



# Approaches to functional activity mapping during natural viewing

Brian E Russ

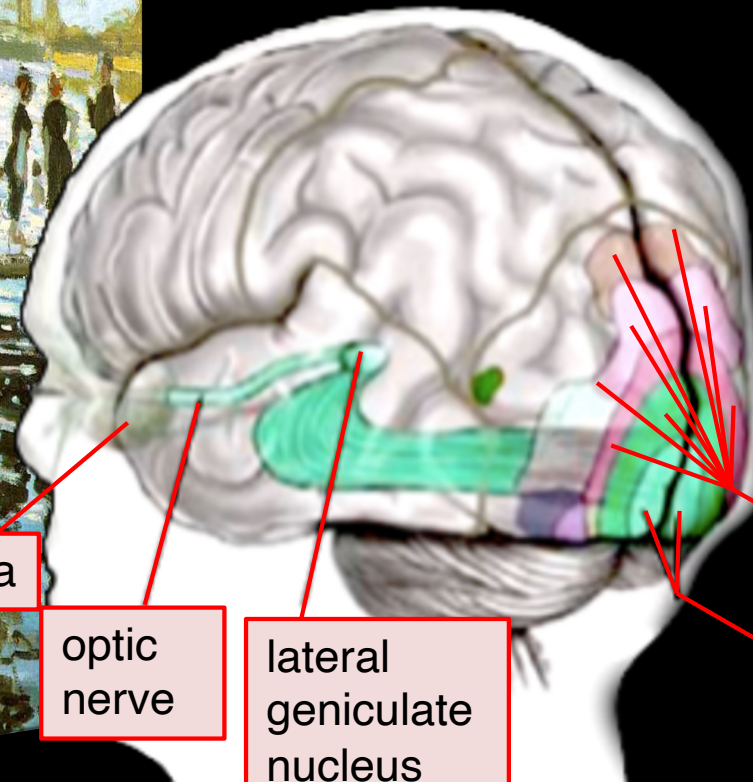
fMRI/MRI Summer Course  
July 01, 2016



# 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

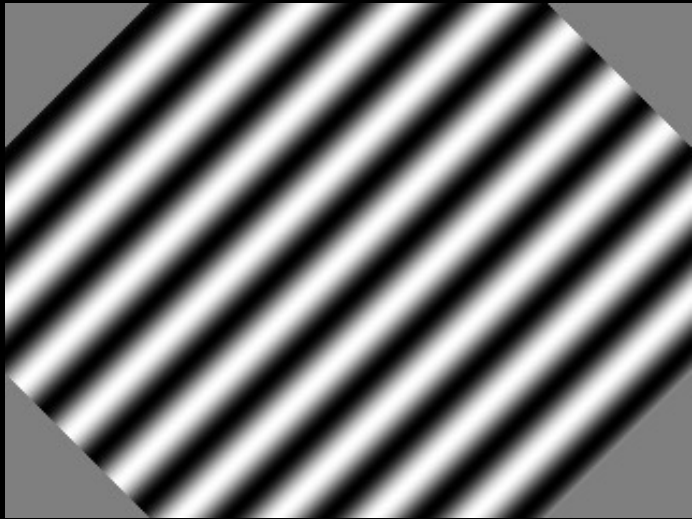
Artificial

Natural

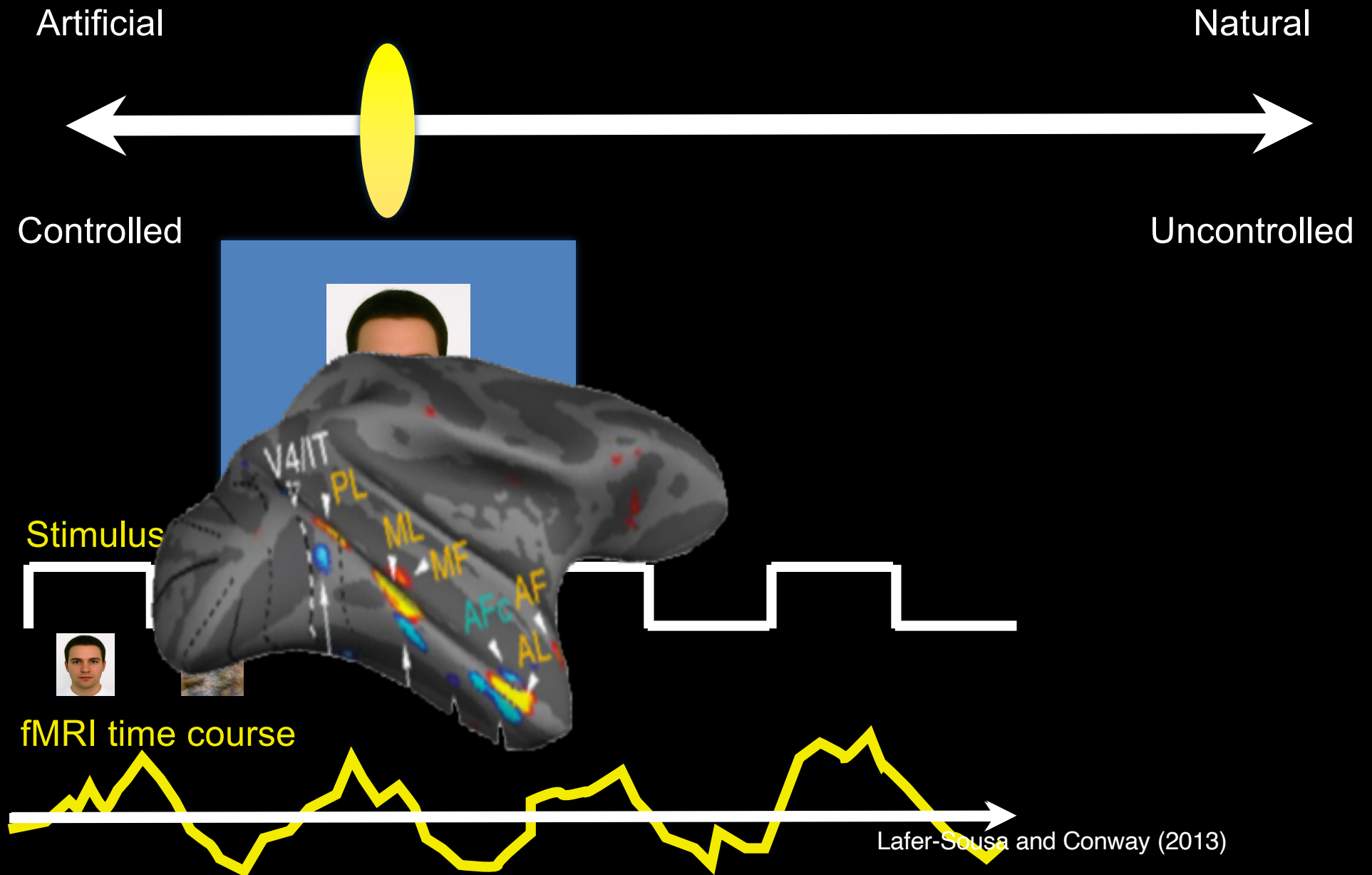


Controlled

Uncontrolled

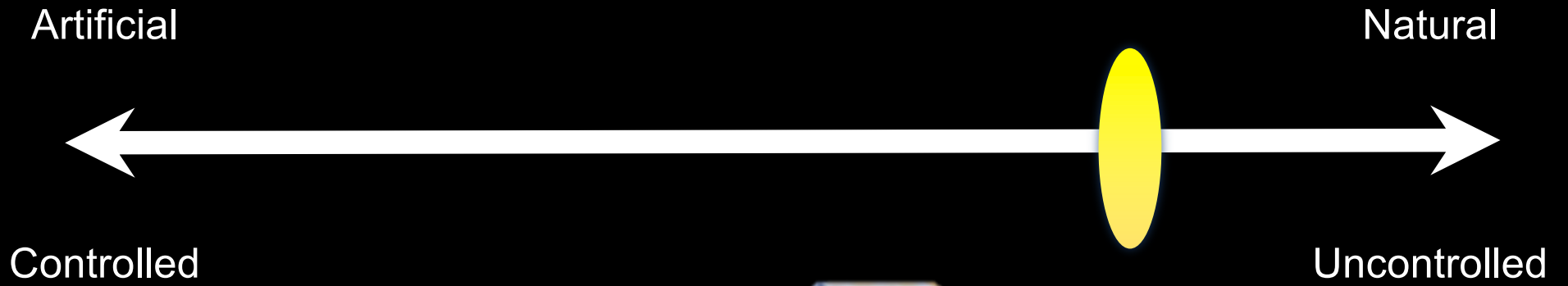


# Experimental Designs






# 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

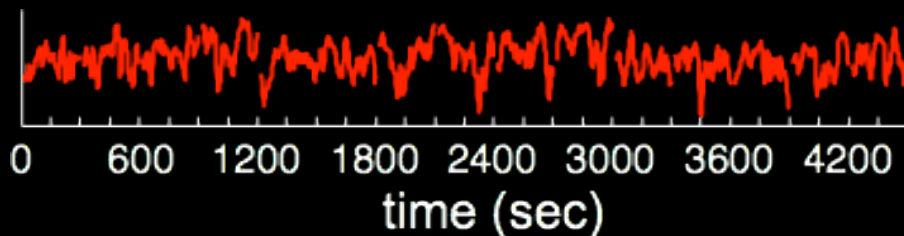
## - Body Parts

Heads  
Faces  
Butts  
Hands/Feet

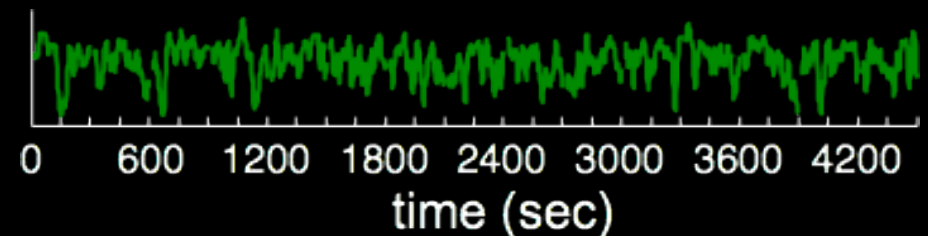
## - Behaviors

Aggression  
Grooming  
Play  
Feeding

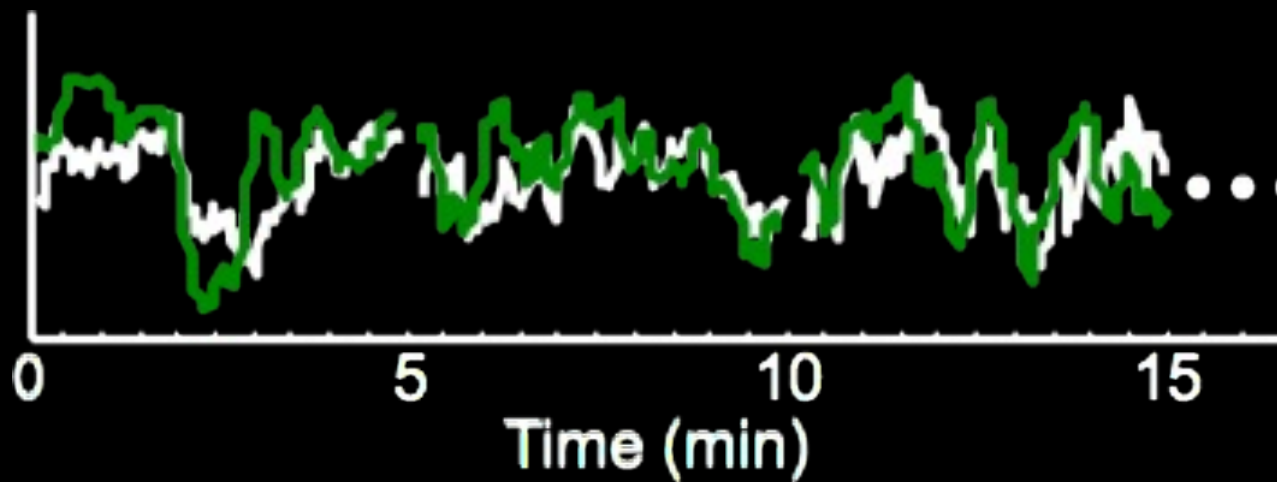
## Motion Time Course



## One Face Time Course

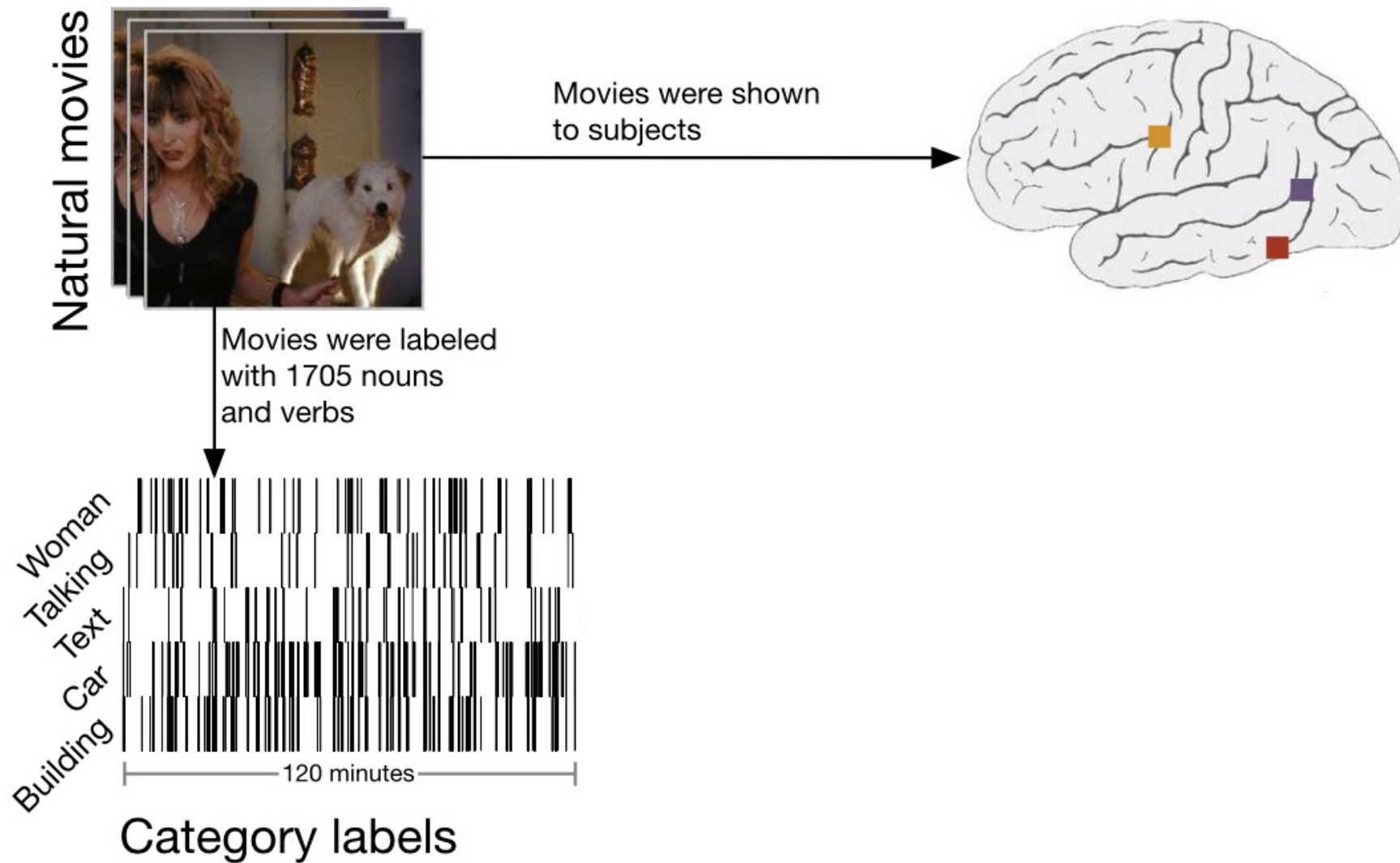


# Feature Coding



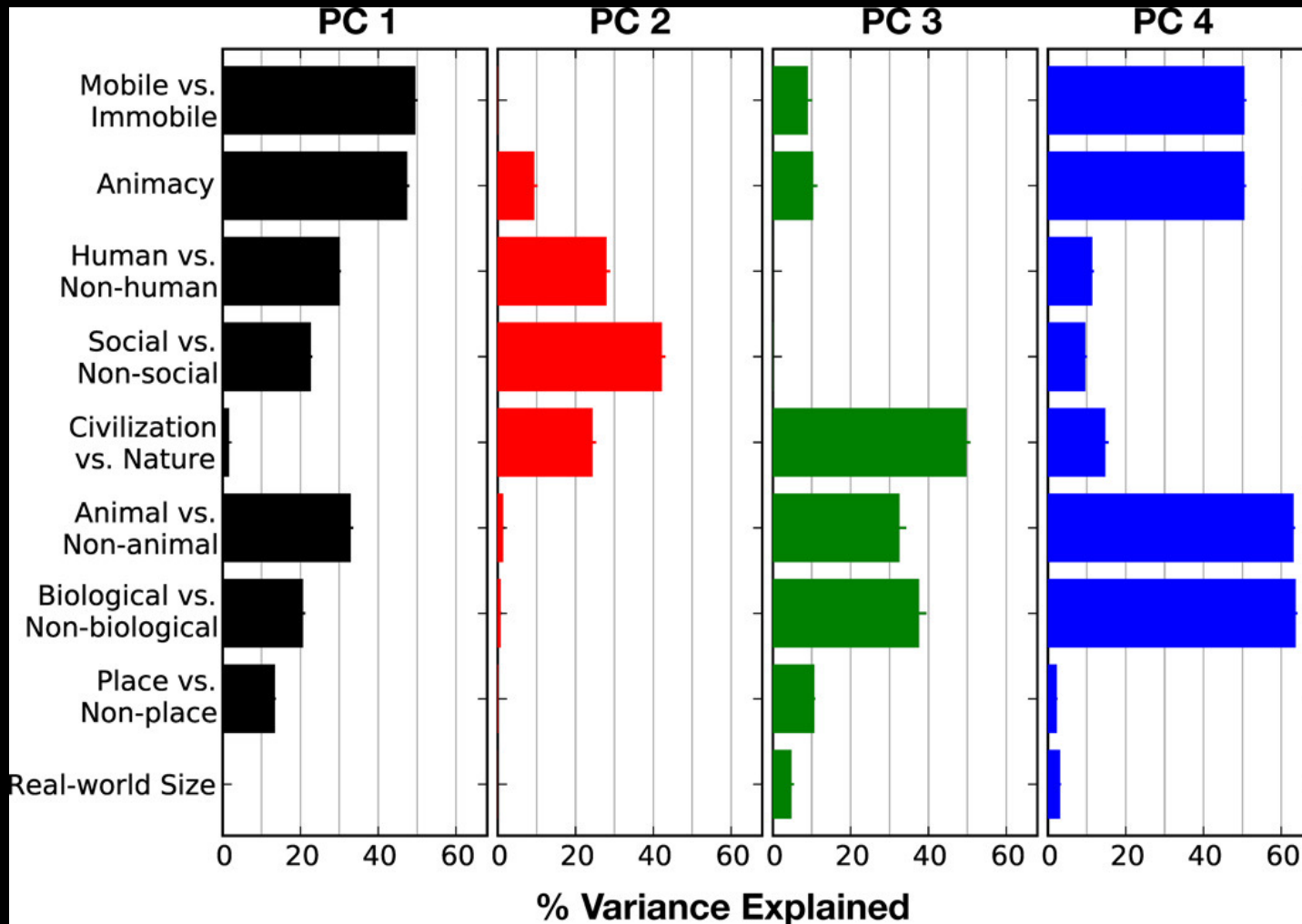
■ voxel time course (AF)  
■ *isolated face feature model*

# Feature Coding



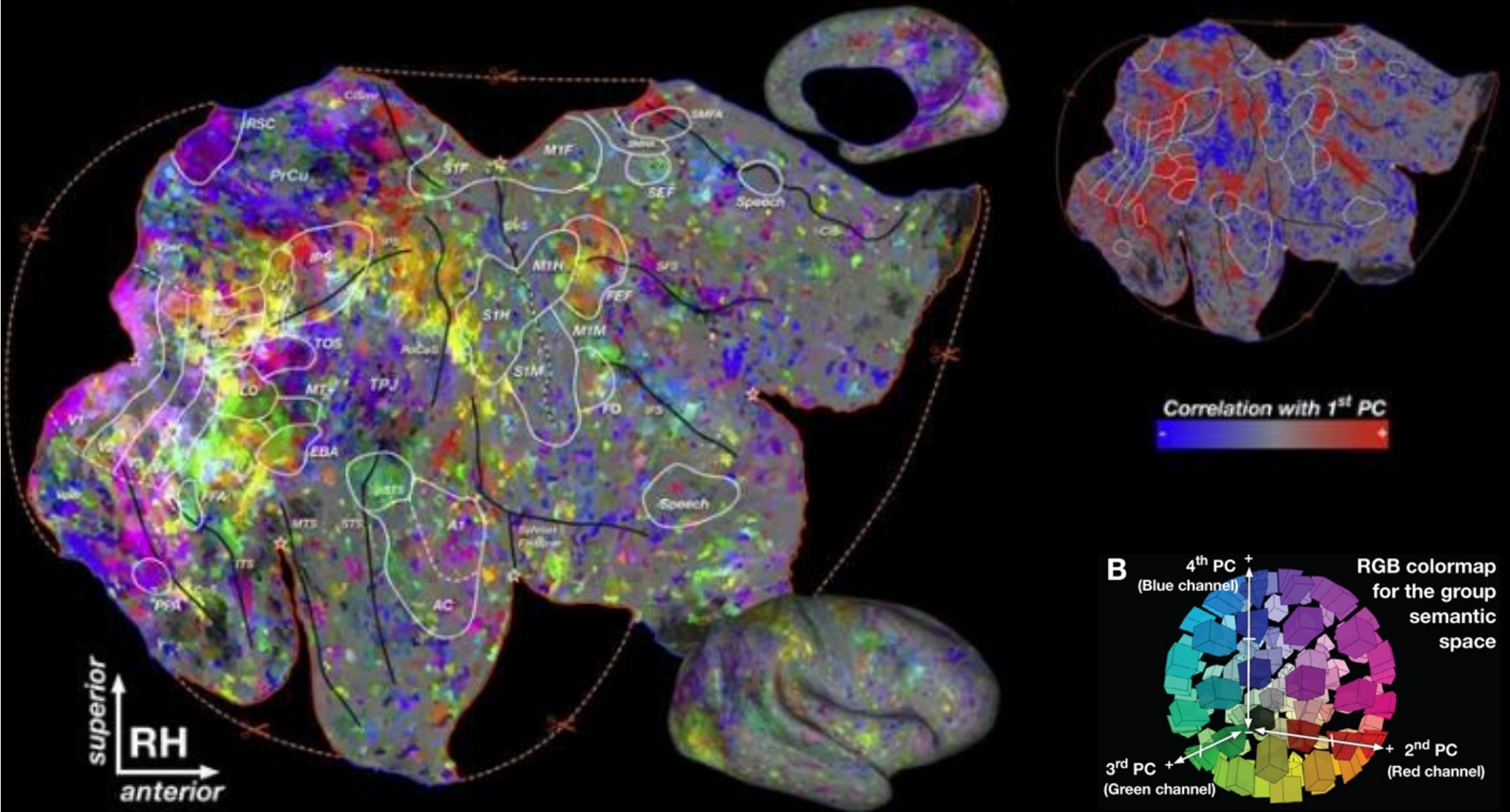


# Semantic Feature Space

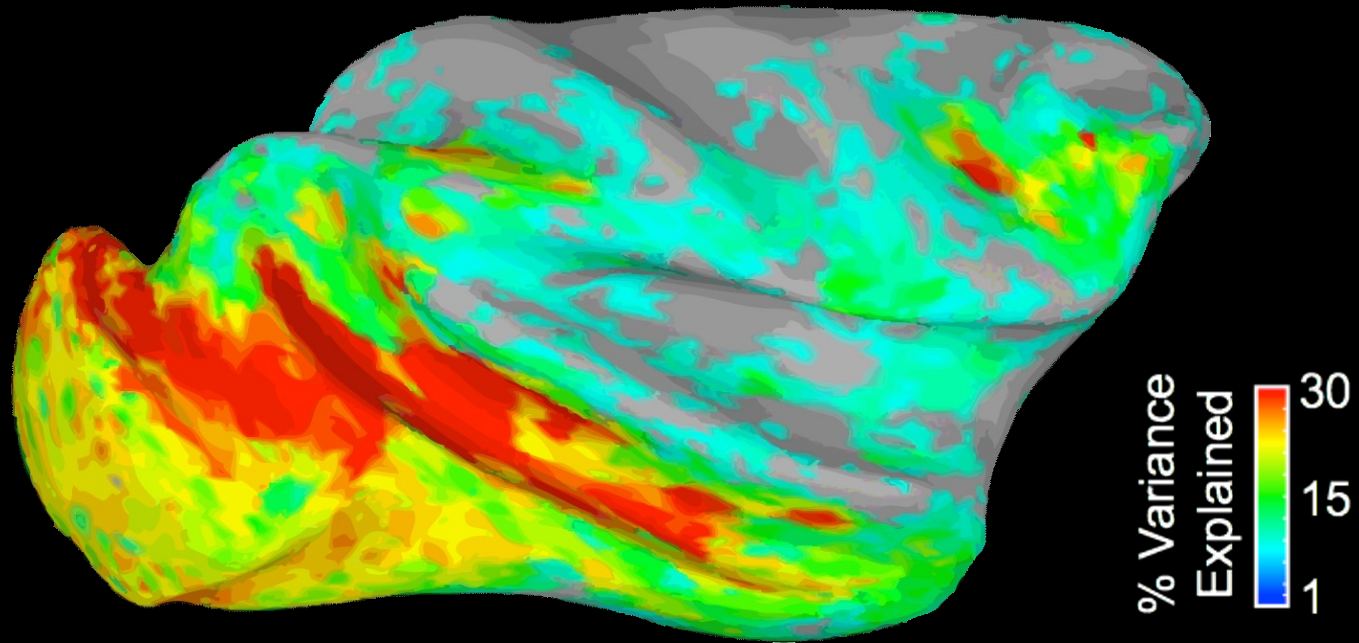




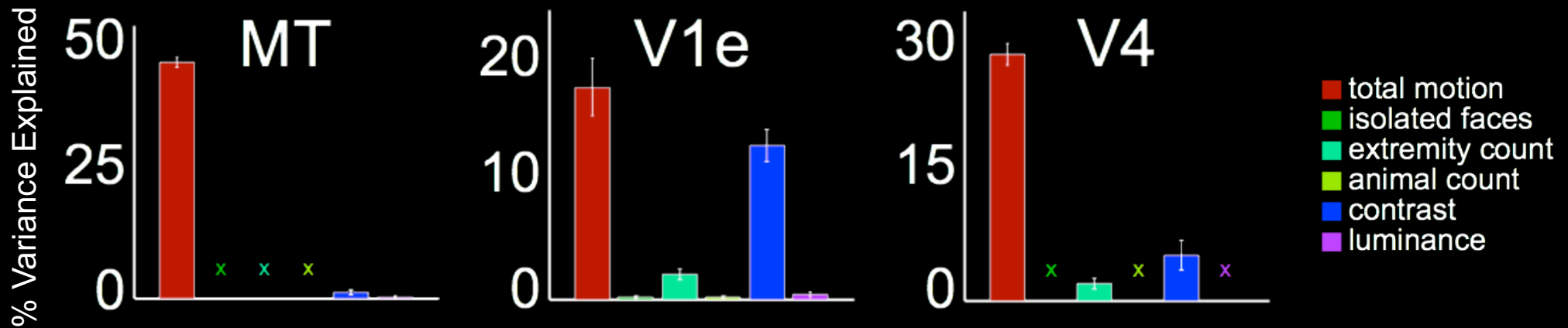
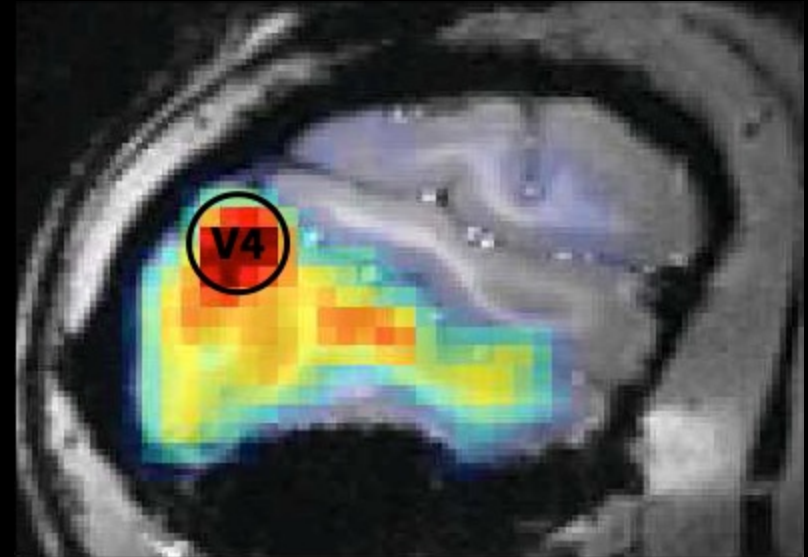
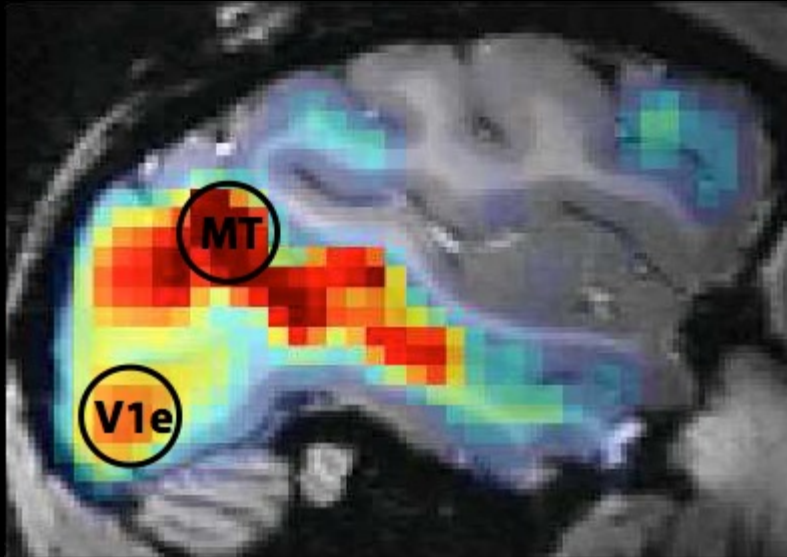
# Semantic Feature Space



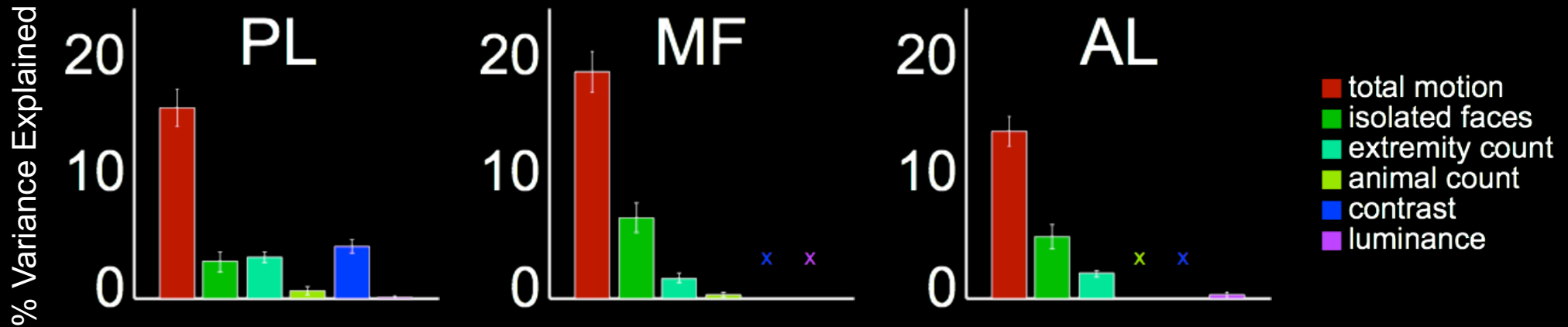
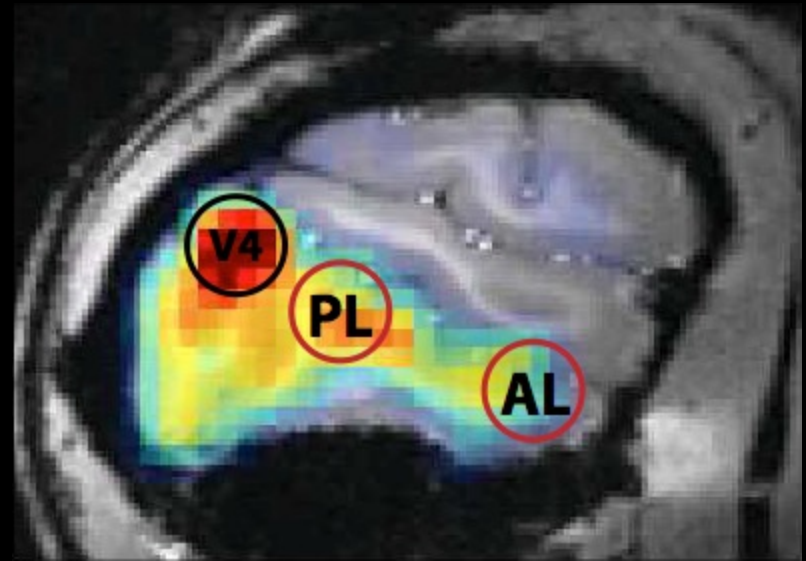
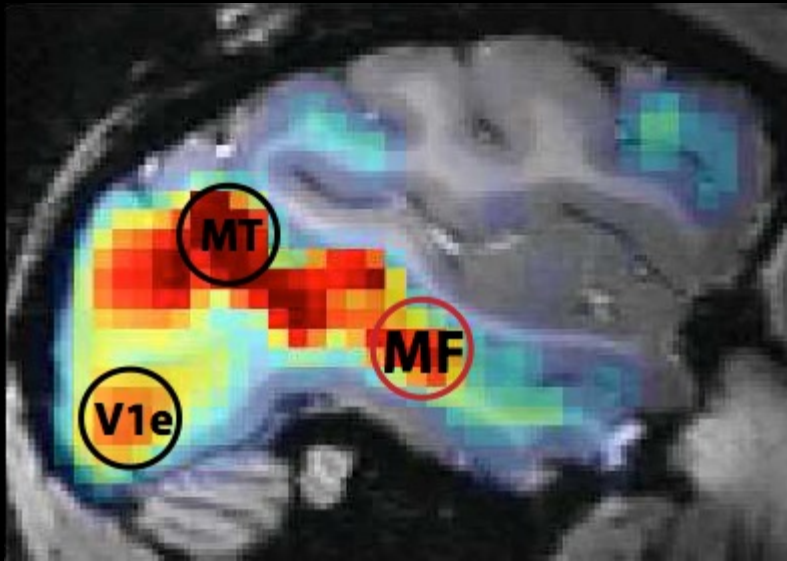
# Neural Variance Explained



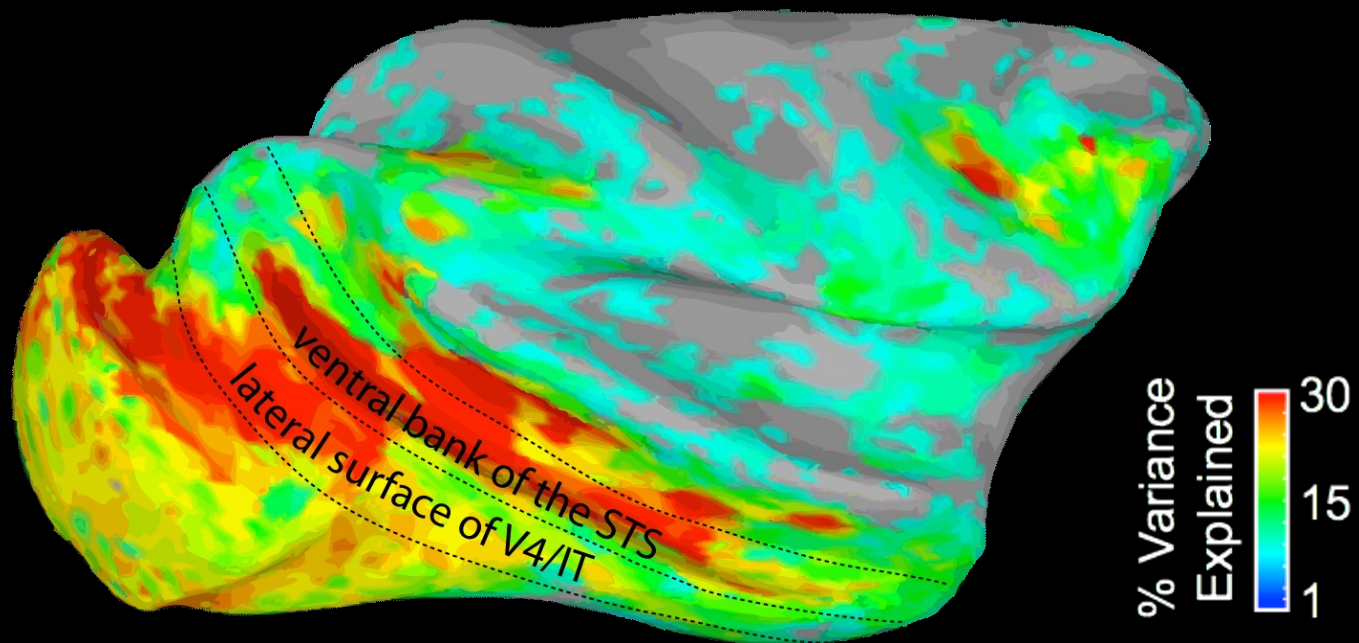
# Neural Variance Explained



# Neural Variance Explained

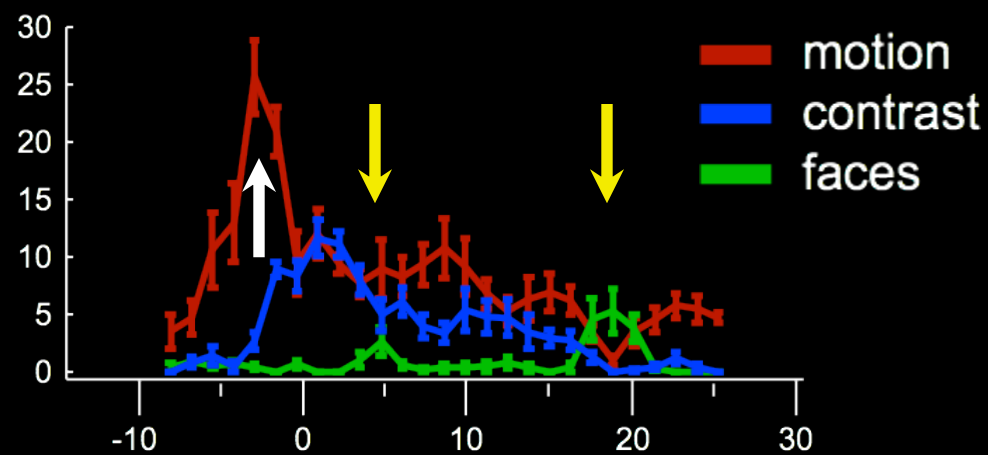
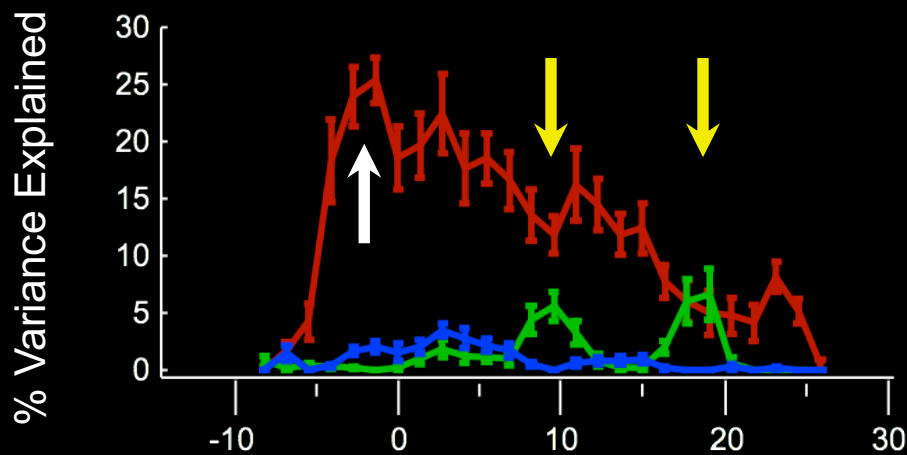


# Stimulus Motion Dominates



ventral bank of the STS

lateral surface of V4/IT

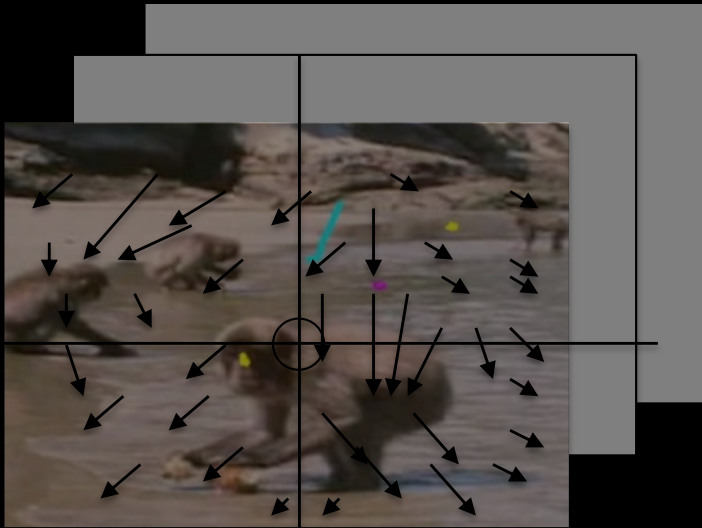


coronal slice # (relative to interaural line)

Russ & Leopold 2015

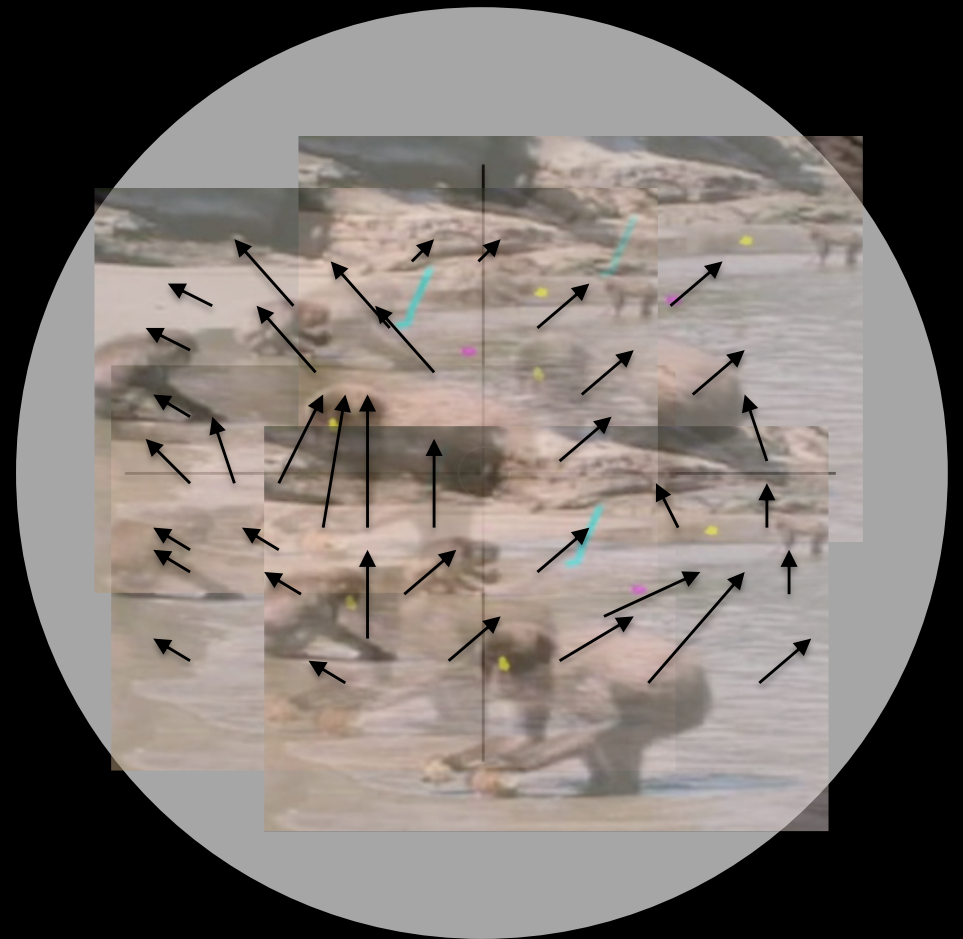
# Stimulus vs. Self-generated Motion

Screen-based reference frame



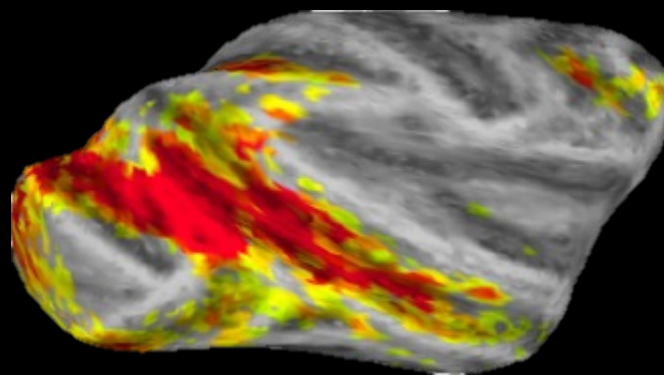
Motion vector field

Retina-based reference frame

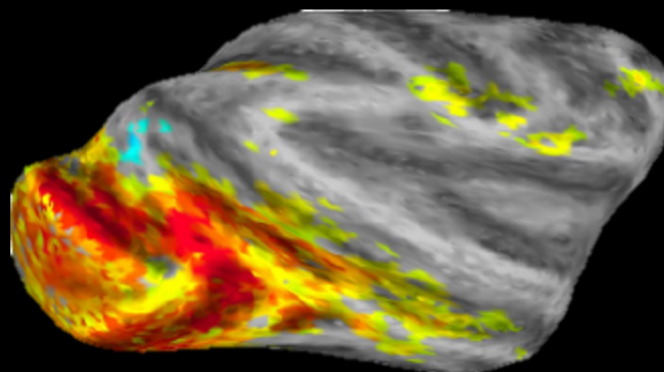


# Stimulus vs. Self-generated Motion

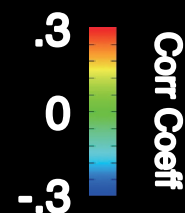
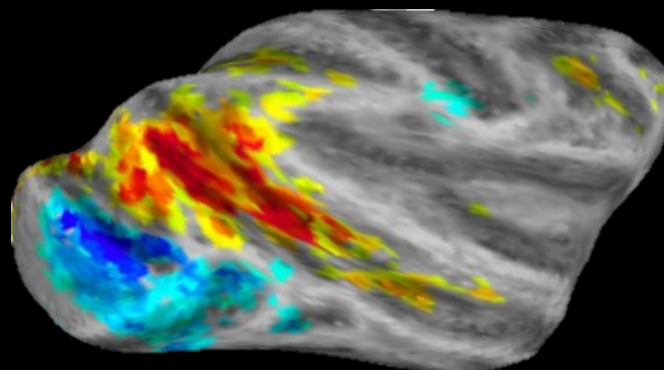
Activity caused by **video motion**  
(ignoring eye movements)



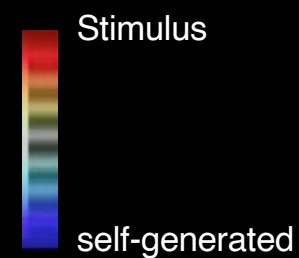
Activity caused by **eye movements**  
(ignoring video motion)



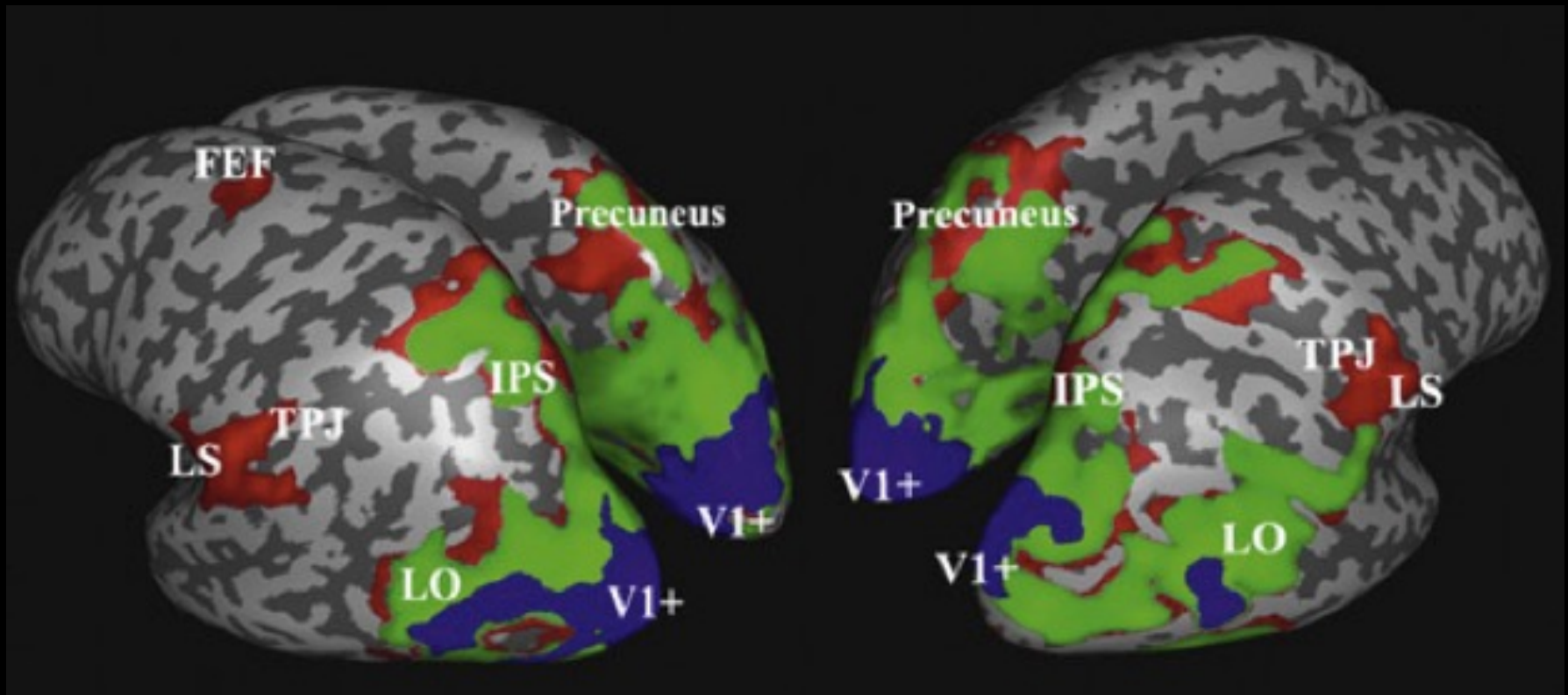
Video motion – eye movements  
(external vs. self-generated motion)



Corr Coeff



# Temporal Receptive Fields

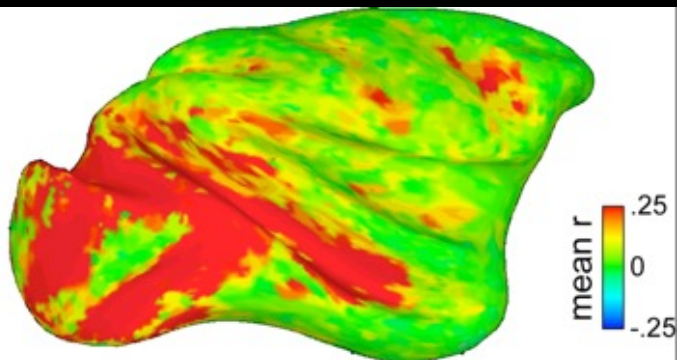


- Long (36 $\pm$ 4sec)
- Mid (12 $\pm$ 3sec)
- Short (4 $\pm$ 1sec)

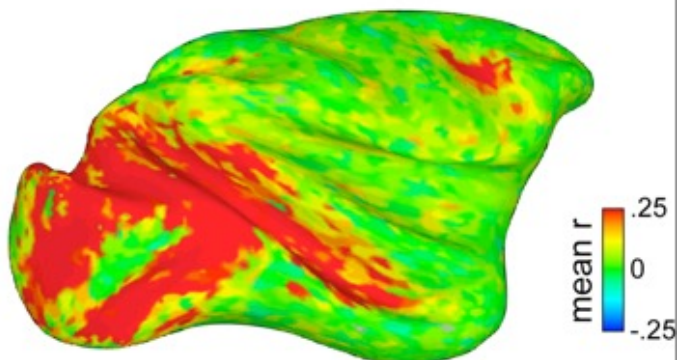


# Social Content

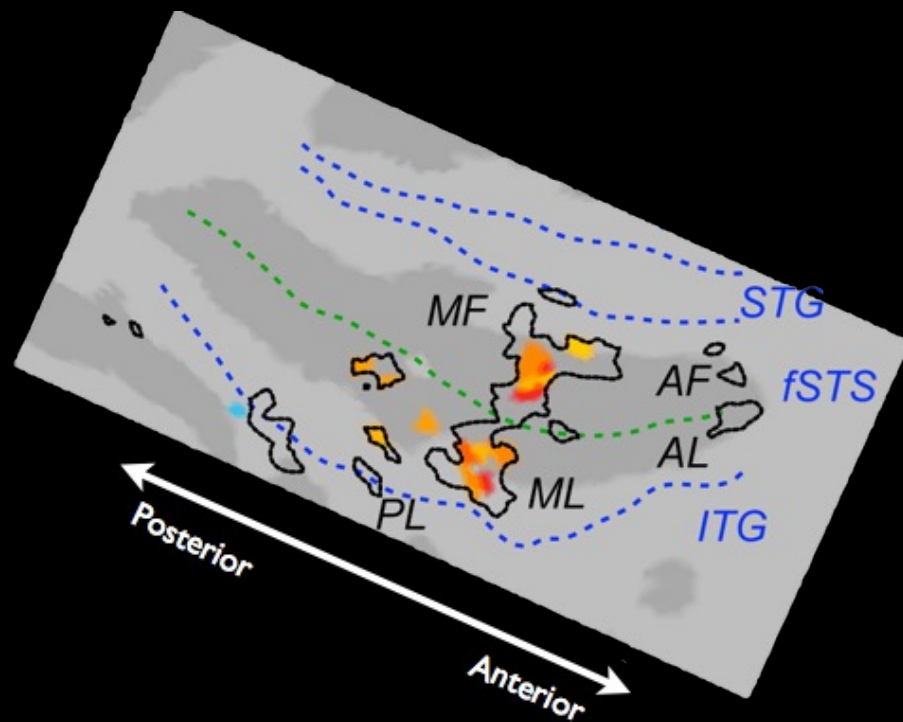
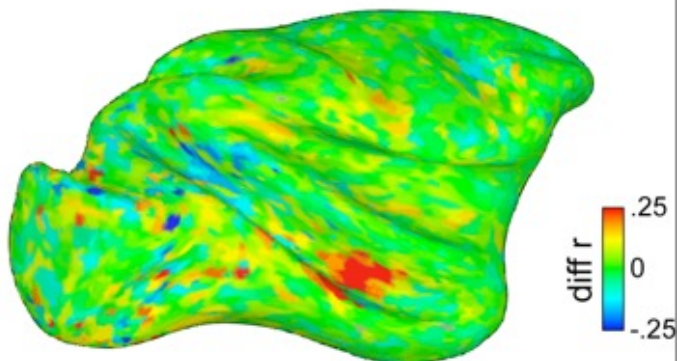
(with animals)



(without animals)



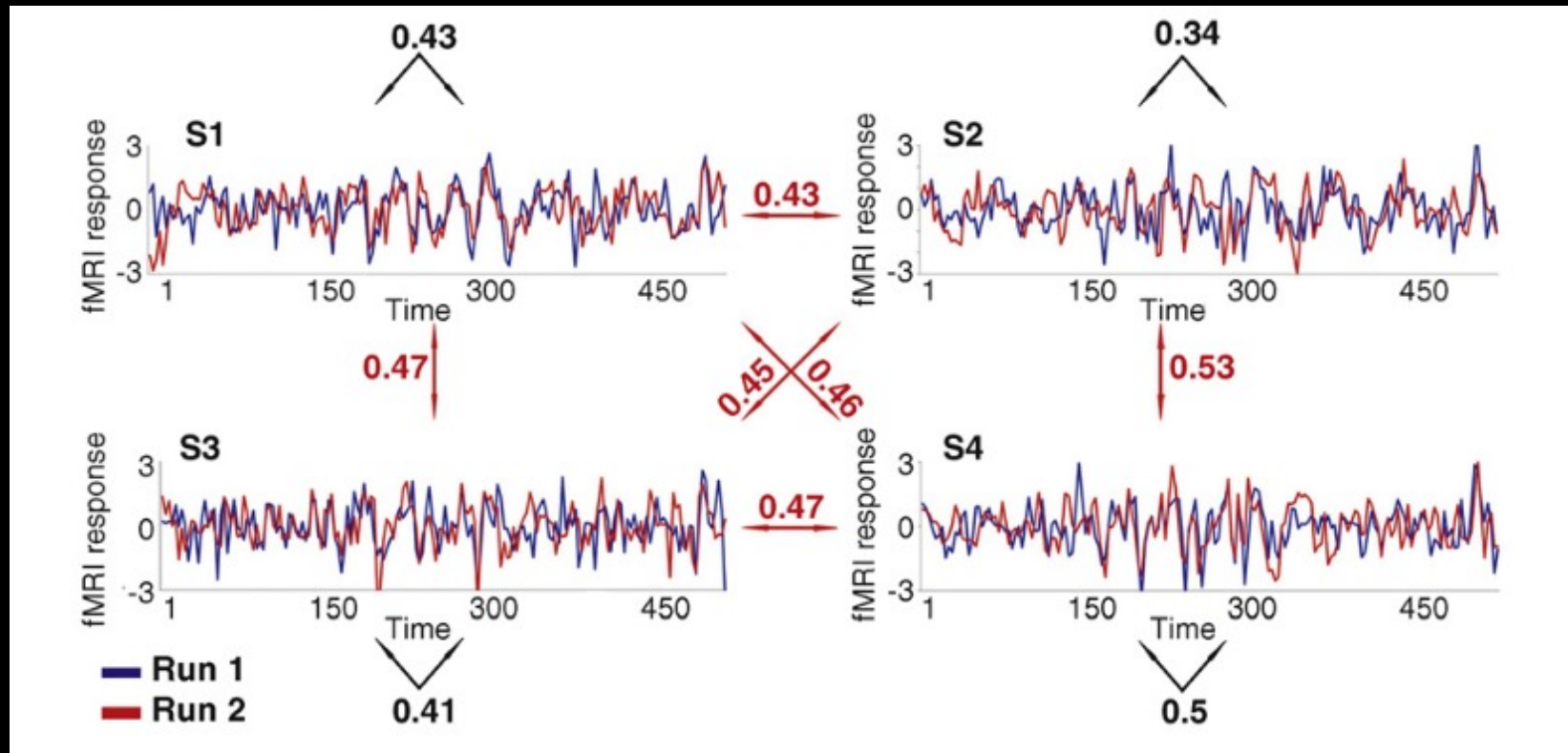
Difference



# Outline

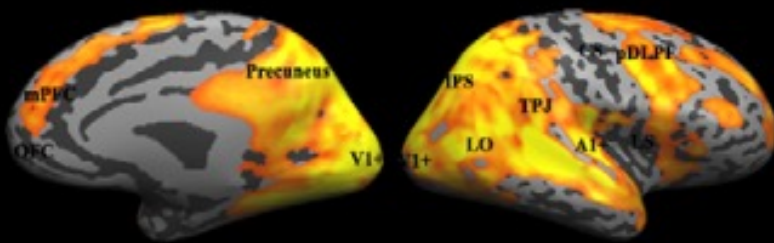
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# Synchronized Brain Activity

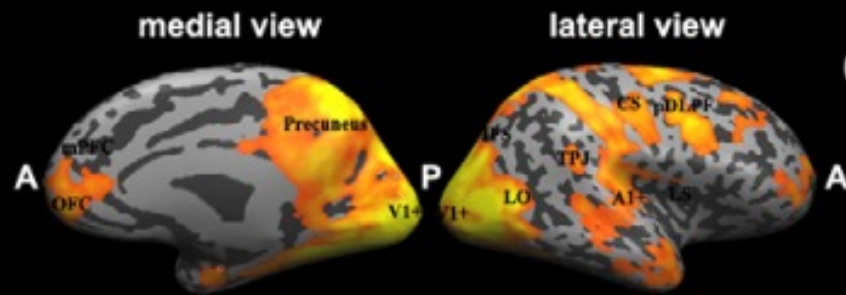


# Synchronized Brain Activity

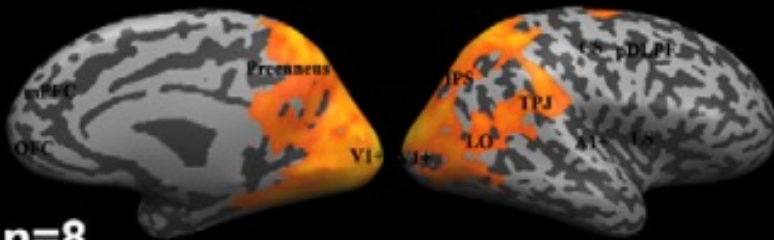
(a) **Bang! You're Dead** (Alfred Hitchcock)



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

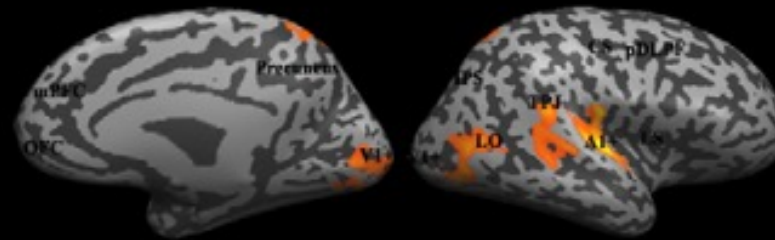


(c) **City Lights** (Charlie Chaplain)

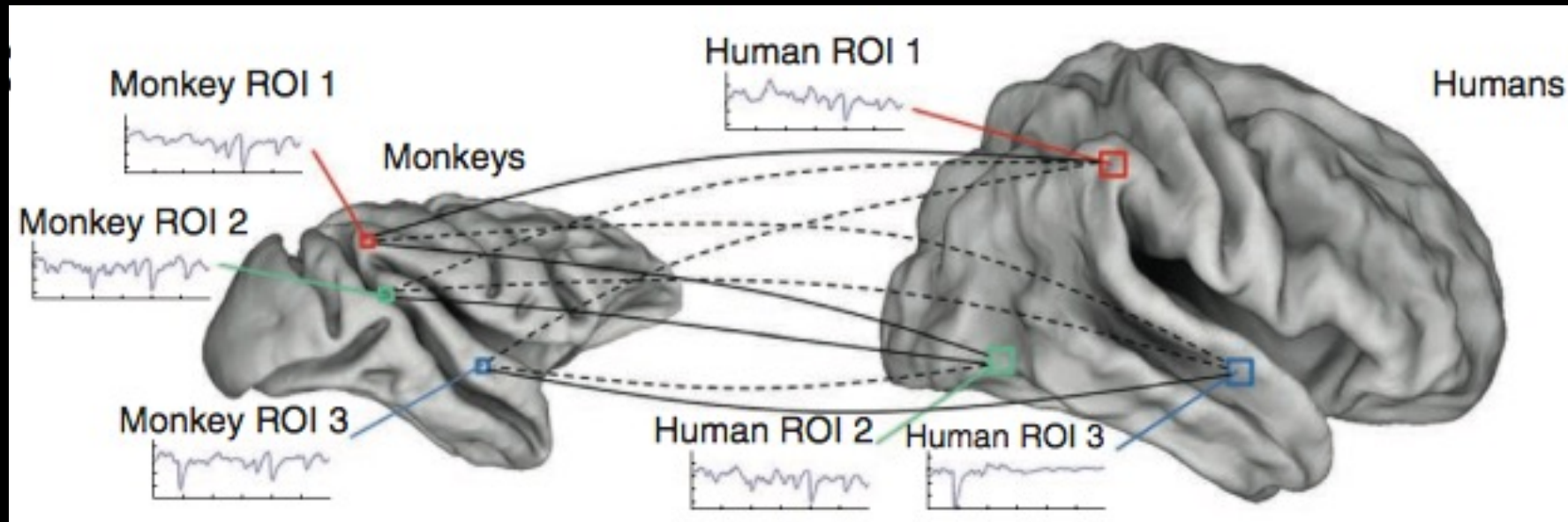
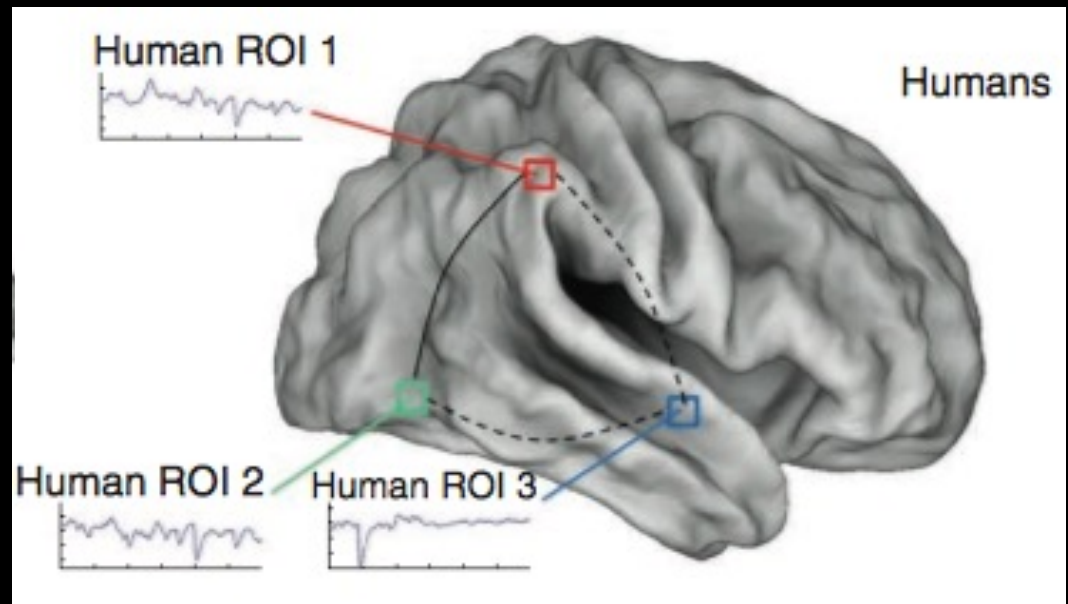
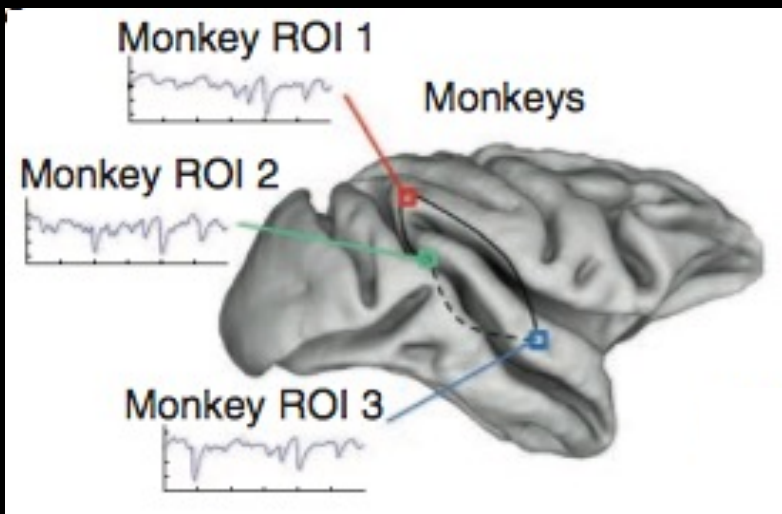


n=8

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

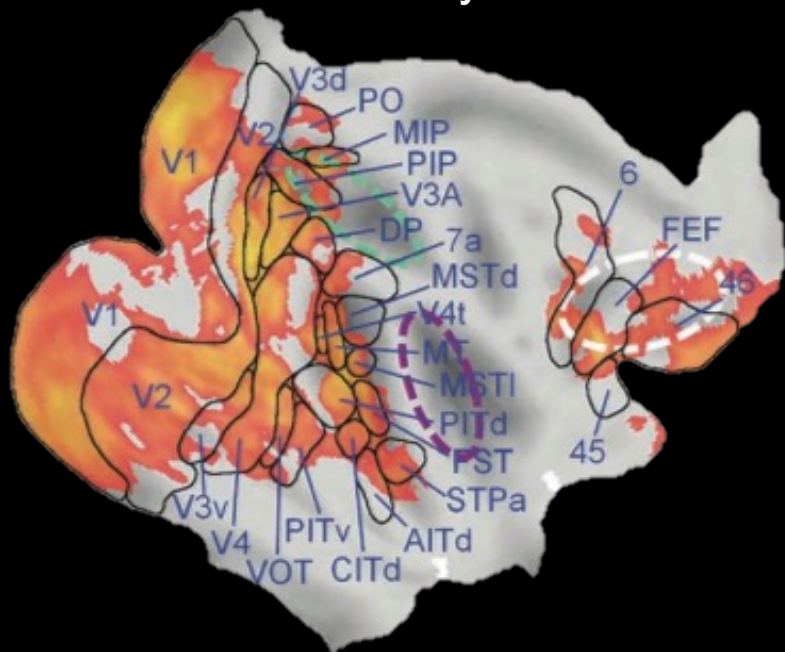


# Cross-Species Brain Activity

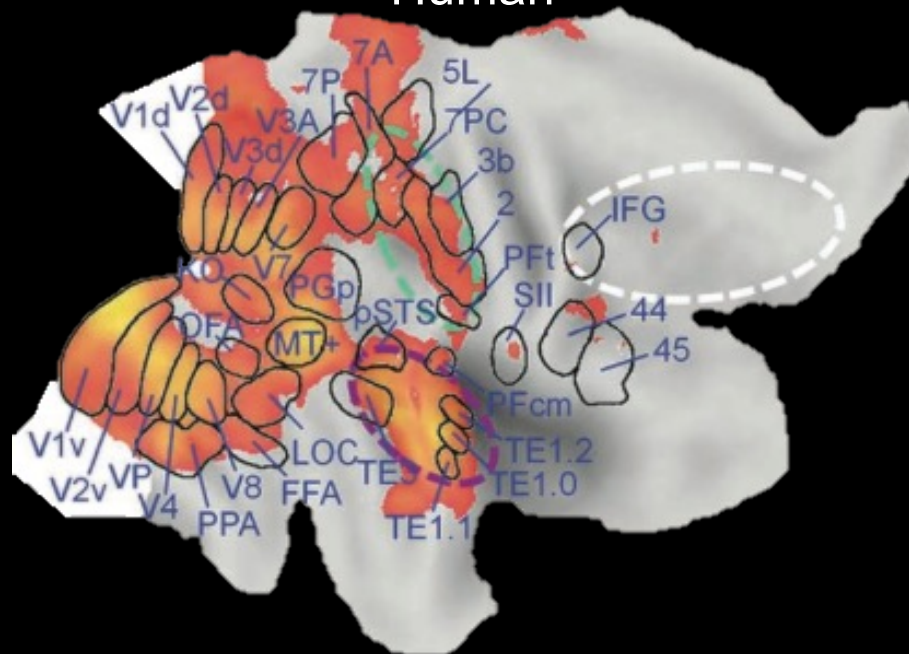


# Cross-Species Brain Activity

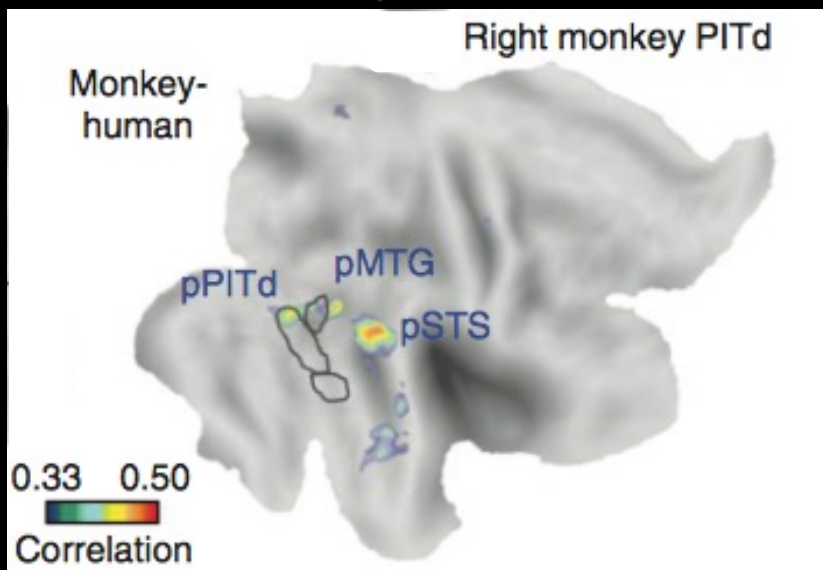
Monkey



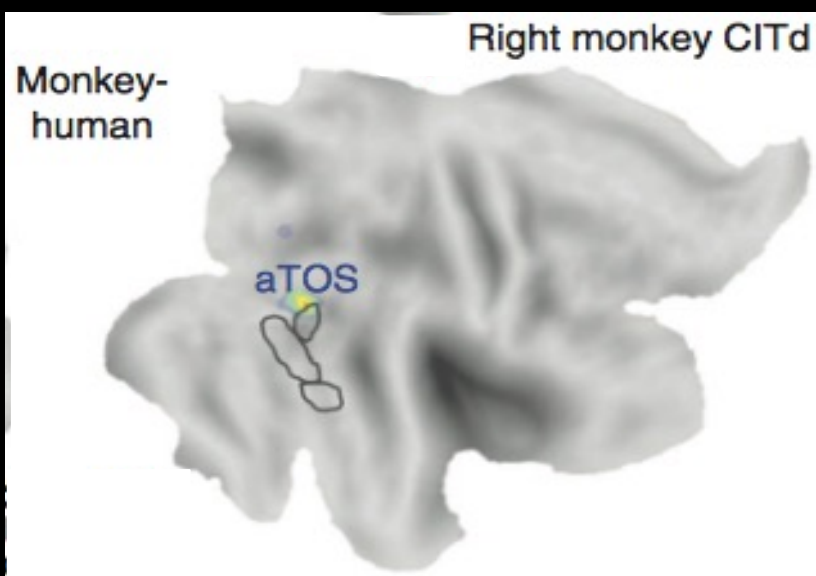
Human



Right monkey PITd

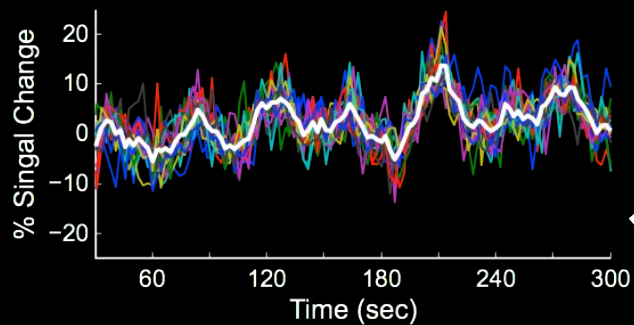


Right monkey CITd

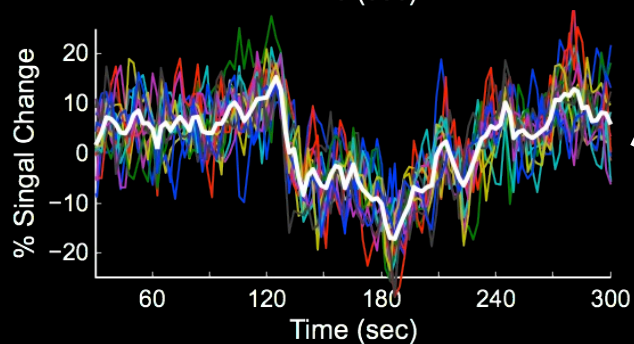


# Cross-Species Brain Activity

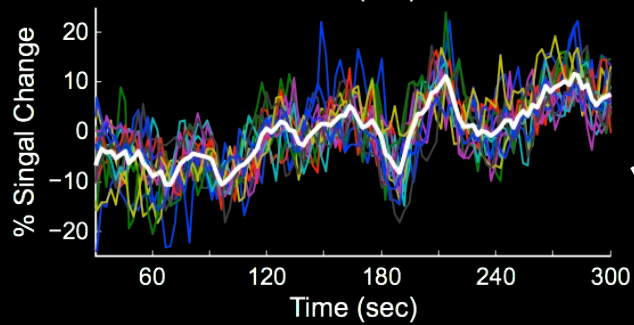
MT



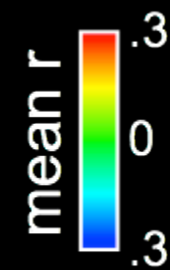
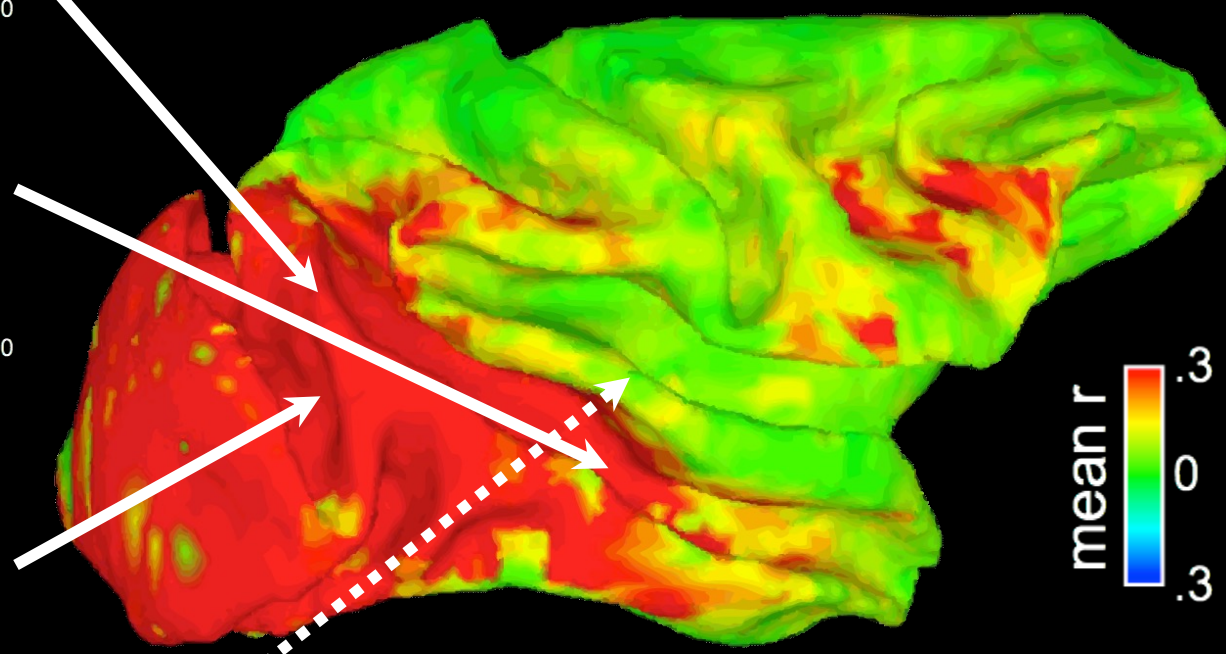
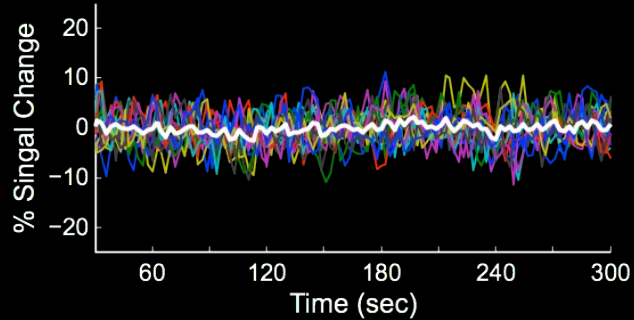
TE



V4



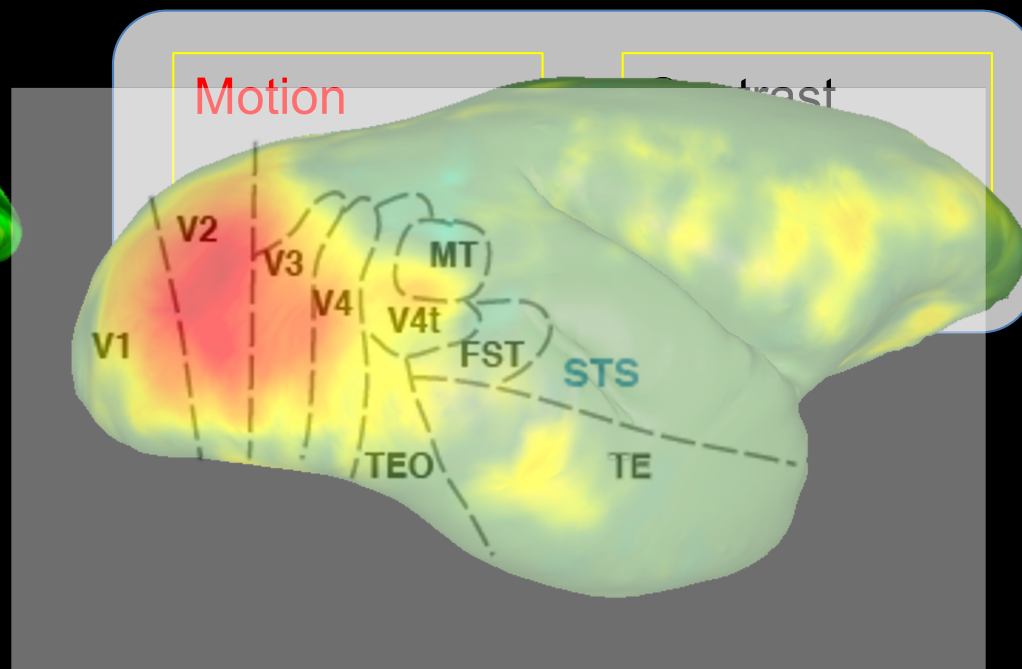
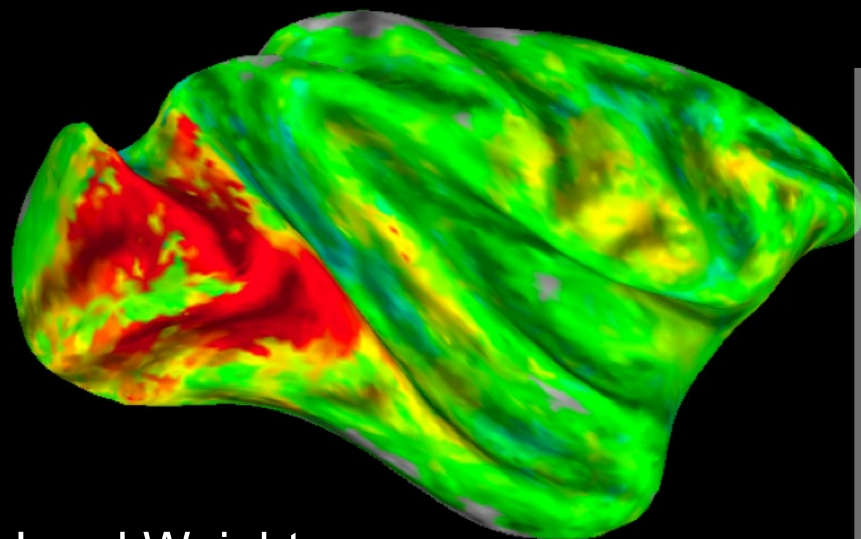
A1



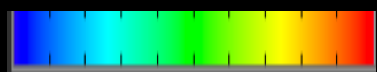
# Cross-Species Brain Activity

Space IC- Macaque

Space IC- Marmoset



Load Weight



-0.5

0.5



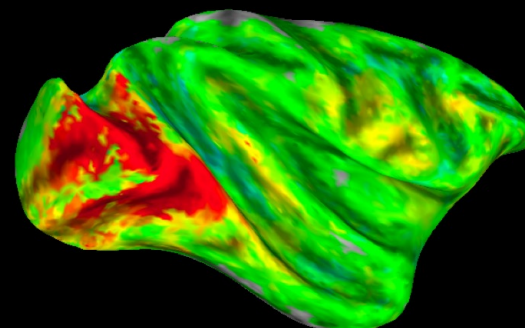
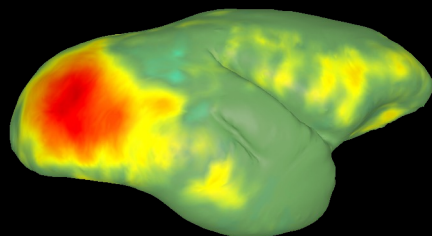
# Cross-Species Brain Activity

Feature

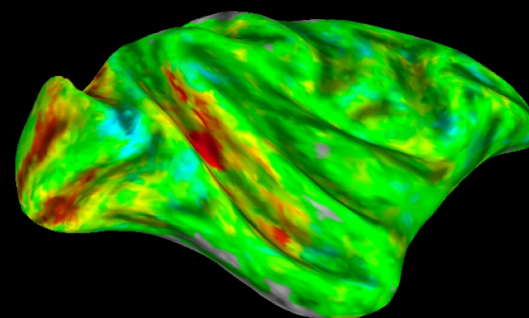
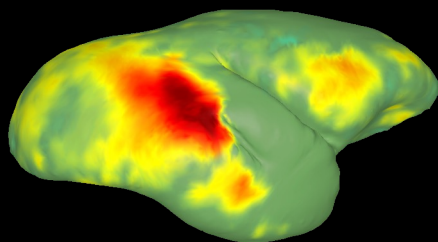
marmoset

macaque

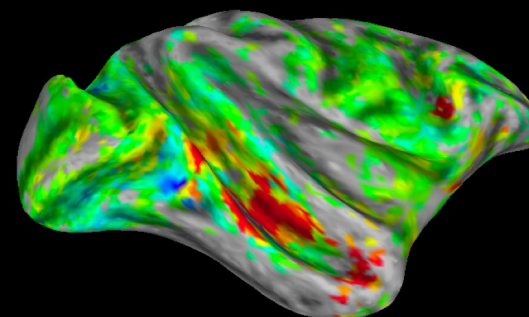
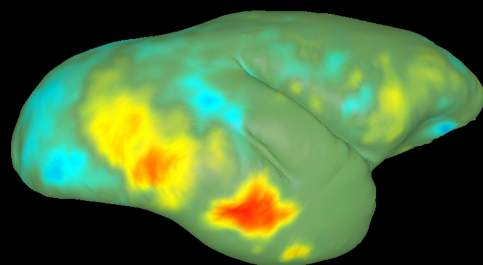
contrast



motion



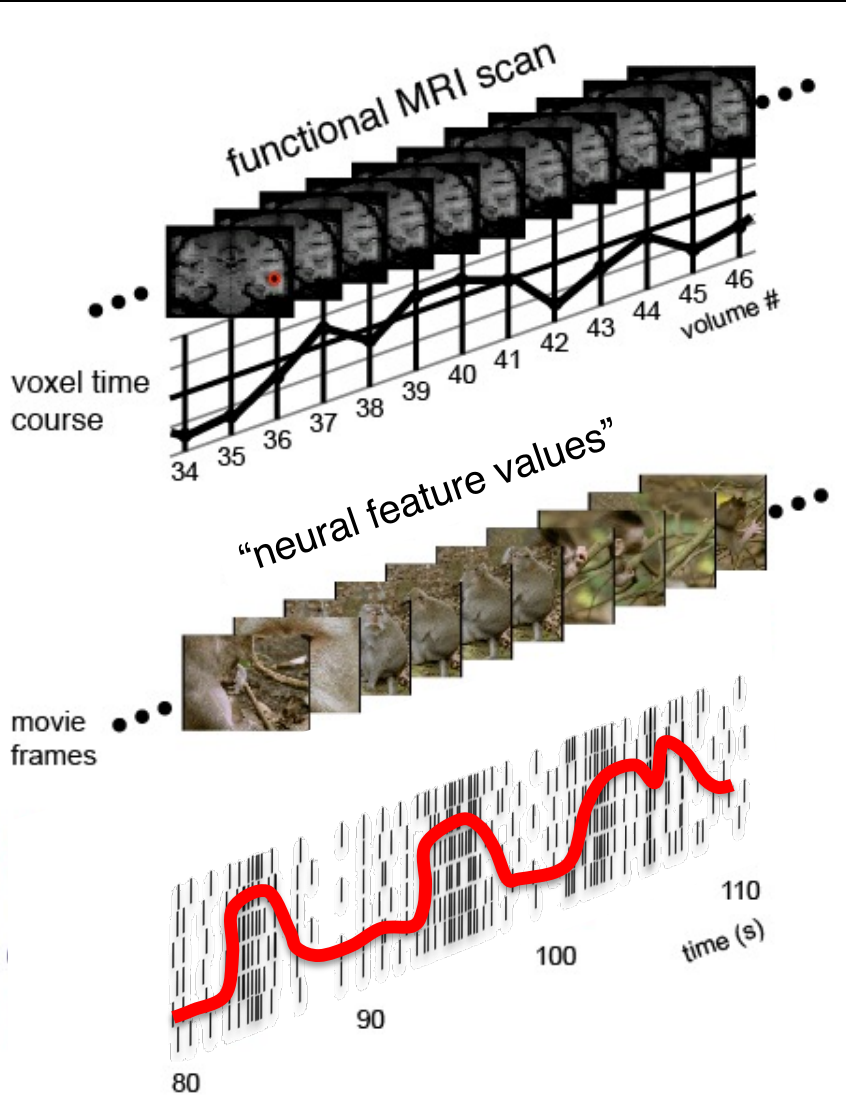
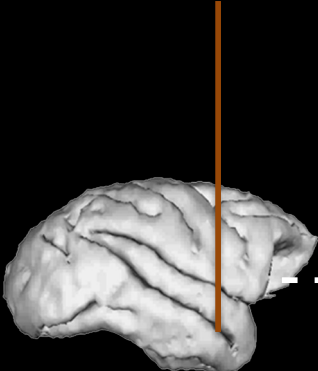
Face responses



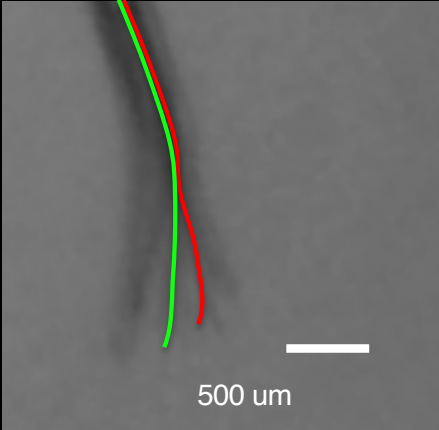
# Across Methods

multiple single unit recordings

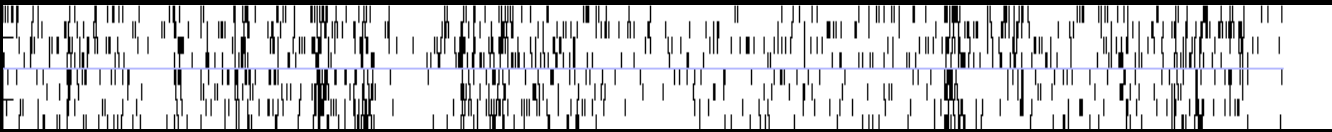
fMRI acquisition



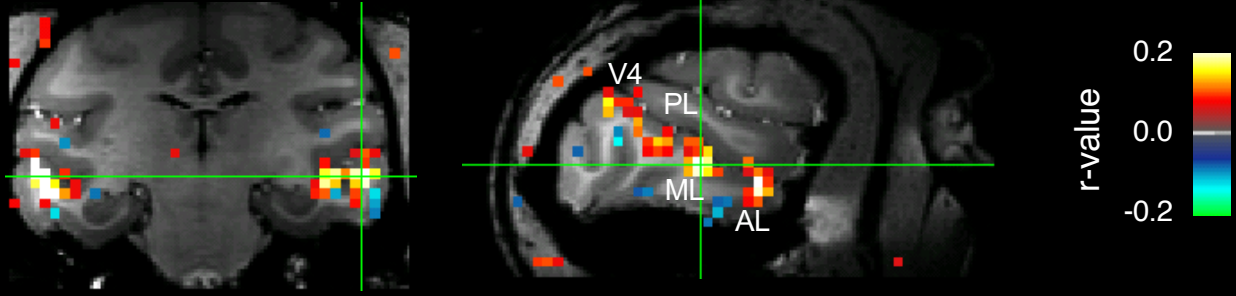
# Across Methods



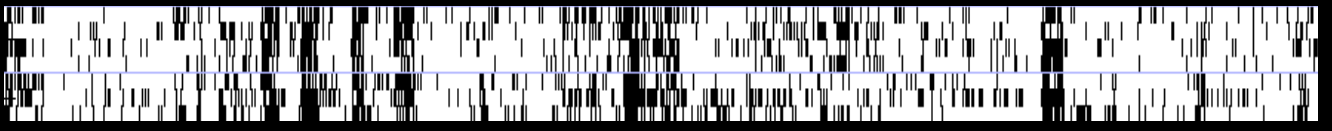
Cell 10



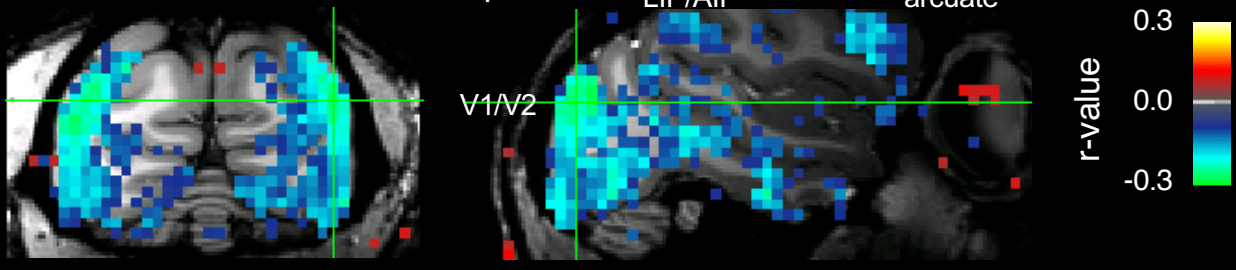
correlation plot



Cell 3



correlation plot



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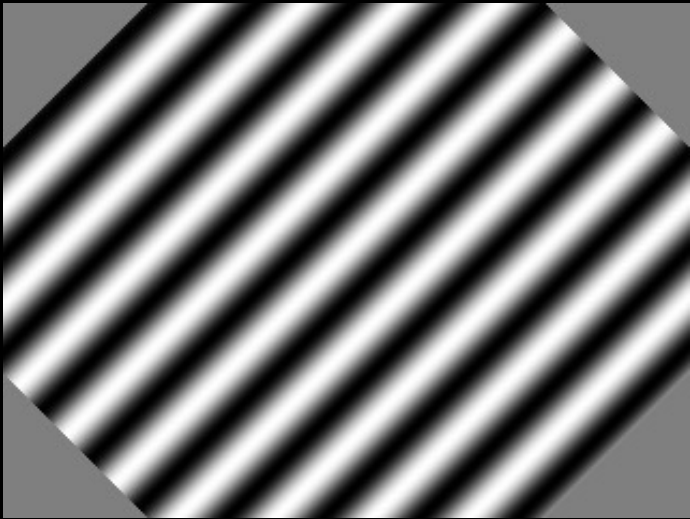
Artificial

Natural



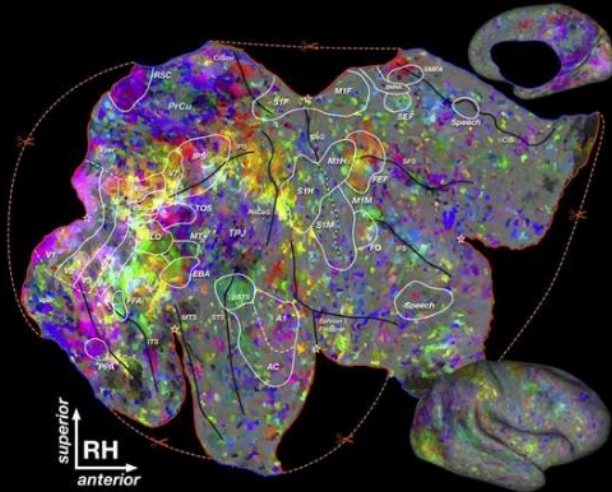
Controlled

Uncontrolled



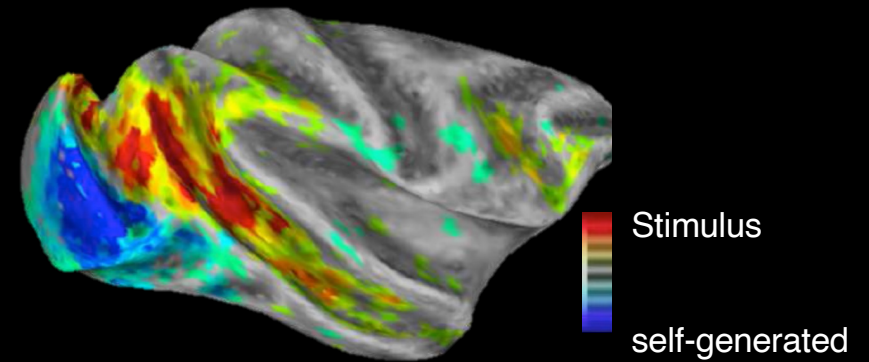
# SUMMARY

## Feature Regression

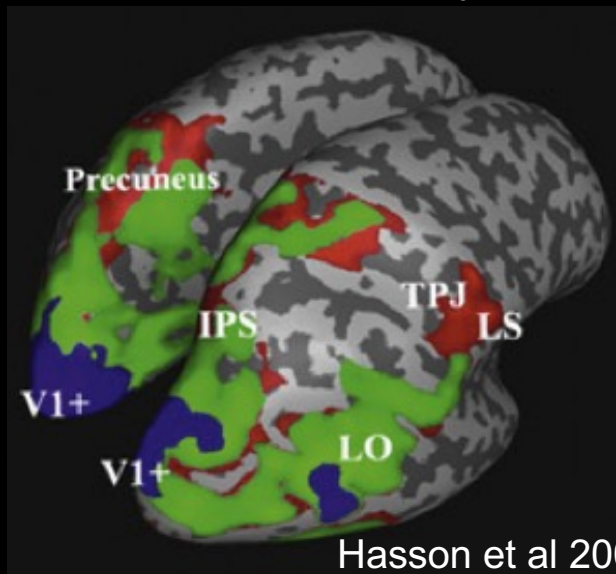


Huth et al 2012

## Stimulus & Behavioral Comparisons

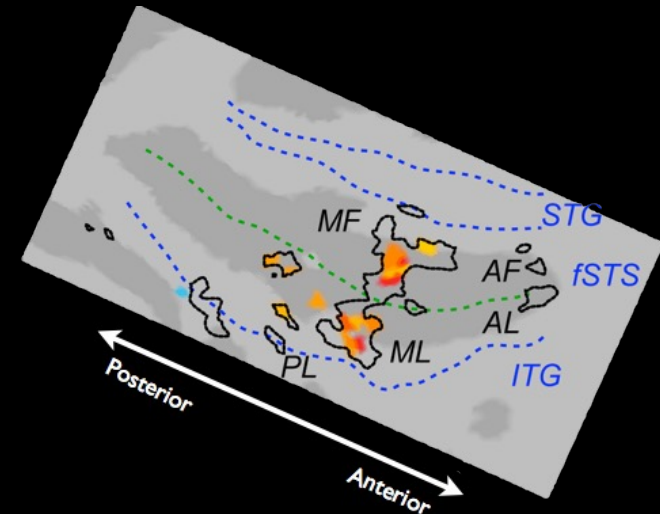


## Temporal Analysis



Hasson et al 2008

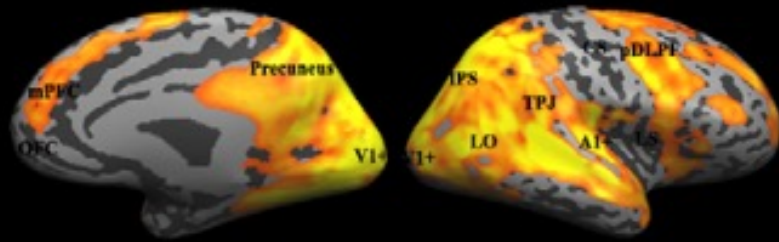
## Content Specific Reliability



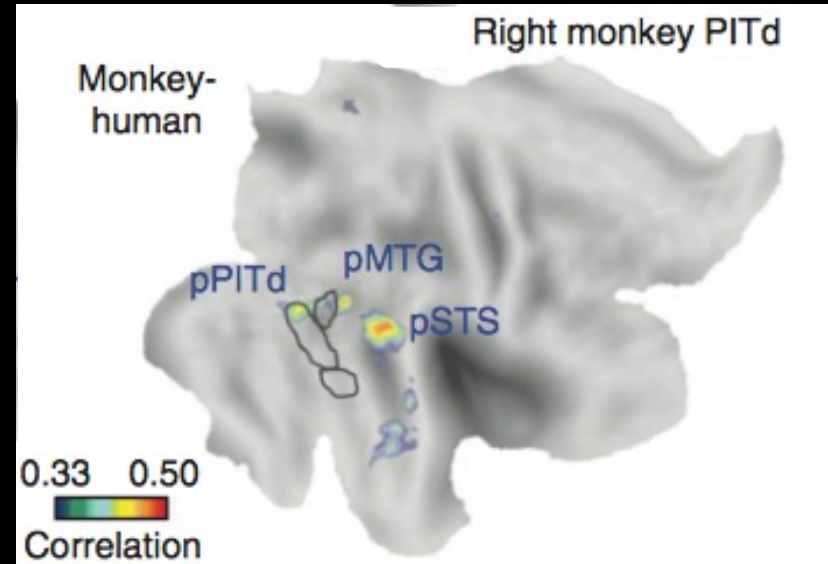
# SUMMARY

## Inter-subject Similarities

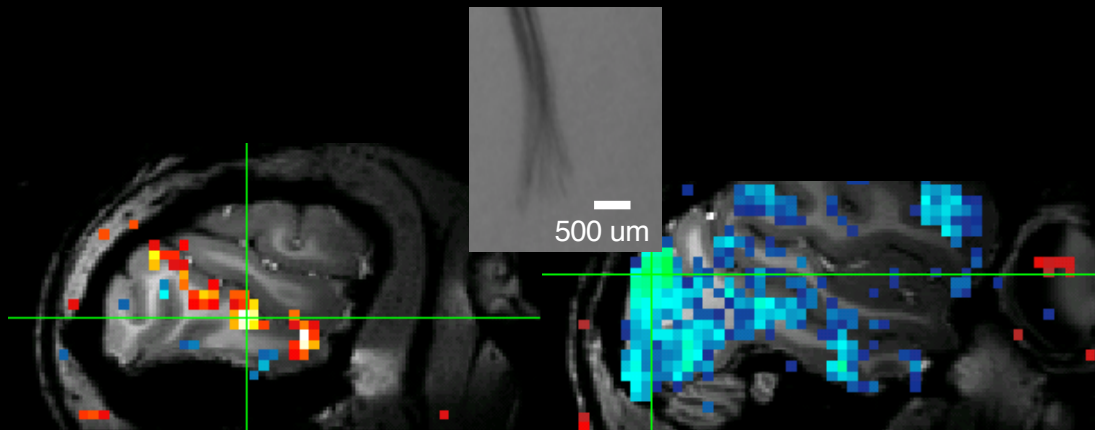
(a) Bang! You're Dead (Alfred Hitchcock)



## 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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