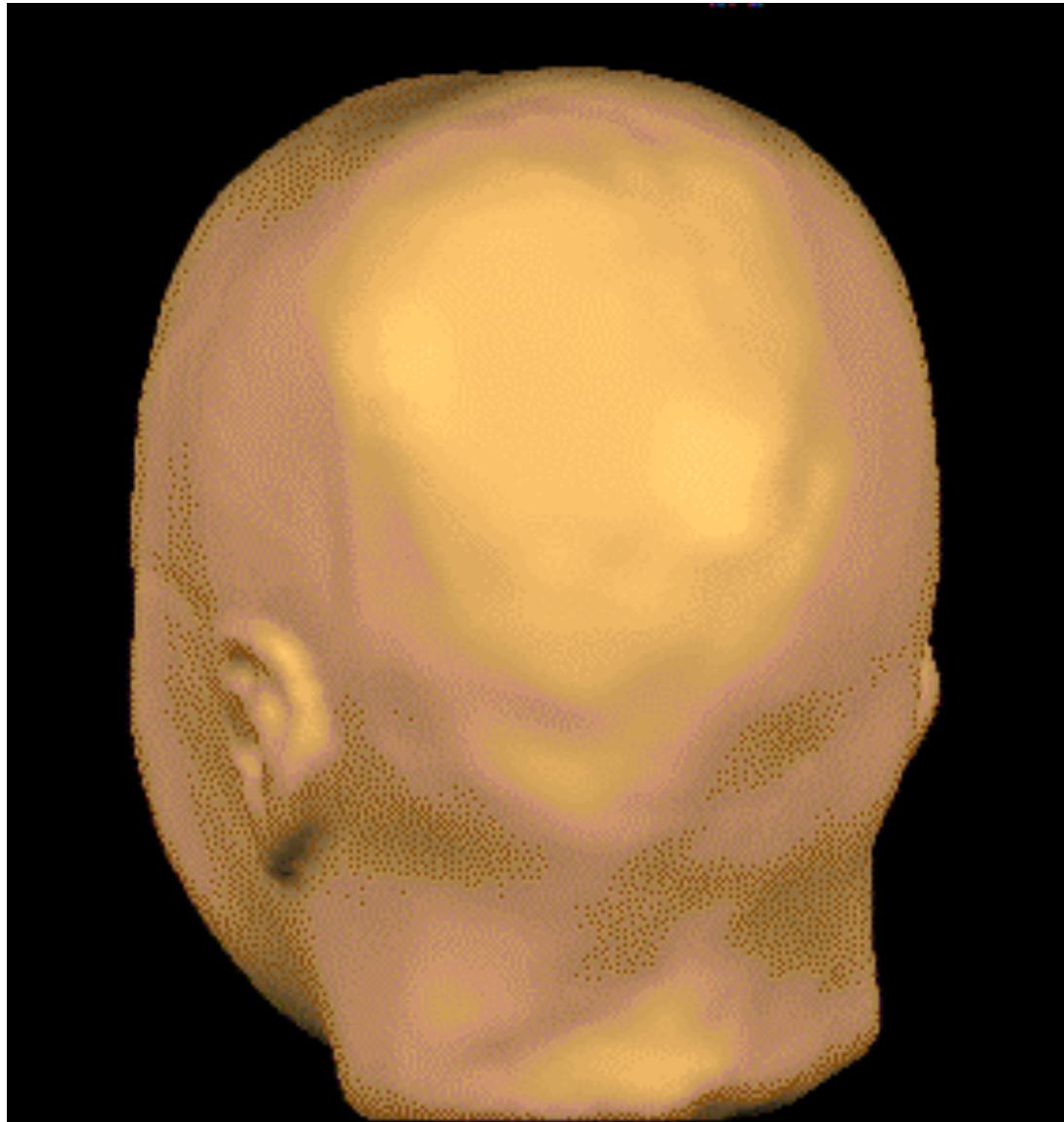


Welcome to the fMRI Methods Workshop

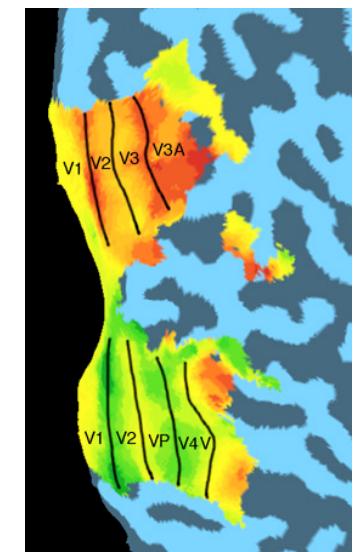
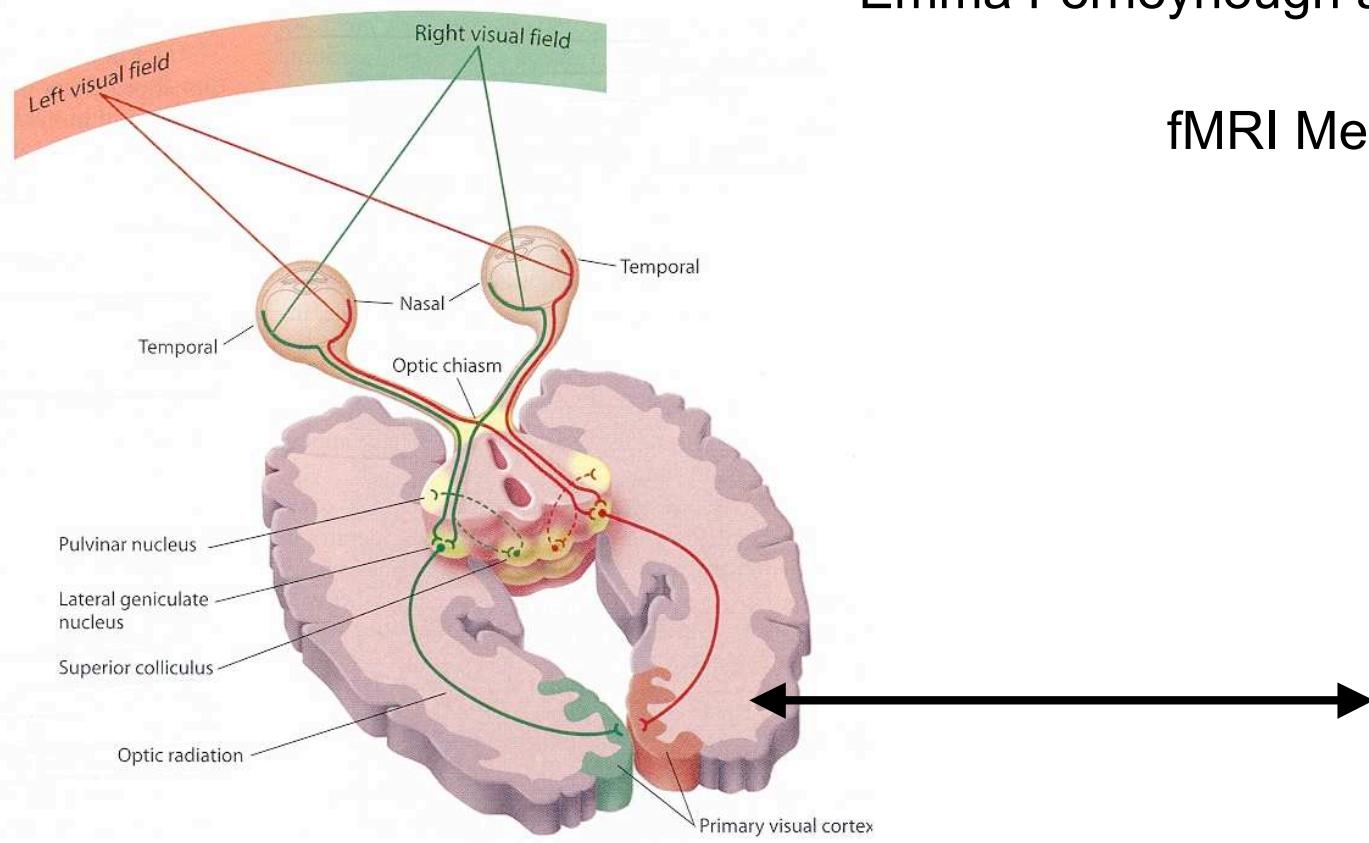


Goebel

Mapping Retinotopic Visual Areas on Flattened Brains

Presented by
Emma Ferneyhough and John Dewey

fMRI Methods Workshop
March 14, 2006



Gazzaniga, Ivry, Mangun, 2002

Overview

- *Part I: Retinotopic Mapping Principles and Procedures*
 - Theoretical background information
- *Part II: Retinotopic Flat-mapping with Brain Voyager QX*
 - Actual procedures used in our lab to make retinotopic maps, step by step

Part 1: Retinotopic Mapping

Principles and Procedures

- What is retinotopy?
- Why do it?
- Examples:
 - Inflating a brain
 - Cutting and flattening
 - Actual retinotopic maps
- Stimuli and procedures
- Polar and Eccentricity maps
- Field-sign maps

What is retinotopy?

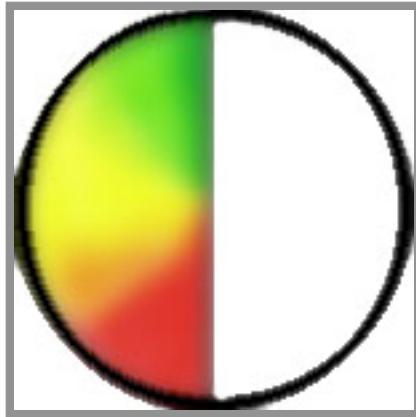
- It is a map of the retina on the brain.
- Areas next to each other on the retina are represented next to each other on cortex.
 - The parts of the brain that represent the fovea are larger than the parts that represent the periphery, even though the fovea is smaller physically on the retina.
- Bottom line → **Retinotopy is the functional organization of the visual cortex.**

Why create retinotopic maps?

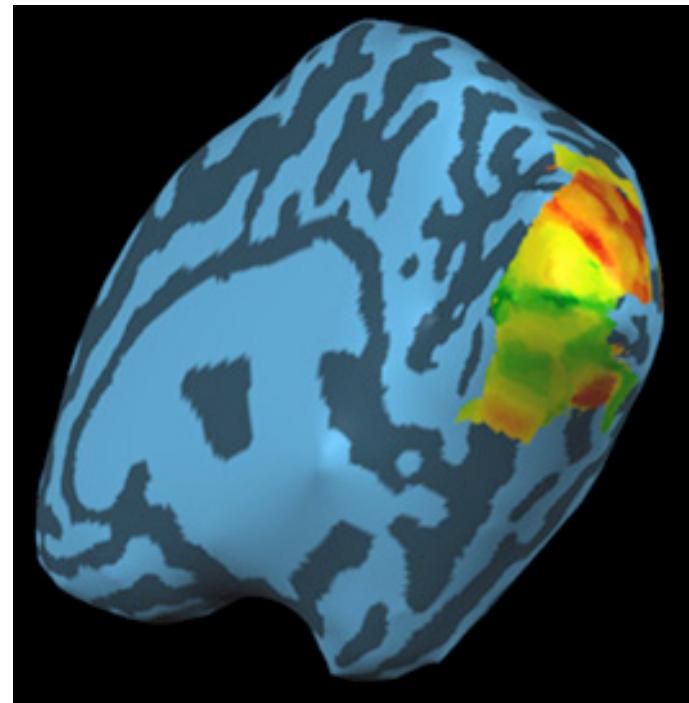
- Different regions of the visual cortex perform different analyses of incoming sensory information.
- Depending on your research questions, it is often useful to know what areas are getting activated.
- You can match activity of multiple objects in the visual field to multiple regions of activity in cortex.

Example of a retinotopic map

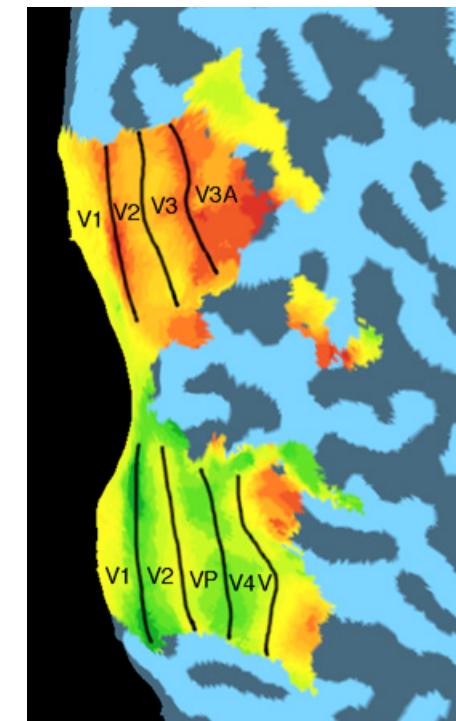
The **left** visual field corresponds to the occipital lobe of the **right** hemisphere.



Left visual field

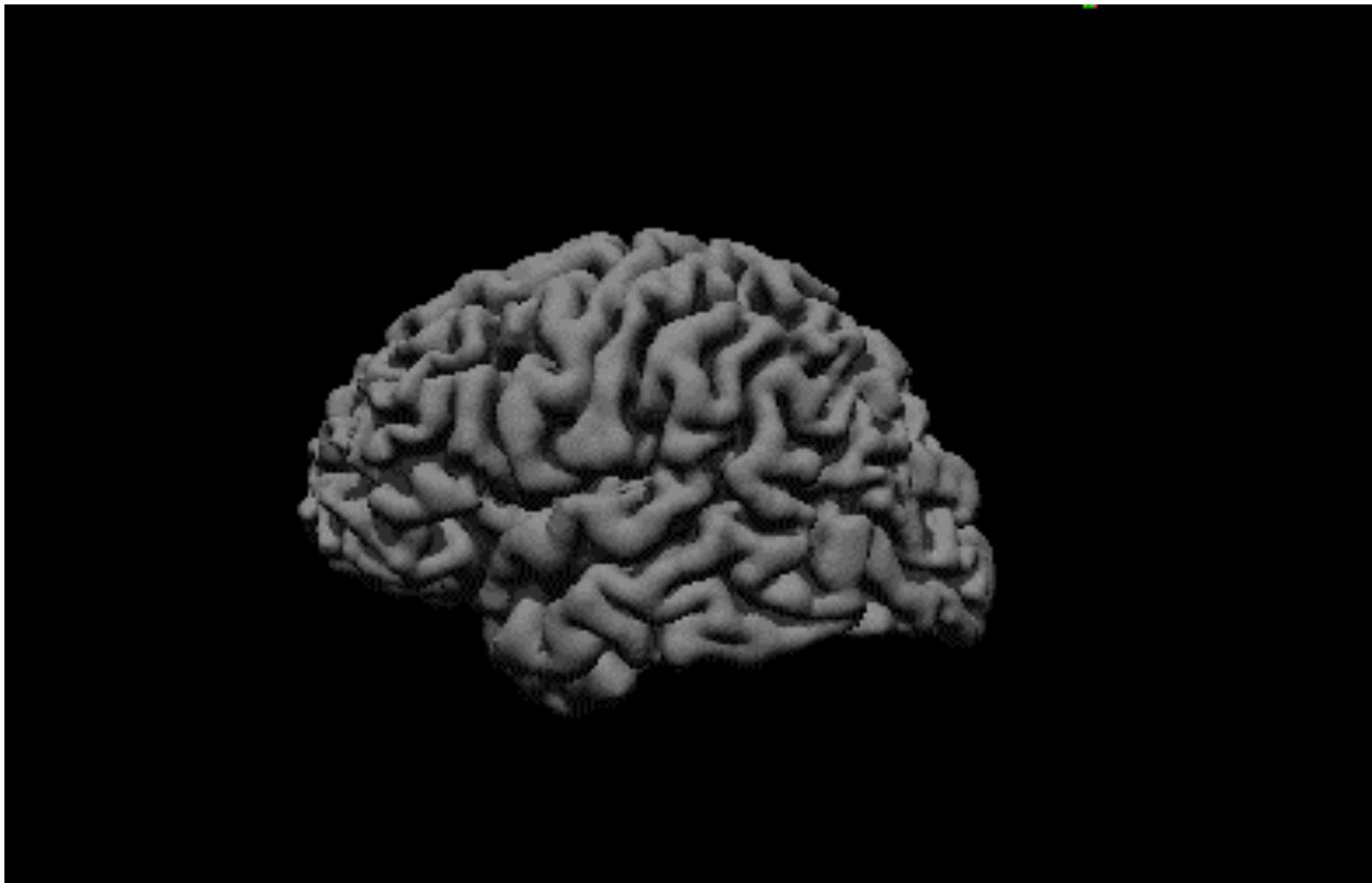


Inflated view of RH



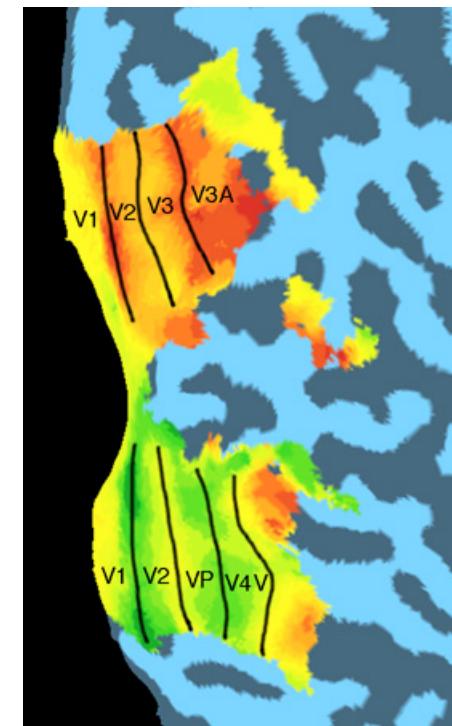
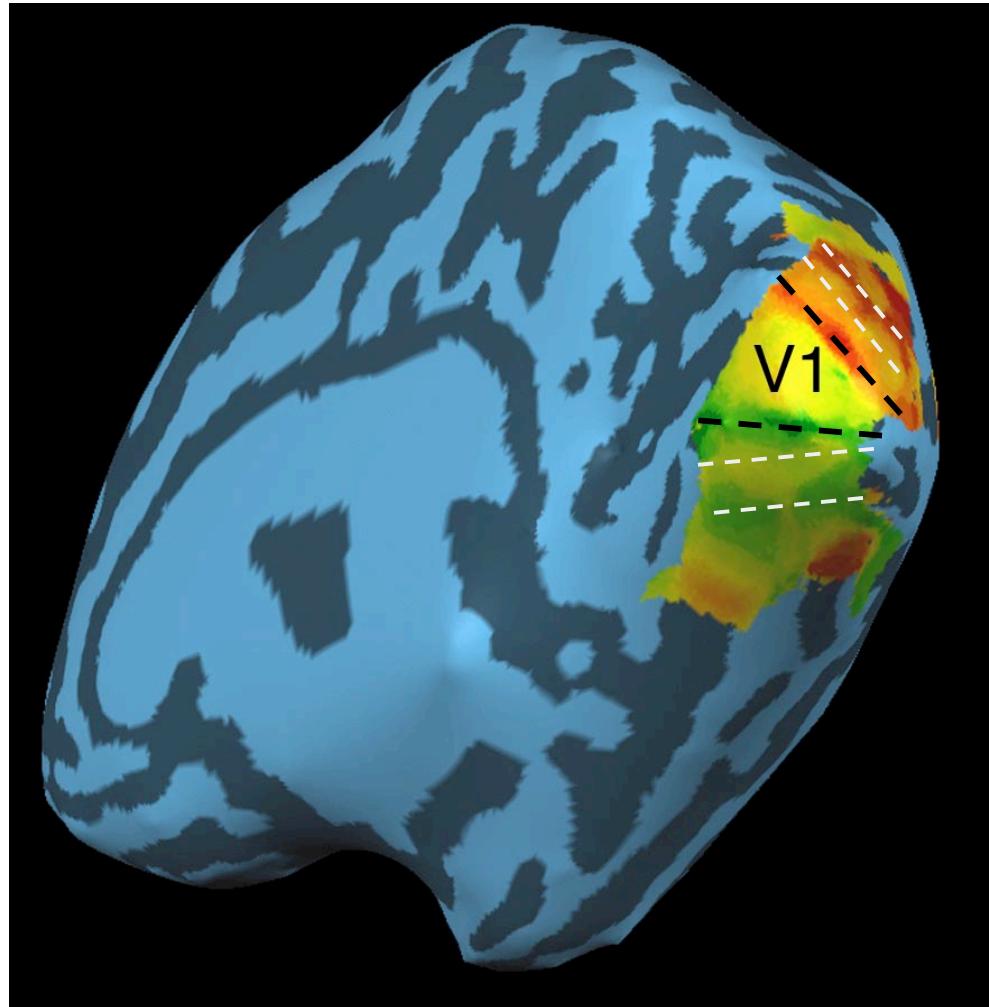
Flattened view

Inflating Brain



Matching inflated brains to flattened ones

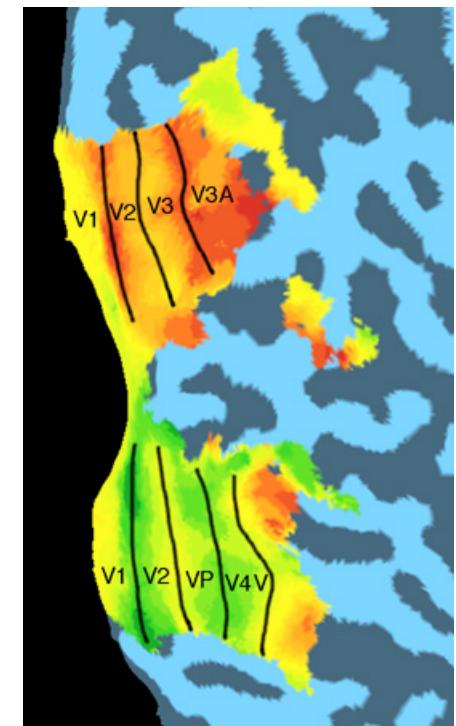
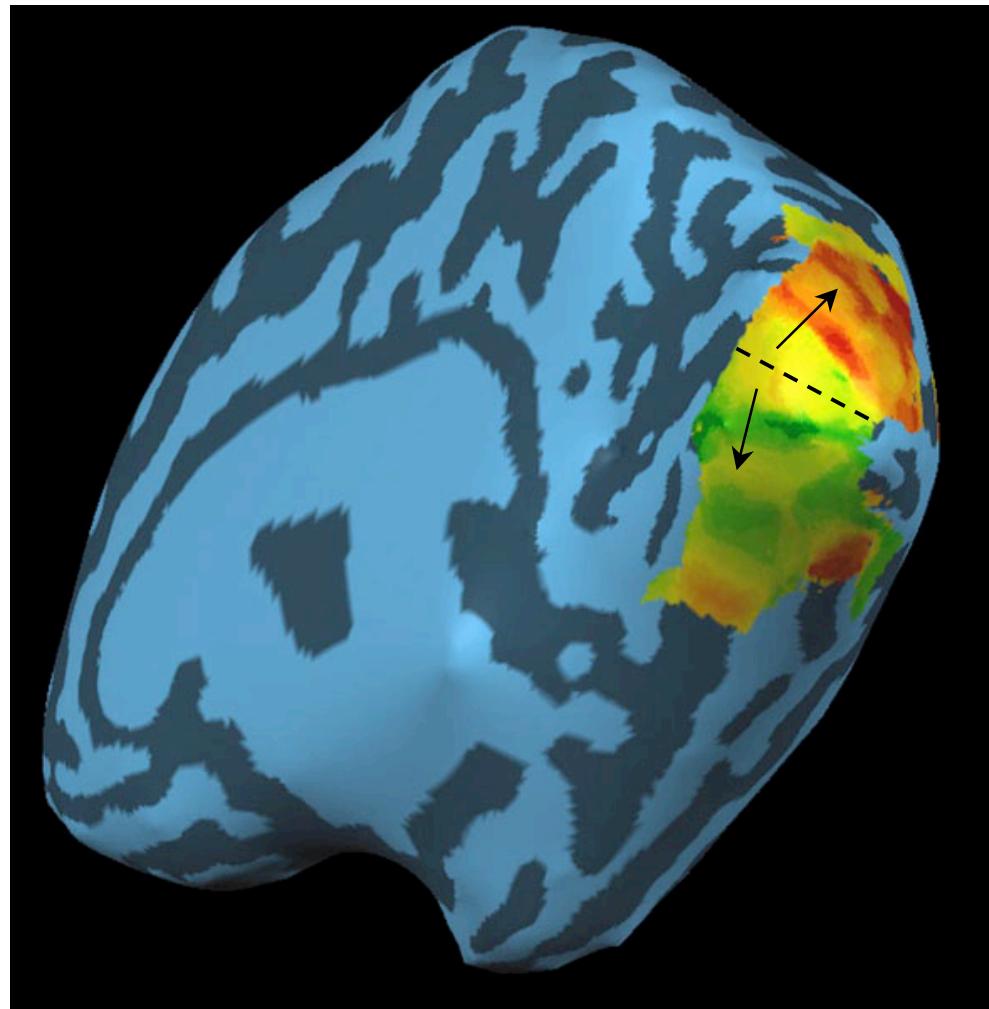
Finding V1 and the calcarine sulcus



Flattened view

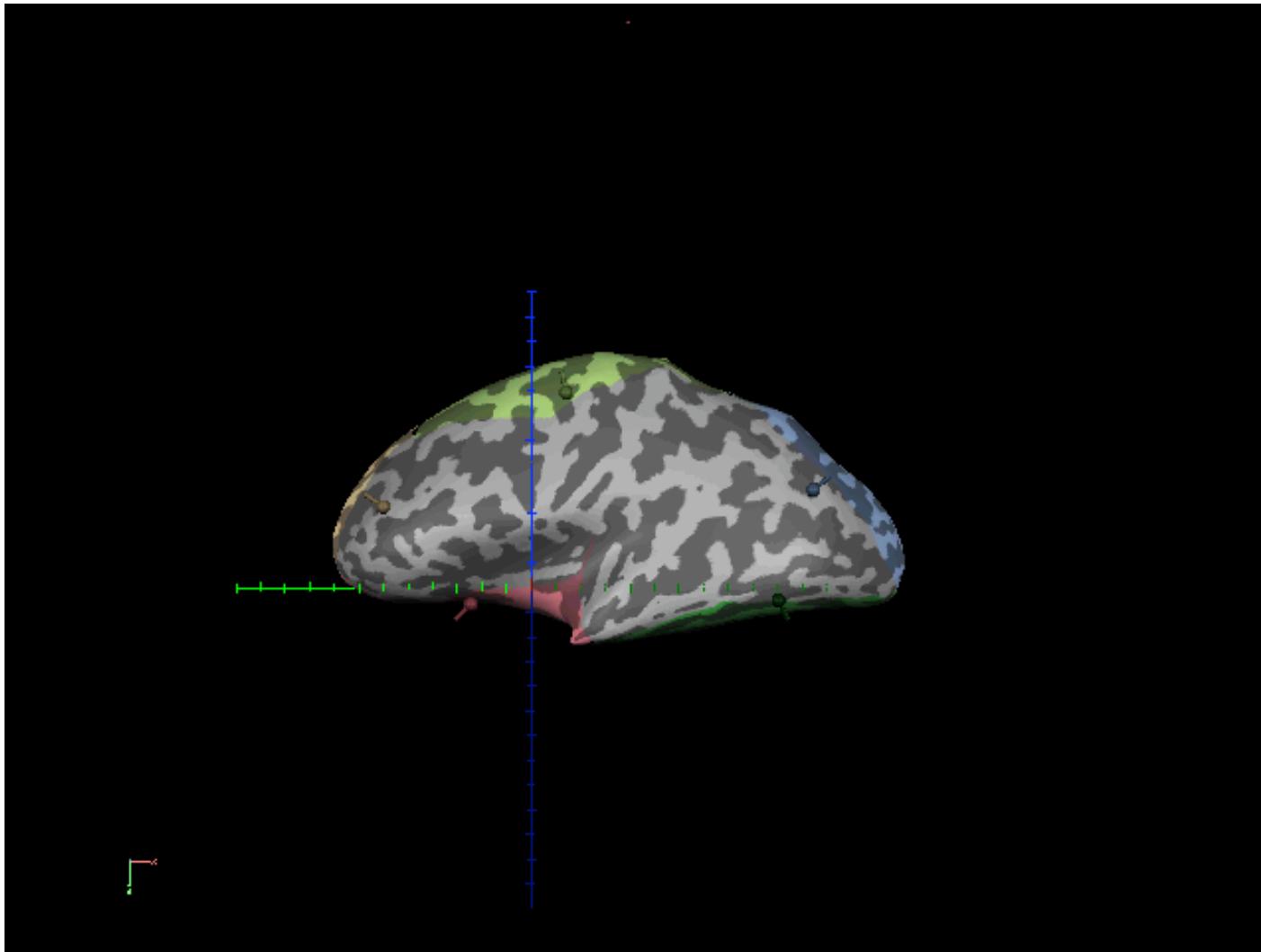
Matching inflated brains to flattened ones

Cutting the inflated brain along the calcarine



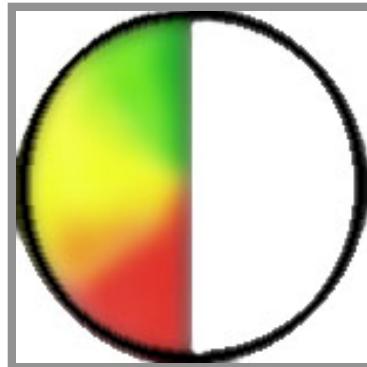
Flattened view

Flattening Brain

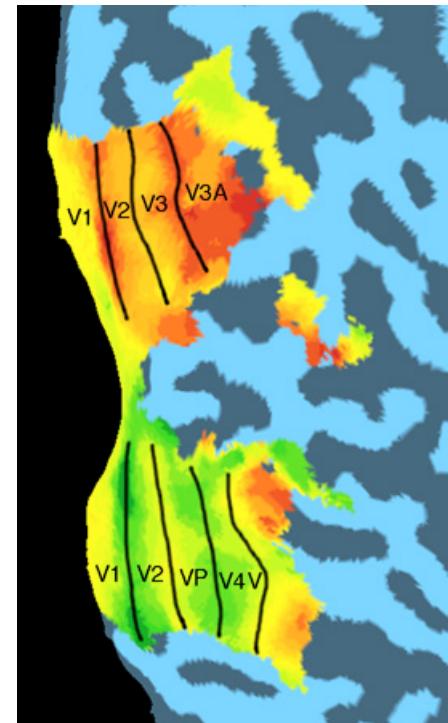


Early Visual Areas and known functions

- V1: orientation, edge discrimination
- V2: perceptual filling-in, subjective contours (?)
- V3: ?
- V3a: motion and depth?
- V4v: color and form?



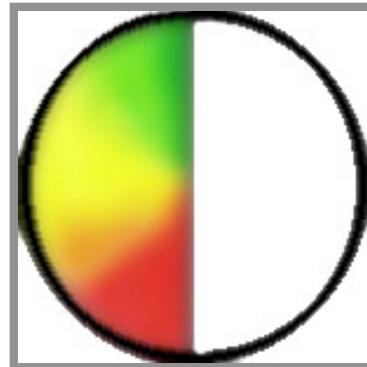
Left visual field



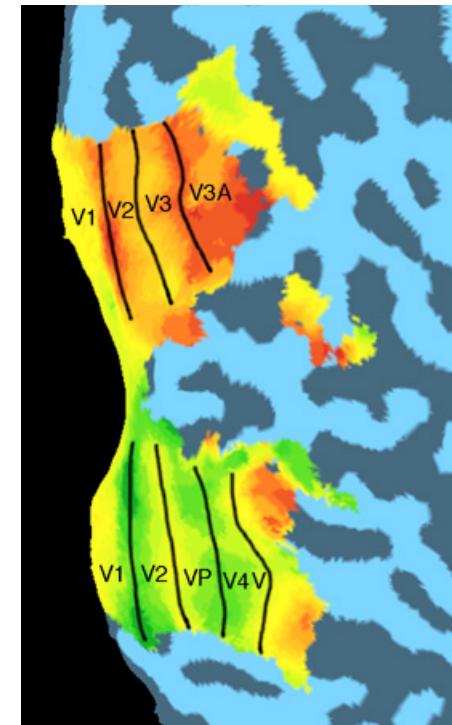
Flattened view

Early Visual Areas and known functions

- Each region represents $\frac{1}{4}$ of the visual field.
- V3a is $\frac{1}{2}$ field.
- If there is repeating activation in cortex, the supposition is that it represents a new visual area.



Left visual field

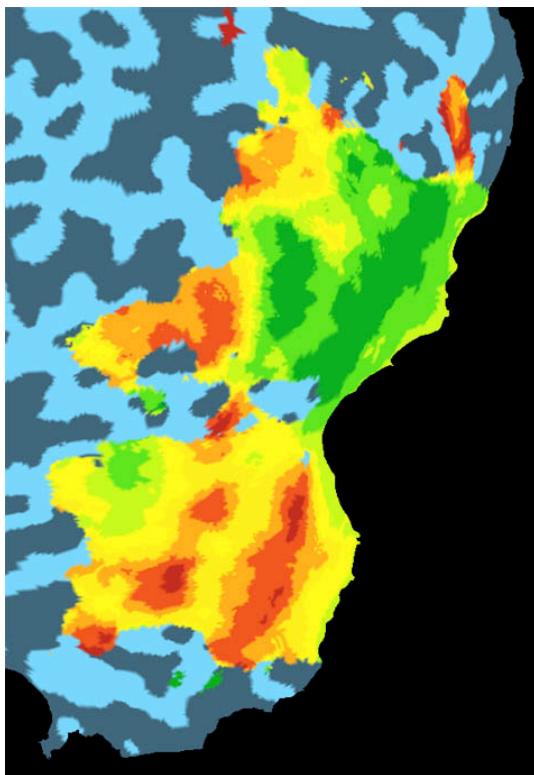


Flattened view

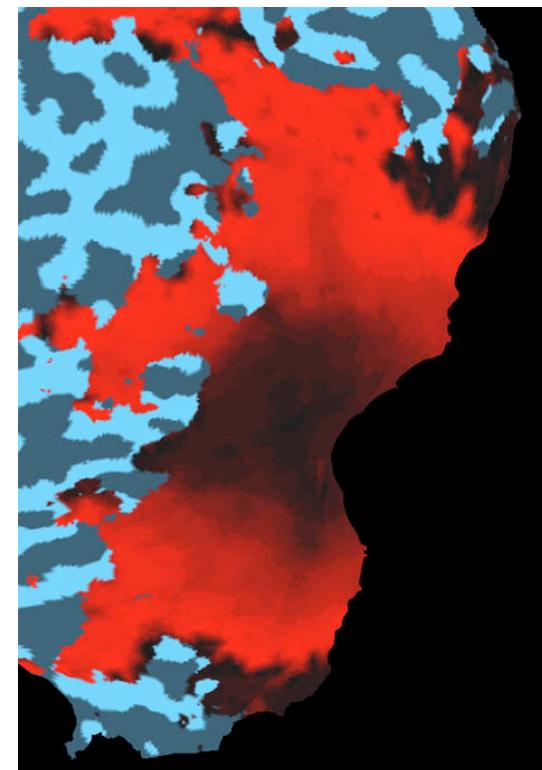
So, how do you make retinotopic maps?

First, we create polar and eccentricity maps of visual cortex using BrainVoyager software (Brain Innovation, Maastricht, The Netherlands).

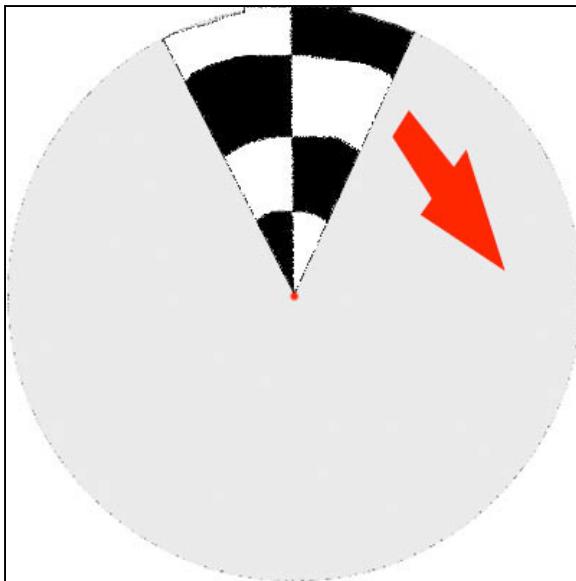
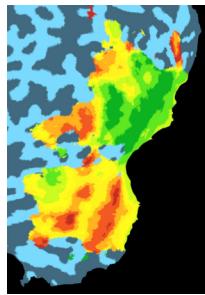
Polar angle map



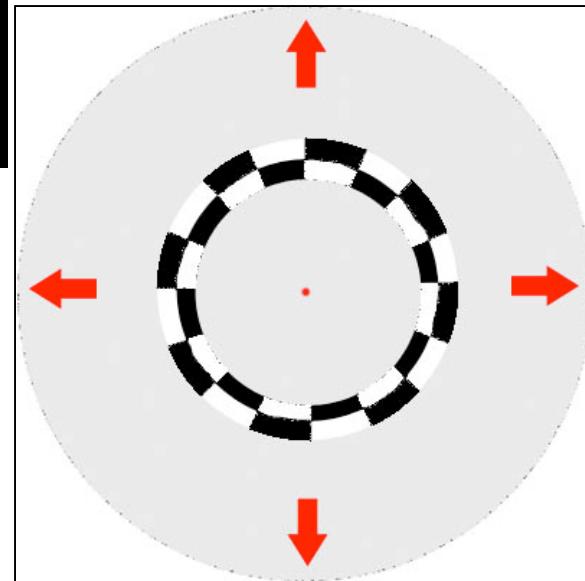
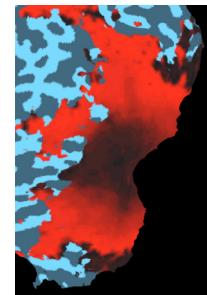
Eccentricity map



Stimuli



- Rotating wedge stimulus with rapidly flickering checkerboard pattern



- Expanding ring stimulus with rapidly flickering checkerboard pattern

32 secs per complete cycle, 10 cycles per run

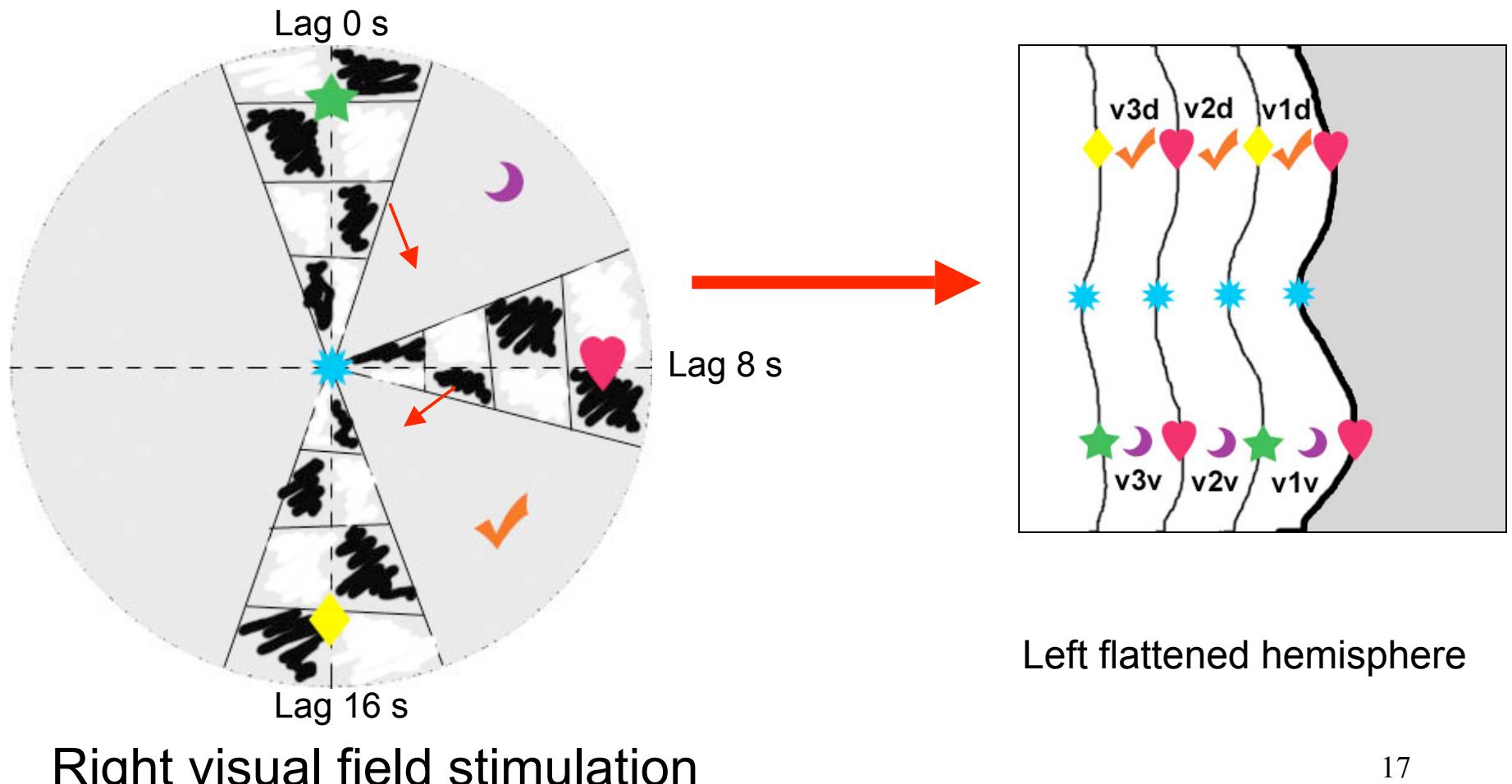
Scanning Procedures

- Minimum of 2 polars and 1 eccentricity run
- Usually do 6-8 polar and 2-4 eccentricity runs
- To reduce head motion, we use a bite bar with our most experienced subjects.



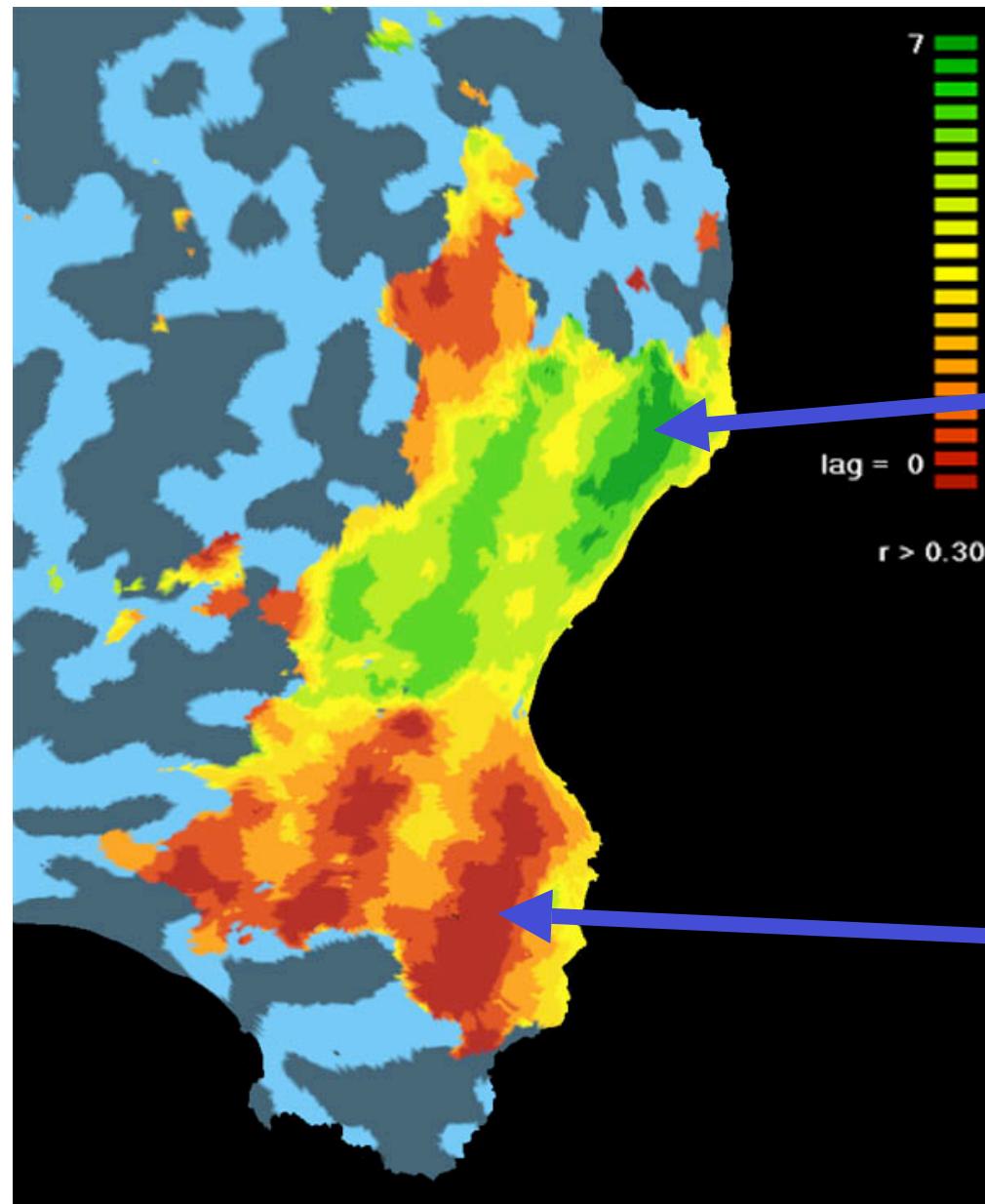
Explanation of polar maps

As the 45° wedge rotates, corresponding regions in cortex are activated.

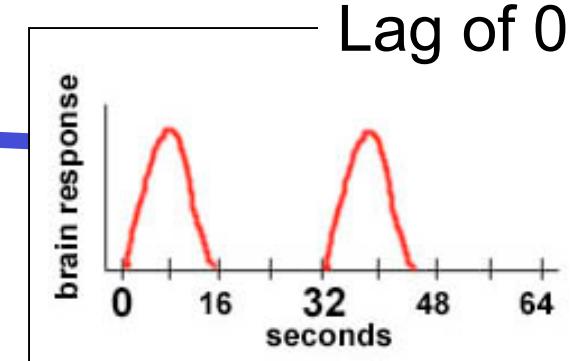
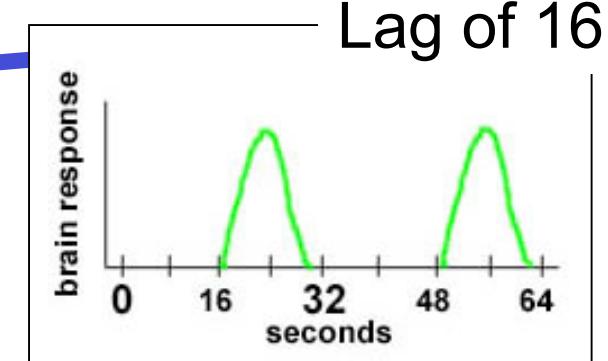


Lags

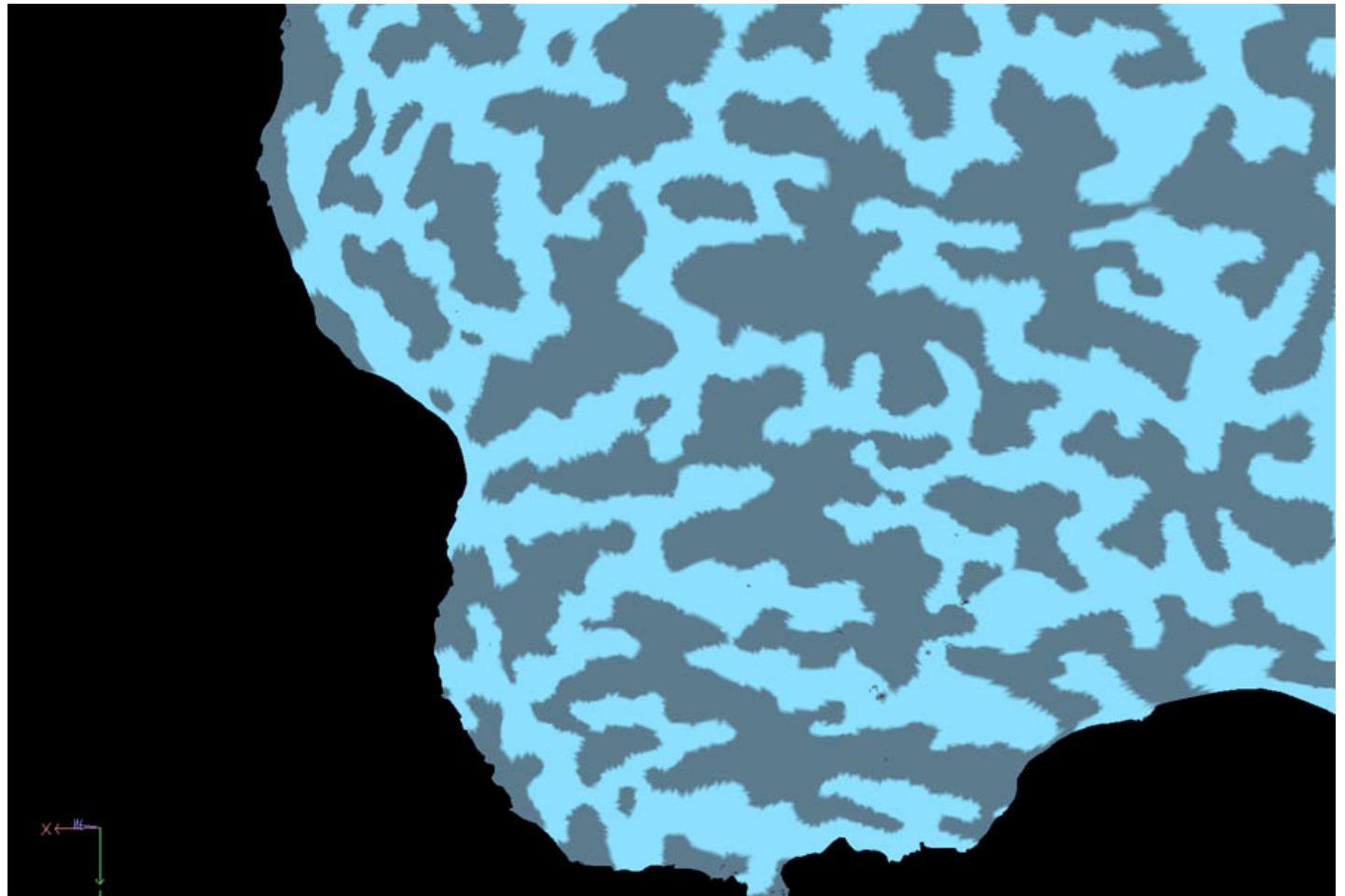
- Space = Time
- We can map visual cortex by measuring the time each region takes to hit its peak activity
 - The colors on our map correspond to specific time points of these peak activities during the 32 second stimulation cycle



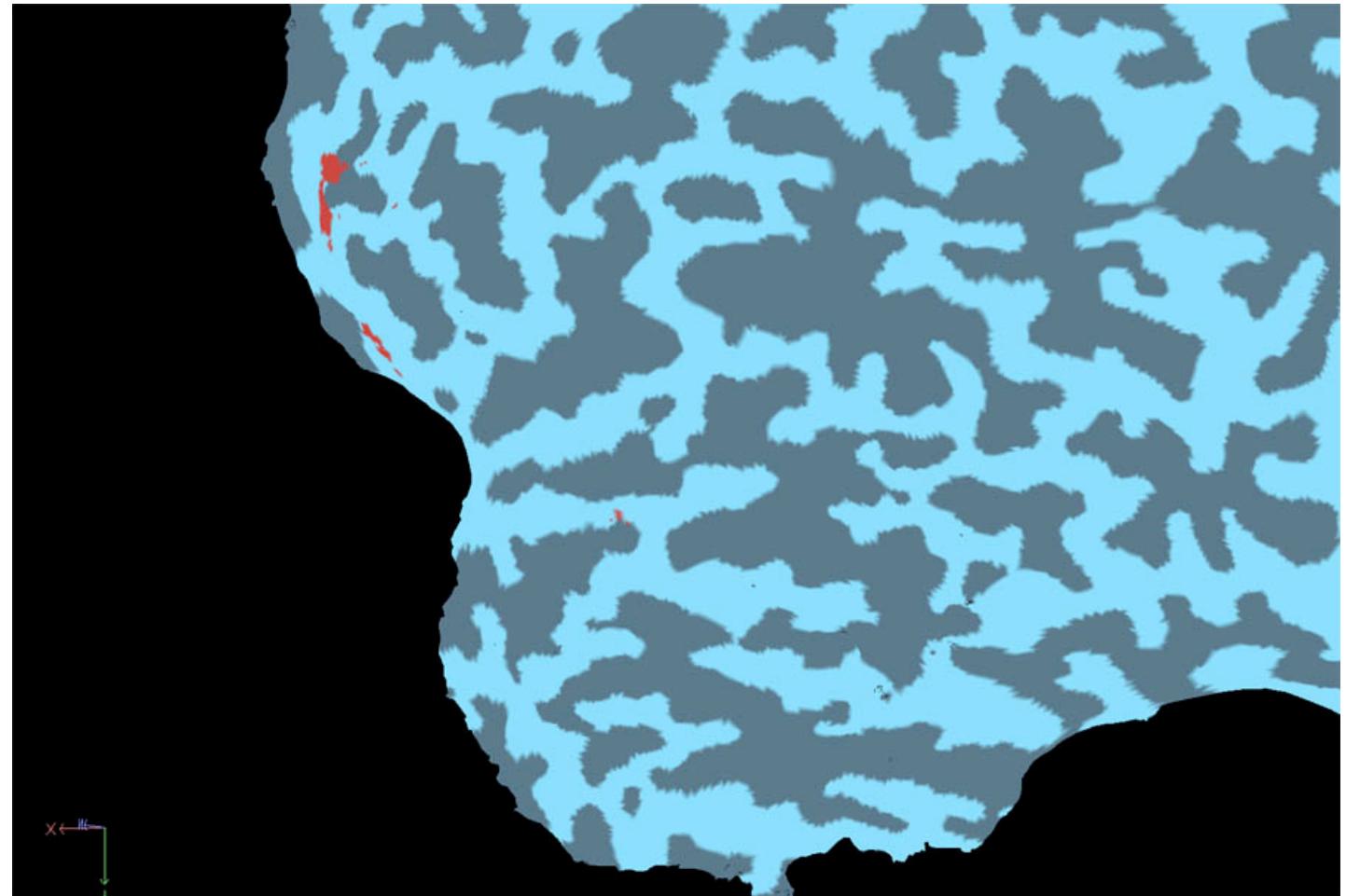
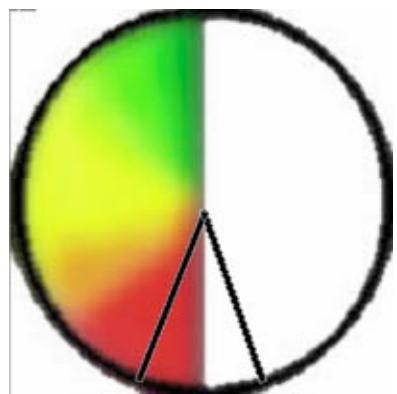
Lags
Space = Time



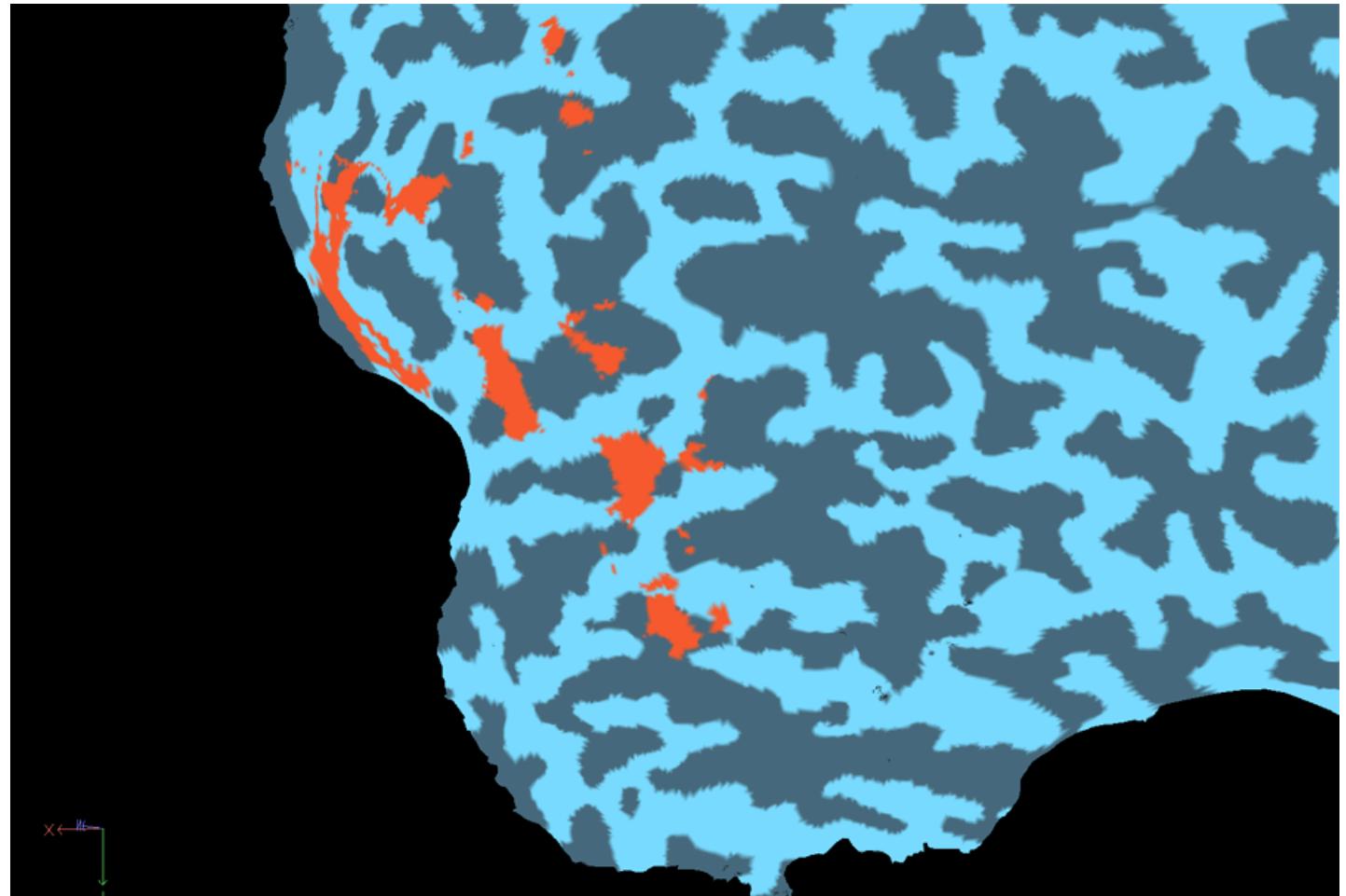
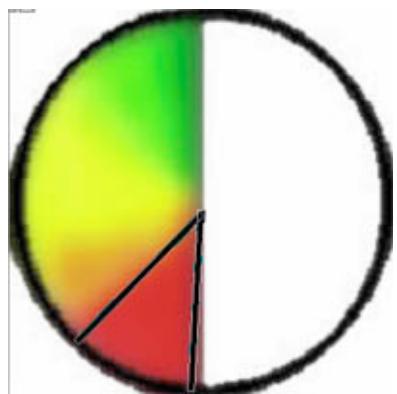
RH
Flatmap



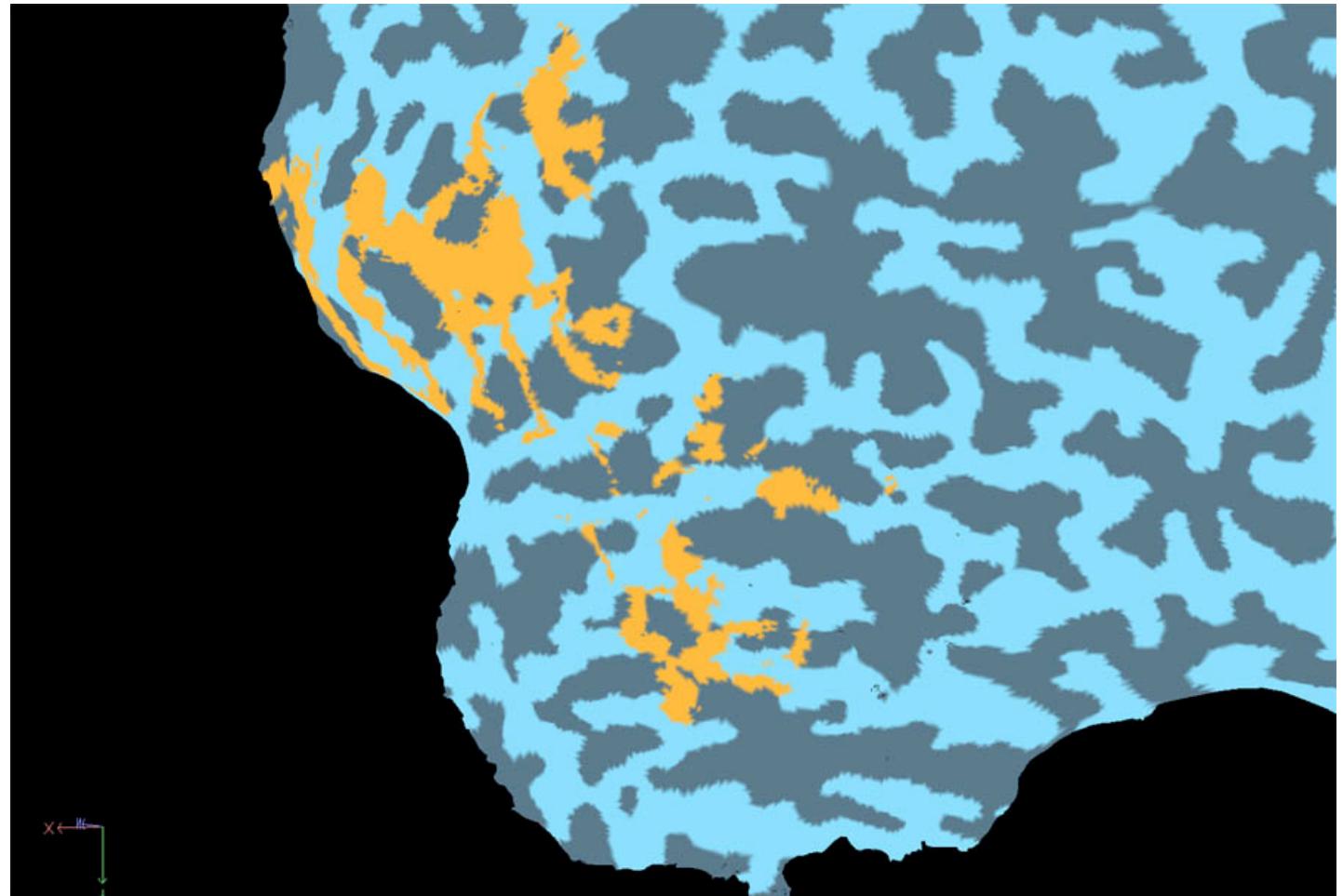
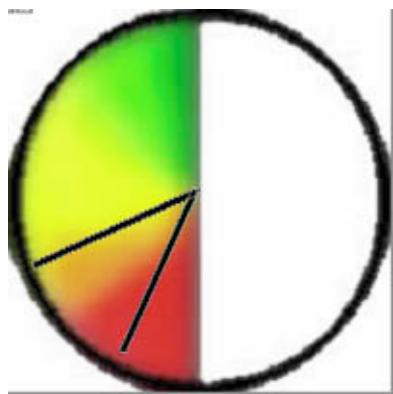
Lag 0
seconds



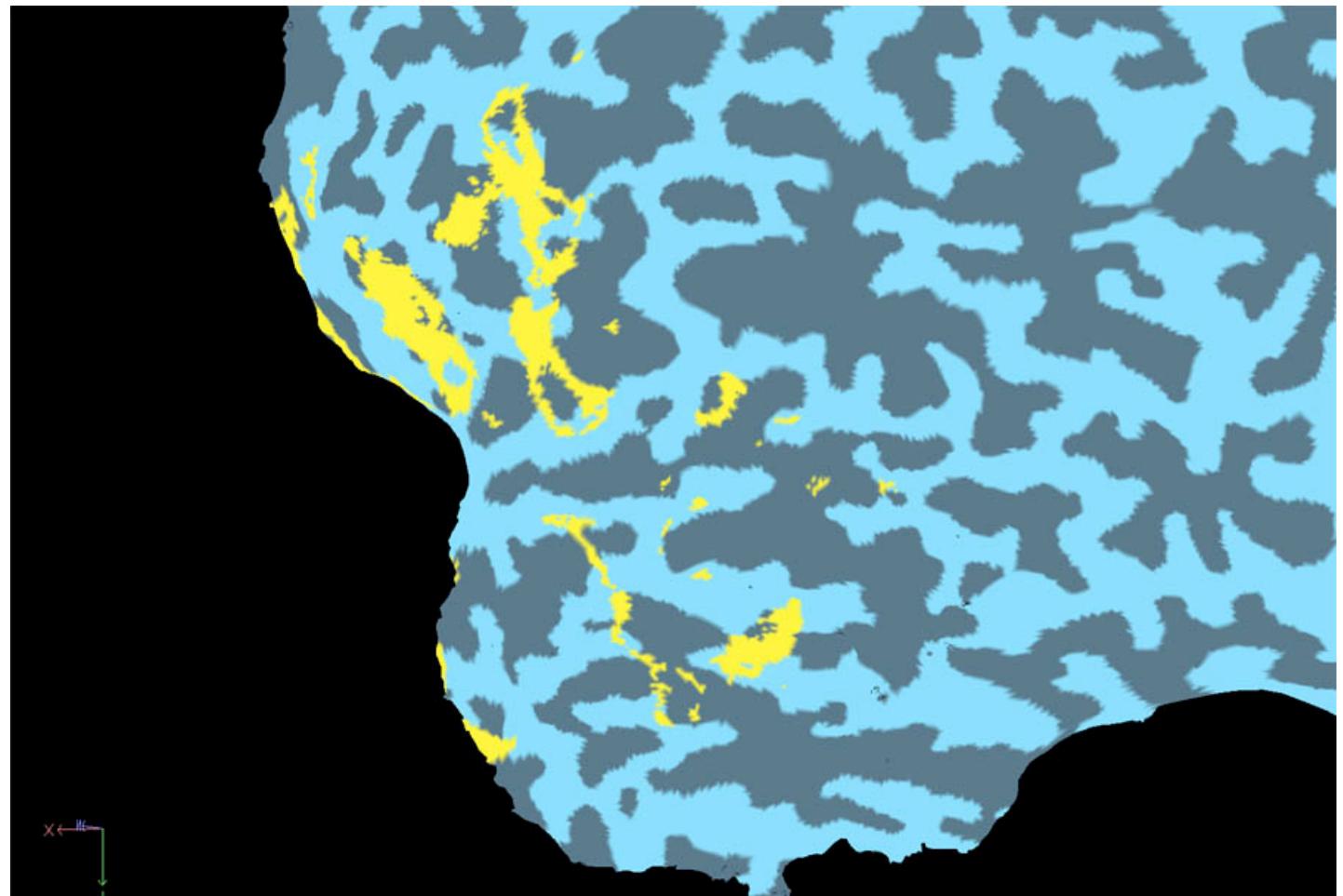
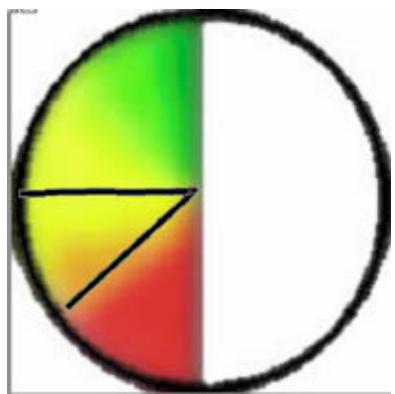
Lag 2
seconds



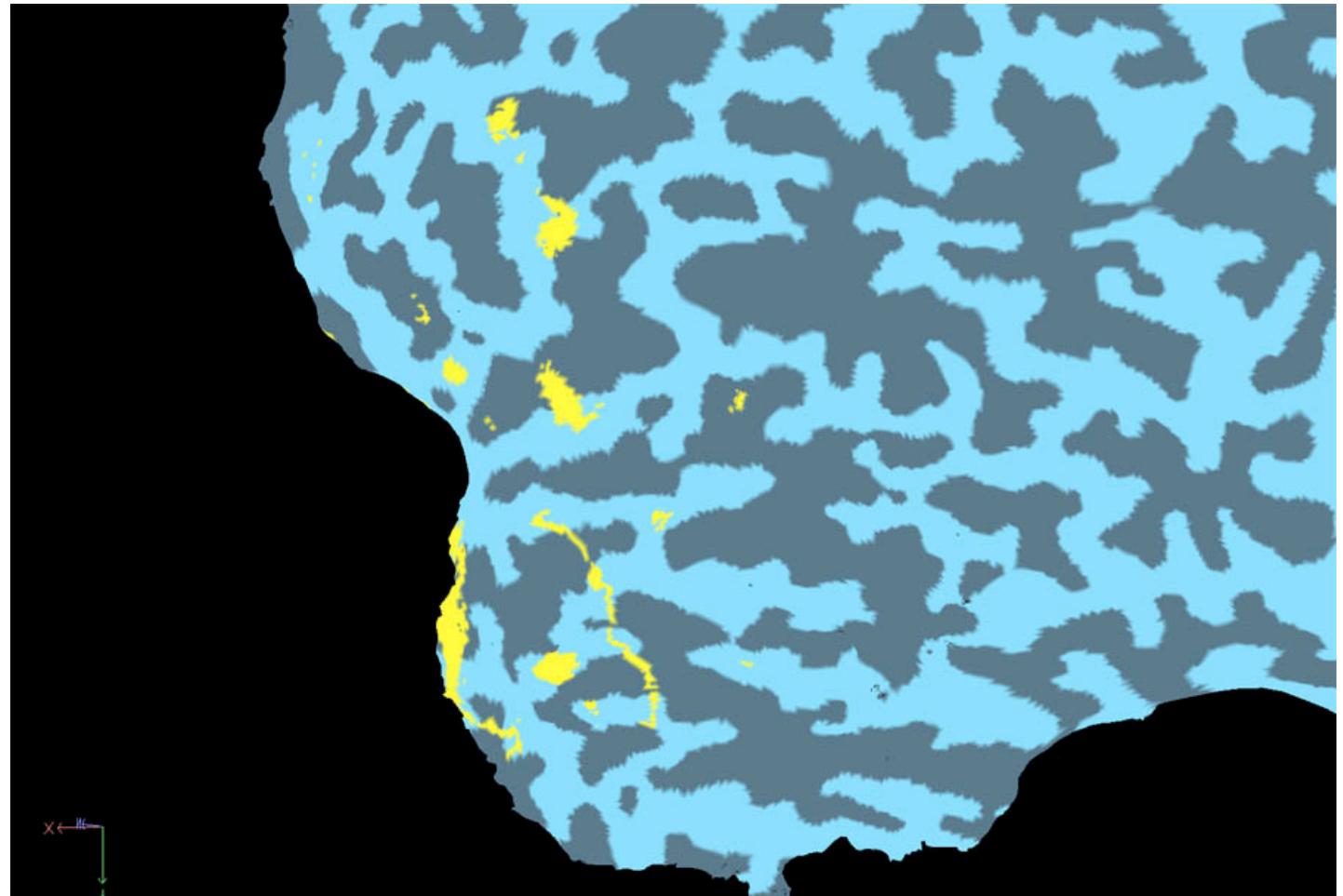
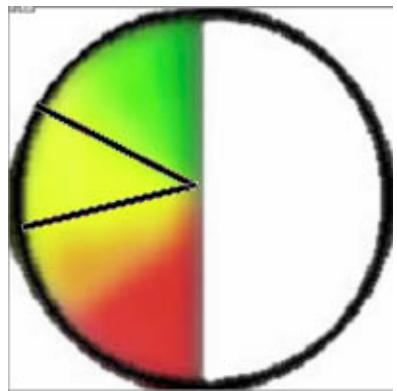
Lag 4
seconds



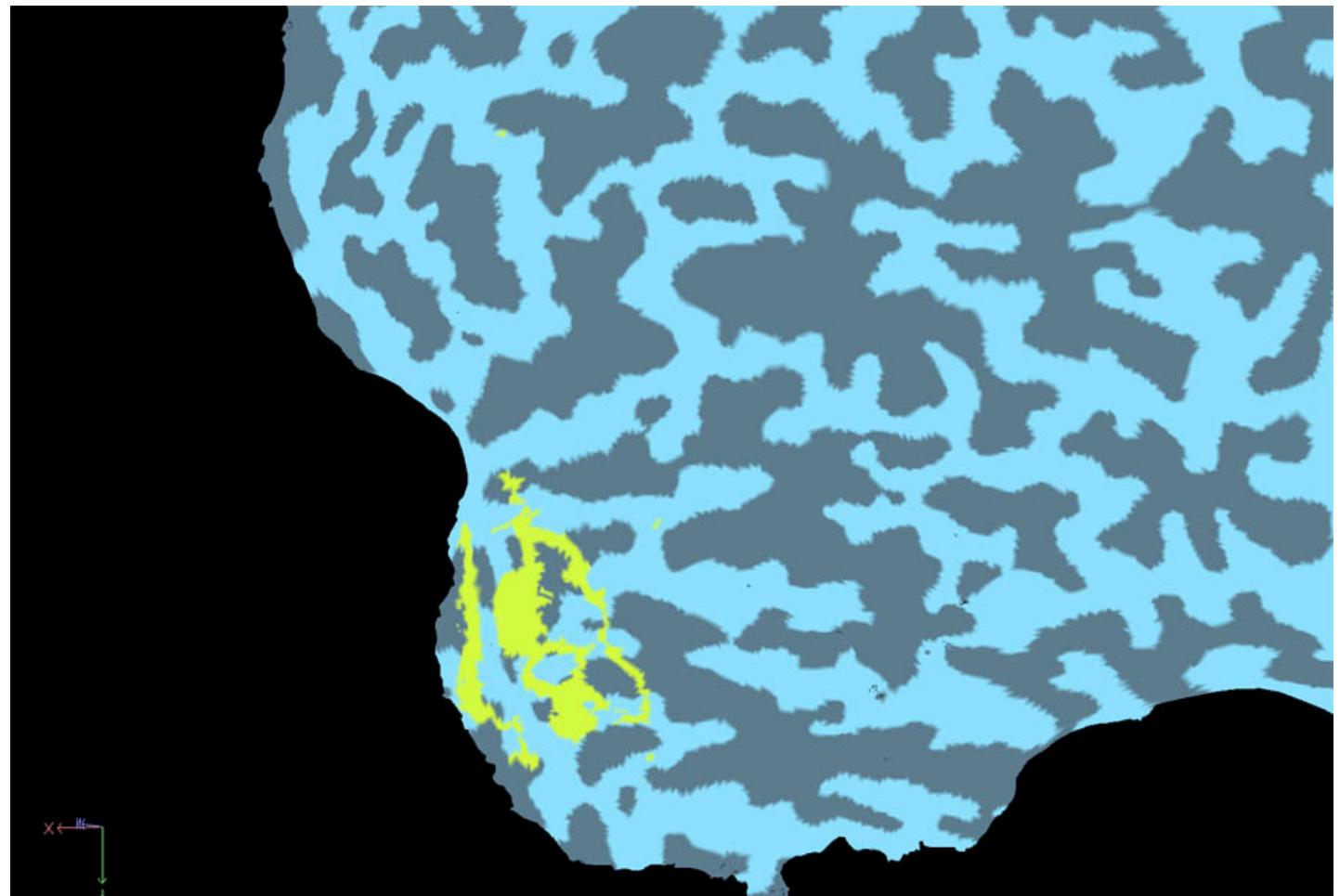
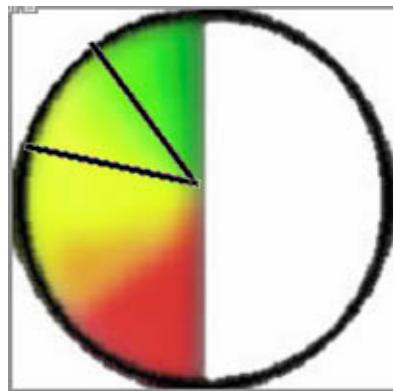
Lag 6
seconds



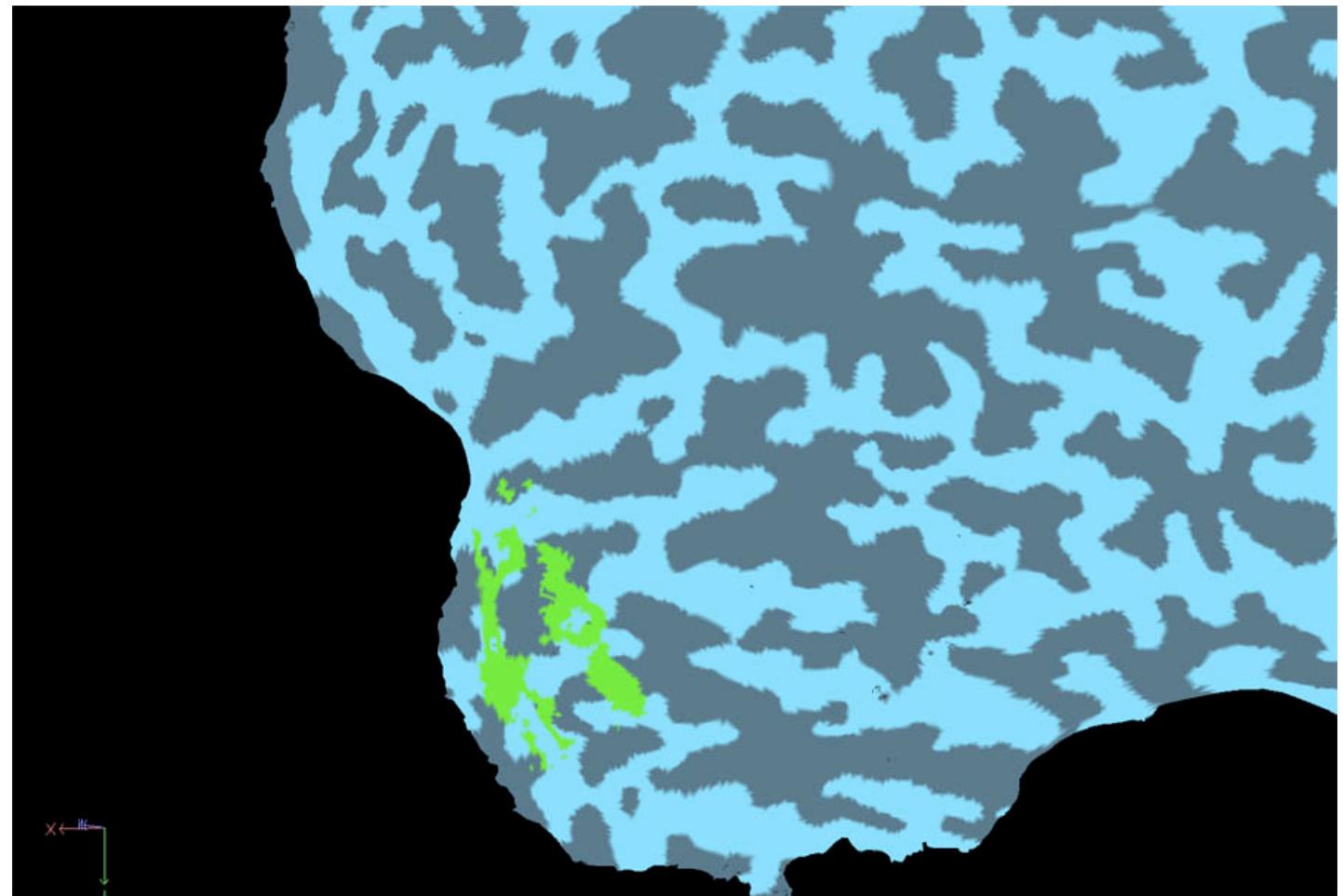
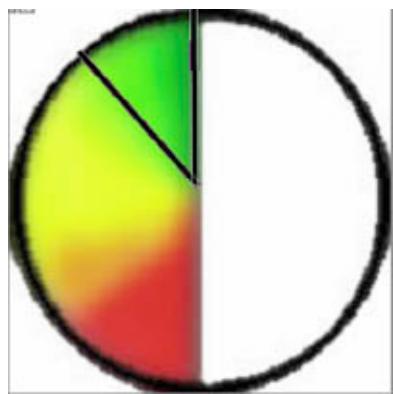
Lag 8
seconds



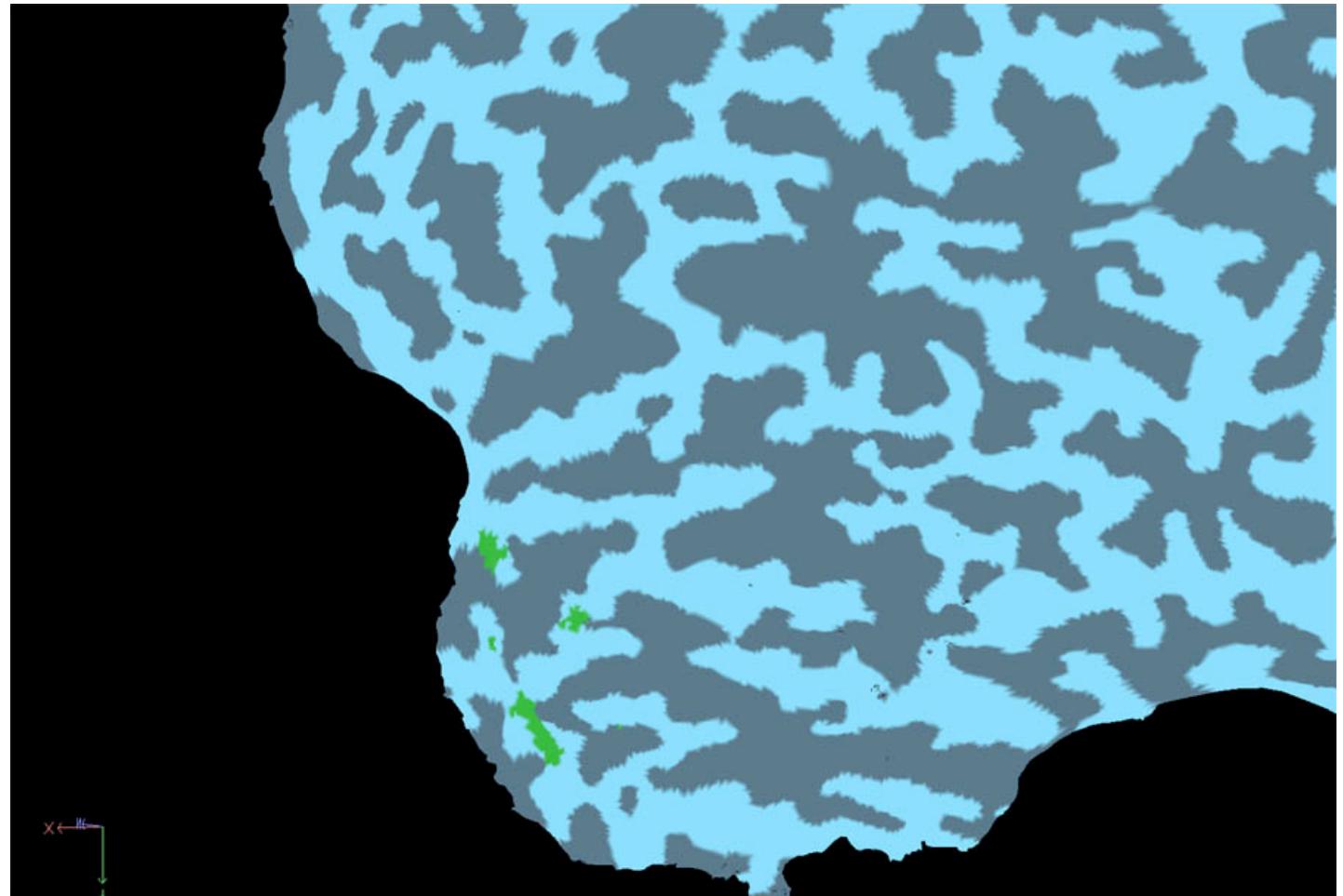
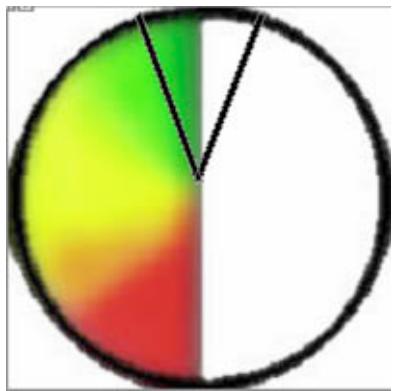
Lag 10
seconds



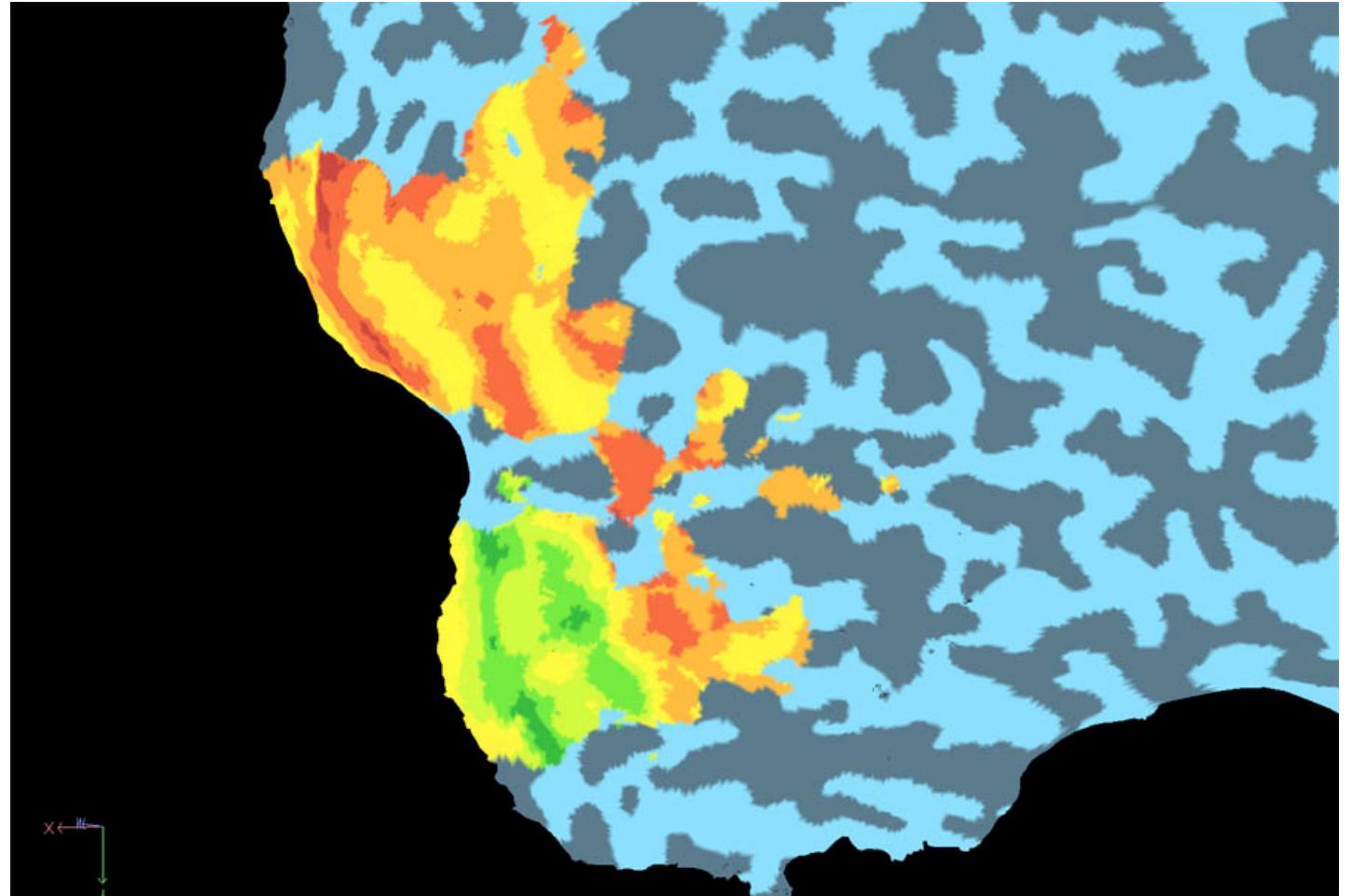
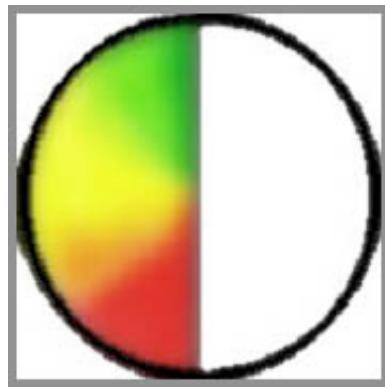
Lag 12
seconds



Lag 14
seconds

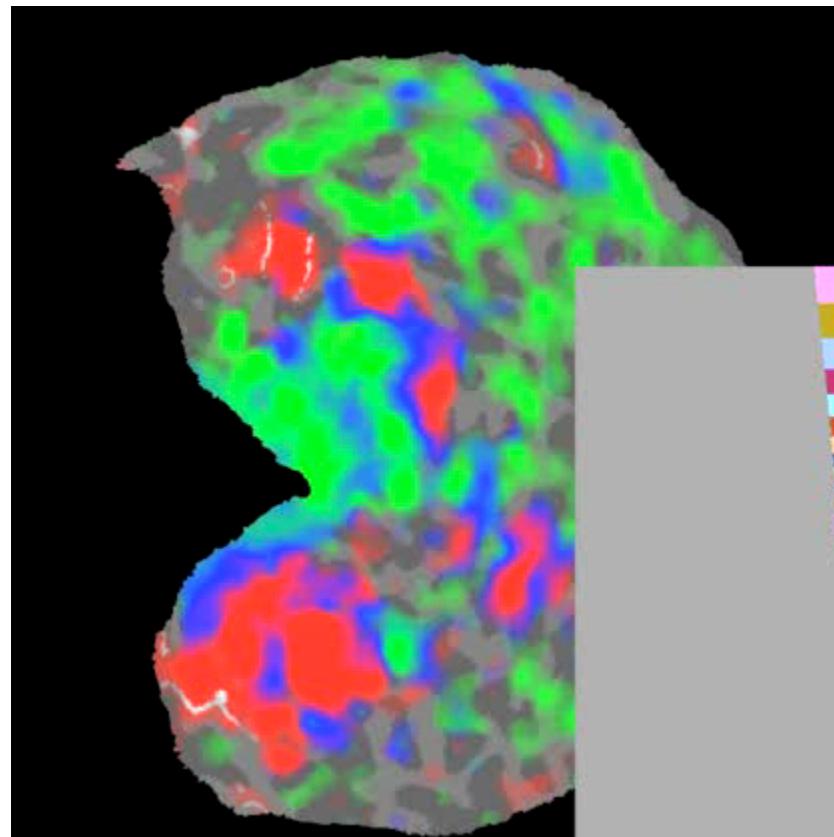


Lags combined



Put together all 16 seconds and this is what you get – a complete mapping of polar angle on the flattened brain

Polar angle movie

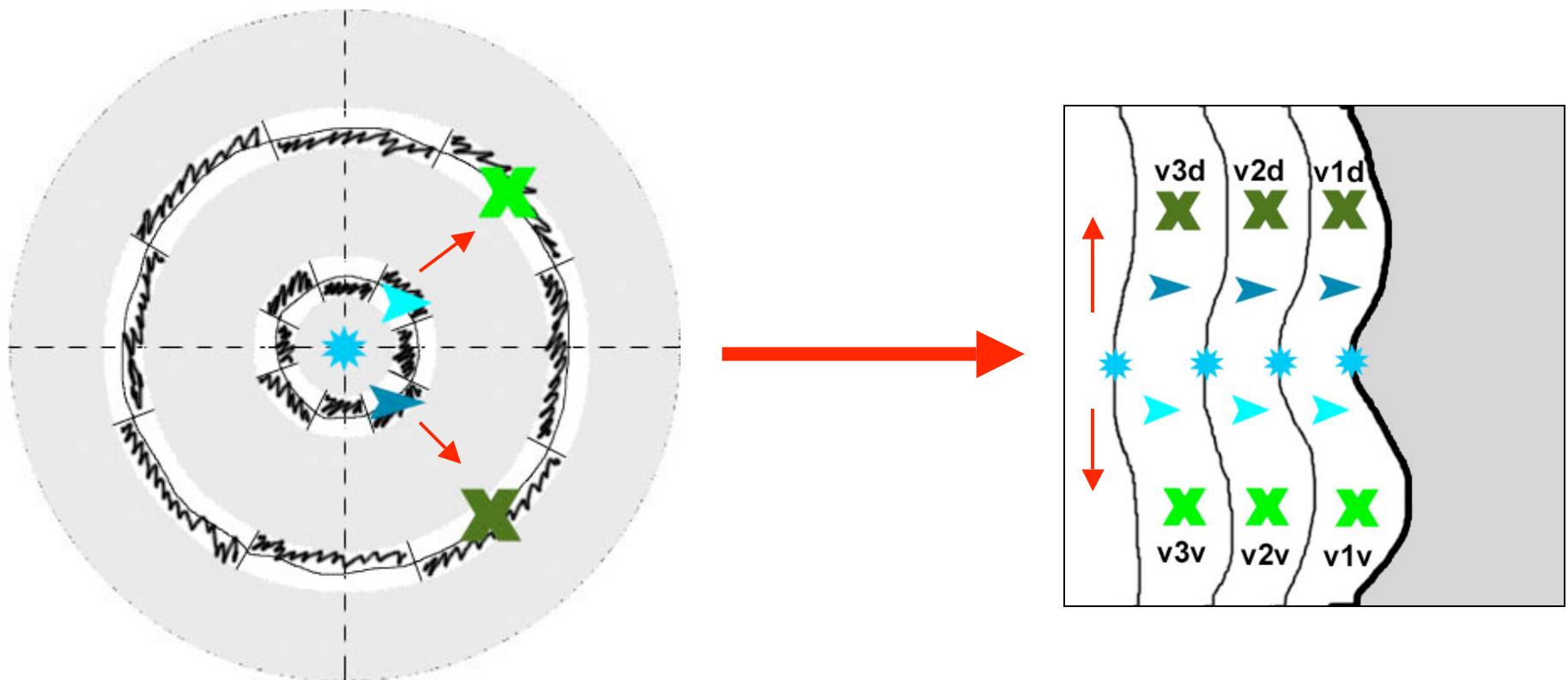


RH (LVF stimulation)

Sereno, MI (<http://cogsci.ucsd.edu/~sereno/>)

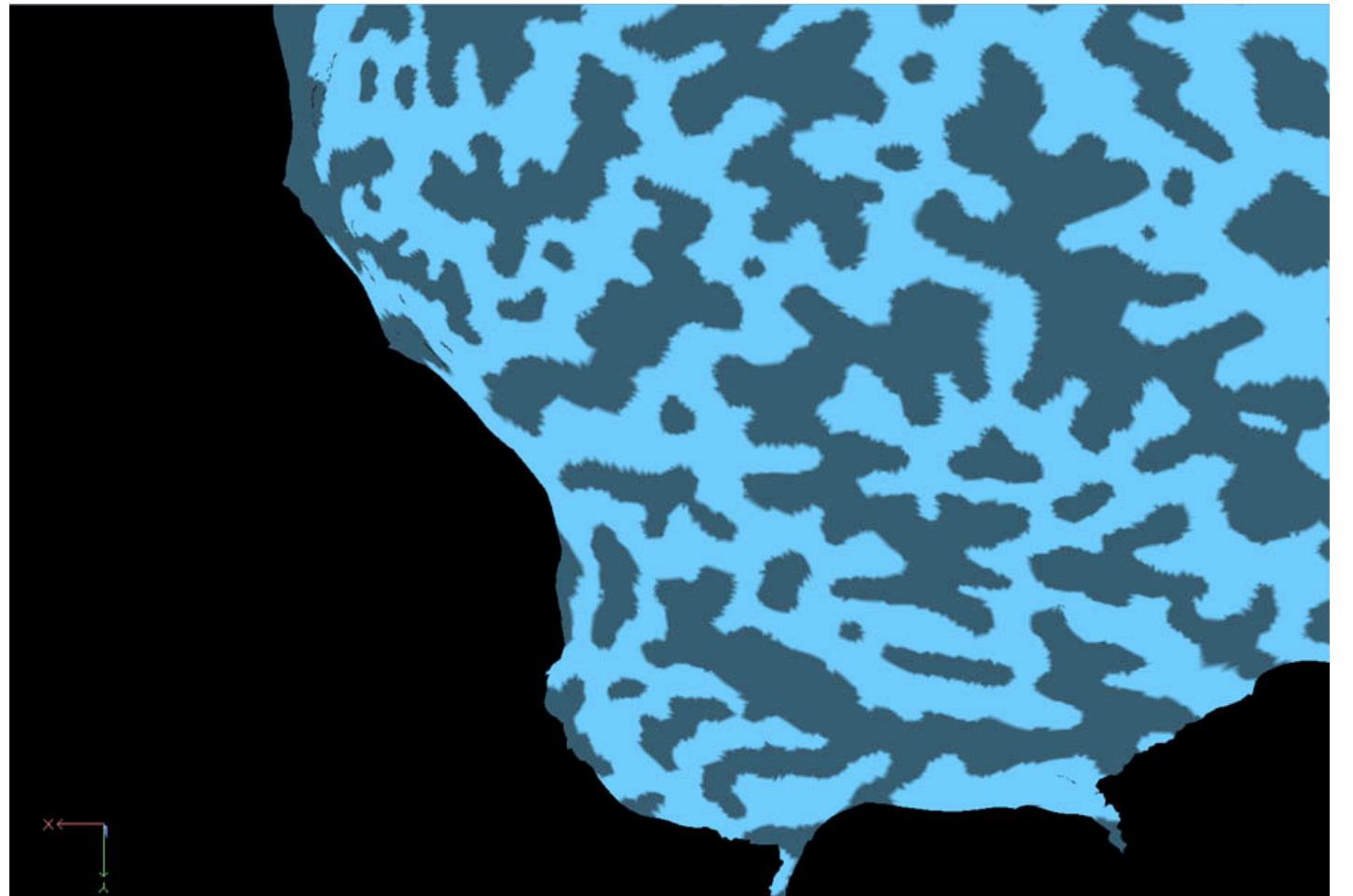
Explanation of eccentricity maps

As the ring expands from the center, corresponding regions in cortex are activated.

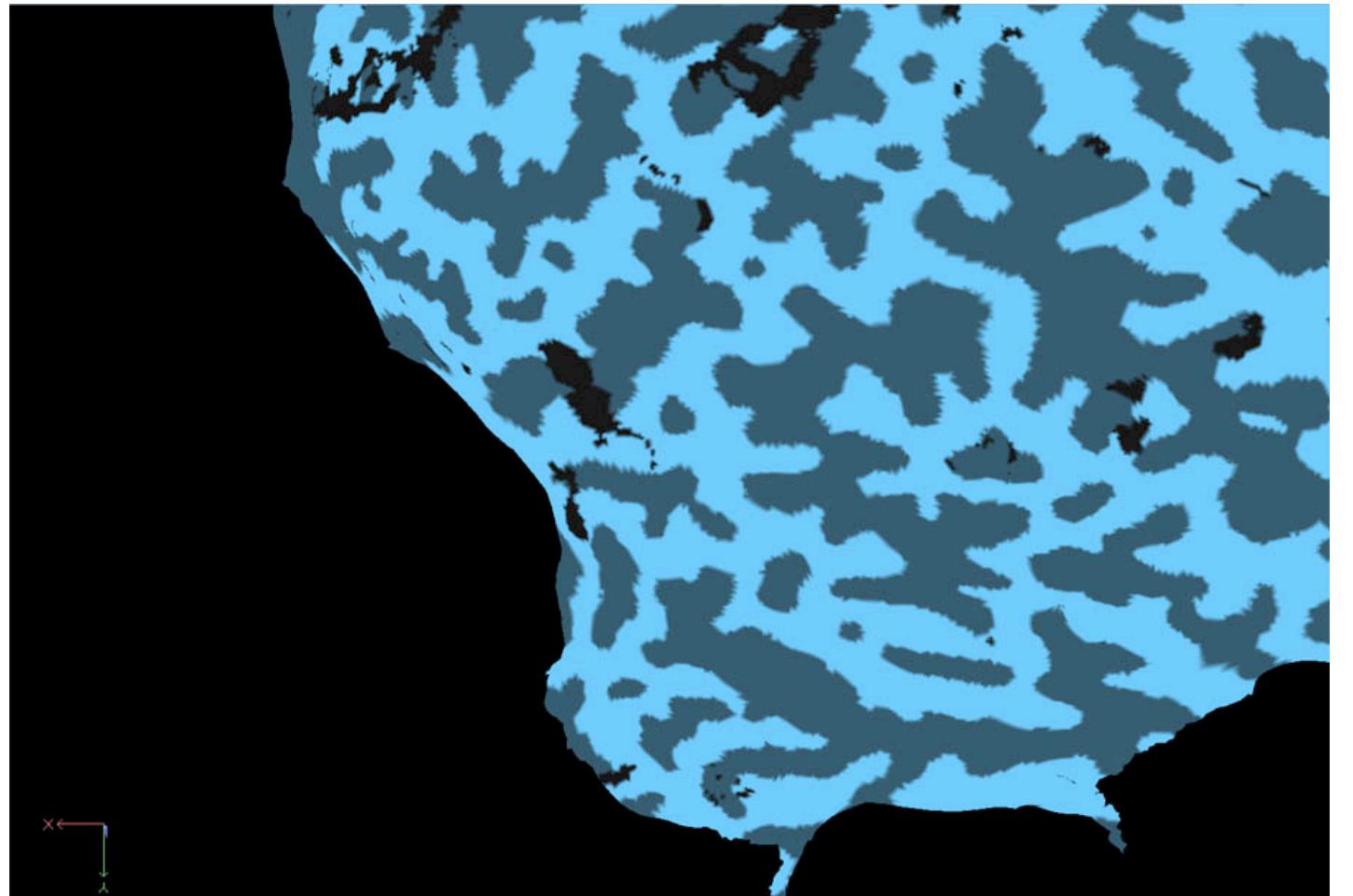


Left flattened hemisphere

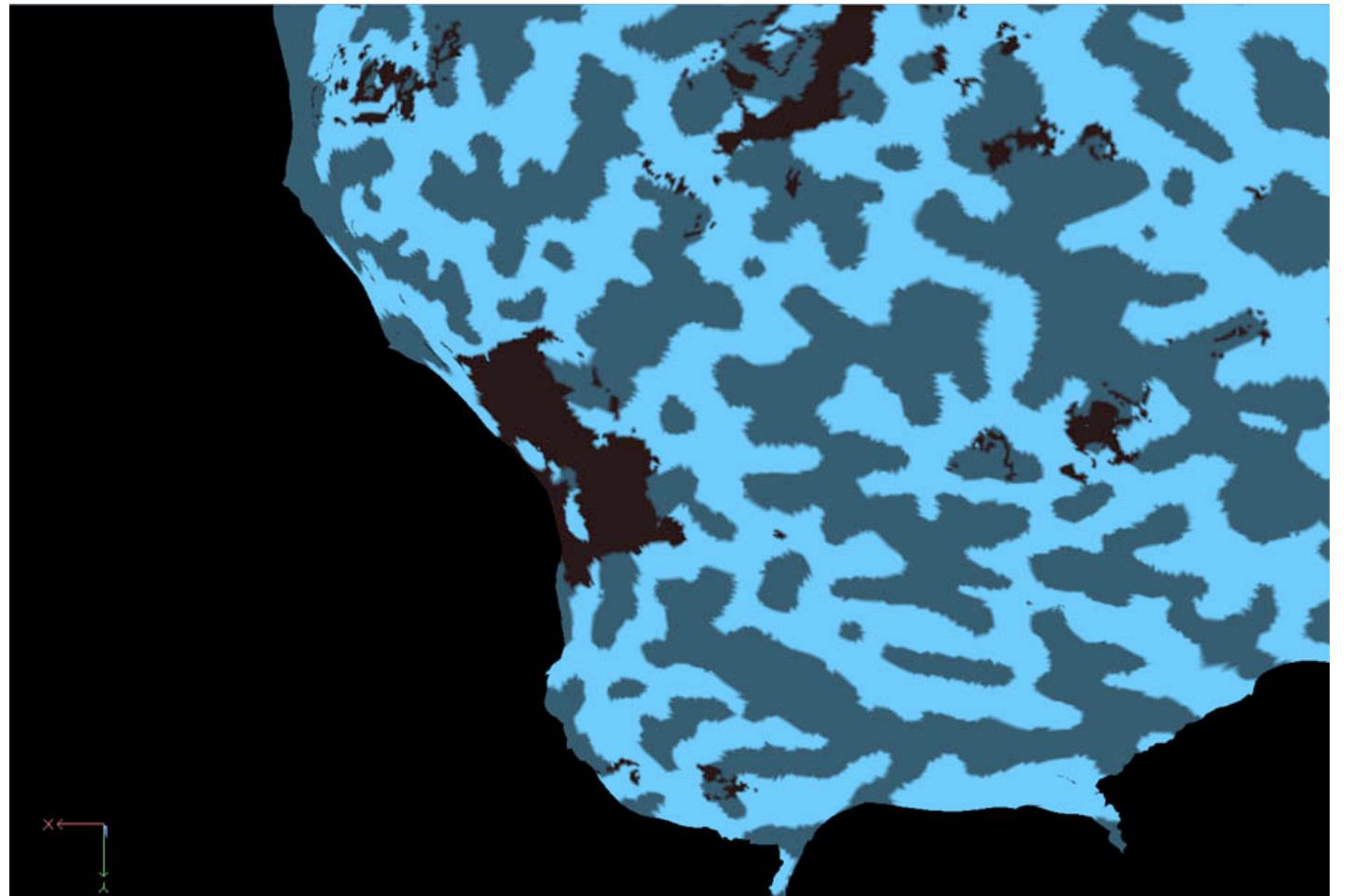
Right visual field stimulation



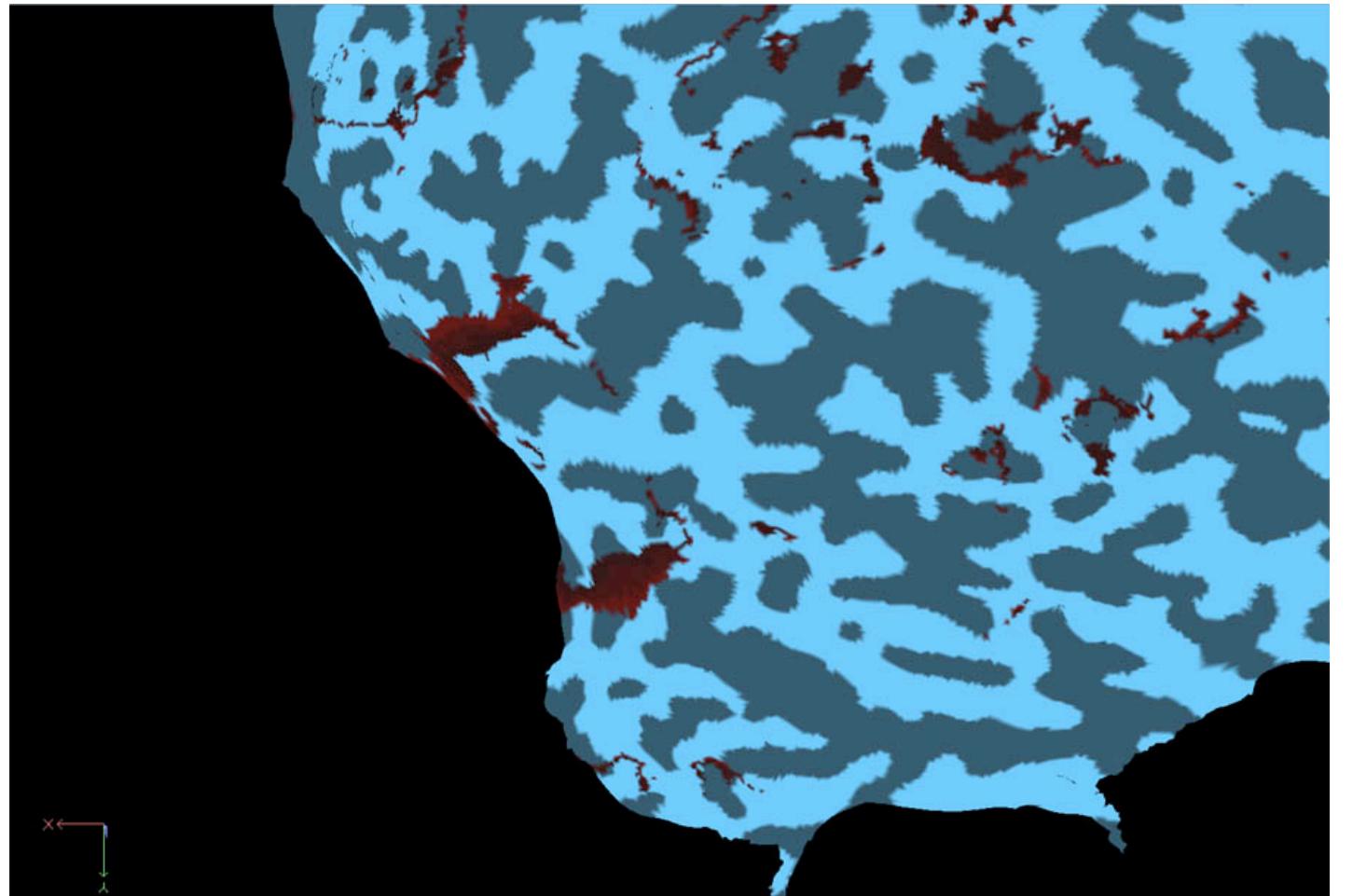
RH Flatmap



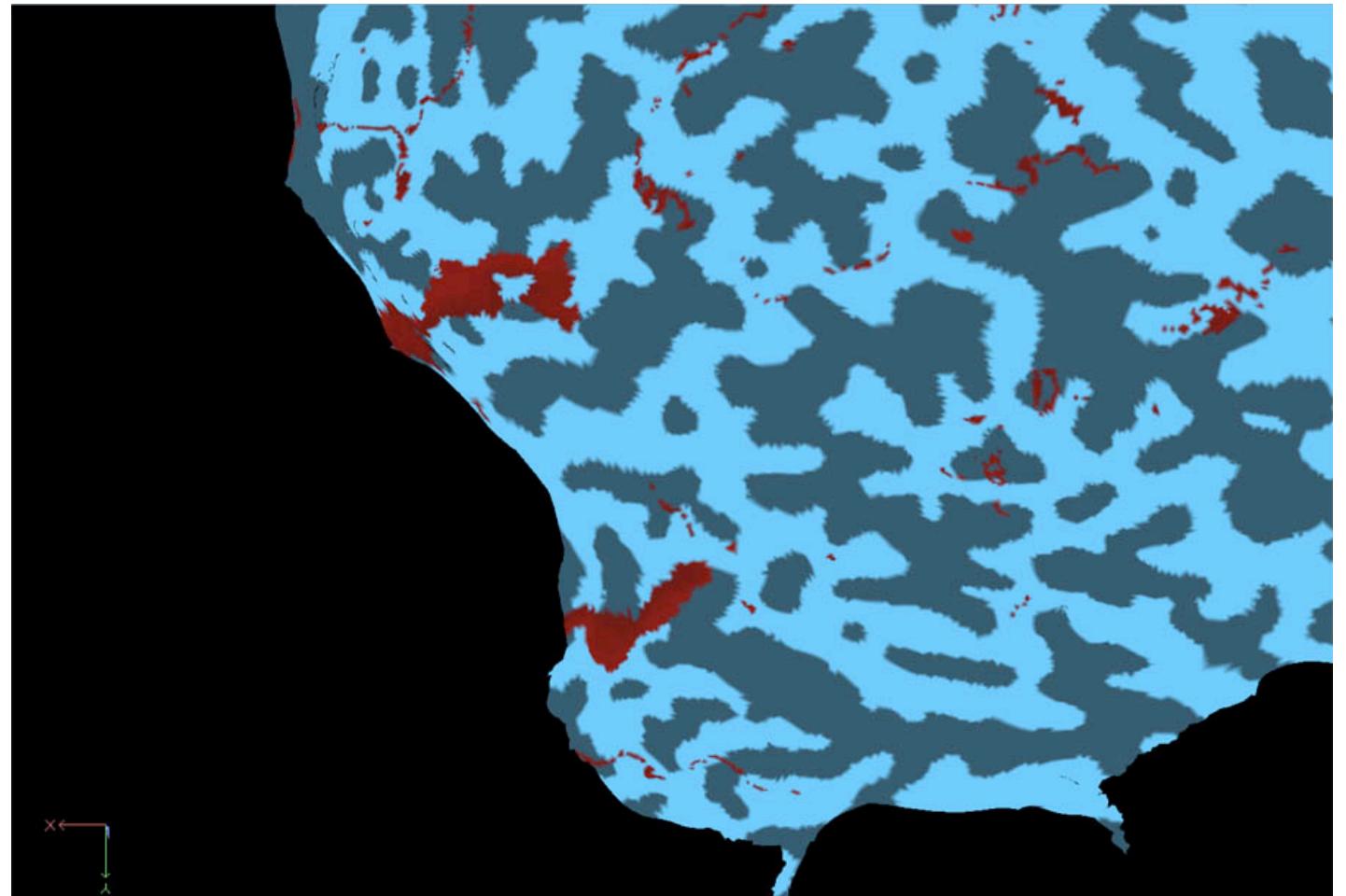
Lag 0 seconds



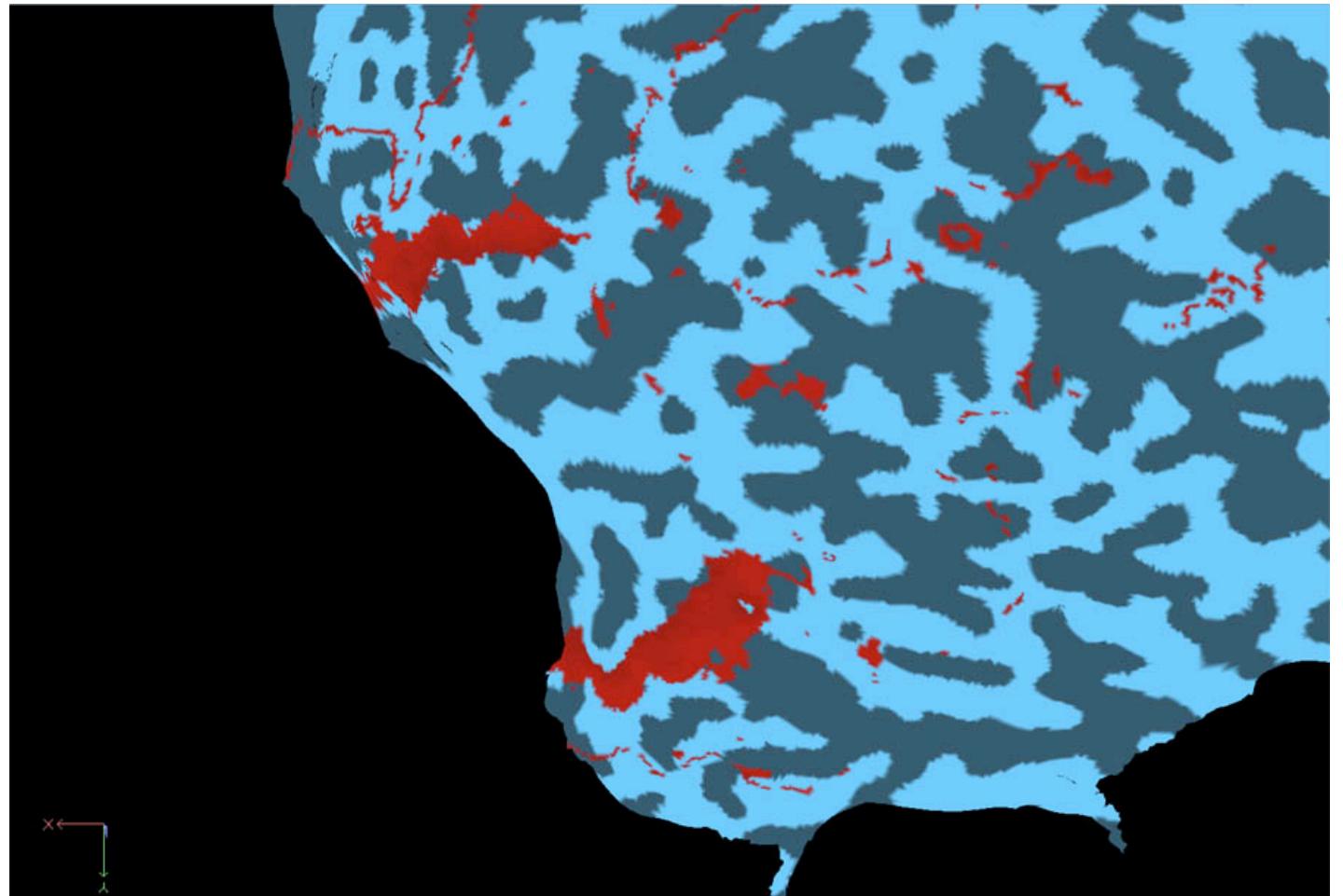
Lag 2 seconds



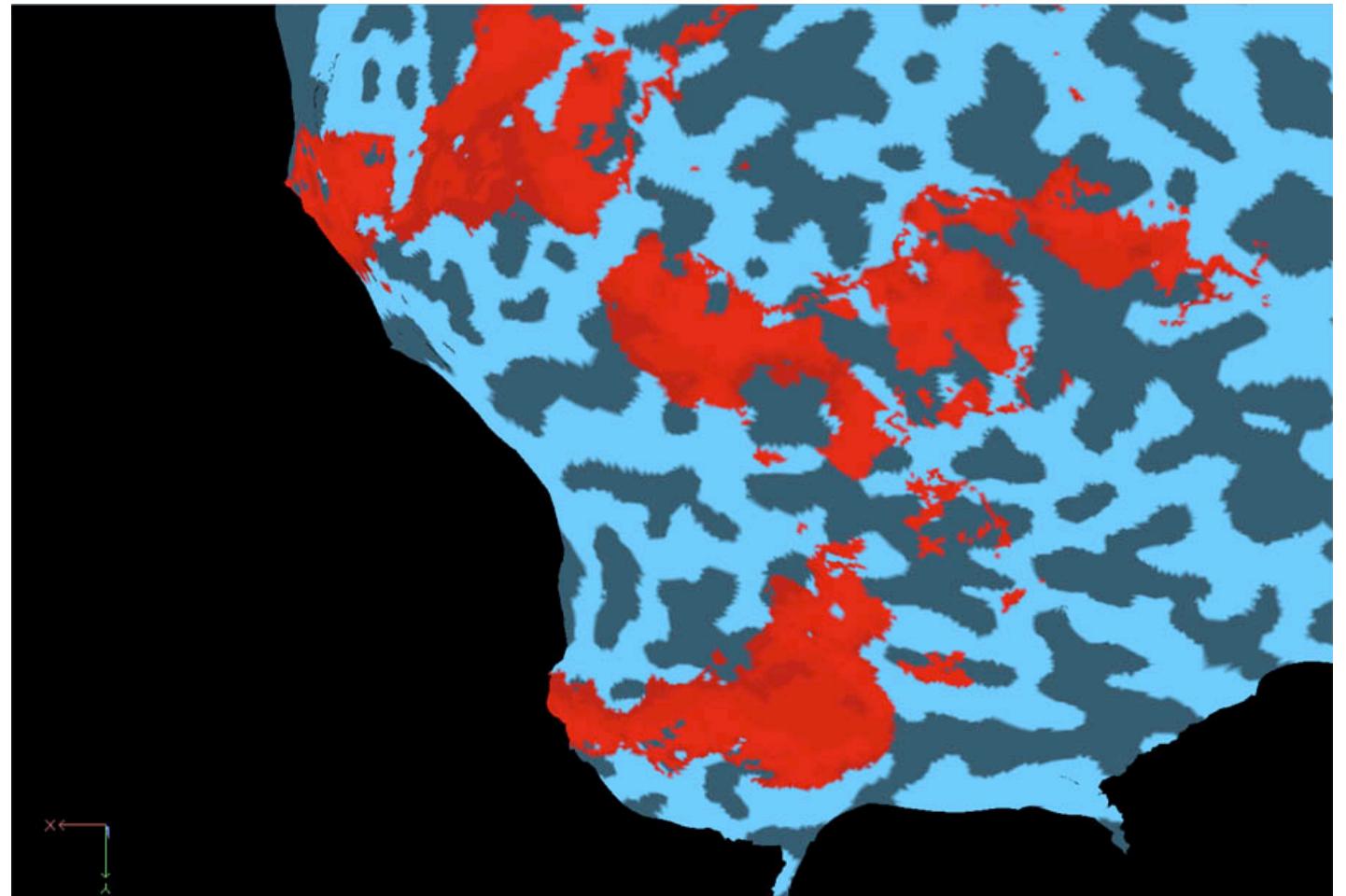
Lag 4-8 seconds



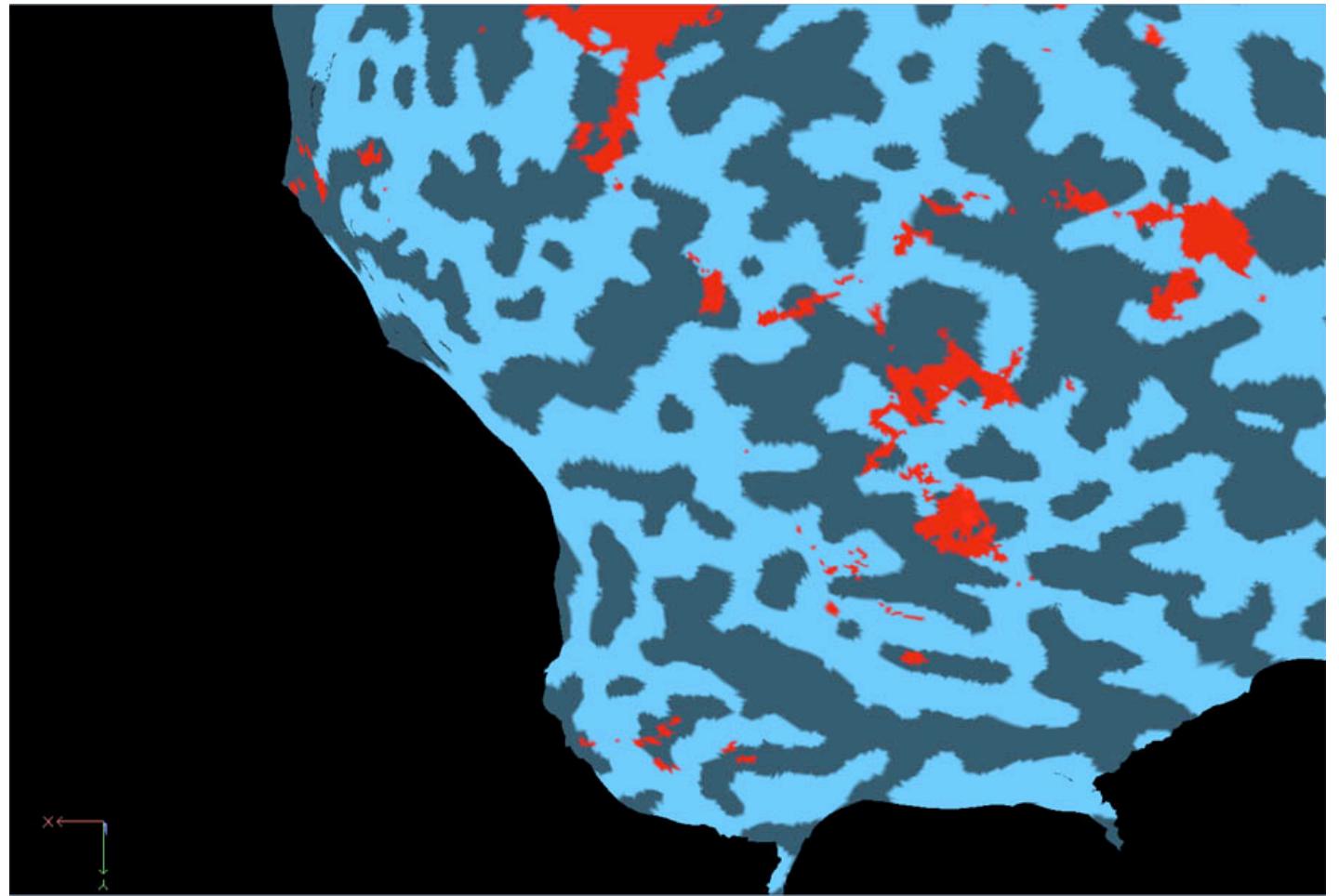
Lag 10-14 seconds



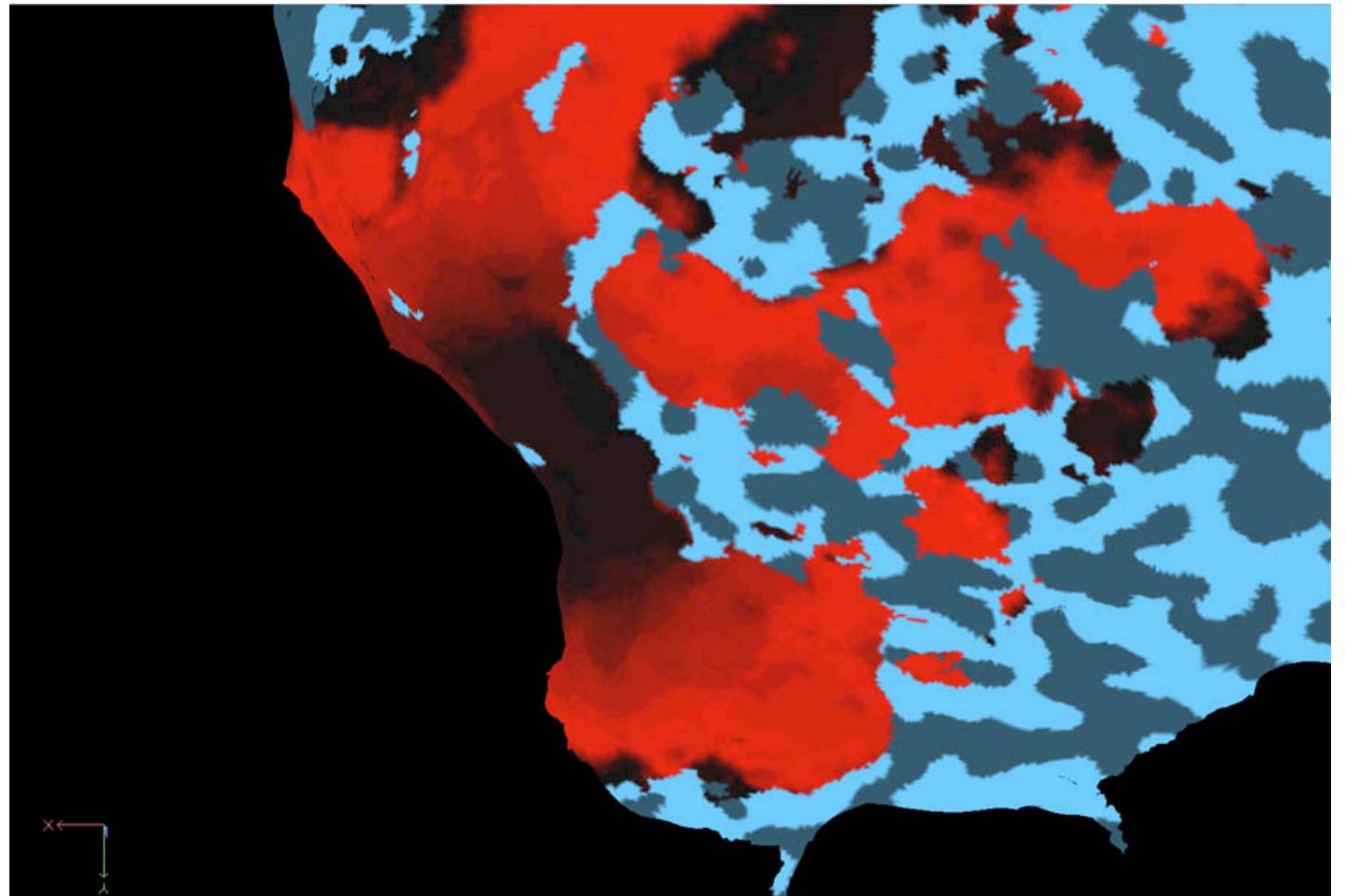
Lag 16-20 seconds



Lag 22-26 seconds

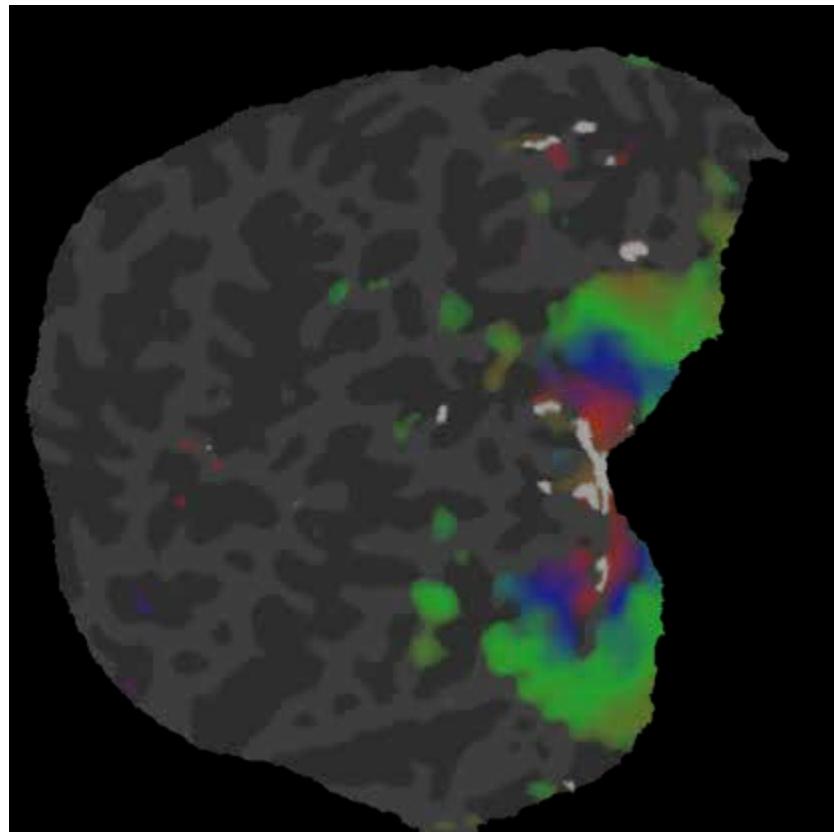


Lag 28-32 seconds



Lags combined

Eccentricity movie



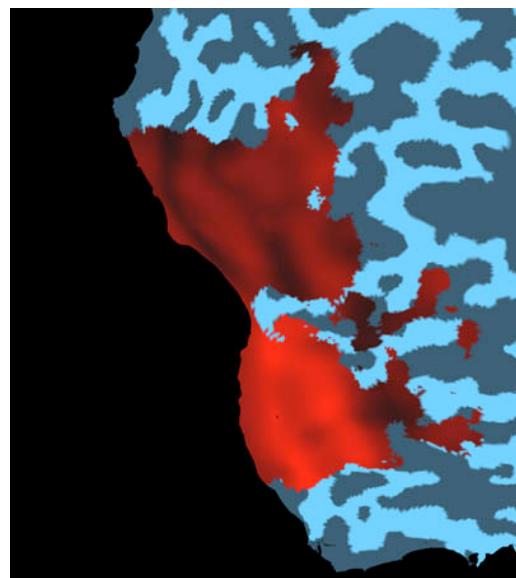
LH

Sereno, MI (<http://cogsci.ucsd.edu/~sereno/>)

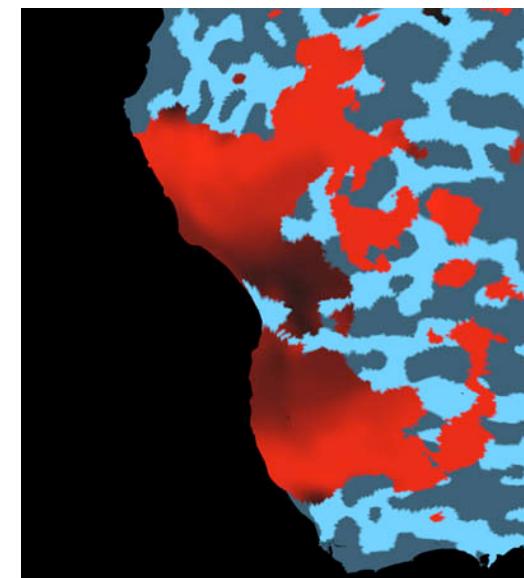
What is a field-sign map?

- It is a map of the points of reversal in polar angle, where boundaries are drawn at 90° meridians.
- It uses the gradient changes of both polar maps and eccentricity maps to decide where to draw the lines.

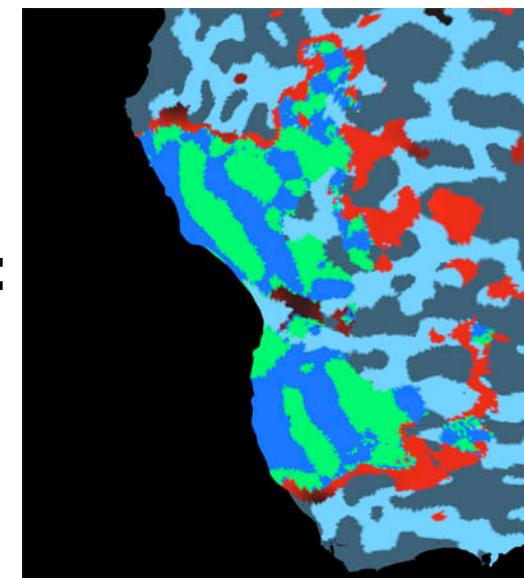
Making field-sign maps



Polar angle



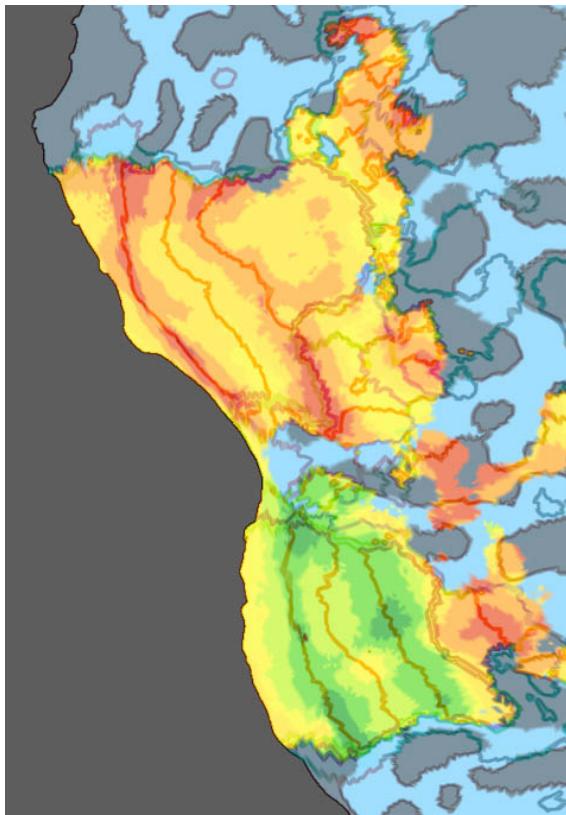
Eccentricity



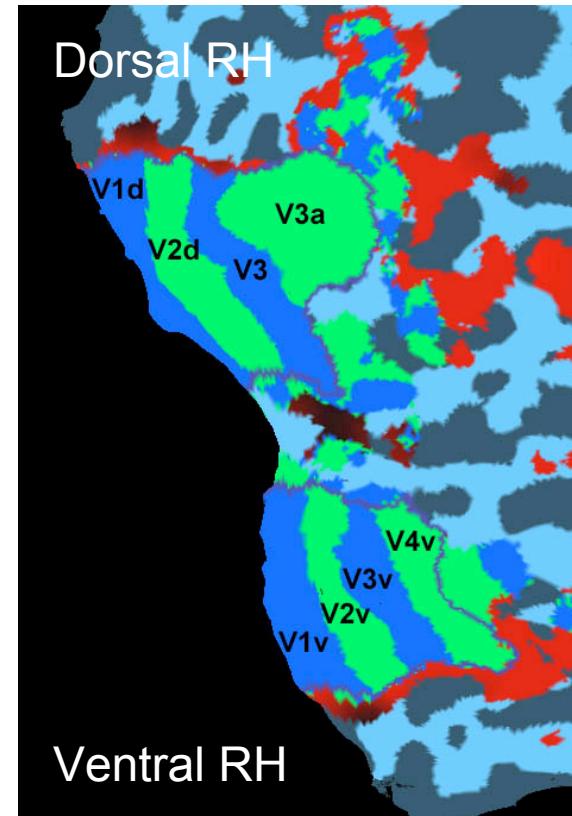
Raw field-sign map

Field-Sign Maps

- We then clean up these maps and delineate boundaries between regions.



Raw fsm overlaid on polar map in Photoshop



Finished fsm in BV

Part 2: Retinotopic Flat-mapping with Brain Voyager QX

John will cover:

- using VTCs to compute linear correlation maps of polar angle and eccentricity functional data
- inhomogeneity correction on anatomical data
- gray-white matter segmentation
- cortical inflation, cutting and flattening
- field-sign mapping
- creating ROIs

Questions?

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