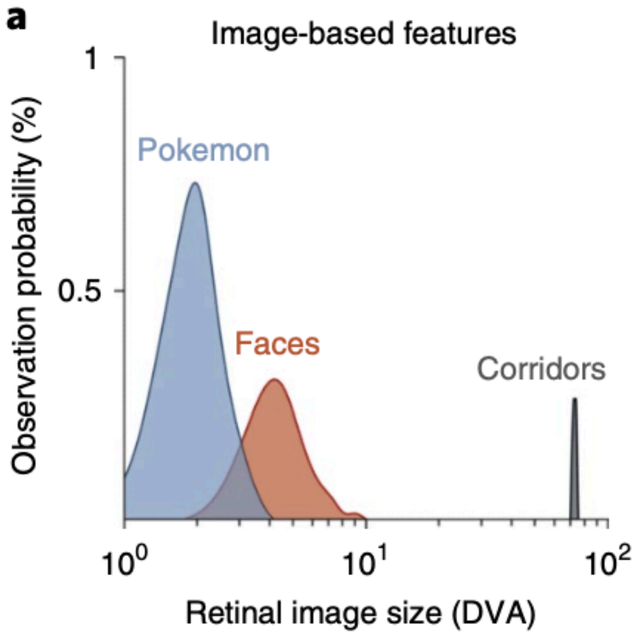


Perceived animacy

L ⟷ M



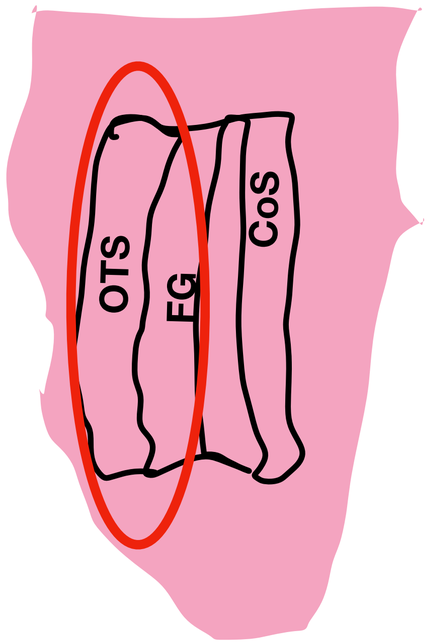
Retinal Image Size



Attributes that affect topography in visual cortex

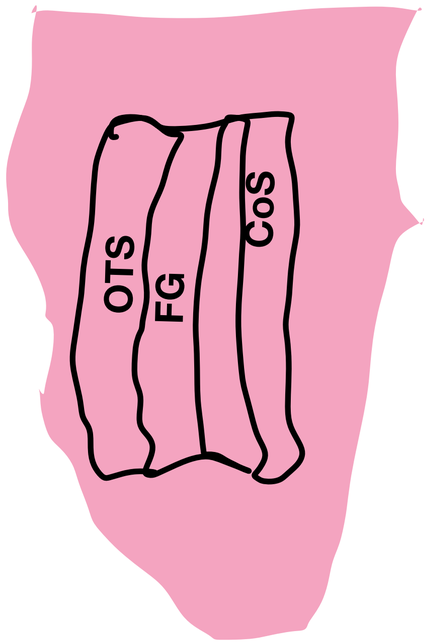
Eccentricity

L ⟷ M



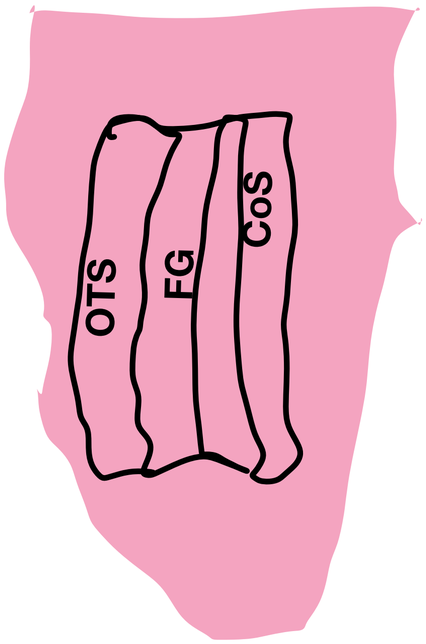
Rectilinearity

L ⟷ M



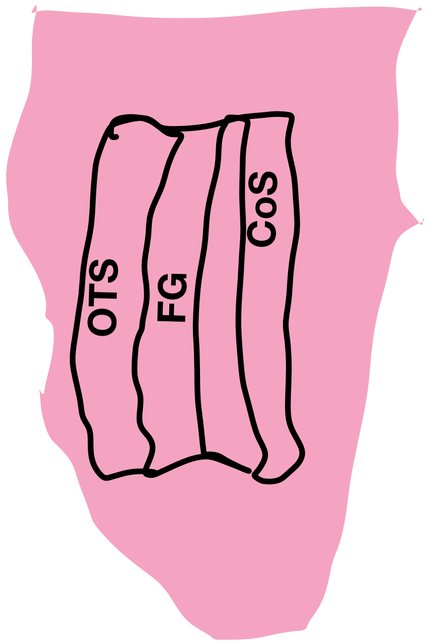
Perceptual Physical Size

L ⟷ M



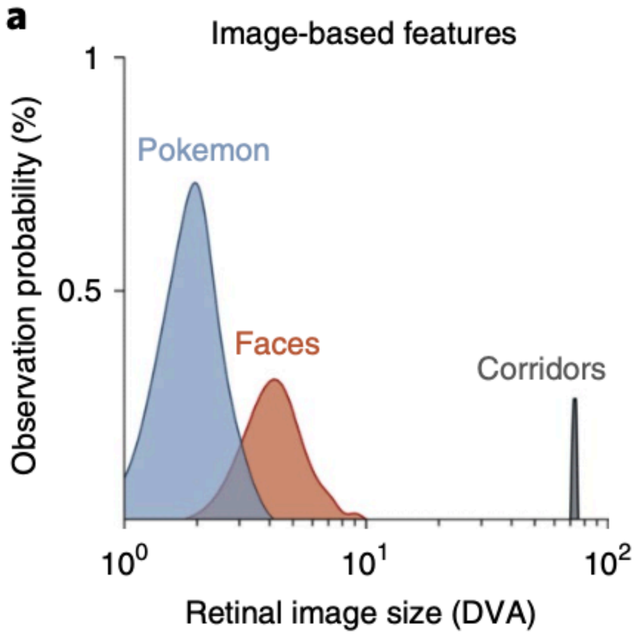
Perceived animacy

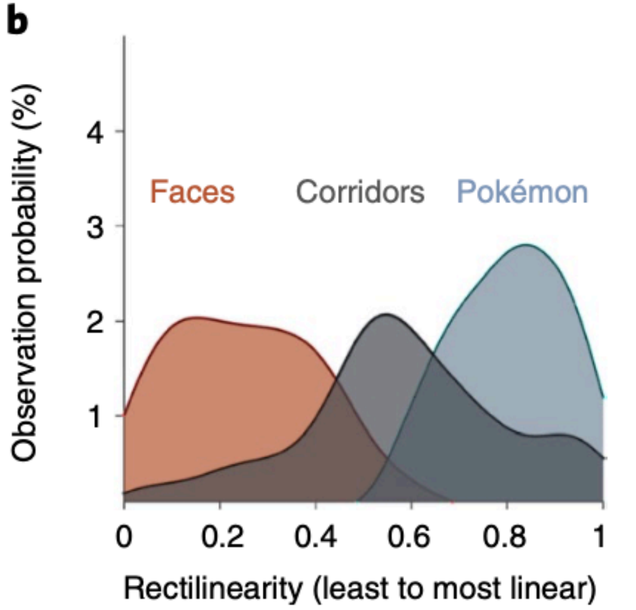
L ⟷ M



Retinal Image Size

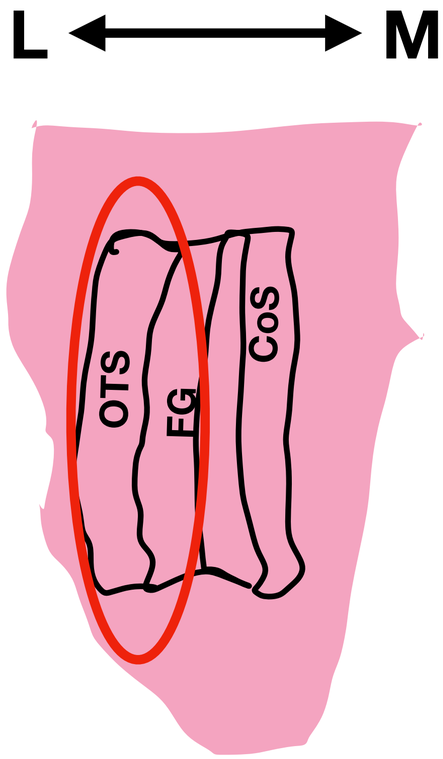
Rectilinearity



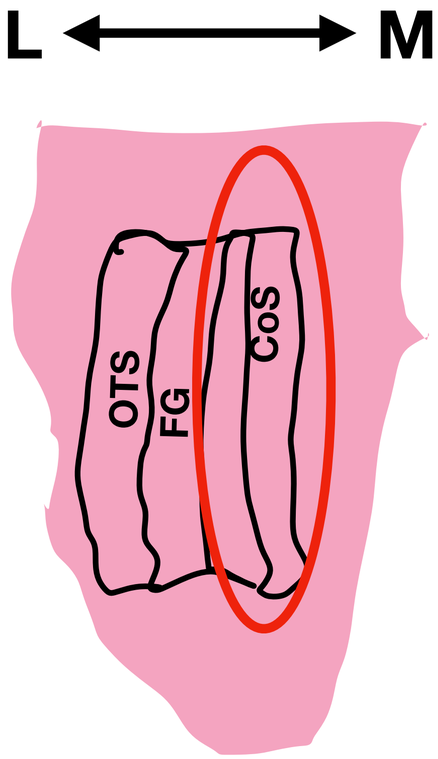


Attributes that affect topography in visual cortex

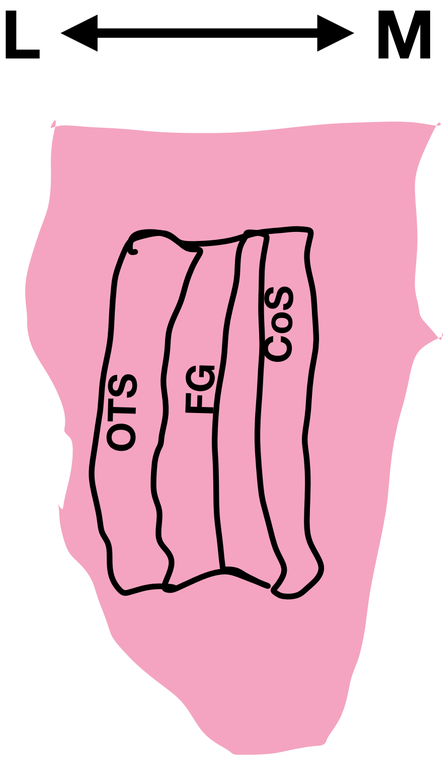
Eccentricity



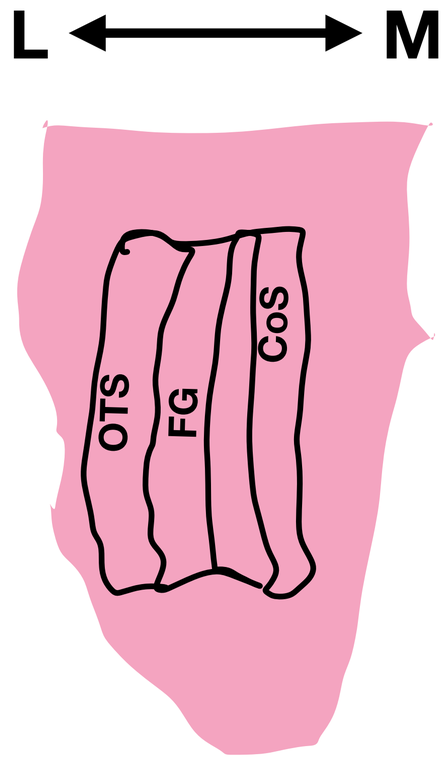
Rectilinearity



Perceptual Physical Size



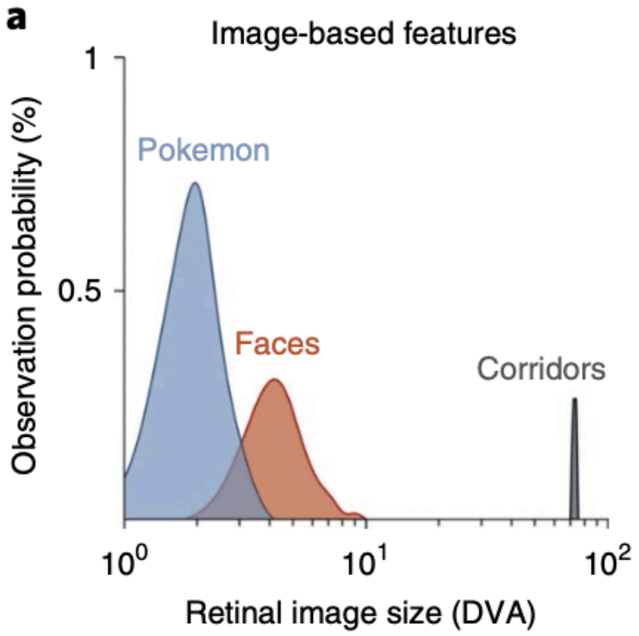
Perceived animacy

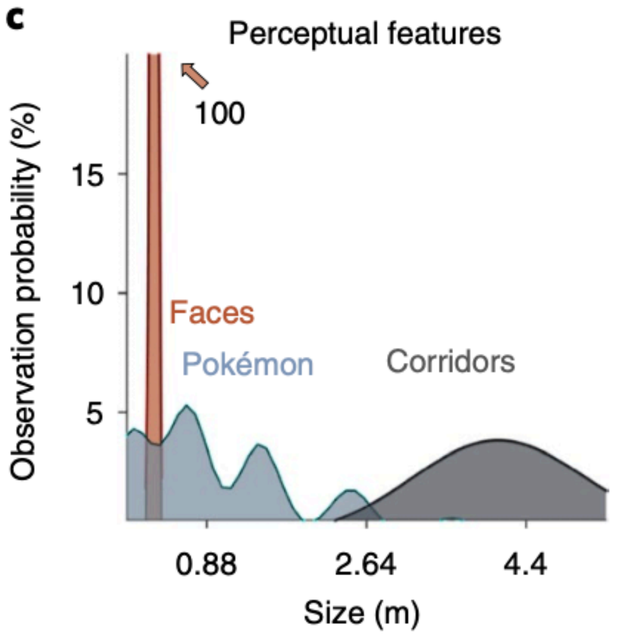


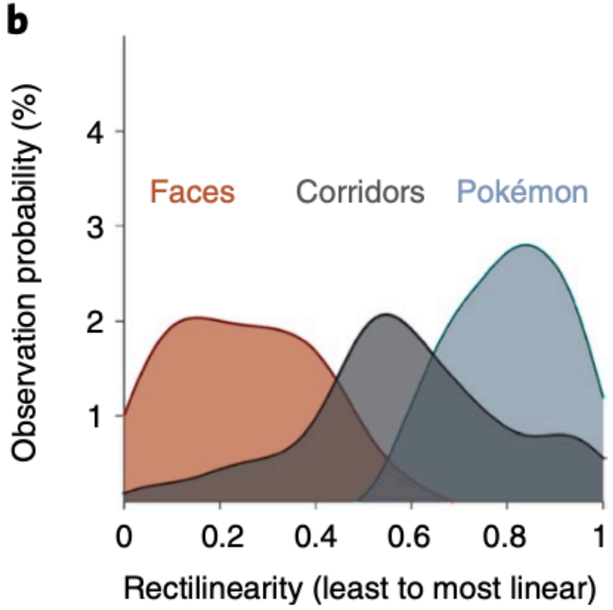
Retinal Image Size

Rectilinearity

Perceptual Physical Size

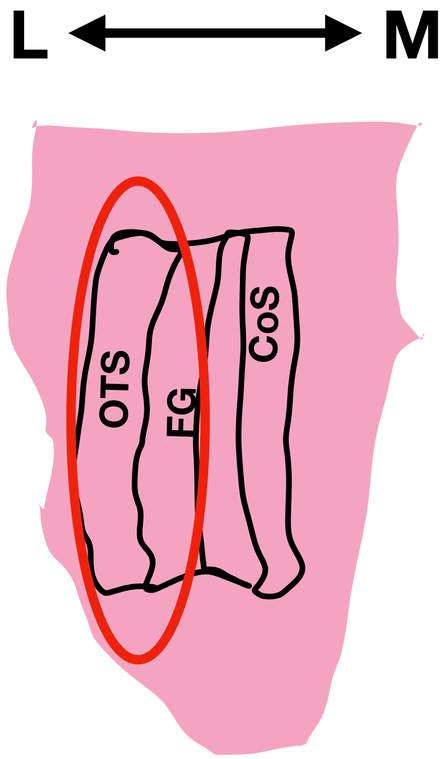




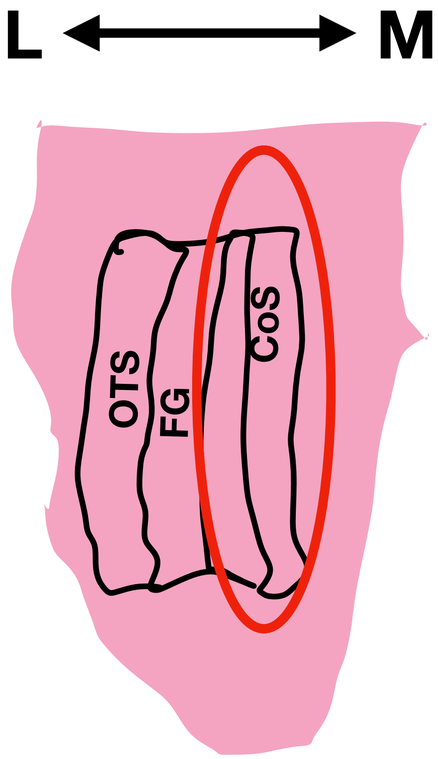


Attributes that affect topography in visual cortex

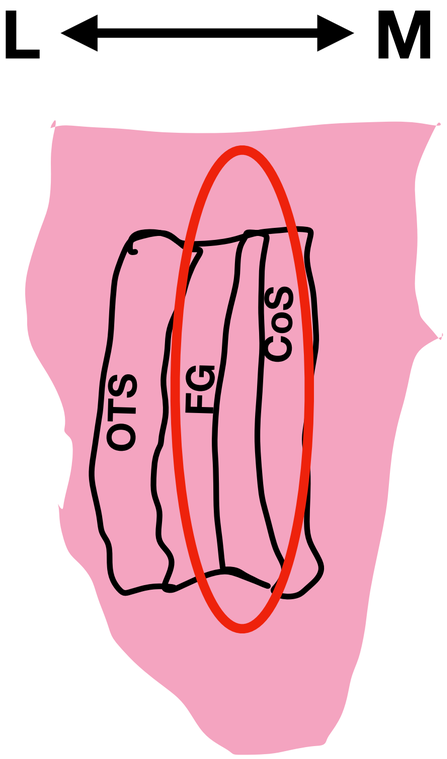
Eccentricity



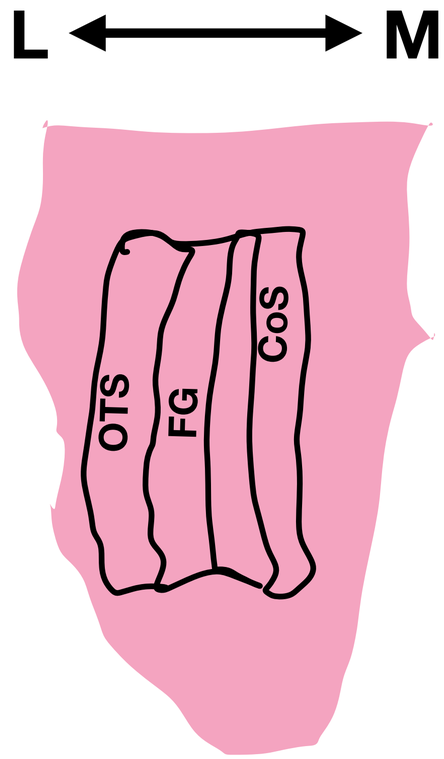
Rectilinearity



Perceptual Physical Size



Perceived animacy

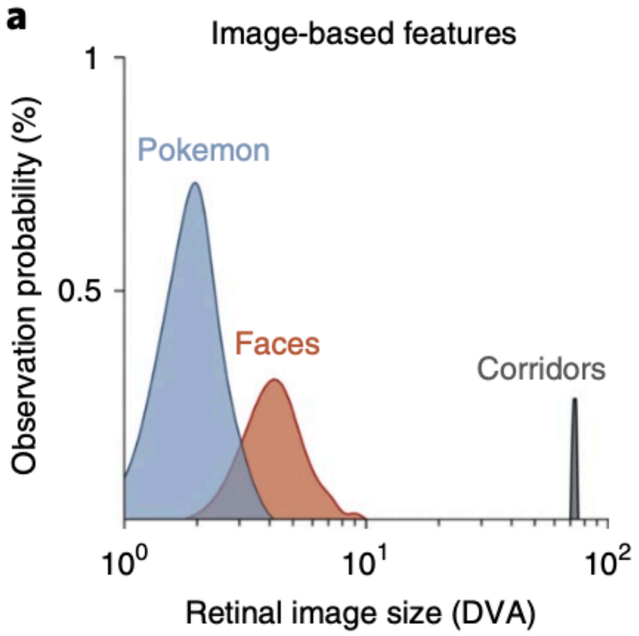


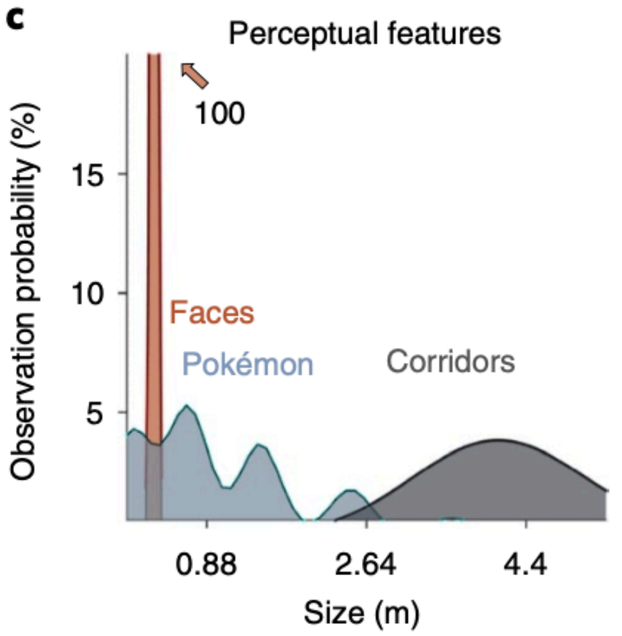
Retinal Image Size

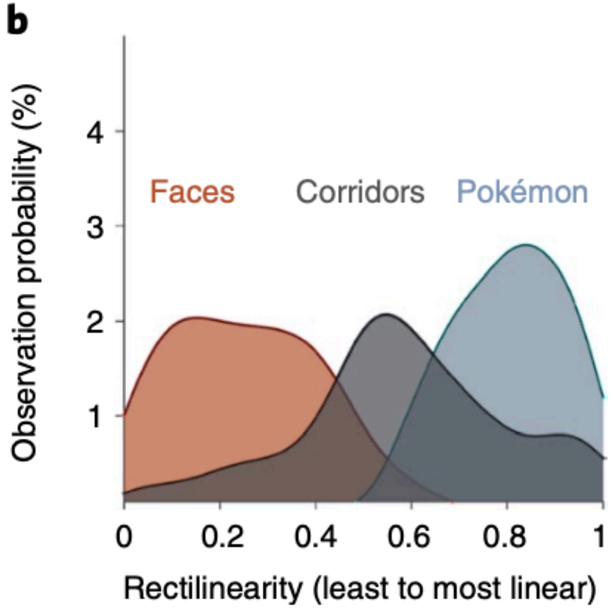
Rectilinearity

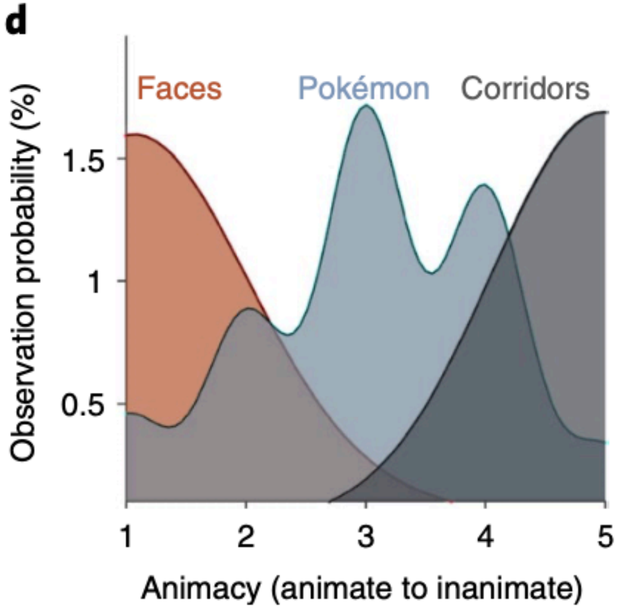
Perceptual Physical Size

Perceived animacy





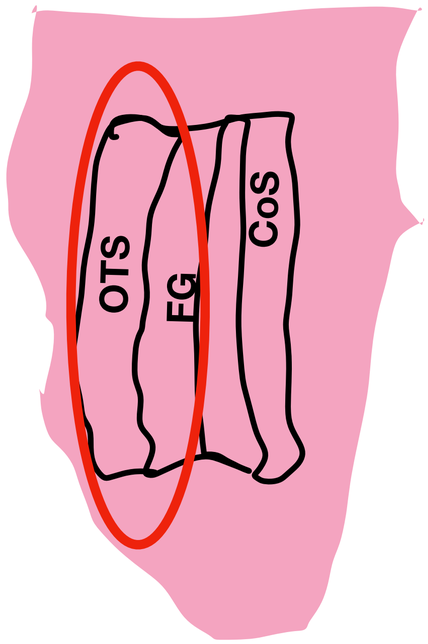




Attributes that affect topography in visual cortex

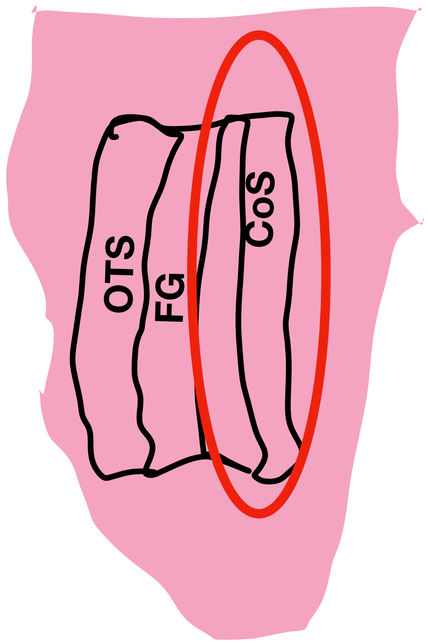
Eccentricity

L ⟷ M



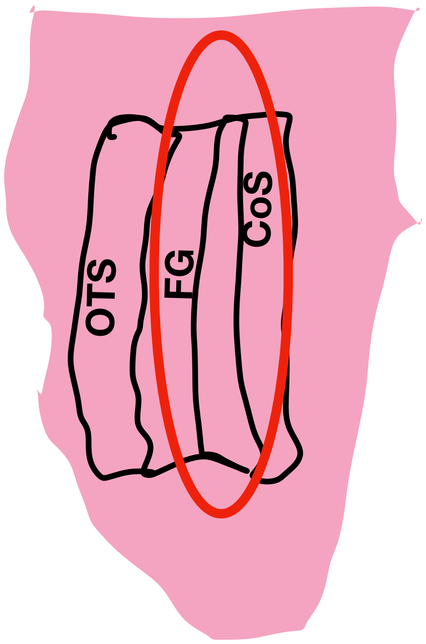
Rectilinearity

L ⟷ M



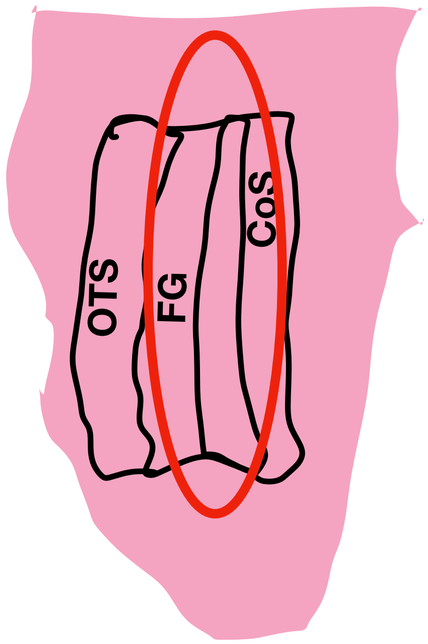
Perceptual Physical Size

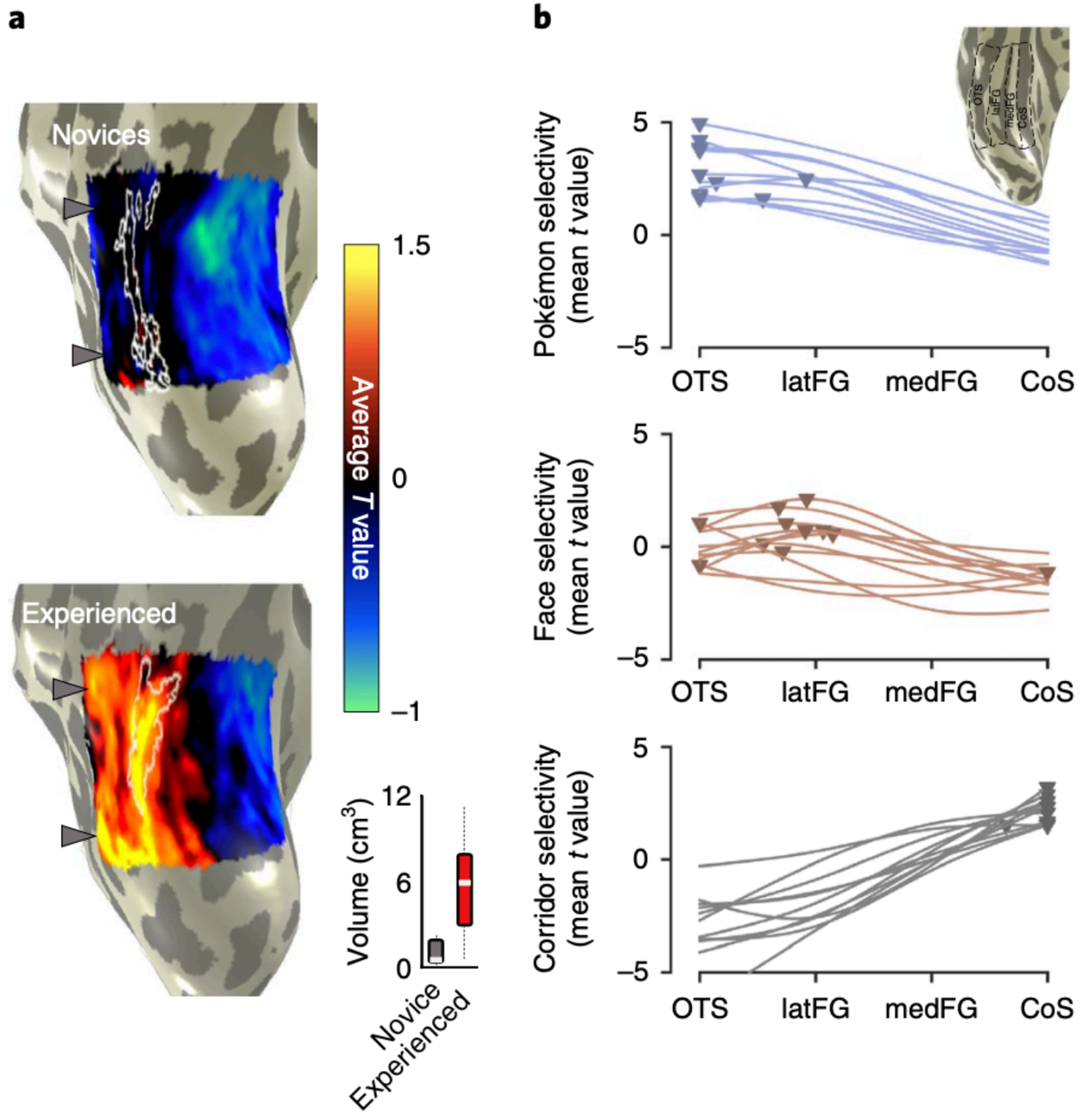
L ⟷ M



Perceived animacy

L ⟷ M



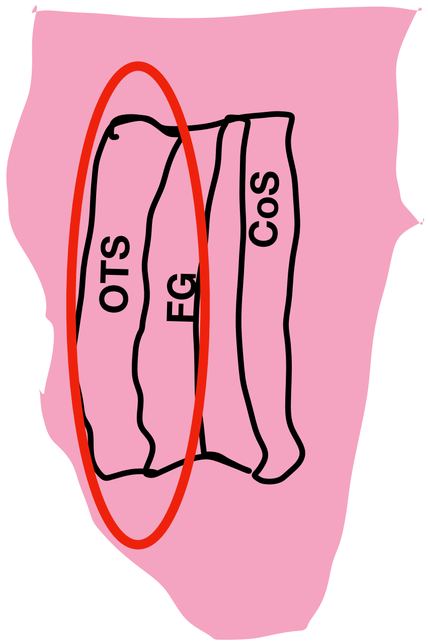

a
Novices
Experienced
1.5
Average T value
0
−1
12
6
0
Volume (cm3)
Novice
Experienced
b
Pokémon selectivity (mean t value)
Face selectivity (mean t value)
Corridor selectivity (mean t value)
5
0
−5
OTS
latFG
medFG
CoS

OTS
latFG
medFG
CoS

Attributes that affect topography in visual cortex

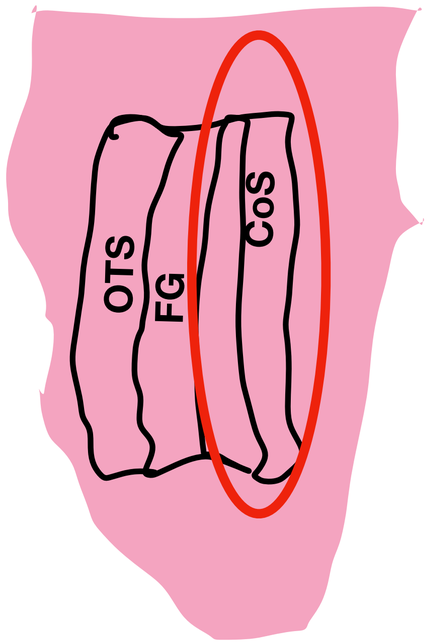
Eccentricity

L ⟷ M



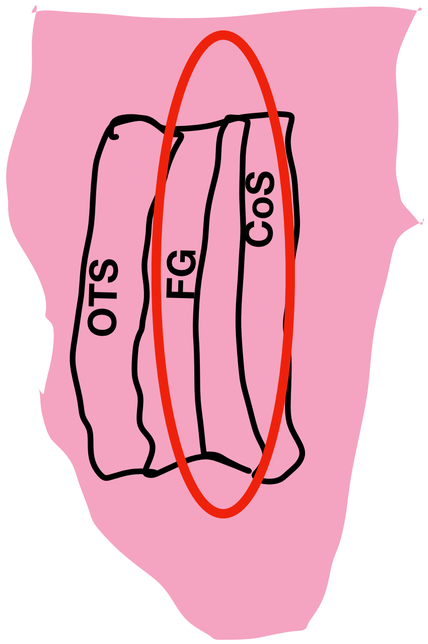
Rectilinearity

L ⟷ M



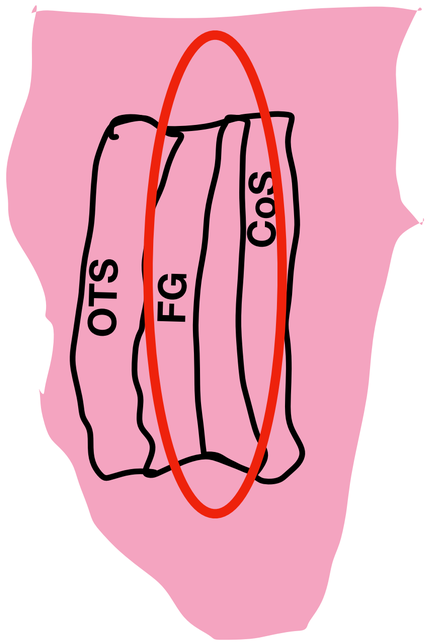
Perceptual Physical Size

L ⟷ M

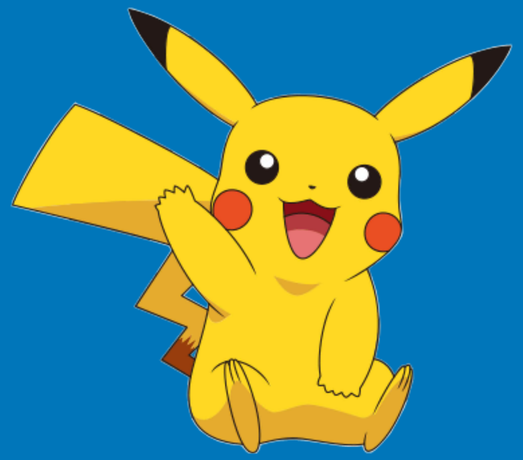


Perceived animacy

L ⟷ M



Eccentricity appears to be driving the topographical organization of the VTA!

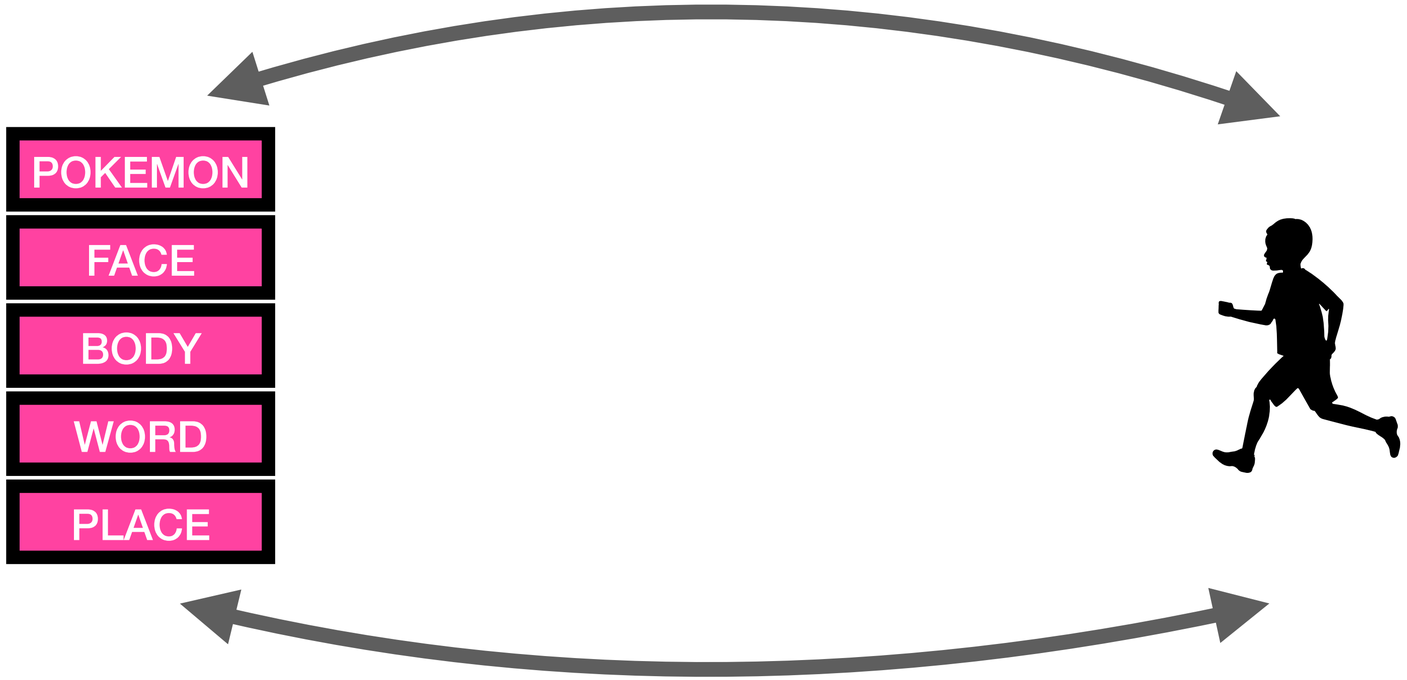


Questions they aim to address:

1. Does extensive experience with Pokemon from early childhood to adulthood result in novel representation in the visual cortex? ✓

2. Does the features of Pokemon help us theorizes which features of visual stimuli drives the development and topographical organization in high-level visual cortex? ✓

CONCLUSION



Extensive exposure to a unique stimuli led to the emergence of its own cortical representation in the VTC!

Suggests that experiences in childhood play a critical role in shaping the development of these acquired categories and sculpting the brain's responses to various stimuli

Discussion Questions

1. How would you describe an “experienced” Pokemon participant? Is it the video game? Or is extensively watching of the cartoon show and/or card games a component to consider as well?

2. Do you think there are other stimuli that could find similar results and add contextual information — like Yu-Gi-Oh!, for example? How would this help the purpose of this study?Would these have their own region or share space with Pokemon?

3. What do you think the implications of this study are? How does this research inform other topics in developmental cognitive neuroscience research? What does it not tell us?

THANK YOU!!