



# Approaches to functional activity mapping during natural viewing

Brian E Russ

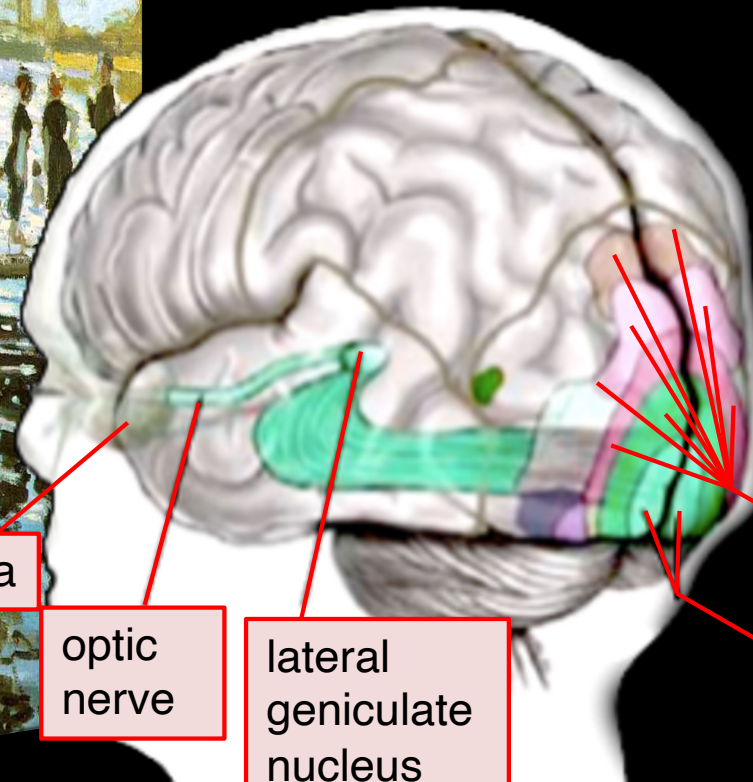
fMRI/MRI Summer Course  
June 23, 2017



# Outline

- Visual Experience
- Experimental Design Choice
- Feature Responses during Natural Viewing
- Inter-subject Responses
- Summary

# How does the brain make sense a complex world?



retina

optic  
nerve

lateral  
geniculate  
nucleus

primary  
visual  
cortex

extrastriate  
visual  
cortex

How does the brain make sense a complex world?





How does the brain make sense a complex world?



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# Experimental Trade-offs

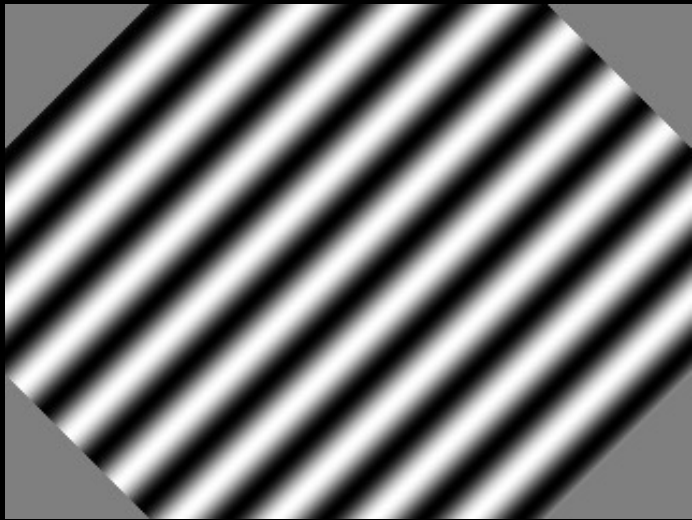
Artificial

Natural

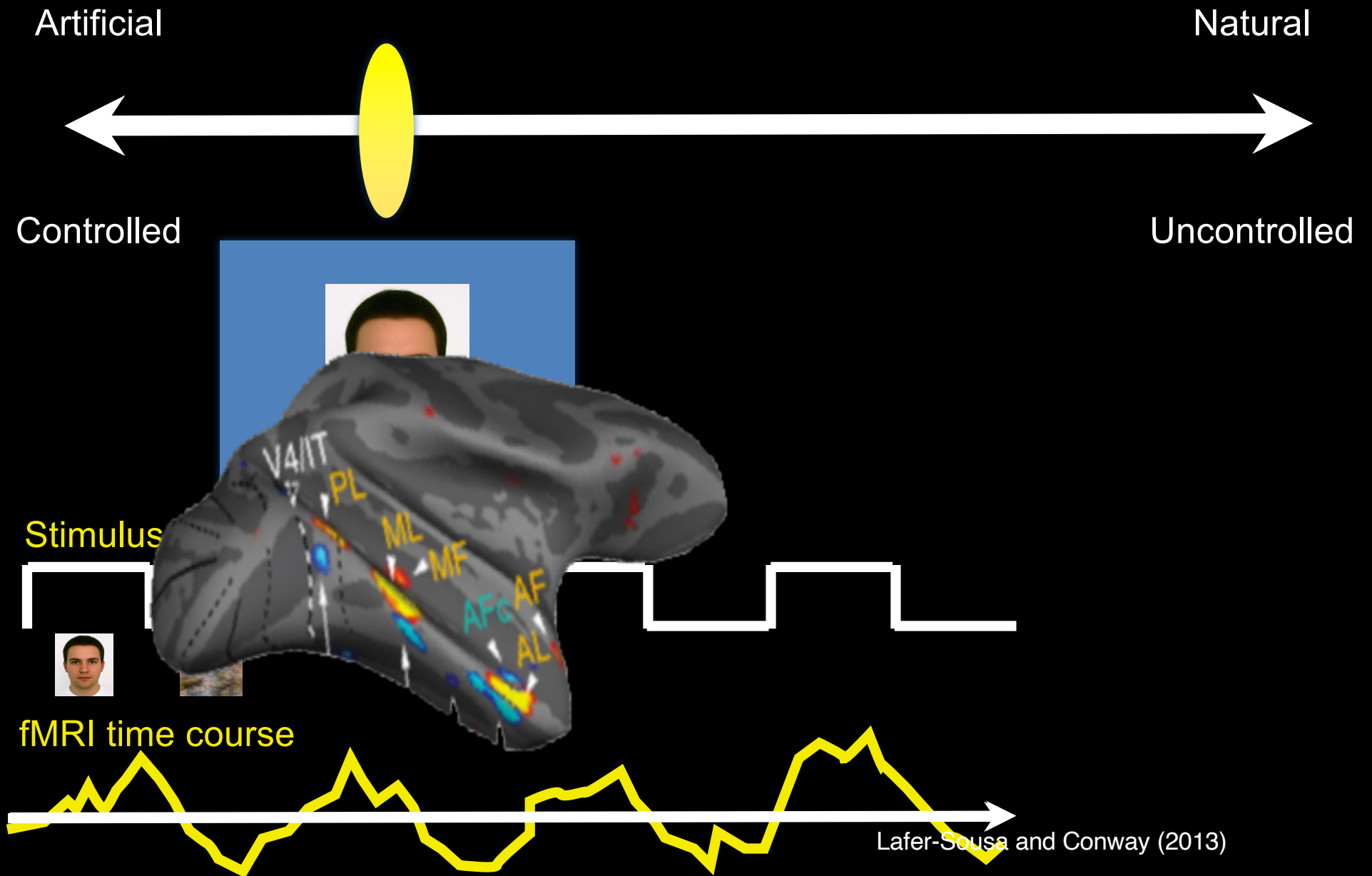


Controlled

Uncontrolled

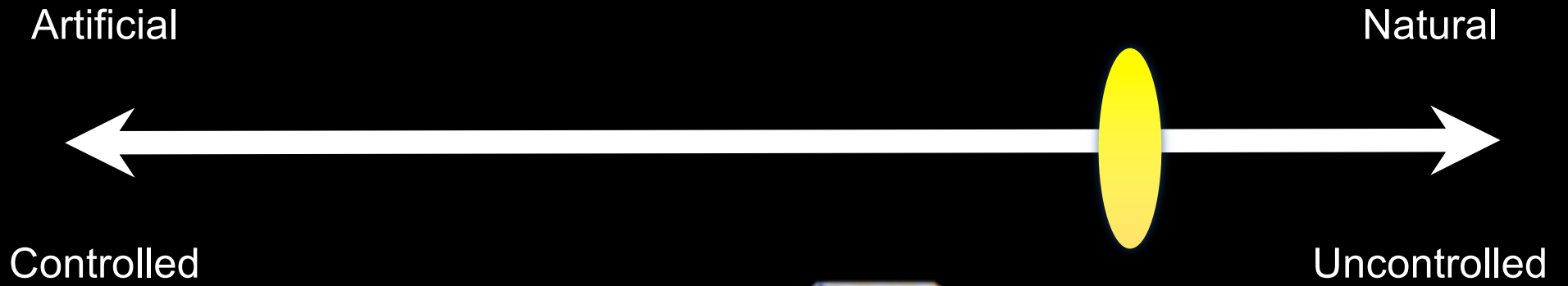


# Experimental Designs






# Experimental Designs



# Natural Viewing Paradigms



FANDANGO  
MOVIECLIPS 

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# Feature Coding



## - Visual Features - Animals

Luminance  
Global Motion  
Spatial Frequency  
Contrast

Conspecifics  
Heterospecific macaques  
Mammals  
Humans

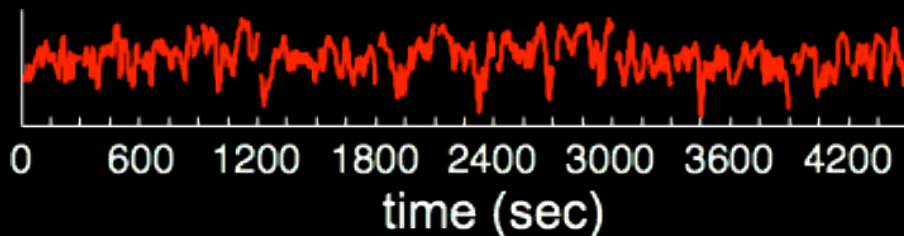
## - Body Parts

Heads  
Faces  
Butts  
Hands/Feet

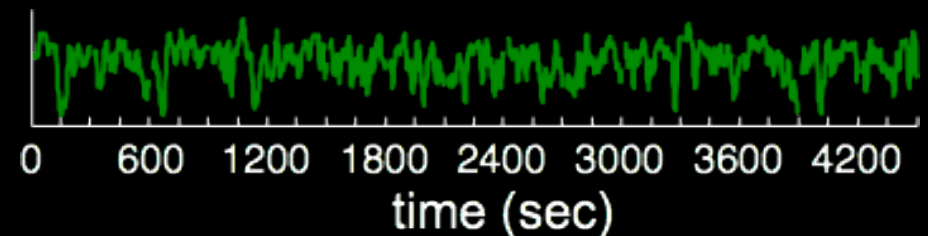
## - Behaviors

Aggression  
Grooming  
Play  
Feeding

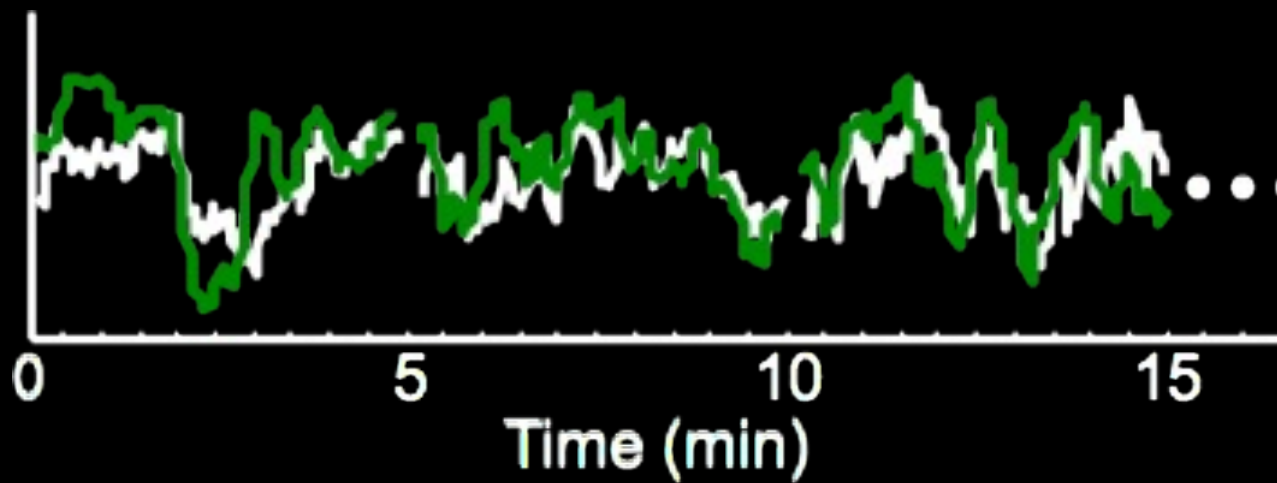
## Motion Time Course



## One Face Time Course



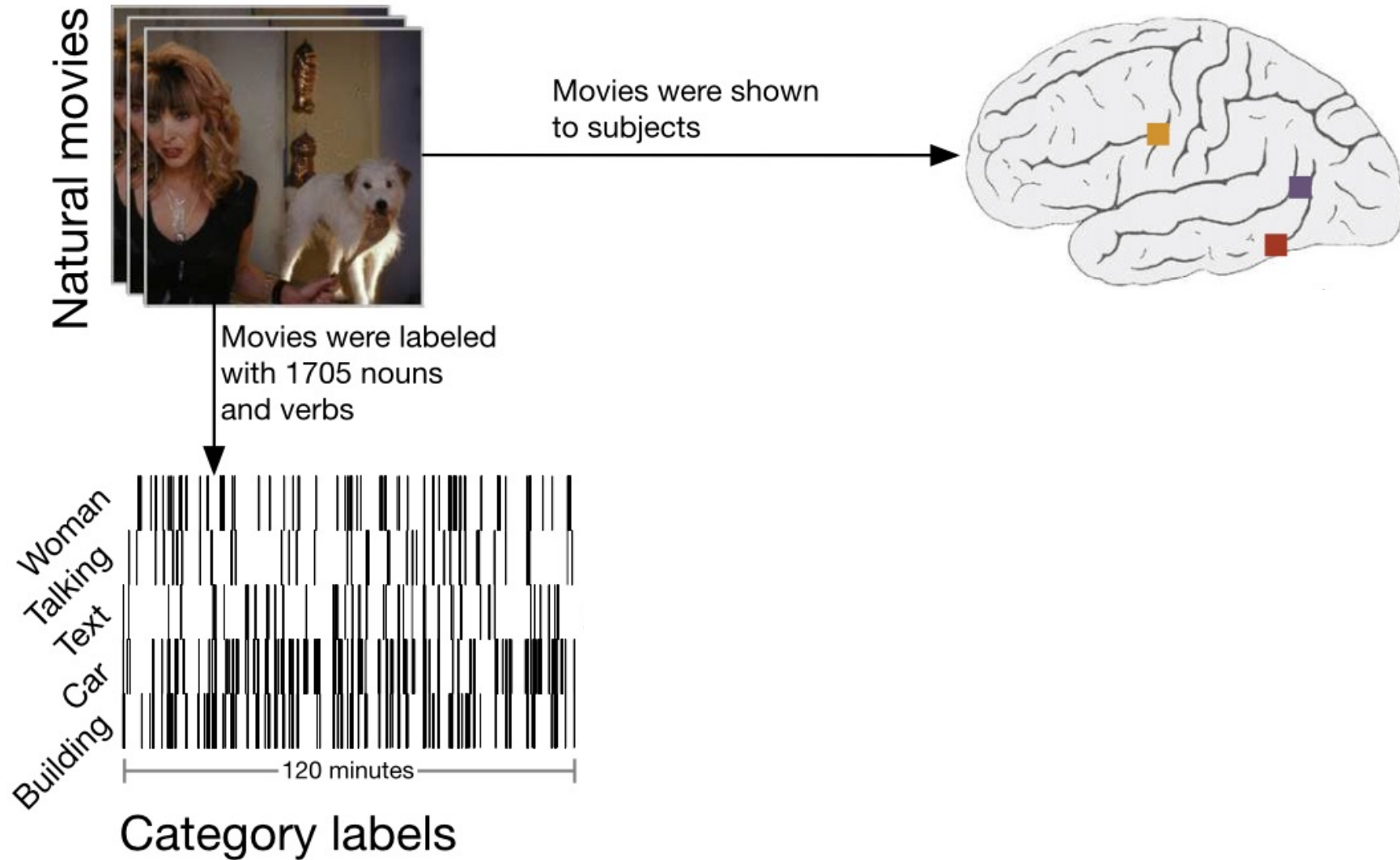
# Feature Coding



- voxel time course (AF)
- *isolated face feature model*

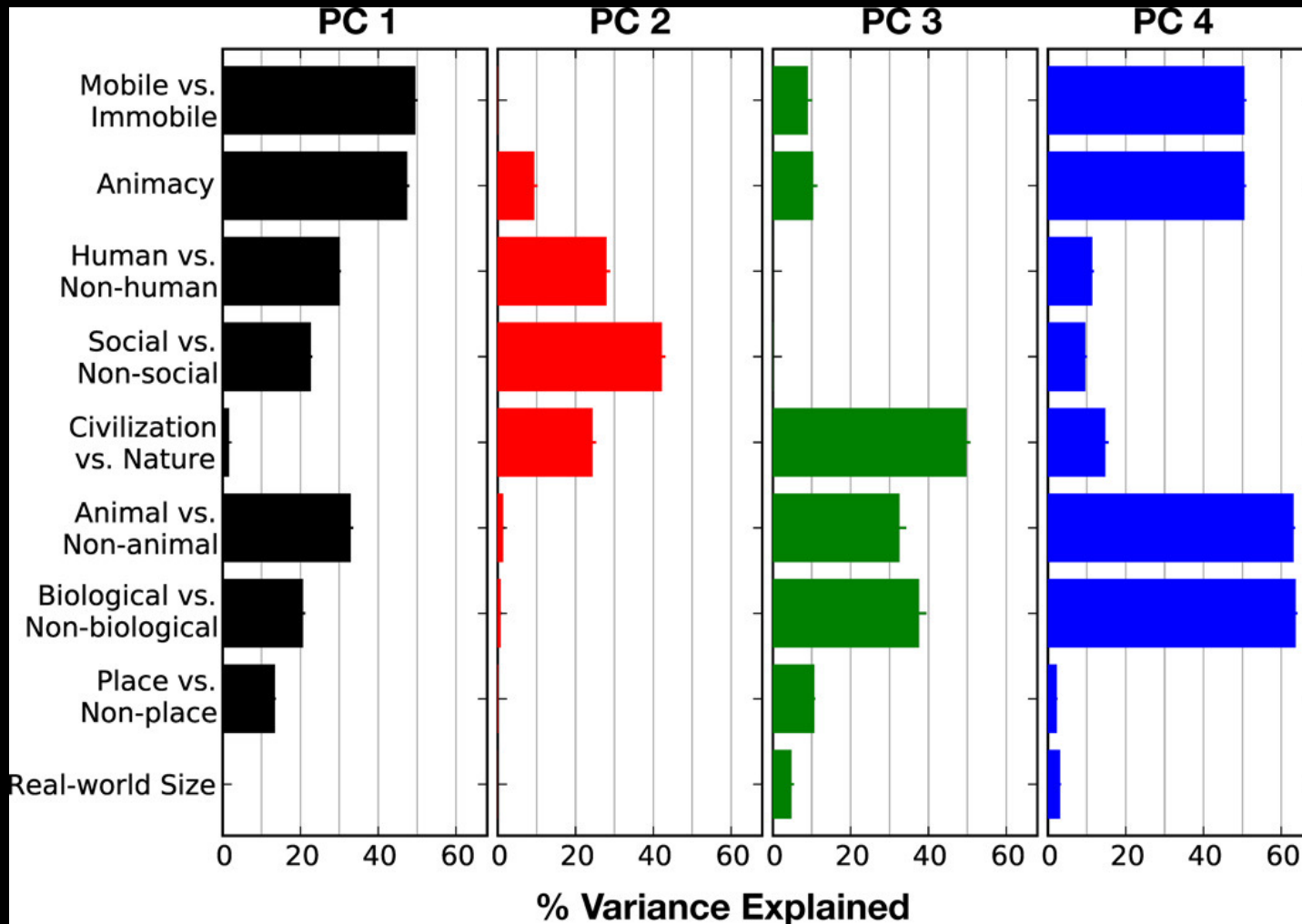


# Feature Coding





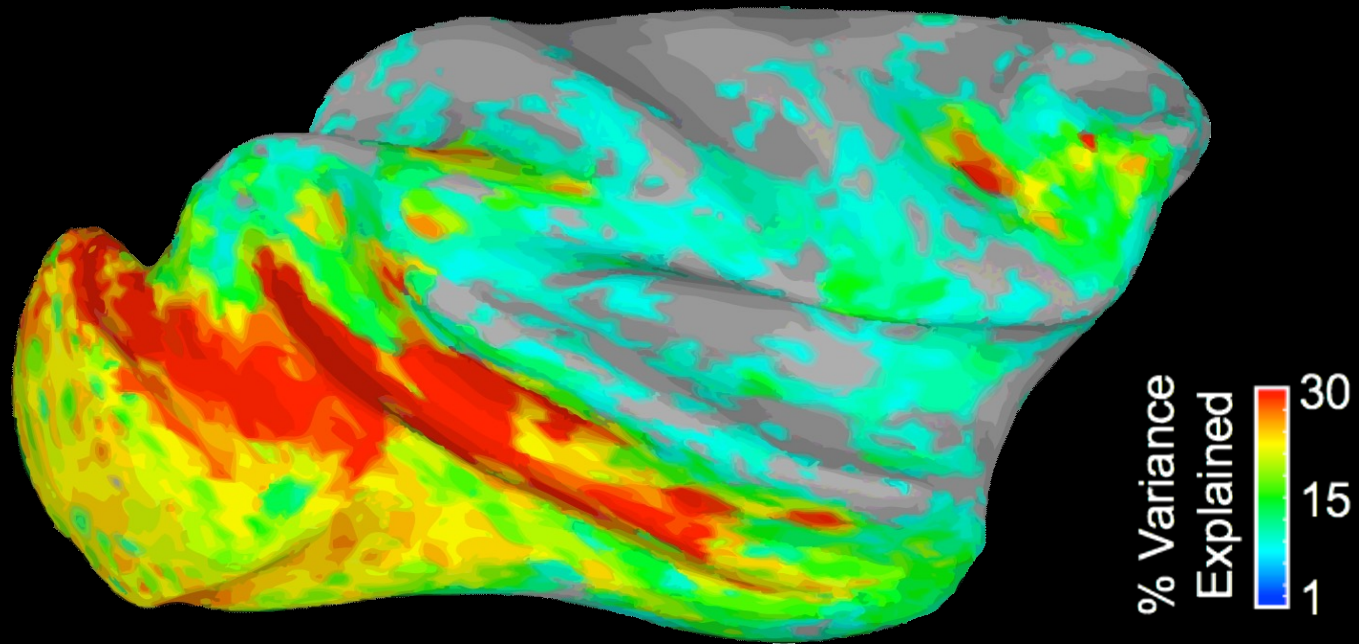
# Semantic Feature Space





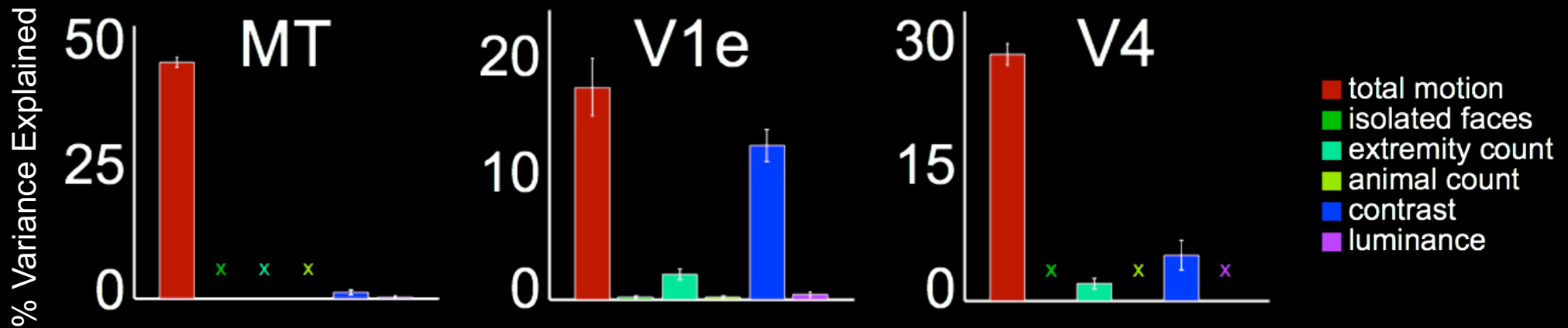
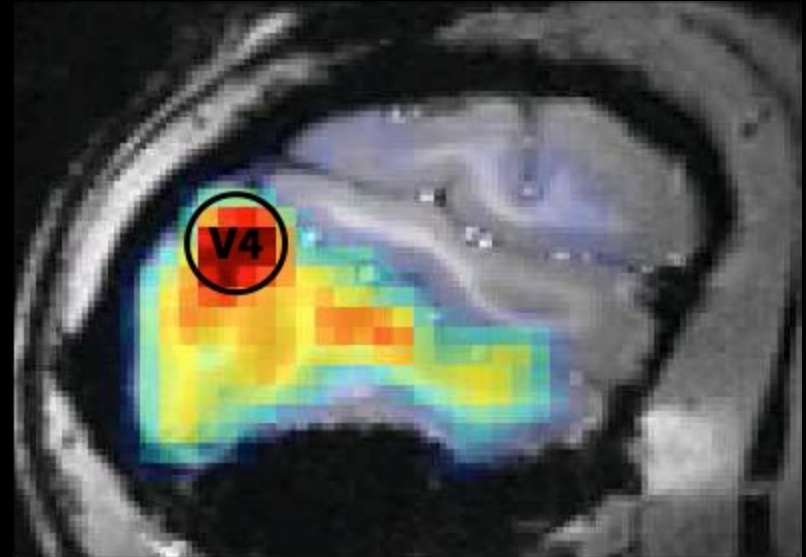
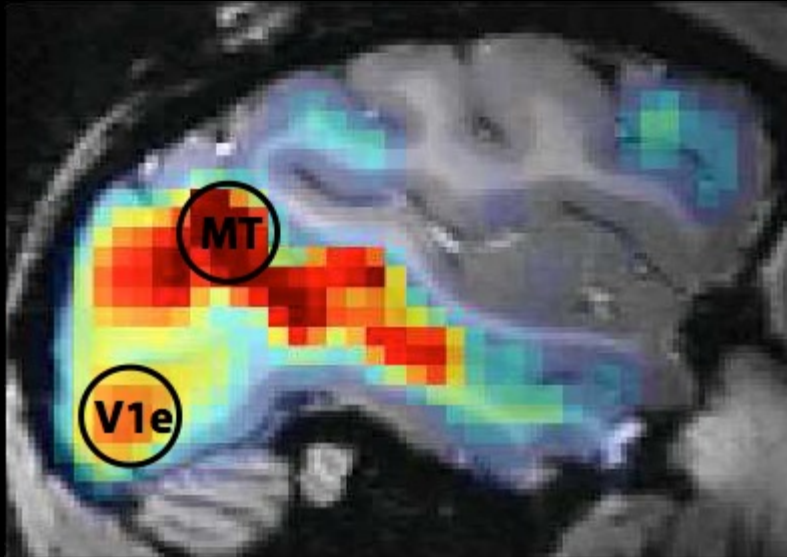


# Neural Variance Explained

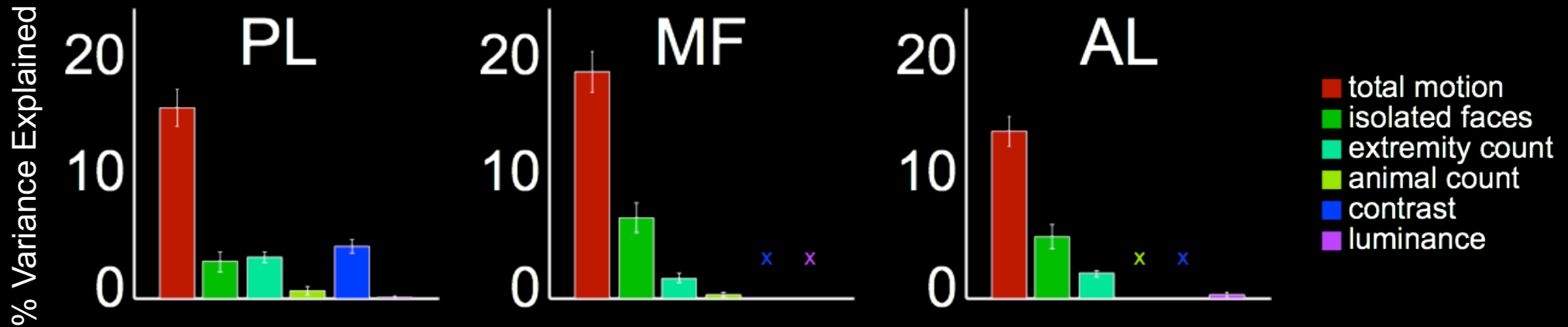
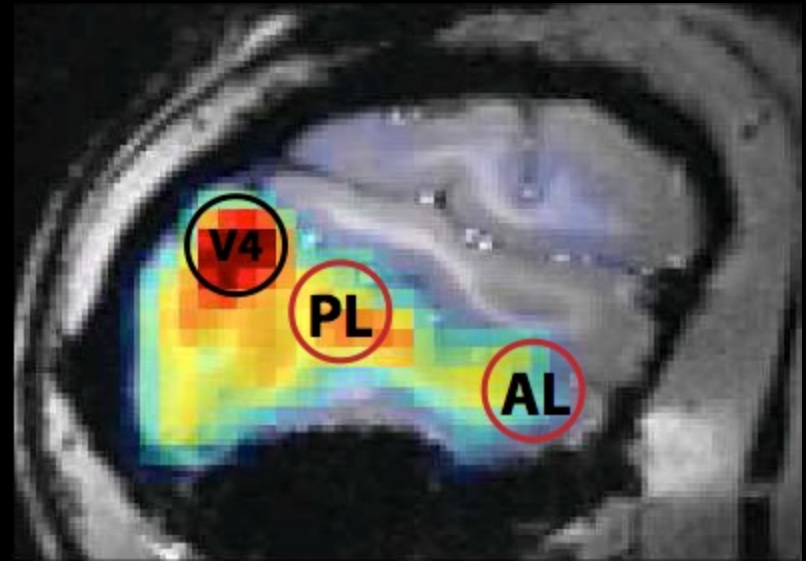
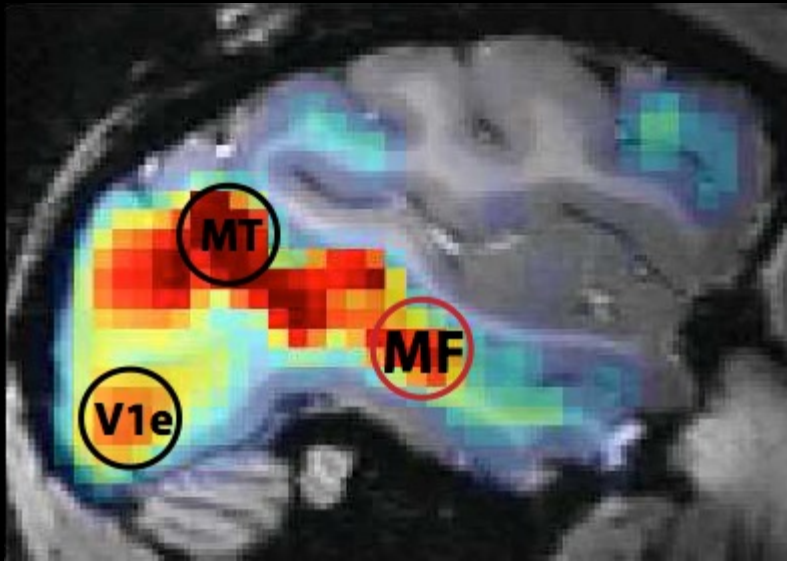




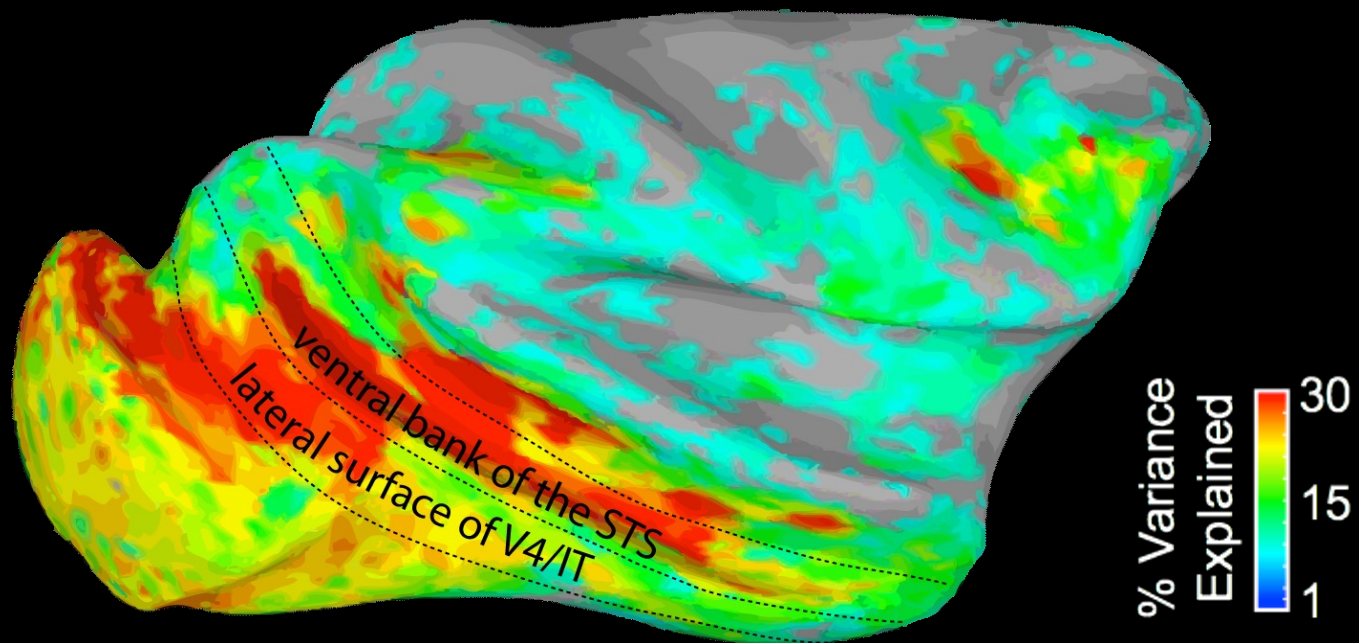
# Neural Variance Explained



# Neural Variance Explained

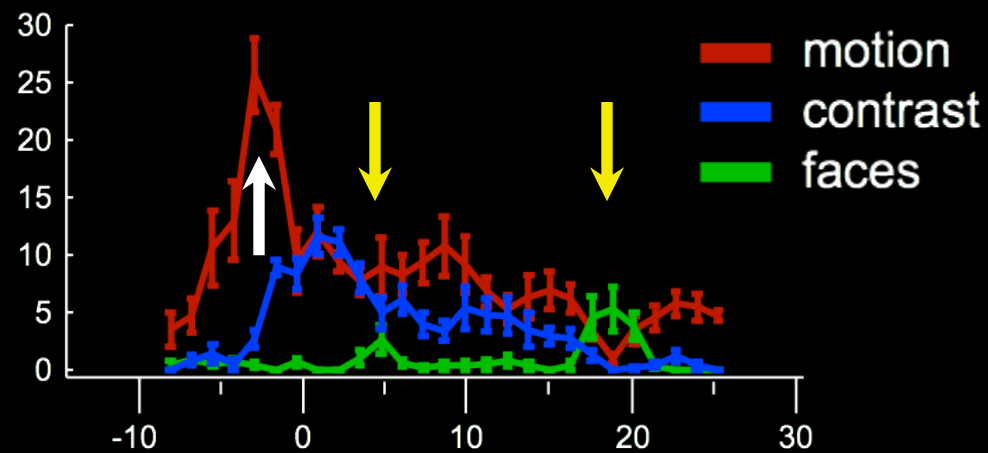
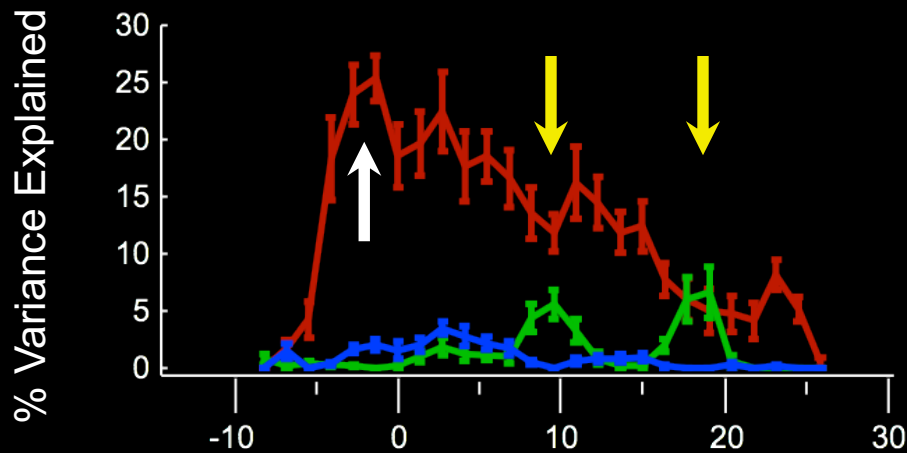


# Stimulus Motion Dominates



ventral bank of the STS

lateral surface of V4/IT

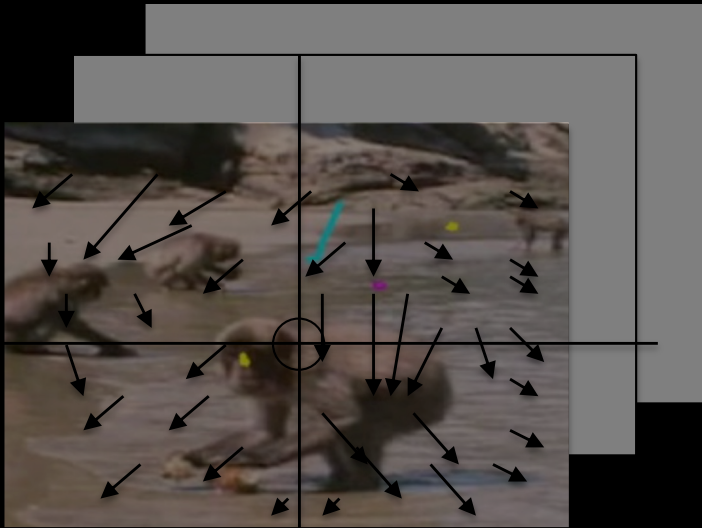


coronal slice # (relative to interaural line)

Russ & Leopold 2015

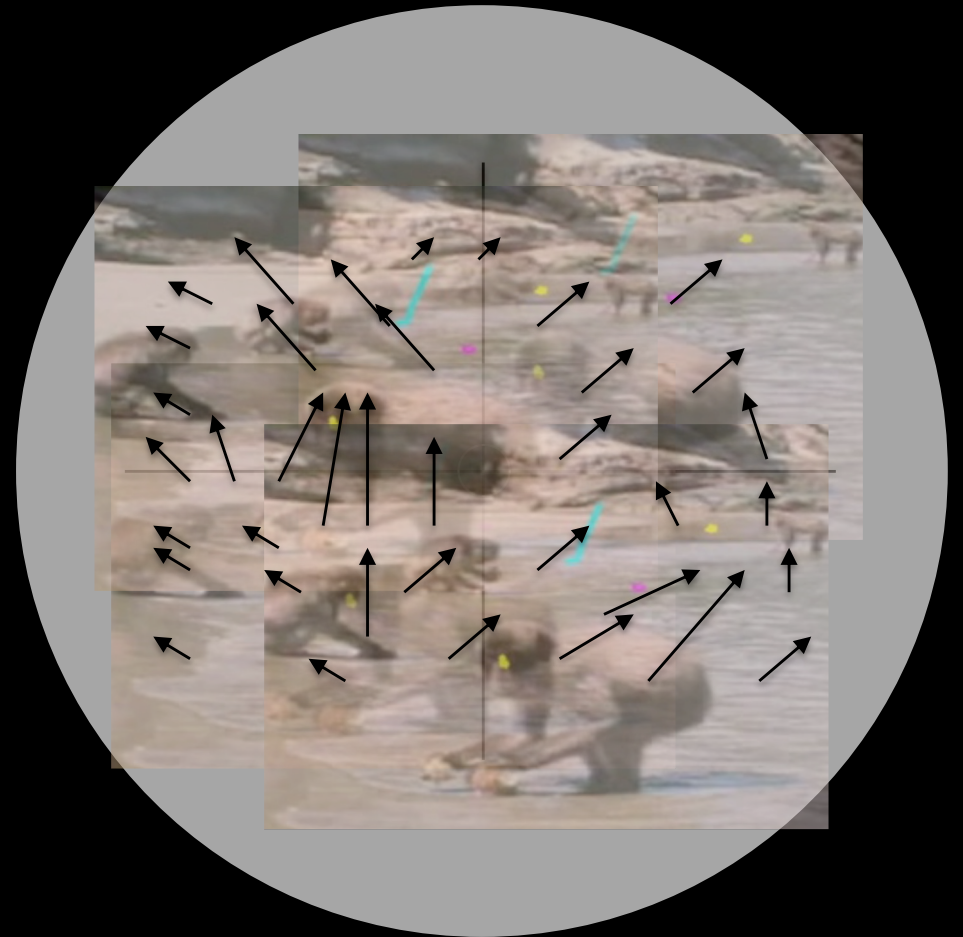
# Stimulus vs. Self-generated Motion

Screen-based reference frame



Motion vector field

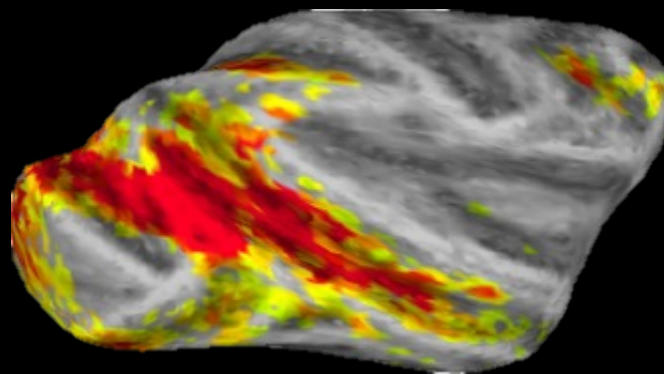
Retina-based reference frame



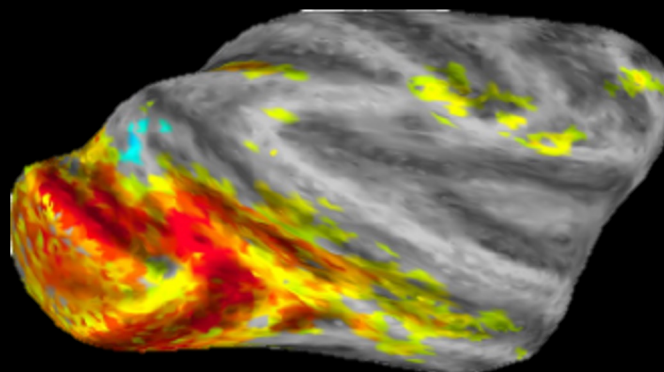


# Stimulus vs. Self-generated Motion

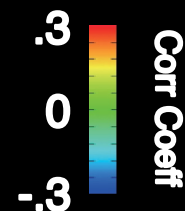
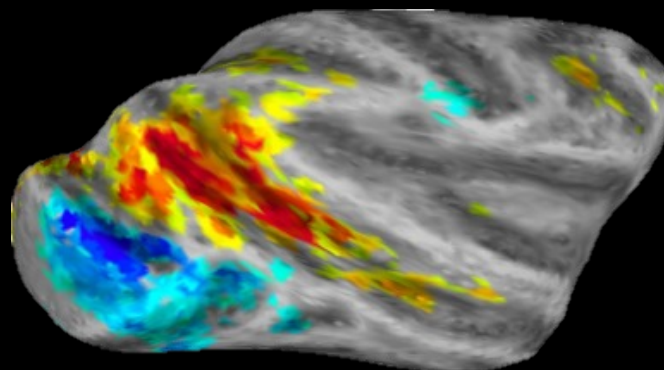
Activity caused by **video motion**  
(ignoring eye movements)



Activity caused by **eye movements**  
(ignoring video motion)

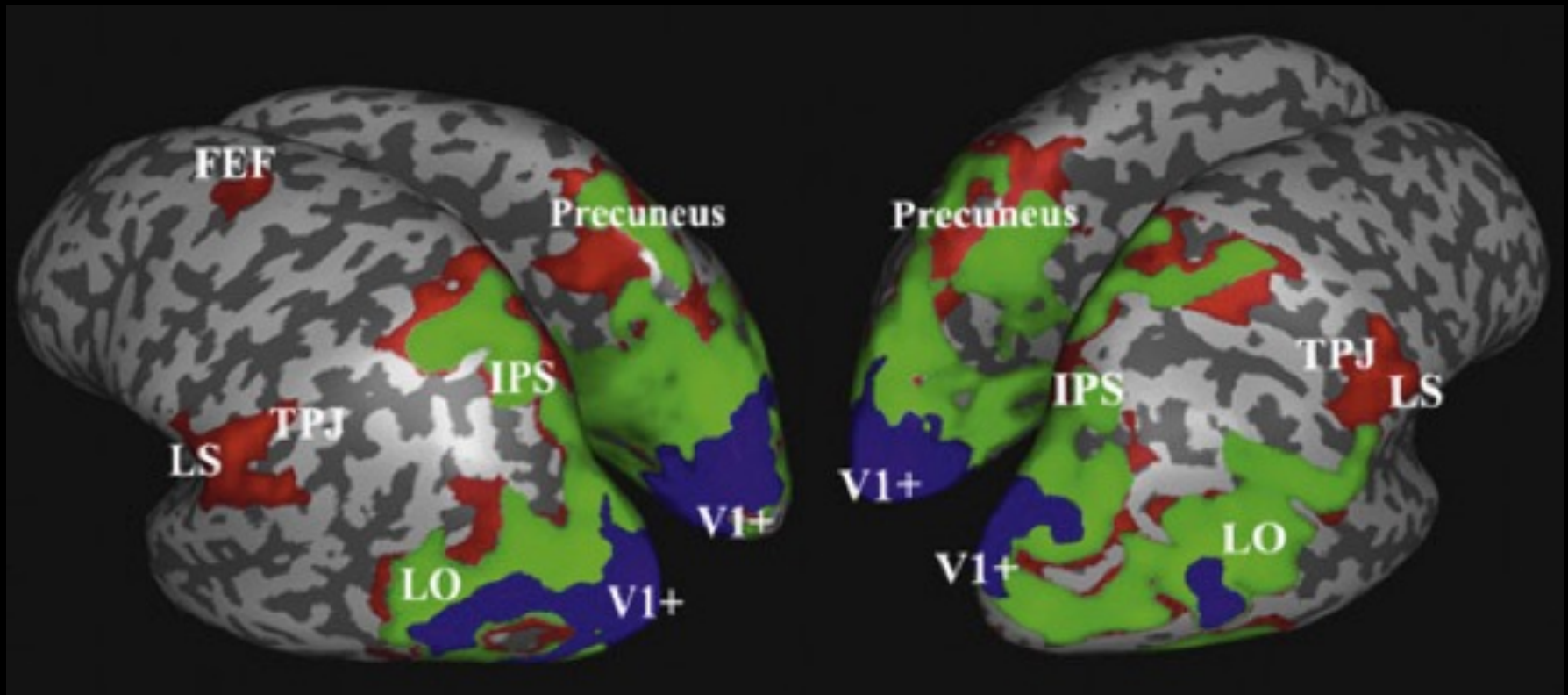


Video motion – eye movements  
(external vs. self-generated motion)





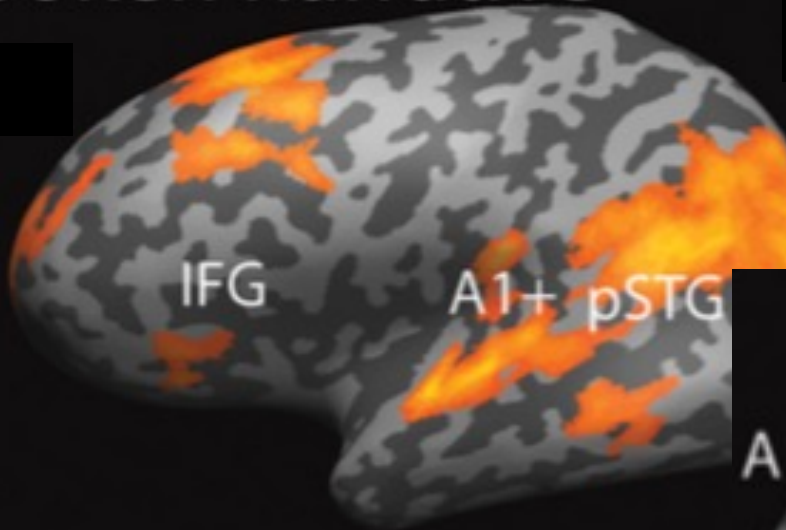
# Temporal Receptive Fields



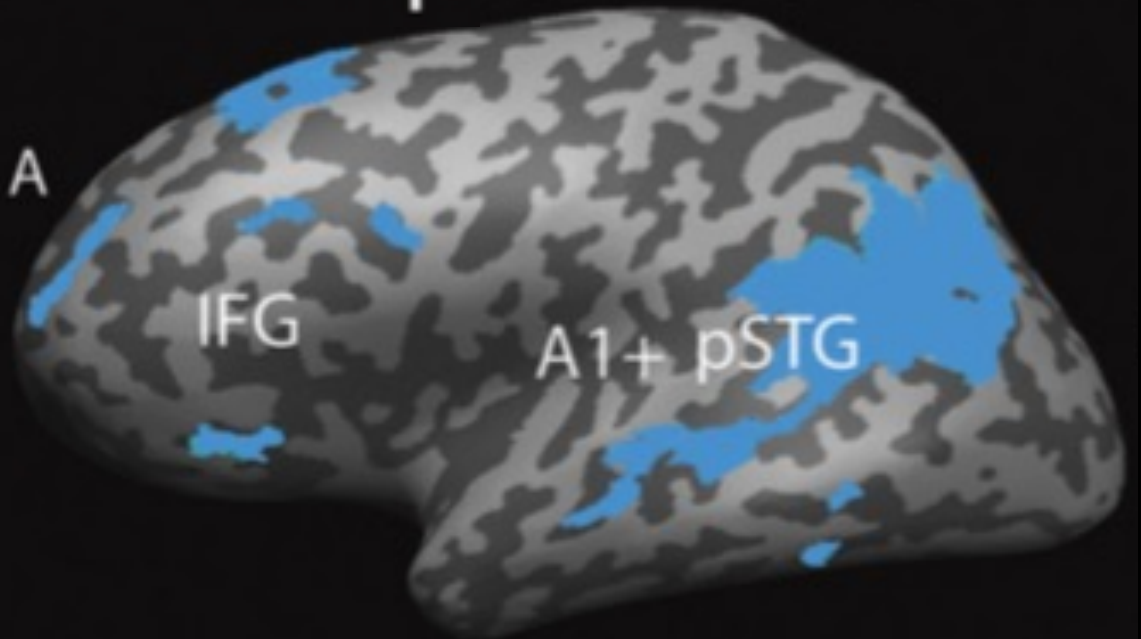
- Long (36±4sec)
- Mid (12±3sec)
- Short (4±1sec)

# Temporal Receptive Fields

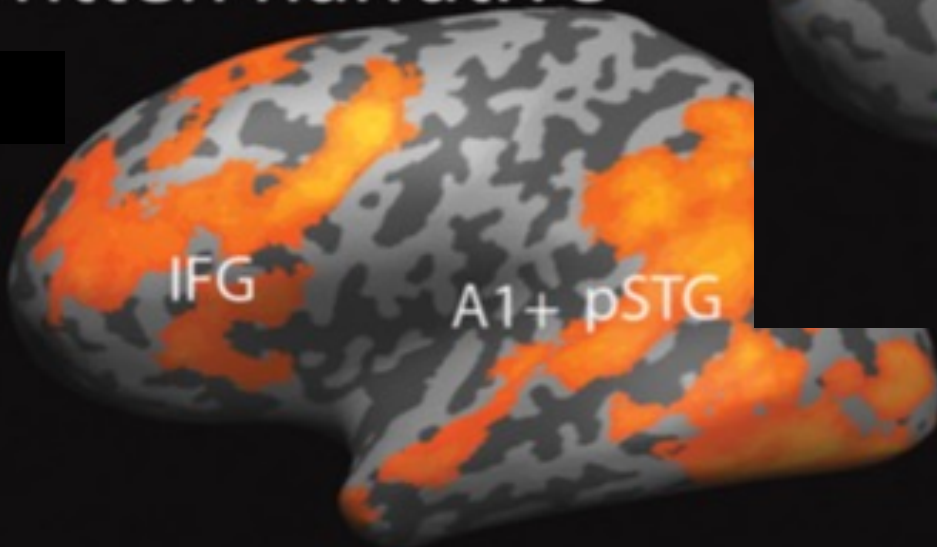
Spoken narrative



Overlap

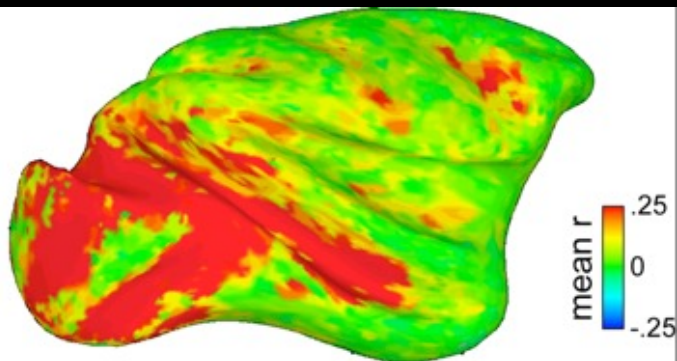


Written narrative

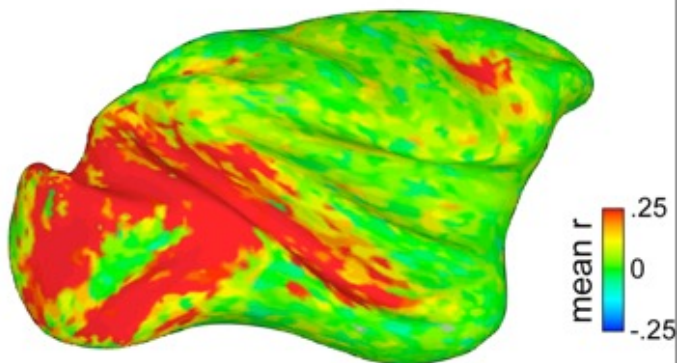


# Social Content

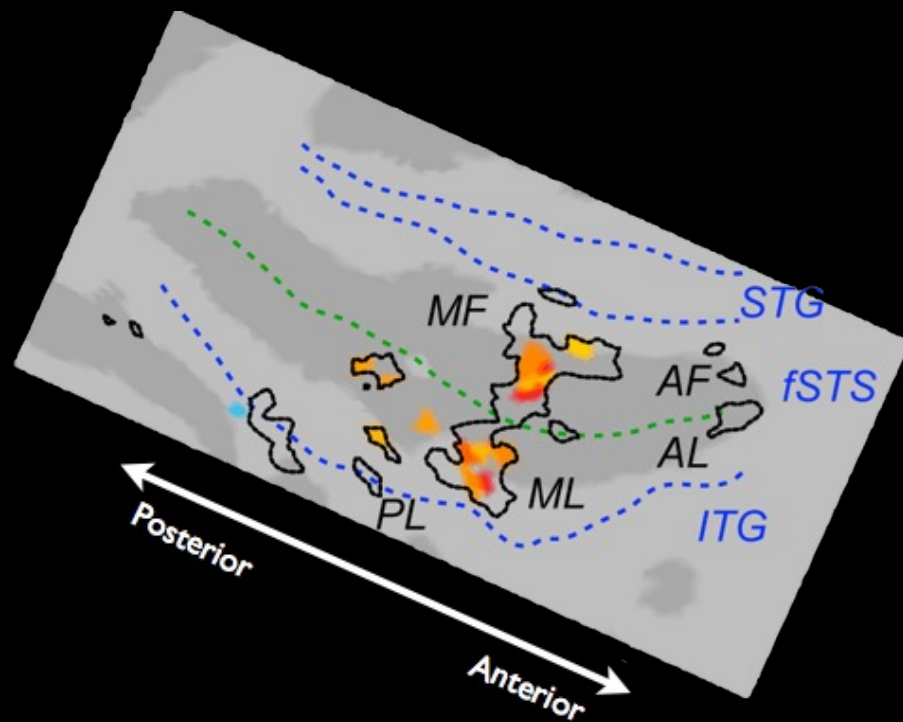
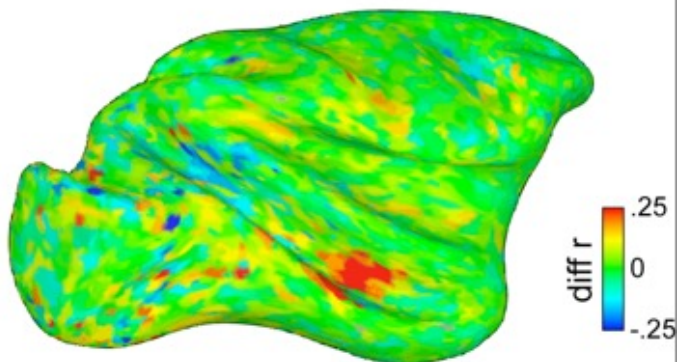
(with animals)



(without animals)



Difference

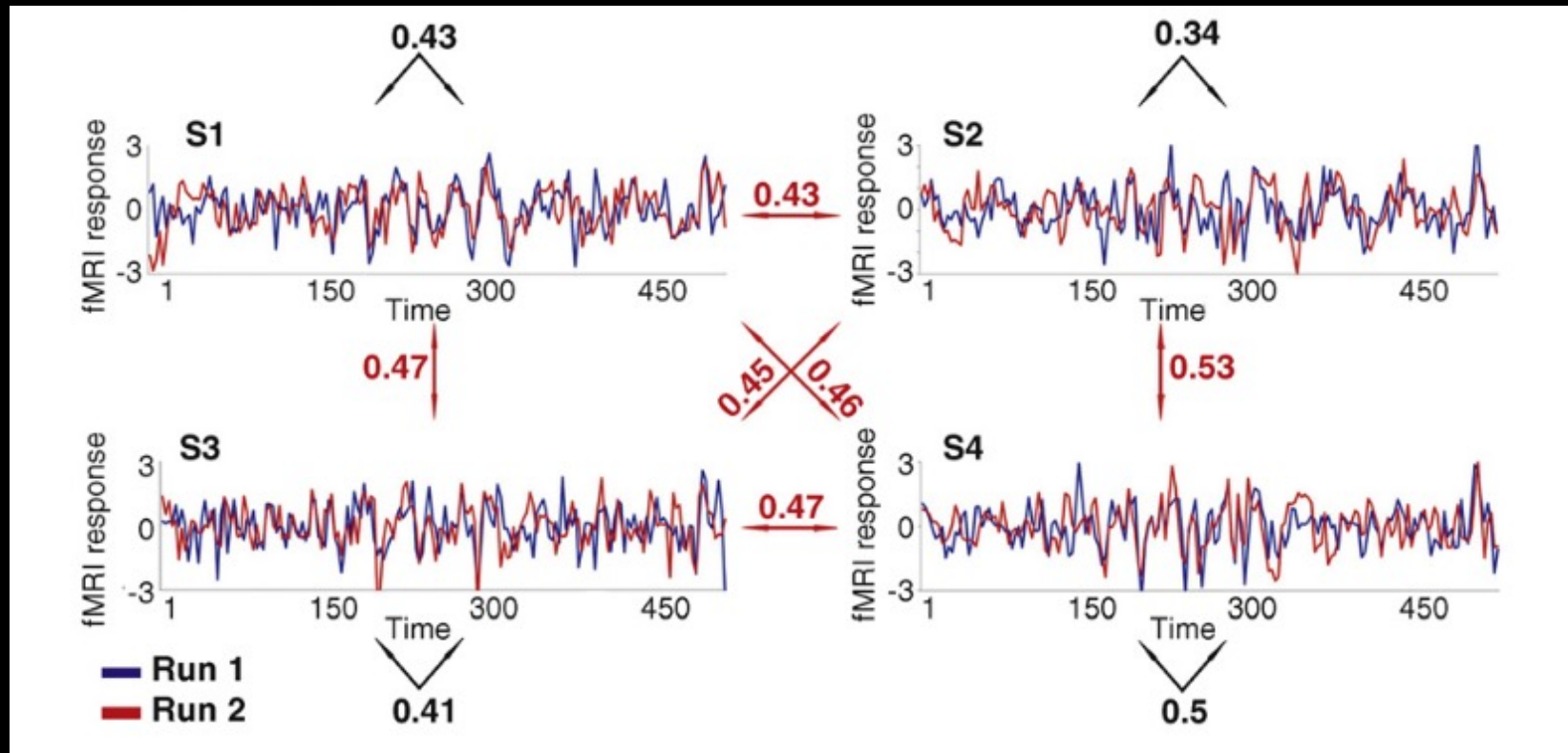


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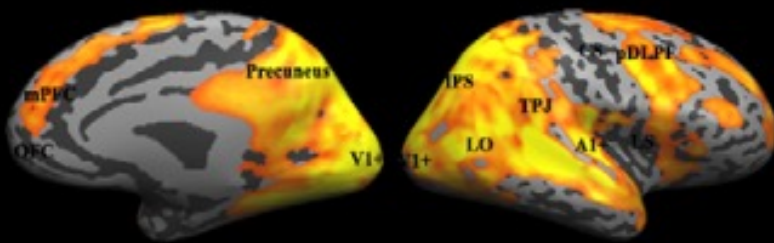
# Synchronized Brain Activity



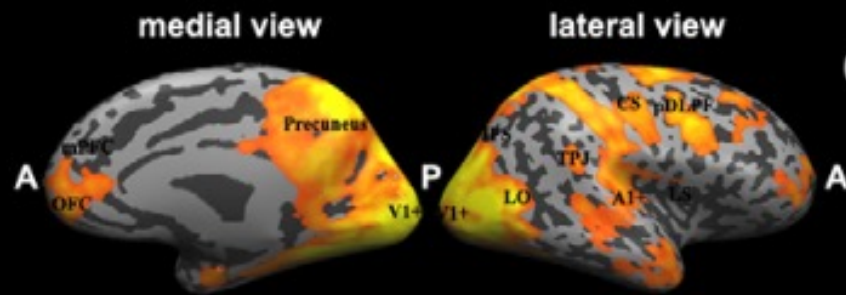


# Synchronized Brain Activity

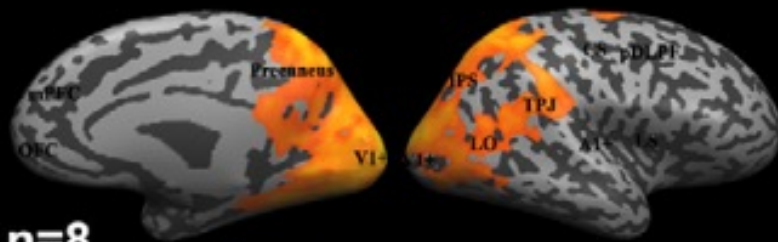
(a) **Bang! You're Dead** (Alfred Hitchcock)



(b) **The Good bad and ugly** (Sergio Leone)

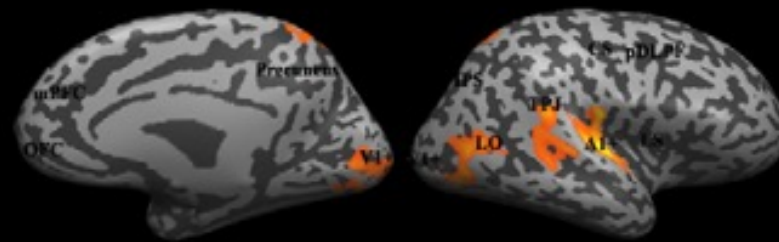


(c) **City Lights** (Charlie Chaplain)

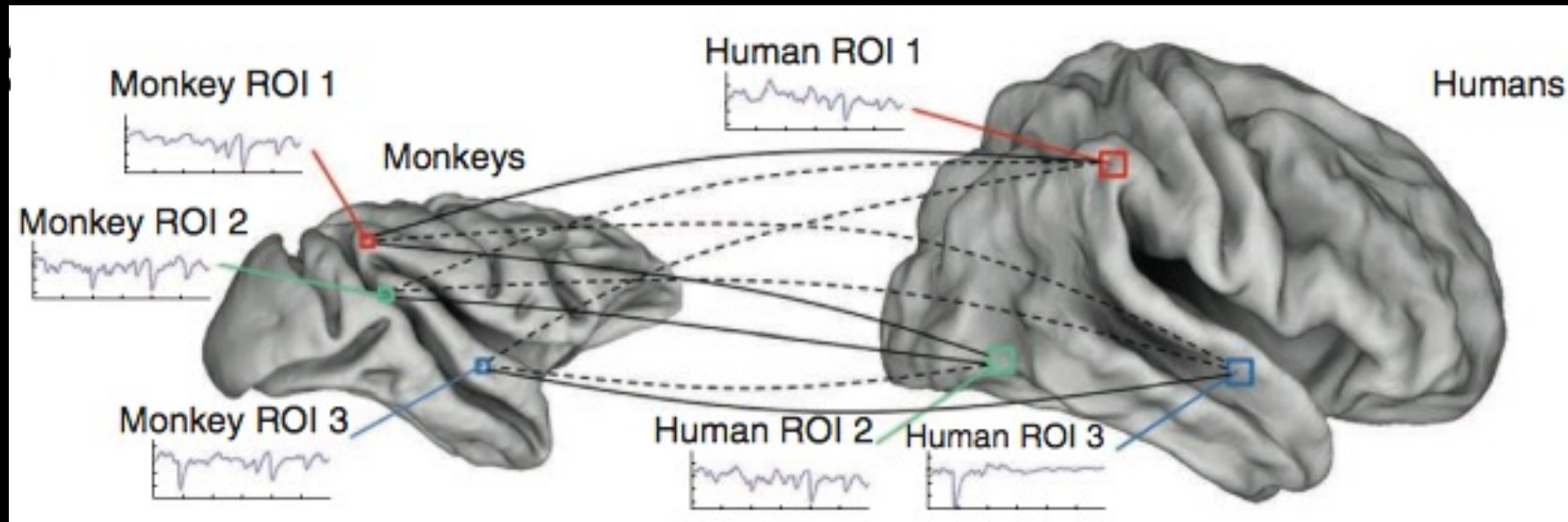
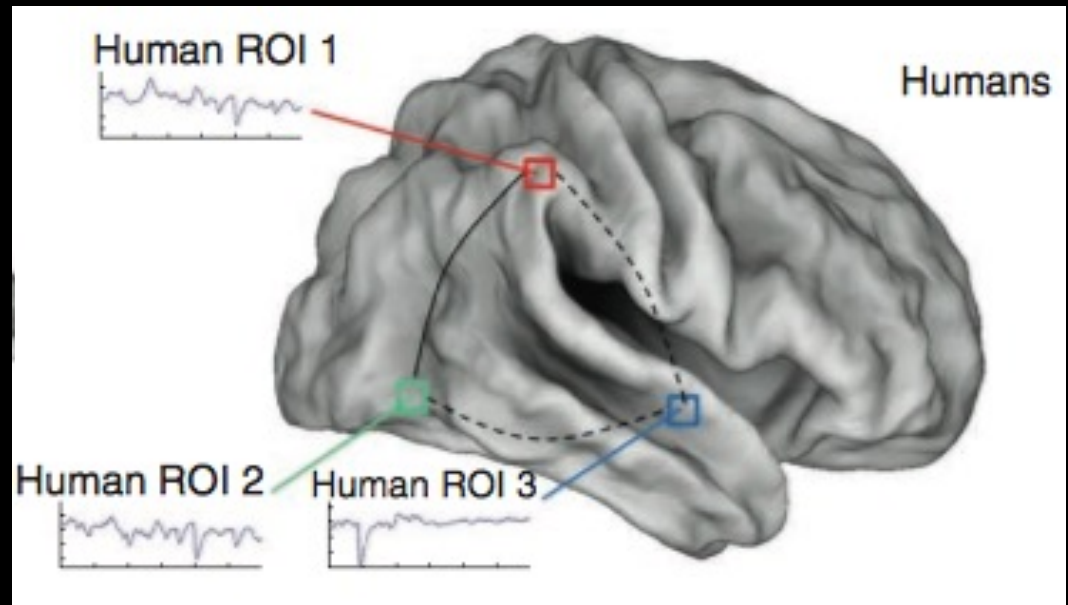
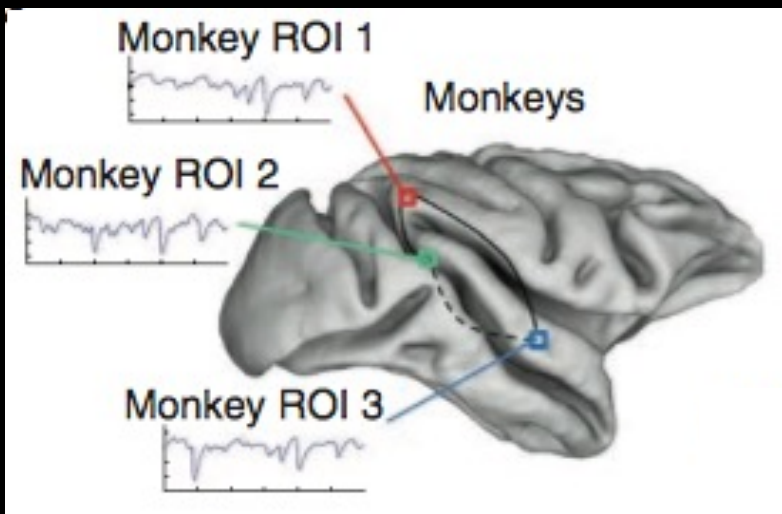


n=8

(d) **Washington Square Park** (segment of reality)

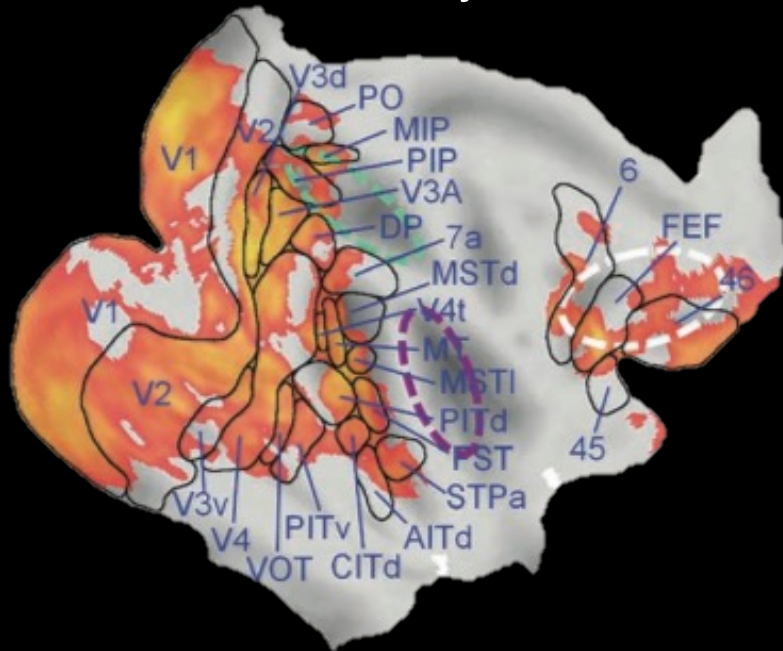


# Cross-Species Brain Activity

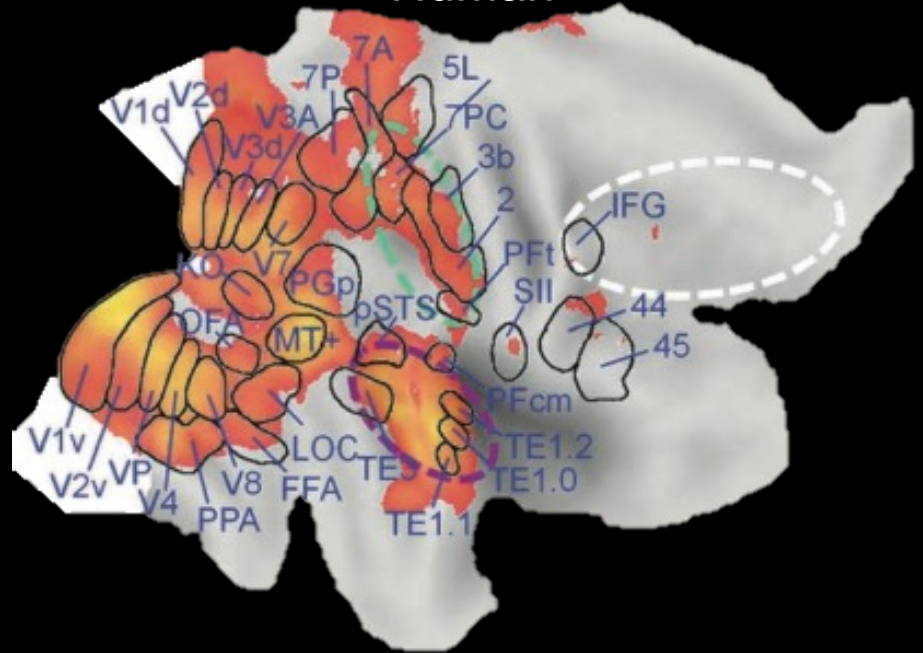


# Cross-Species Brain Activity

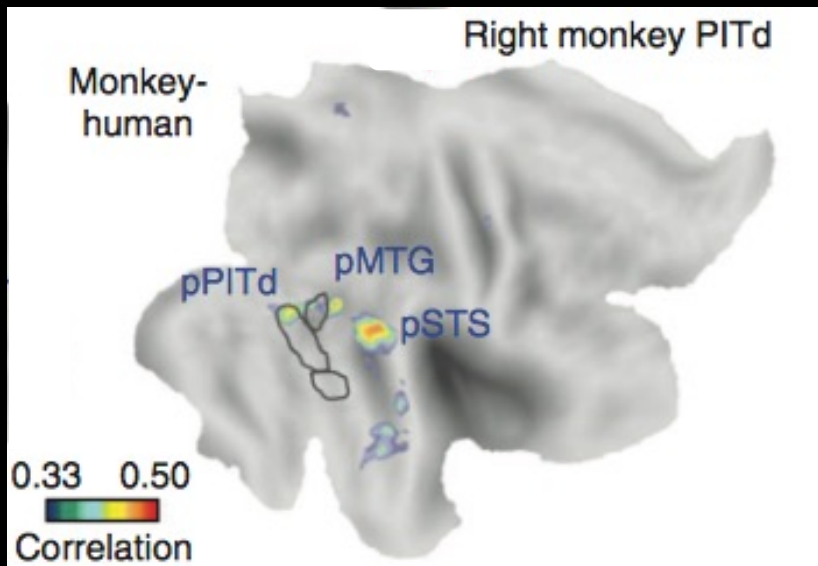
Monkey



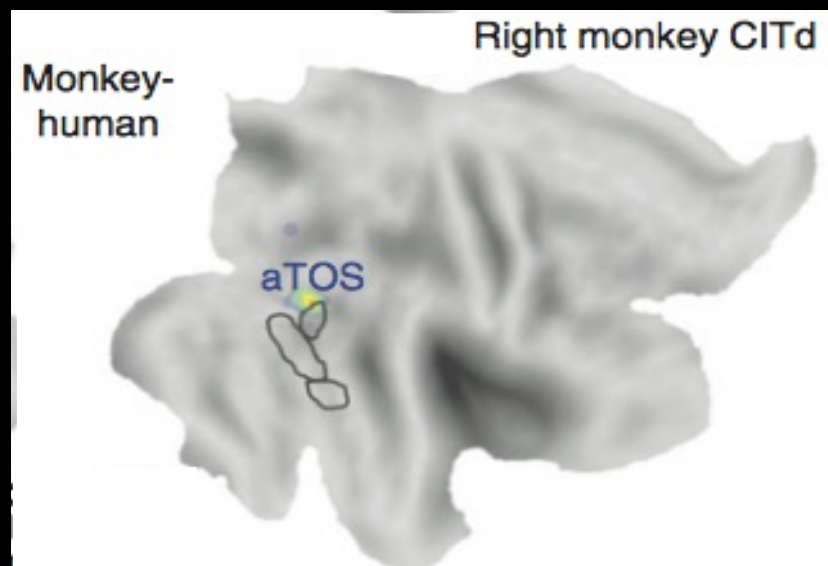
Human



Right monkey PITd



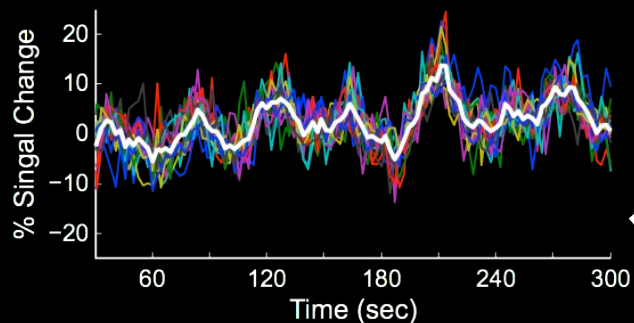
Right monkey CITd



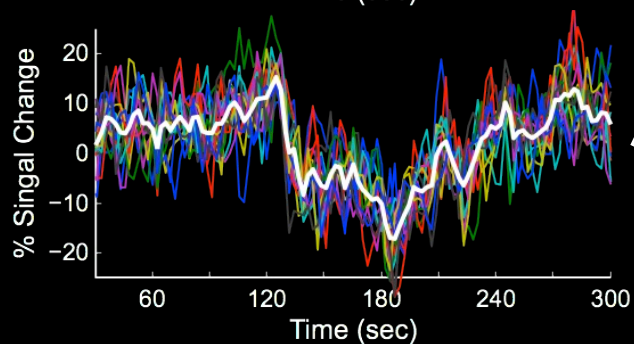


# Cross-Species Brain Activity

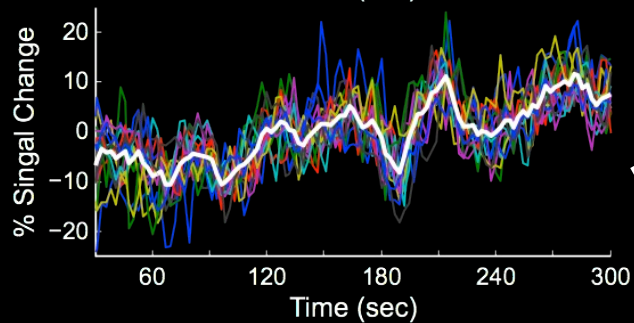
MT



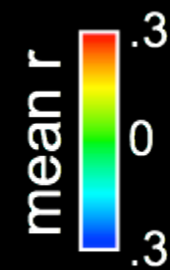
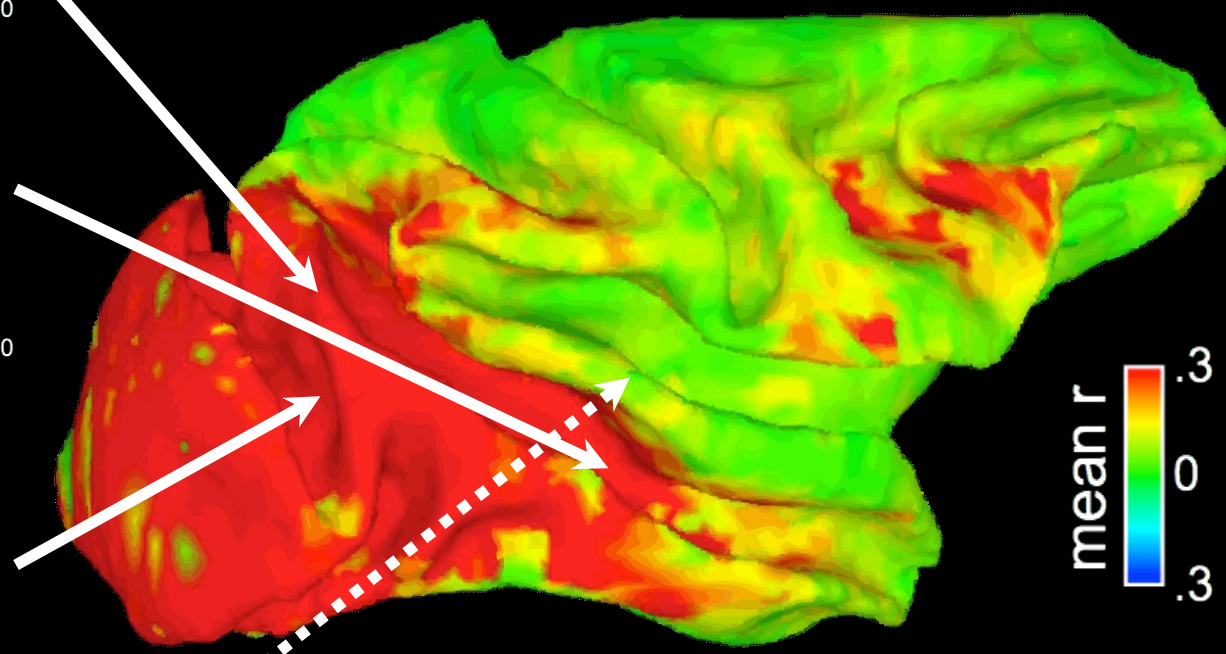
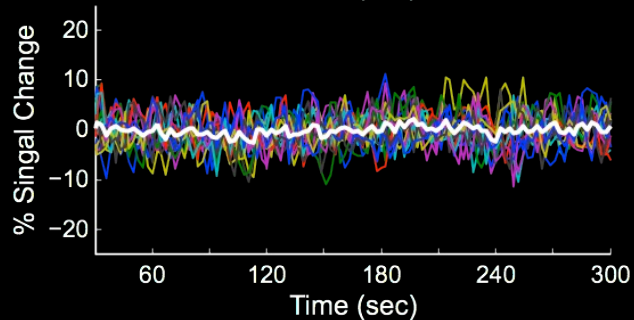
TE



V4



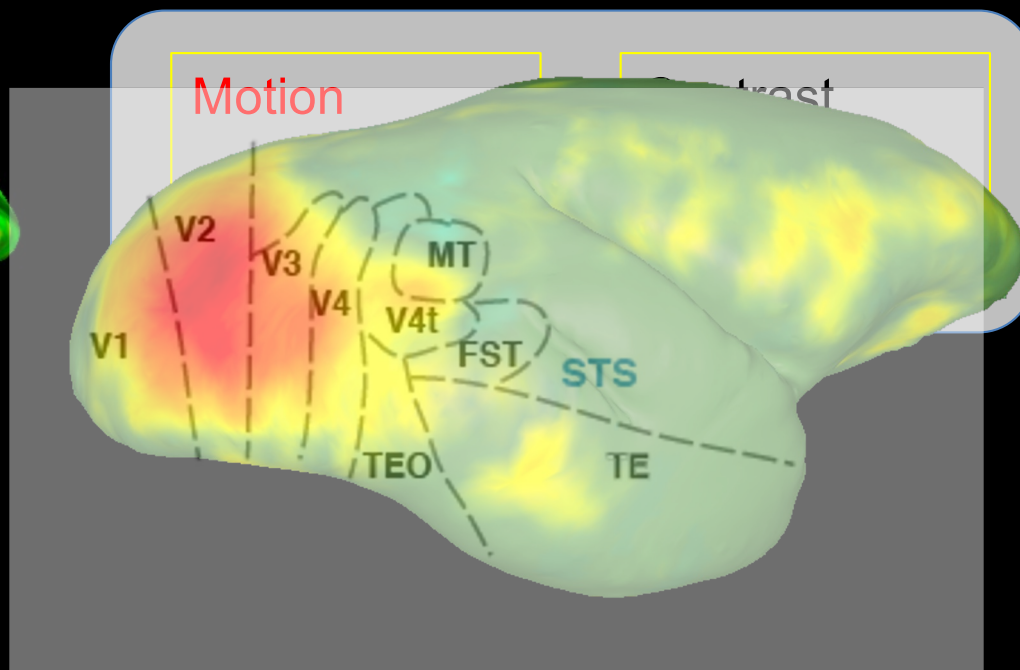
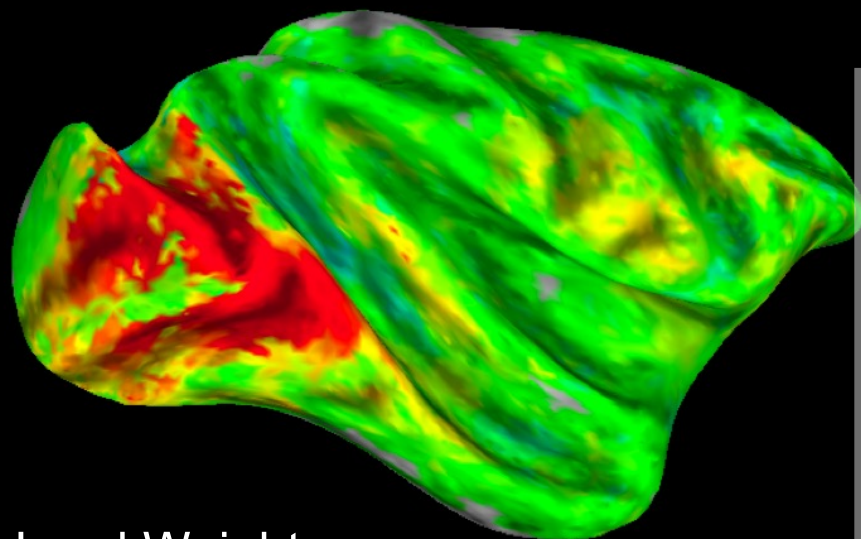
A1



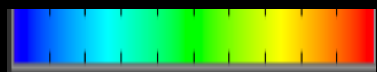
# Cross-Species Brain Activity

Space IC- Macaque

Space IC- Marmoset



Load Weight



-0.5

0.5



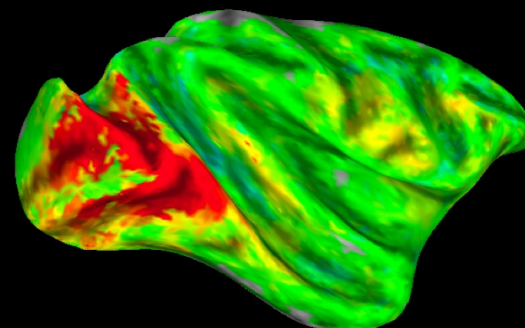
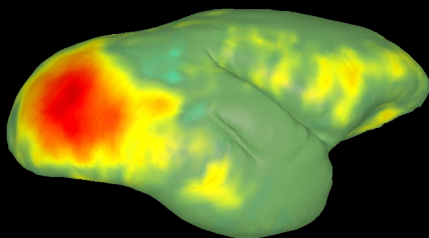
# Cross-Species Brain Activity

Feature

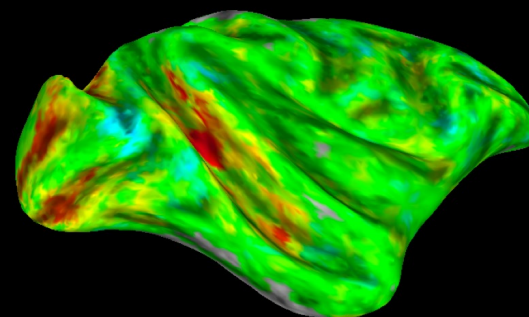
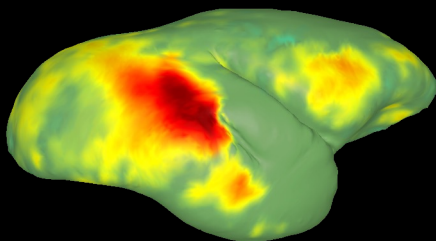
marmoset

macaque

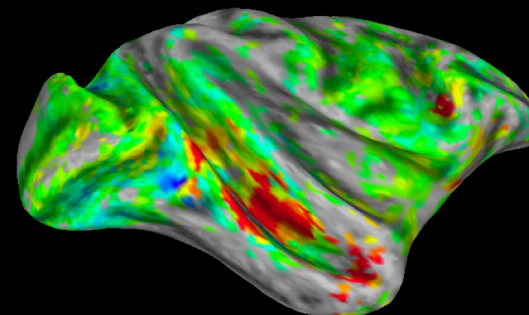
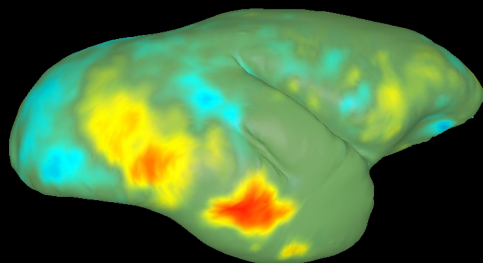
contrast



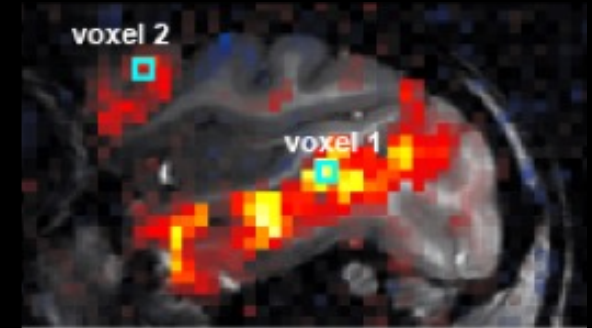
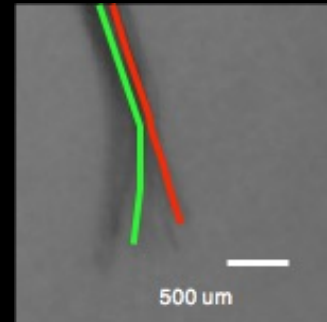
motion



Face  
responses

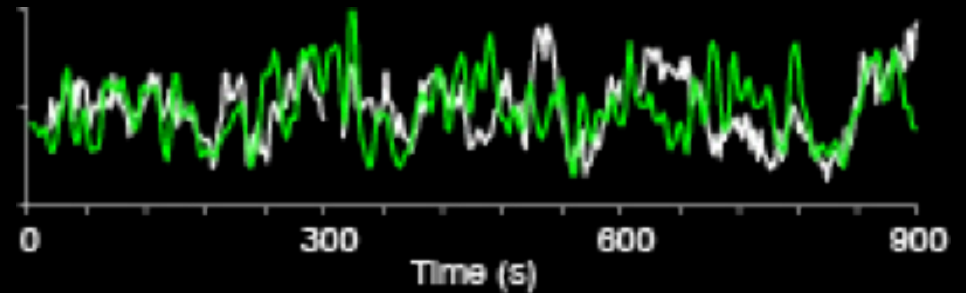
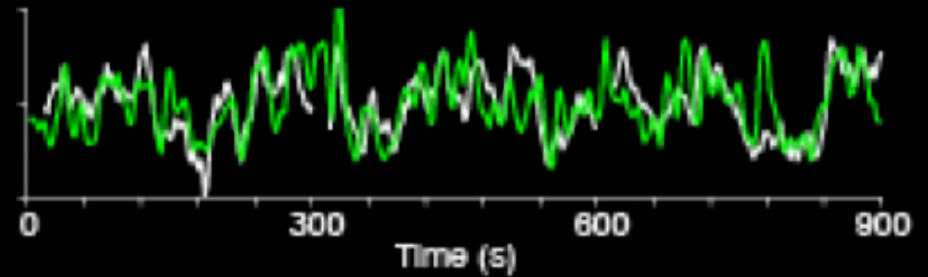


# Across Methods

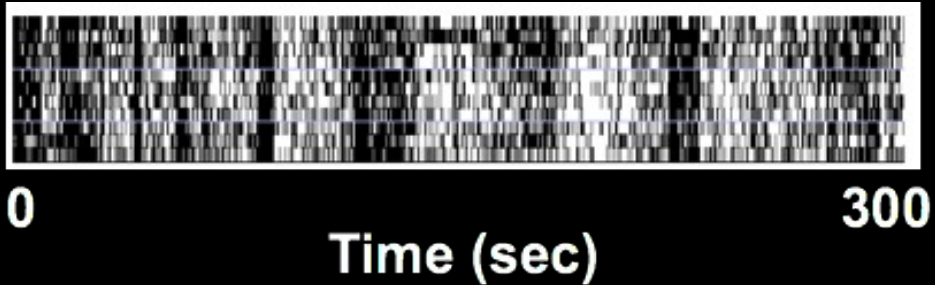
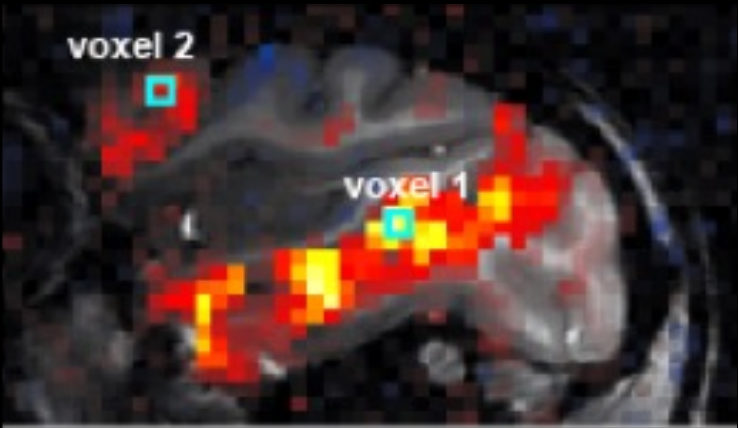
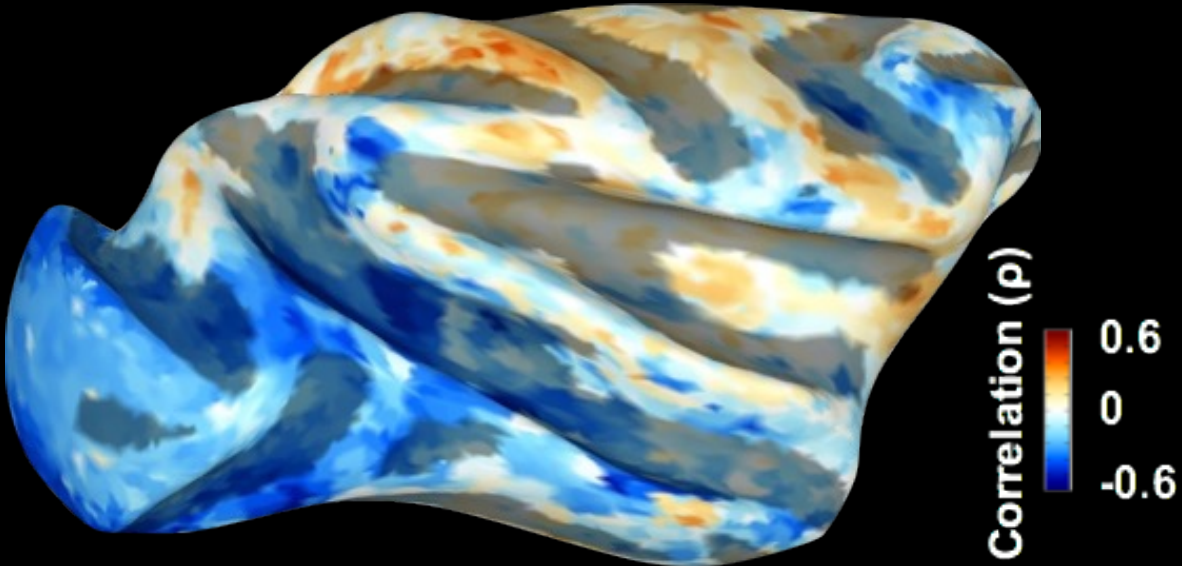
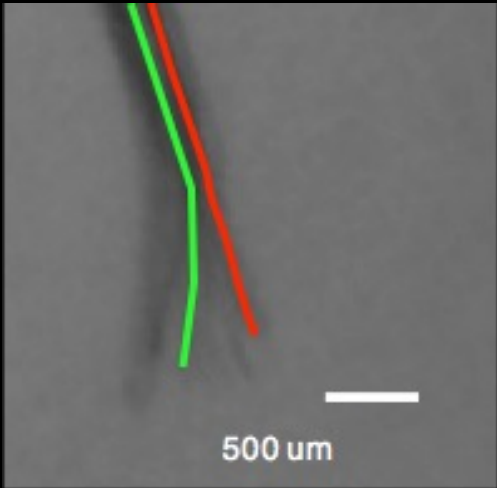


multiple single unit recordings

fMRI acquisition



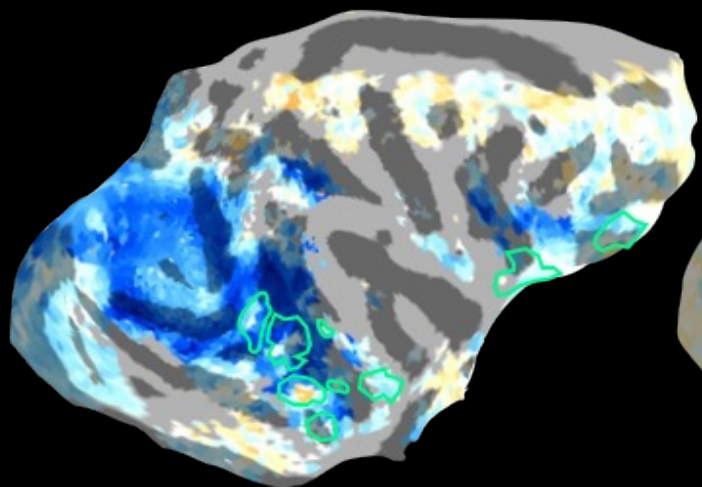
# Across Methods



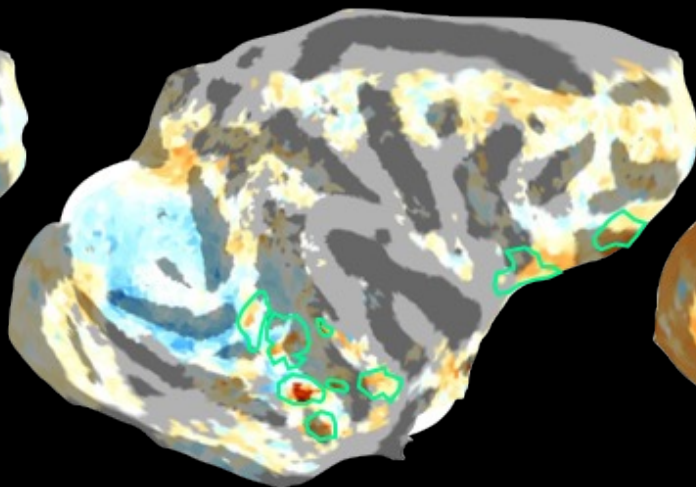


# Across Methods

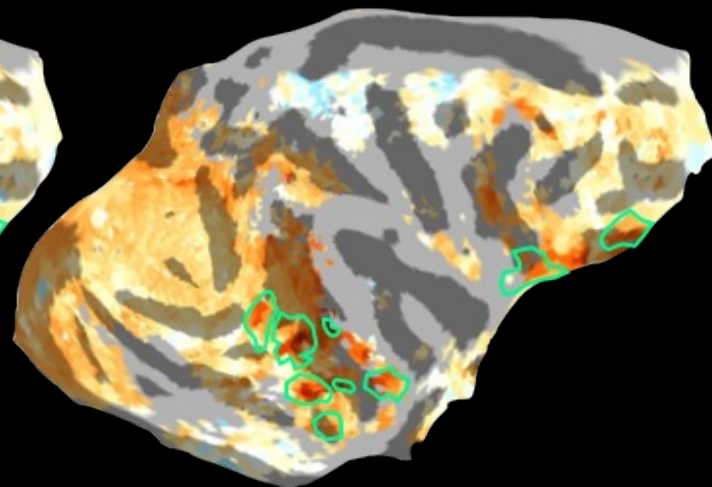
cluster 1



cluster 2



cluster 3





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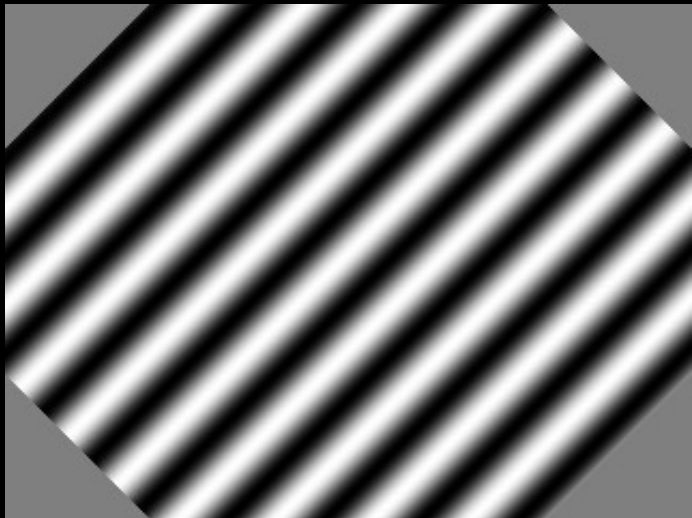
Artificial

Natural



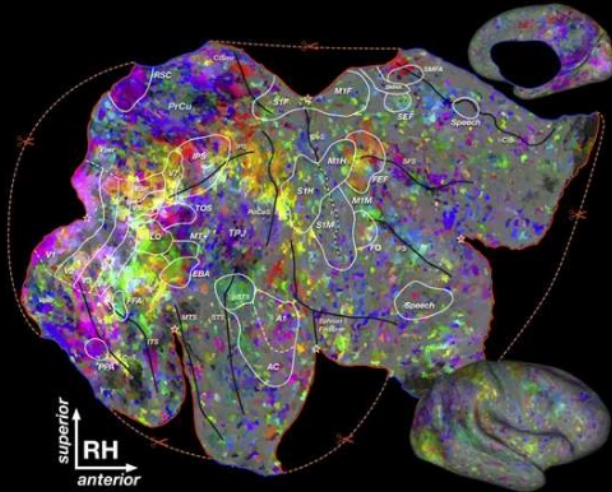
Controlled

Uncontrolled



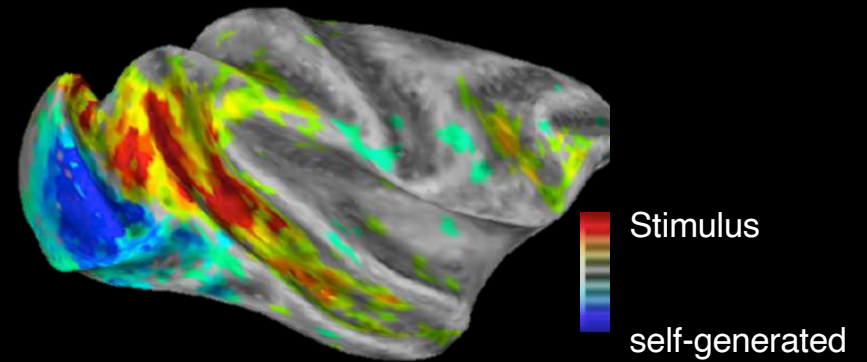
# SUMMARY

## Feature Regression

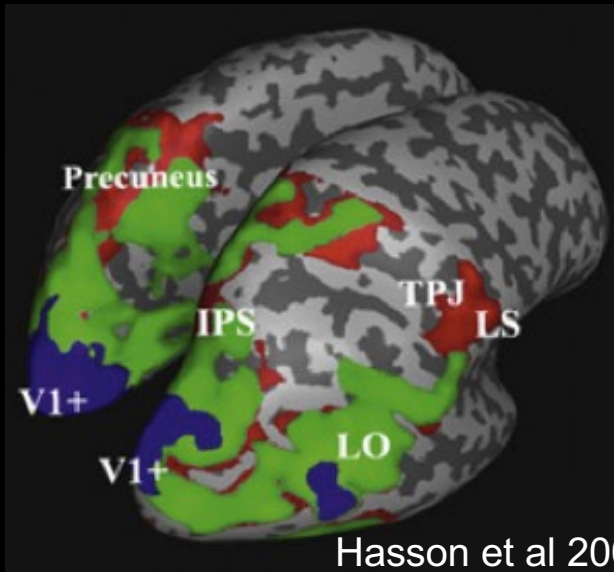


Huth et al 2012

## Stimulus & Behavioral Comparisons

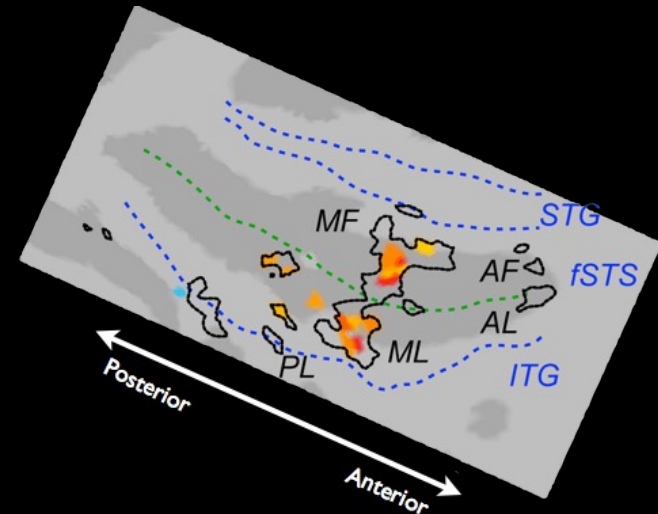


## Temporal Analysis



Hasson et al 2008

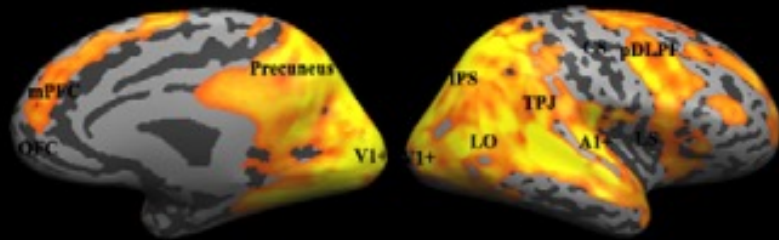
## Content Specific Reliability



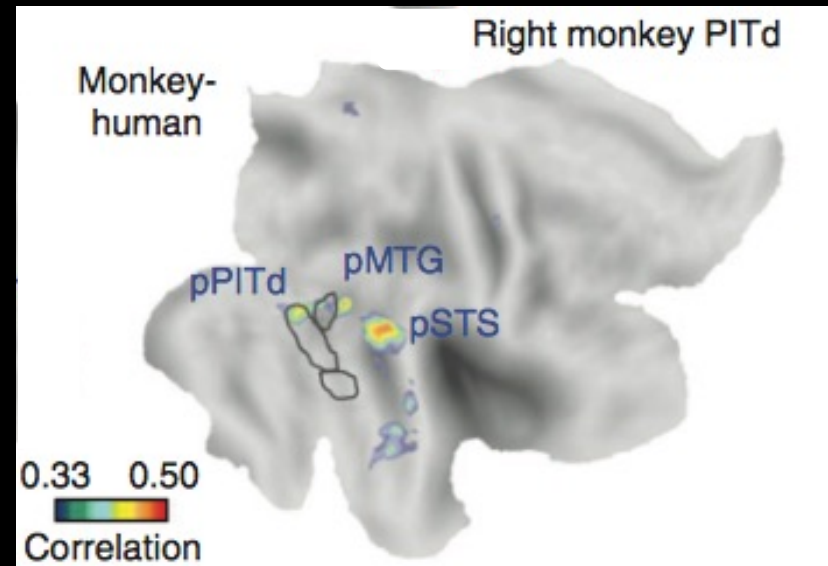
# SUMMARY

## Inter-subject Similarities

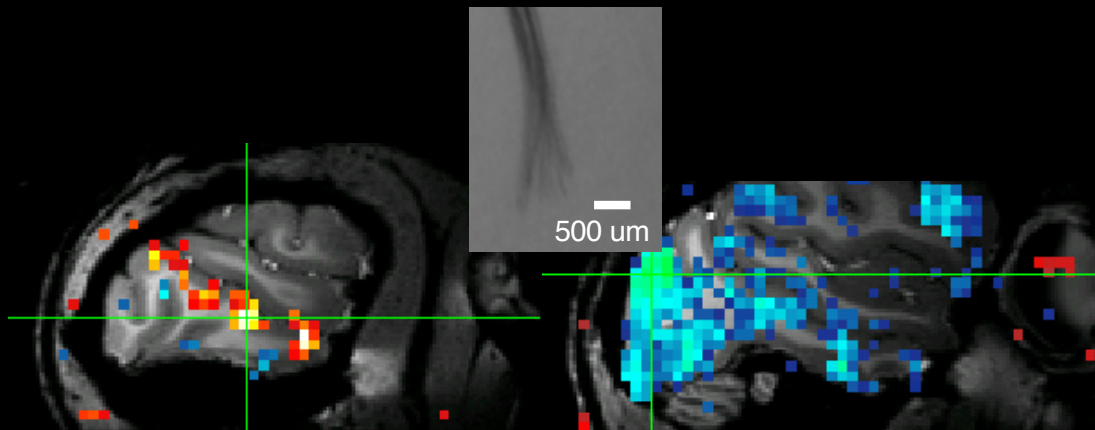
(a) Bang! You're Dead (Alfred Hitchcock)



## Inter-species Similarities



## Between Methodologies





# Thanks

David Leopold  
Chris Baker  
Alden Hung  
Soo Hyun Park

David McMahon  
Katy Smith  
Charles Zhu  
Frank Ye

## References

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