Visual white matter

Automated method for Whi(te) M(atter) S(egmentation) of the V(isual) System: WhiMS-V

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Perceiving the visual world

Vision helps us navigate our complex world

Bonnen et al (*Nature Scientific Reports, 2021*)

Perceiving the visual world

Vision helps us navigate our complex world

What part of the visual field are we better at "seeing"?

Do the properties of the visual system subserve our ability to see a specific location?

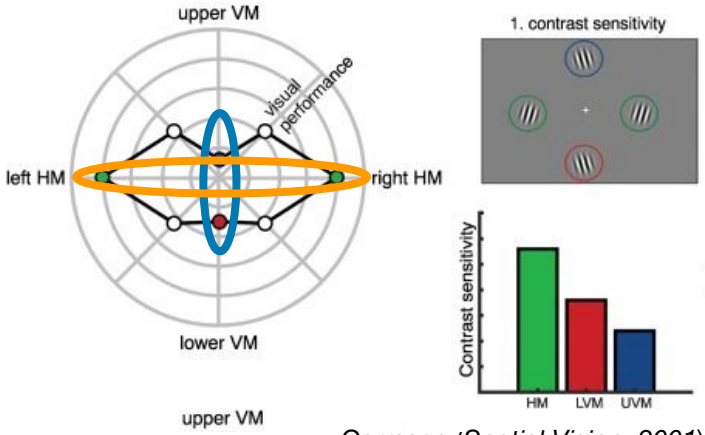
Do we get better with age or experience? Training? Does injury or disease make us worse?

Bonnen et al (*Nature Scientific Reports, 2021*)

Asymmetries in our vision

Visual system is not uniform

Dr. Carrasco



Carrasco (*Spatial Vision, 2001*)

Asymmetries in...

1. **Visual Behavior**
   a. Contrast sensitivity (Carrasco 2001)
2. **Retinal Structure**
   a. Cone density (Mustafi, 2009)
3. **Cortical morphometry**
   a. V1 surface area (Himmelberg et al, 2022)
4. ***White matter connectivity?***

Horizontal - Vertical Asymmetry (HVA)

- Performance better along horizontal meridian than vertical meridians

Vertical Meridian Asymmetry (VMA)

- Performance better along lower vertical meridian than upper vertical meridian

Lack of FAIR, automated tools for visual white matter investigations

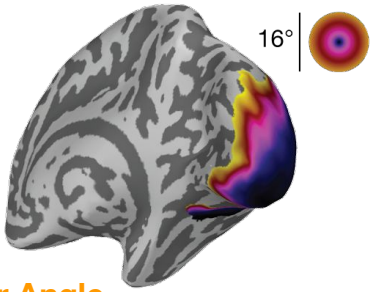
Himmelberg, Winawer, & Carrasco (*Trends in Neuroscience, 2023*)

WhiMS-V

pRF & visual area mapping / segmentation

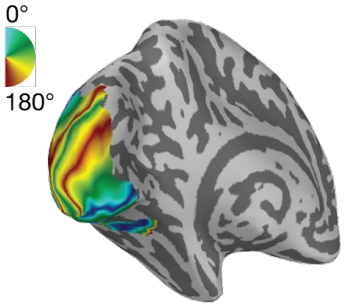
Eccentricity

Distance away from center of visual field

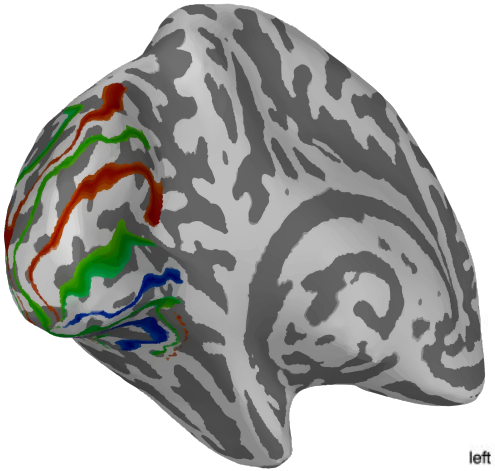


Polar Angle

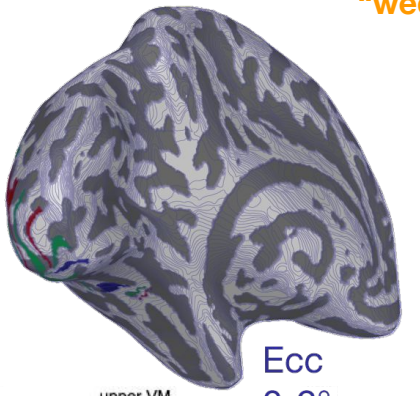
Quadrant of visual field



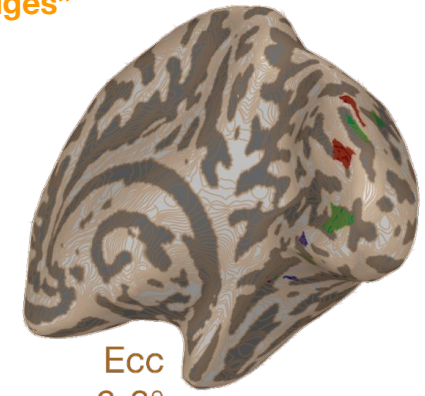
Polar Angle Meridians



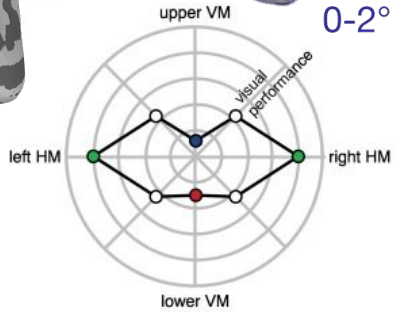
Polar Angle Meridian x Eccentricity "wedges"



Ecc 0-2°



Ecc 6-8°



Horizontal Meridian: 90°
Upper Vertical Meridian: 0°
Lower Vertical Meridian: 180°

+/- 15° "wedges"

Caron et al (*in prep*)

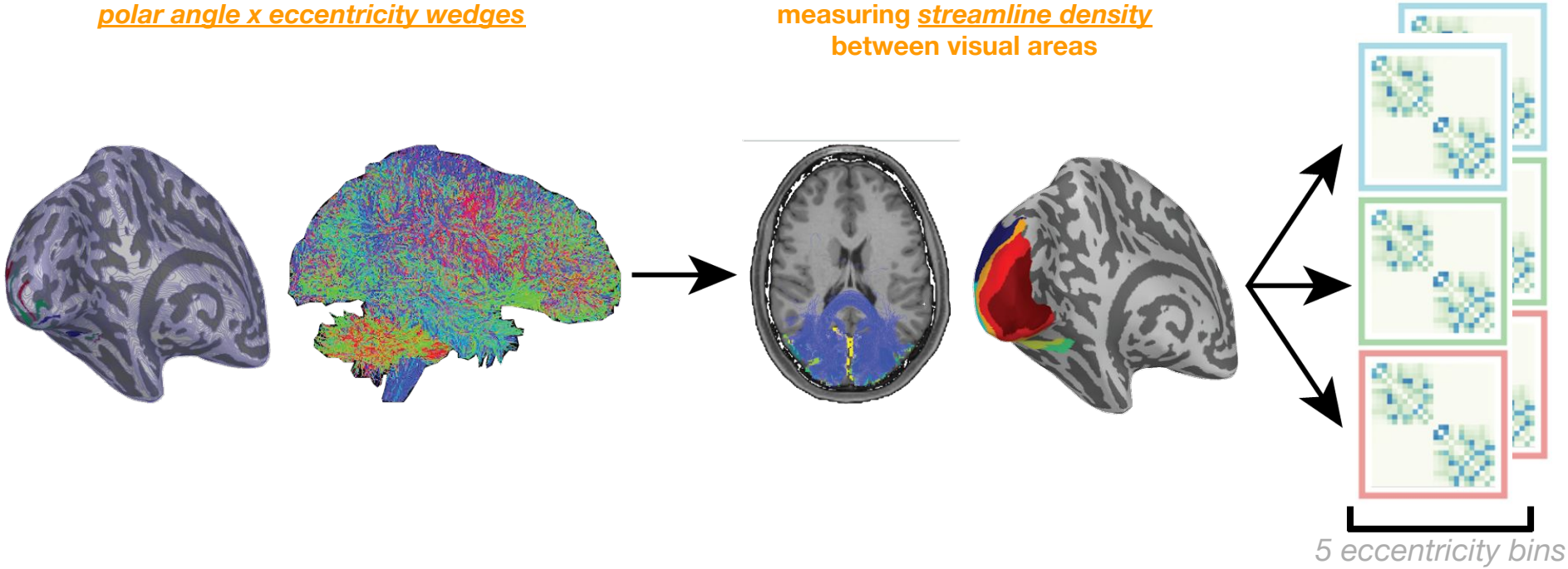
WhiMS-V

Connectivity estimations

Segment streamlines into *polar angle x eccentricity wedges*

Estimate white matter connectivity by measuring *streamline density* between visual areas

Network generation



Caron et al (*in prep*)

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WhiMS-V

HVA & VMA exists in white matter connectivity

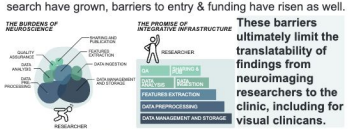
Poster

Slides

Dr. Pestilli

Introduction

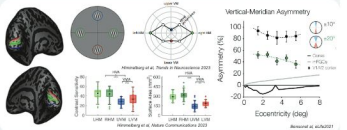
Neuroscience research has expanded dramatically over the past 30 years by advancing standardization & tool development to support rigor & transparency [1]. Consequently, the complexity of the data pipeline for nueroimaging has also increased. As the resources necessary to participate fully in modern neuroscience research have grown, barriers to entry & funding have risen as well.



These barriers ultimately limit the translatability of findings from neuroimaging researchers to the clinic, including for visual clinicans.

Currently there exists a plethora of tools for segmenting cortical and subcortical structure and estimating structural properties of the visual brain[2], and functional mapping measures of visual field properties (i.e. eccentricity, polar angle) via population receptive field mapping (pRF)[3,4,5]. From this work a great deal has been learned regarding the structural and functional properties of the visual brain, and their relation to visual behavior and retinal structure[6]. Although a link between retinal, behavior, and visual white matter (VWM) integrity has been established[7], little is known regarding the connectivity patterns of the visual field.

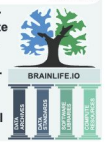
This lack of knowledge is directly related to the lack of FAIR and automated tools available for VWM segmentation.



Here we present a curation of automated tools for segmenting the visual white matter by properties of the visual field.

WhiMS-V

This tool is available via the cloud platform *brainlife.io*[8]. The goal of this work is to reduce the barriers of entry to investigating properties of the visual white matter.

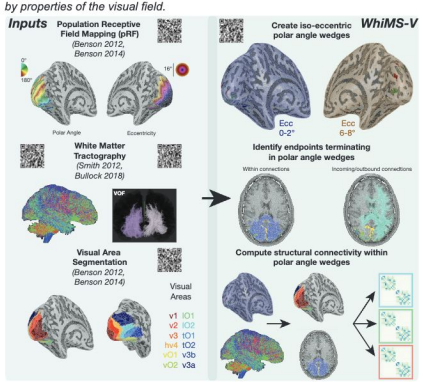


Methods

~1800 participants from three different data cohorts were processed through WhiMS-V. Two specific experiments were performed: 1) attempted identification of horizontal vertical, and vertical meridian asymmetries (HVA, VMA)[9] in visual white matter connectivity, and 2) estimation of connectivity patterns of the vertical occipital fasciulus (VOF).

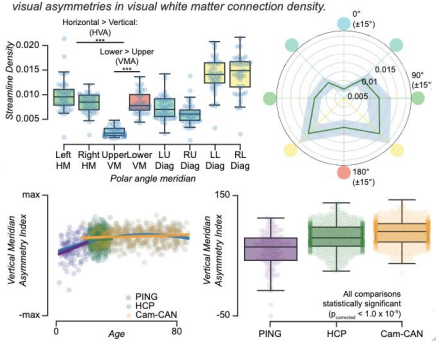
Visual White Matter Segmentation (WhiMS-V)

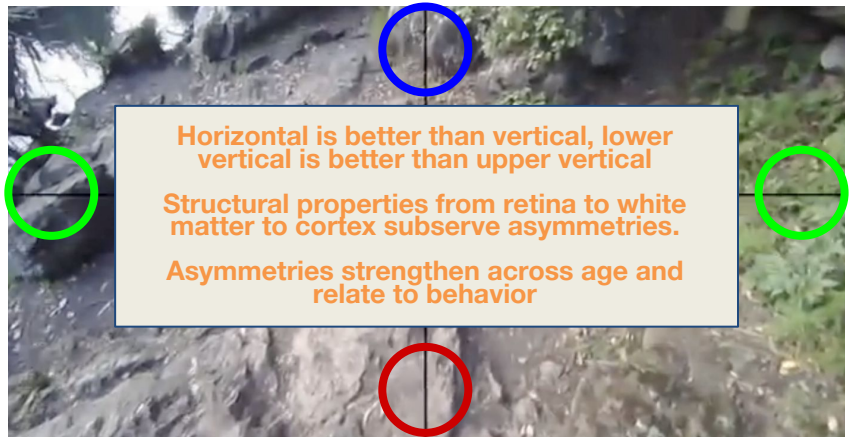
A multi-step process is involved to simulate the visual white matter and segment by properties of the visual field.



Succesful identification of HVA-VMA

Tool shows scientific utility via successful identification & extension of known visual asymmetries in visual white matter connection density.





App

brainlife

Tools available on *brainlife.io*

Caron et al (*in prep*)

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Thank you!

https://pestillilab.github.io/team
https://brainlife.io

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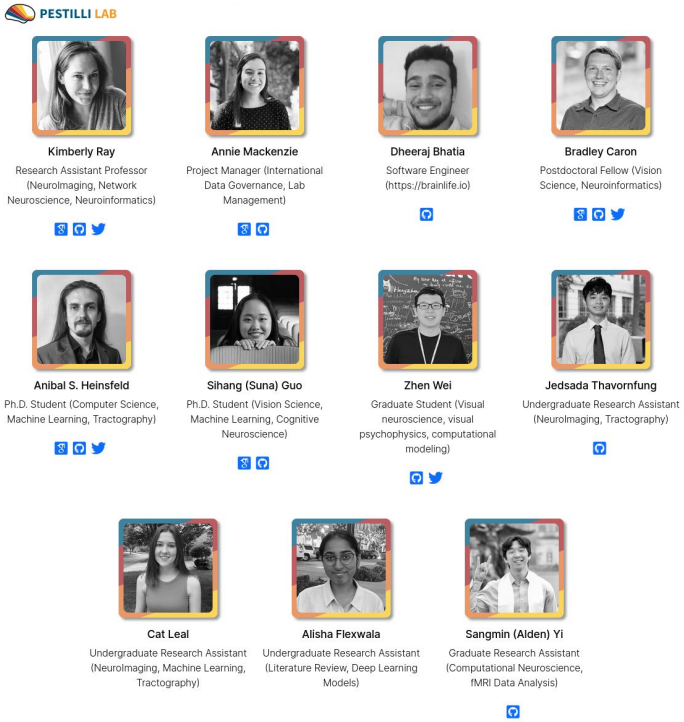

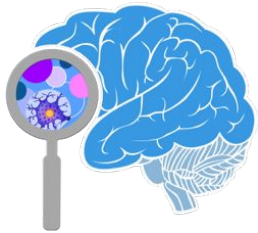

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