

## Visual Cortex is Active in Blind Areas of the Visual Field in Stroke Patients

Colleen Schneider

EWCN Prize

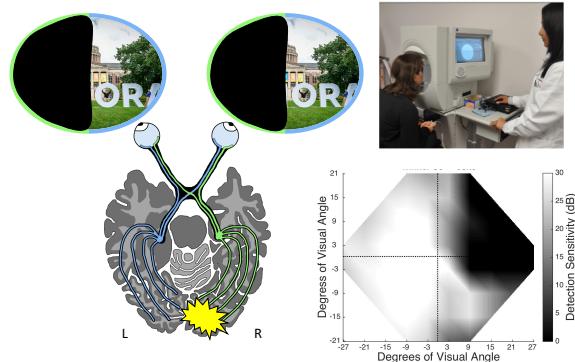
January 27, 2020



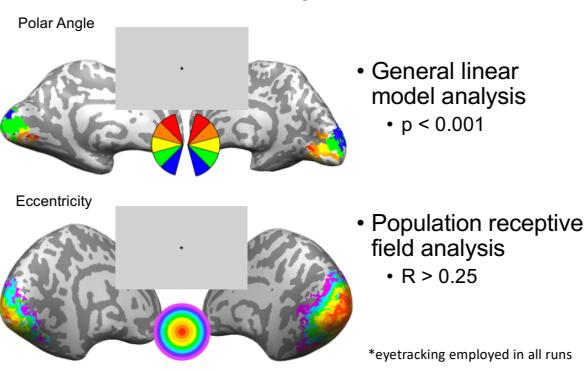
Carnegie  
Mellon  
University

Co-authors: Emily K. Prentiss, Ania Busza, Kelly Matmati, Nabil Matmati, Zoë R. Williams, Bogachan Sahin, Bradford Z. Mahon

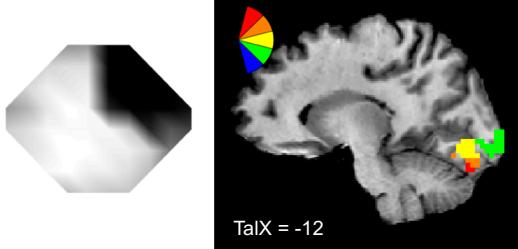
### Cortical Blindness



### Retinotopic Mapping



## Visual cortex activity in the blind field



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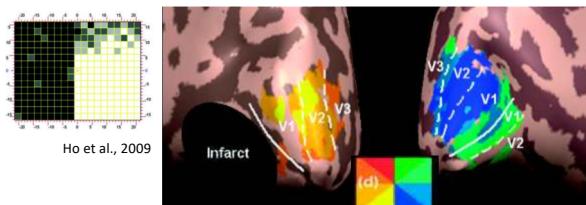
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## Visual cortex activity in the blind field



- Baseler et al., 1999
  - Kleiser et al., 2001
  - Morland et al., 2004
  - Papanikolaou et al., 2014
  - Radoeva et al., 2008
  - Raemaekers et al., 2011
  - Raposo et al., 2011

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## Research Questions

- Is visual cortex activity in the blind field due to:
    - Perceptual filling in (top down predictions)?
    - Neurovascular abnormalities in stroke patients?
    - Analytic approach?
    - Disconnection of V1 from higher order visual areas?
    - Degraded vision that isn't fully blind?

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## Research Participants

- 13 chronic stroke patients (> 6 months)
  - Cross-sectional subset of longitudinal study
- Homonymous visual field deficit caused by the stroke
- 24-2 Humphrey Perimetry
- Retinotopic mapping with fMRI

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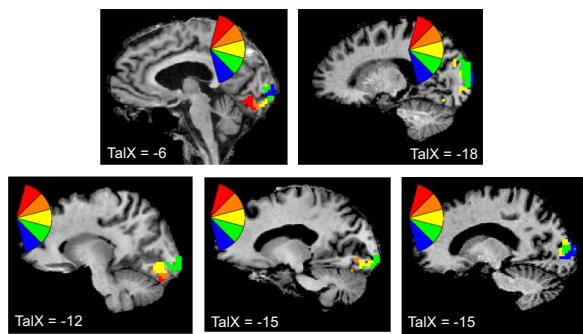
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## Visual cortex activity in the blind field



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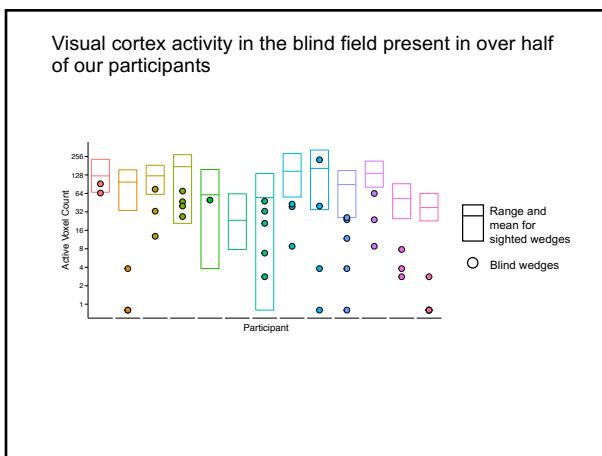
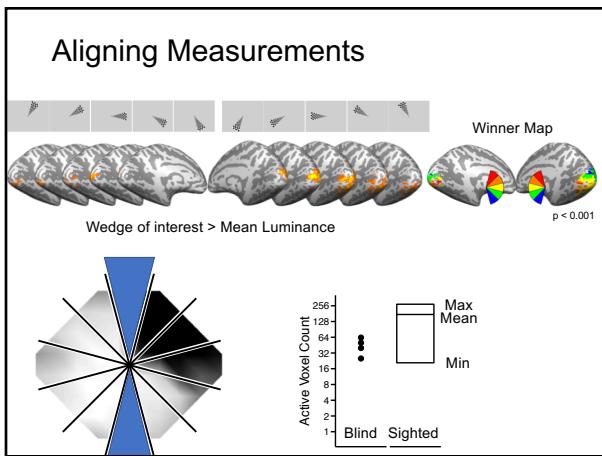
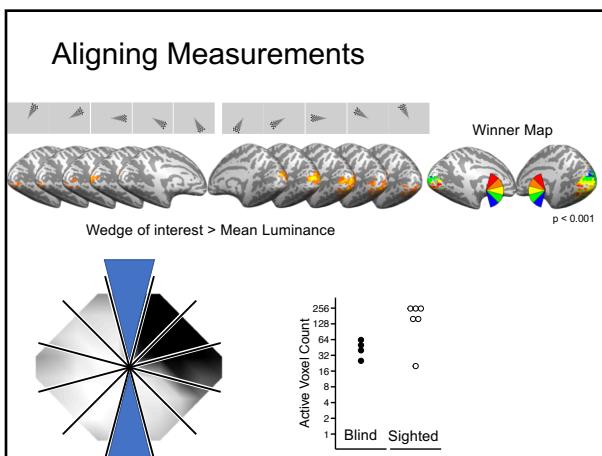
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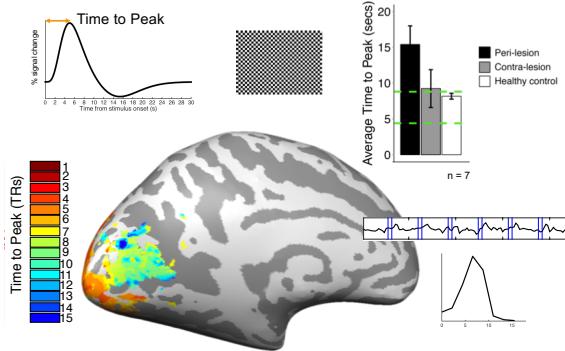
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Hemodynamics are altered near the stroke lesion



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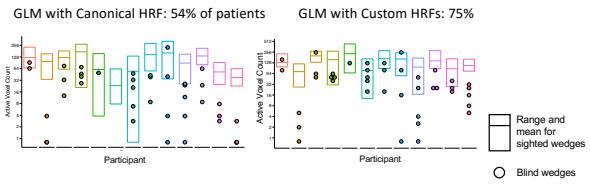
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Visual cortex activity in the blind field present in over half of our participants



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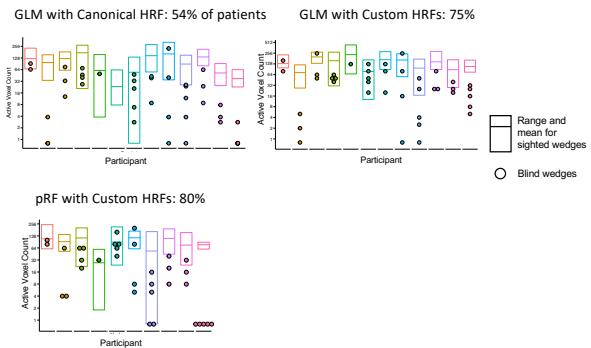
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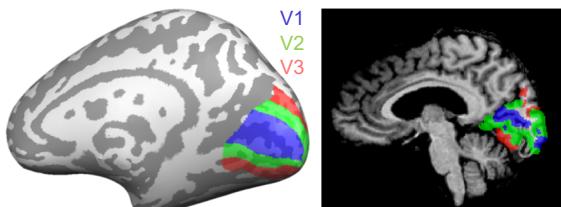
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Are 'blind voxels' still present when analysis restricted to V1?



Atlas from Benson et al. 2012

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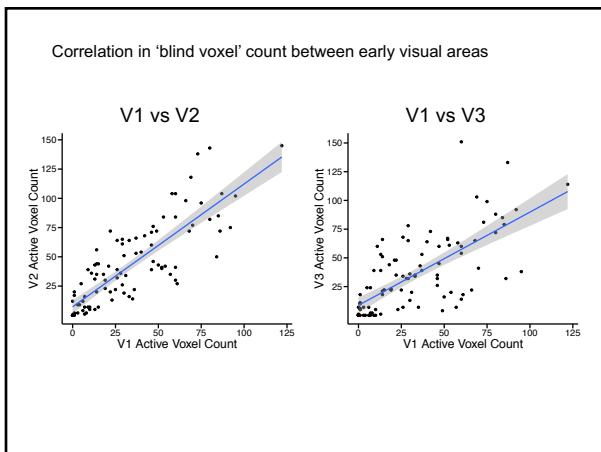
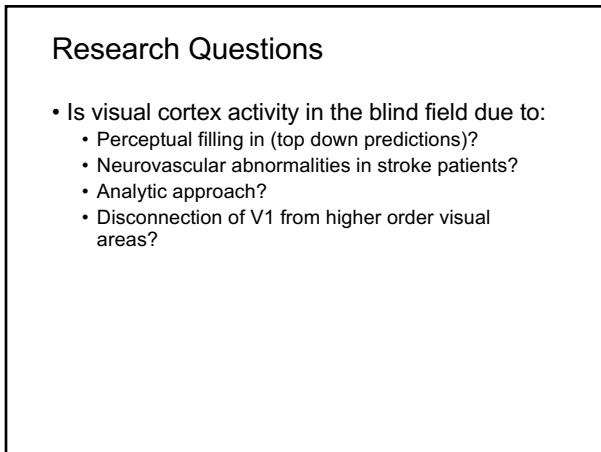
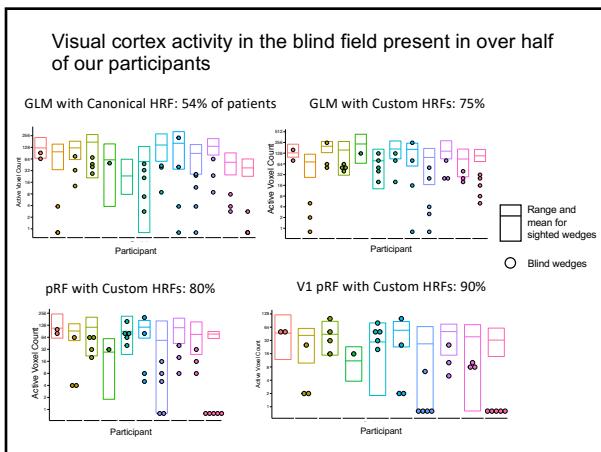
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## Research Questions

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  - Disconnection of V1 from higher order visual areas?
  - Degraded vision that isn't fully blind?

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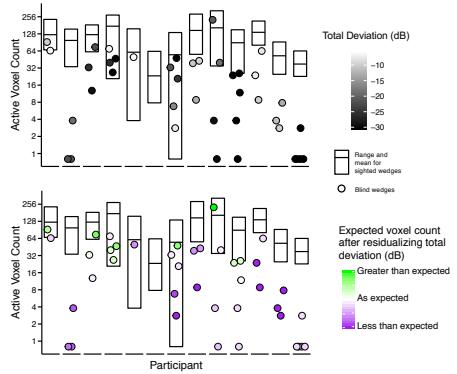
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## Are 'blind voxels' actually just 'degraded sight voxels' ?



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## Research Questions

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  - Neurovascular abnormalities in stroke patients?
  - Analytic approach?
  - Disconnection of V1 from higher order visual areas?
  - Degraded vision that isn't fully blind?
- What are the functional implications of visual cortex activity in the blind field?
  - Impact on post-stroke retinal ganglion cell degeneration

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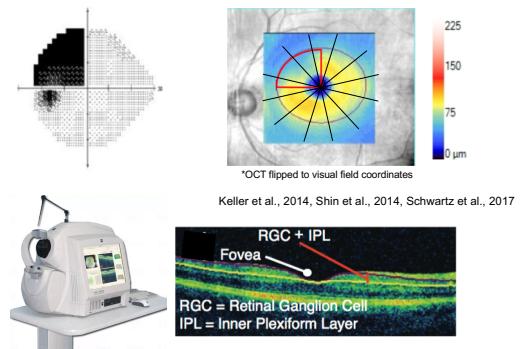
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#### Functional implications: preventing RGC degeneration



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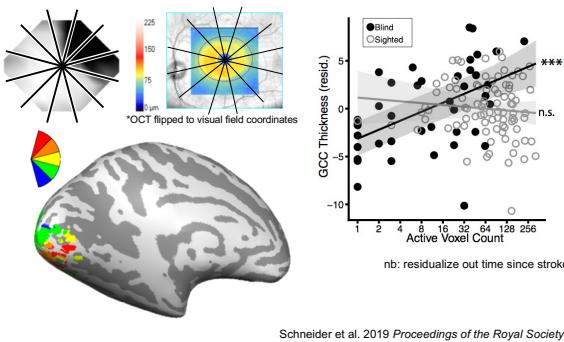
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#### Functional implications: preventing RGC degeneration



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    - Perceptual filling in (top down predictions)?
    - Neurovascular abnormalities in stroke patients?
    - Analytic approach?
    - Disconnection of V1 from higher order visual areas?
    - Degraded vision that isn't fully blind?
  - What are the functional implications of visual cortex activity driven by stimuli presented in blind areas of the visual field?
    - Impact on post-stroke retinal ganglion cell degeneration
    - Role in certain types of blindsight phenomena

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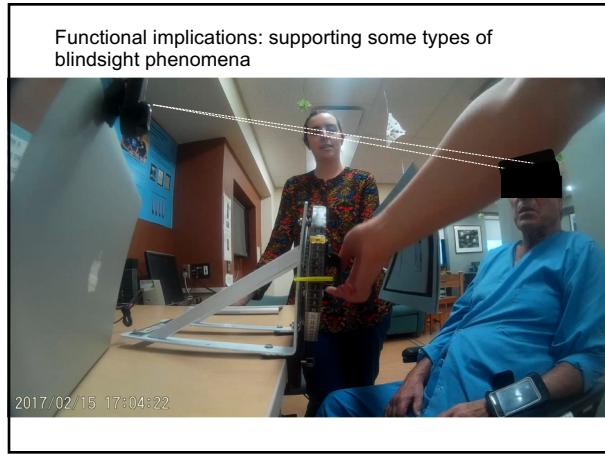
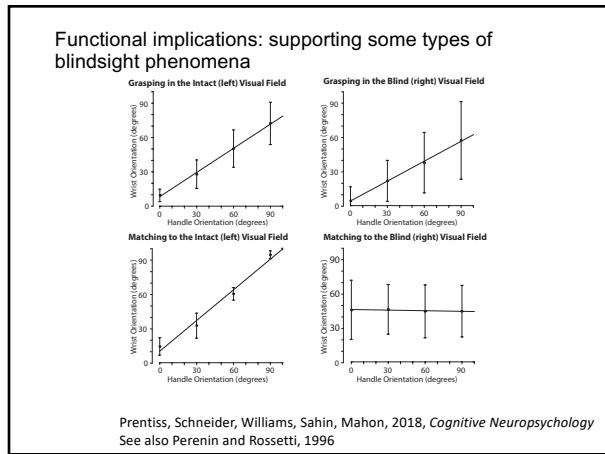
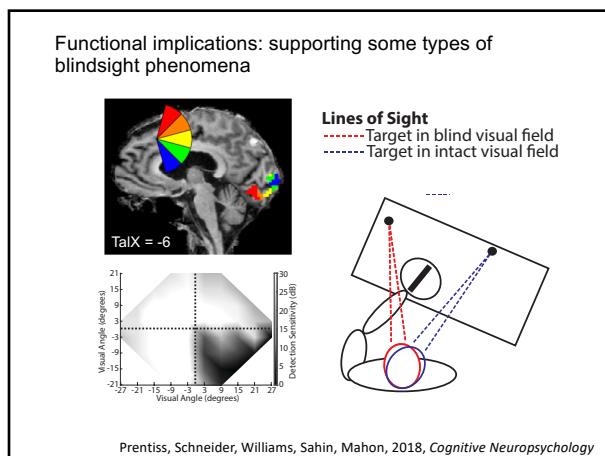
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## Discussion

- Dissociation between vision perception and visual cortex activity in many stroke patients
  - Not due to perceptual filling in, neurovascular abnormalities, analytic approach, disconnection to higher order visual areas, degraded vision
  - Why can't the patient see what V1 'sees'?
    - Disordered information content?
    - Does vision recover with learning a new read-out strategy?
- Functional implications of visual cortex activity in the blind field
  - Decreased retinal ganglion cell degeneration – bodes well for potential for vision recovery in the future
  - Blindsight phenomena?
    - Future direction: does variation among patients in visual cortex activity in the blind field relate to variation in blindsight abilities?

## Acknowledgements



Brad Mahon, PhD    Emily Prentiss, BS    Bogachan Sahin, MD PhD    Ania Busza, MD PhD    Zoe Williams, MD



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University of Rochester MSTP

CAOs Lab Members    Flauum Eye Institute Technicians  
MRI Technologists    UR Undergraduates

