

LECTURE 1-PART 2

Vision and Eye Movements

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Summary Part 1

- Humans use a variety of eye movements to align gaze with visual objects of interest: saccades shift gaze to stationary objects and pursuit helps us track moving objects; fixation is used to stabilize gaze
- Eye movements are critical for vision because the human fovea spans only 1 degree of the visual field
- Eye movements can be used in research and clinics to help us understand healthy and pathological brain mechanisms and aid in diagnosis and treatment of disorders
- We discussed applications in education (e.g., as training tools) and industry (e.g., design of user-controlled interfaces)

Muddiest points

- Microsaccades:

Why can't we perceive them?

Difference between saccades and microsaccades

What do the black dots in the demo mean?

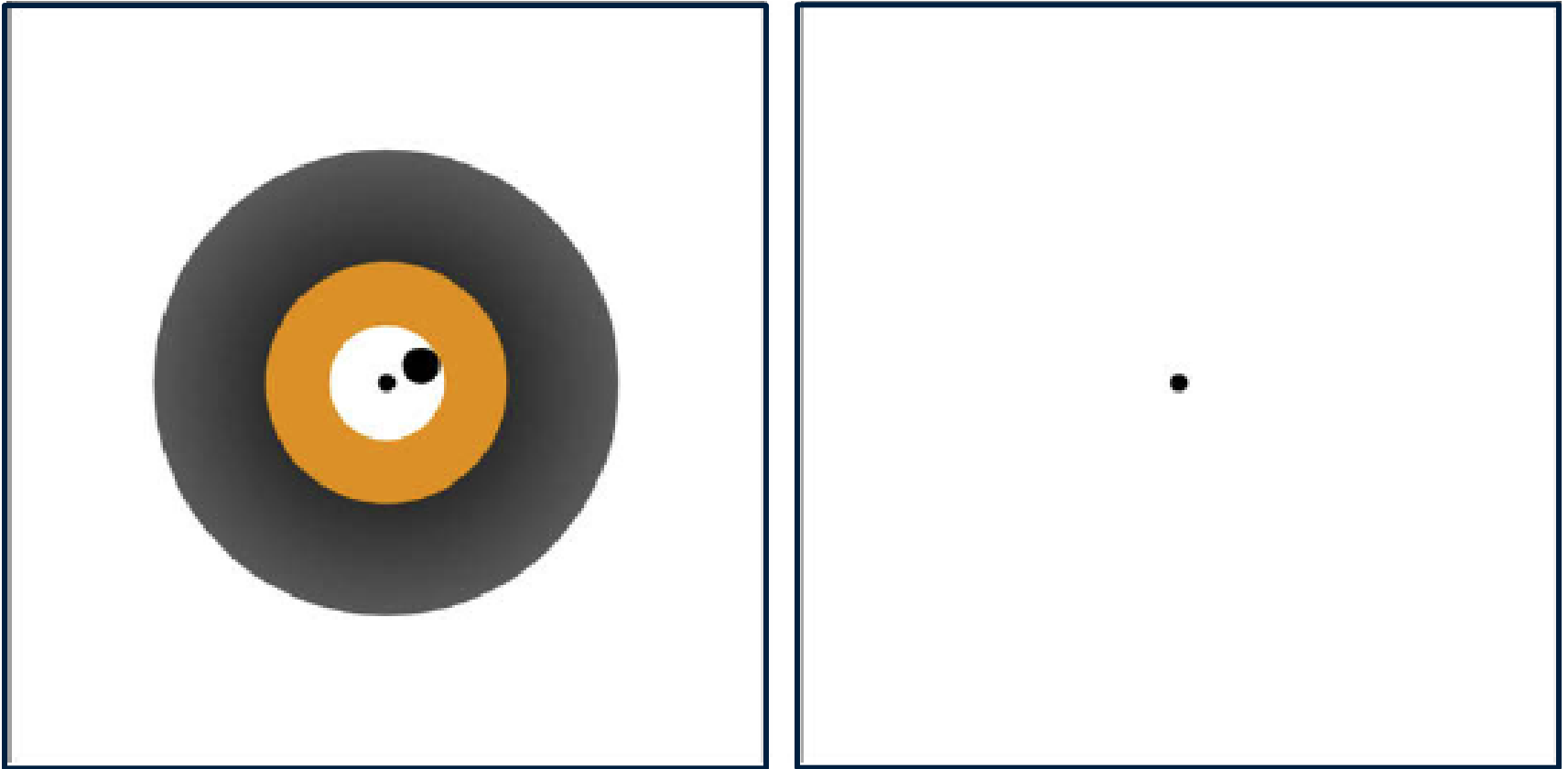
- Pursuit:

Why can't we track imaginary objects?

Mechanisms and pathways of discovery

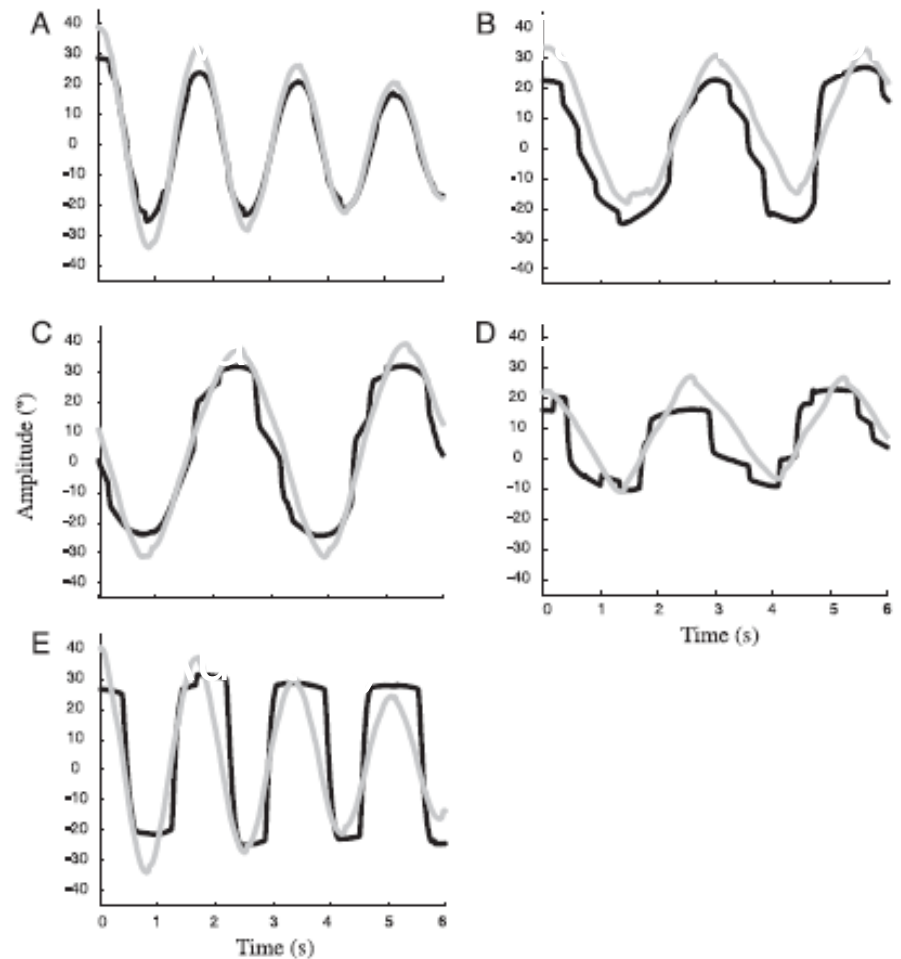
Processing path from retina to cortex

Microsaccades



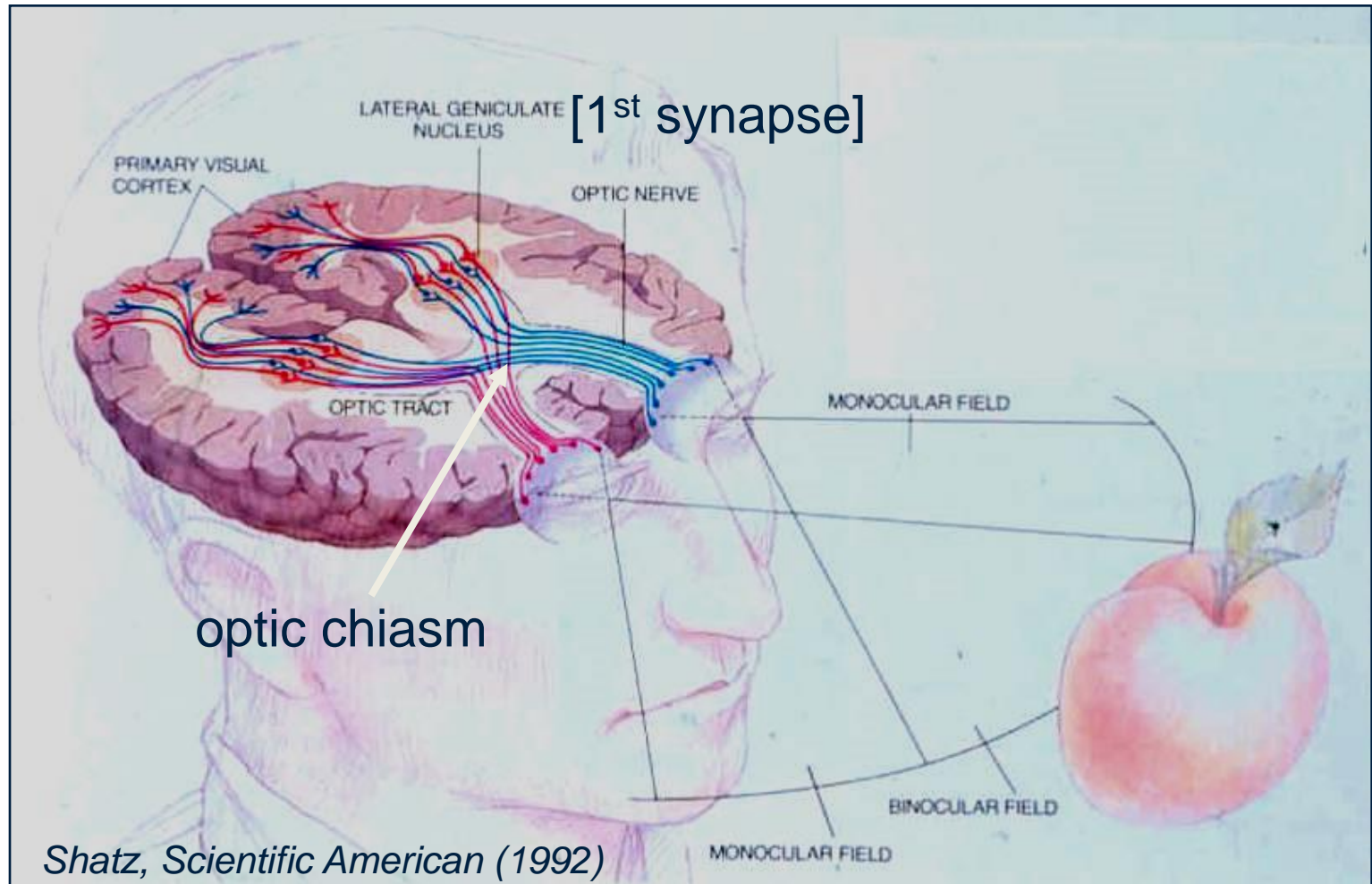
Pursuit requires visual motion

- Pursuit requires perception of a *visual* target; imaginary targets cannot be tracked
- Poor pursuit in response to nonvisual stimuli – auditory, proprioceptive, tactile



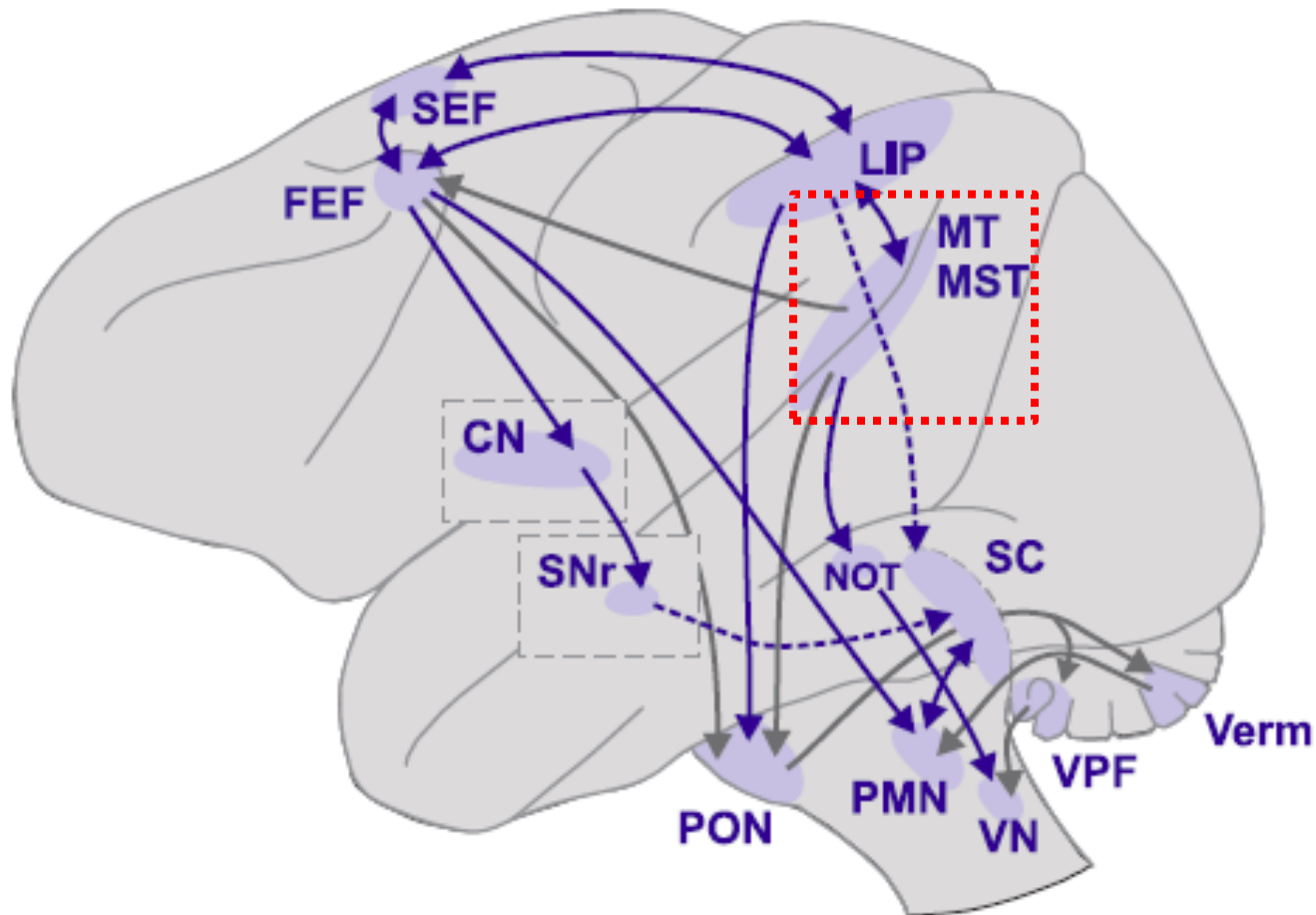
Berryhill et al., J Neurophysiol 2006

Eye to visual cortex: geniculostriate pathway

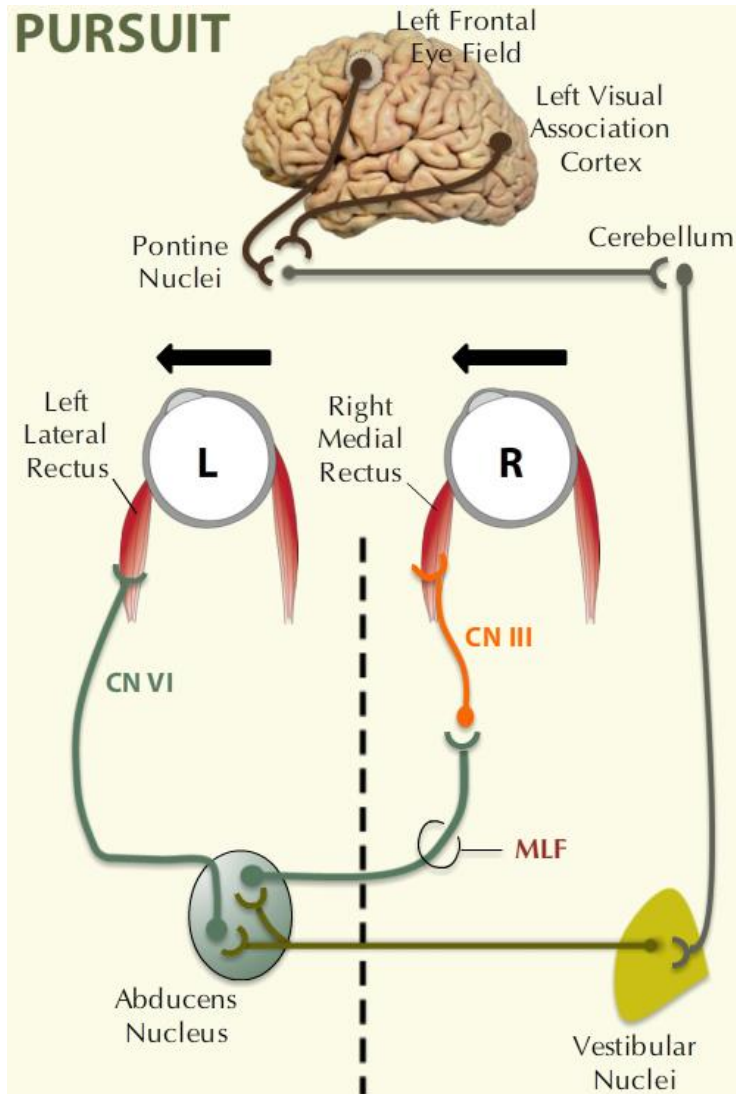


axons from nasal half of each eye cross over to opposite side of brain; axons from temporal half of each eye stay on same side

Why is visual motion perception important for pursuit?



Pursuit control



- 2 cortical inputs:
(1) ipsilateral FEF and
(2) MT/MST to ipsilateral pontine nuclei (brainstem)
- pontine nuclei to contralateral cerebellum
- cerebellum to ipsilateral vestibular nuclei (brainstem)
- vestibular nuclei to contralateral abducens nucleus
- rest is the same as for saccades

Learning Objectives

At the end of this lesson, you will be able to

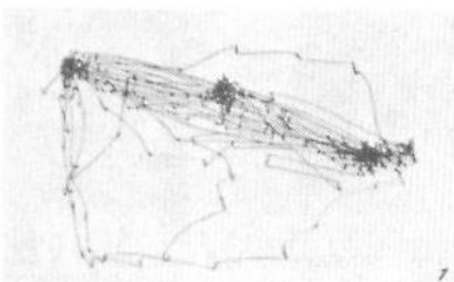
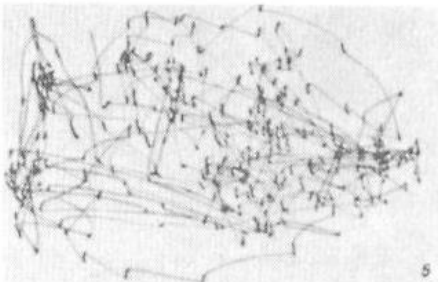
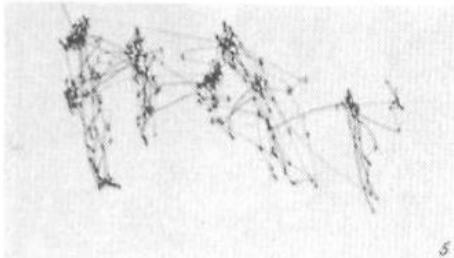
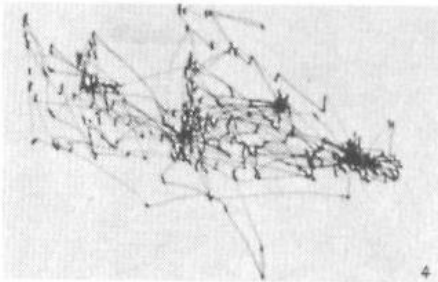
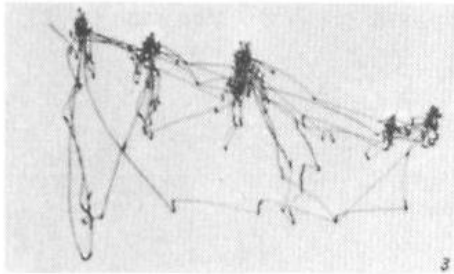
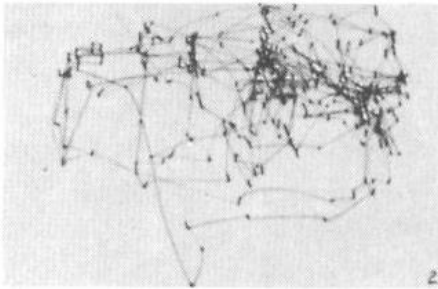
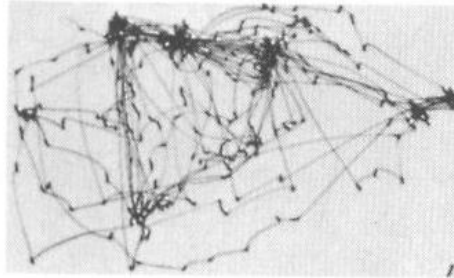
1. appreciate the relationship between vision and awareness (consciousness)
2. understand how to design an experiment to examine visual awareness

When We Track What We Do Not See



Spering & Carrasco
Trends in Neurosciences 2015

Eye Movements As A Window To The Mind



Ilya Repin: The unexpected return (1884-1888)

- 1) Free viewing
- 2) Financial status of family
- 3) Age of people portrayed
- 4) Activities
- 5) Clothes
- 6) Furniture
- 7) How long gone

Yarbus (1967)

Eye Movements As A Window To The Mind



Eye Movements As A Window To The Mind

eye movements during free viewing



Eye Movements As A Window To The Mind

eye movements when counting birds



Eye Movements Reflect Awareness

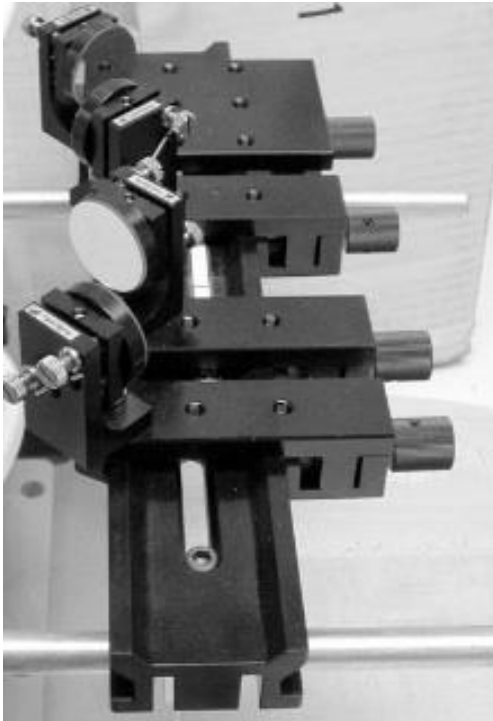
[explicit perceptual report]

- eye movements improve many different aspects of vision

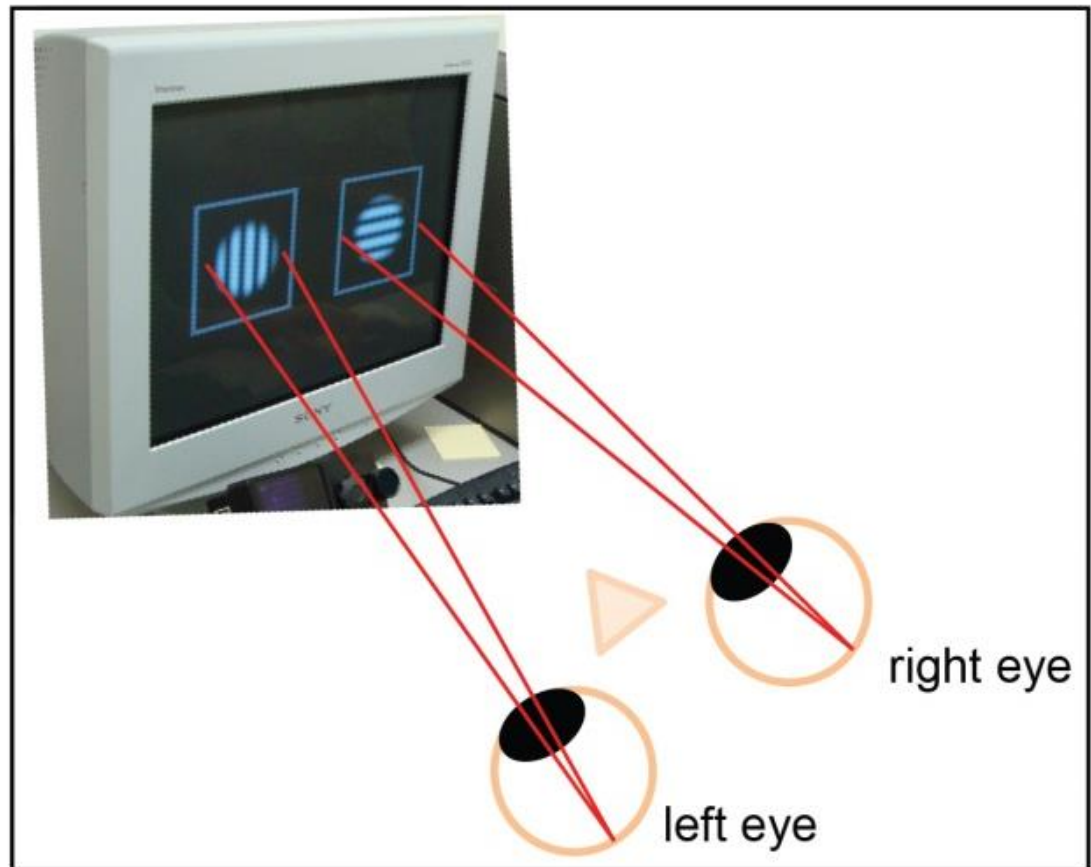
reviews: Kowler 2011; Schütz et al. 2011; Spering & Montagnini 2011



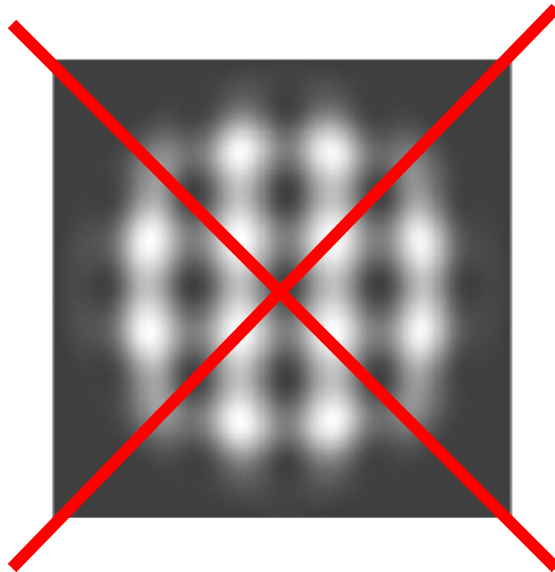
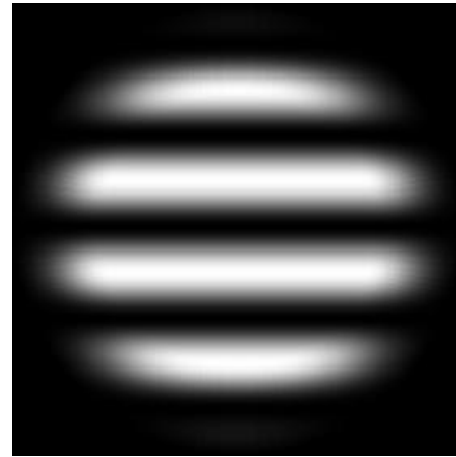
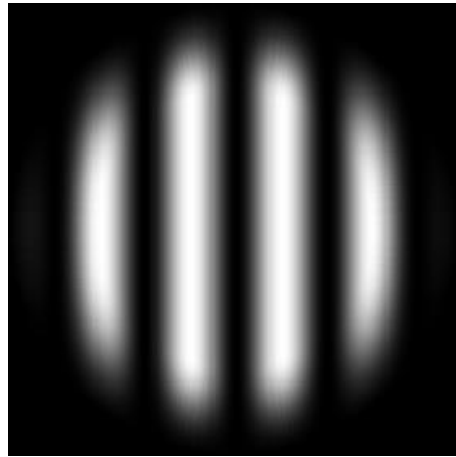
Do Eye Movements Reflect Awareness in Binocular Rivalry?



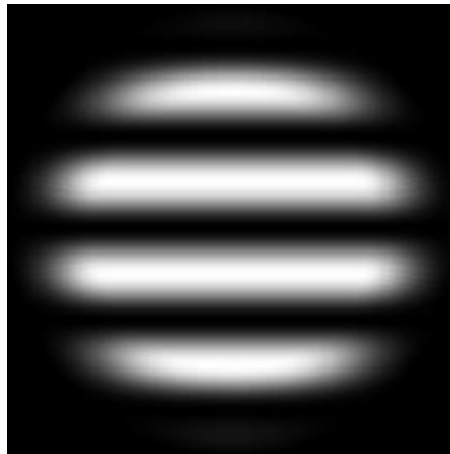
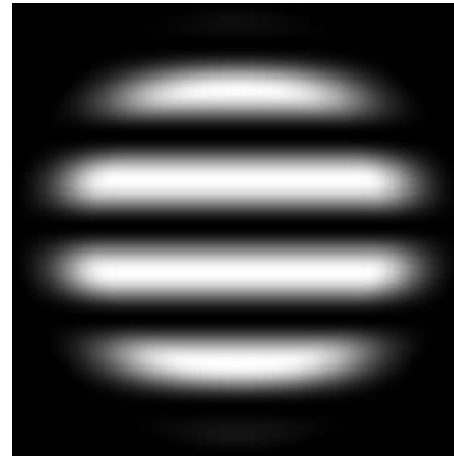
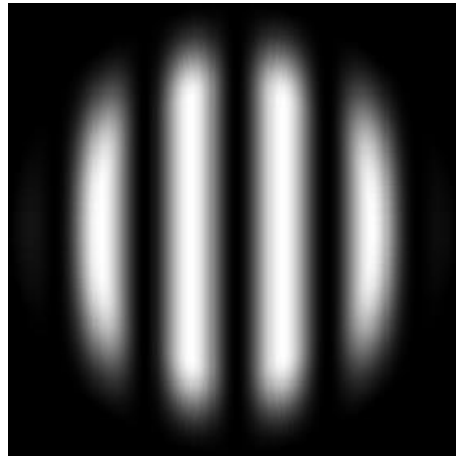
stereoscope: separate presentation to each eye



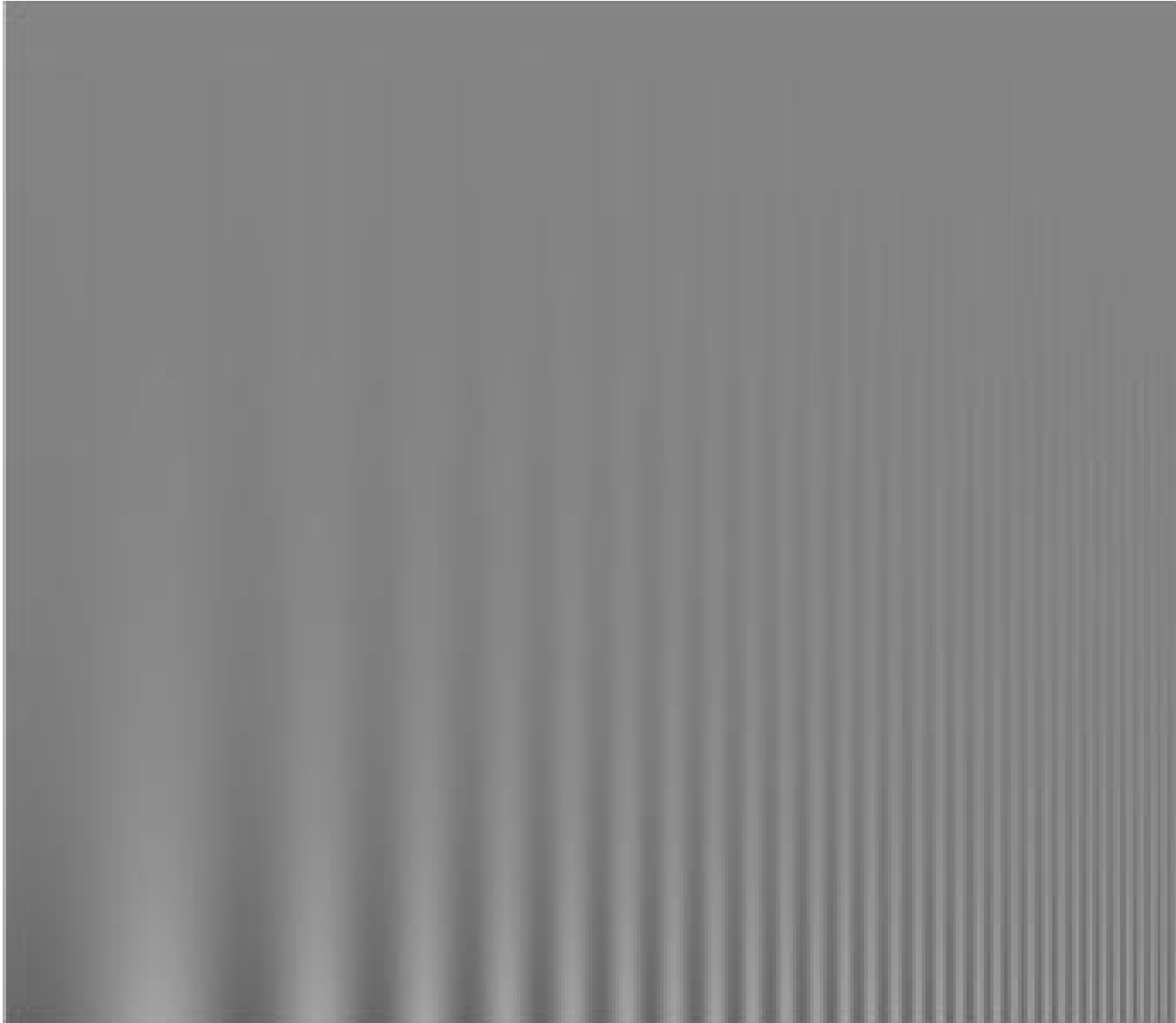
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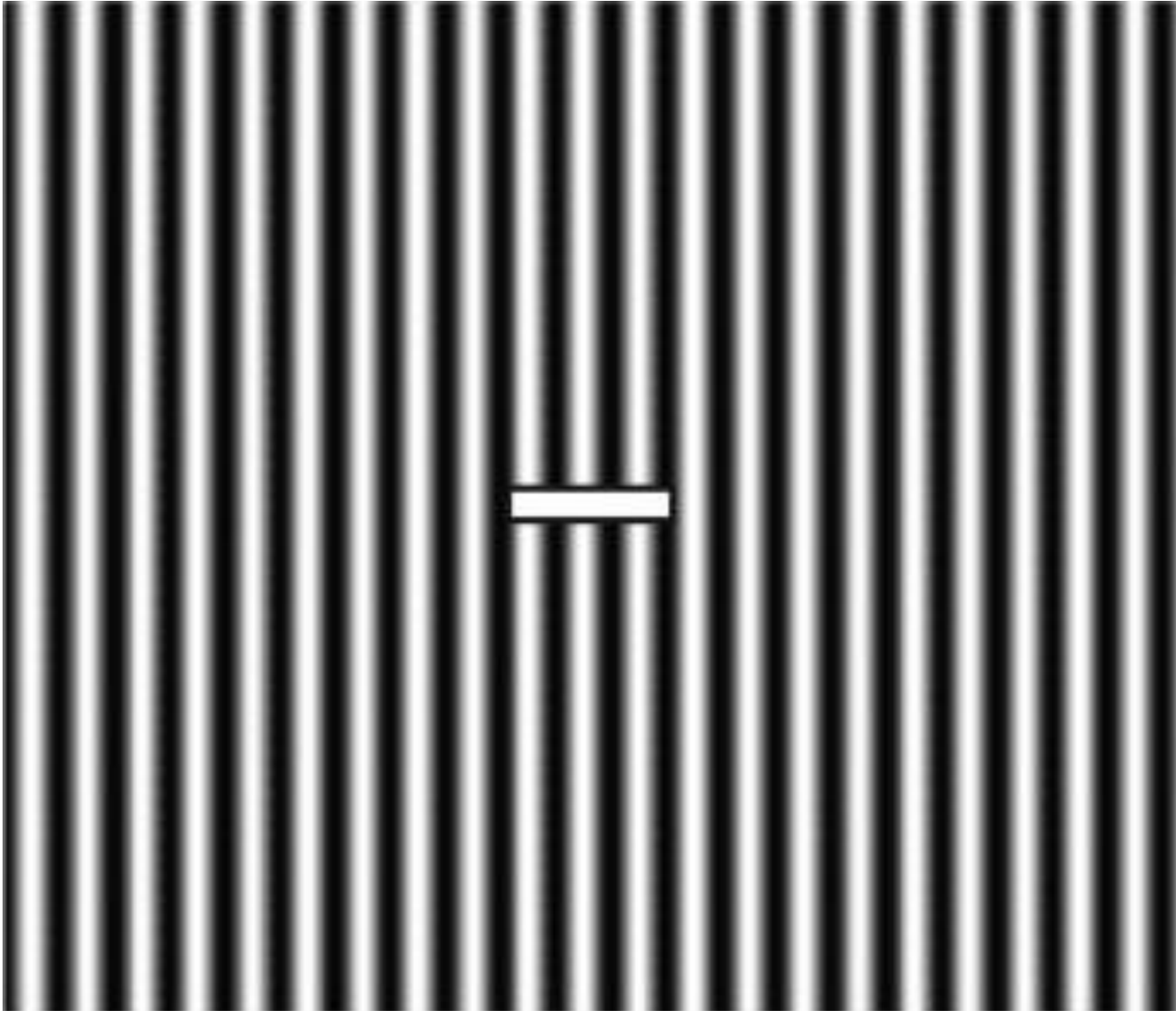
Do Eye Movements Reflect Awareness in Binocular Rivalry?



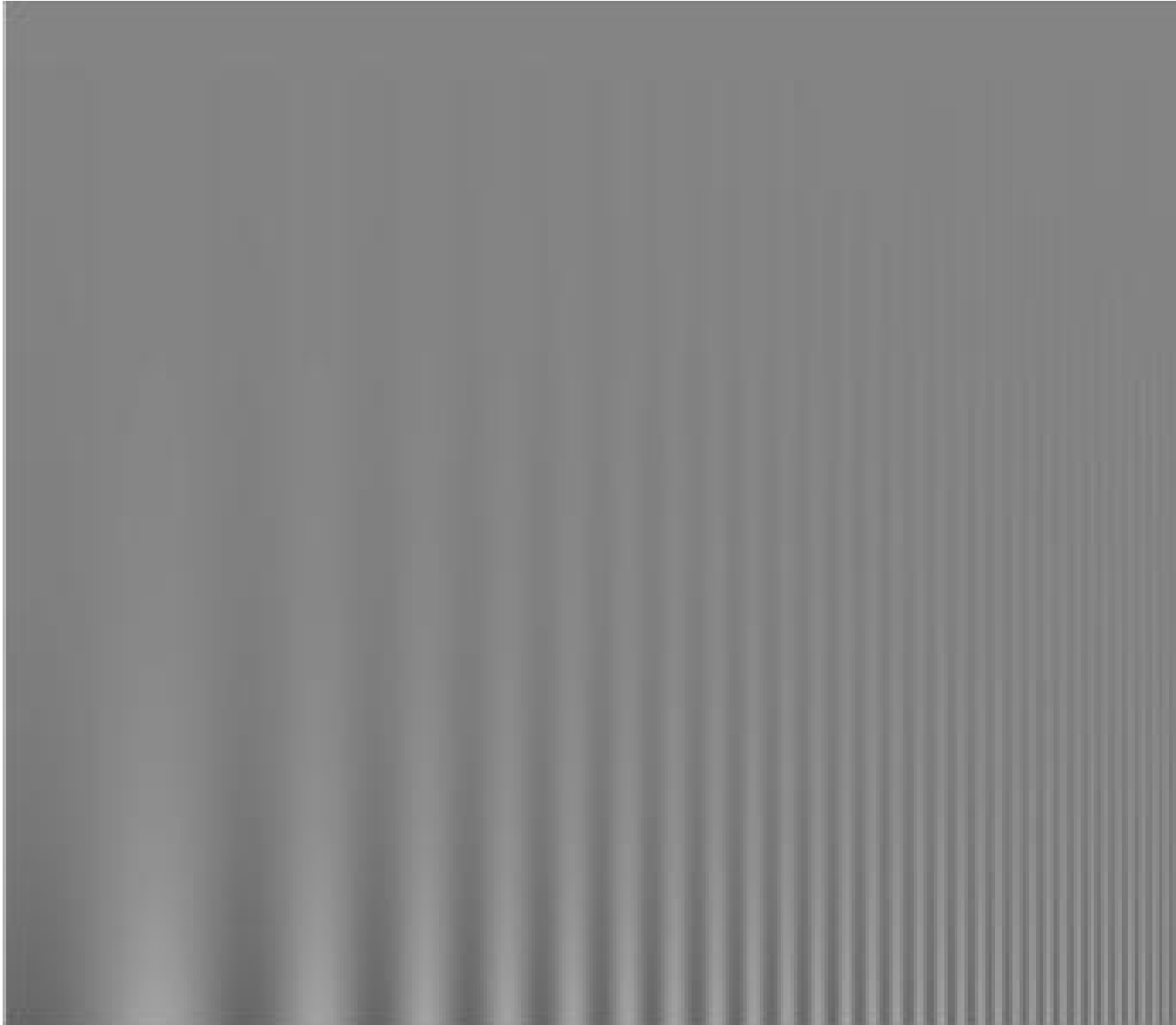
Demo: Adaptation



move your eyes along the horizontal bar



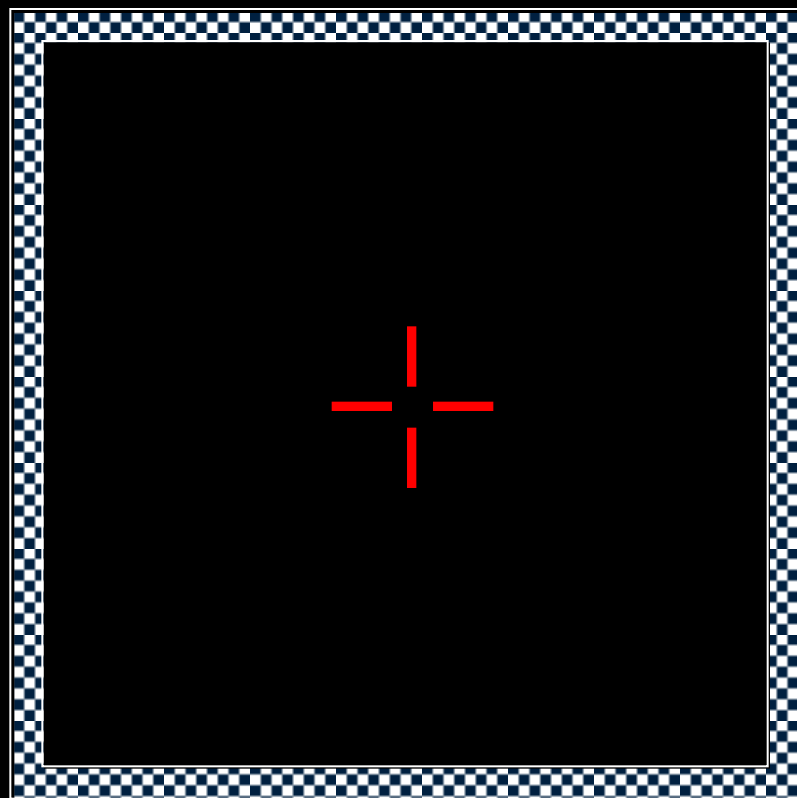
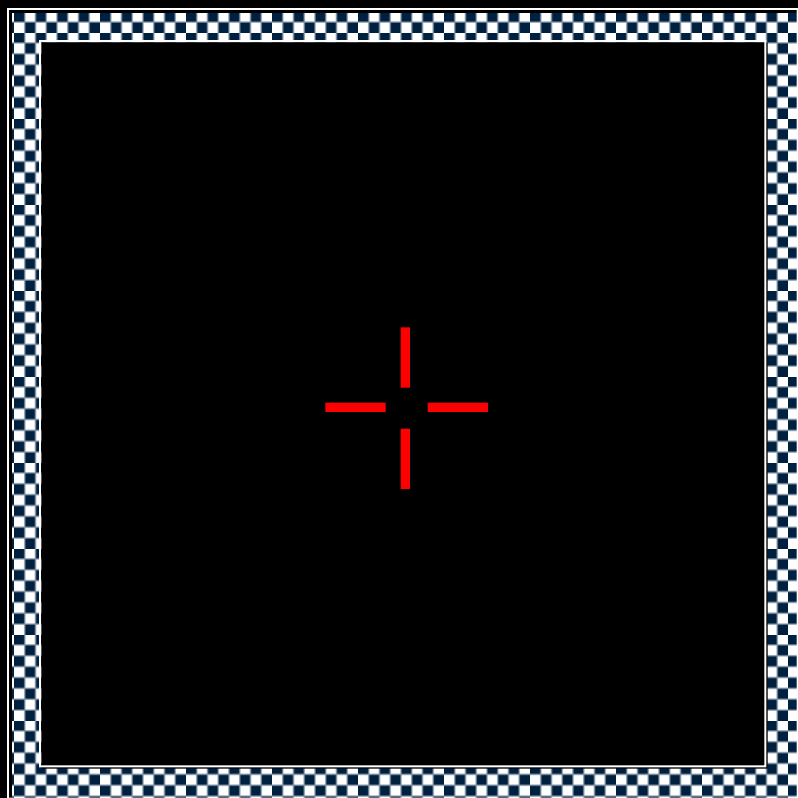
Adaptation Reduces Perceived Contrast

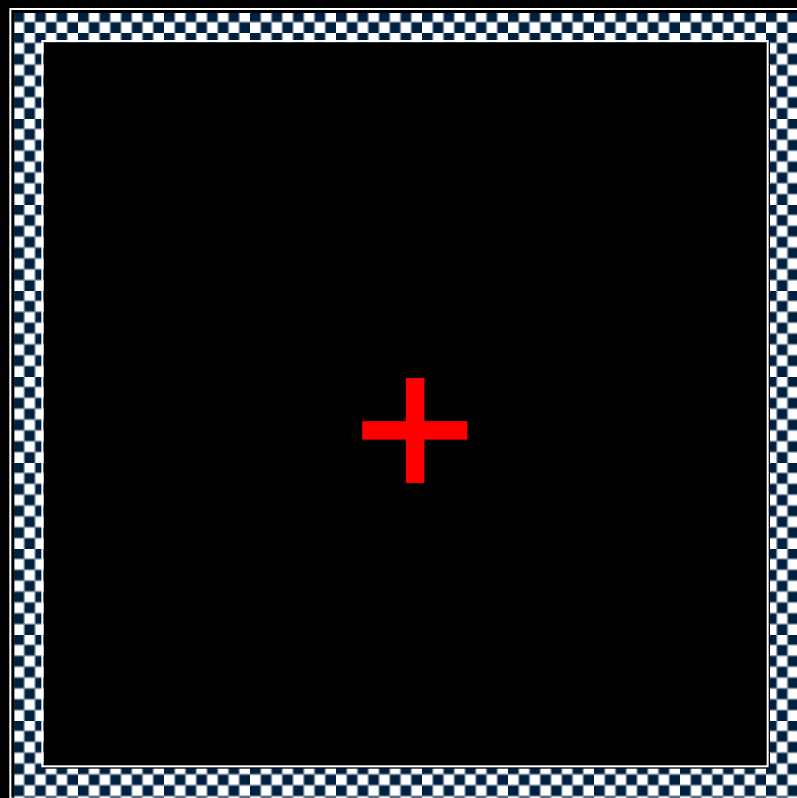
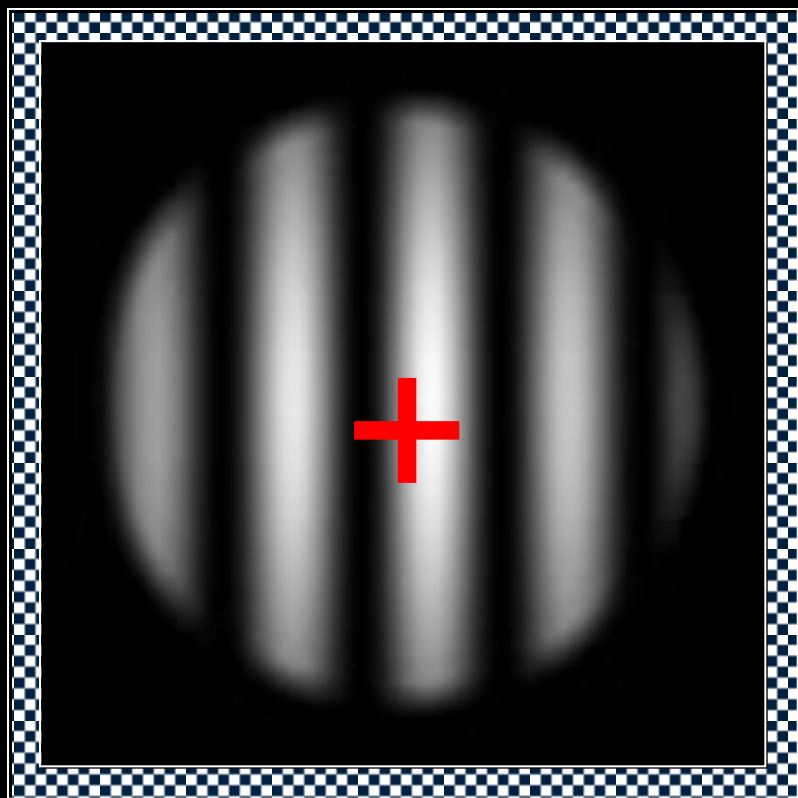


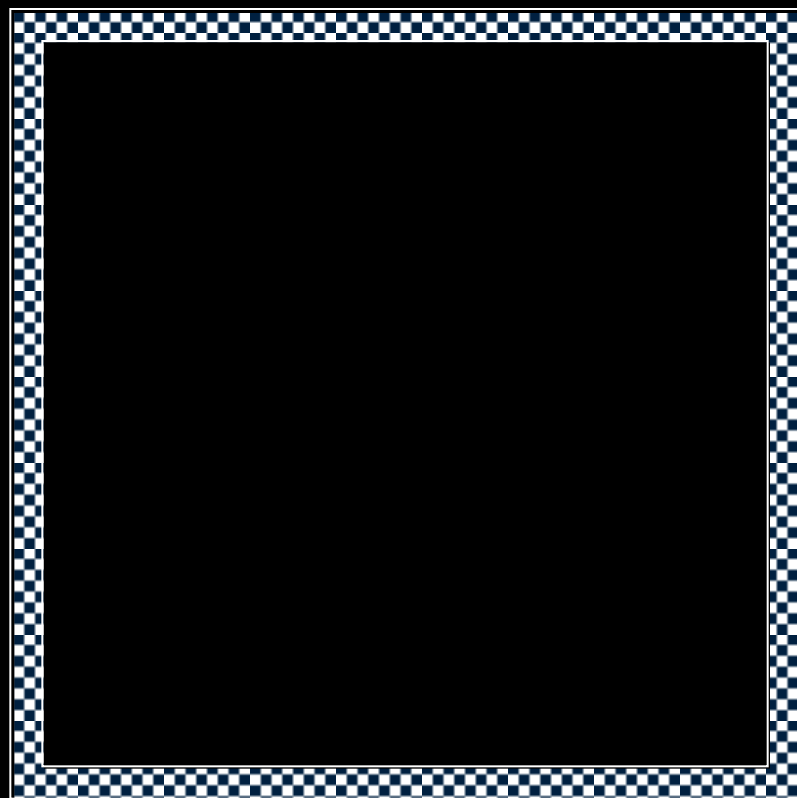
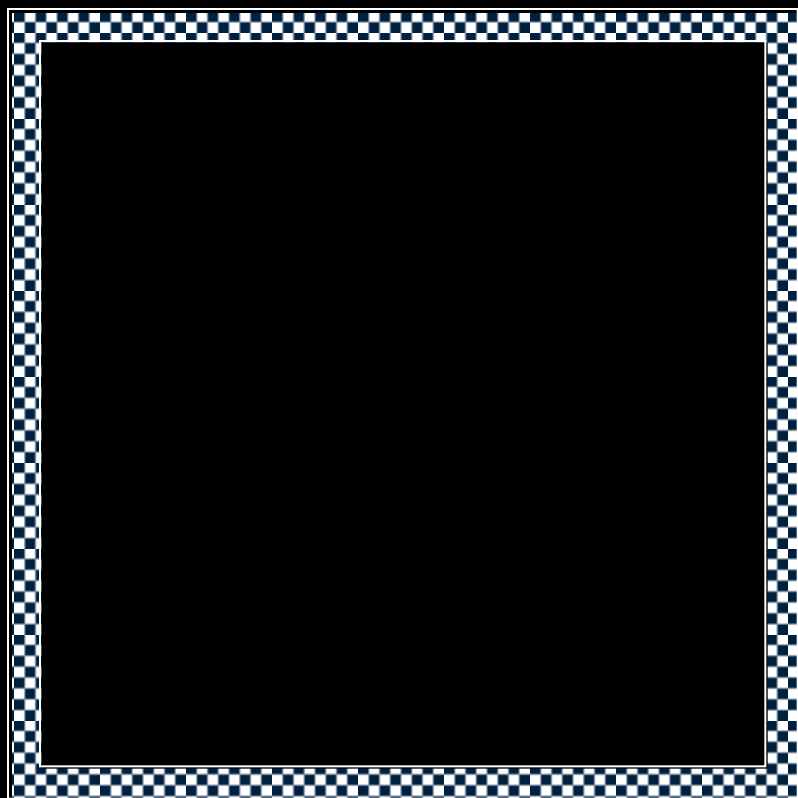
Monocular Adaptation & Binocular Presentation



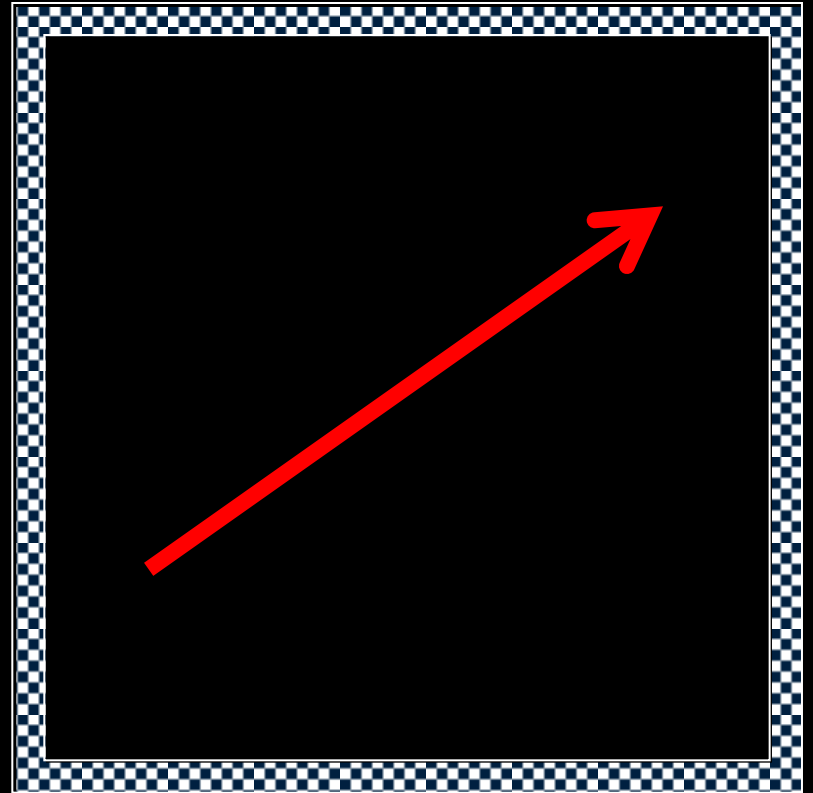
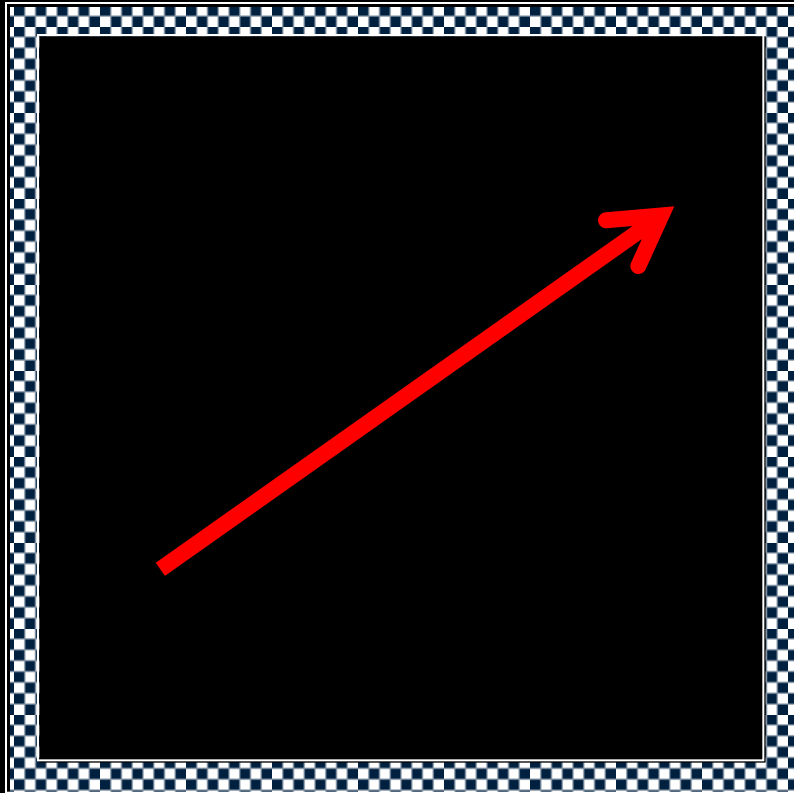
Spring, Pomplun & Carrasco, Psych Sci 2011

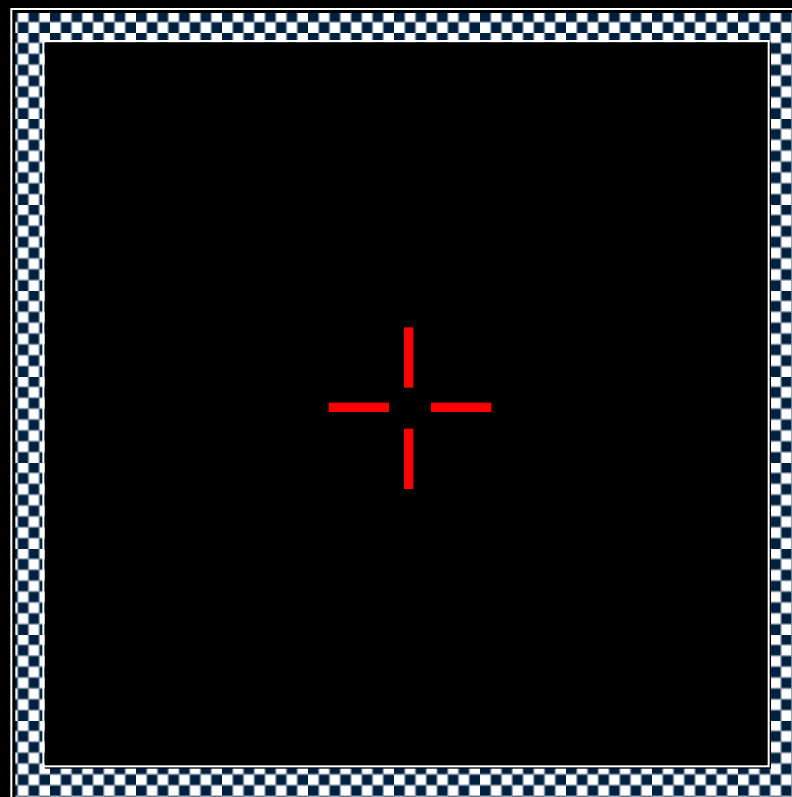


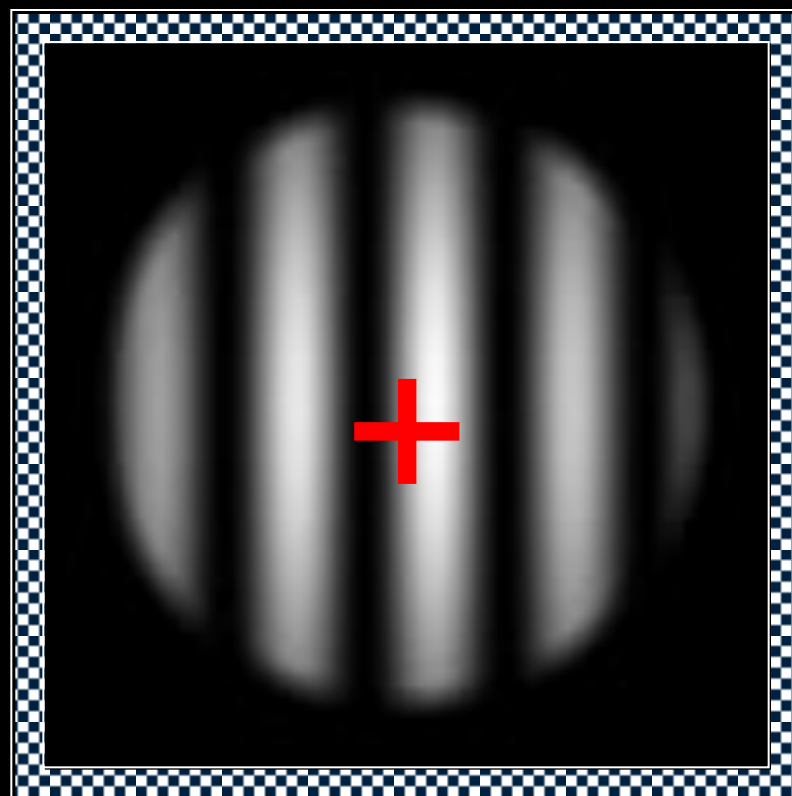


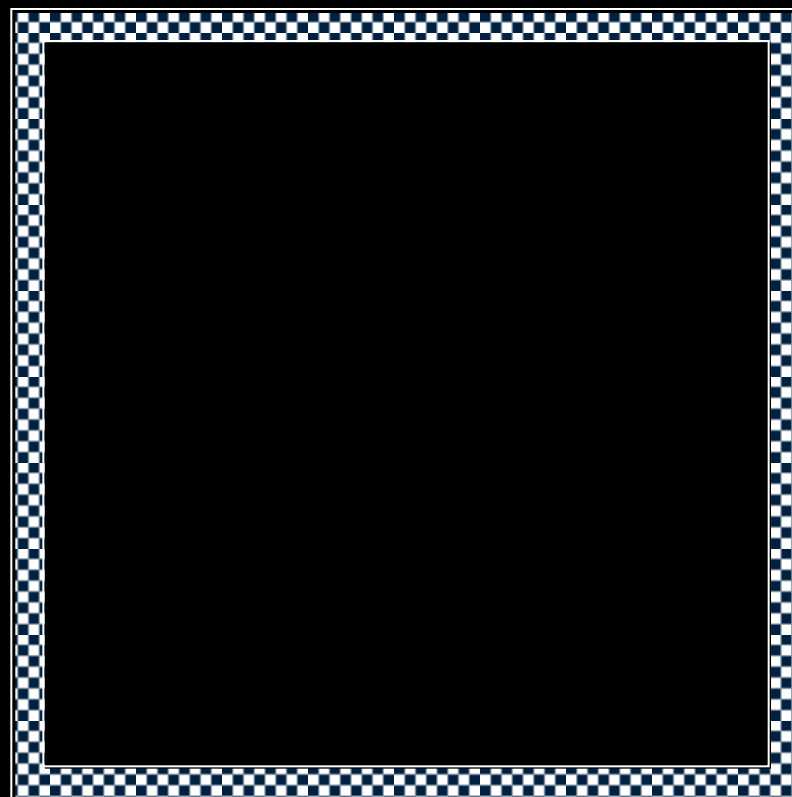




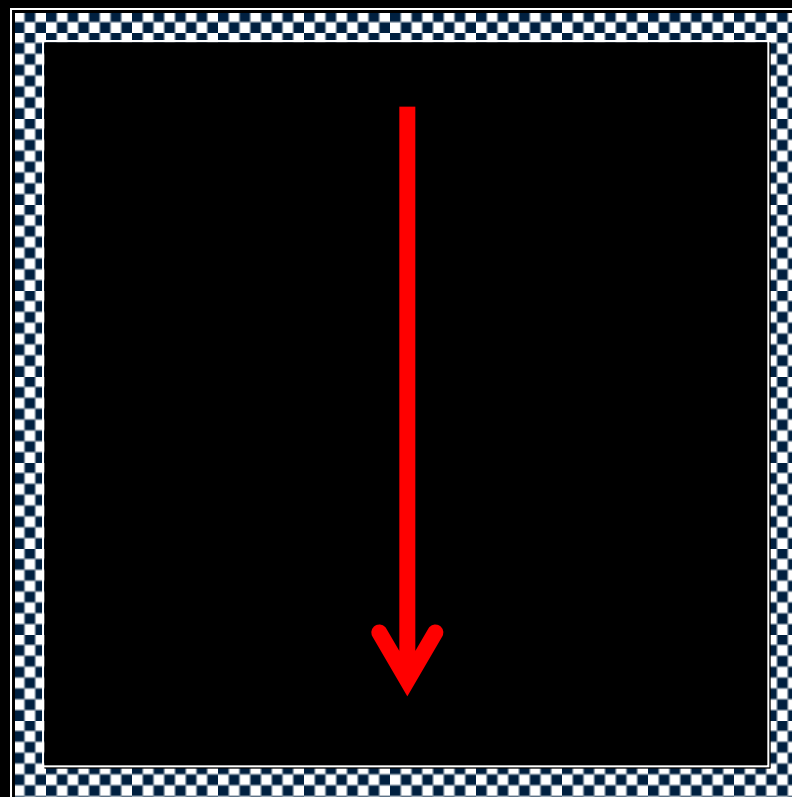




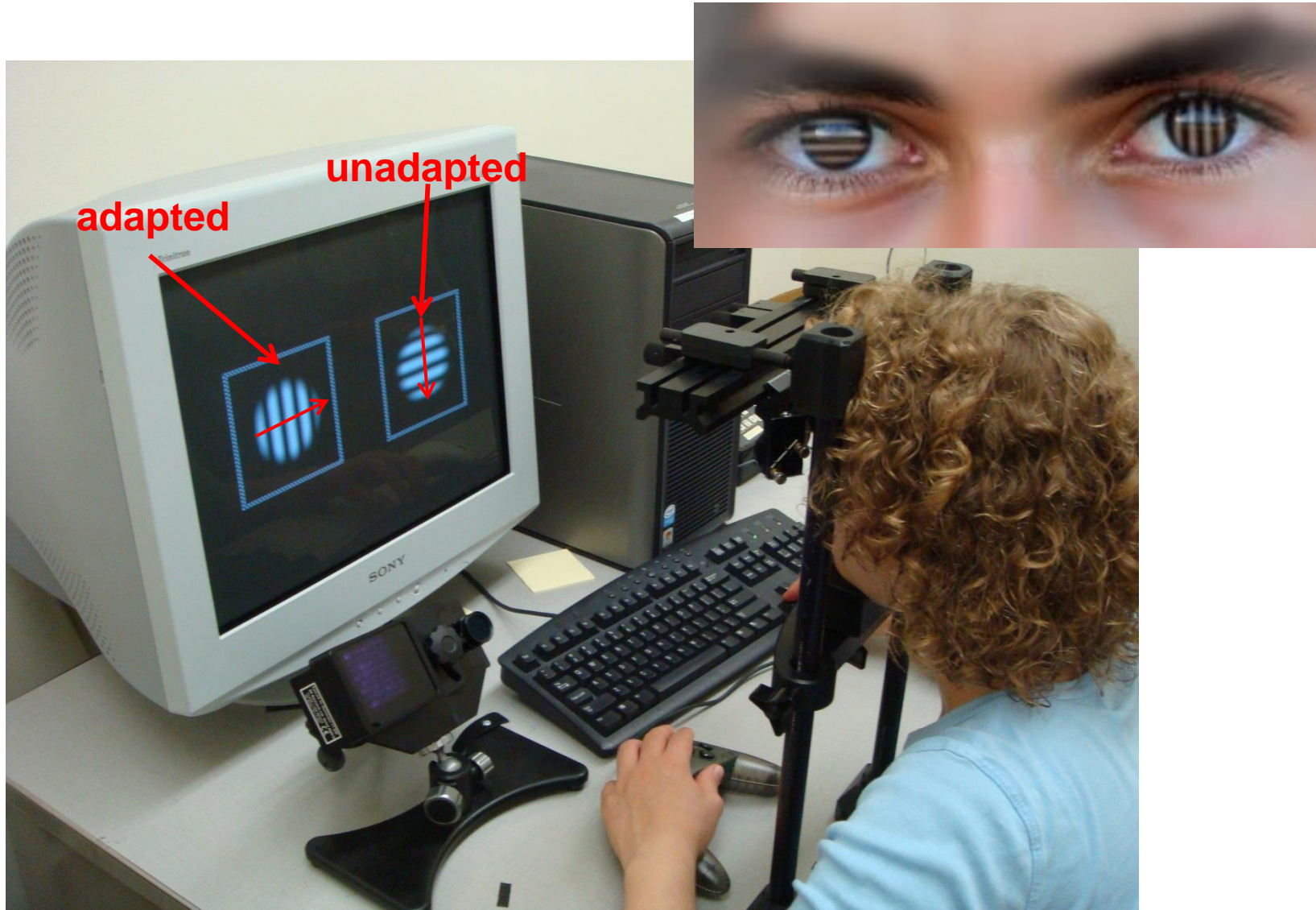






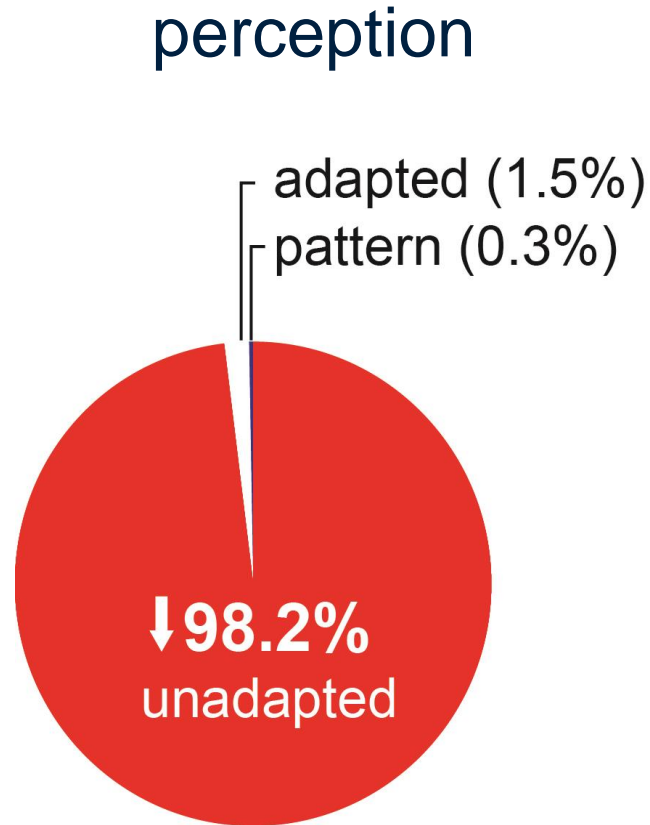


Do We Track What We See?



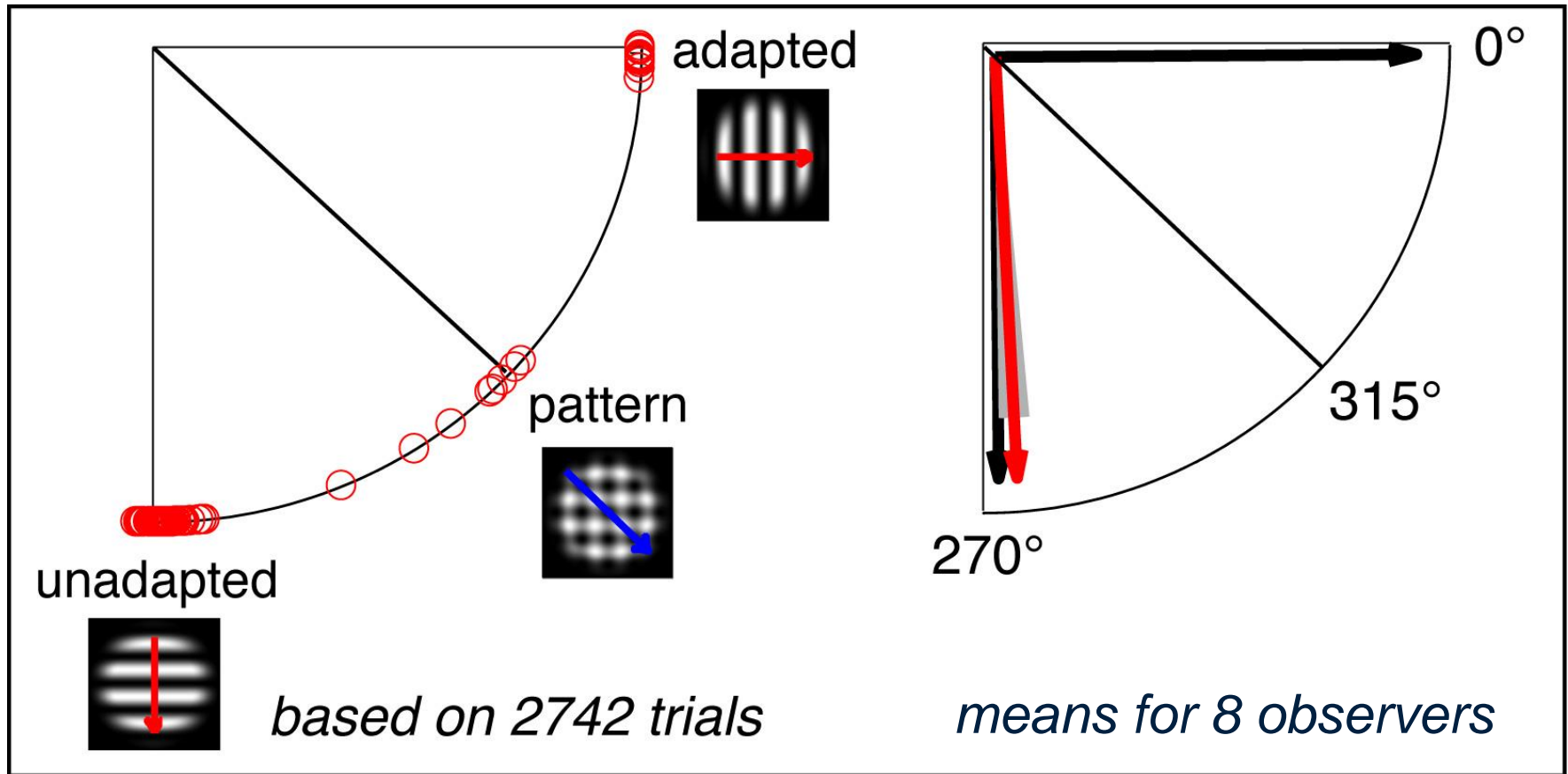
eye position obtained with video-based Eyelink 1000 (1000 Hz)

Observers Perceive The Unadapted Stimulus

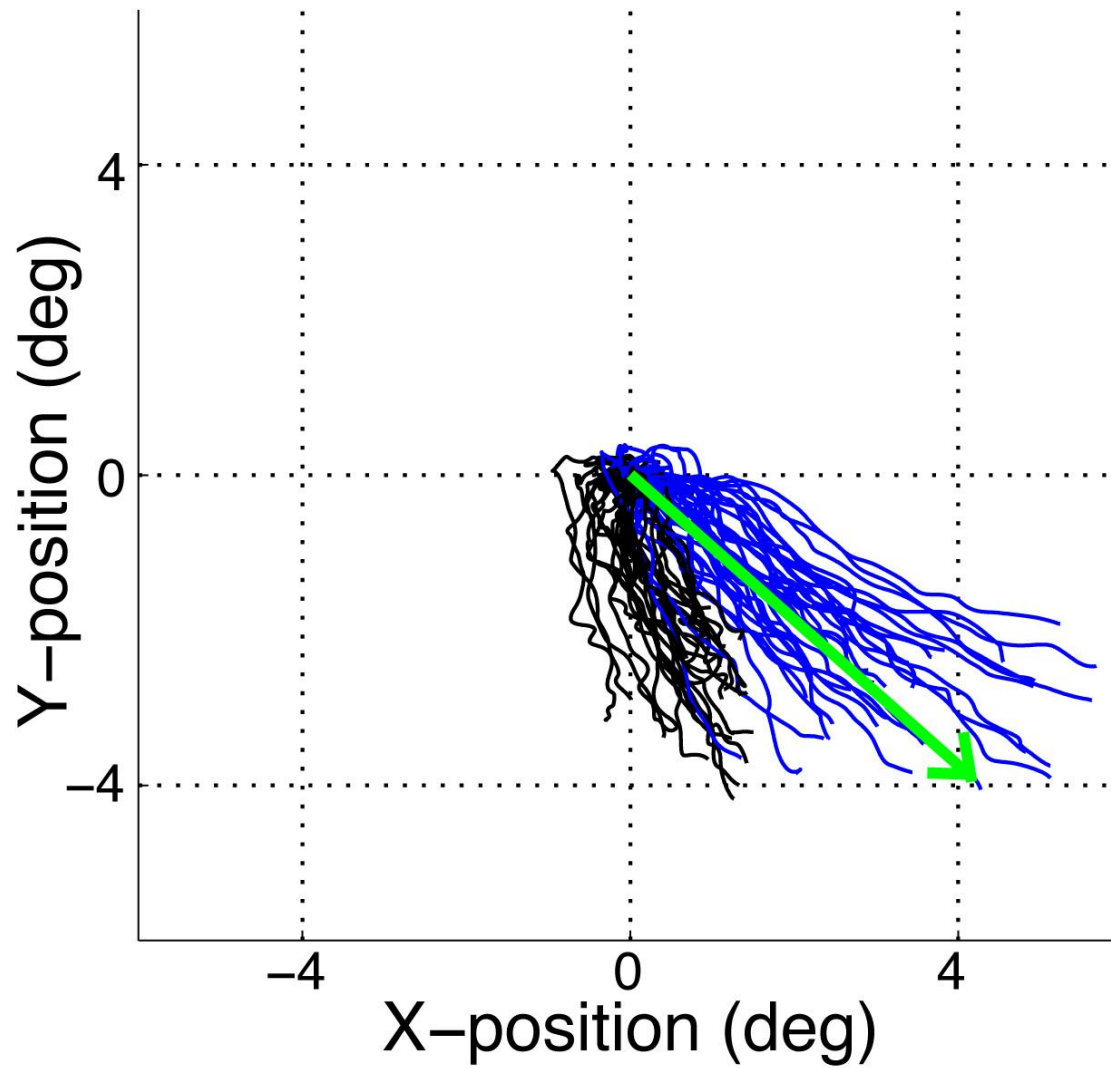


Spering, Pomplun & Carrasco, Psych Sci 2011
Spering & Carrasco, J Neurosci 2012
Spering & Carrasco, TiNS 2015

Observers Perceive The Unadapted Stimulus

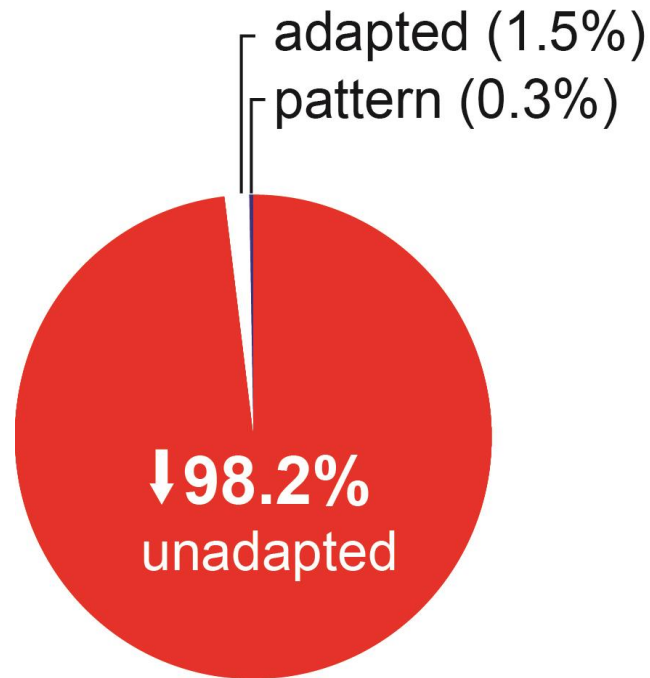


Eye Movements

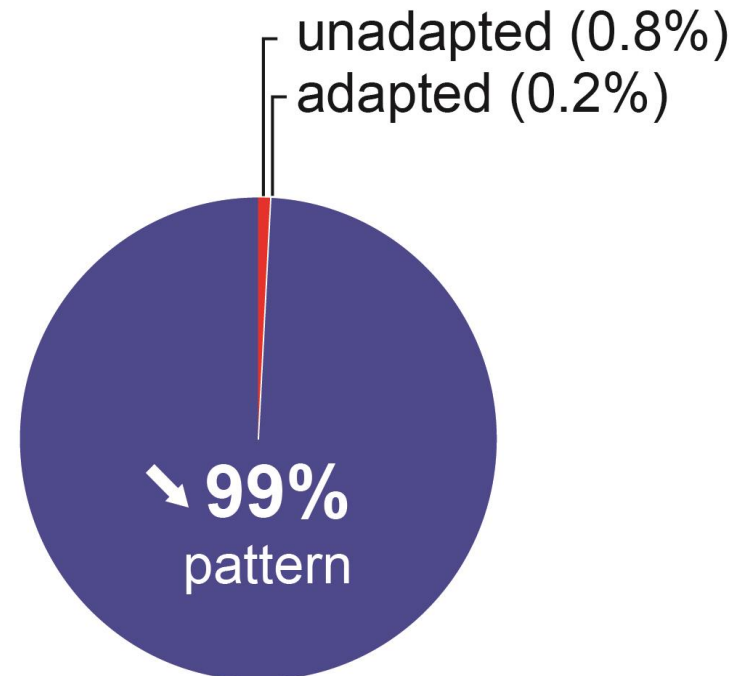


Pursuit Averages Both Directions

perception



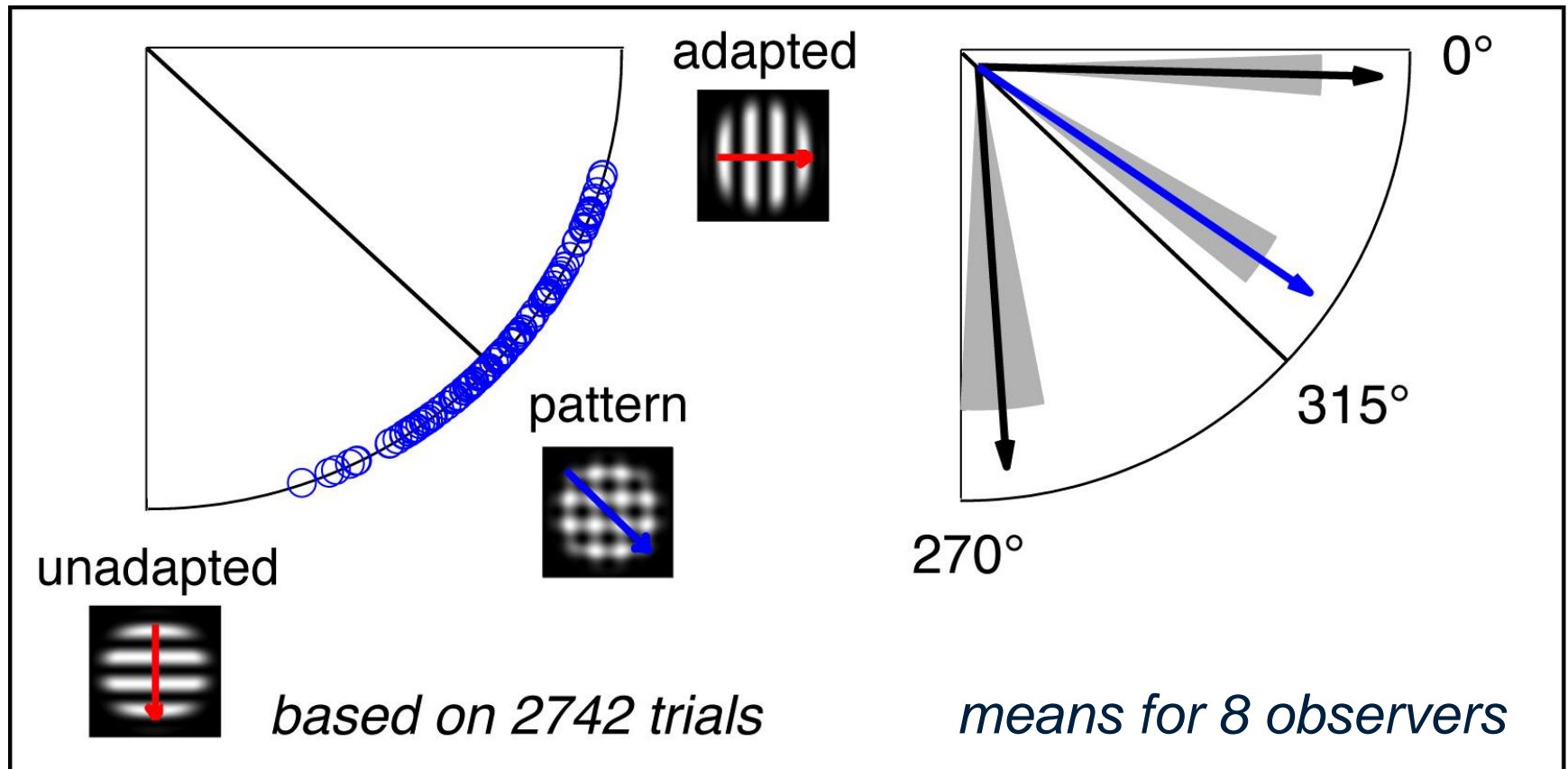
pursuit



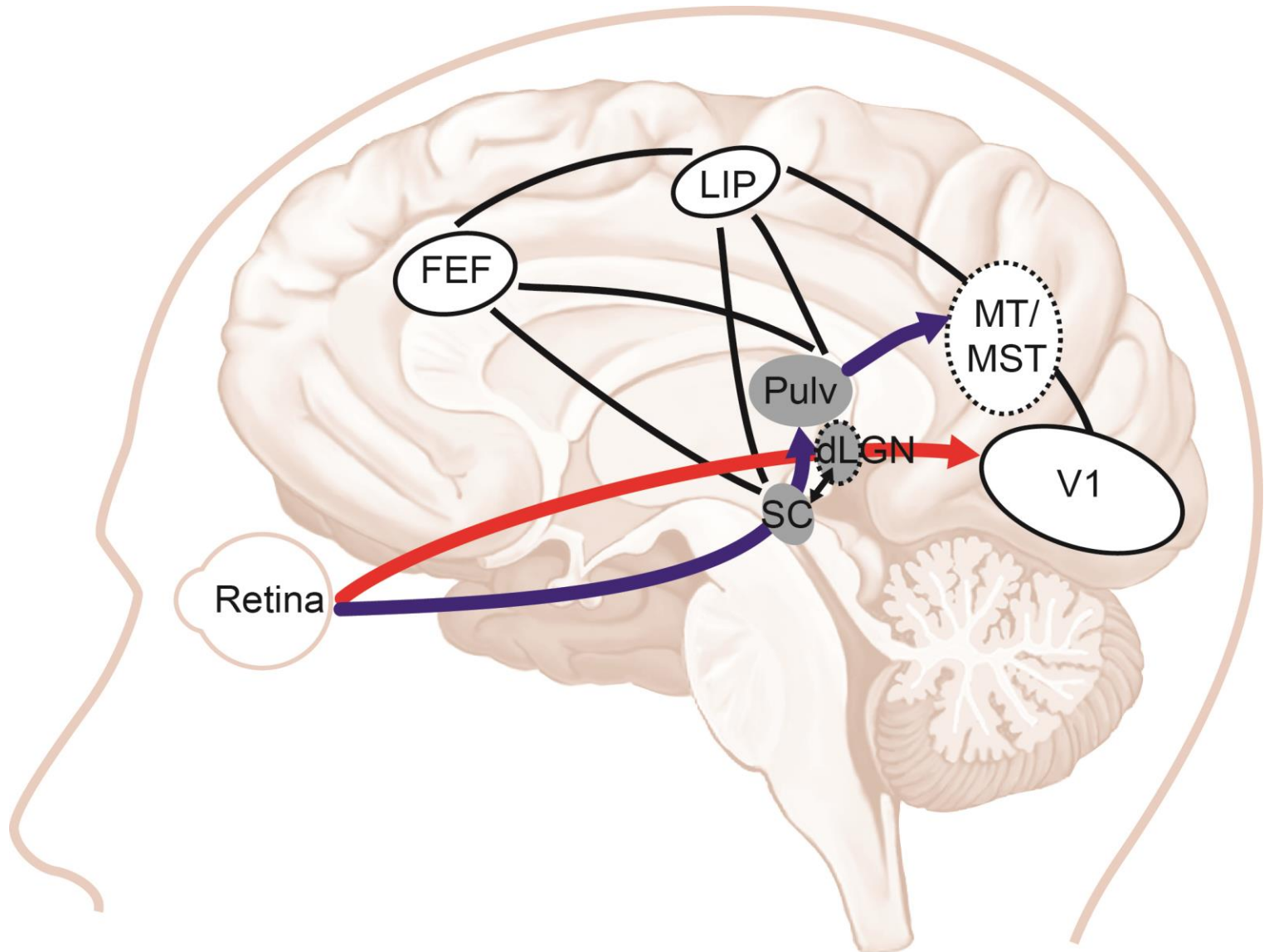
Sperring, Pomplun & Carrasco, Psych Sci 2011
Sperring & Carrasco, J Neurosci 2012
Sperring & Carrasco, TiNS 2015

Pursuit Follows Pattern Motion

average direction between adapted and unadapted stimulus, irrespective of stimulus strength

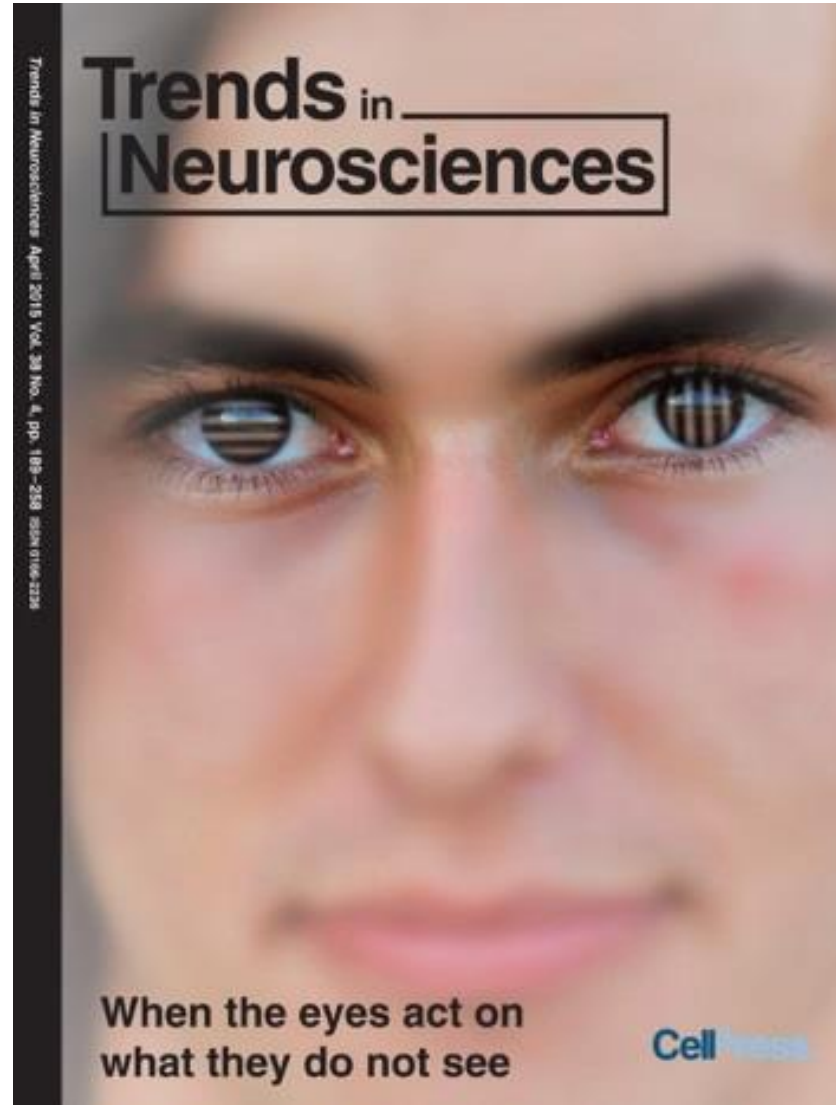


Separate Pathways for Perception and Action?



Spering & Carrasco (Trends Neurosci 2015)

eye movements reflect processing of unaware information



Sperring & Carrasco 2015

Group work: design an experiment

Please think about the limitations of the discussed study in terms of defining visual awareness.

- Can you think of an alternative way of studying awareness / consciousness?

Hint: What other methodological tools are available to tap into brain mechanisms that underlie consciousness?