

Distinct human eye fields unraveled by visual field and oculomotor mapping tasks

Uriel Lascombes, Sina Kling, Guillaume Masson & Martin Szinte

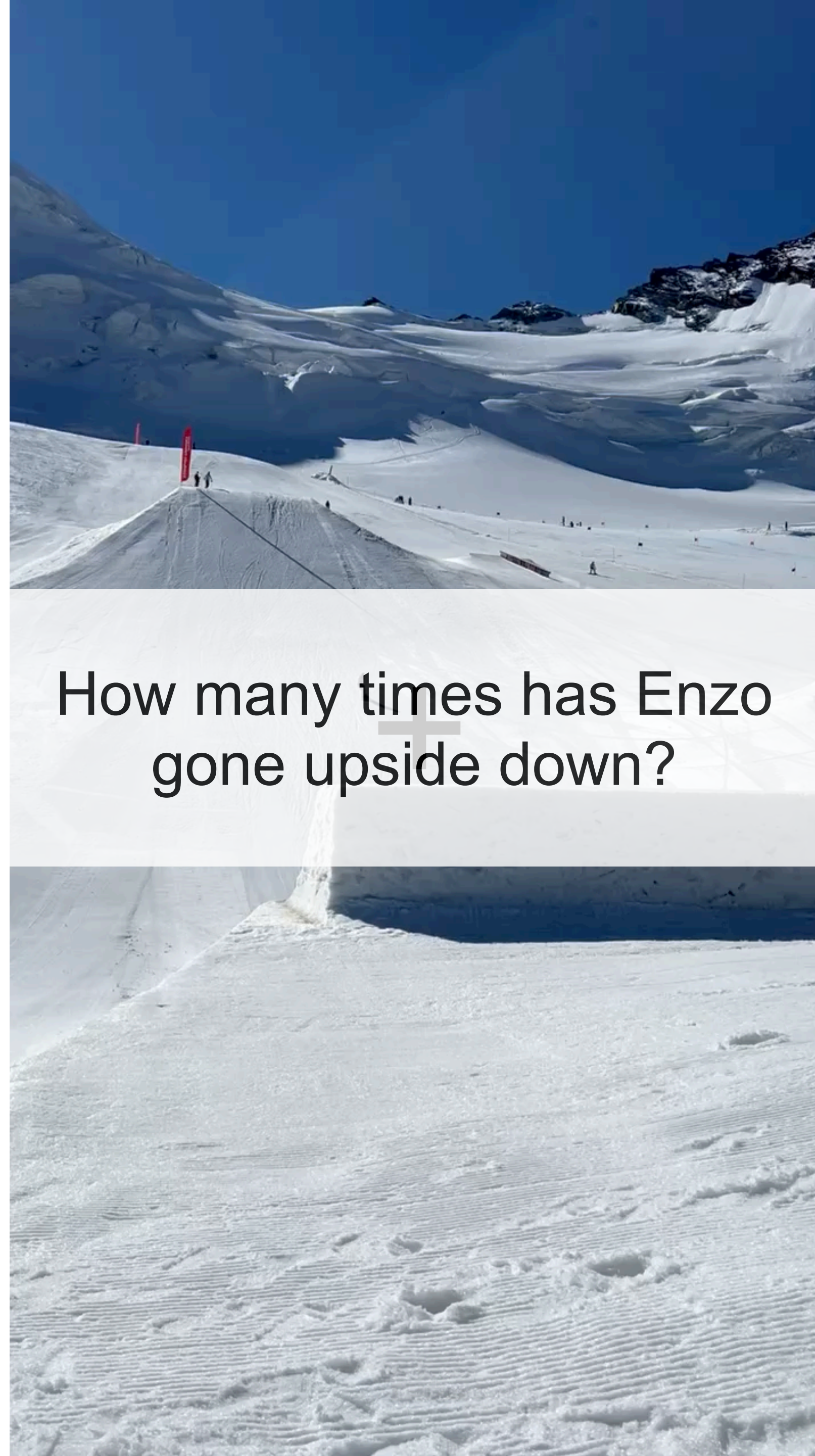
Eye movements, and vision



Eye movements, and vision



Eye movements, and vision



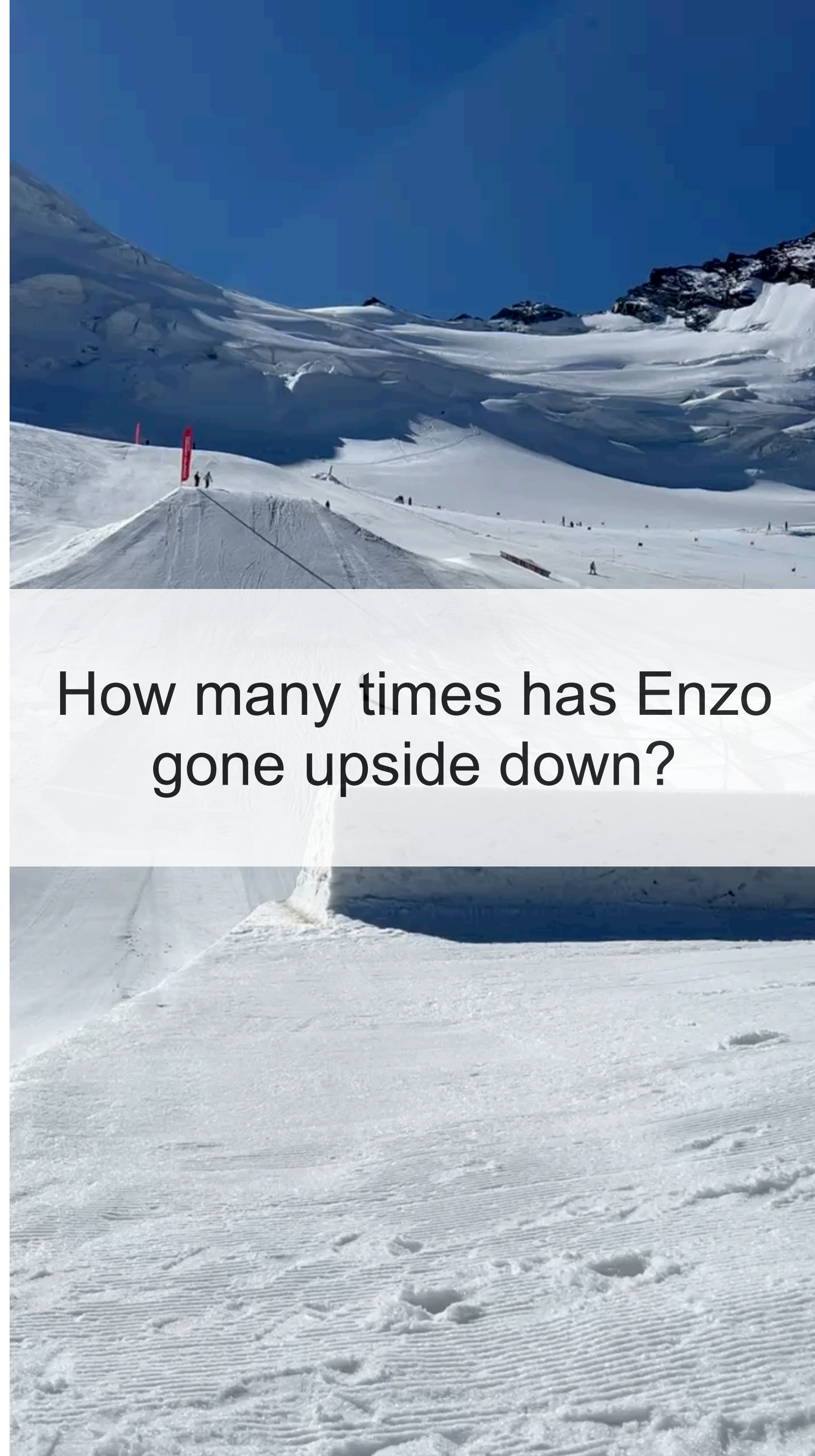
Eye movements, and vision



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Eye movements, and vision



How many times has Enzo
gone upside down?

Eye movements, and vision

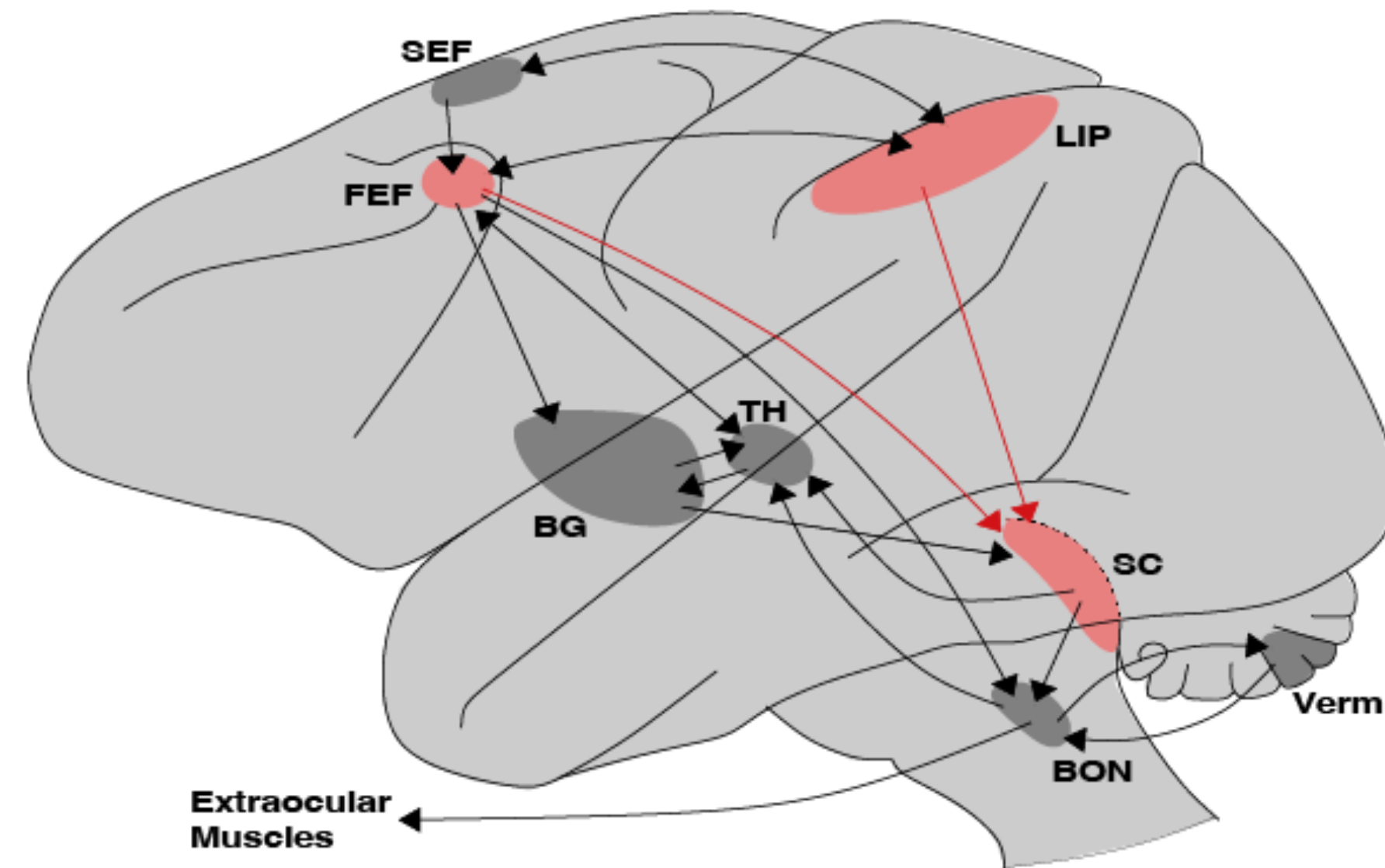


Eye movements enable us to
interact with a constantly
changing environment



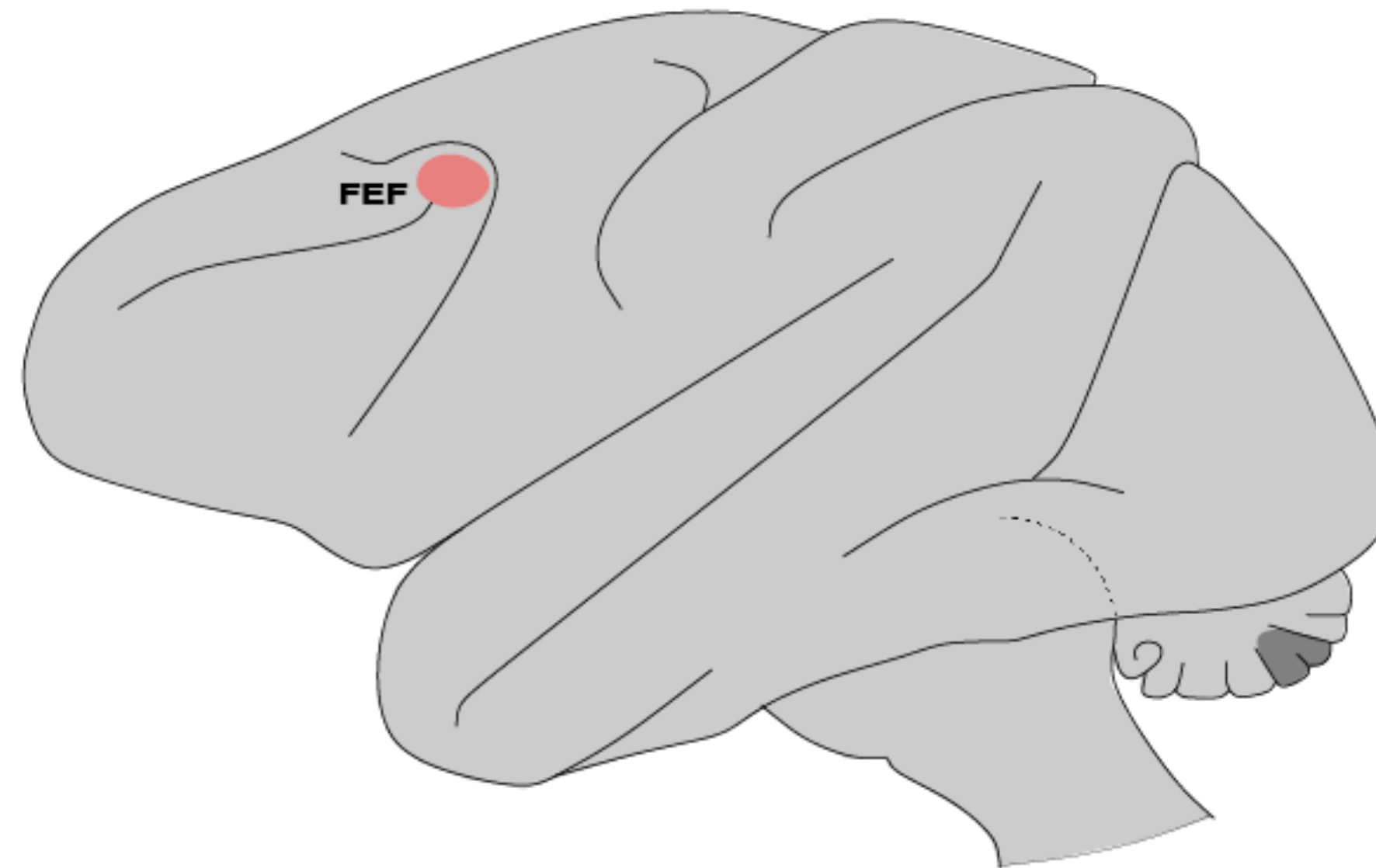
How are eye movements generated by the brain ?

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Monkey studies

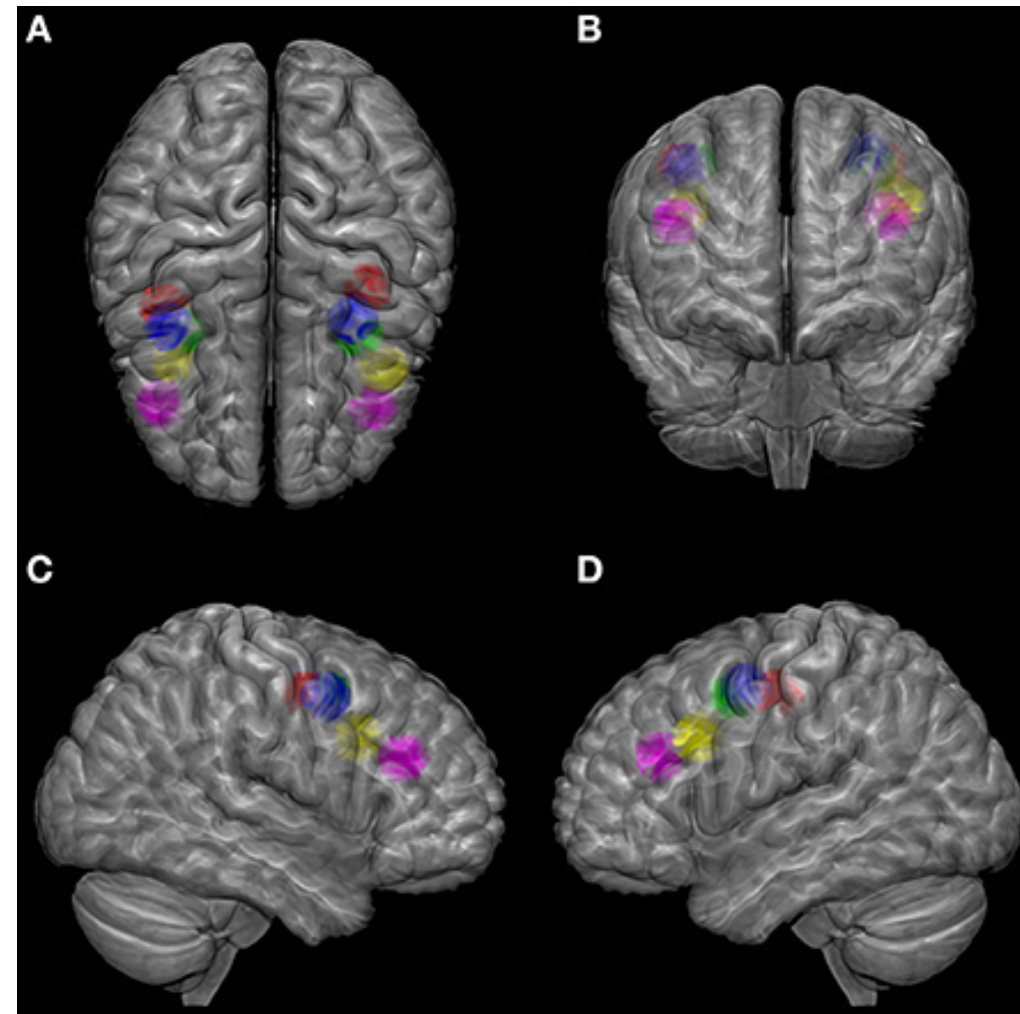


How are eye movements generated by the brain ?
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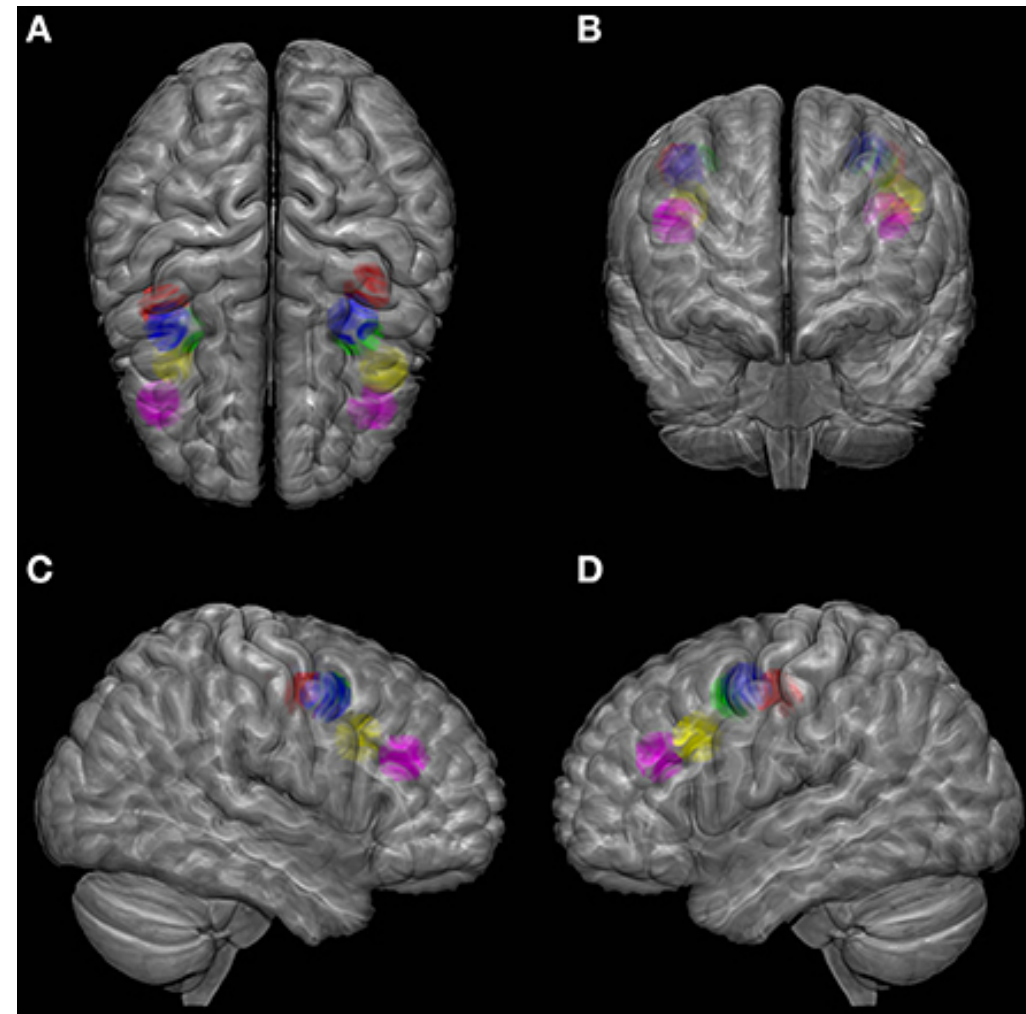
An area containing visual,
motor, and visuo-motor
cells



How are eye movements generated by the brain ? Humans studies

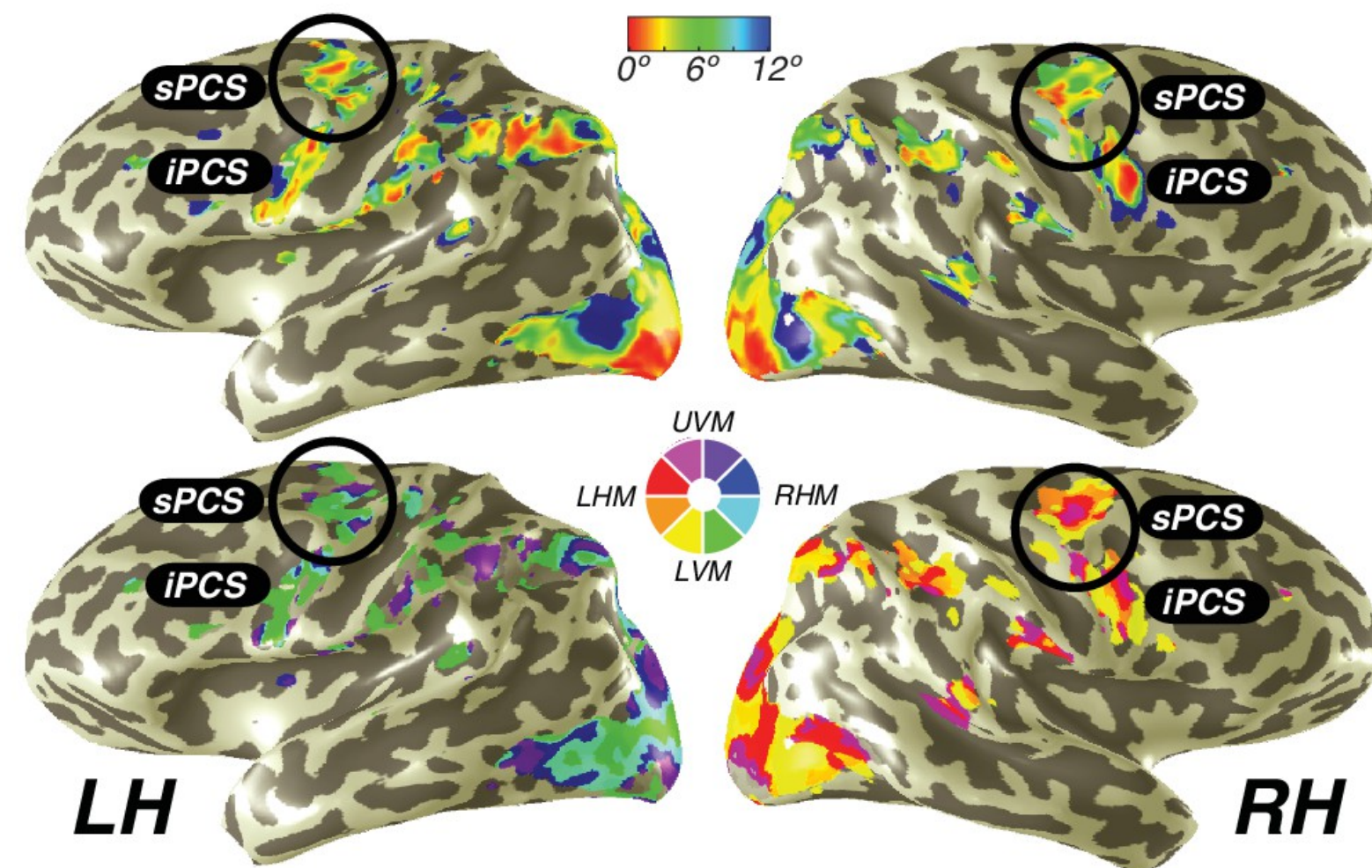


How are eye movements generated by the brain ?
Humans studies



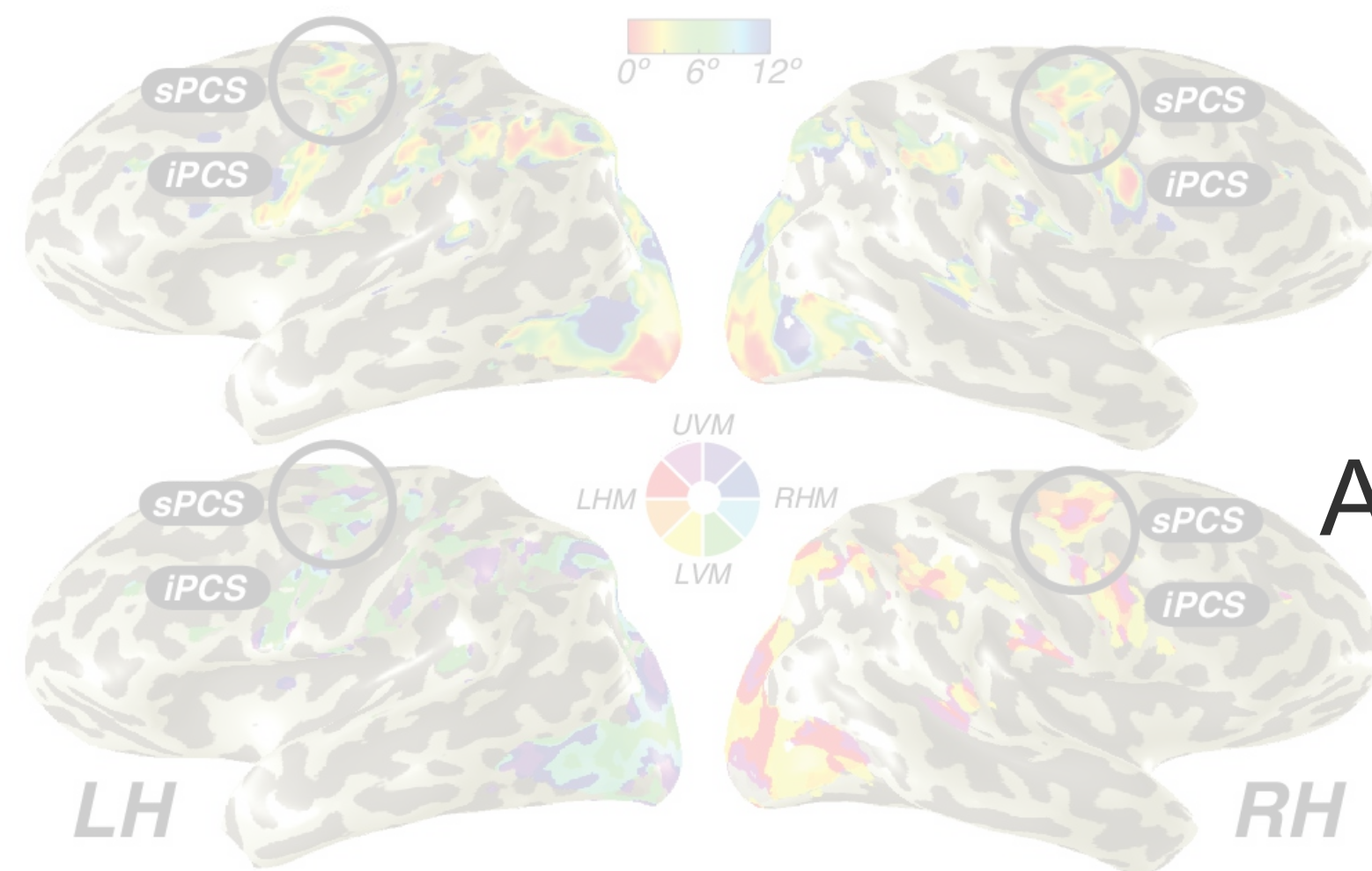
1 Large cluster near the precentral and superior frontal sulcus

How are eye movements generated by the brain ?
Humans studies



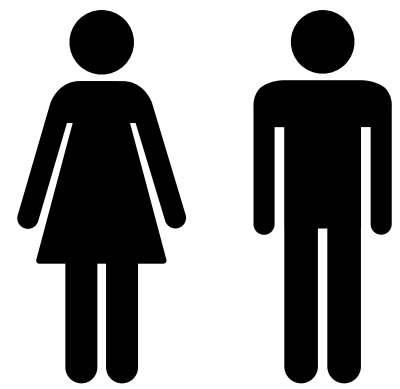
3 sub areas distributed on the pre-central sulcus with visual answer and following retinotopic rules

How are eye movements generated by the brain ? Humans studies

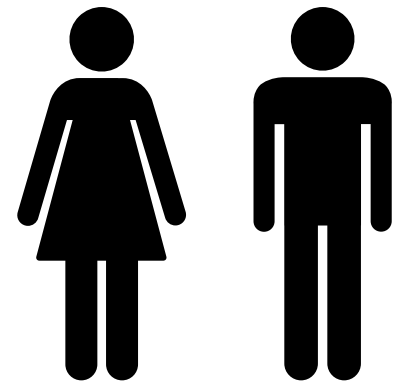


3 sub areas distributed on the pre-central sulcus with visual answer and following retinotopic rules

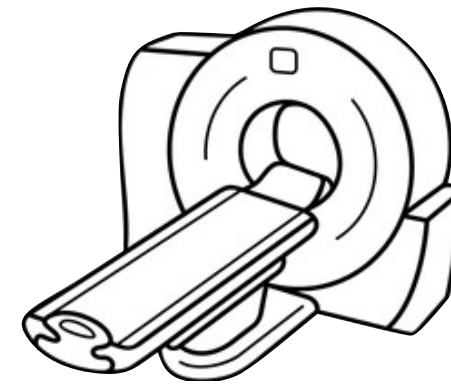
Are this areas visuo-motor ?



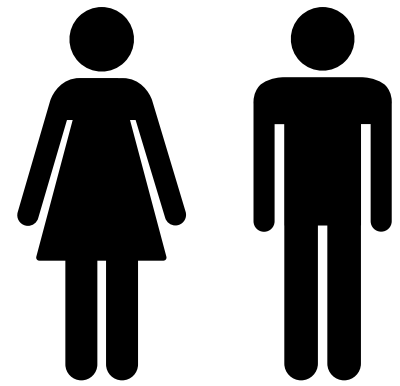
20 Participants
10 Women
29 +/- 11 years



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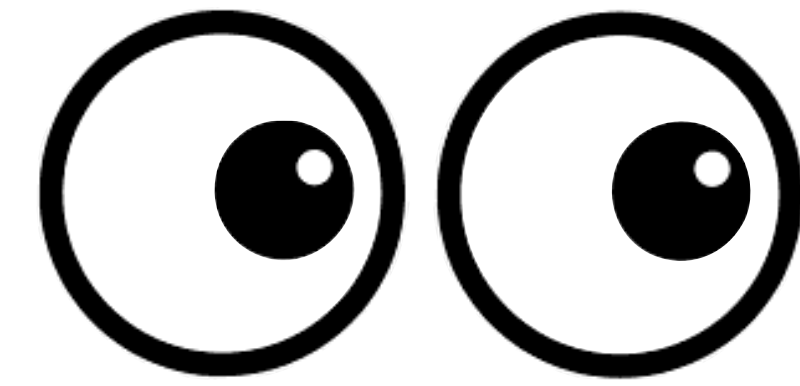
3T fMRI
TR 1.2s
2.0mm isotopique



20 Participants
10 Women
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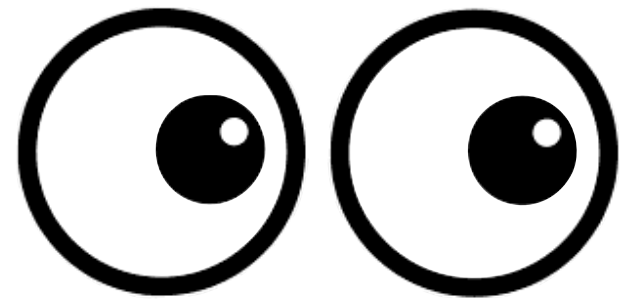


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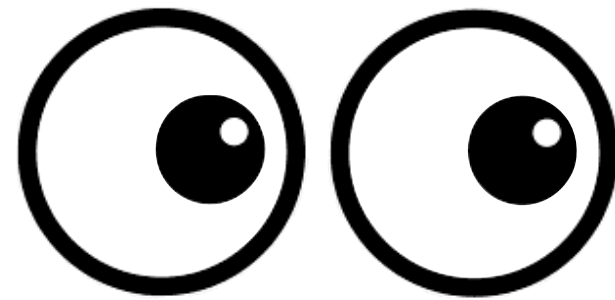
6Tasks

6
tasks



Population Receptive Field mapping (pRF) : 5 runs
keep fixation during bar pas exposure

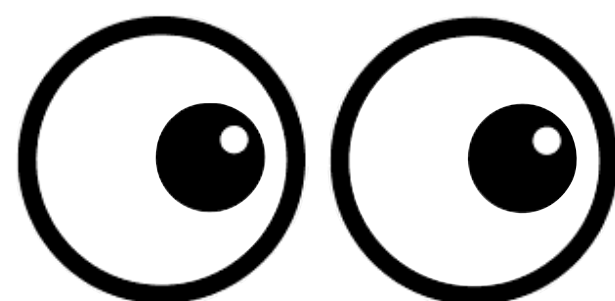
6
tasks



Population Receptive Field mapping (pRF) : 5 runs
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Saccade Localization (SacLoc) : 2 runs
Make directed saccade in 32 directions/ 5 amplitudes

6
tasks



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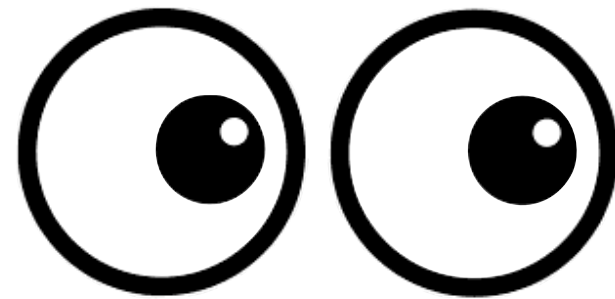
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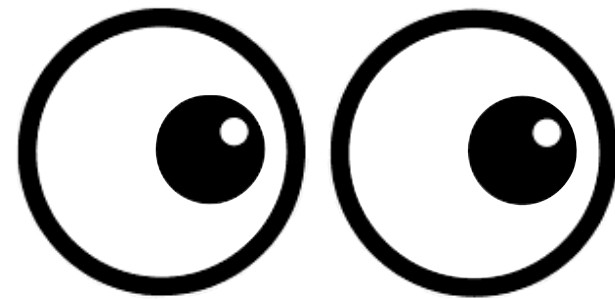
Saccade Localization 2 (SacVELoc) : 2 runs

Make directed and memorised saccade in 4 directions

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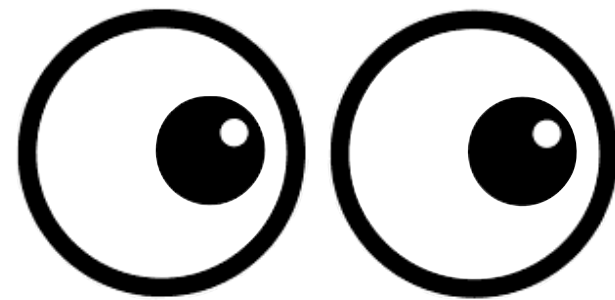
Saccade Localization 2 (SacVELoc) : 2 runs

Make directed and memorised saccade in 4 directions

Pursuit Localization (PurLoc) : 2 runs

Make directed pursuit in 32 directions/ 5 amplitudes

6
tasks



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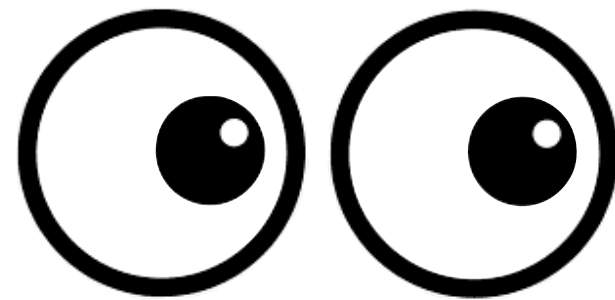
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Pursuit Localization 2 (PurVELoc) : 2 runs
Make directed pursuit with disparition of the stimulus

6
tasks



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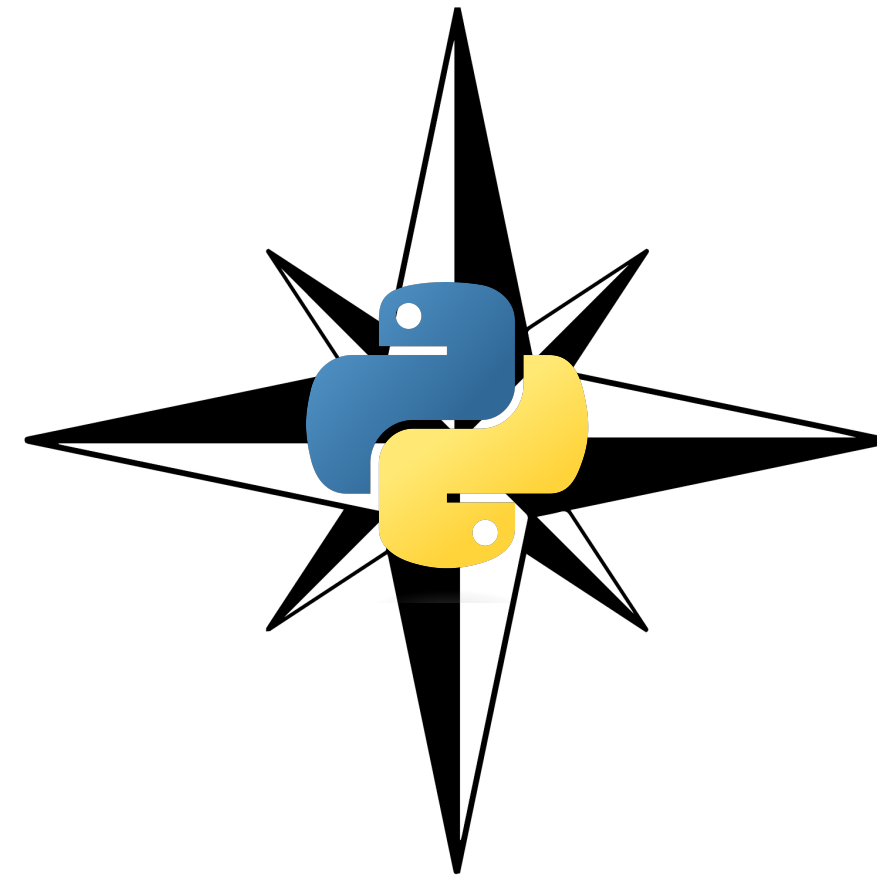
Pursuit Localization 2 (PurVELoc) : 2 runs

Make directed pursuit with disparition of the stimulus

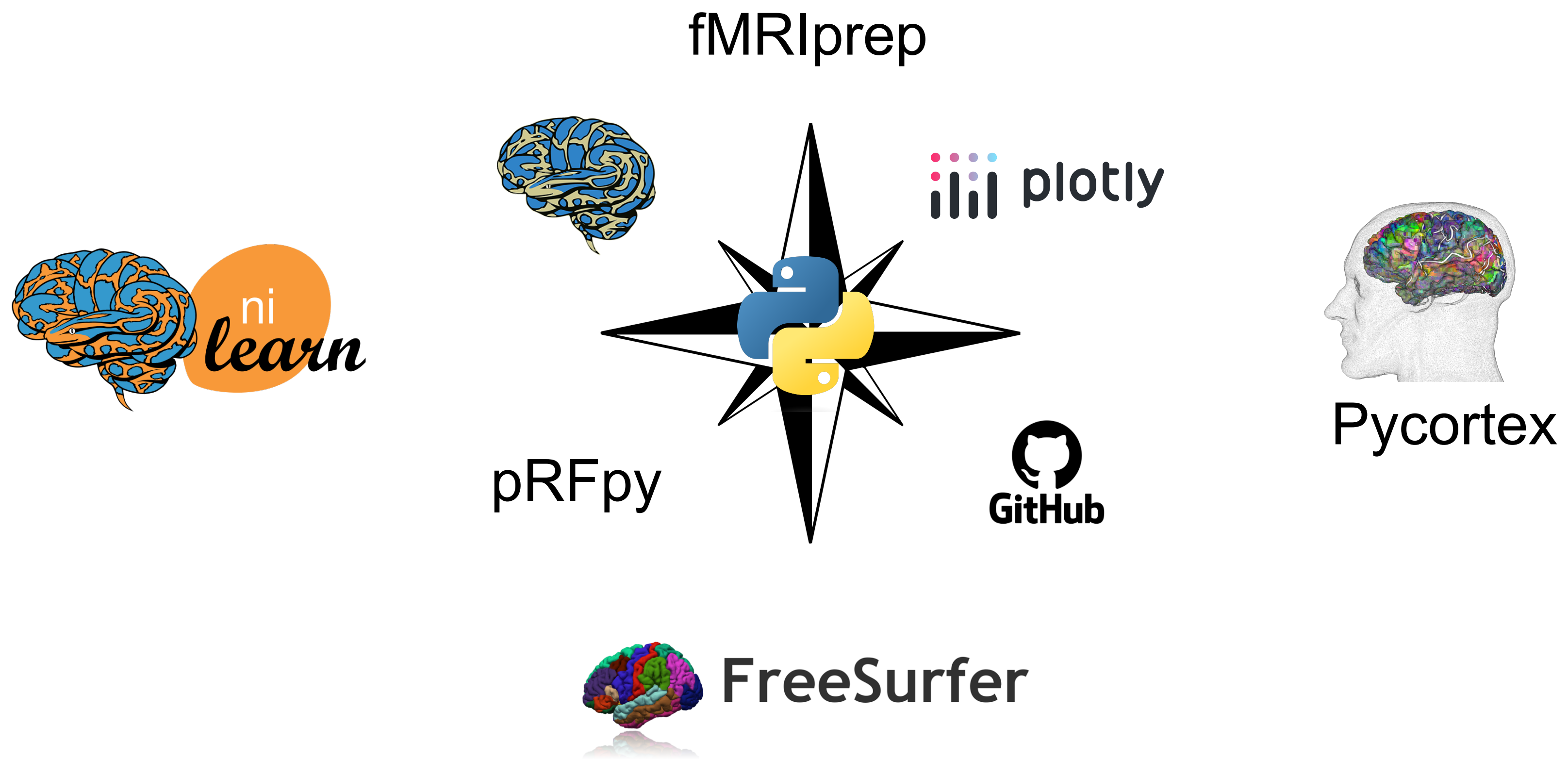
Resting state (rest) : 2 runs

Keep fixation

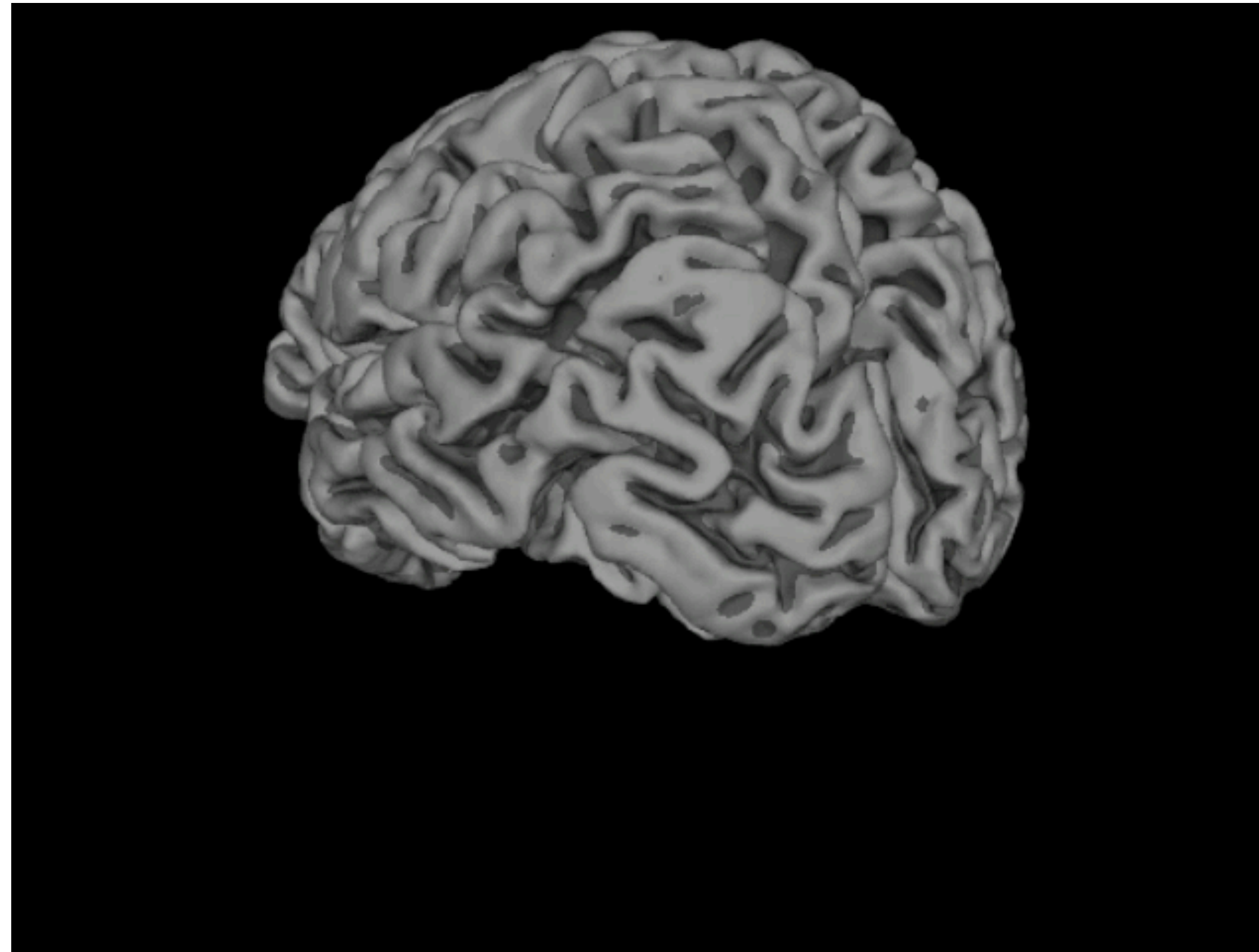
We are developing a Python pipeline for surface-based fMRI analysis



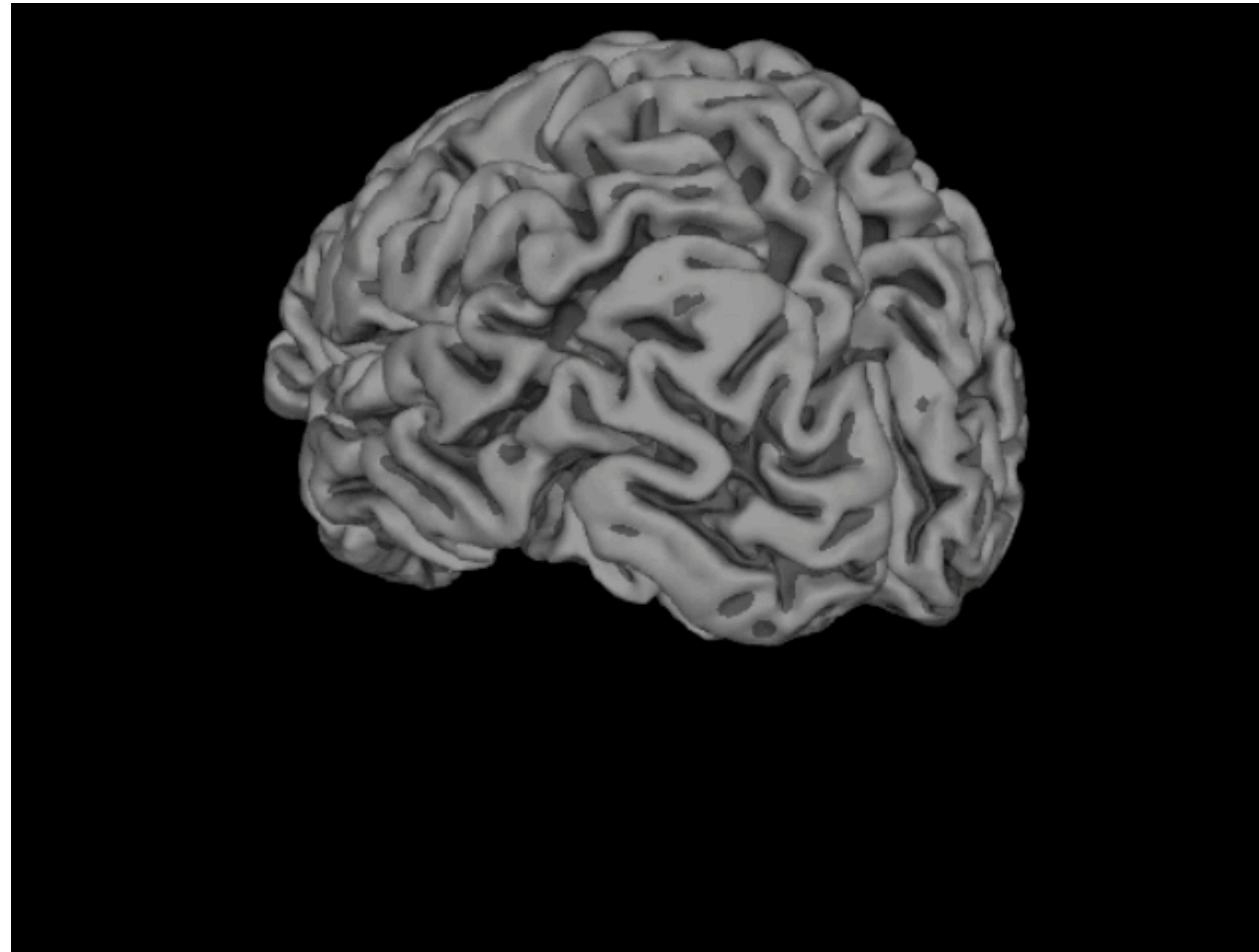
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Surfacique fMRI



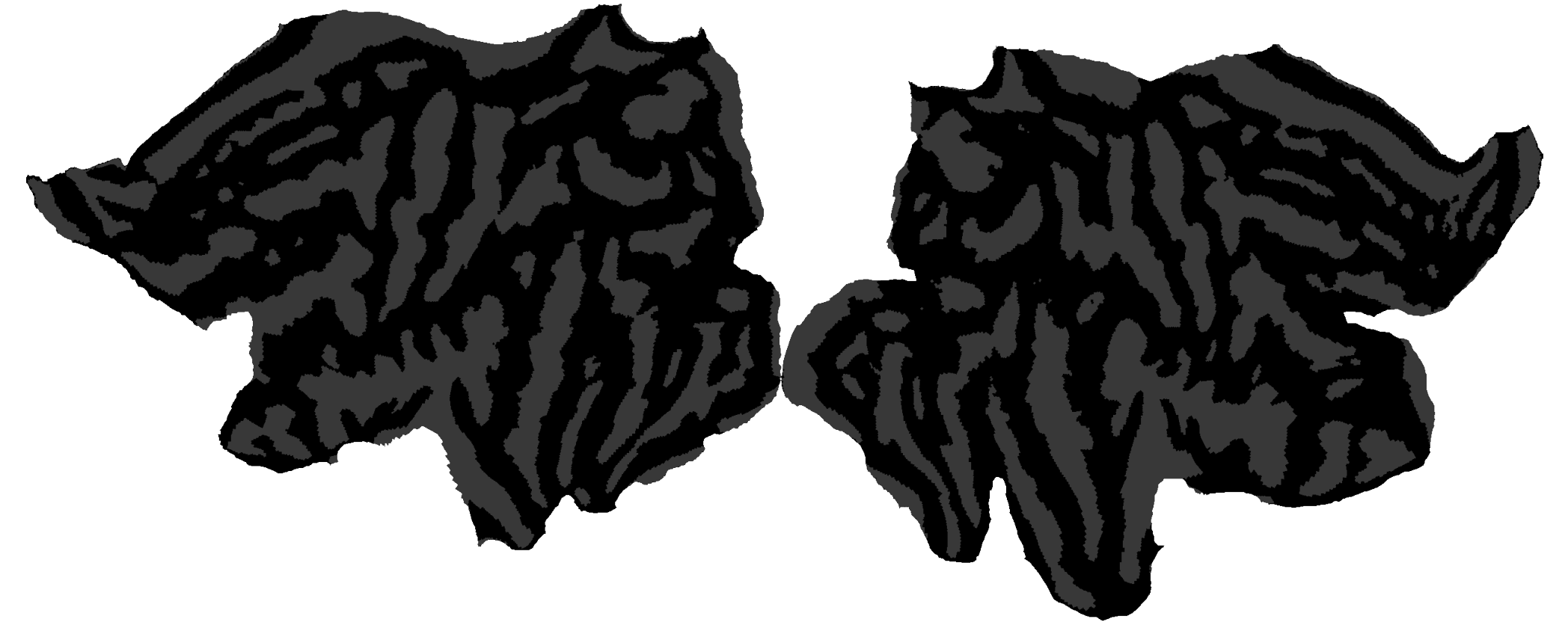
Surfacique fMRI



Flat Maps



Subject base
fsnative format

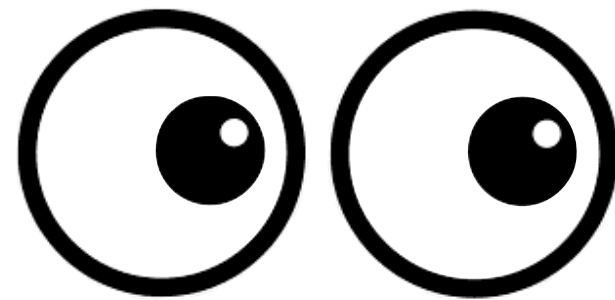


Template base
HCP 170k format

Population Receptive Field mapping (pRF) : 5 runs

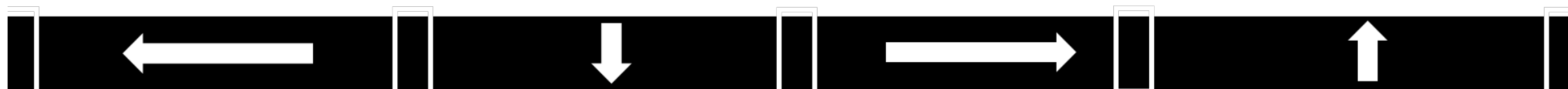
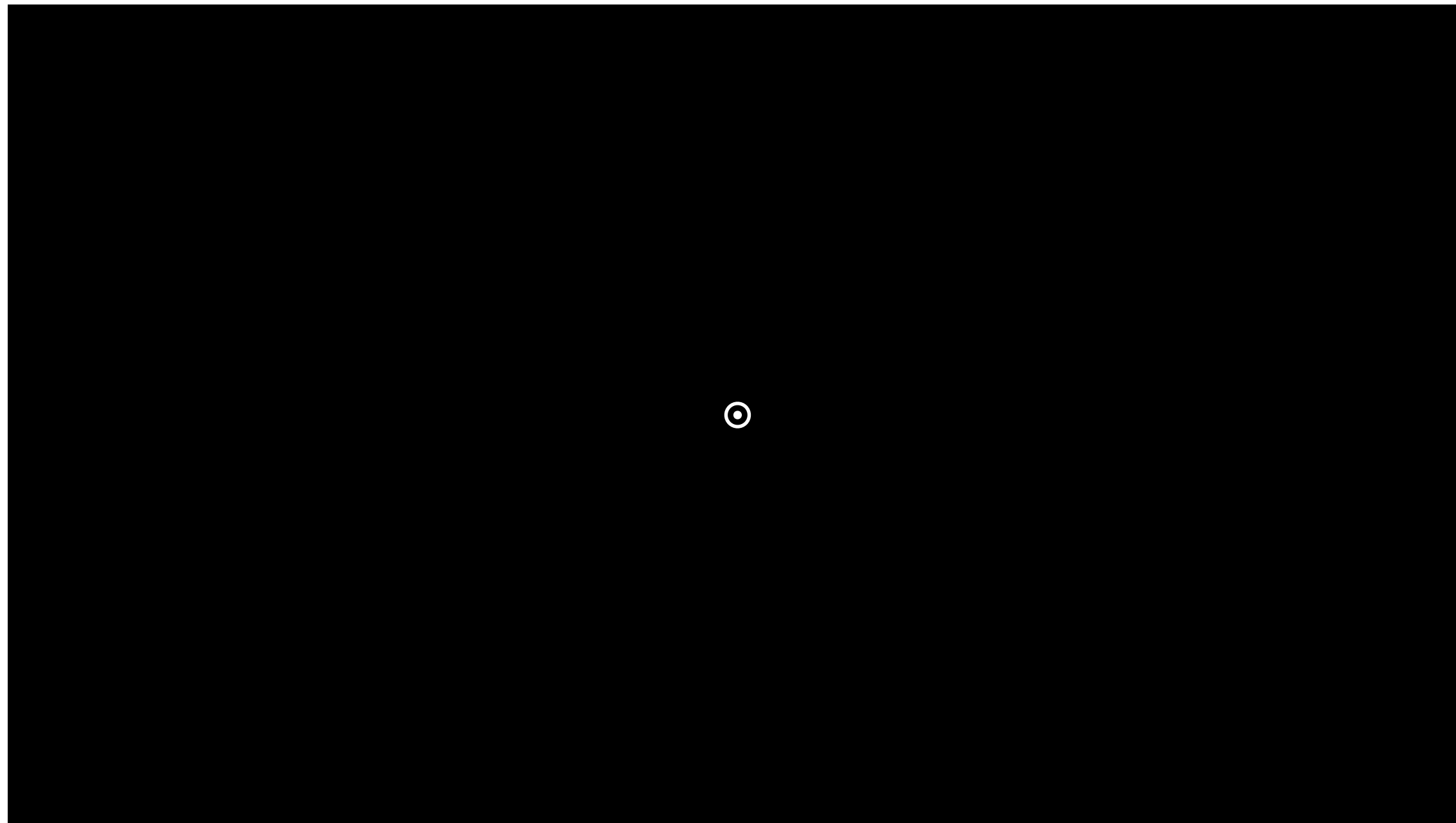
keep fixation during bar pas exposure

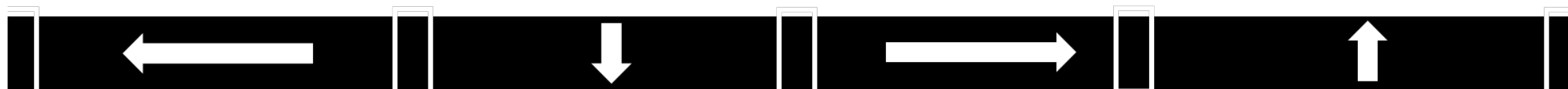
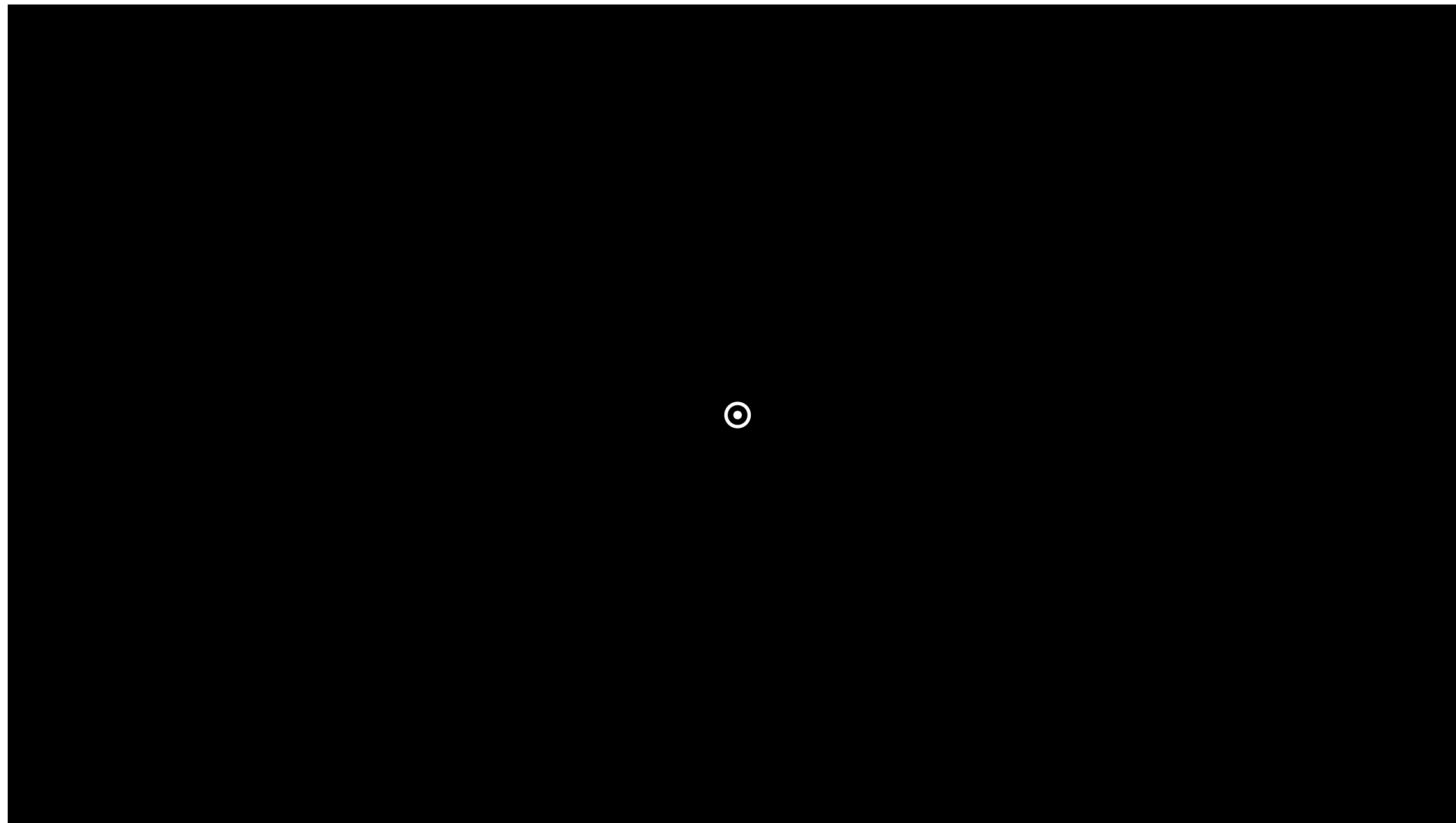
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tasks



Instructions :

Keep fixation on screen center and report the noise orientation





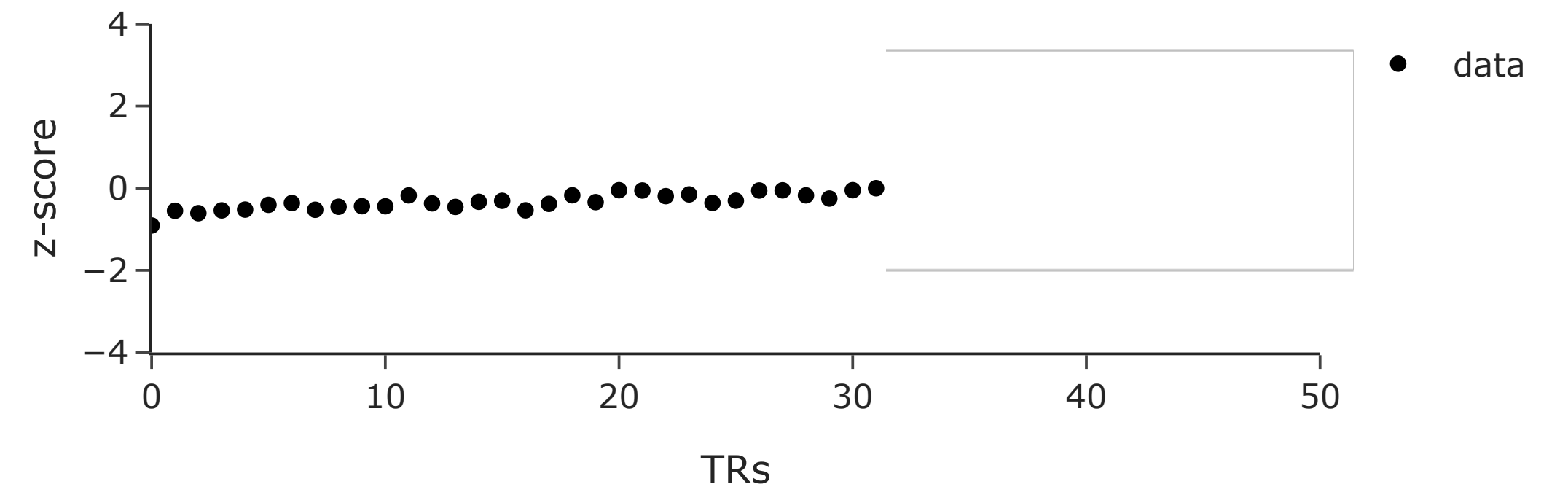
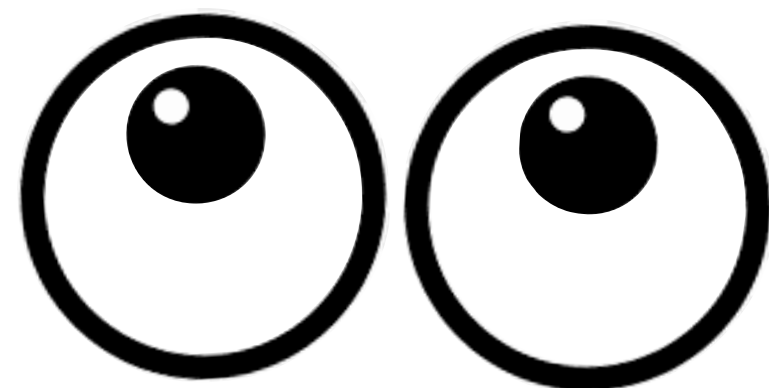
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Details :

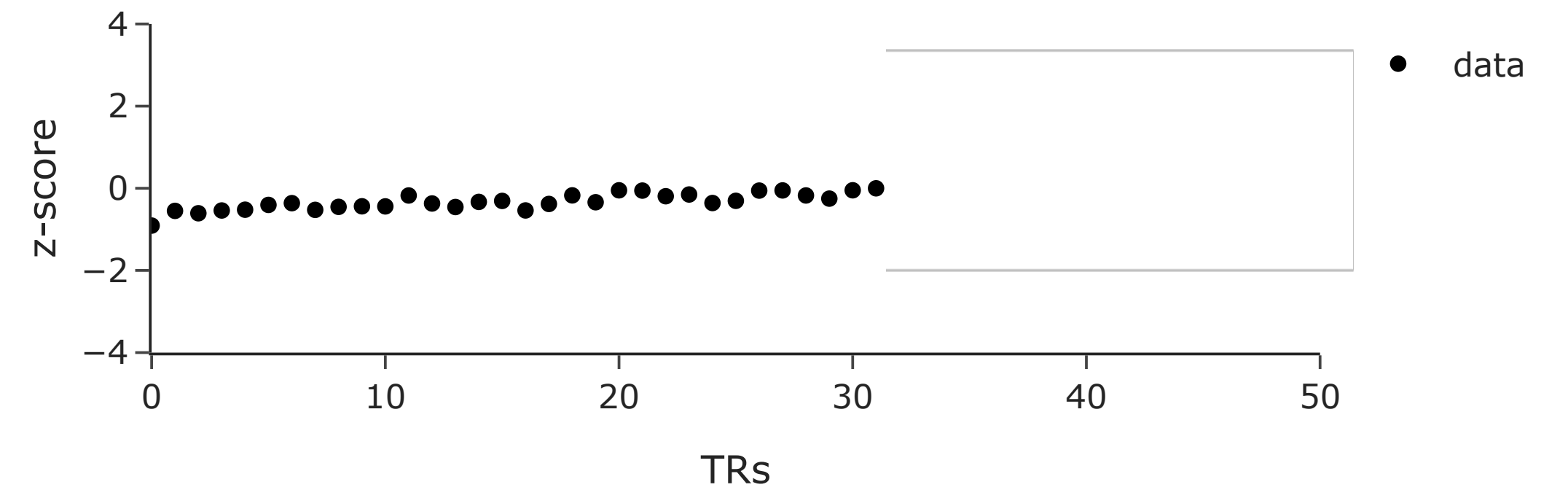
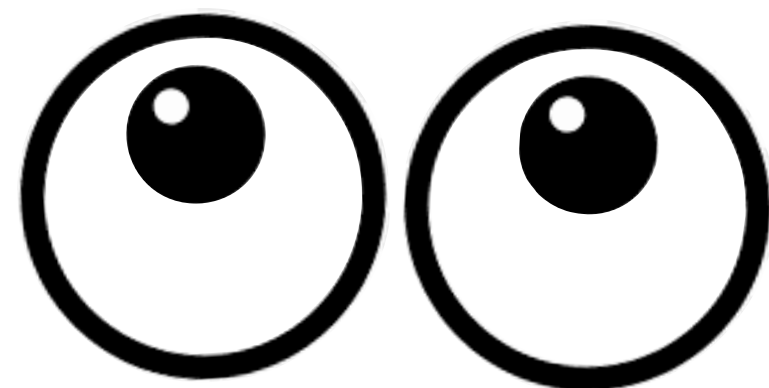
- 5 Runs (~20min)
- 4 Bar pass directions per run
- Bar movement on each TR
- Eye tracking recording during all run

What are population Receptive Fields ?



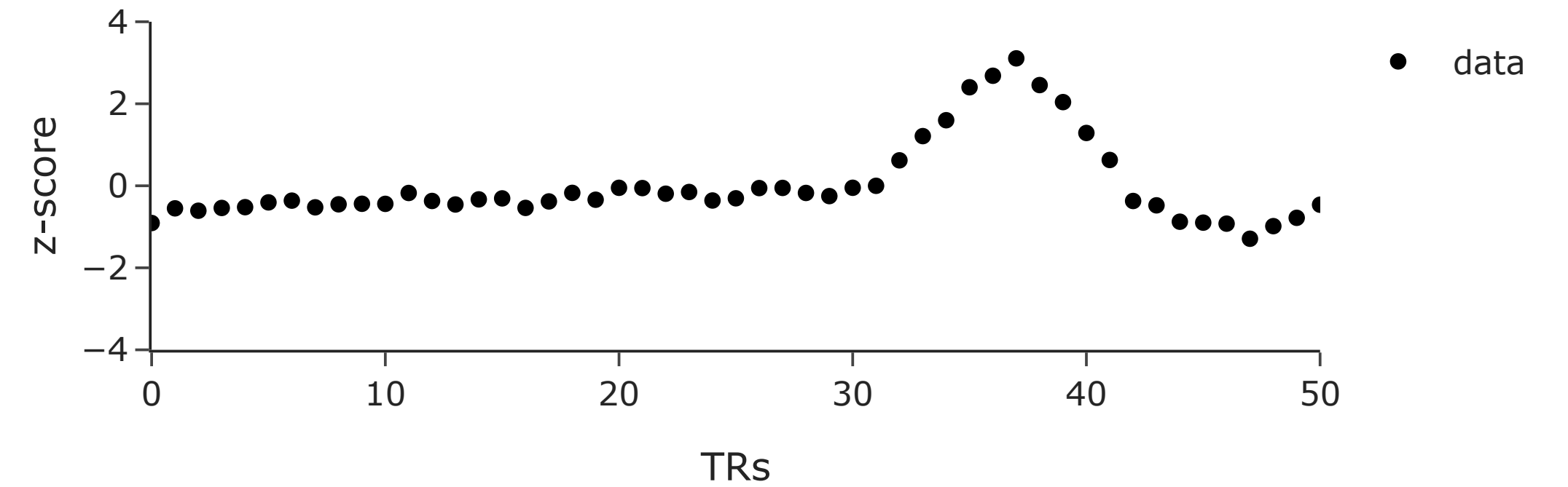
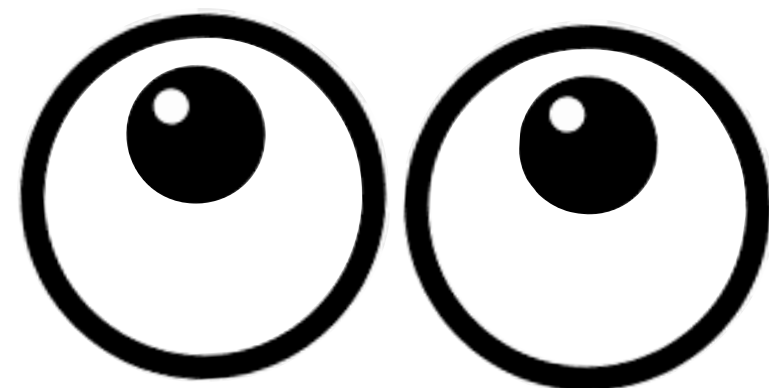
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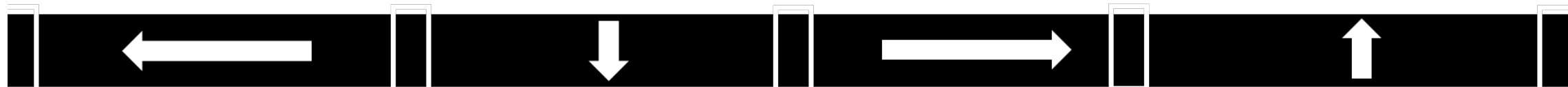
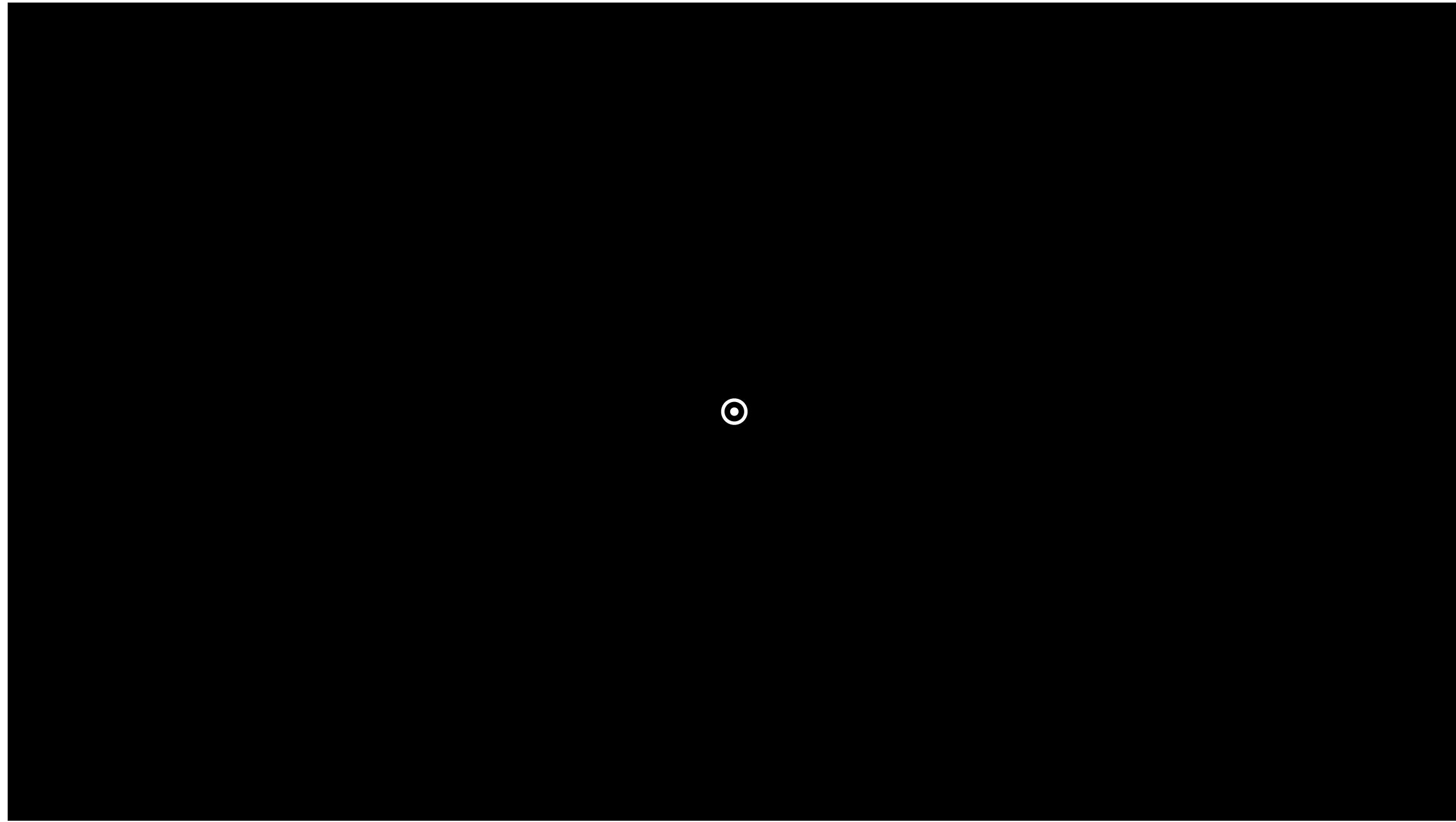
Portions of the visual space that elicit a response from a population of neurons

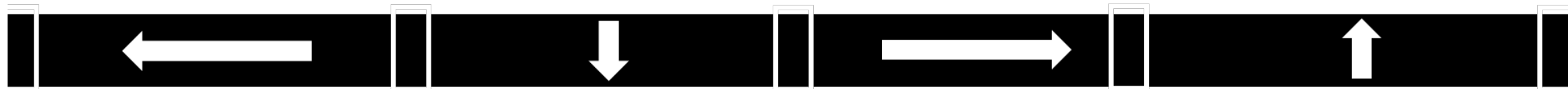
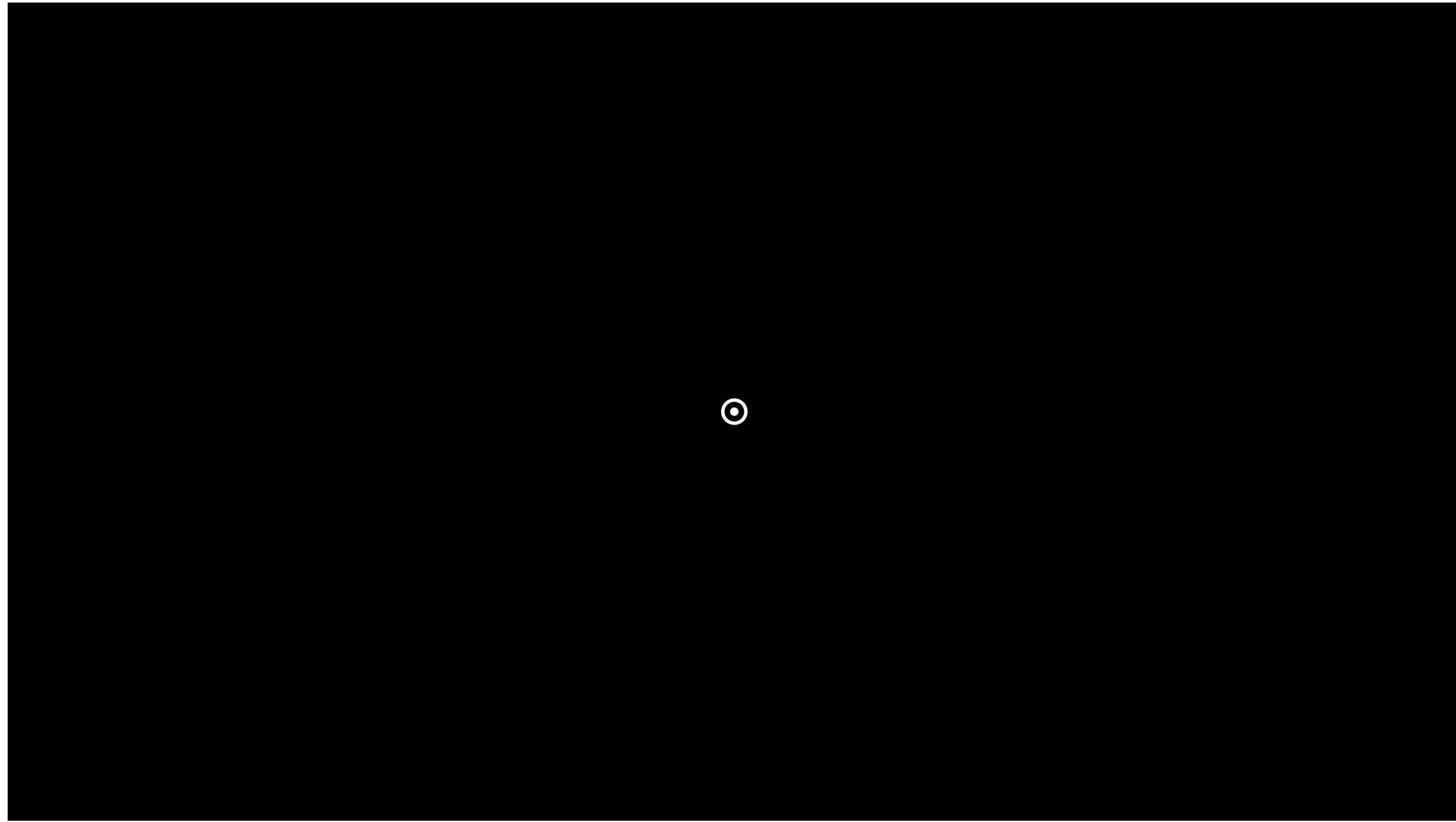


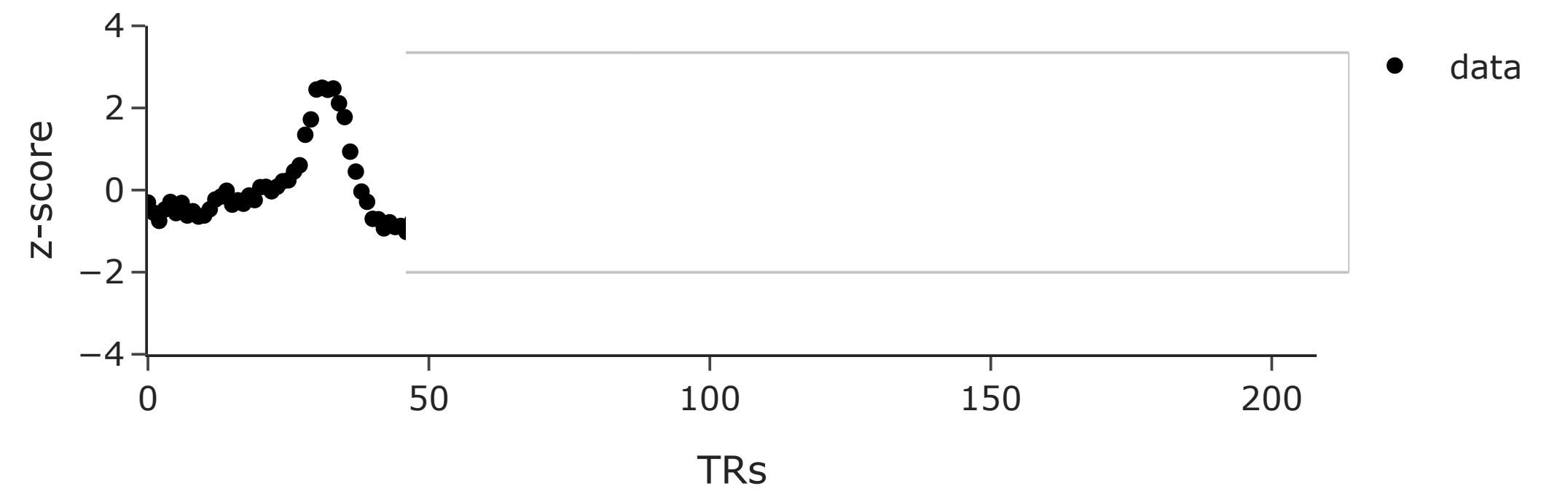
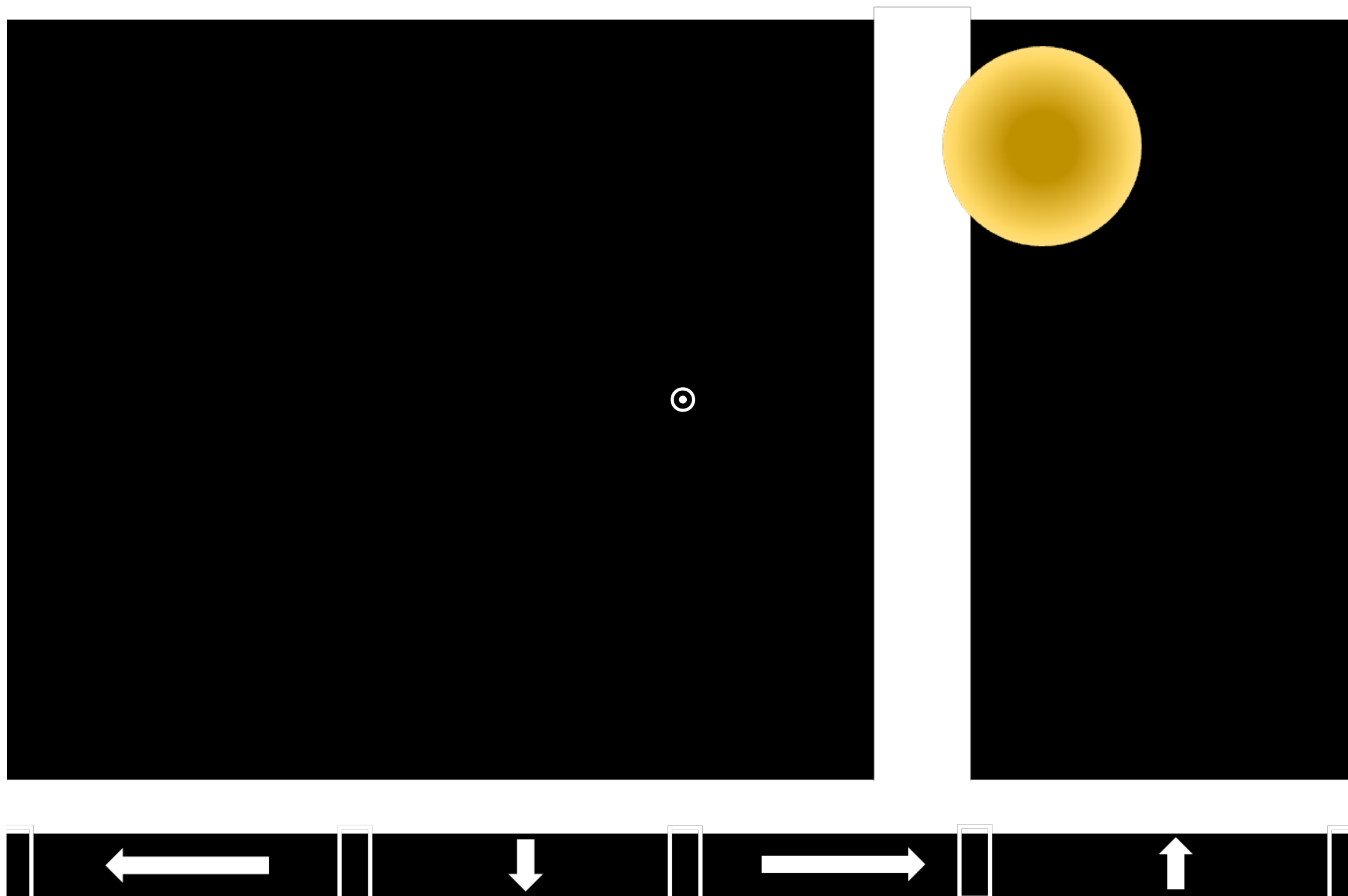
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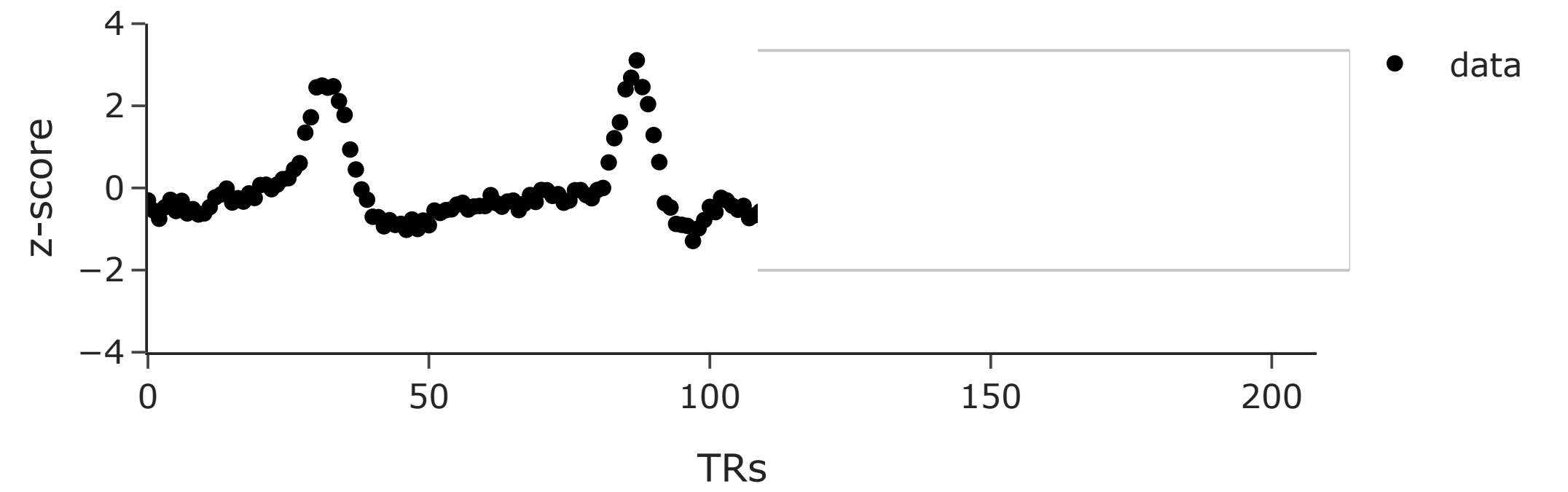
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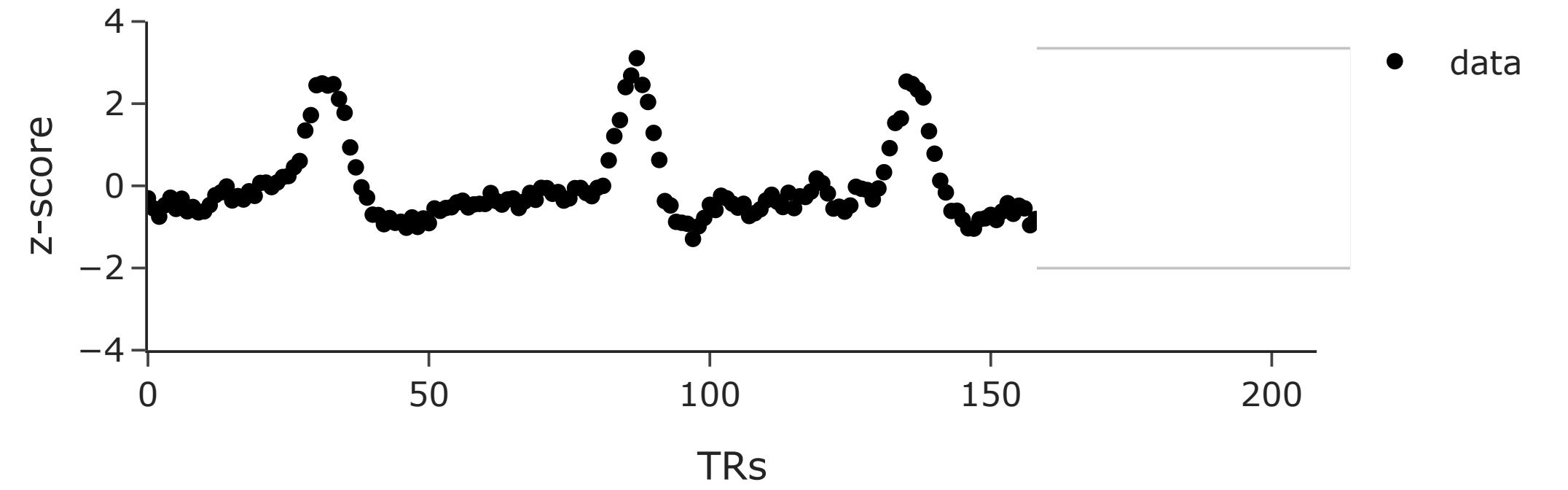
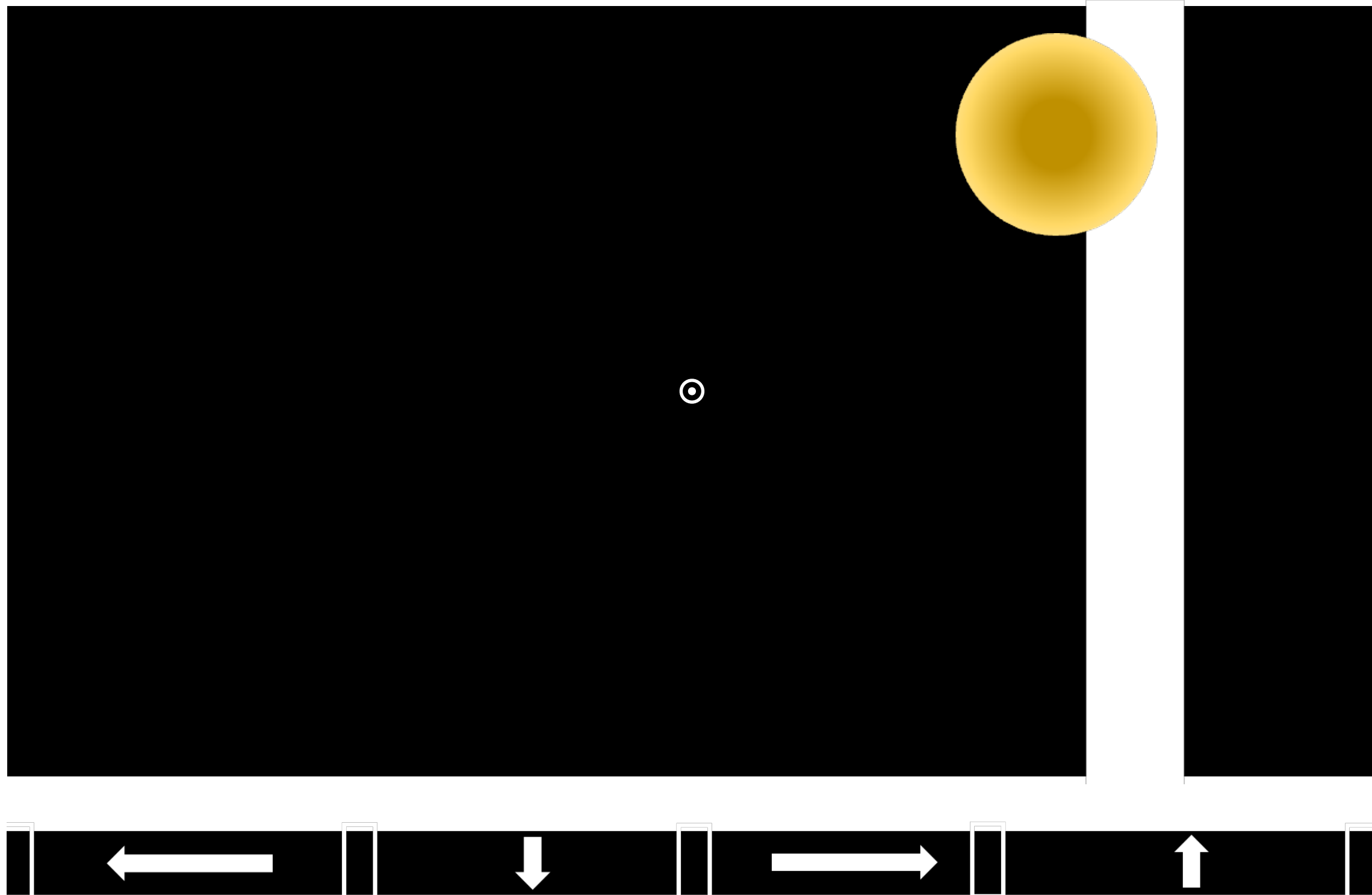


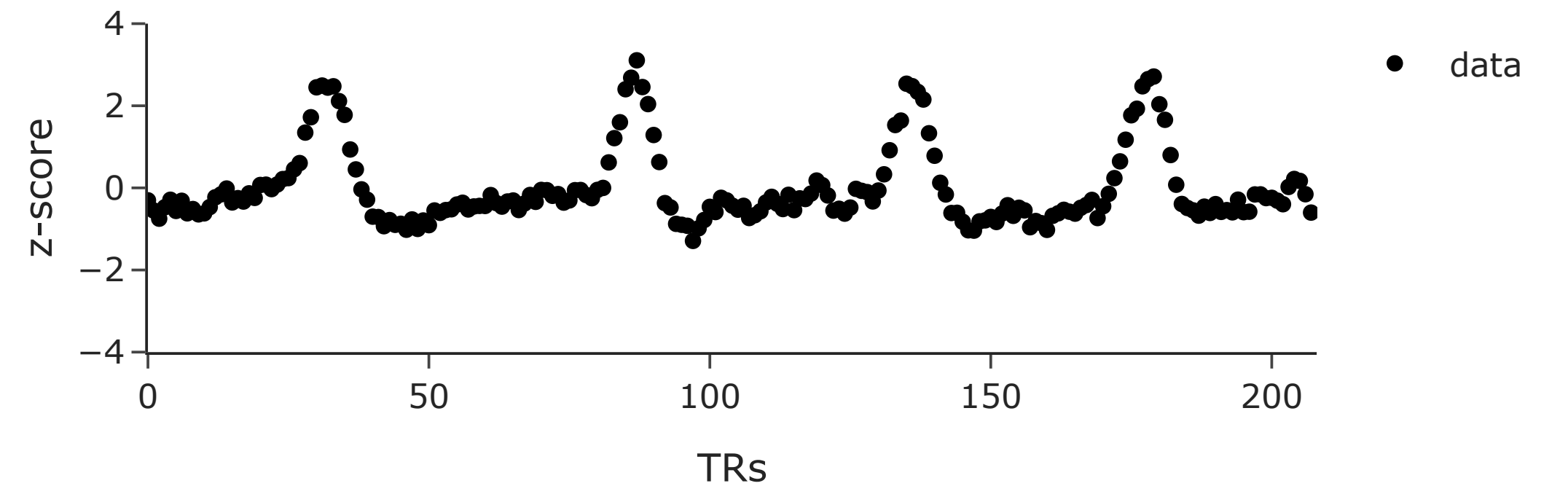


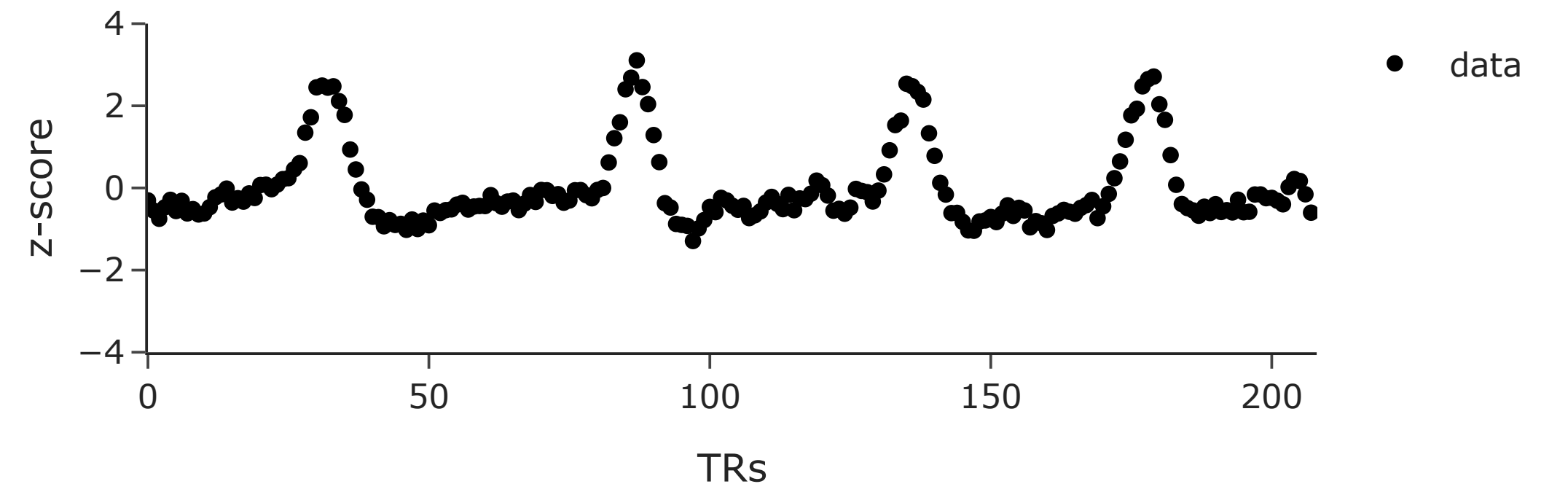


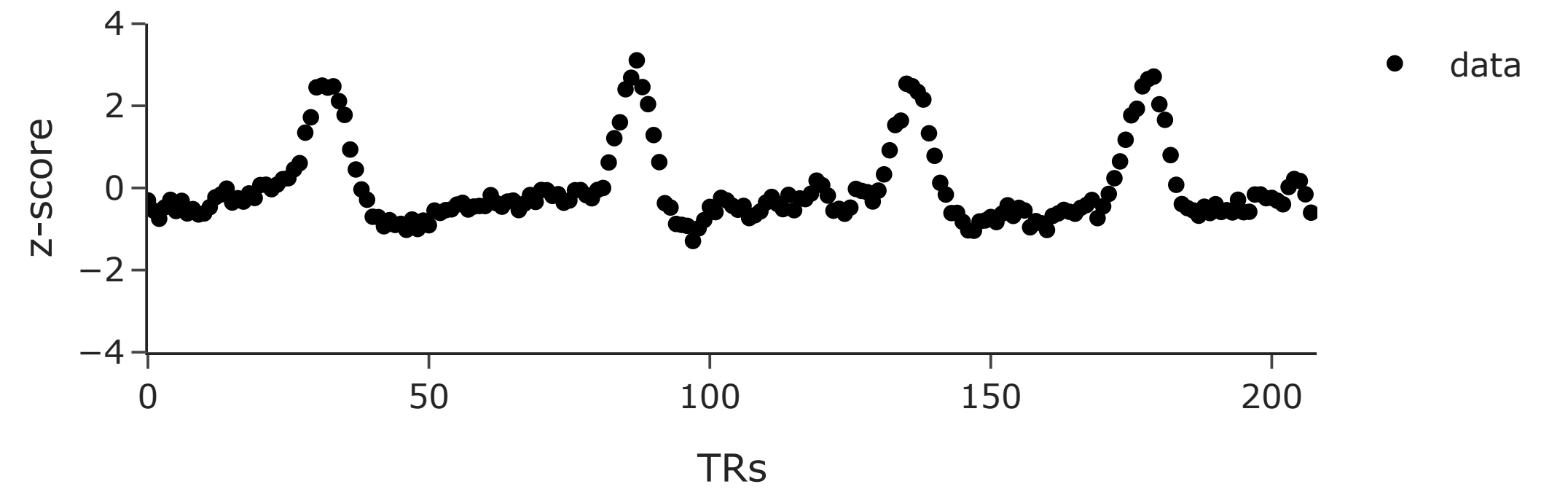
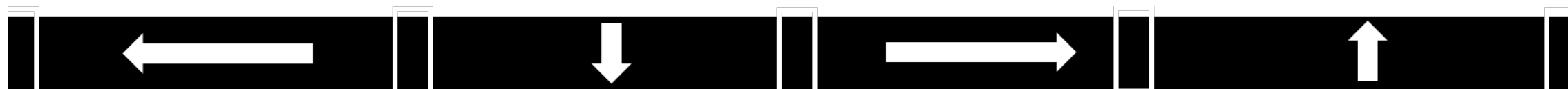
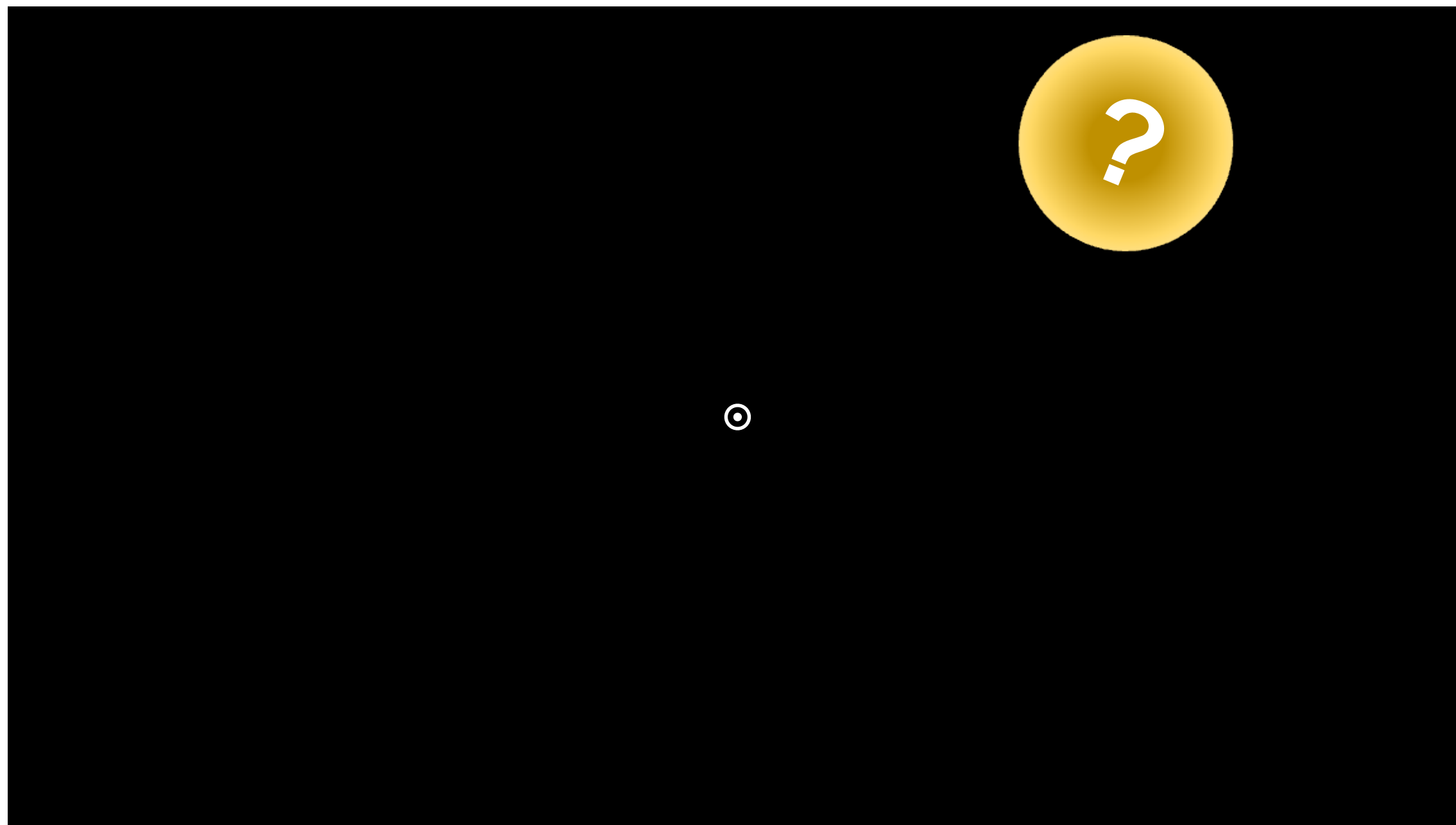


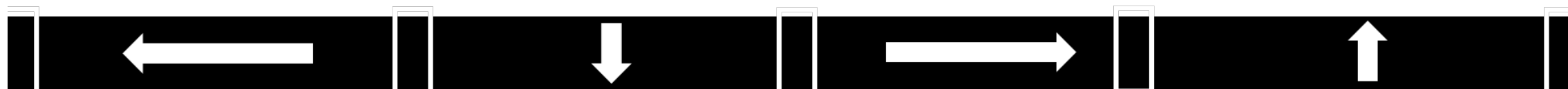
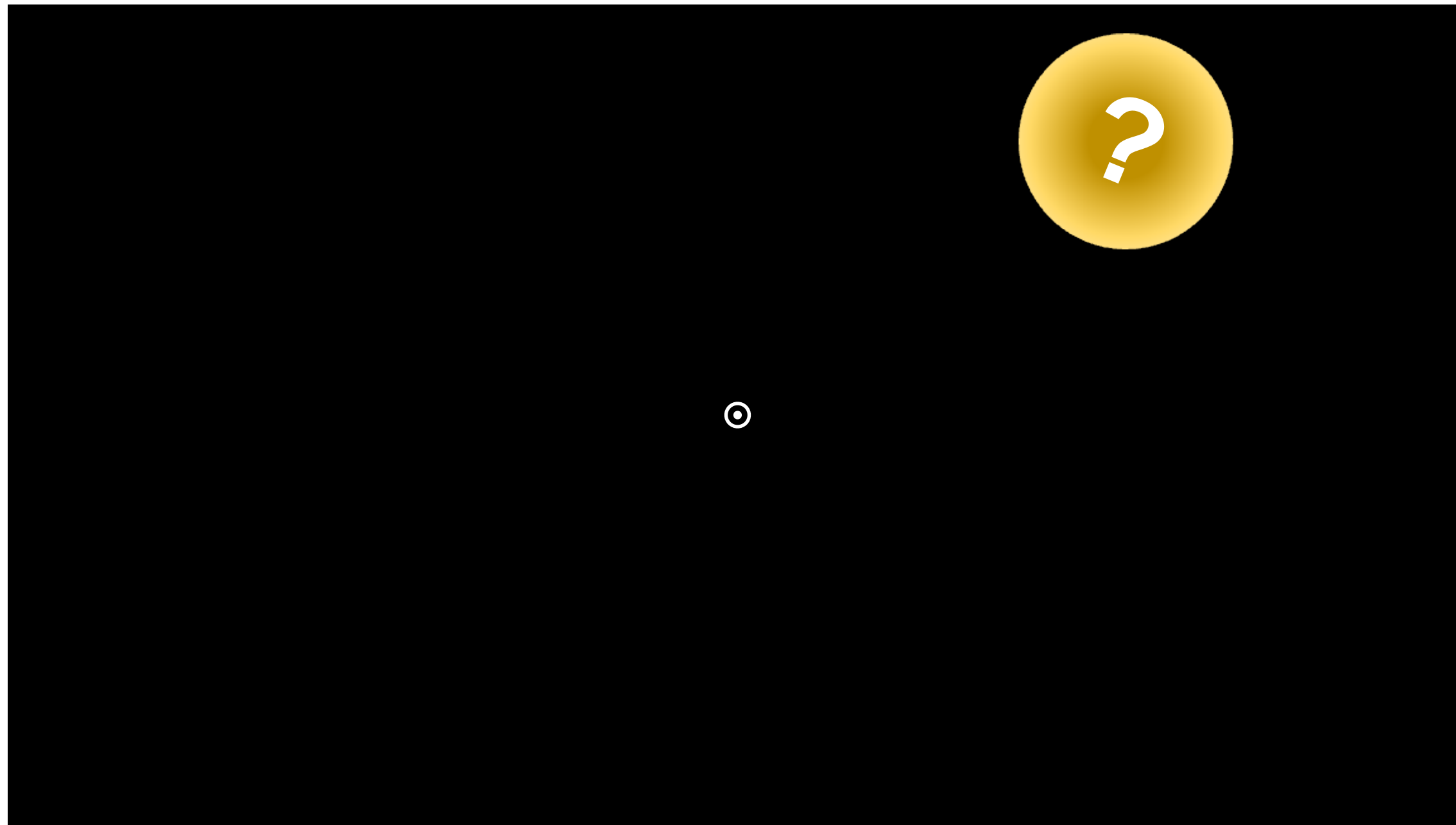


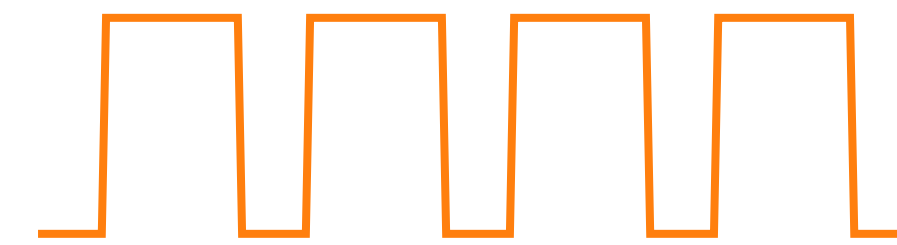
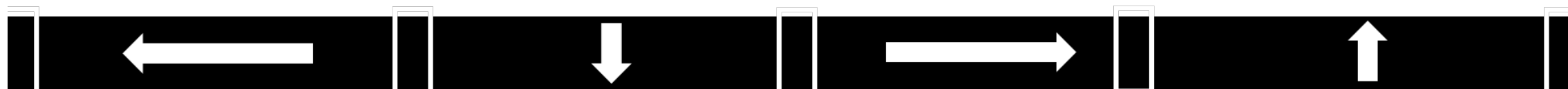
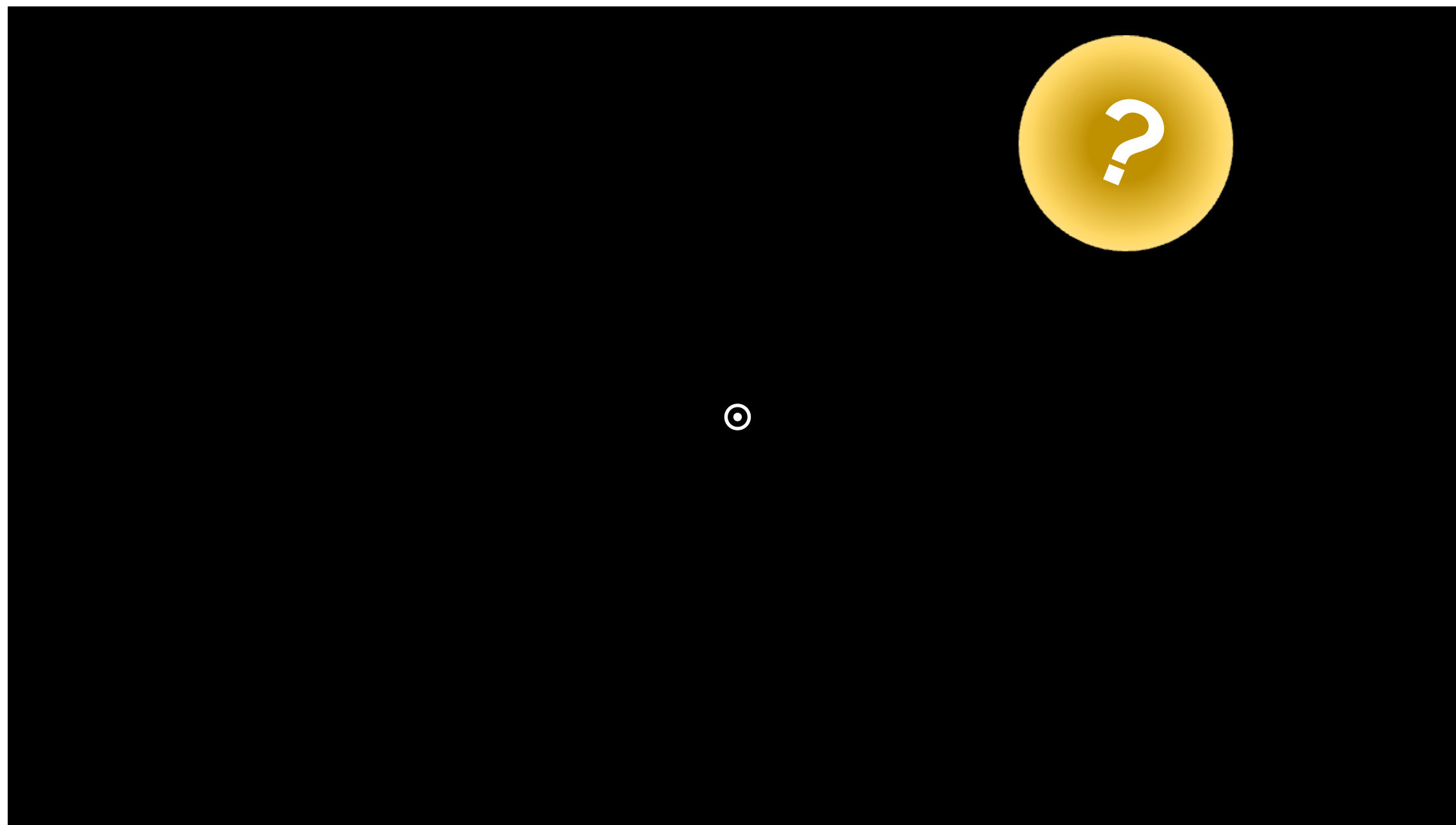




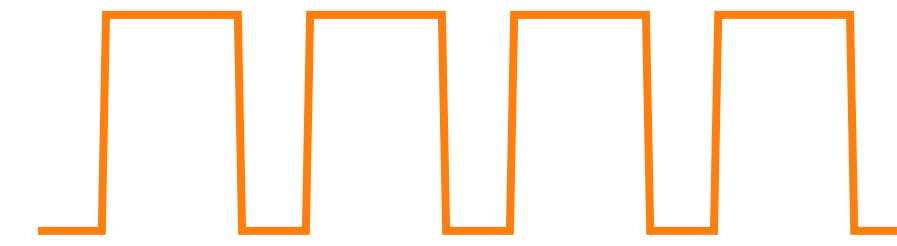
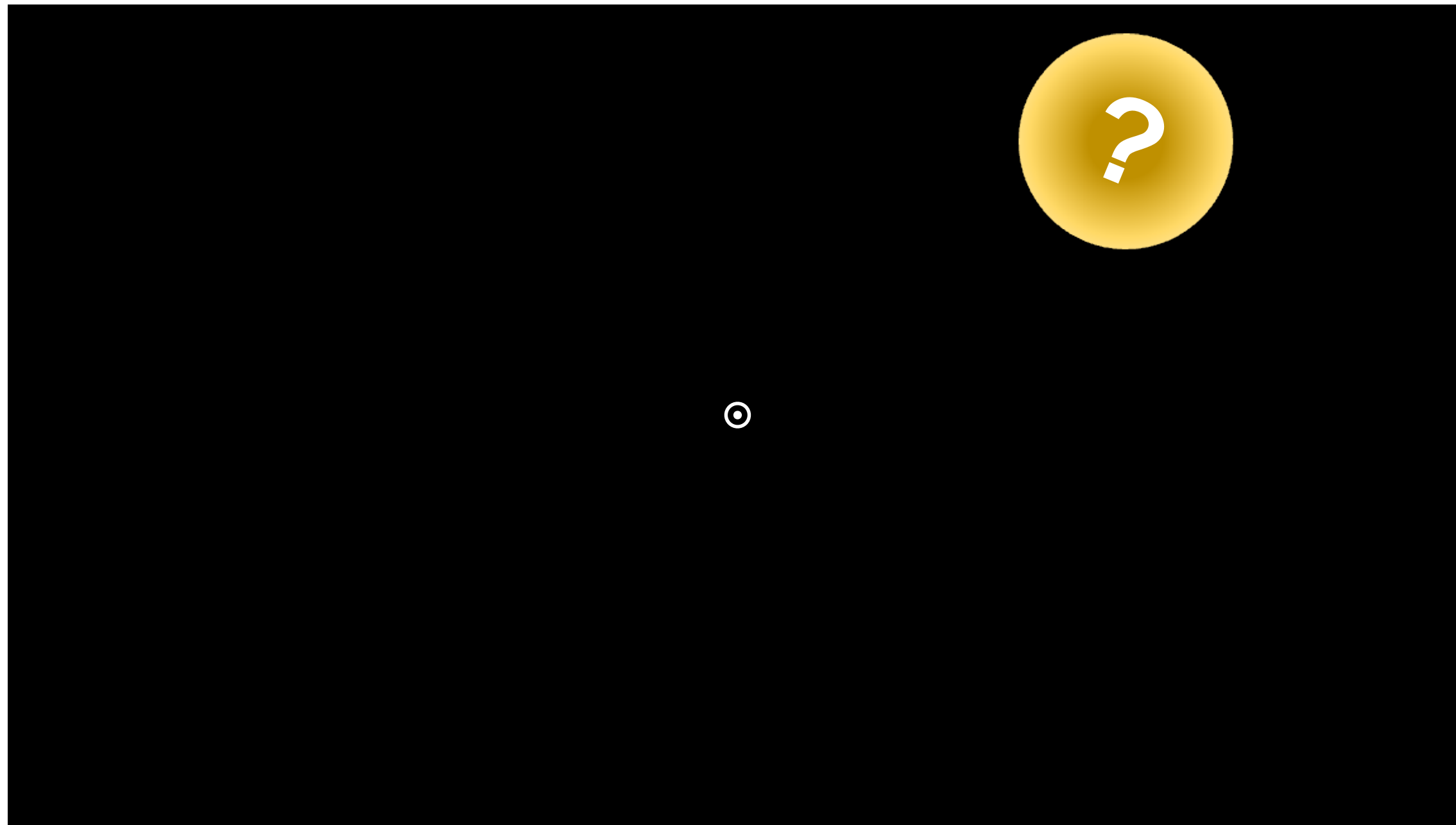








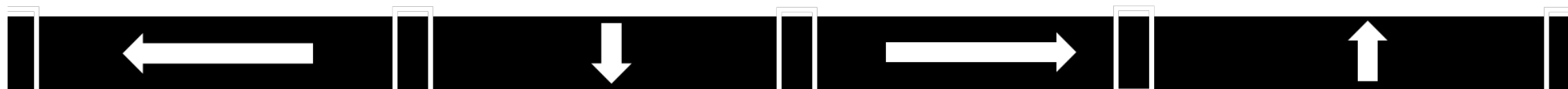
Stimulus
position

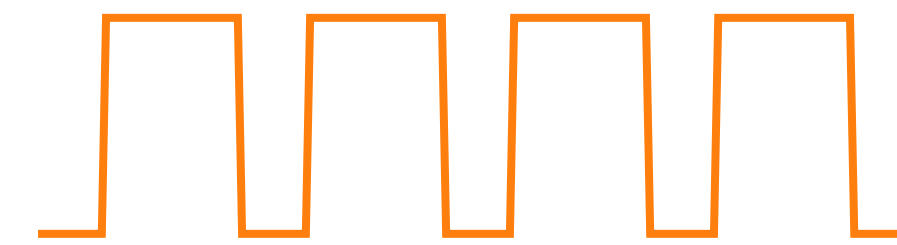
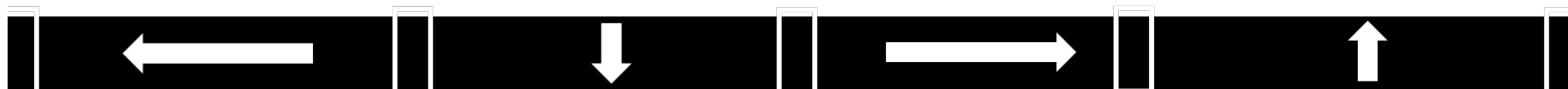
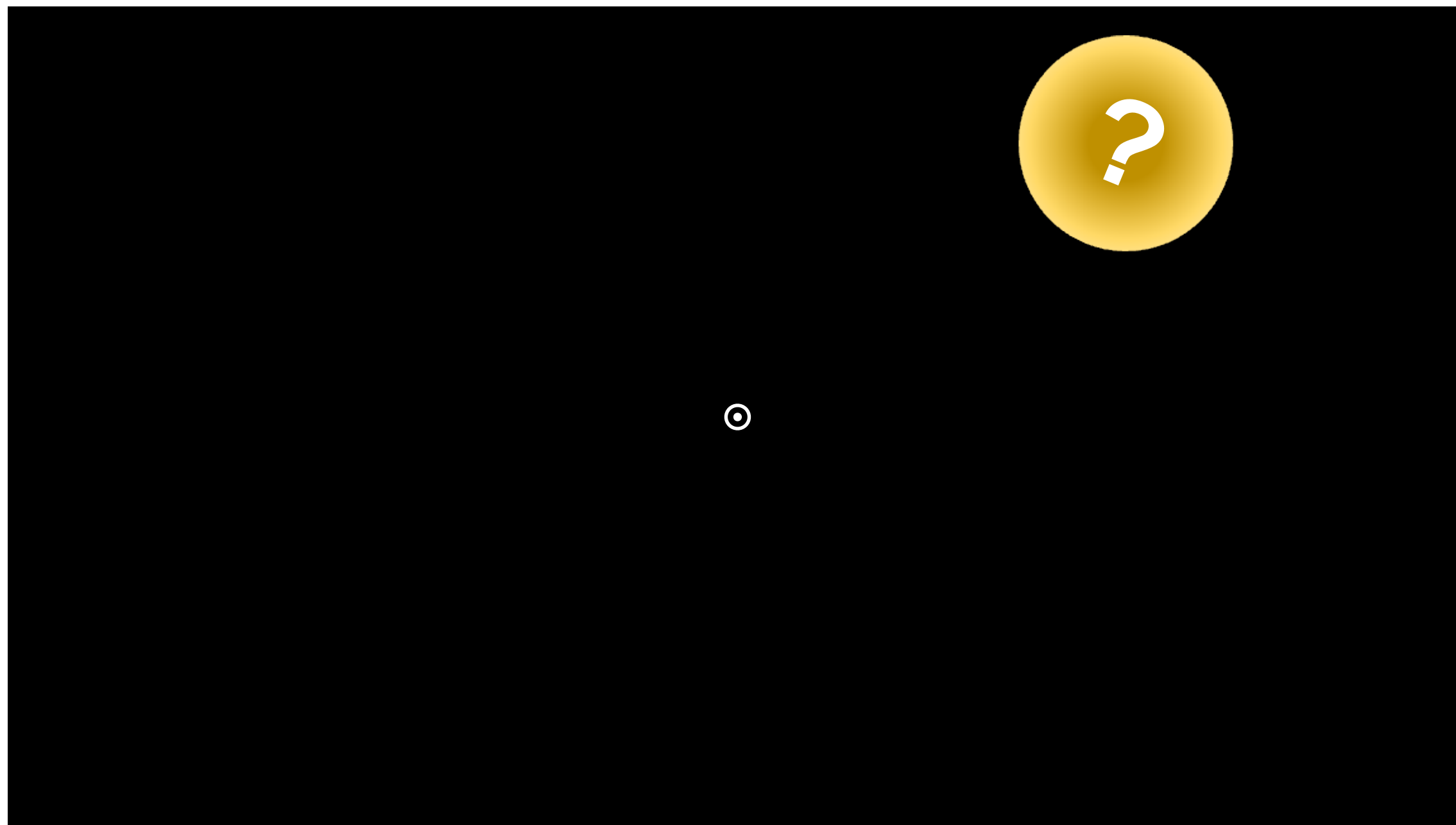


Stimulus position



HRF model

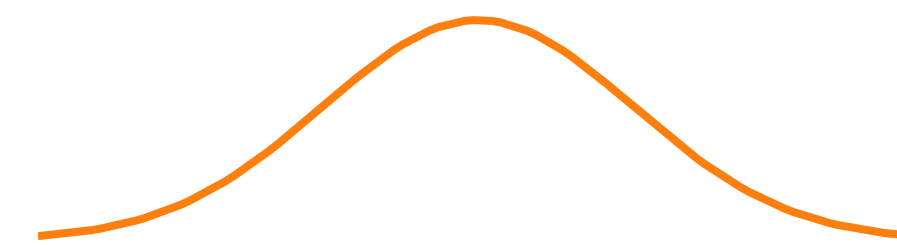




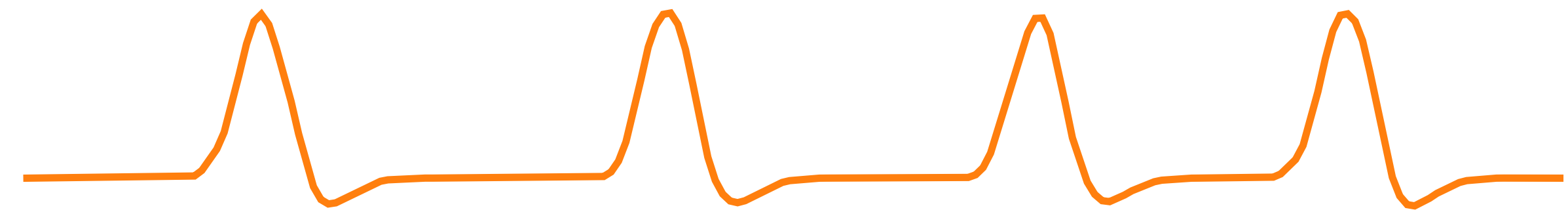
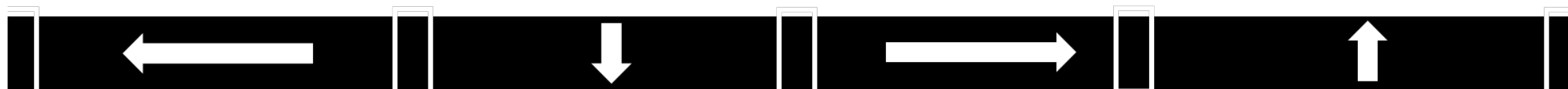
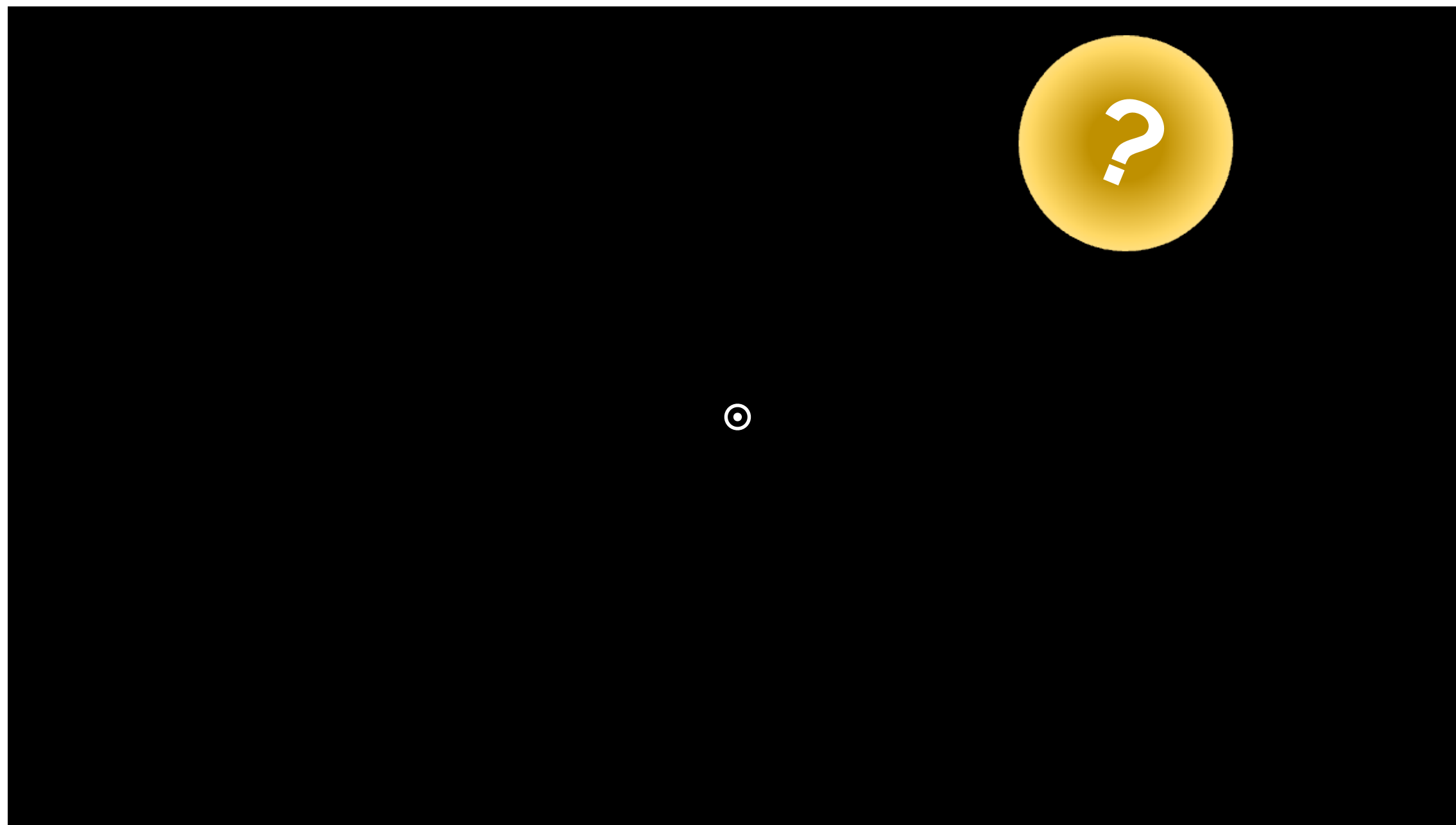
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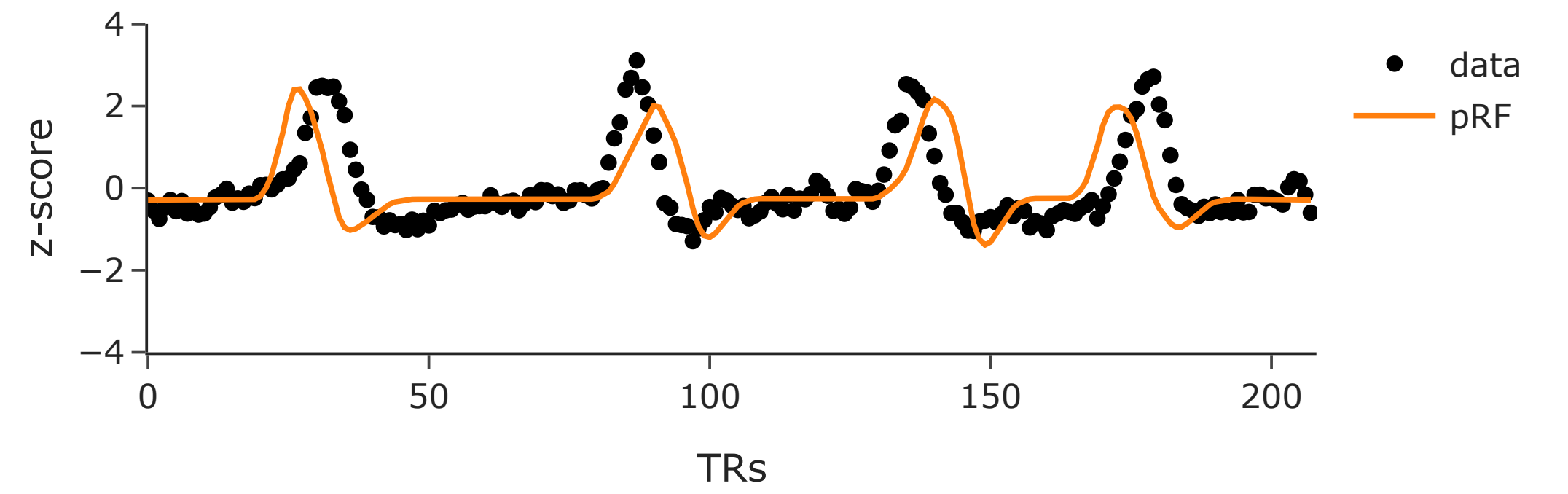
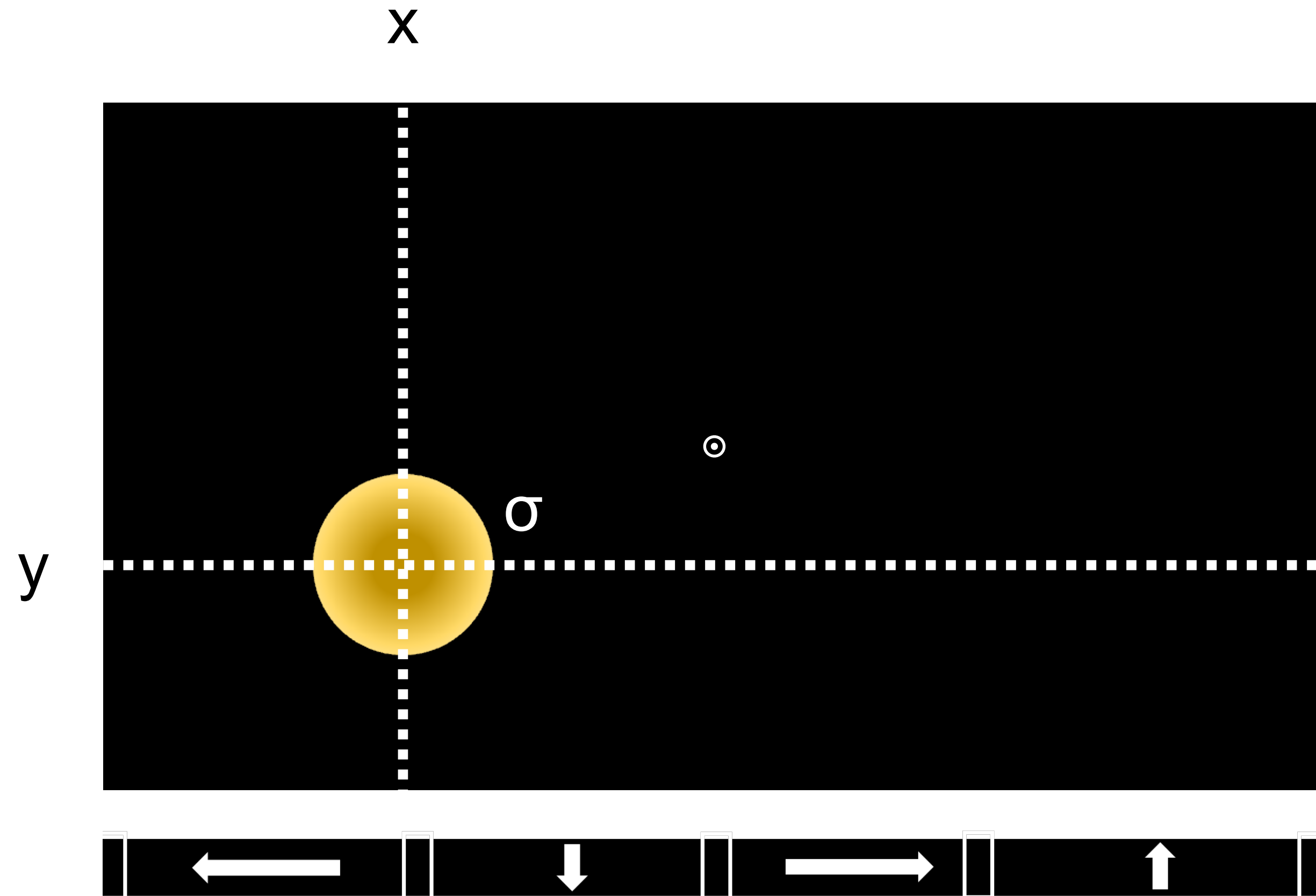
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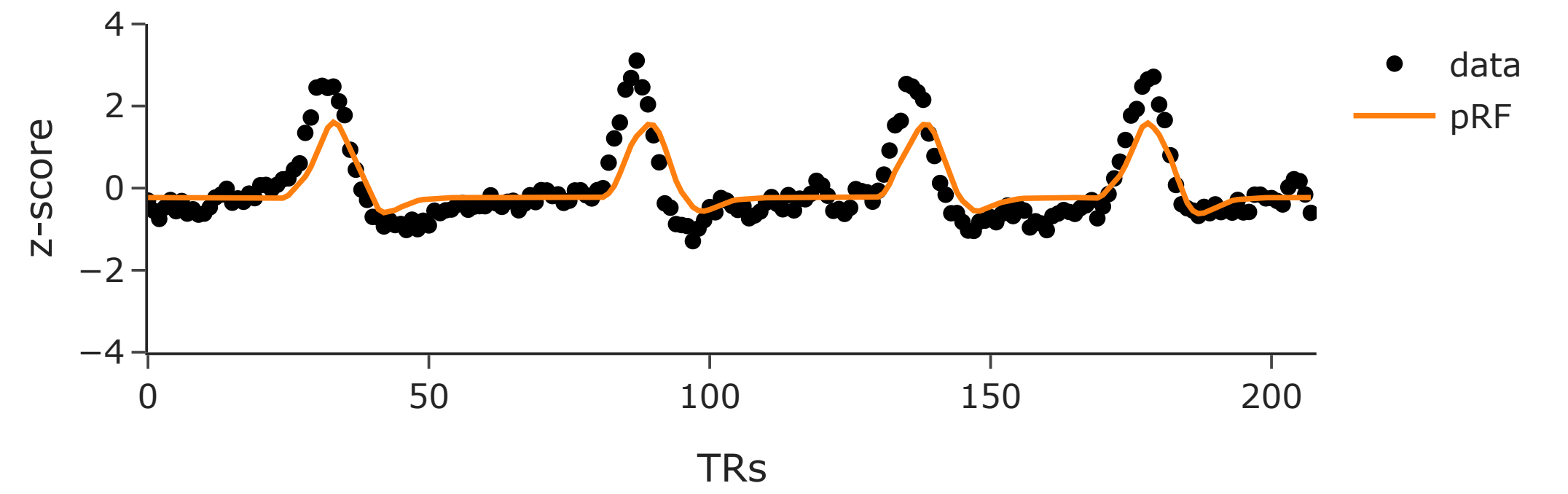


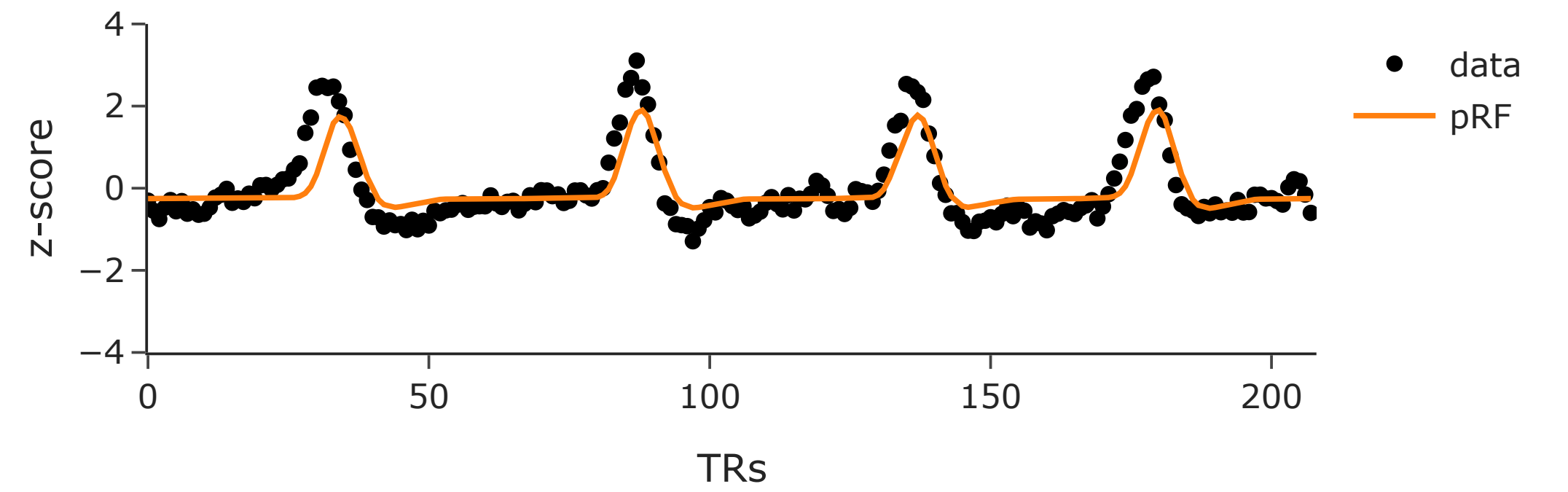
receptive field model
(position, size...)

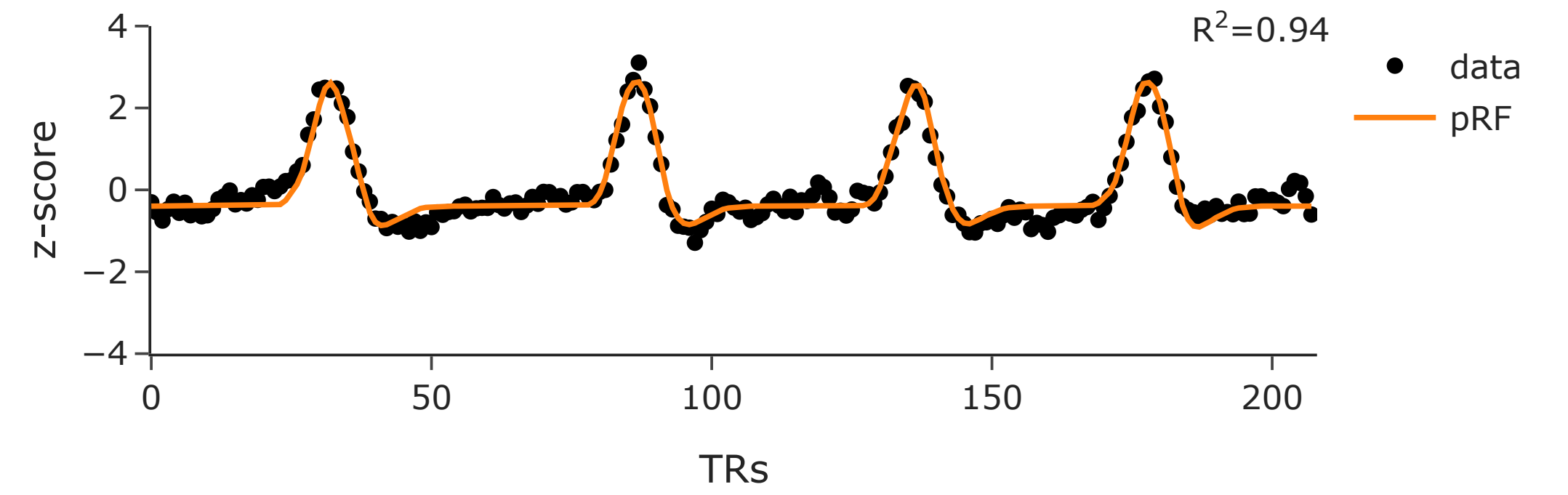
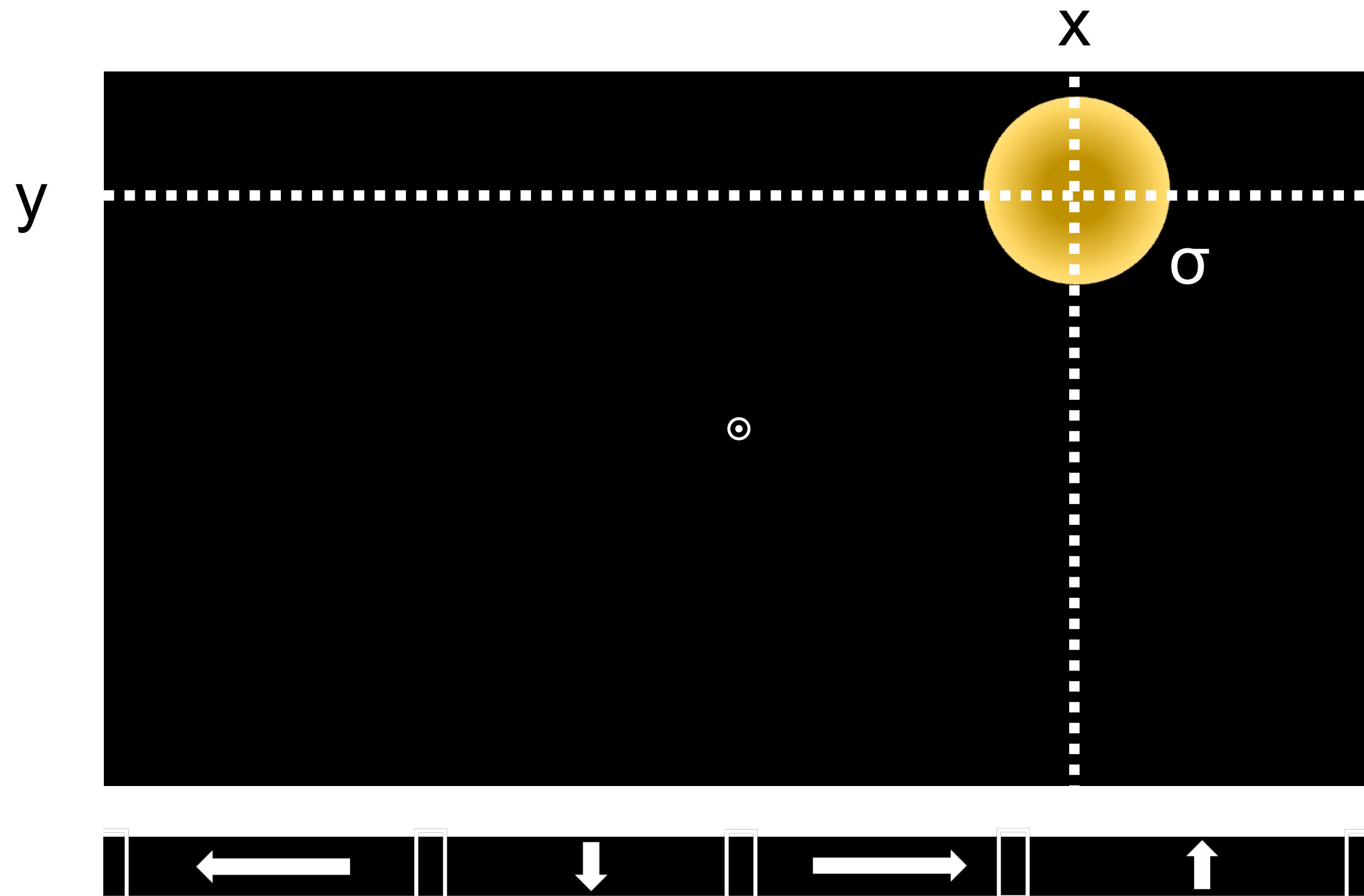


Model
Prediction

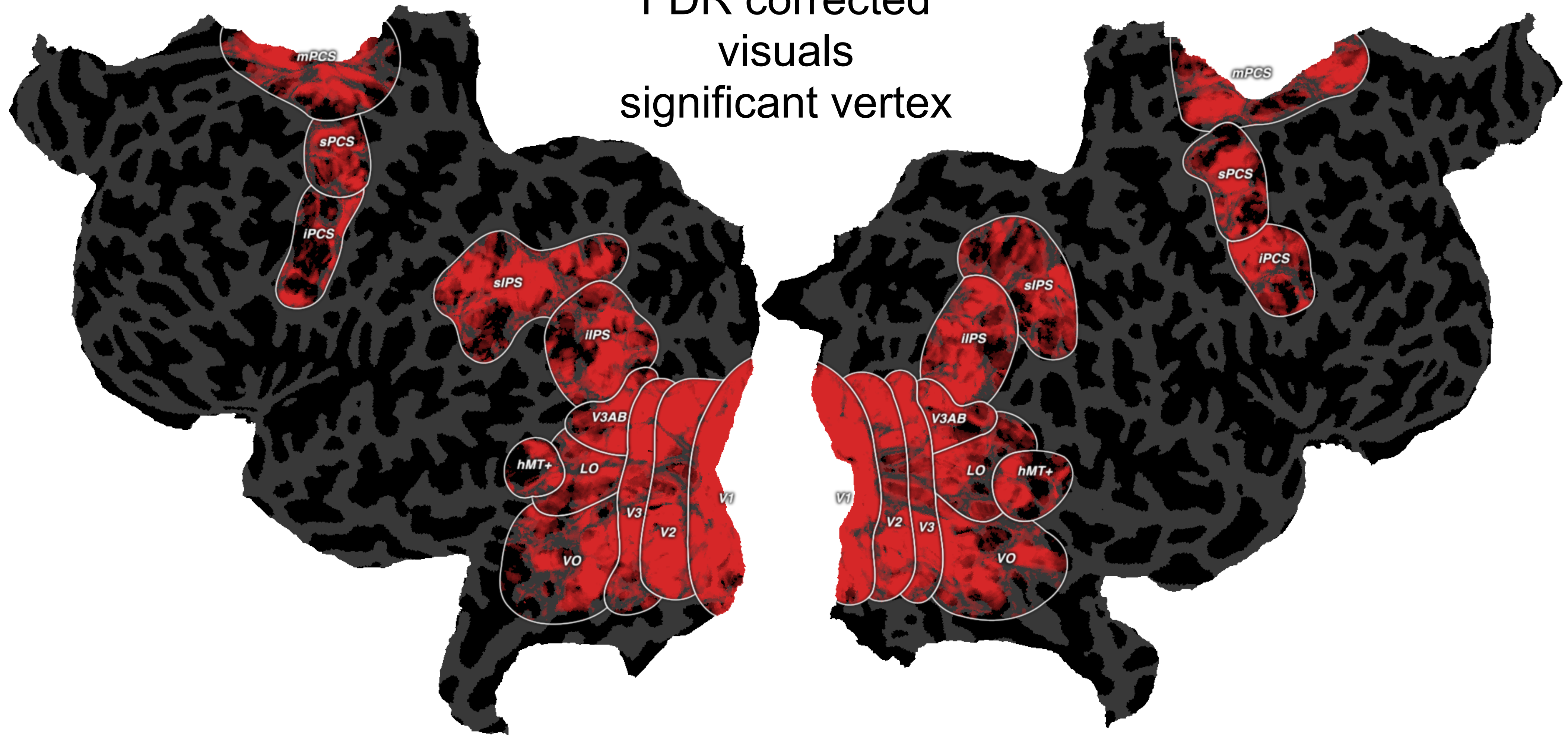




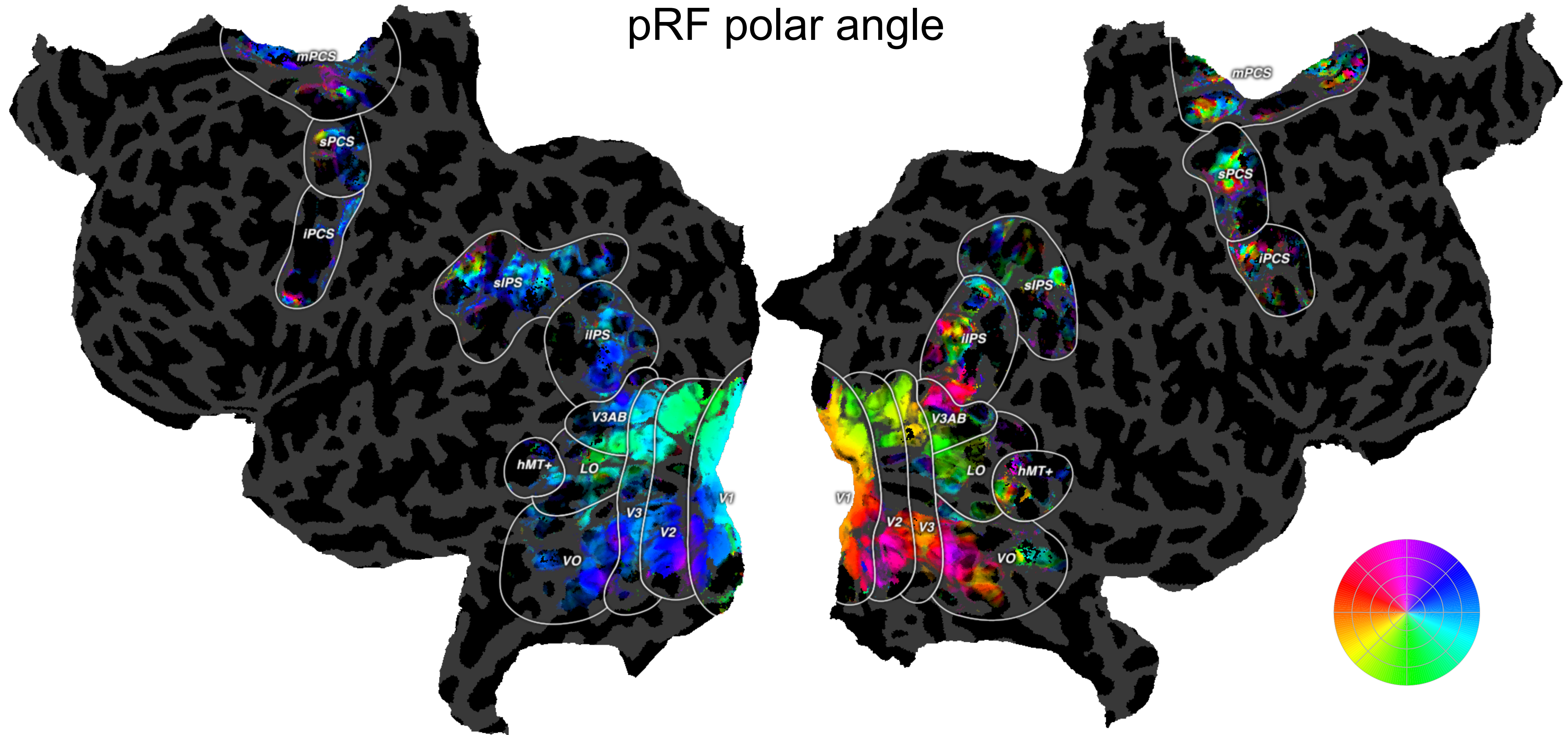




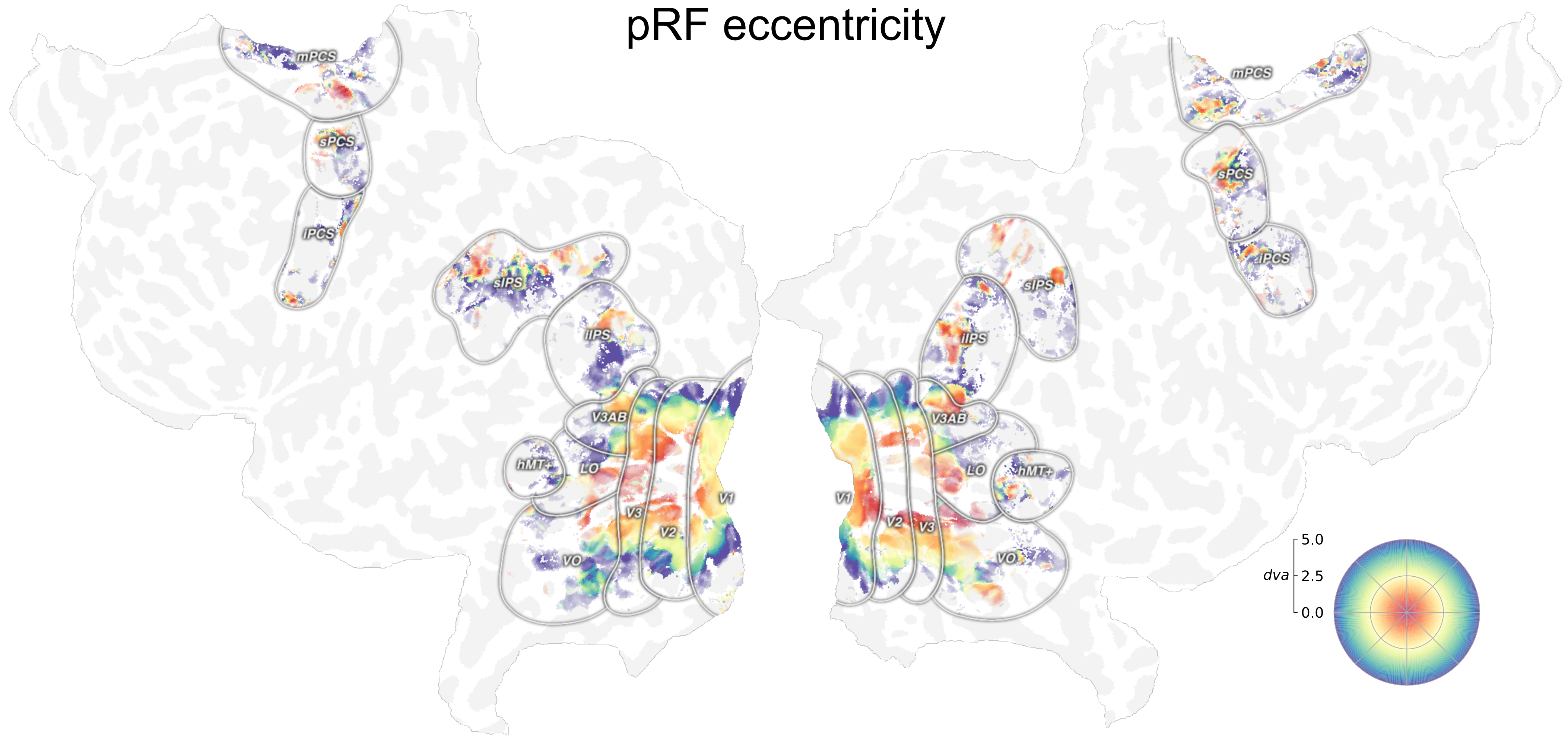
Sub-12
FDR corrected
visuals
significant vertex



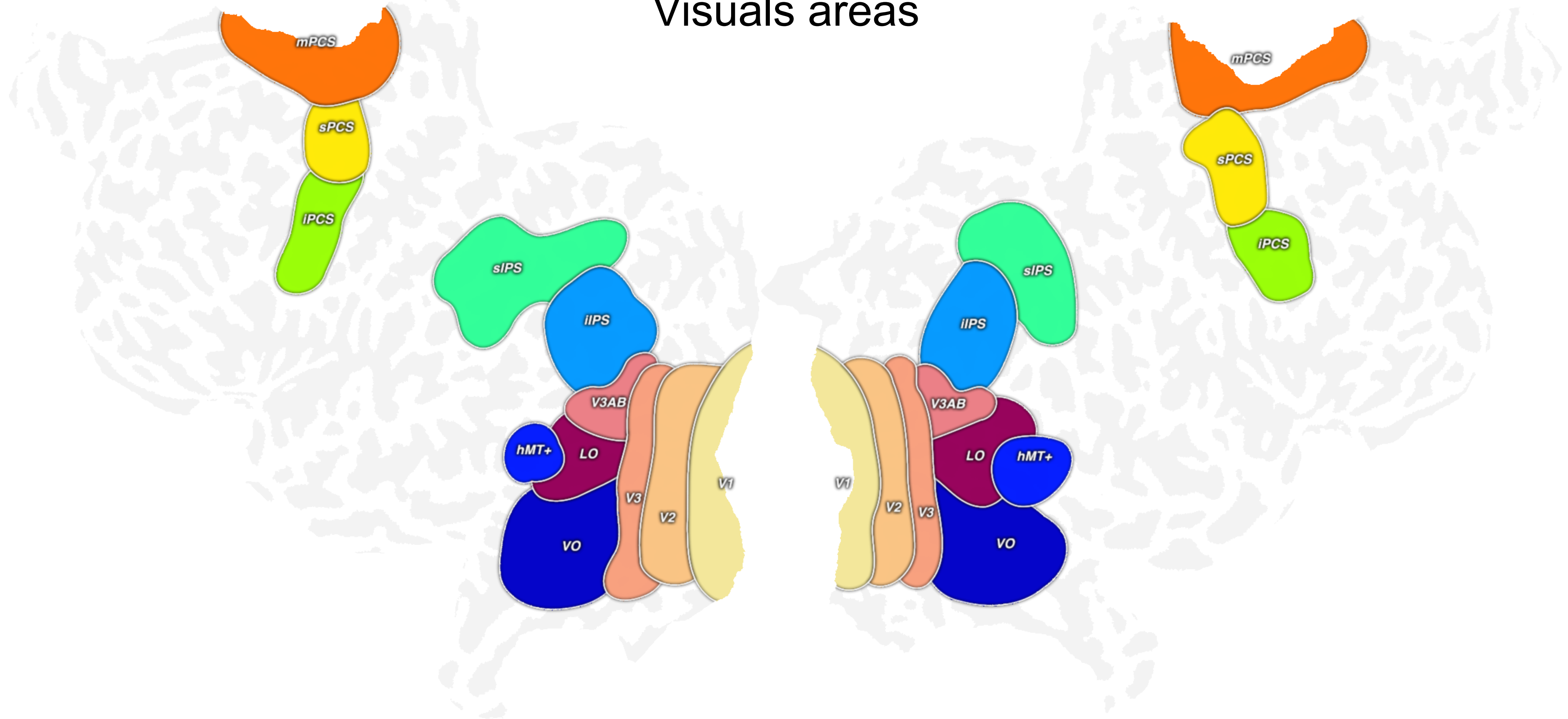
Sub-12 pRF polar angle



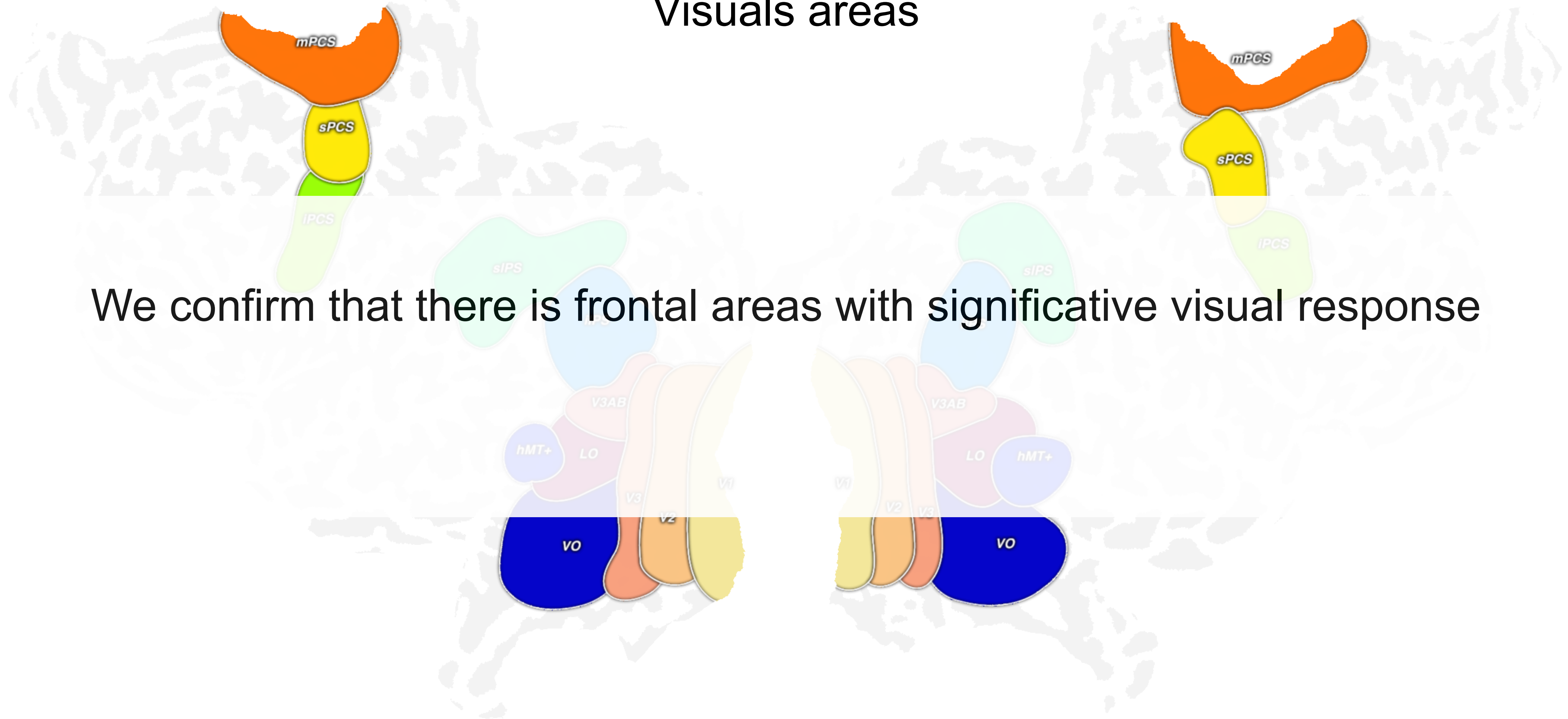
Sub-12 pRF eccentricity



Sub-12 Visuals areas

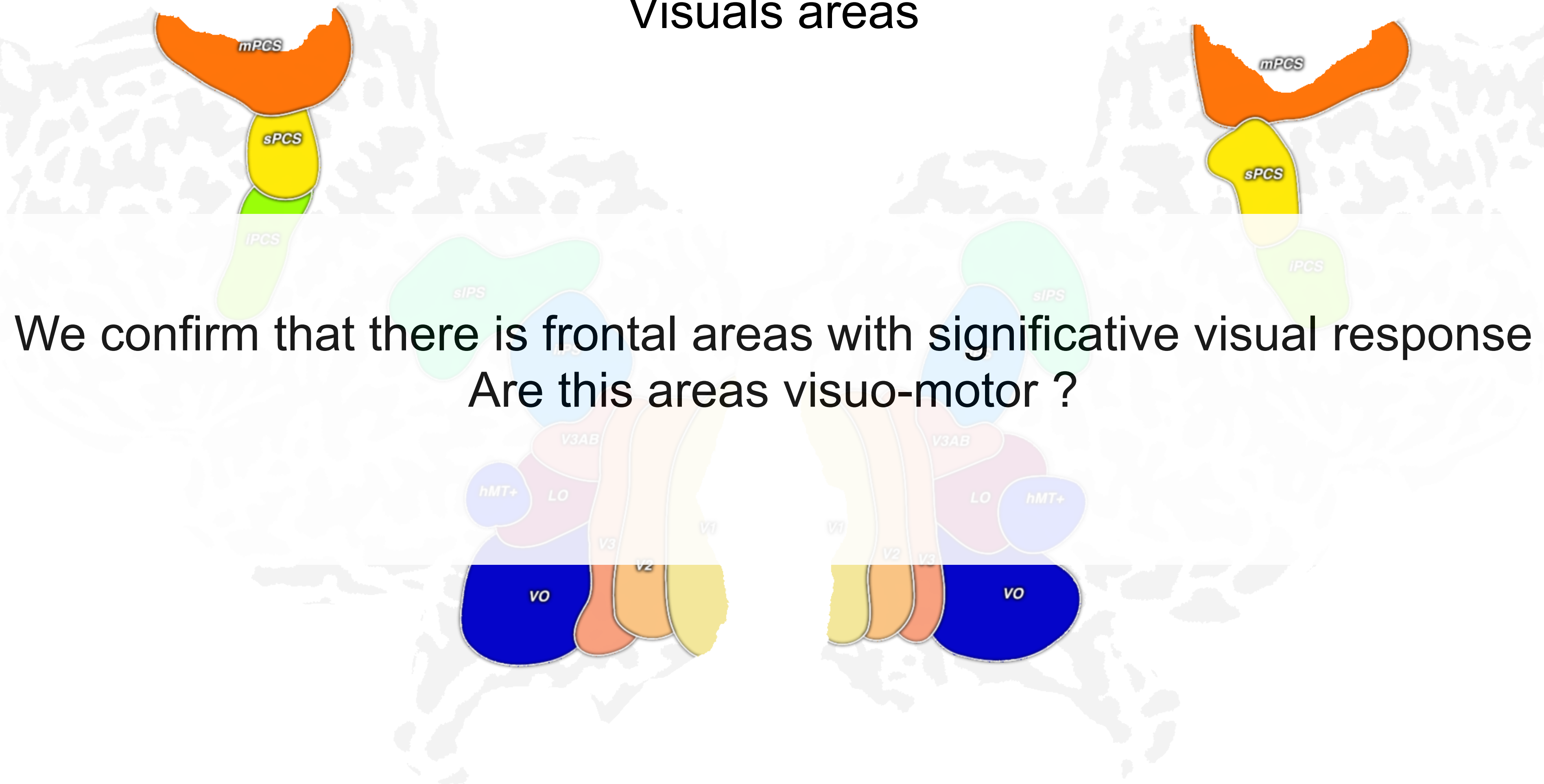


Sub-12 Visuals areas



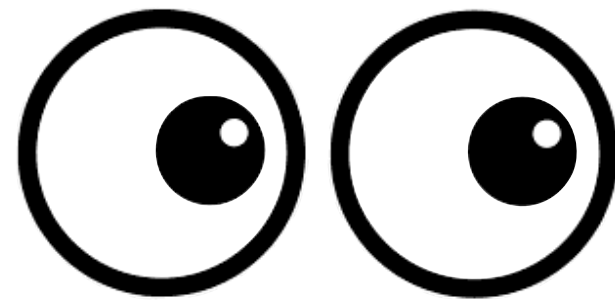
We confirm that there is frontal areas with significant visual response

Sub-12 Visuals areas



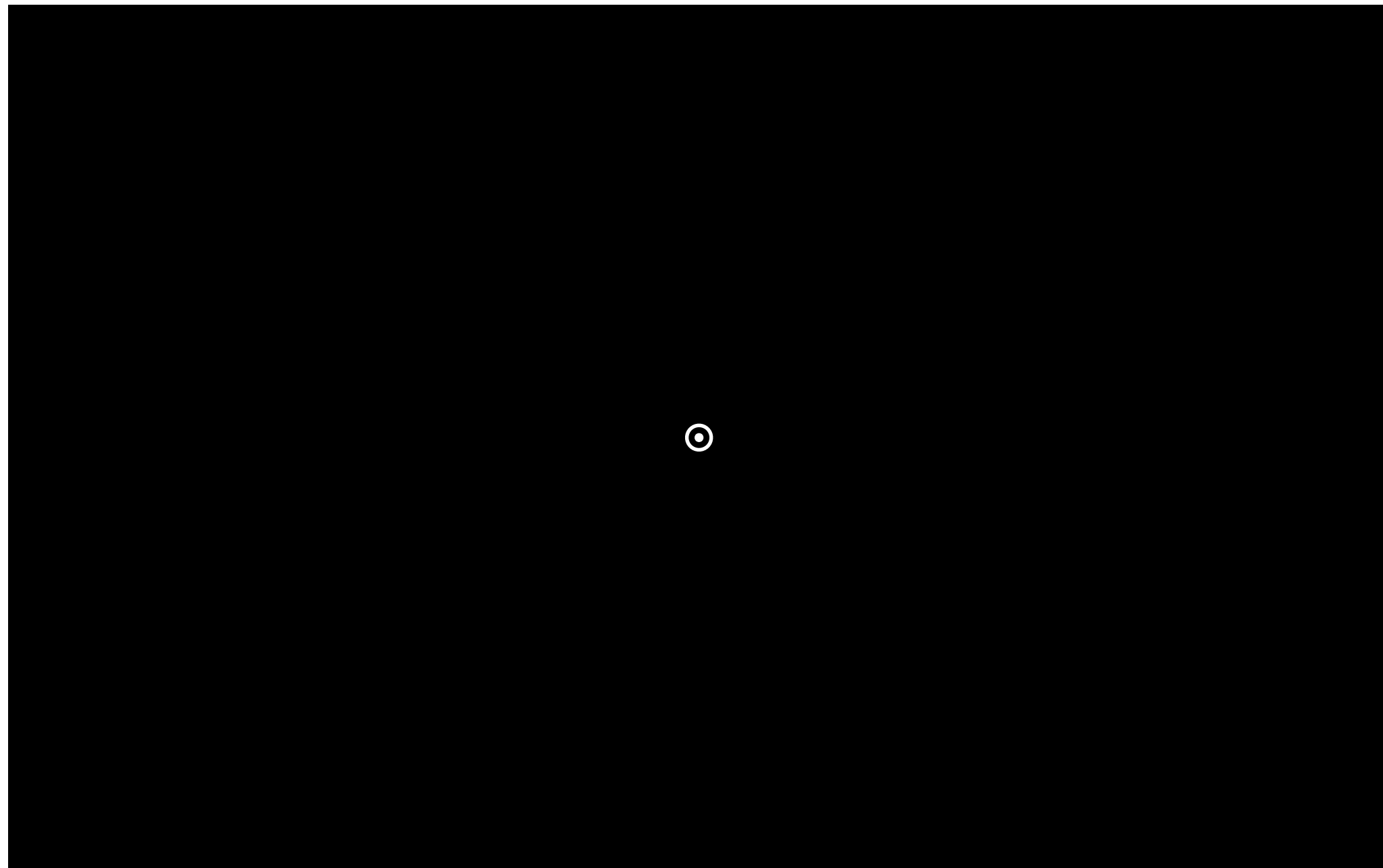
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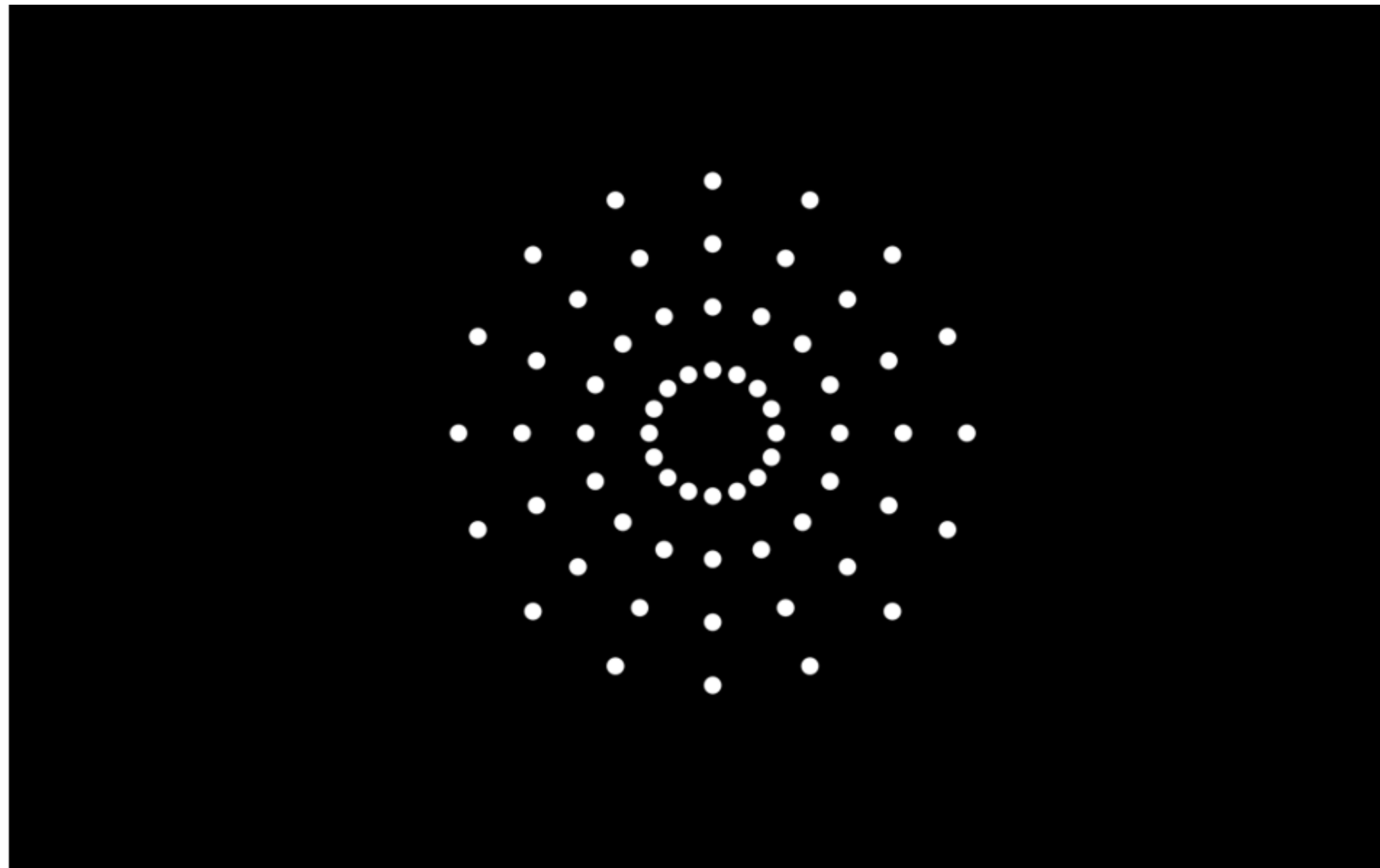
6
tasks



Instructions :

Make saccade to reach the point





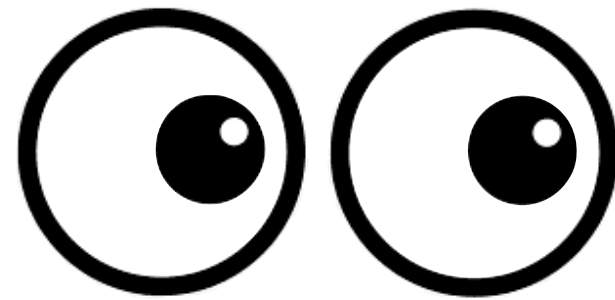
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Make saccade to reach the point

Details :

- 2 Runs (~10min)
- 32 Directions
- 4 Amplitudes
- Eye movement on each TR
- Eye tracking recording during all runs

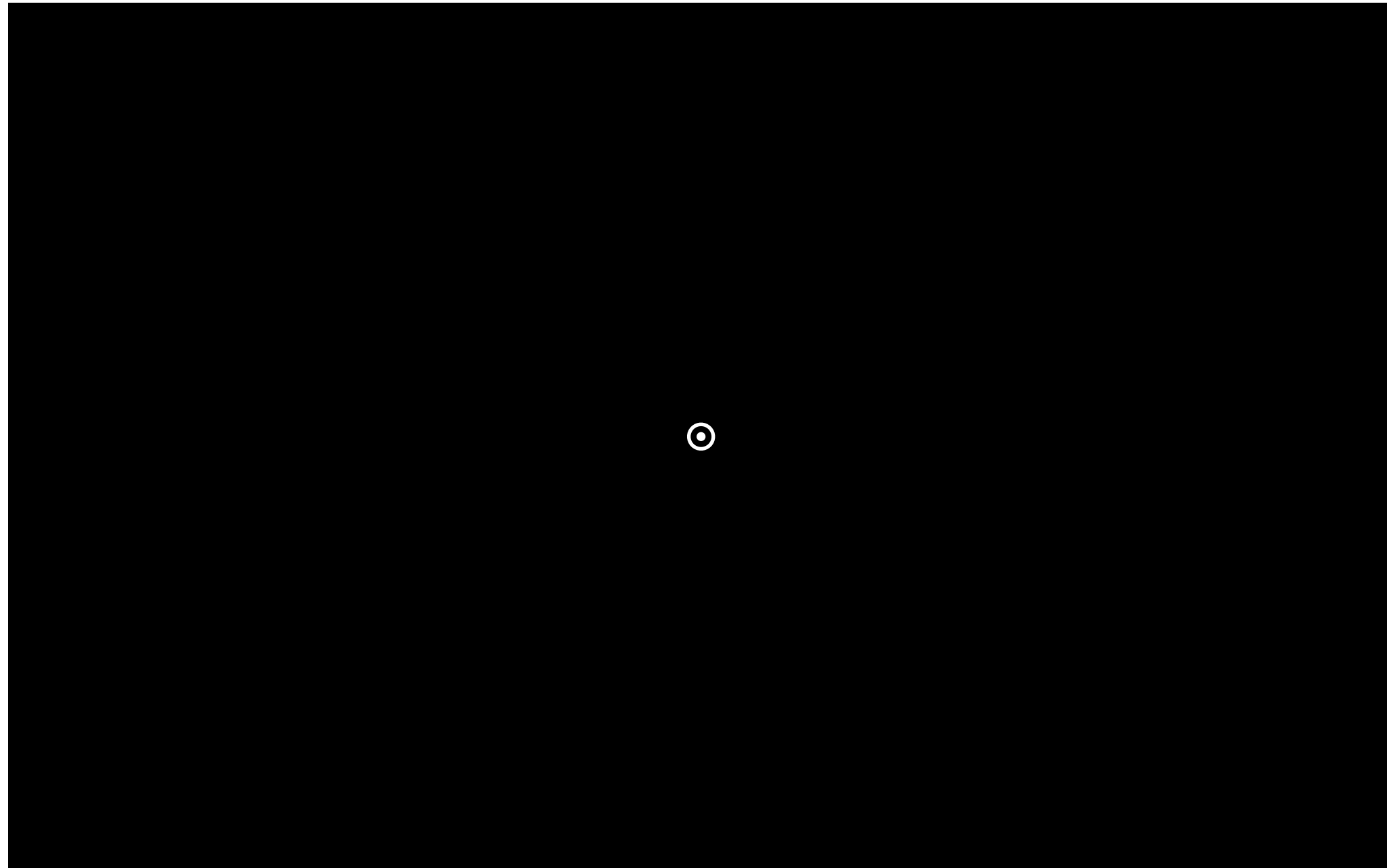
6
tasks

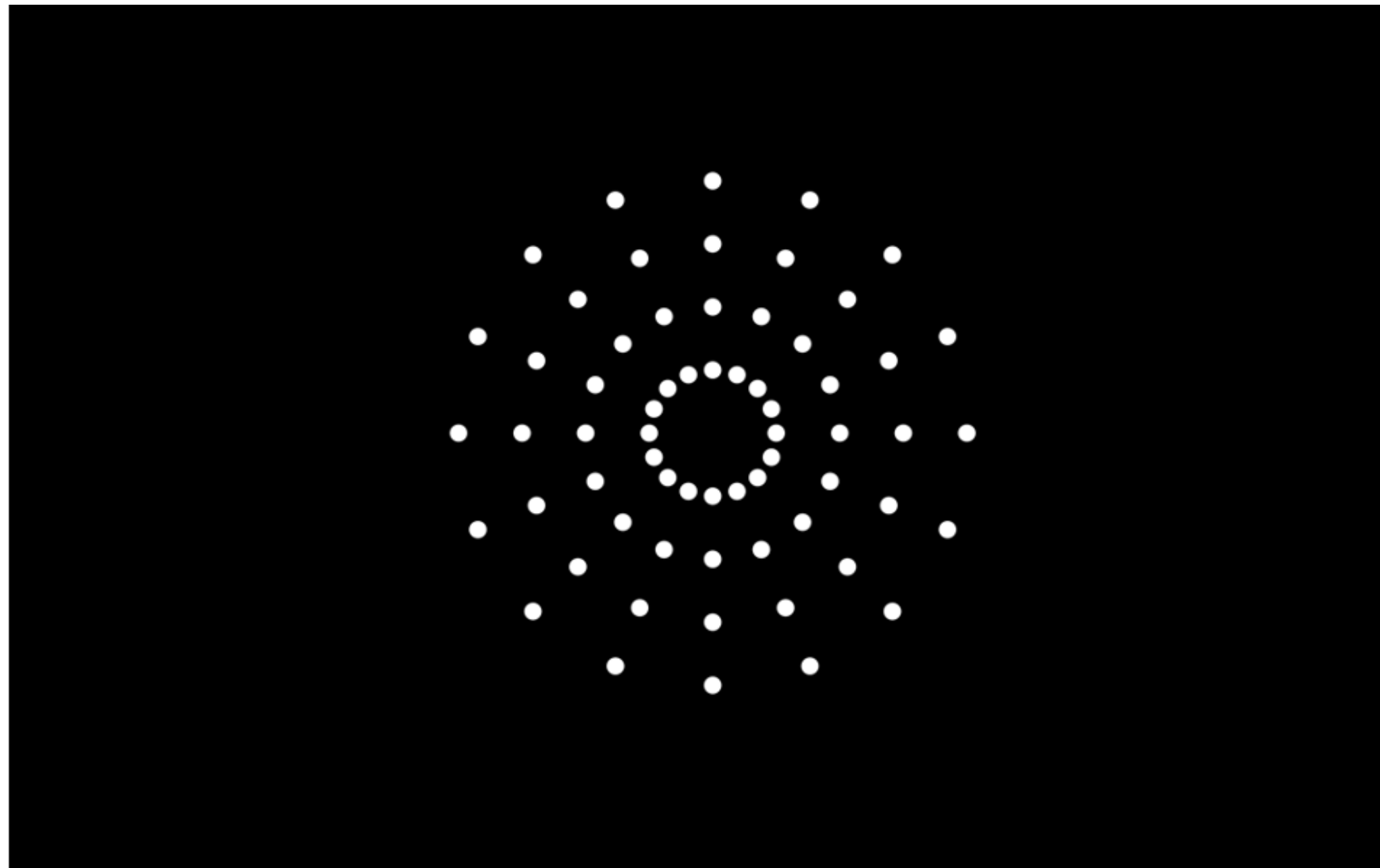


Pursuit Localization (PurLoc) : 2 runs
Make directed pursuit in 32 directions/ 5 amplitudes

Instructions :

Track the bull's eye with your eye



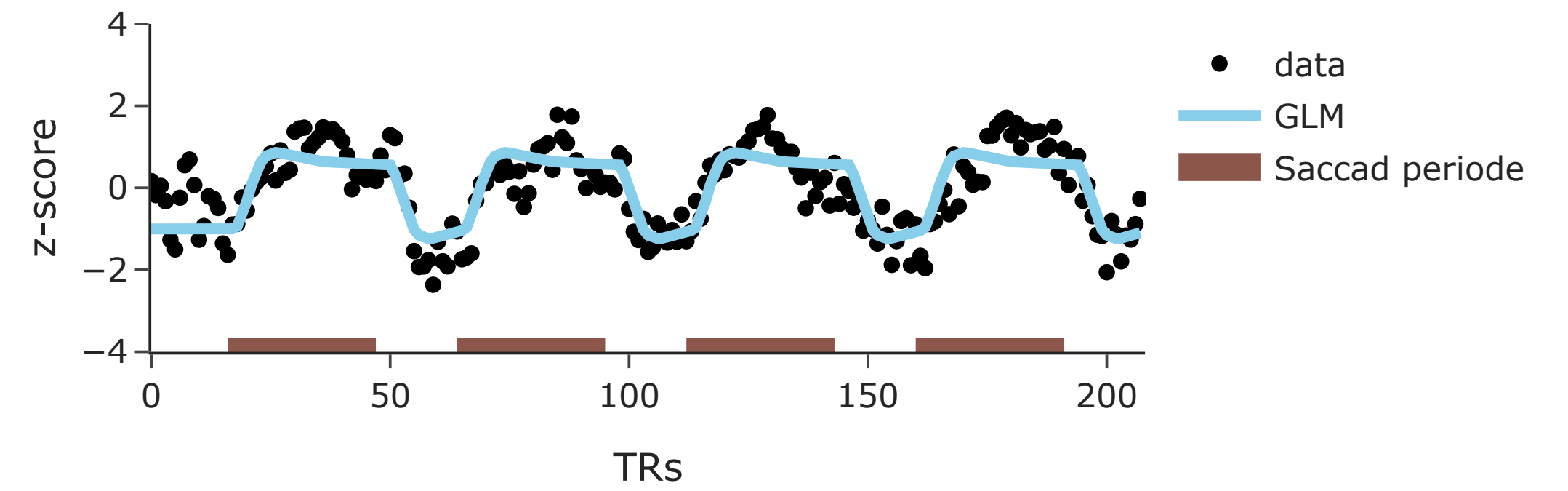
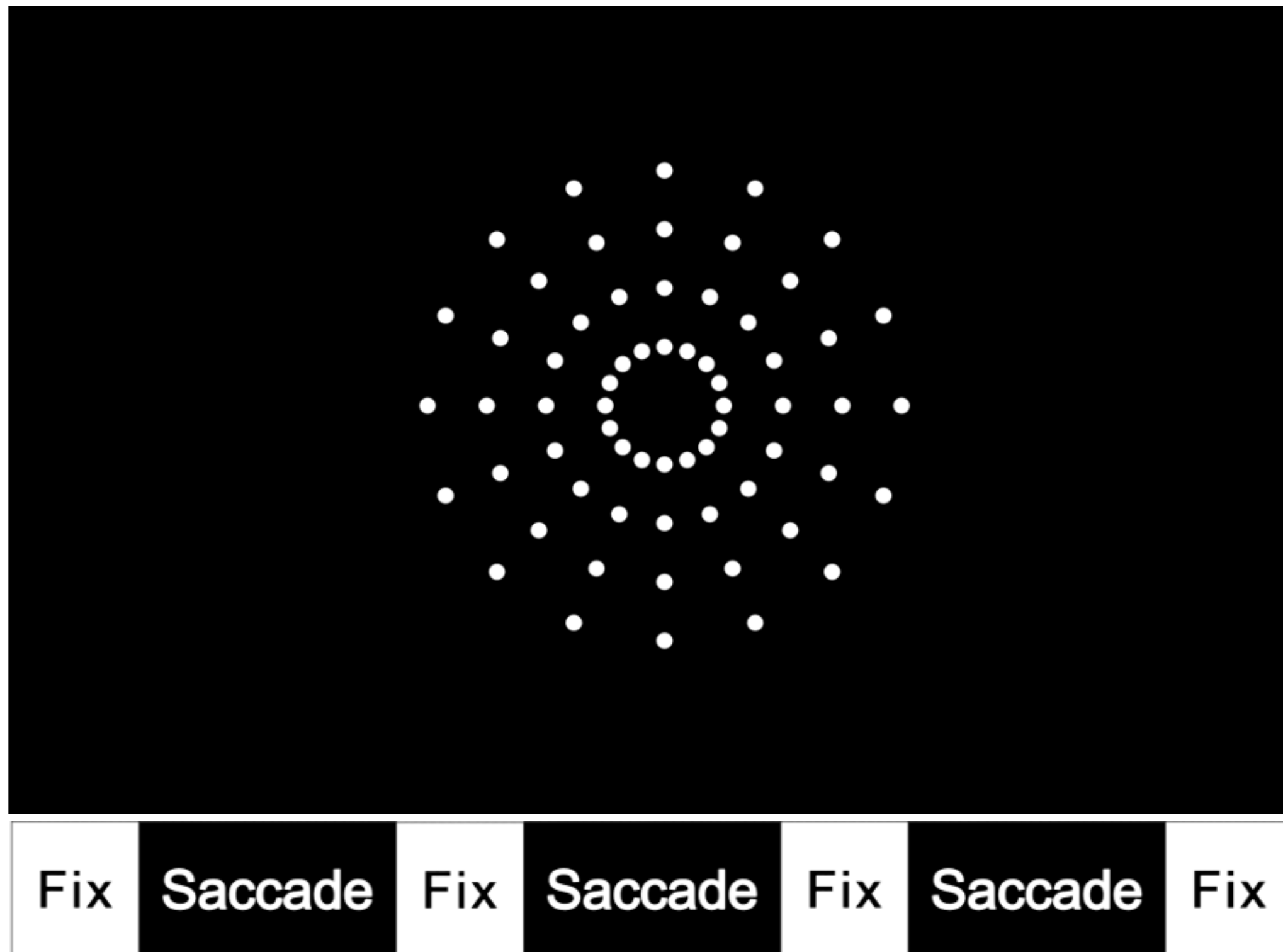


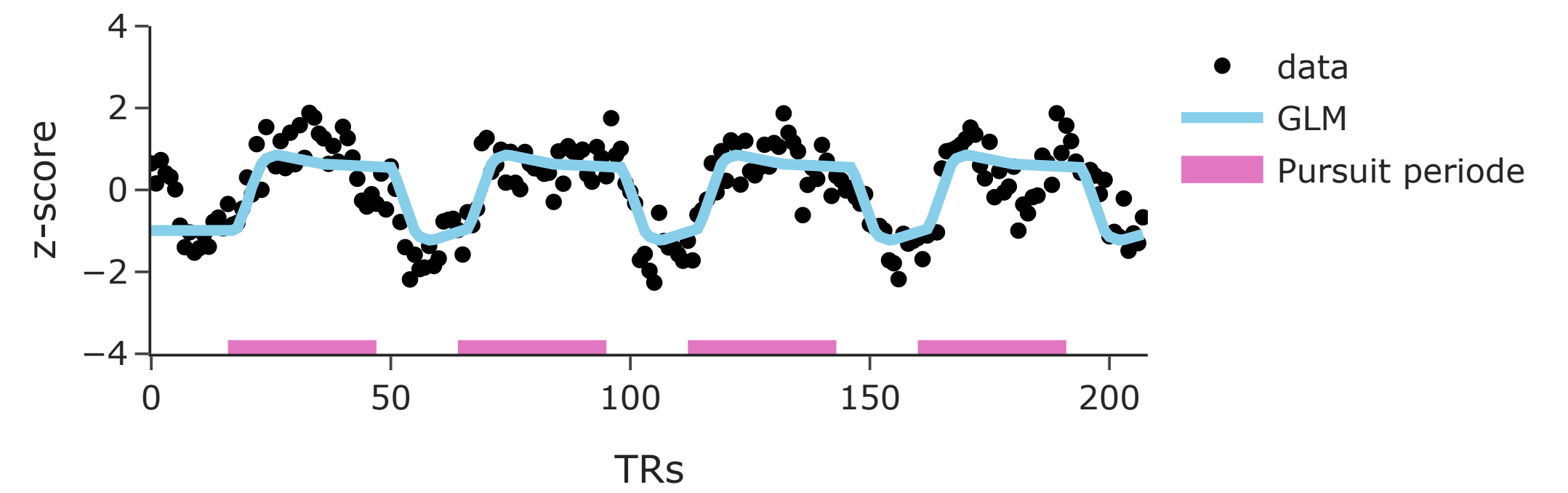
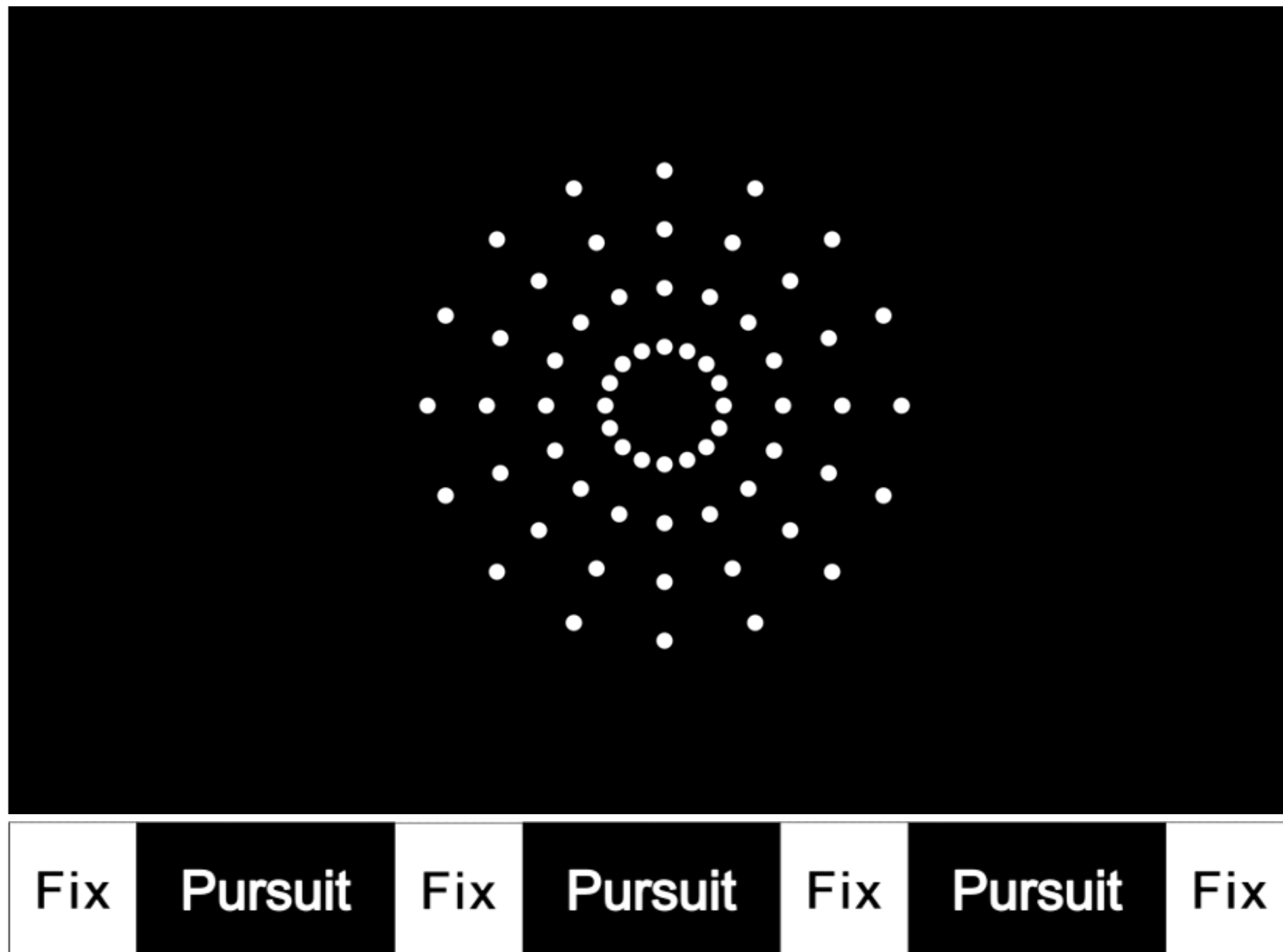
Instructions :

Track the bull's eye with your eye

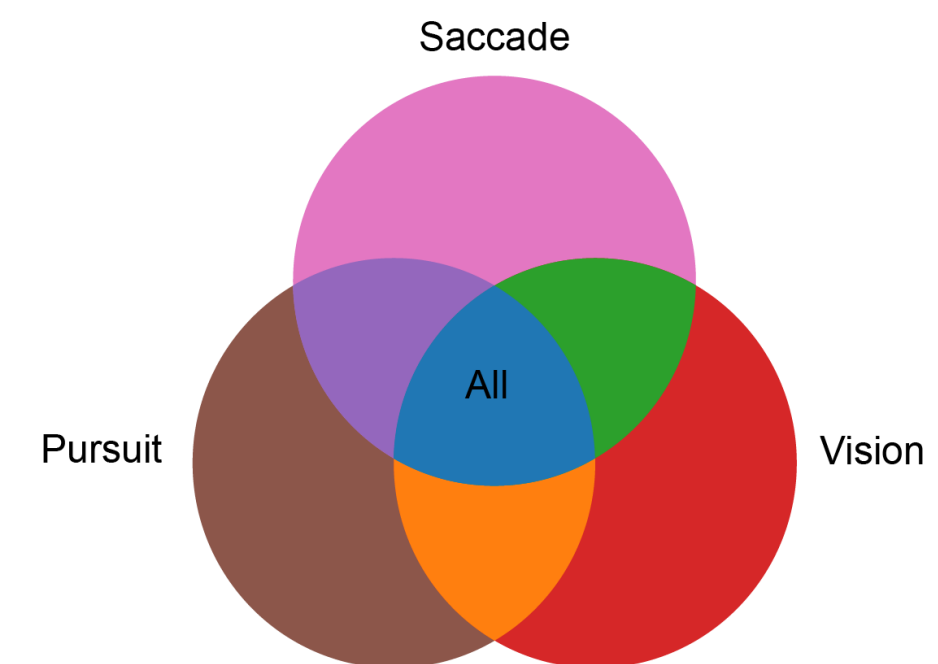
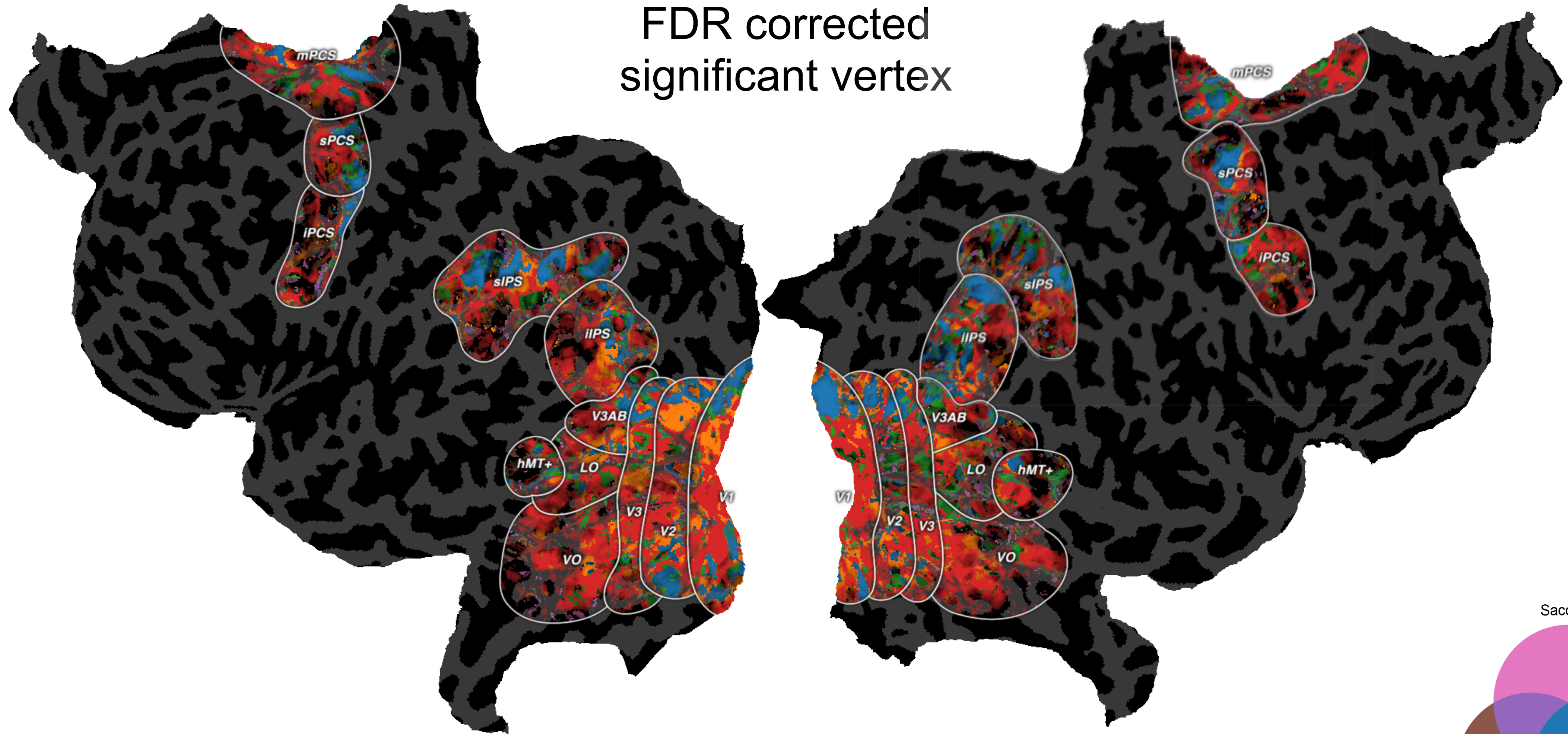
Details :

- 2 Runs (~10min)
- 32 Directions
- 4 speeds and amplitudes
- Eye movement on each TR
- Eye tracking recording during all runs

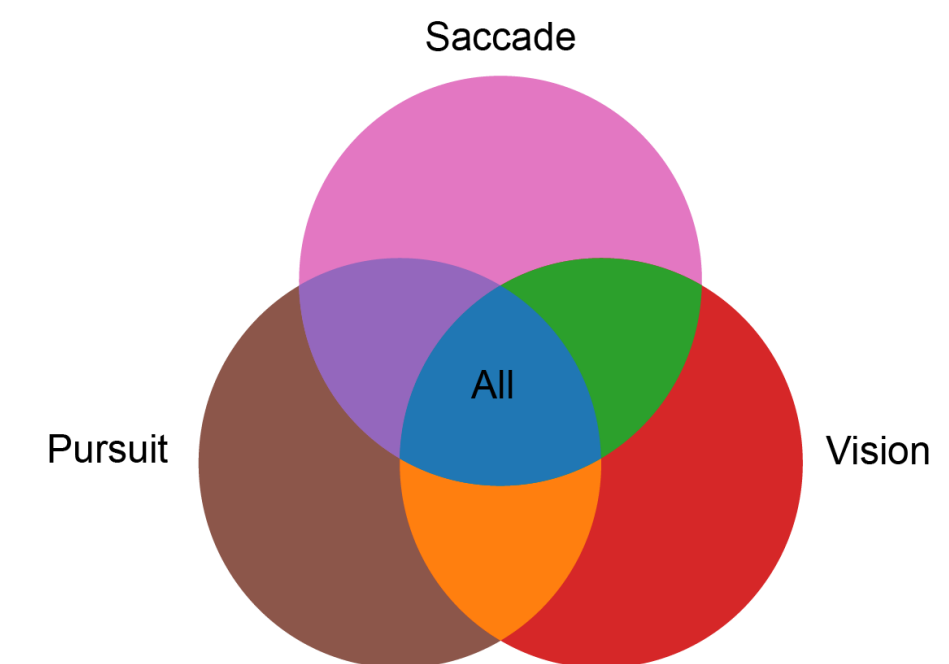
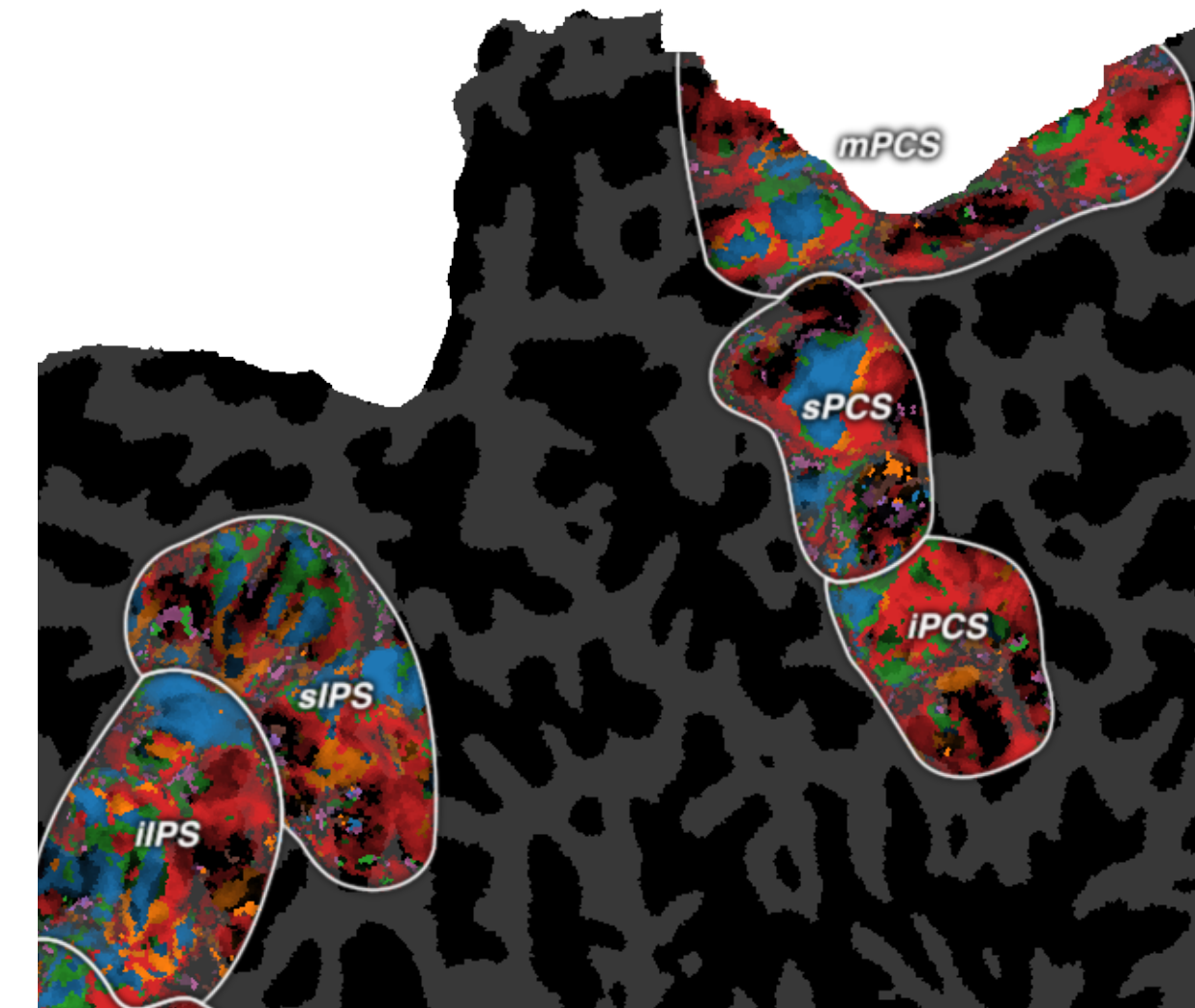




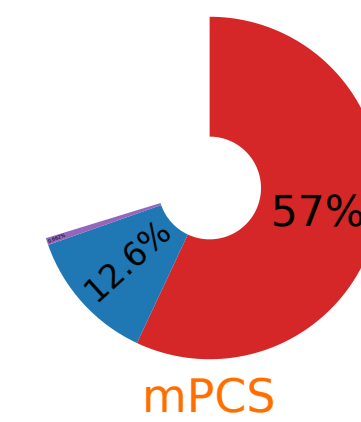
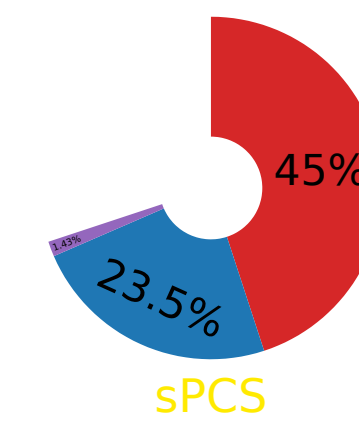
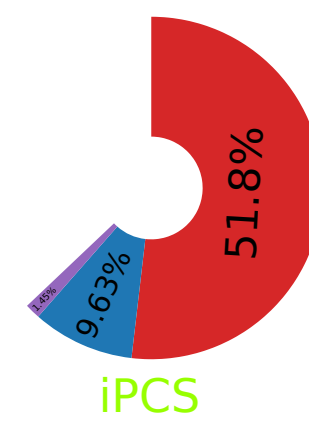
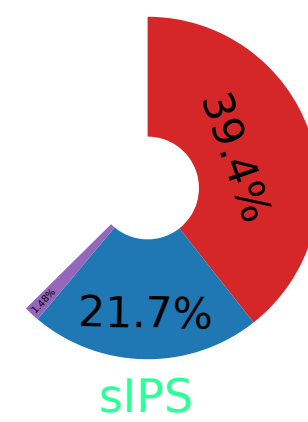
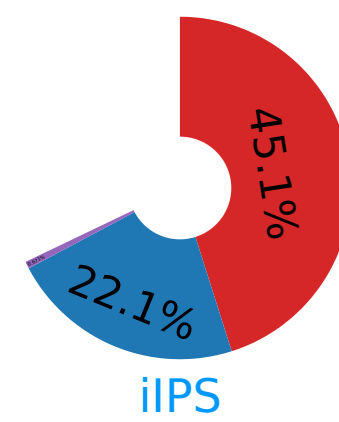
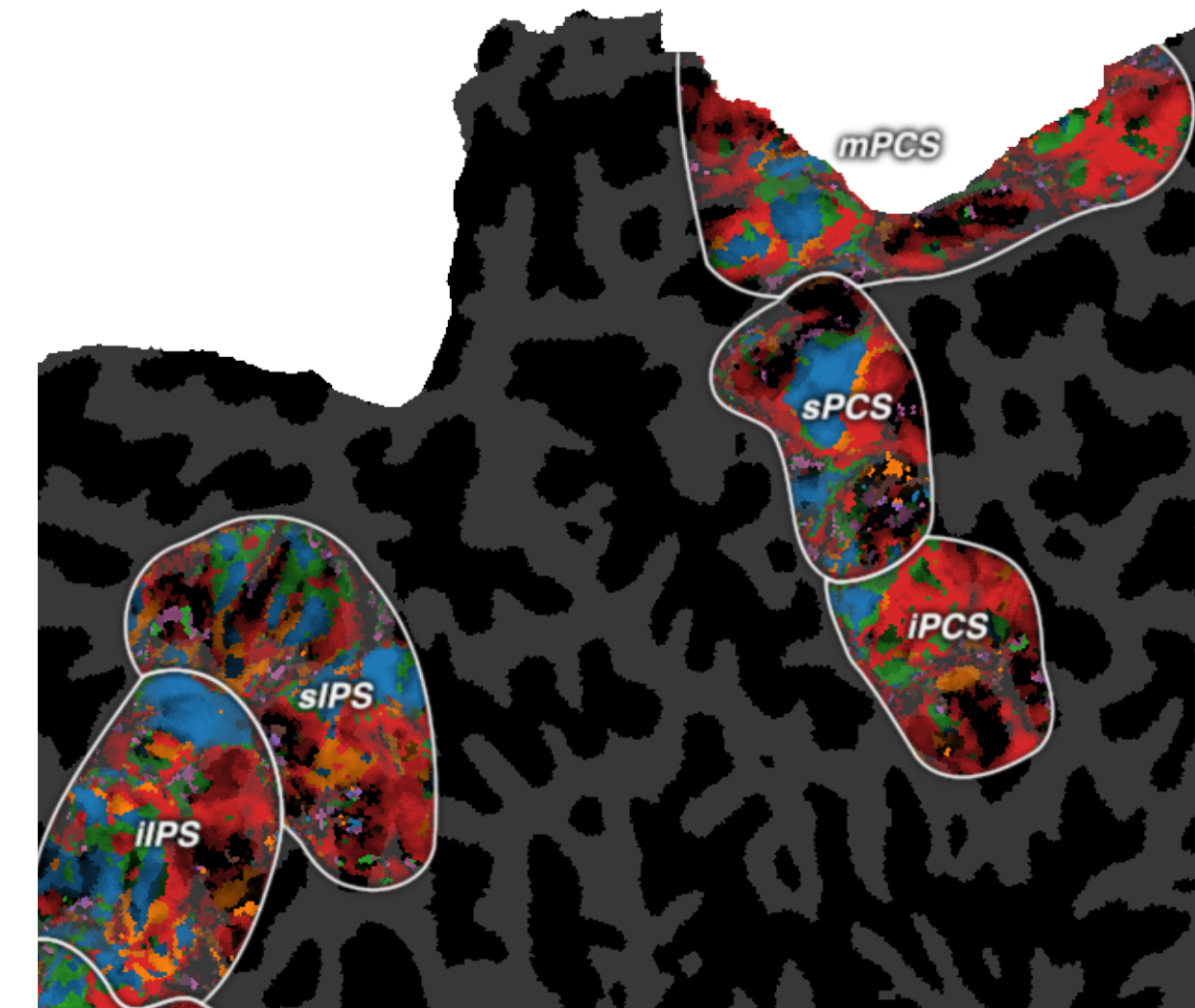
Sub-12
FDR corrected
significant vertex



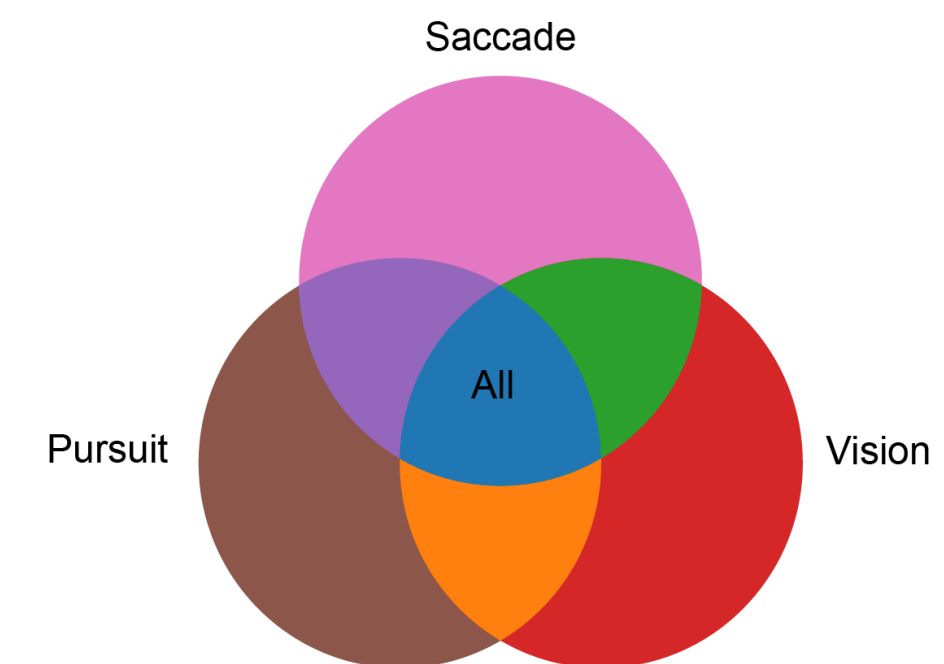
Sub-12
FDR corrected
significant vertex



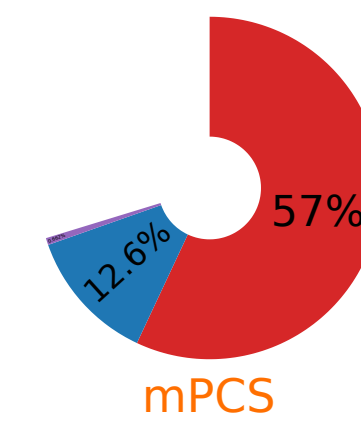
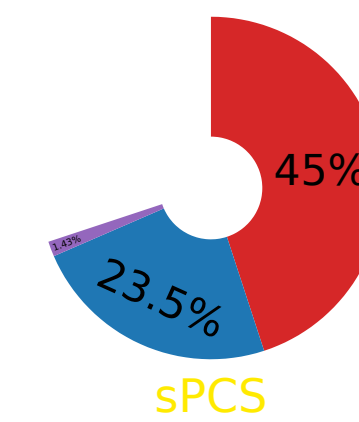
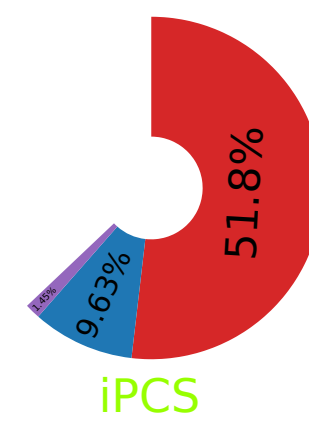
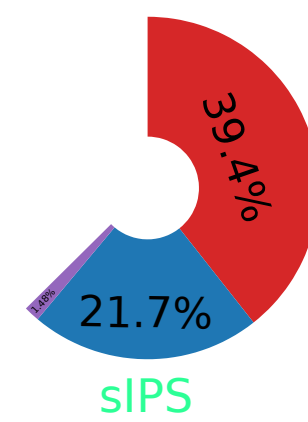
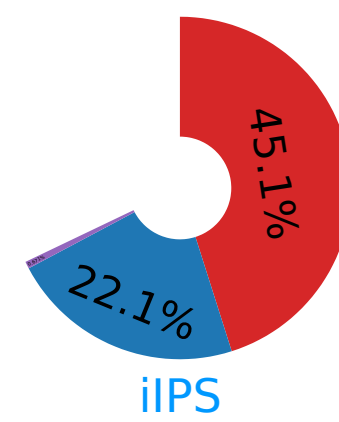
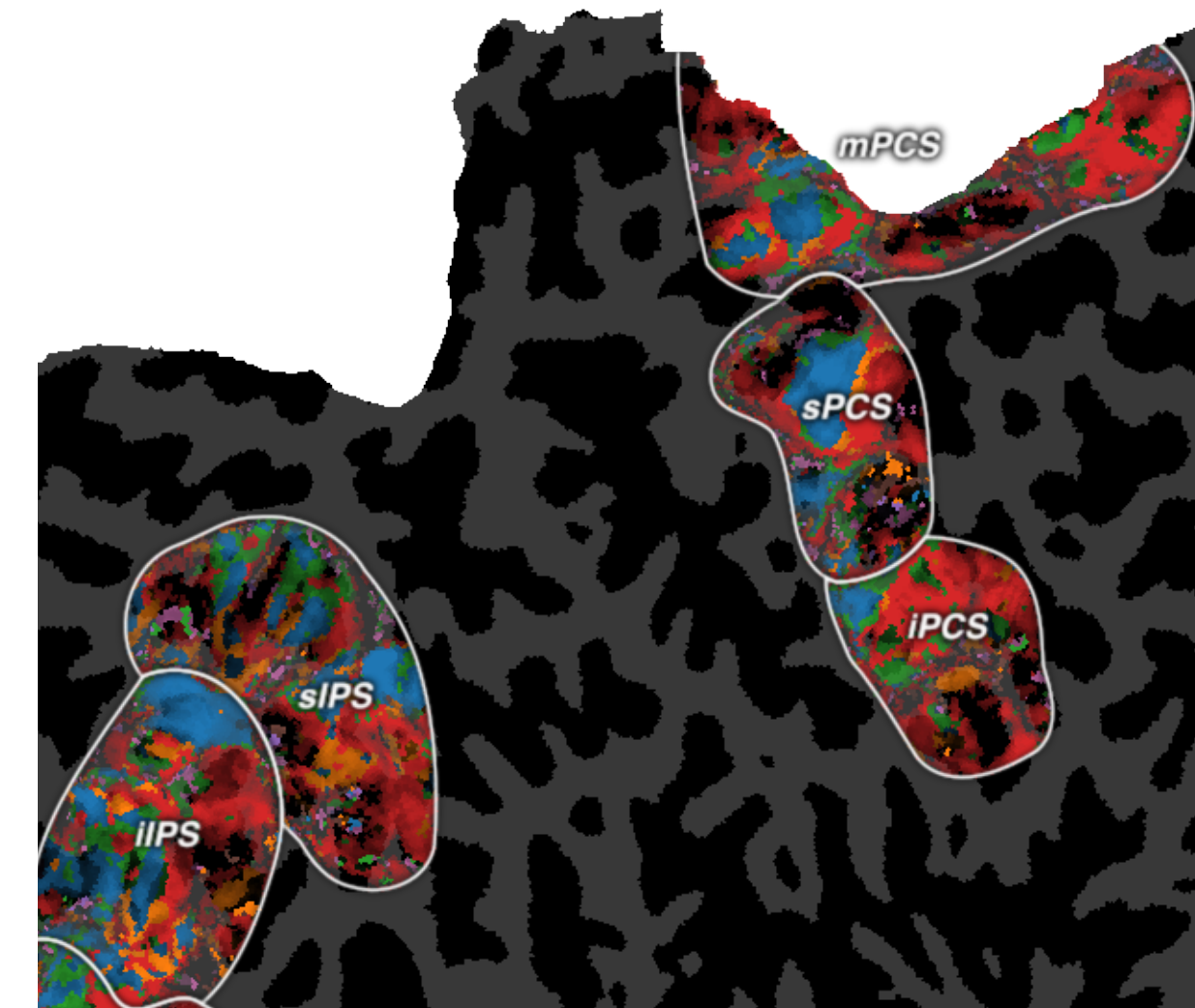
Sub-12
FDR corrected
significant vertex



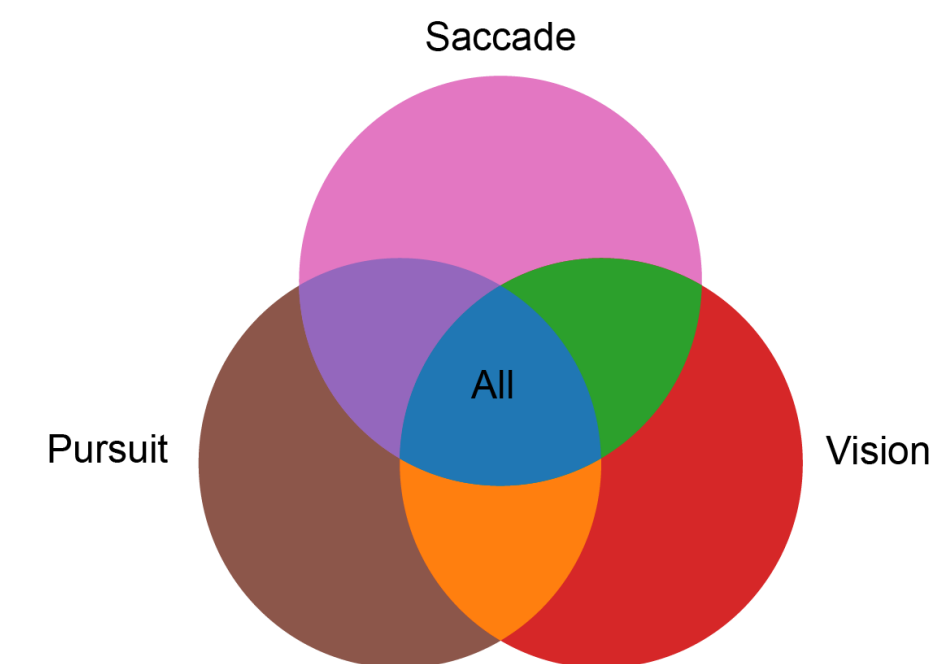
Categories proportions



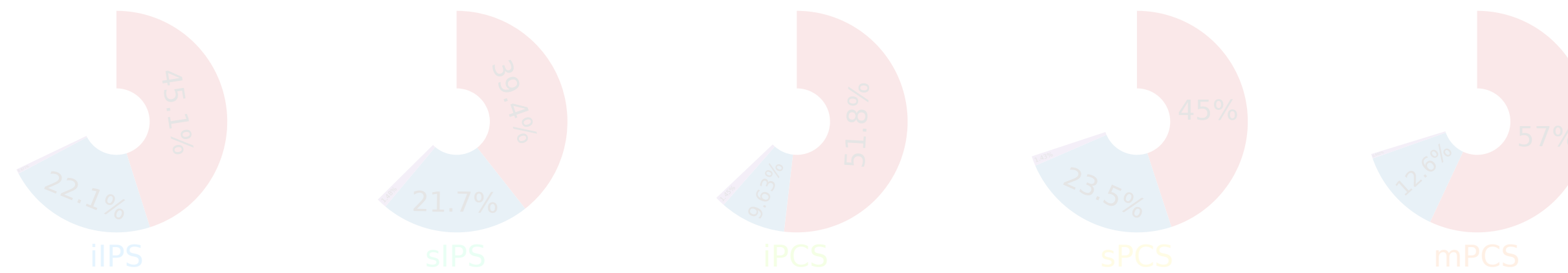
Sub-12
FDR corrected
significant vertex



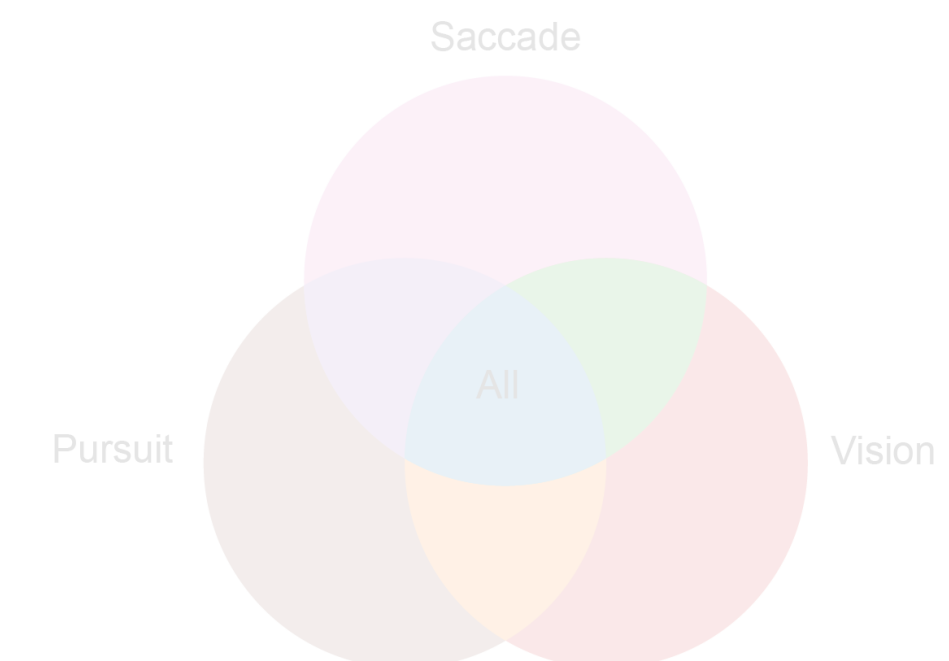
Categories proportions



Sub-12
FDR corrected
significant vertex



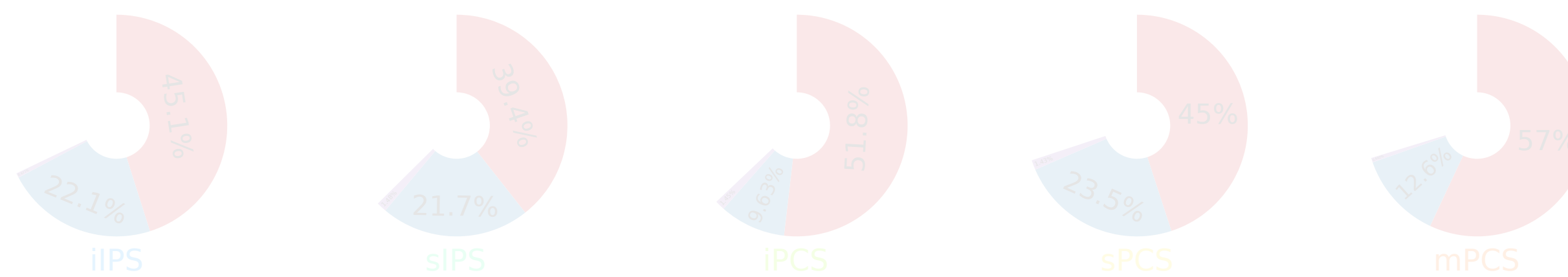
Categories proportions



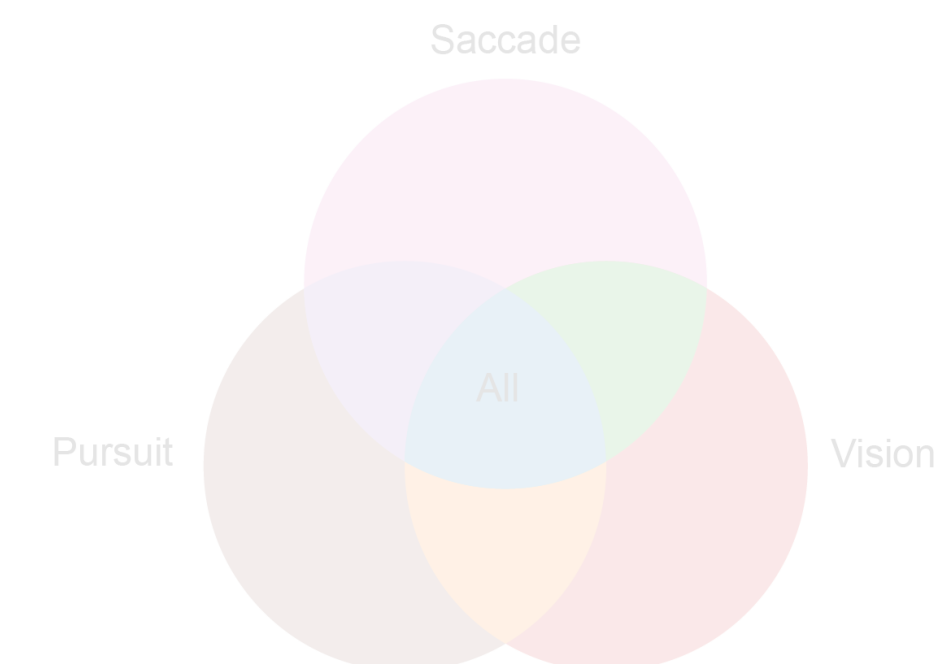
Sub-12
FDR corrected
significant vertex



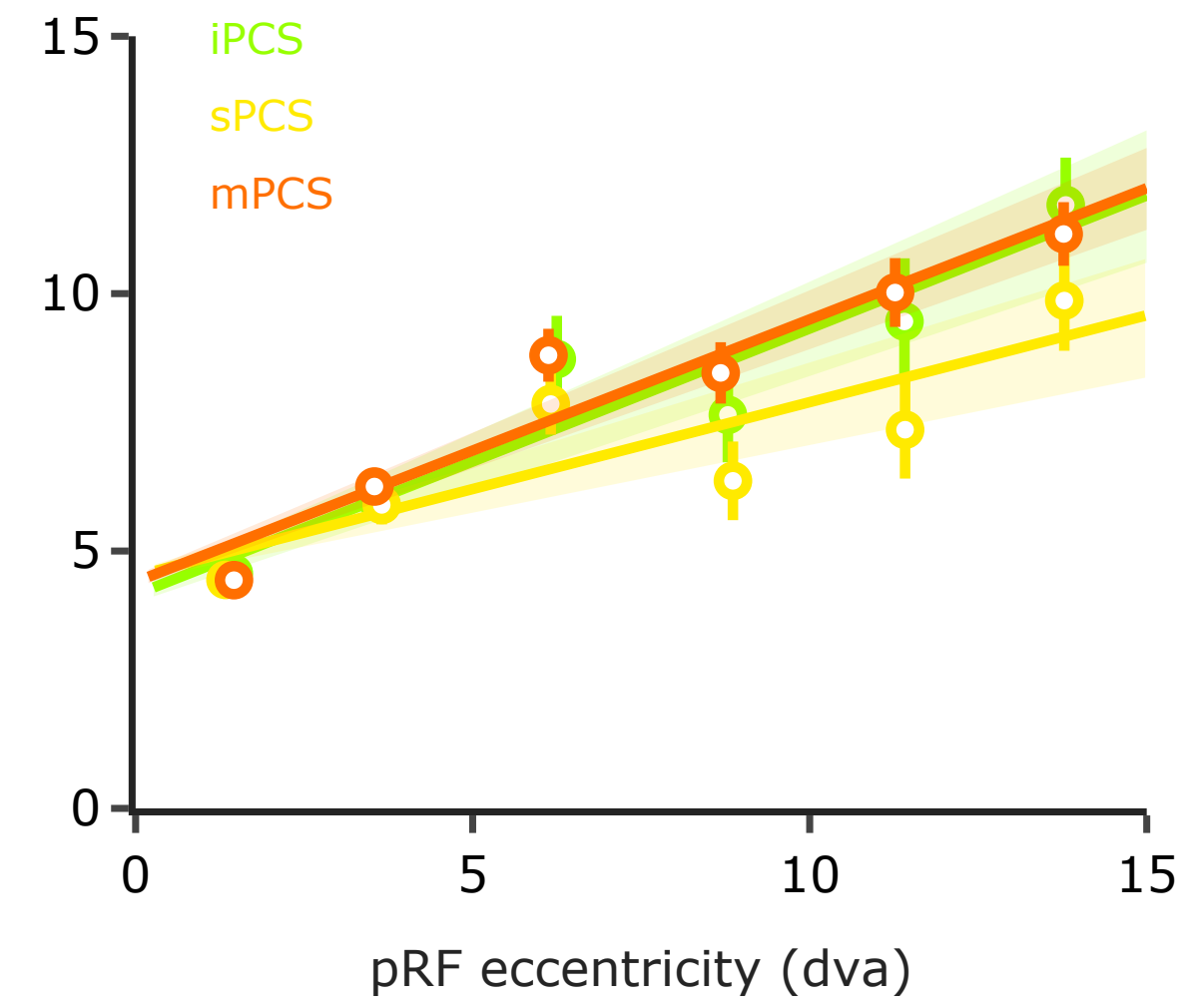
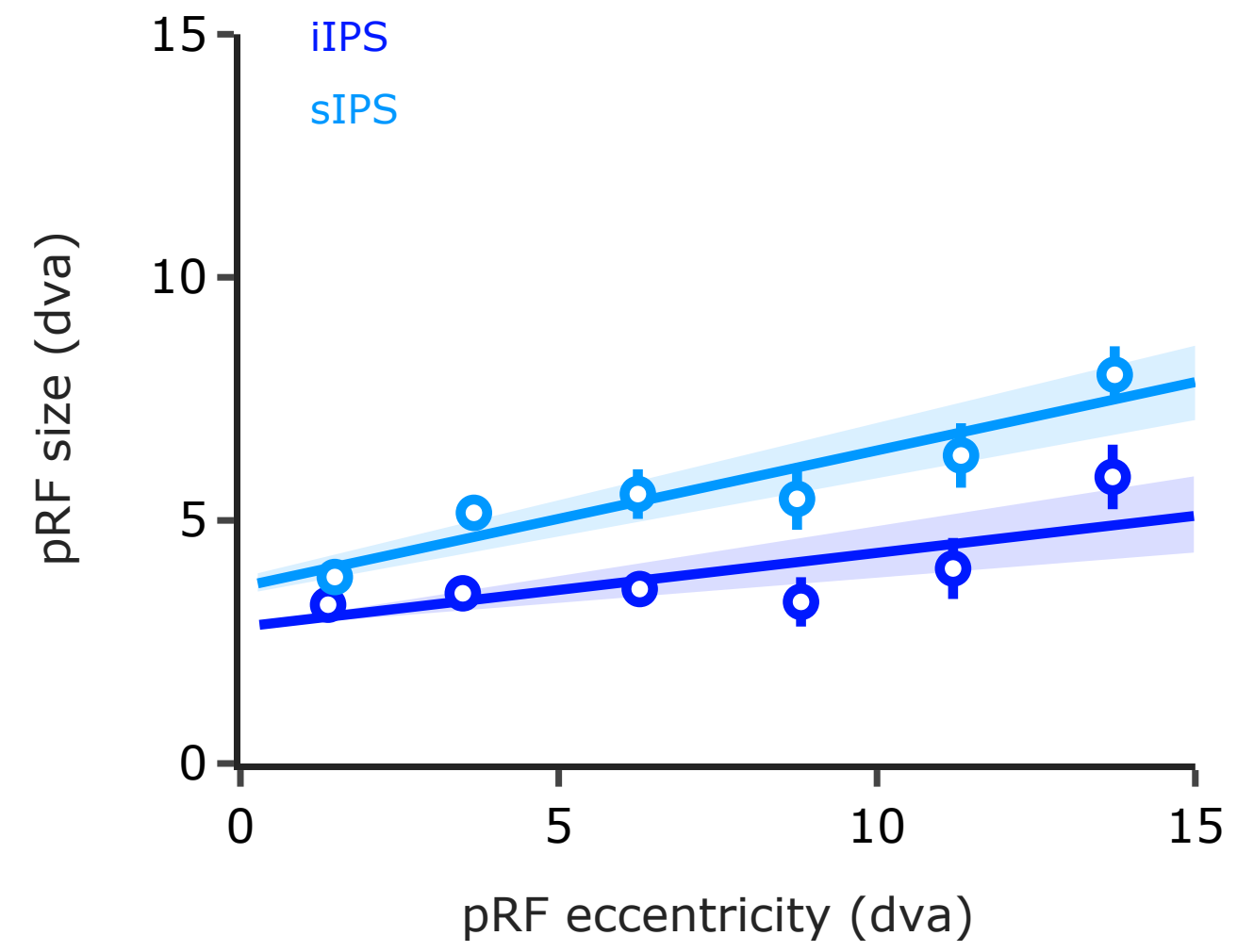
What is the organisation of visual processing in these areas ?



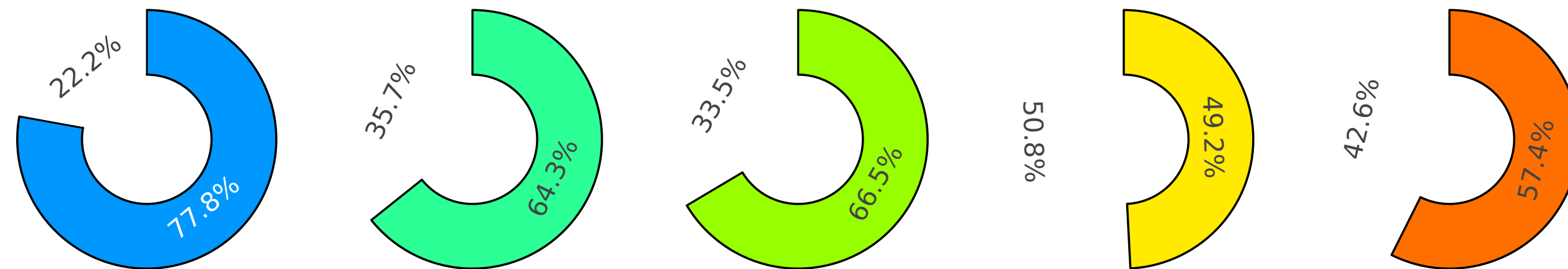
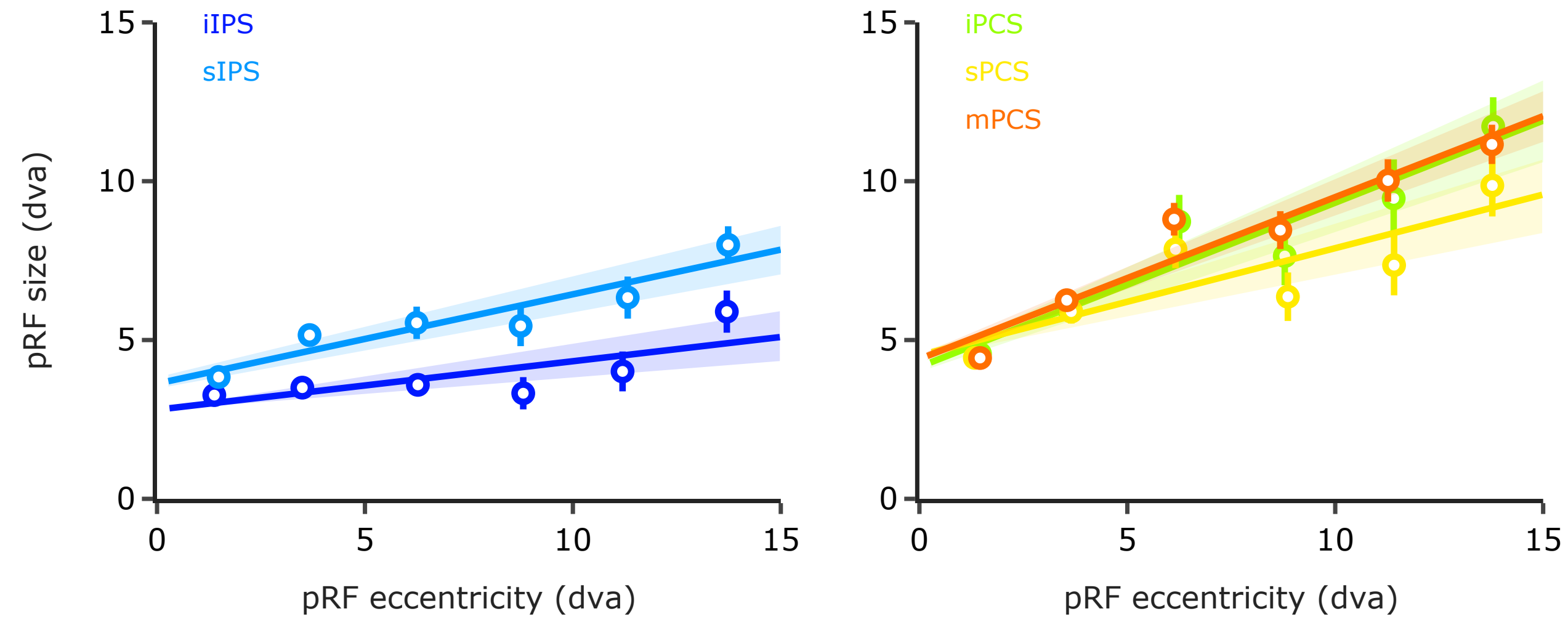
Categories proportions



Sub-12 pRF eccentricity and size relation

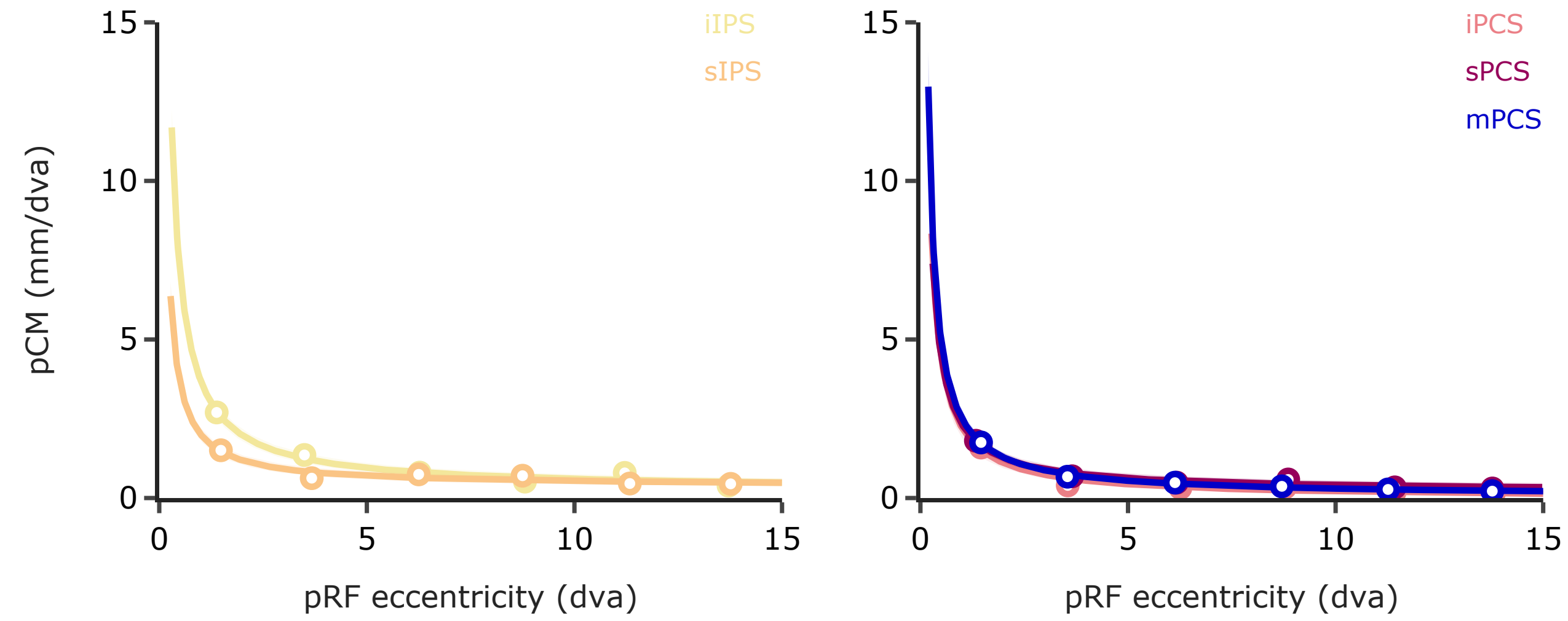


Sub-12 pRF eccentricity and size relation



pRF contralaterality

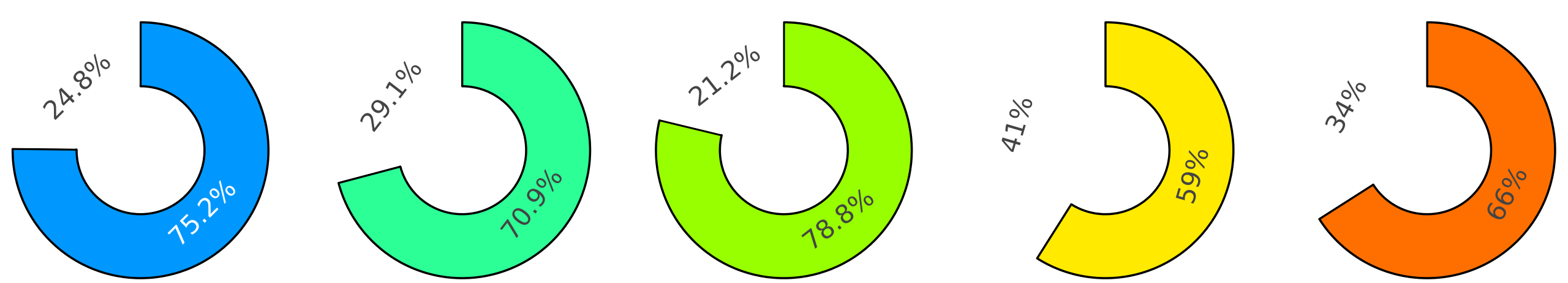
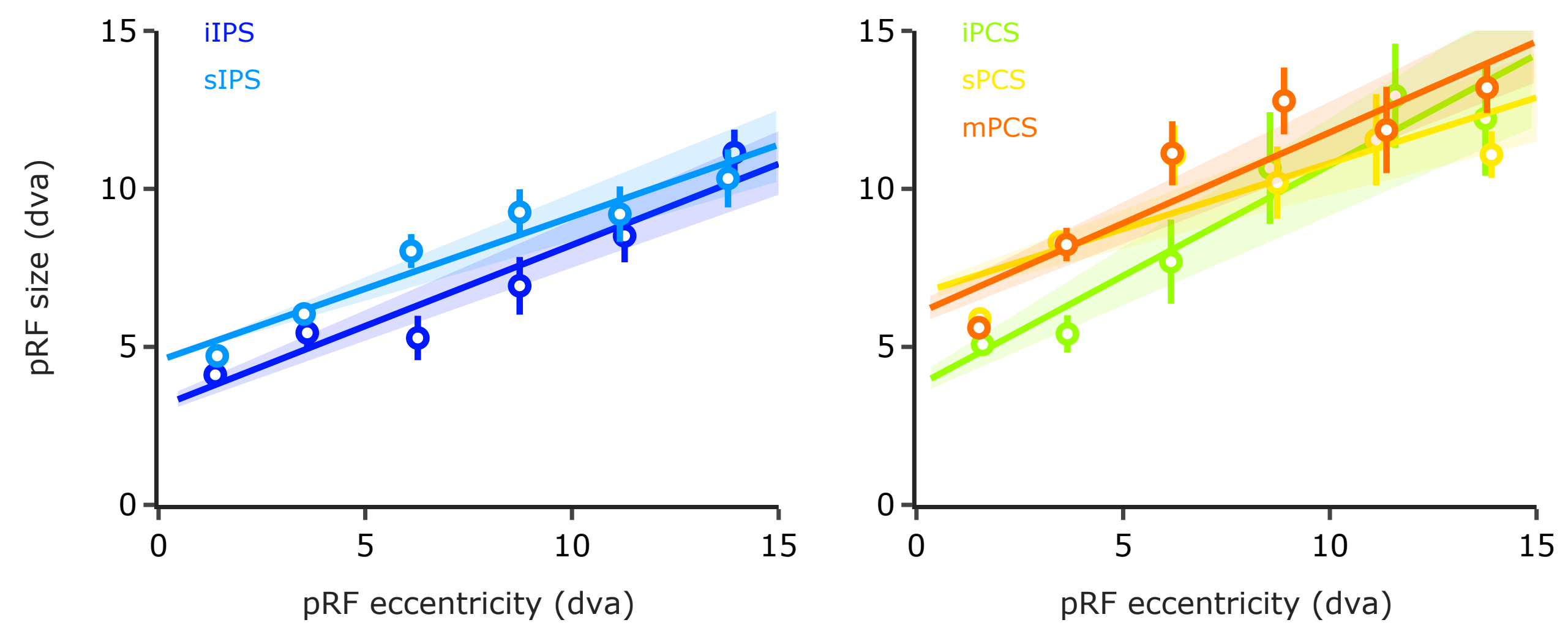
Sub-12 pRF eccentricity and pCM relation



Population Cortical Magnification

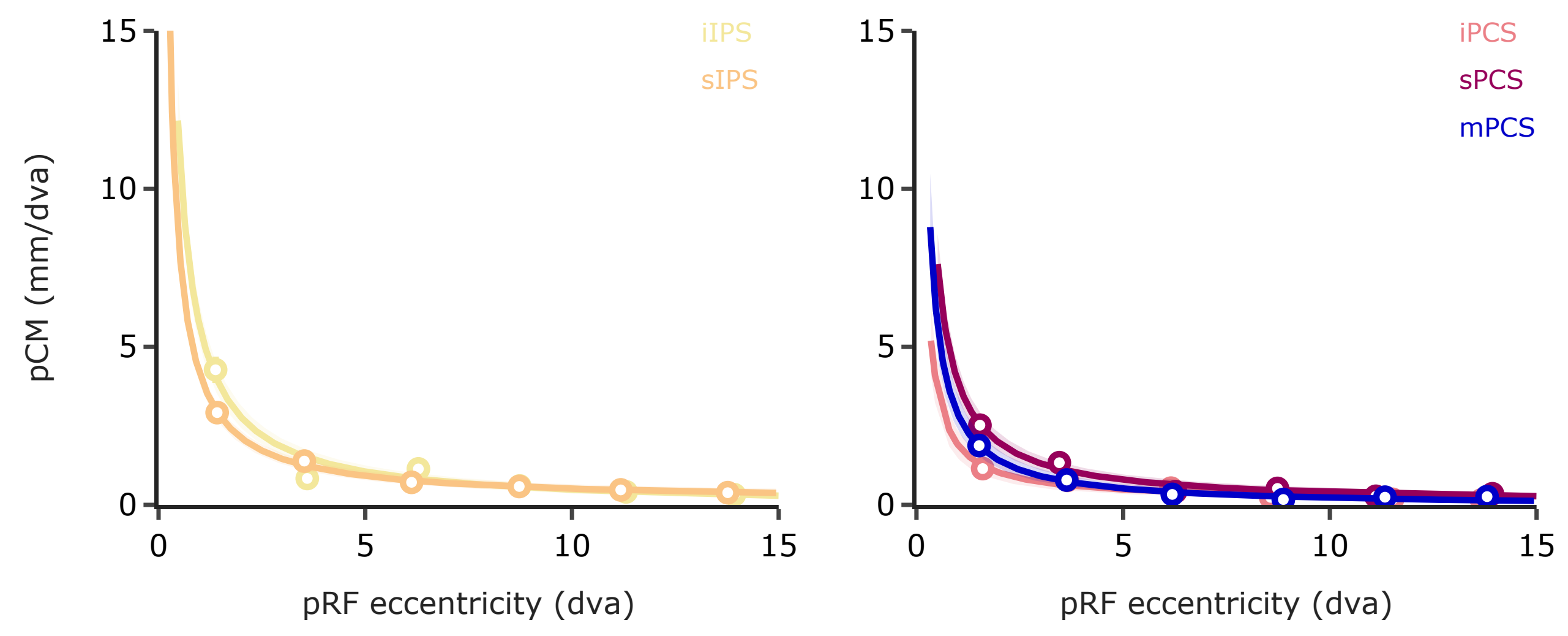
Refers to the proportion of the visual field processed by a specific area of the brain

Sub-12 pRF parameters



pRF contralaterality

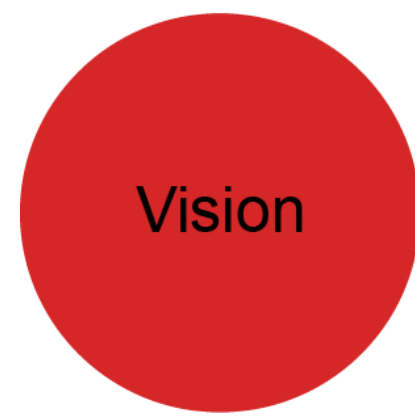
Sub-12 pRF eccentricity and pCM relation



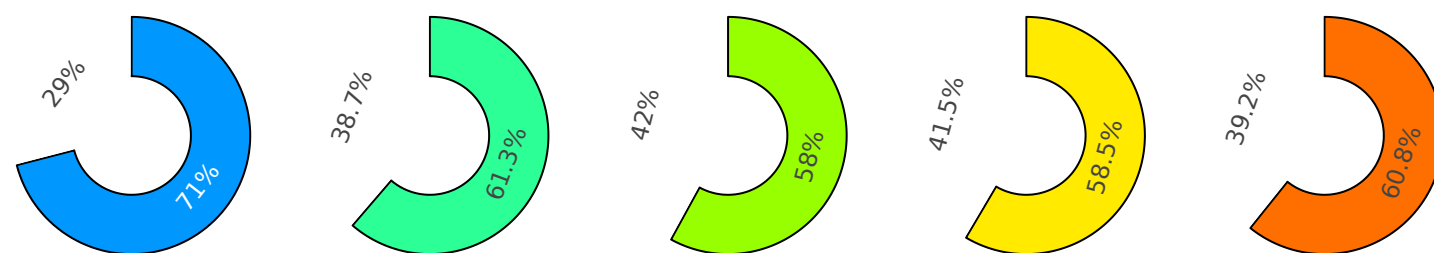
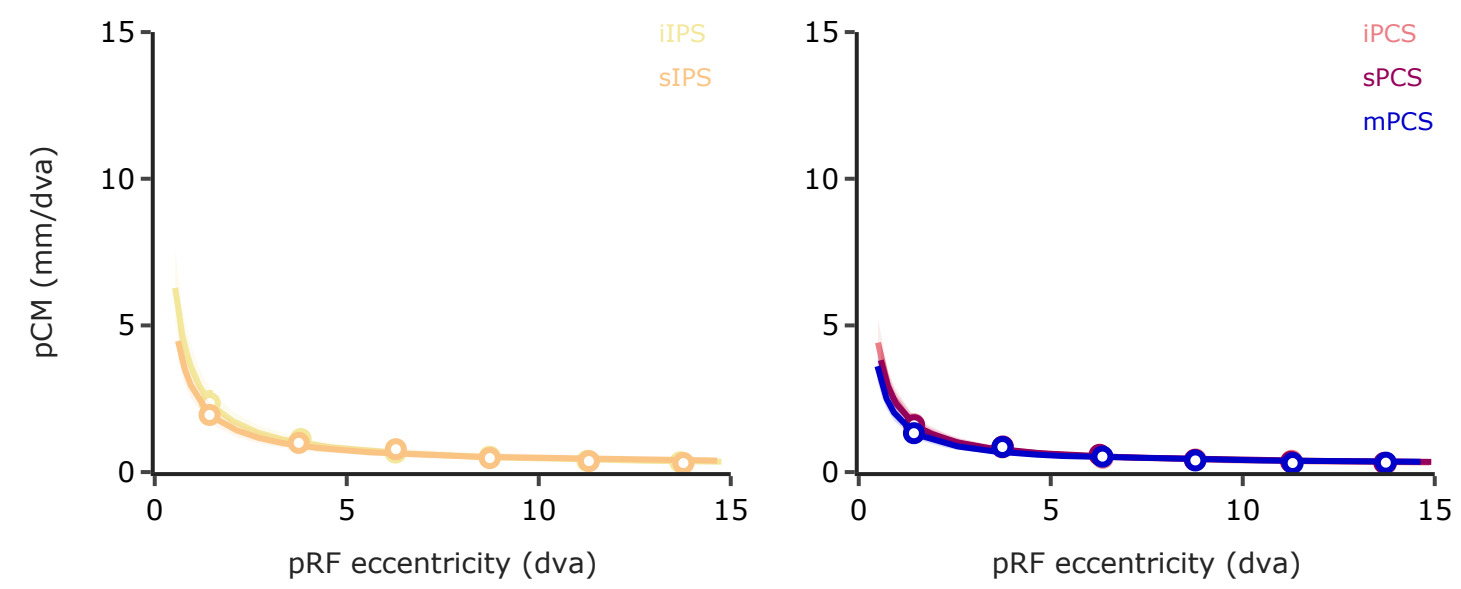
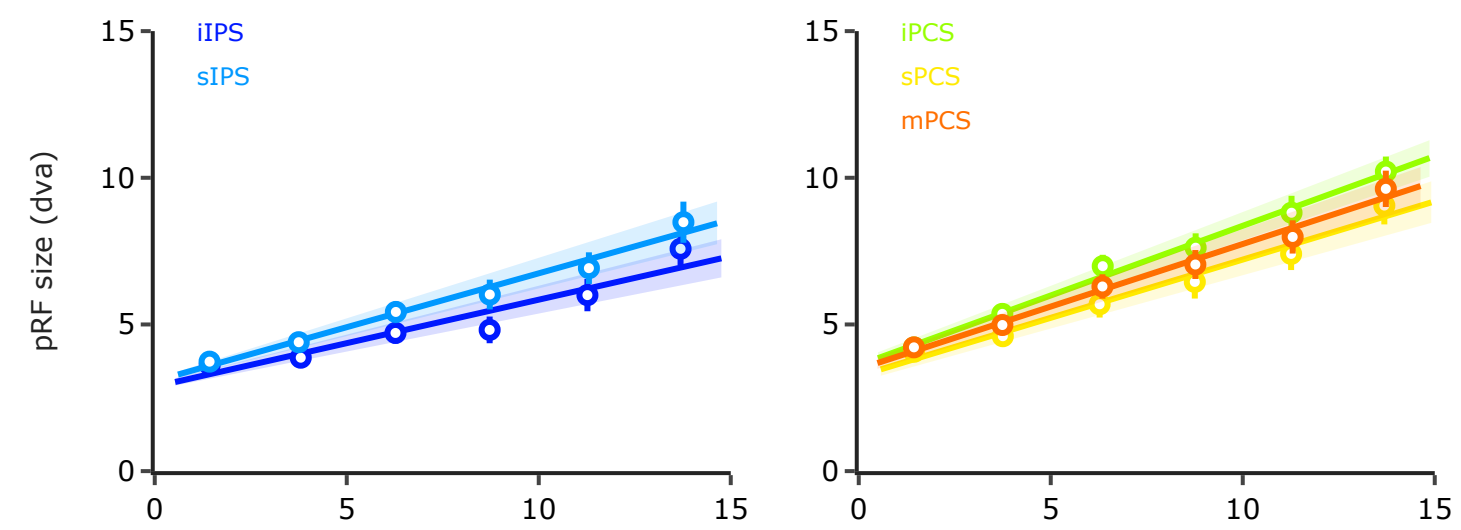
Population Cortical Magnification

Refers to the proportion of the visual field processed by a specific area of the brain

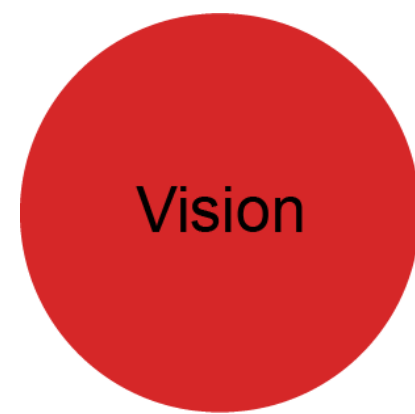
Group analysis



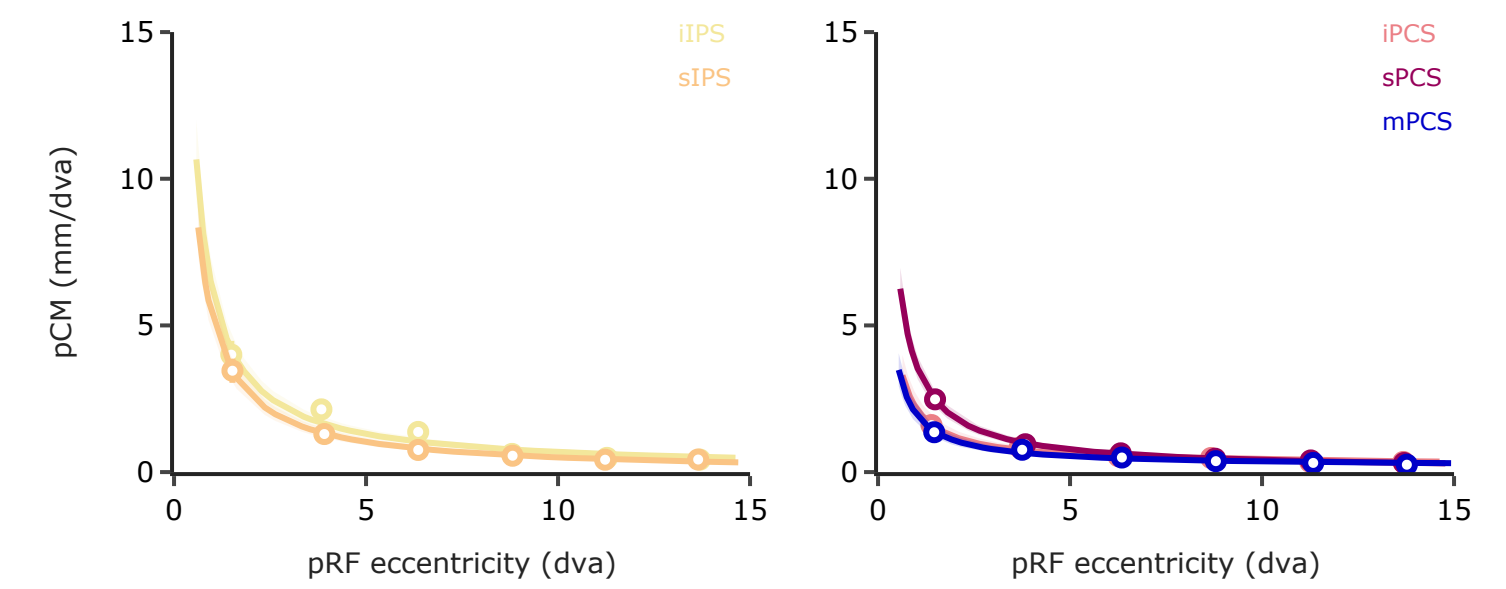
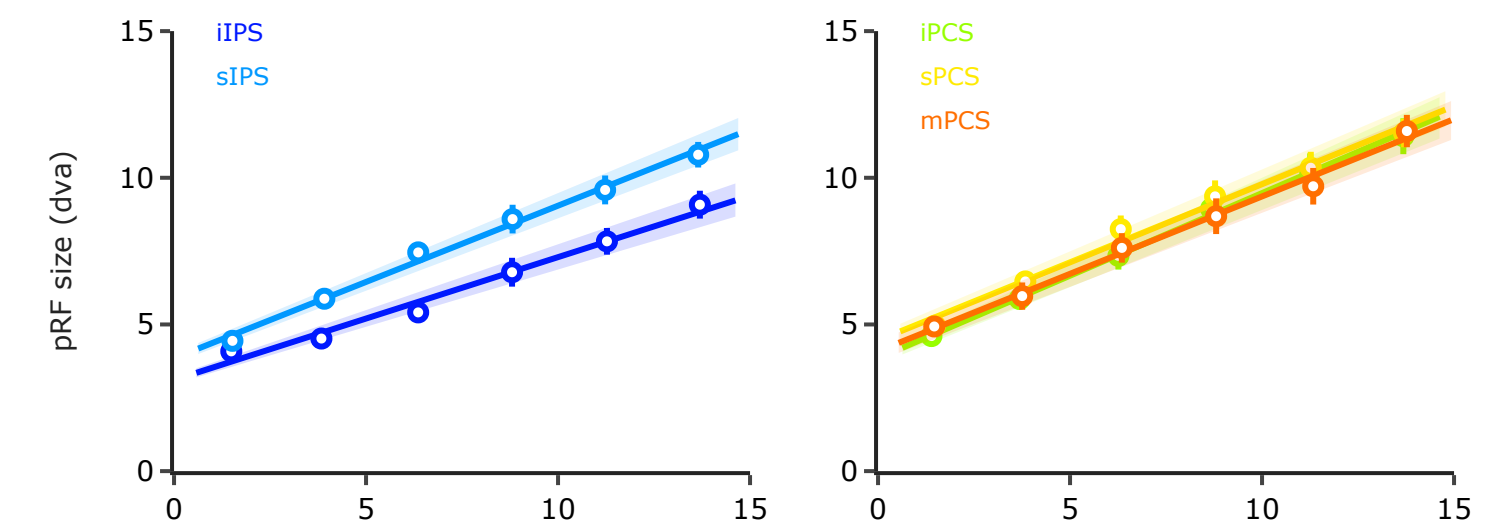
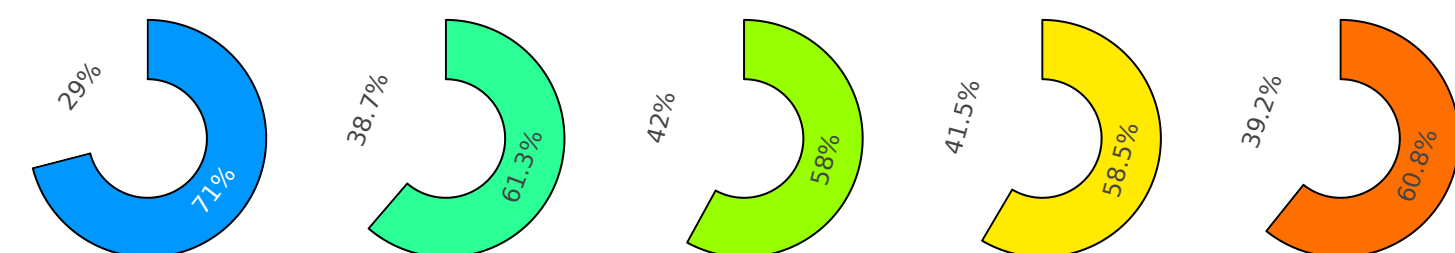
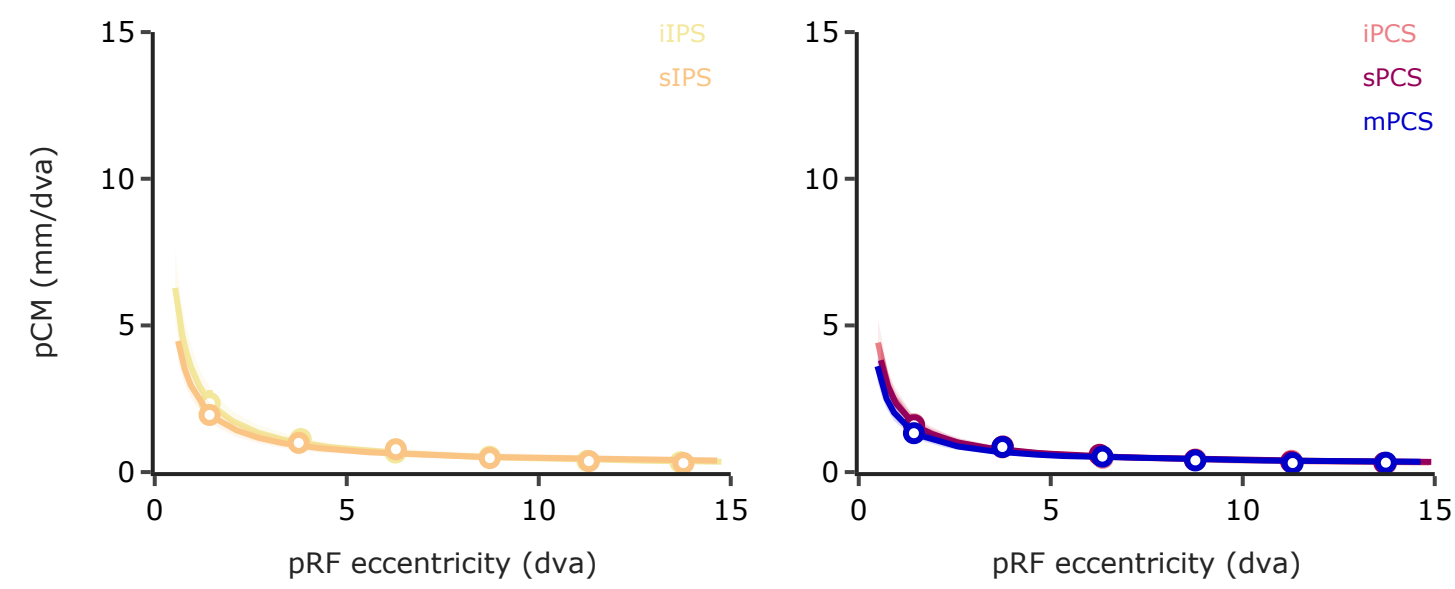
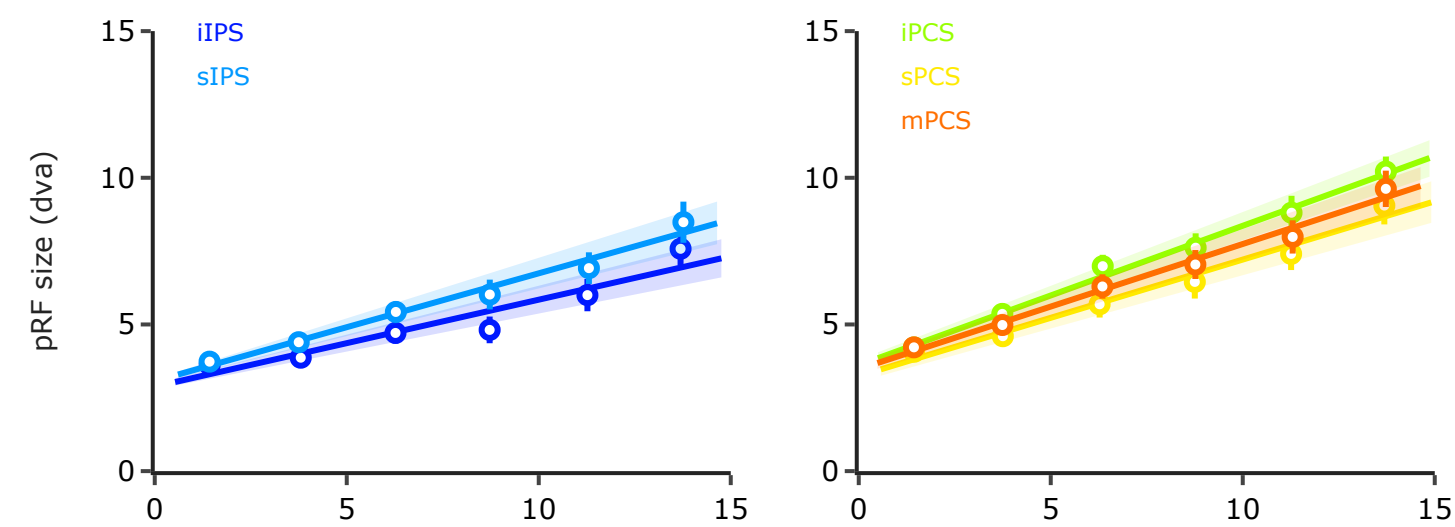
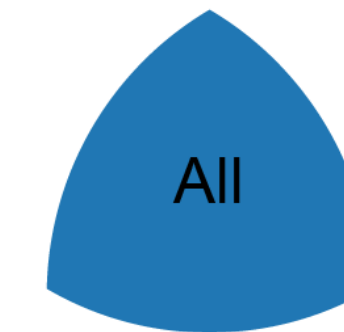
Group (n=20) pRF parameters



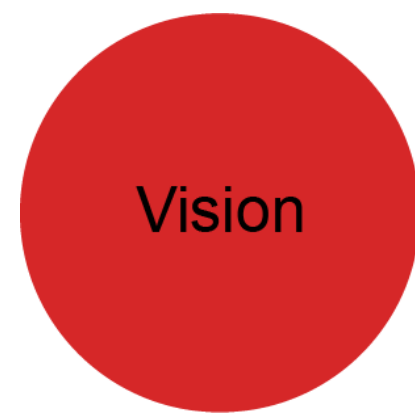
Group analysis



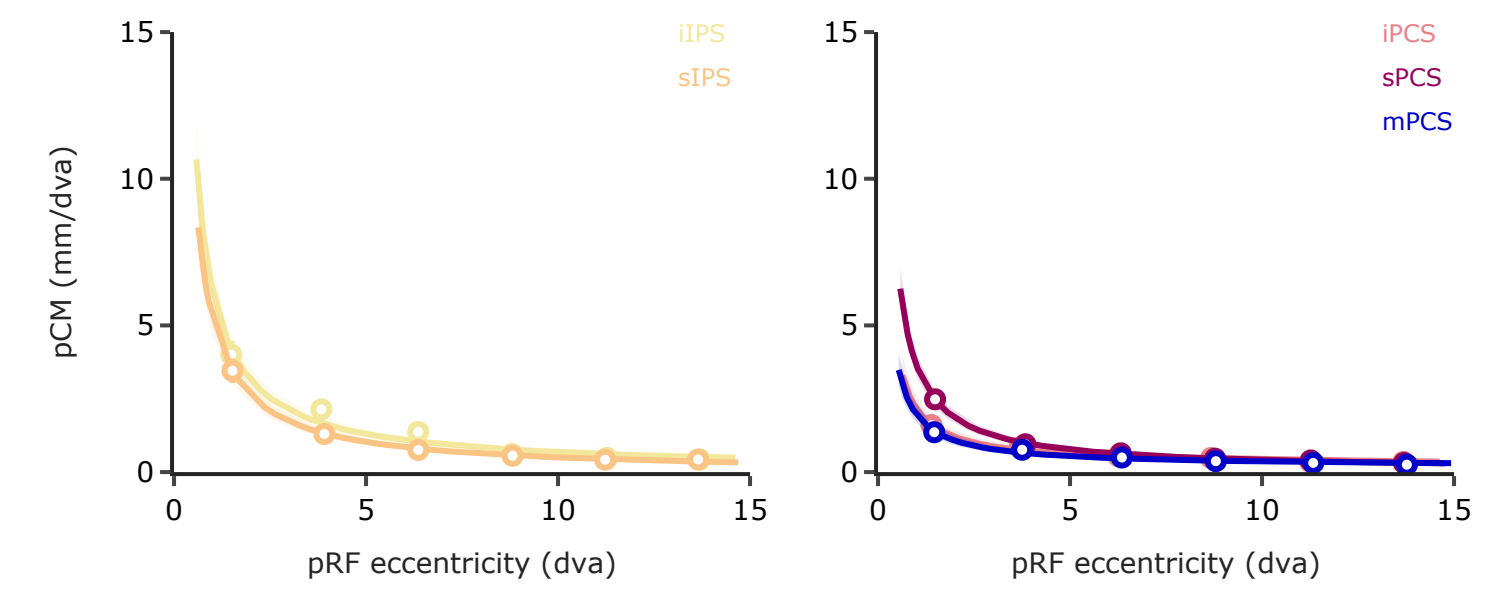
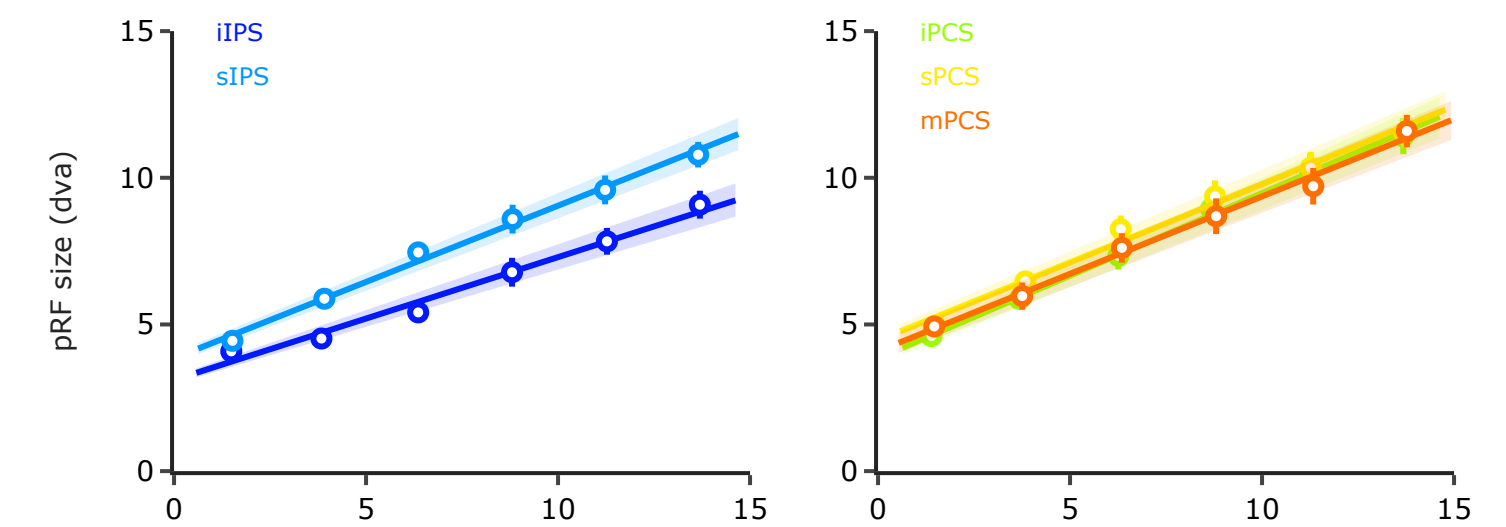
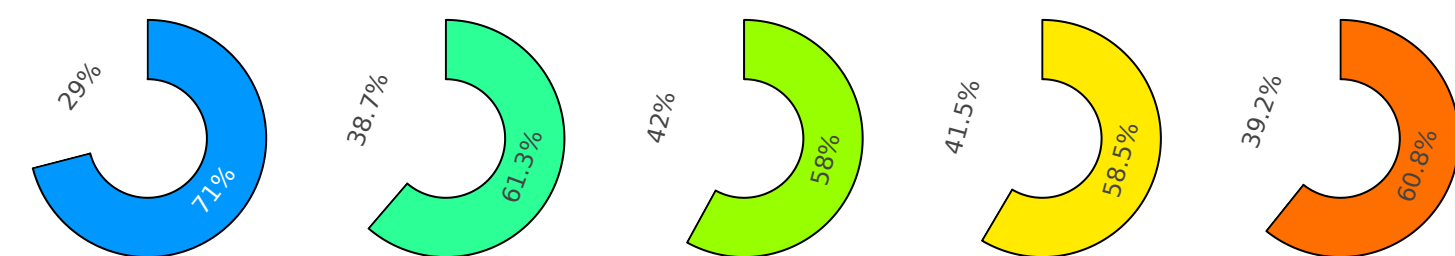
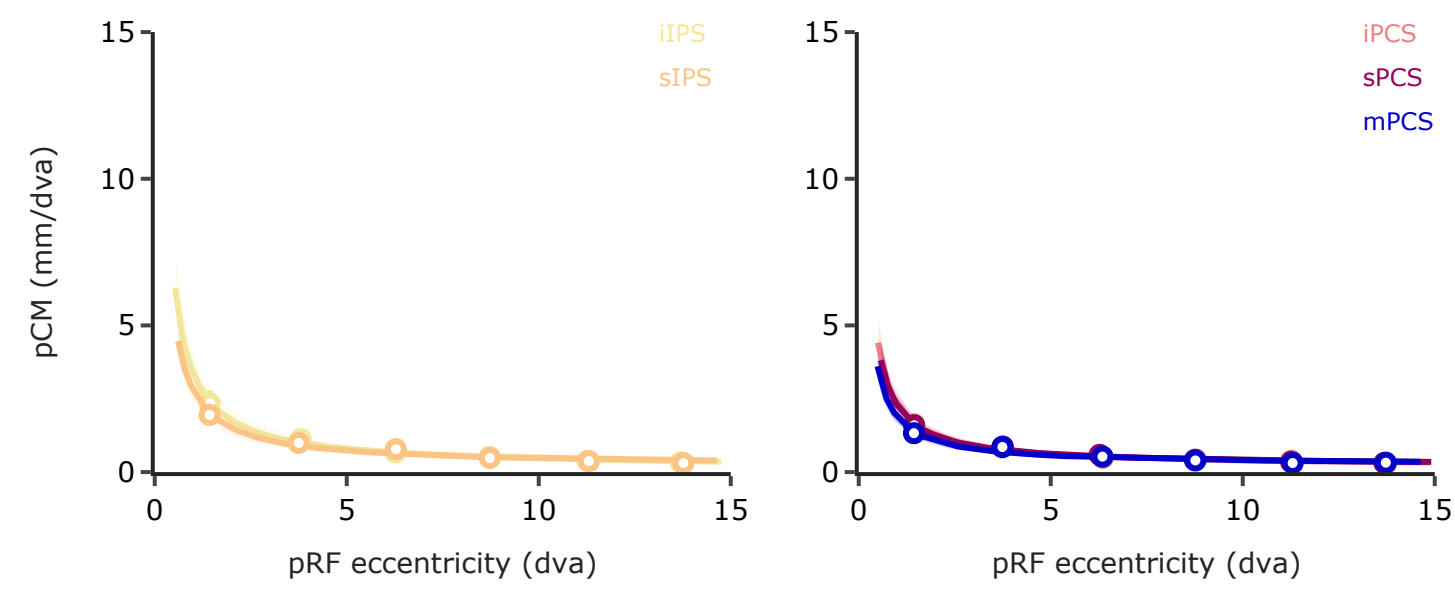
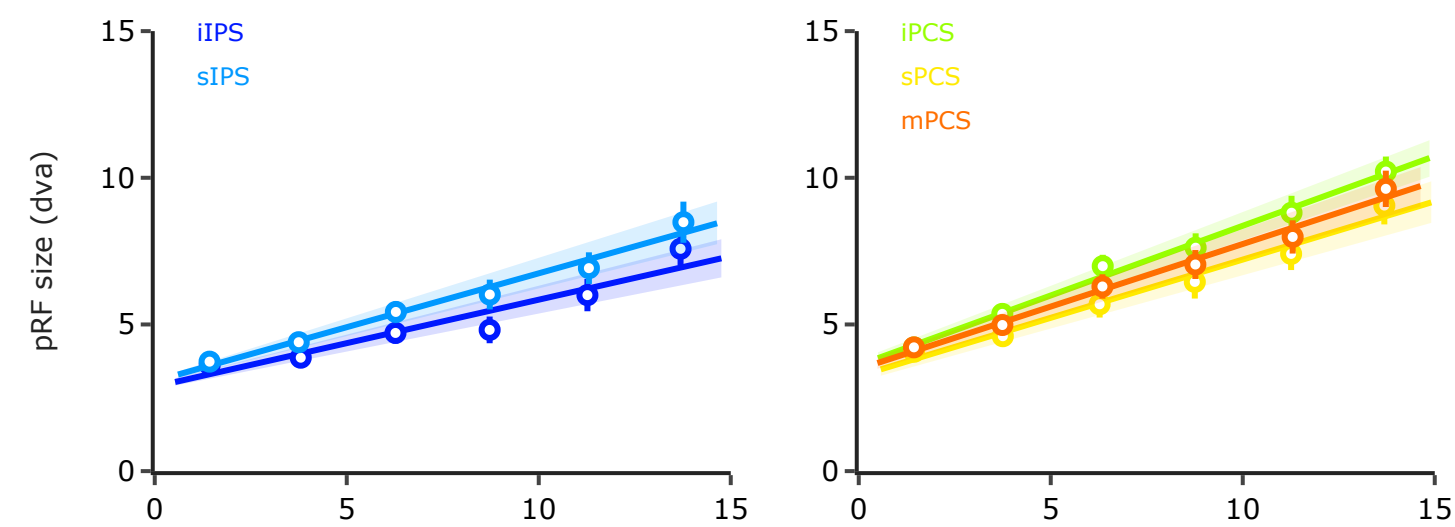
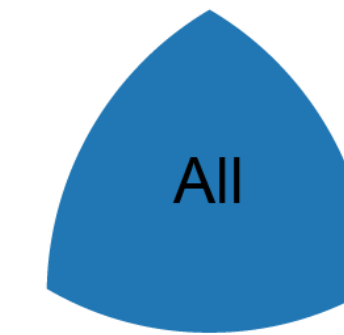
Group (n=20) pRF parameters



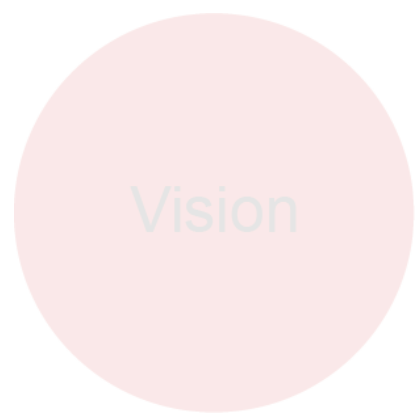
Group analysis



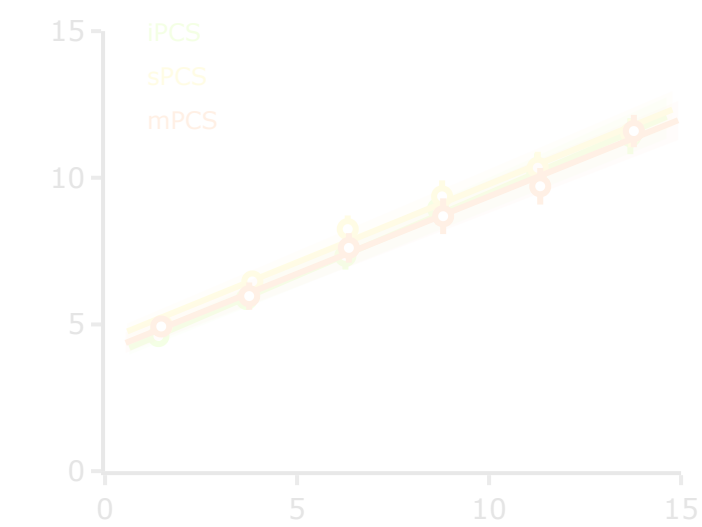
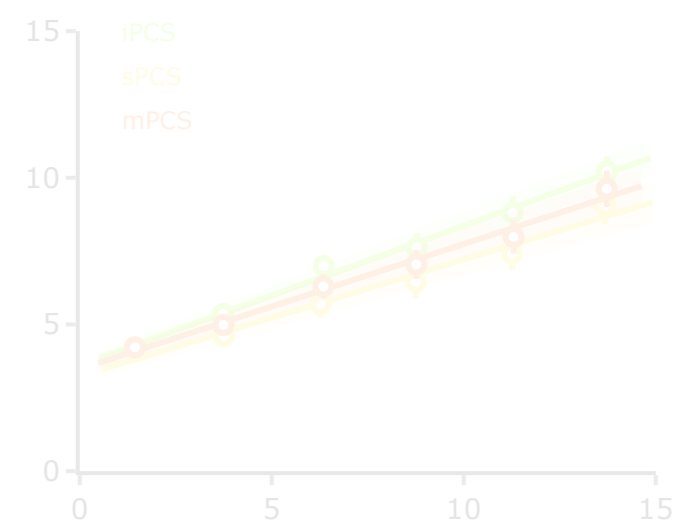
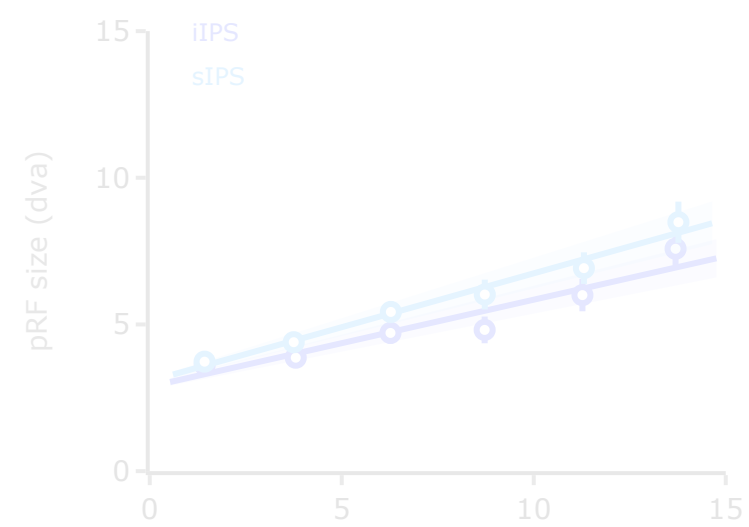
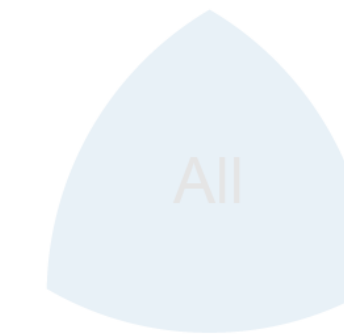
Group (n=20) pRF parameters



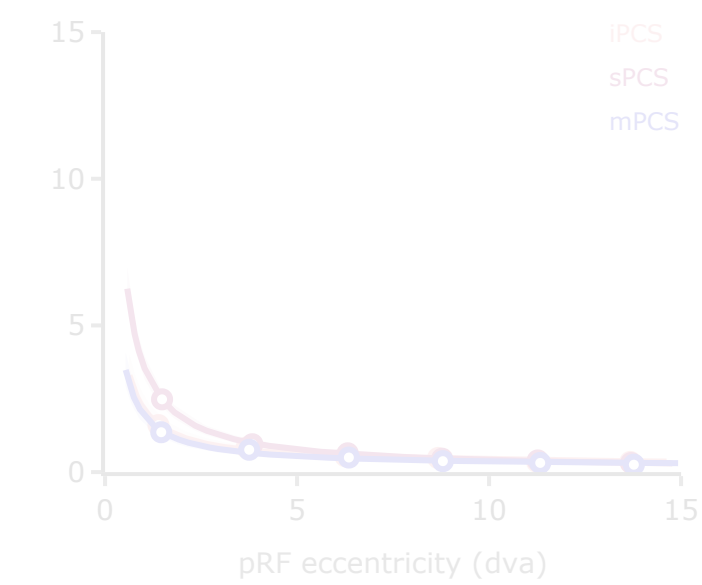
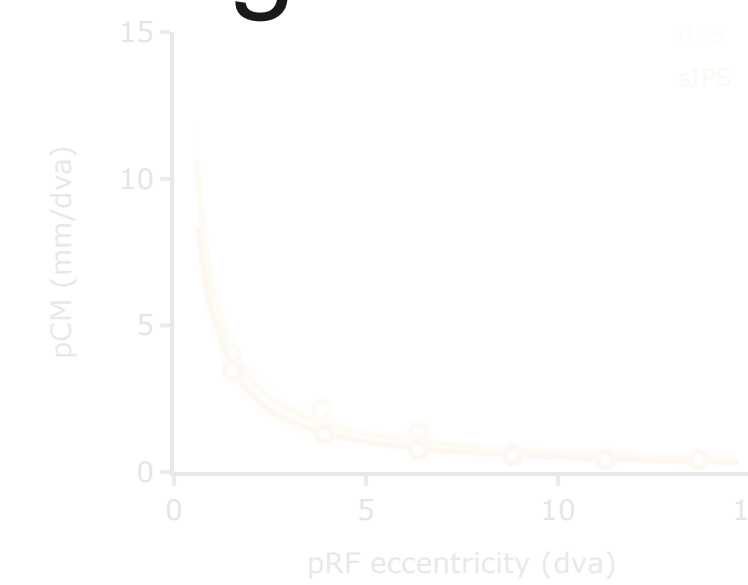
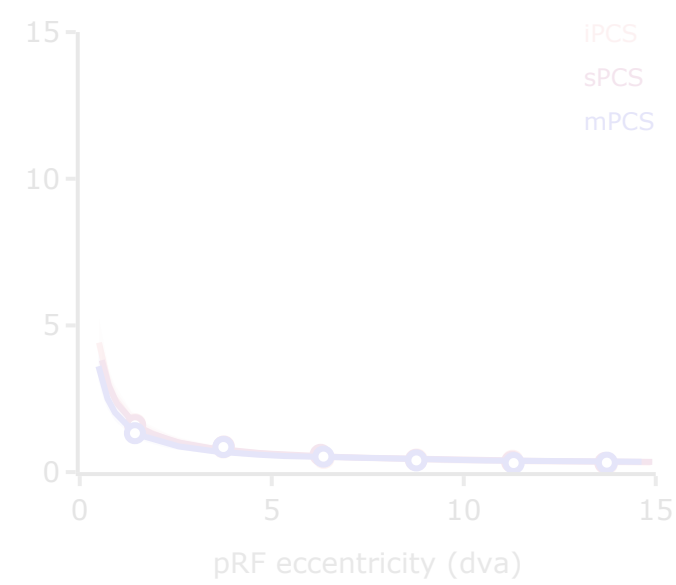
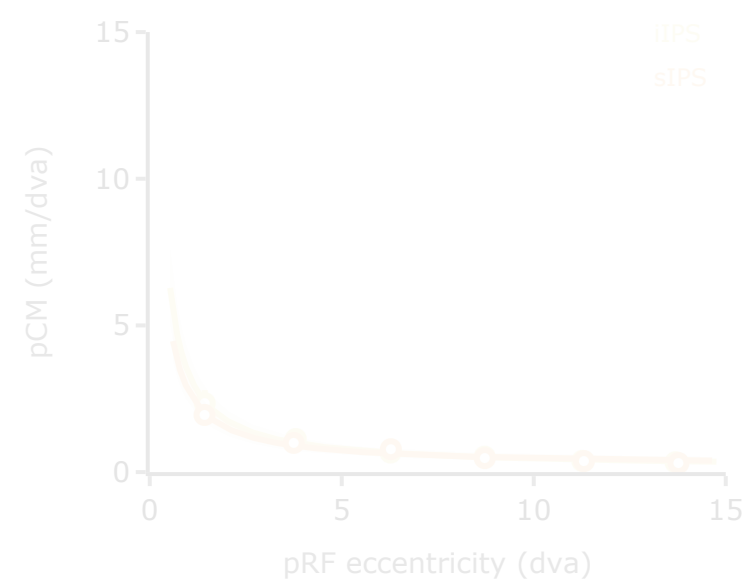
Group analysis



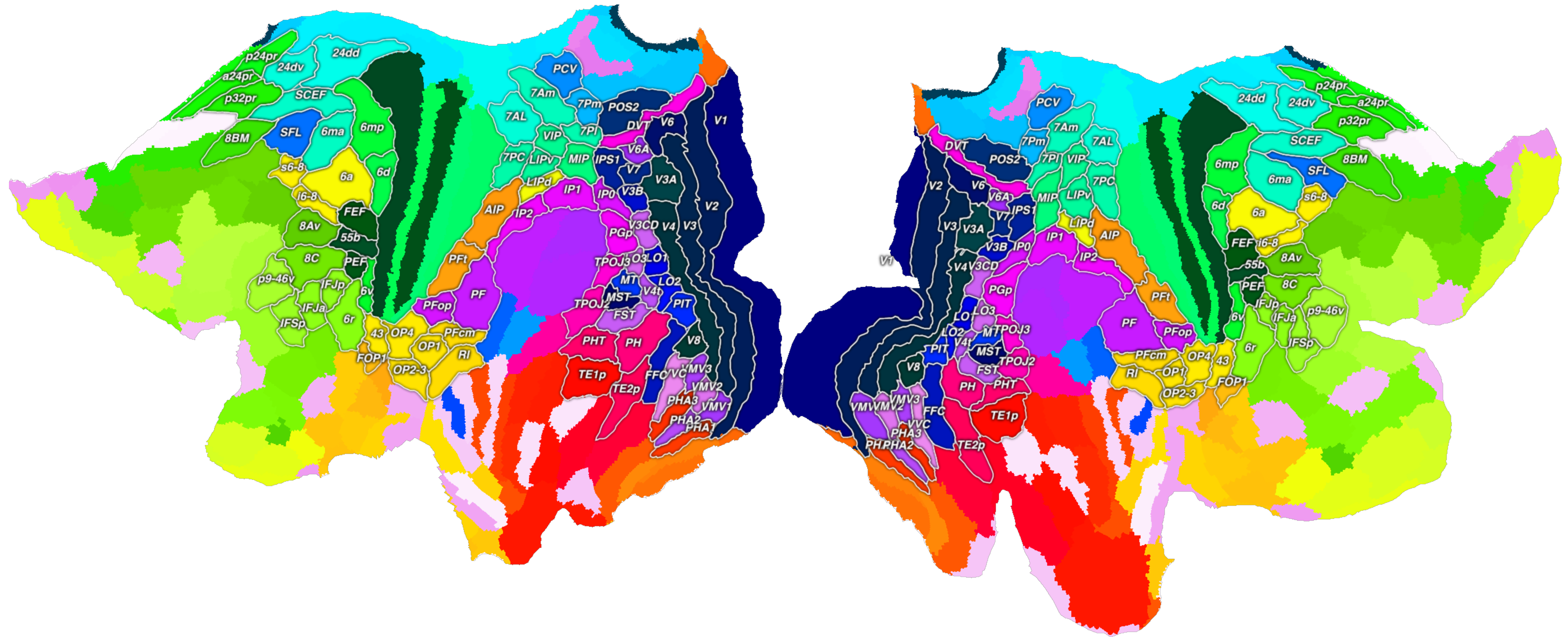
Group (n=20)
pRF parameters



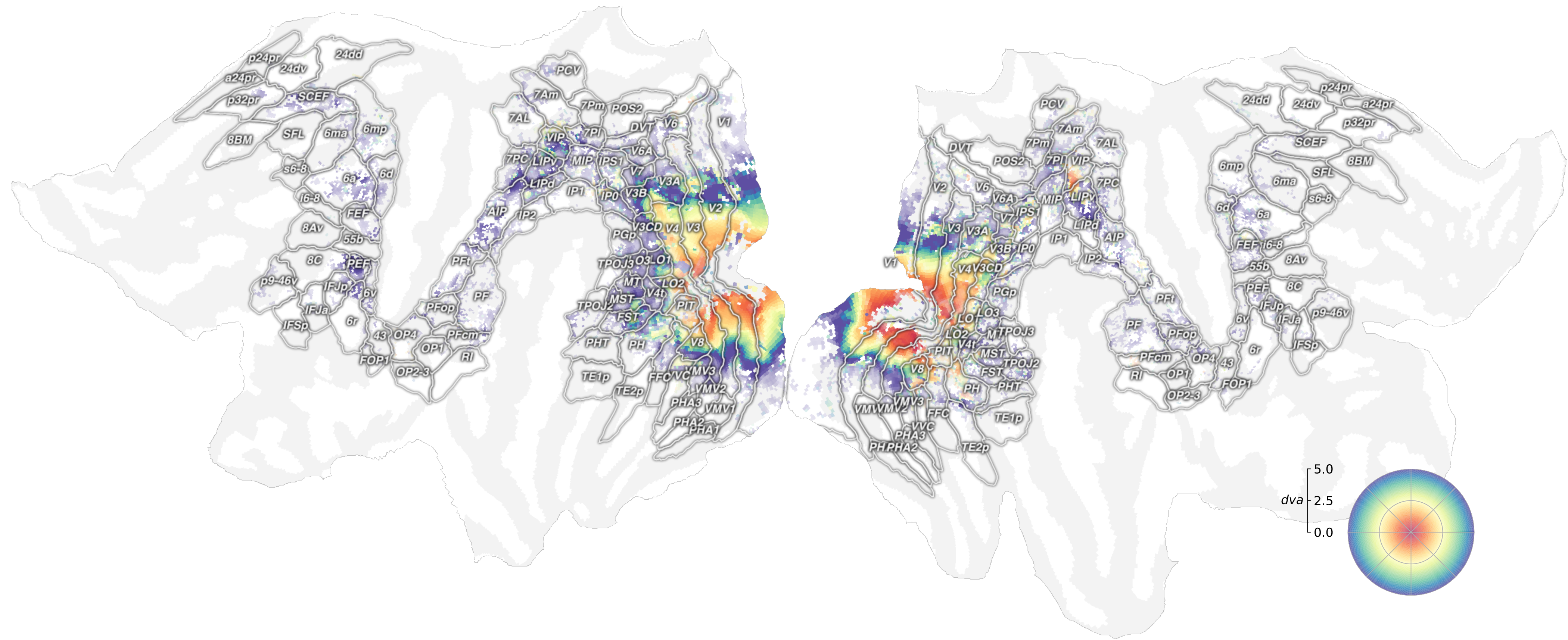
**iIPS, sIPS, iPCS, sPCS and mPCS
are visuo-motric areas with retinotopic organisation**



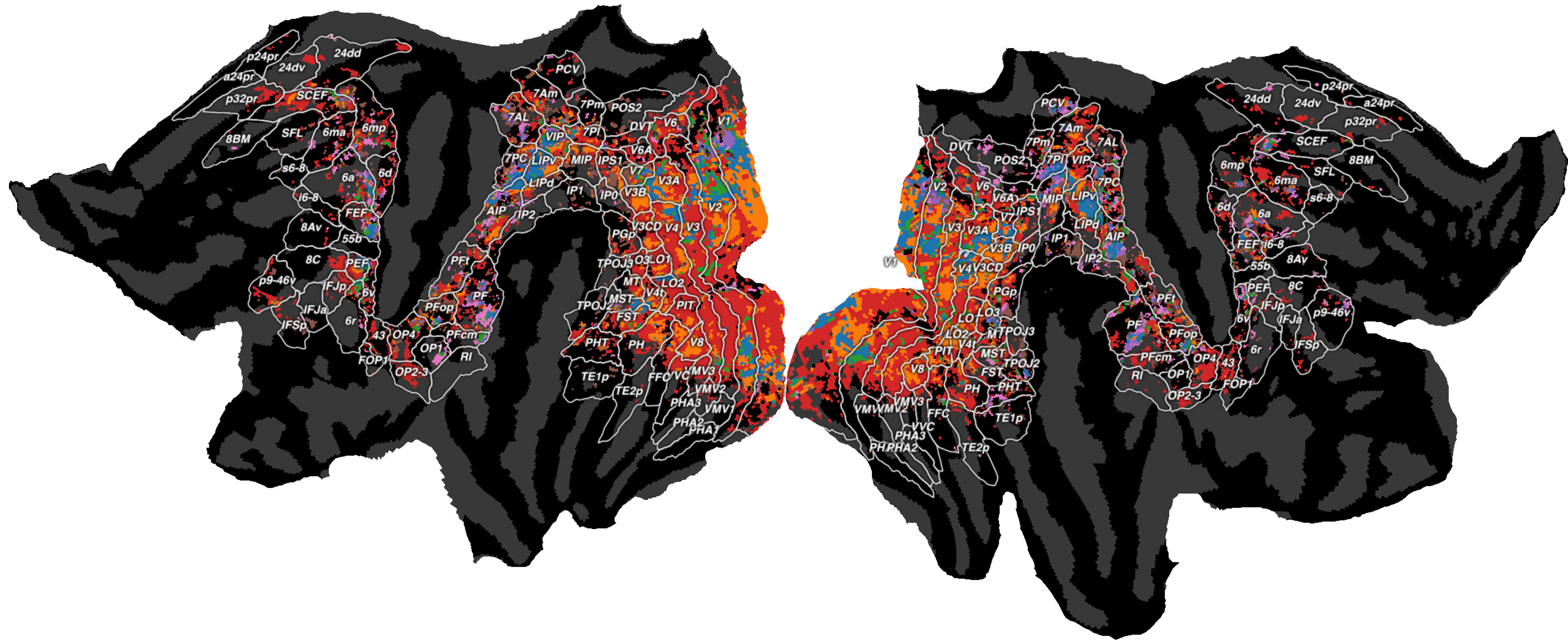
Glasser Multi-modal parcellisation



20 subjects average pRF eccentricity

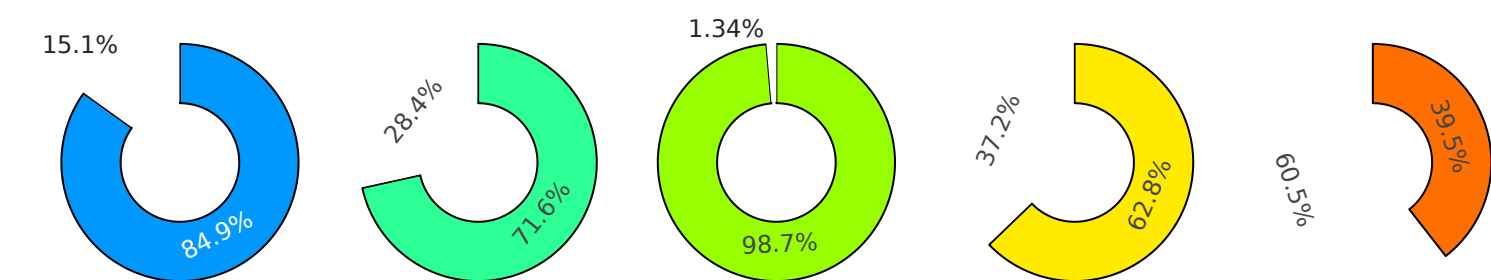
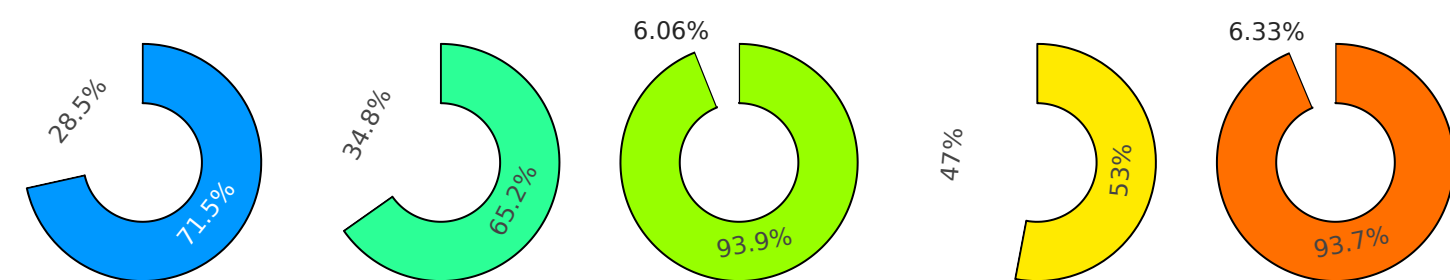
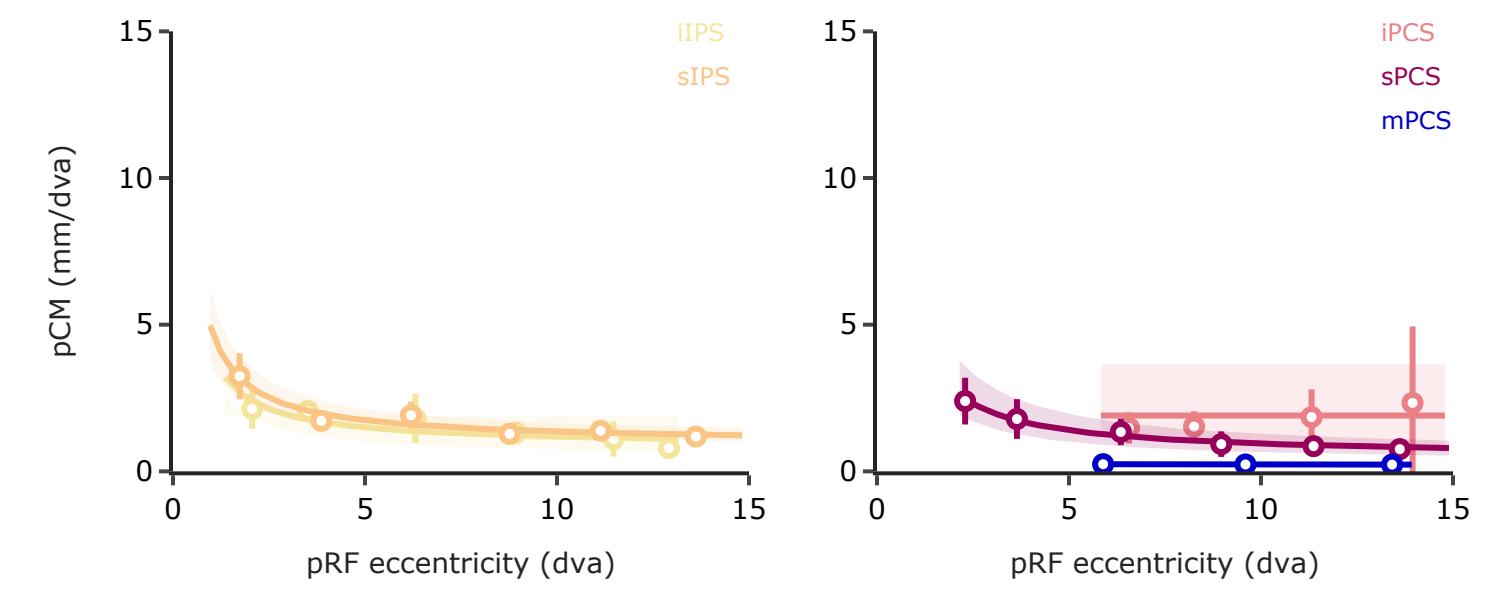
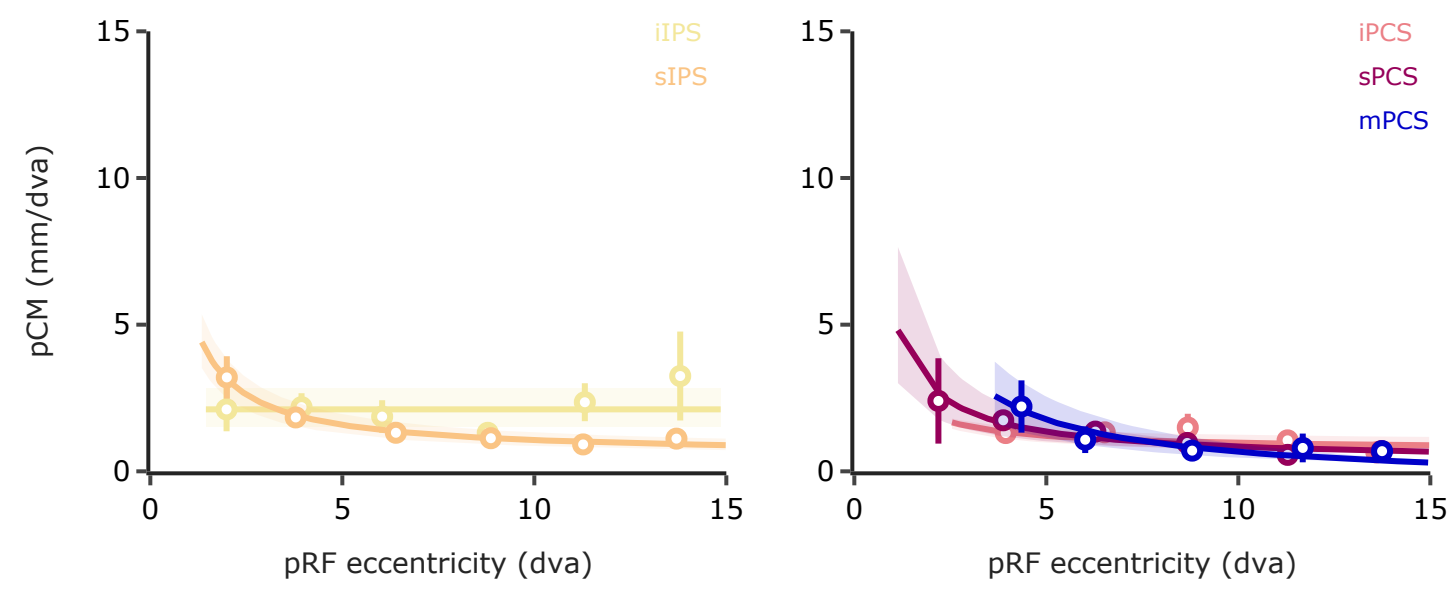
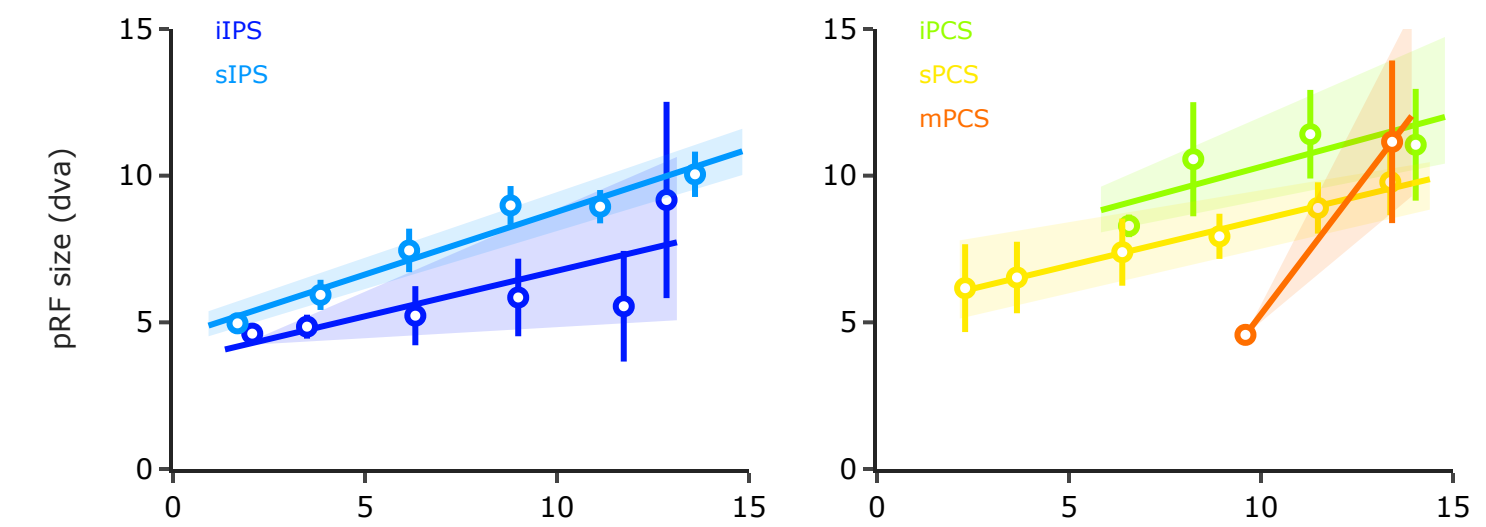
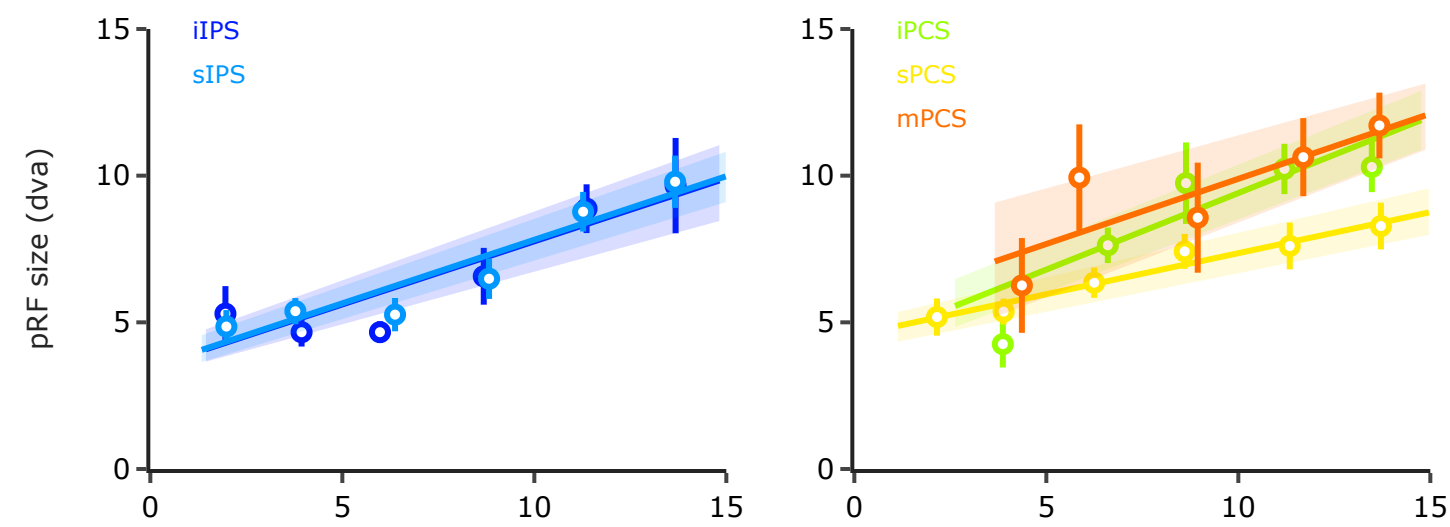
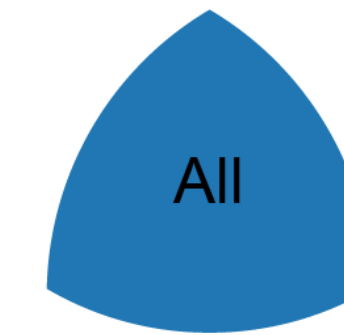
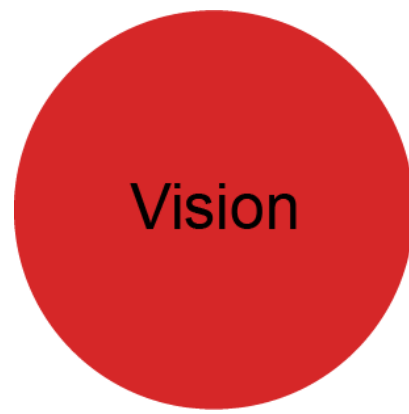


20 subjects average
FDR corrected
significant vertex

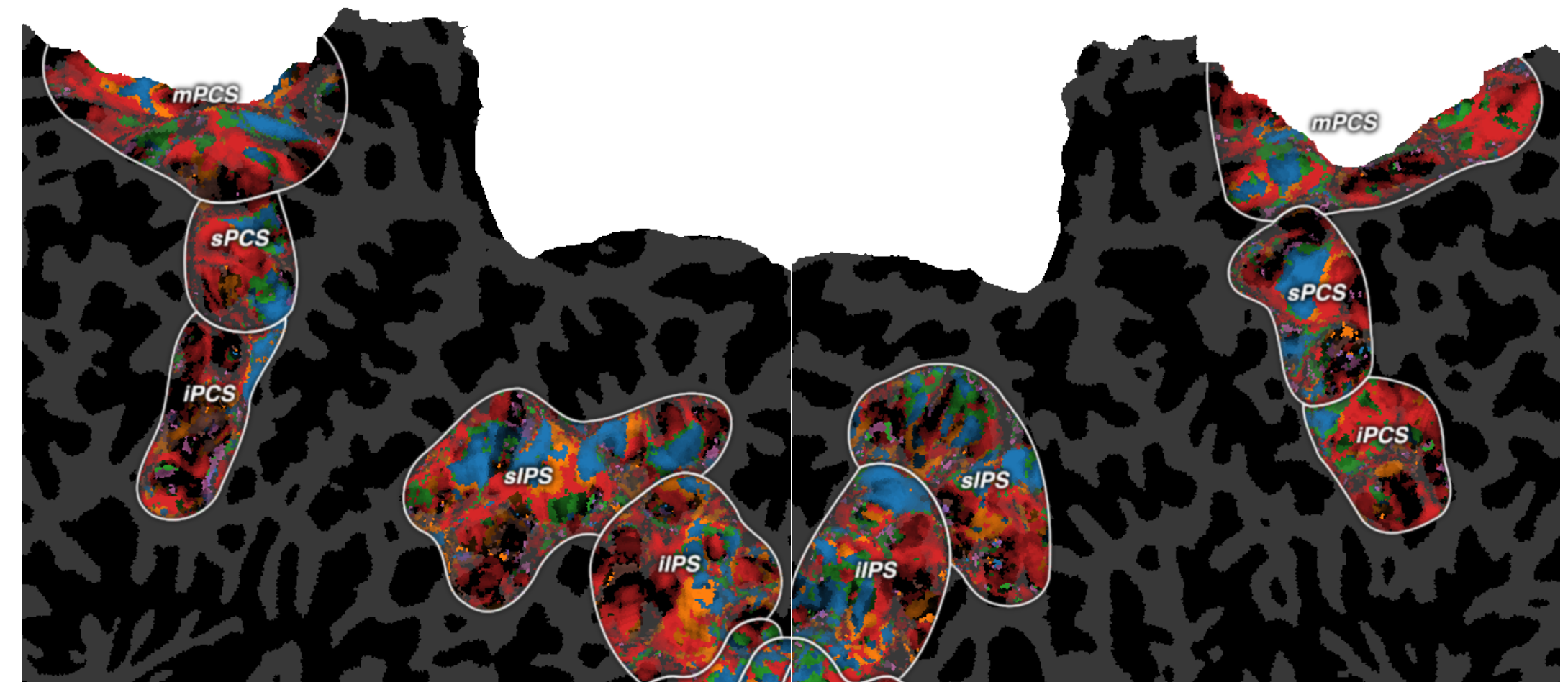


Atlas analysis

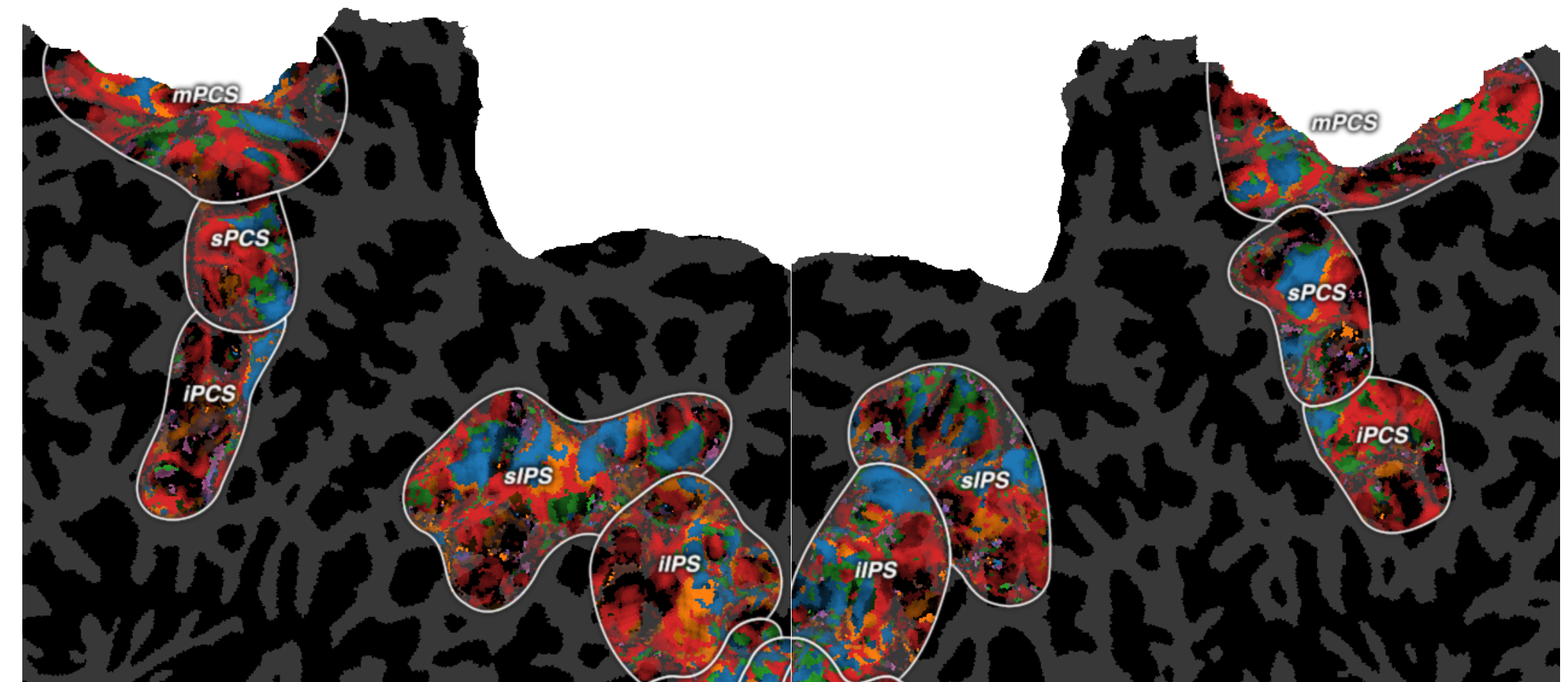
20 subjects average pRF parameters



RetinoMaps Summary



- We are developing a Python pipeline for surface-based fMRI analysis, which integrates atlas-based and subject-specific surface data.



- We are developing a Python pipeline for surface-based fMRI analysis, which integrates atlas-based and subject-specific surface data.
- We demonstrate the existence of five visuo-motor areas with retinotopic organisation distributed across the precentral and intraparietal sulci.



- Analyse eye tracking datas



- Analyse eye tracking datas



RetinoMaps

What next ?

- Analyse eye tracking datas
- Analyse other tasks



- Analyse eye tracking datas
- Analyse other tasks
- Create a model of visual input for eye movement tasks to reduce noise



- Analyse eye tracking datas
- Analyse other tasks
- Create a model of visual input for eye movement tasks to reduce noise
- Create a model of motor fields



- Analyse eye tracking datas
- Analyse other tasks
- Create a model of visual input for eye movement tasks to reduce noise
- Create a model of motor fields



Thanks for your attention !
