

Module # 4—Seeing Motion

Visual Perception and the Brain



Topic 1. Seeing Motion

Lesson 1. Definitions

Definitions

- Translation and/or rotation in Euclidean (3D) space
- Physical speed versus perceived speed
- Physical direction versus perceived direction

Lesson 2. Phenomena that Need Explaining

Phenomena that Need Explaining

- Apparent motion (time)
- Motion after effects (tiring)
- The flash-lag effect (speed)
- Aperture effects (direction)

Lesson 3. Apparent Motion

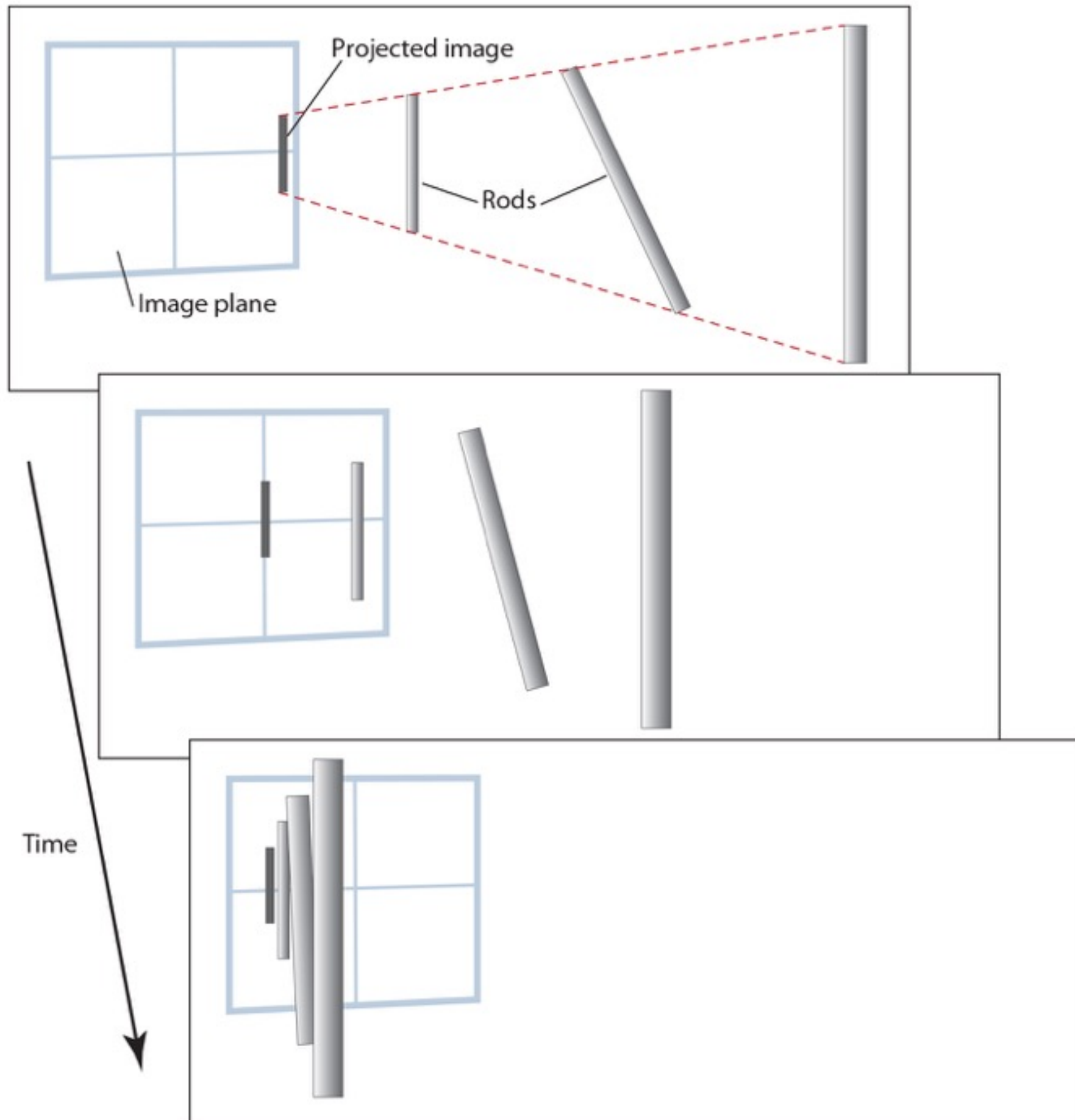


Lesson 4. Motion After Effects

The Waterfall After Effect



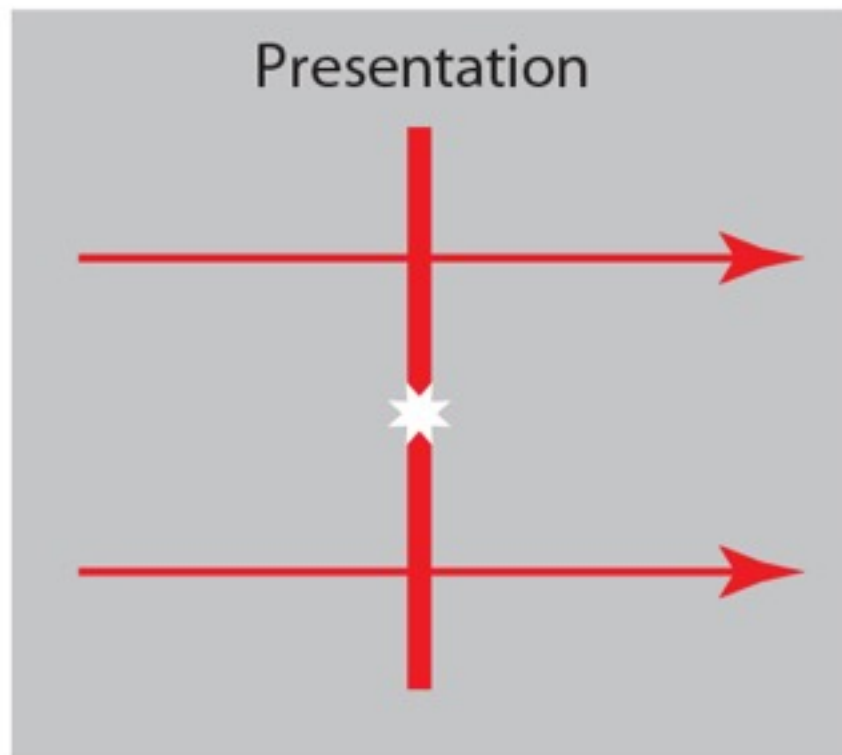
Lesson 5. The Inverse Problem for Motion



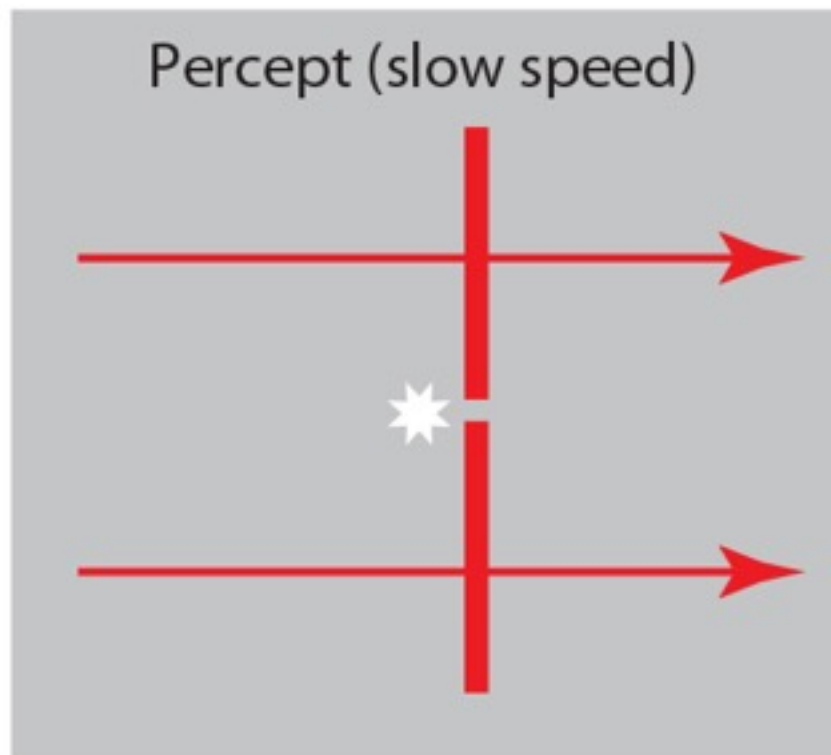
Lesson 6. Perceived Speed: The Flash-Lag Effect

The Phenomenon

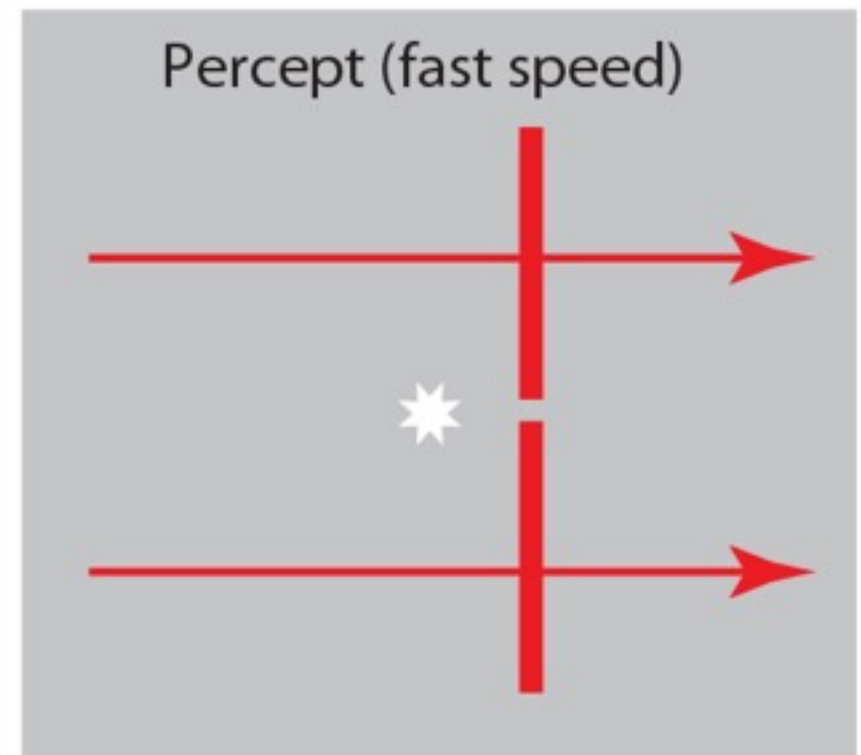
(A)

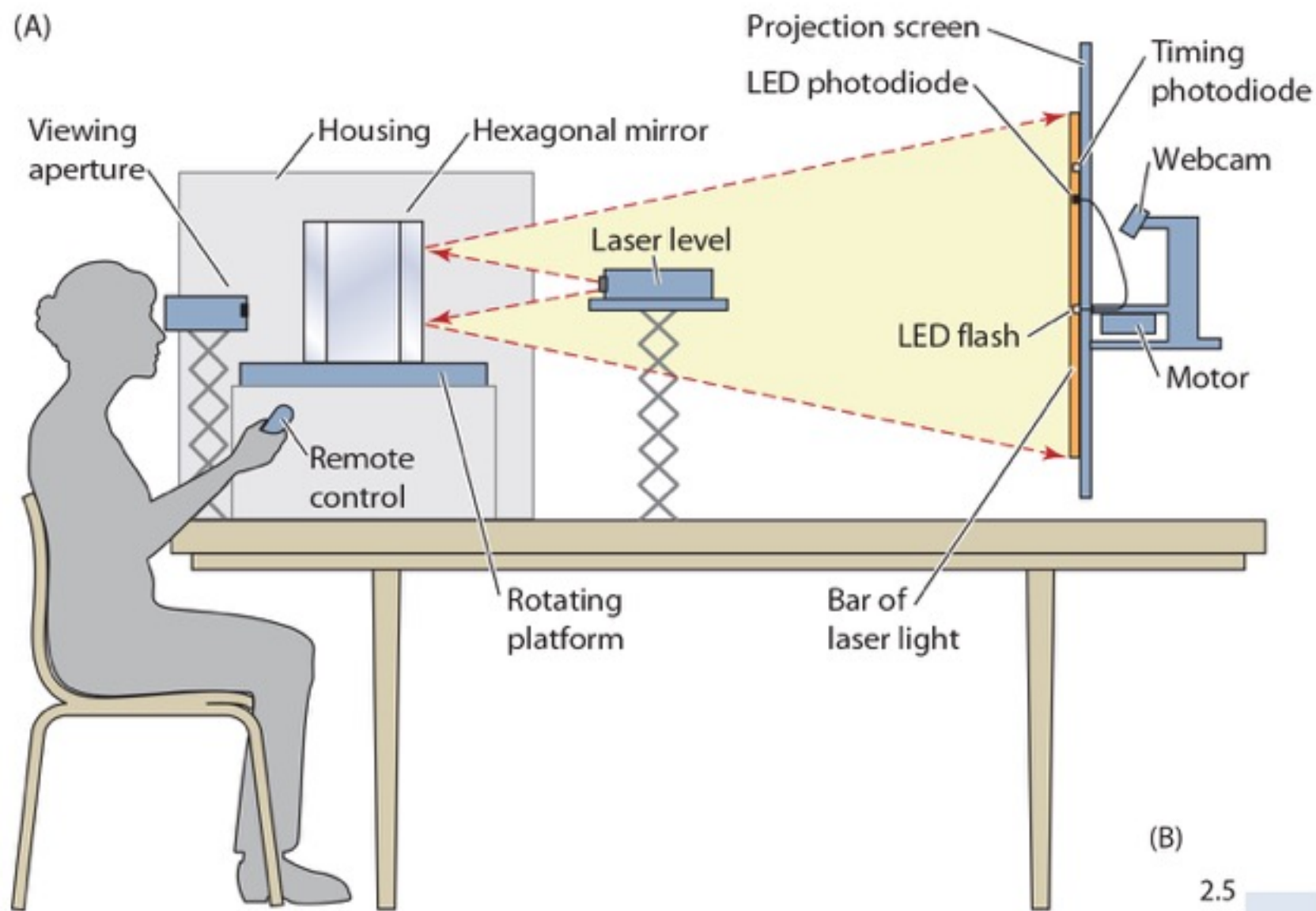


(B)



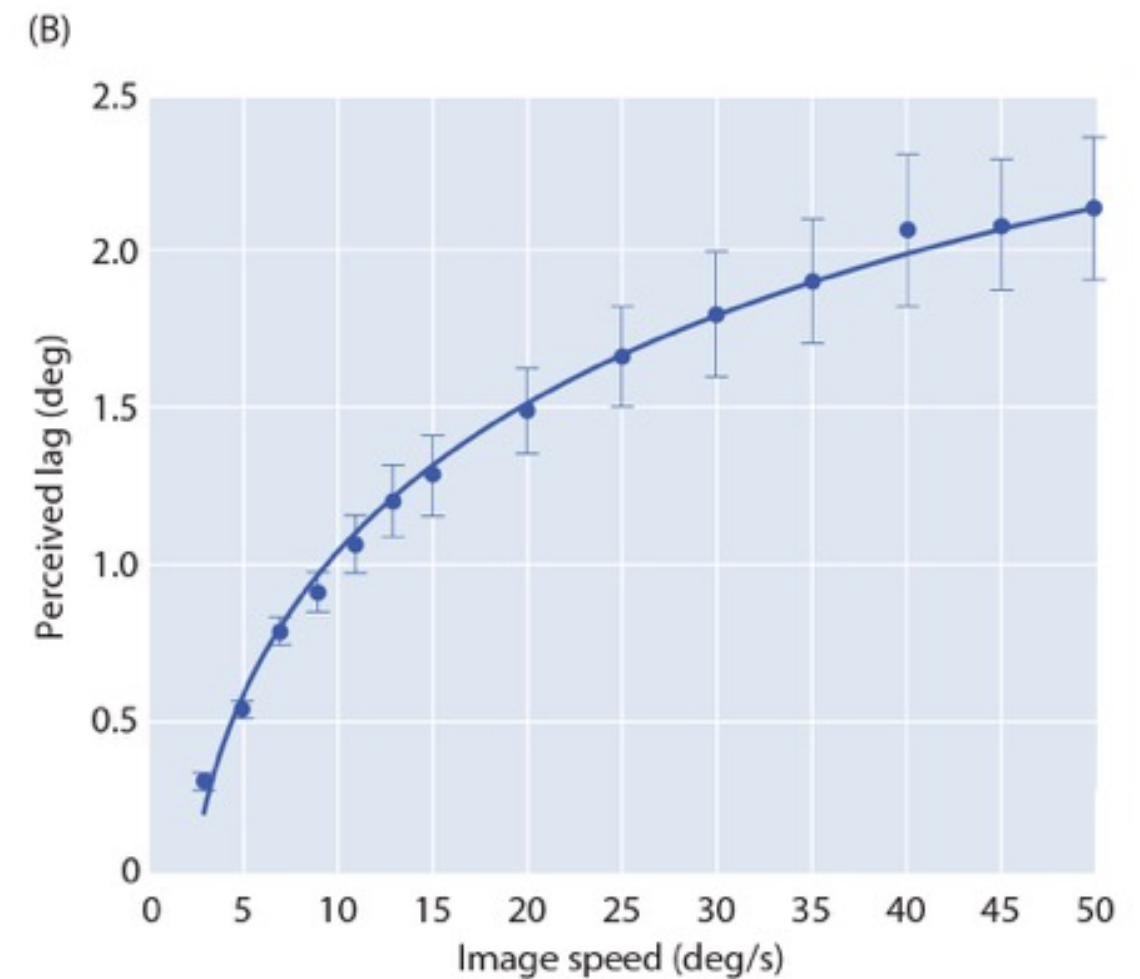
(C)



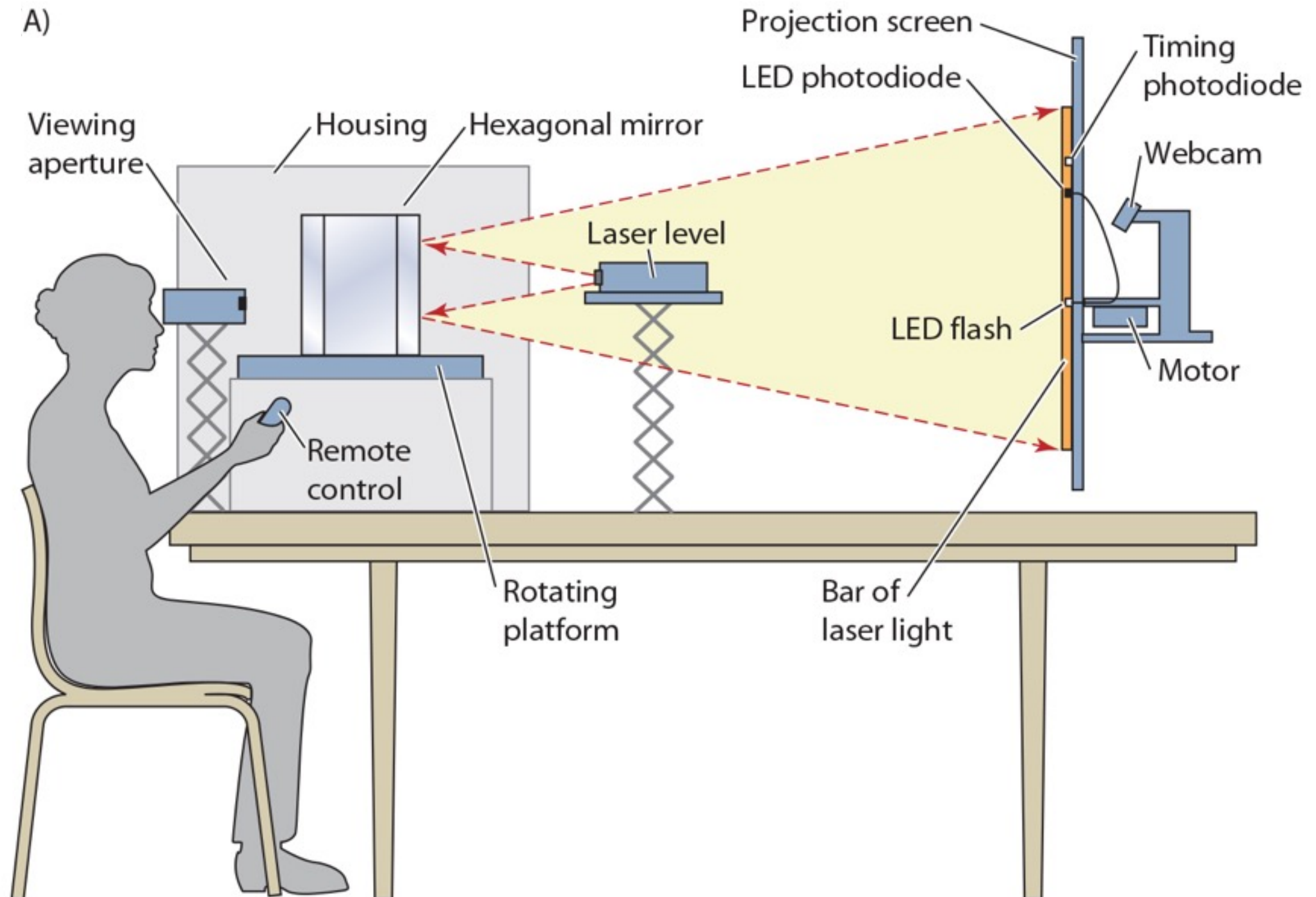


The results

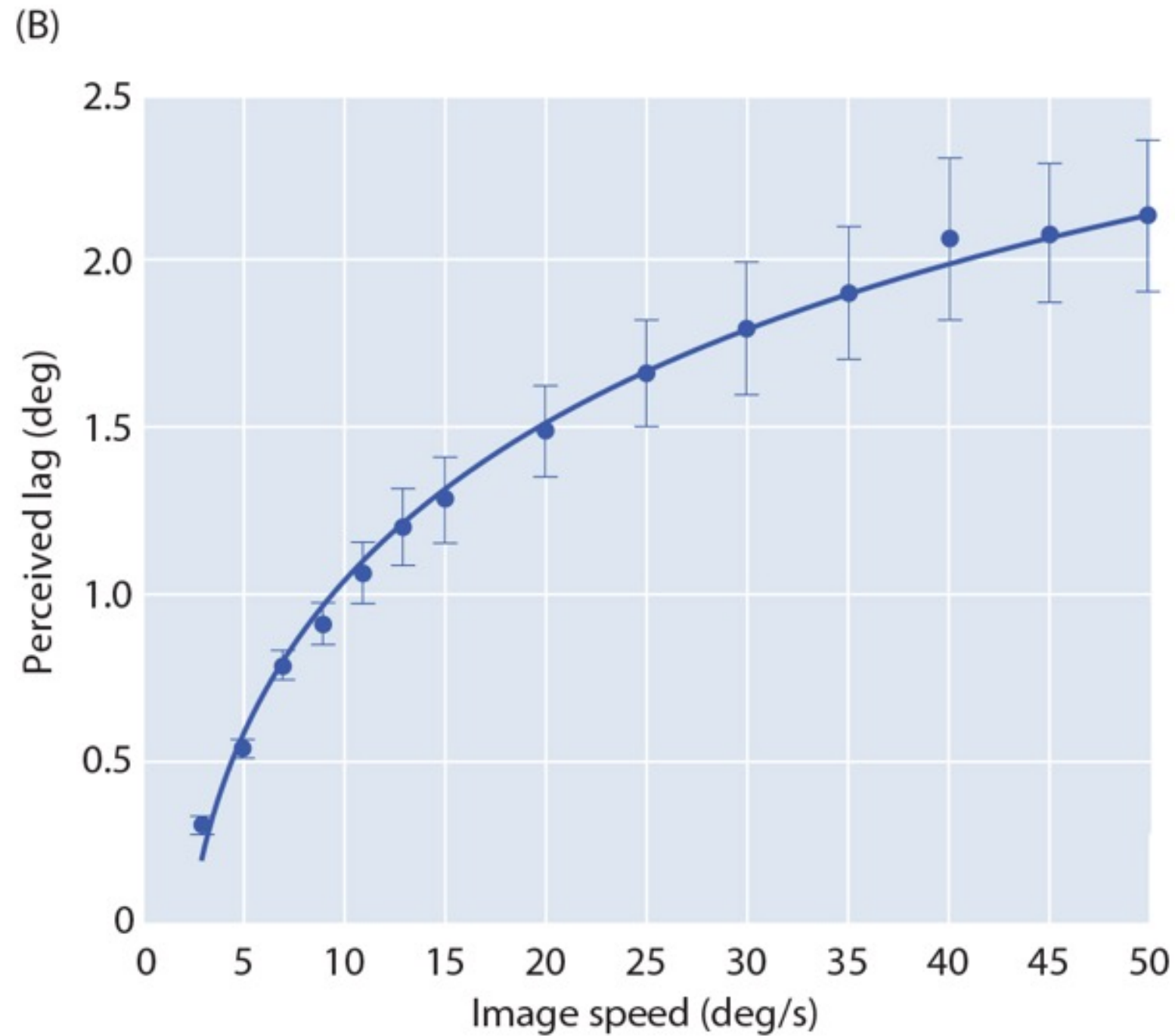
Testing the flash-lag effect



Testing the flash-lag effect

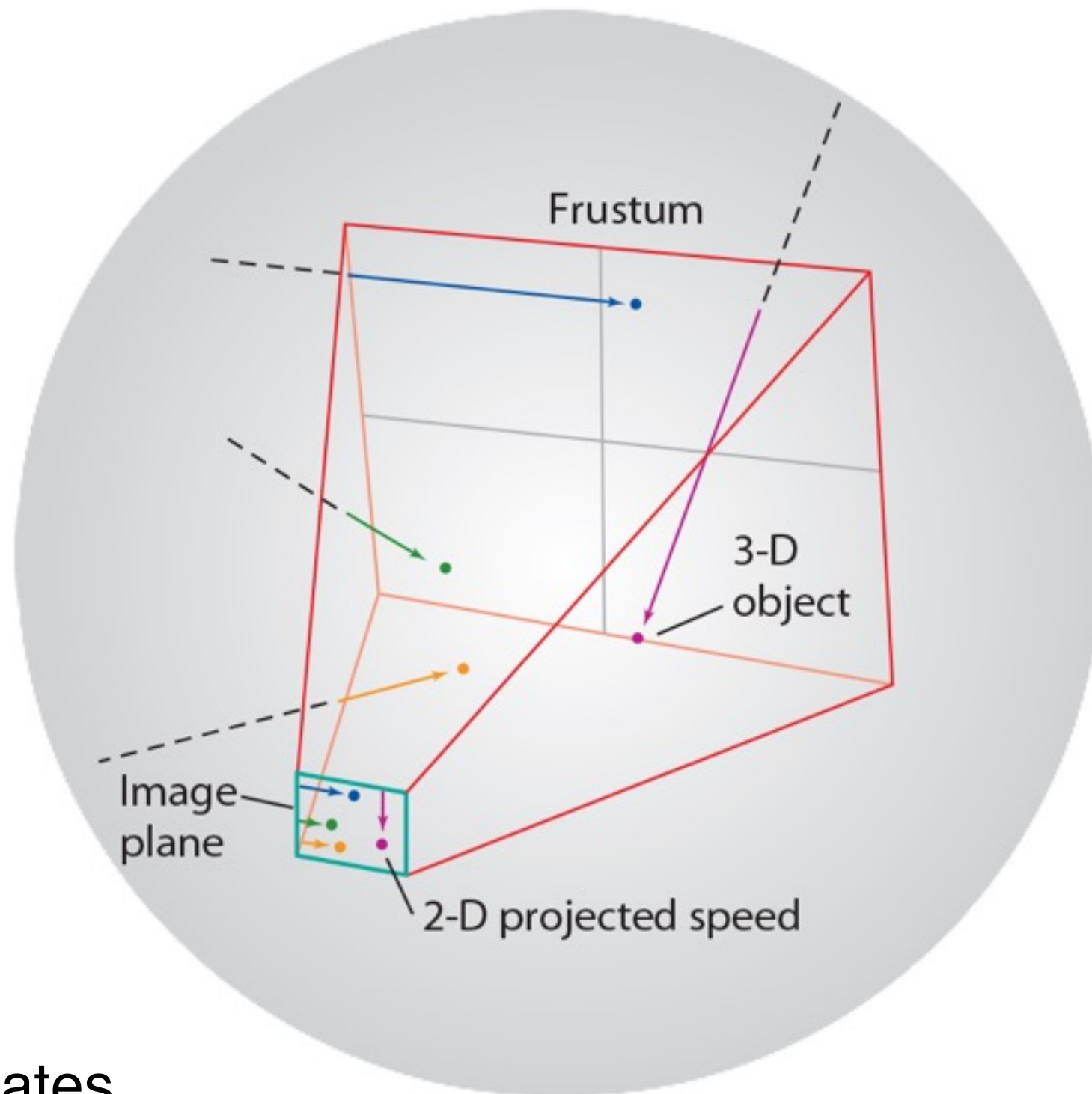


The results

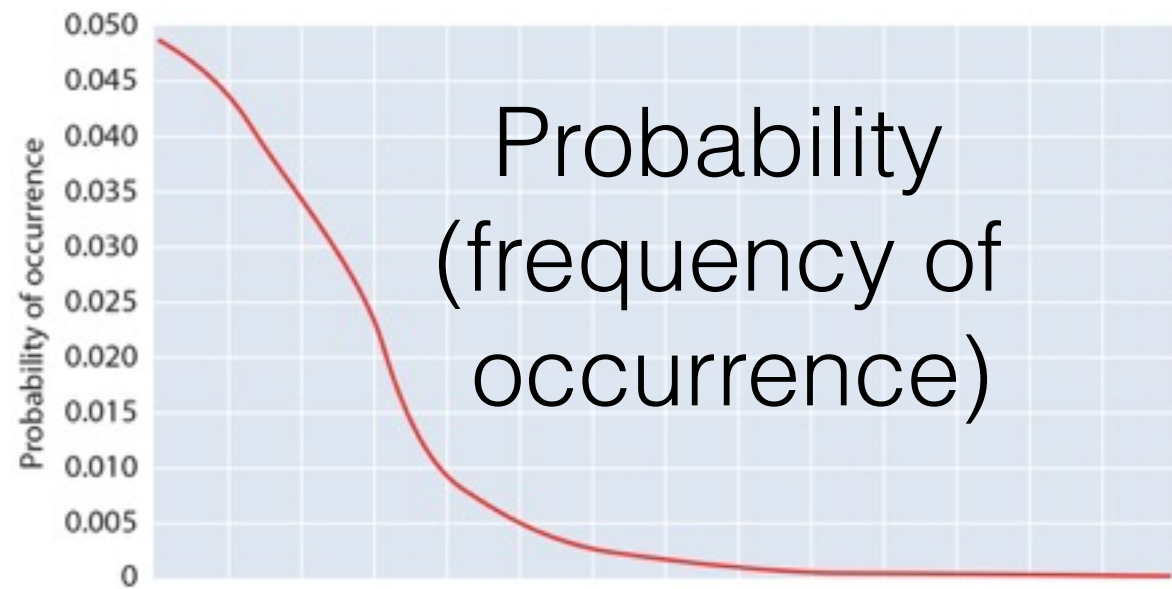


Lesson 7. An Empirical Explanation

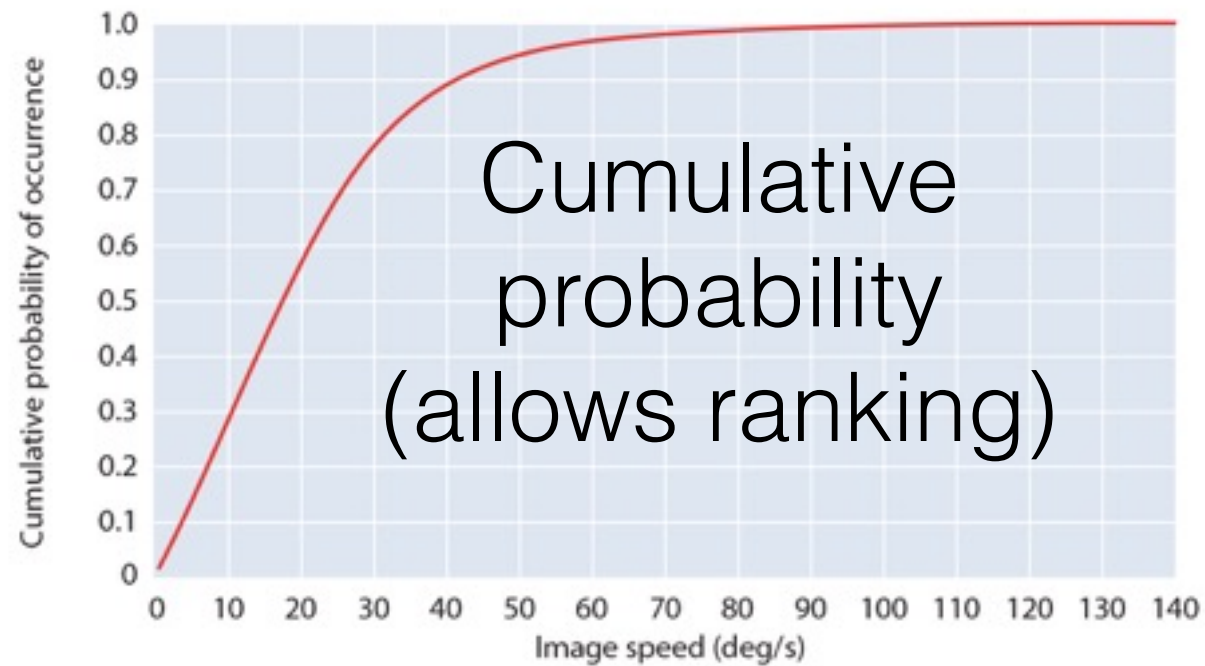
Frequency of occurrence of the speeds of moving objects are projected onto the retina



(A)

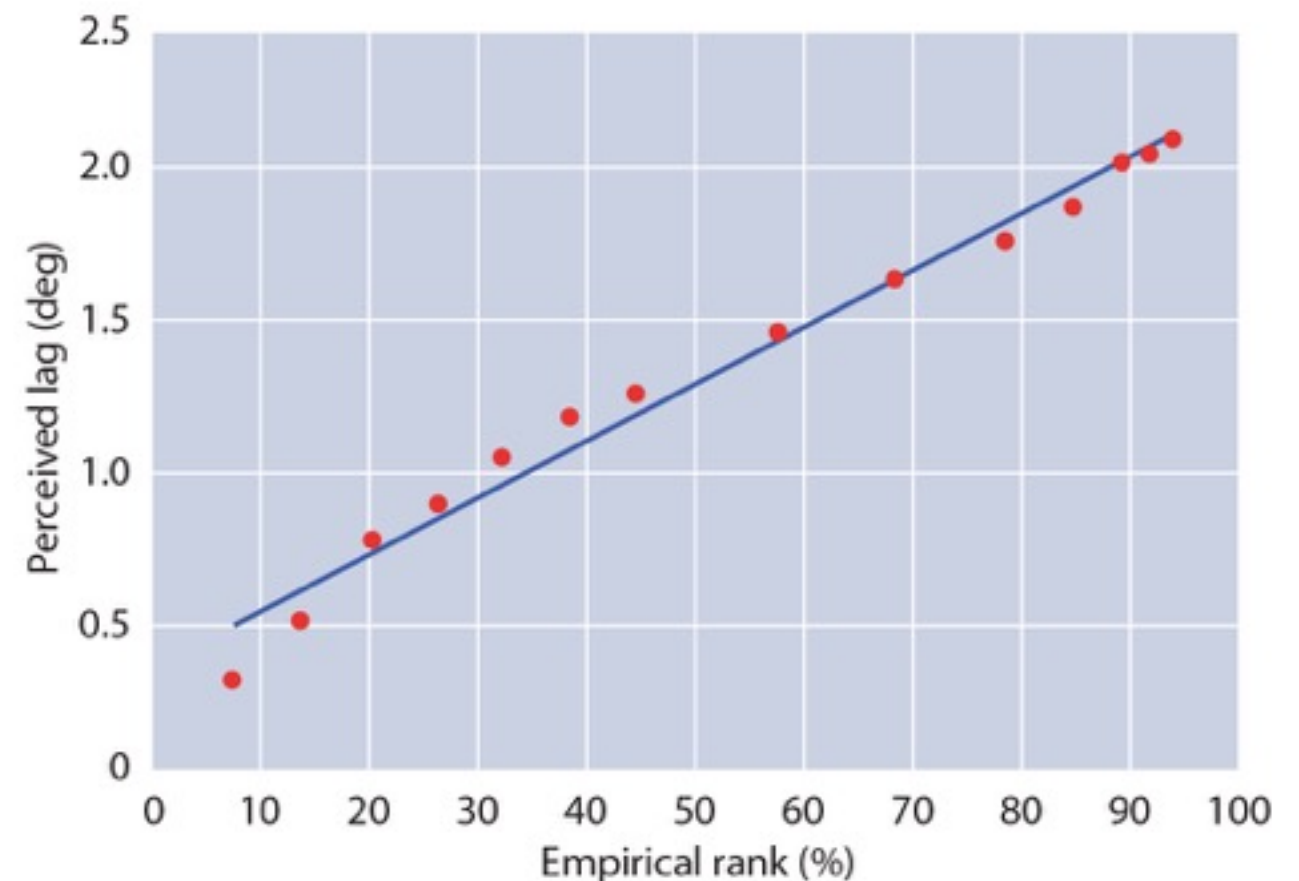


(B)

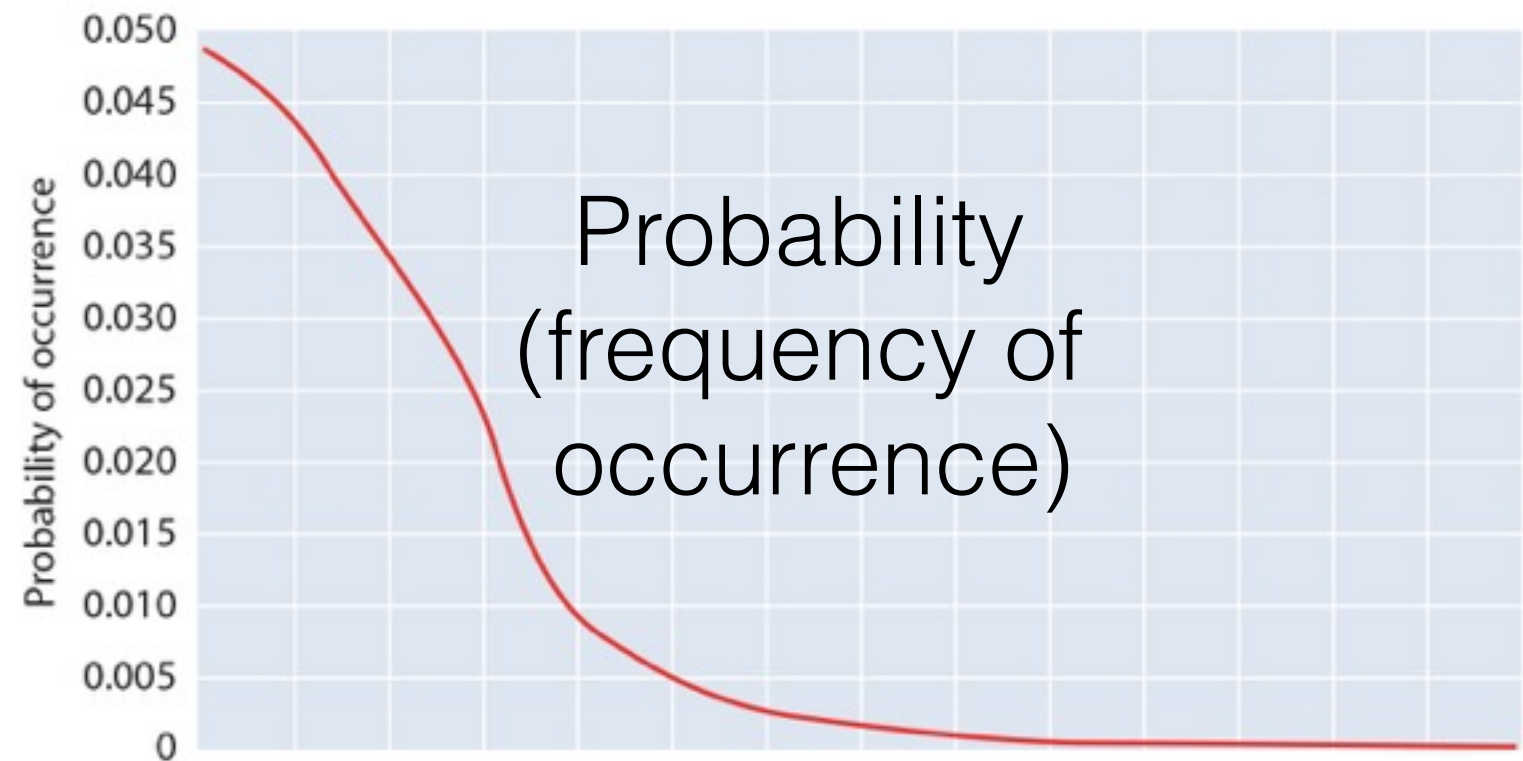


Frequency of stimulus
occurrence (physical)

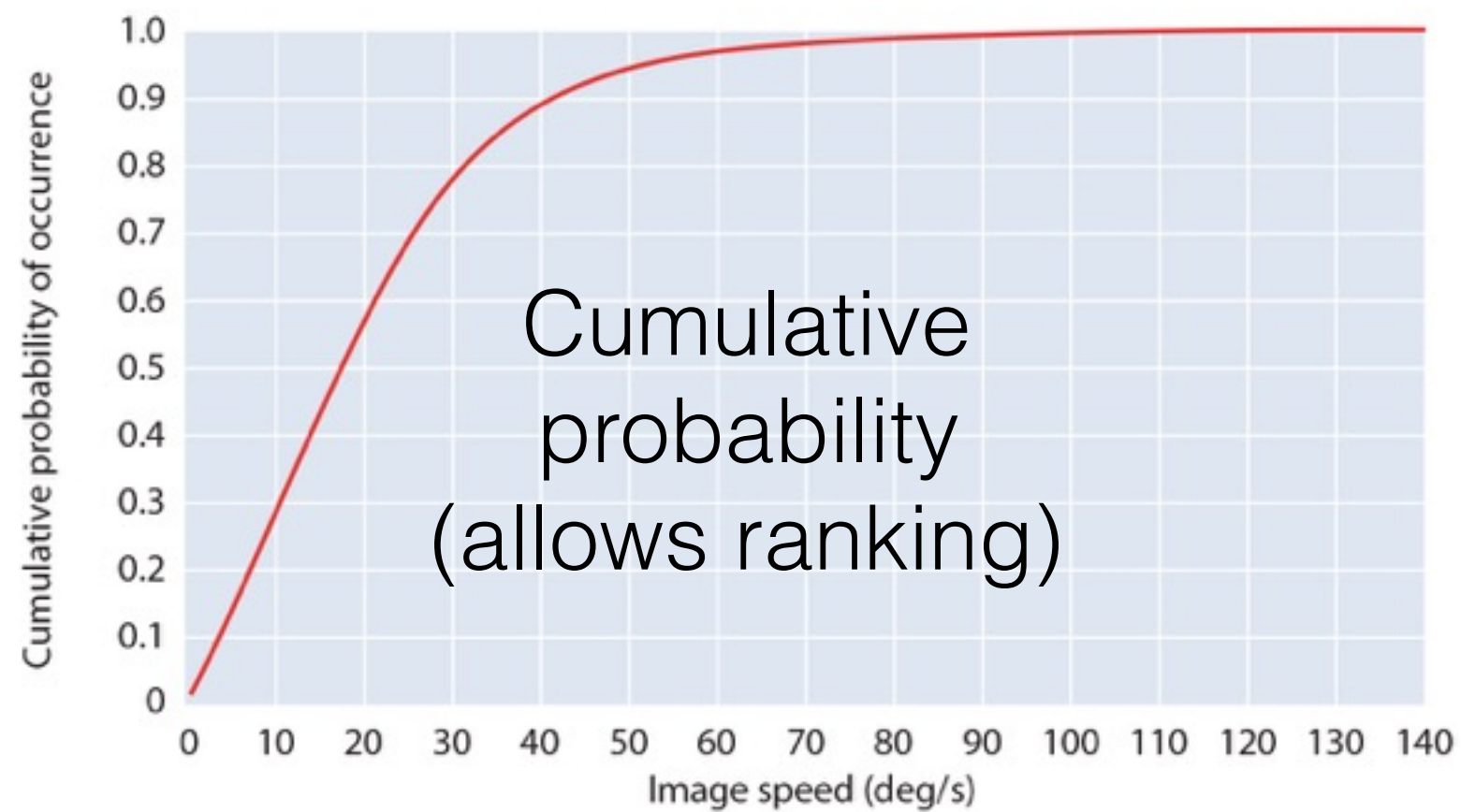
Comparison with
perception



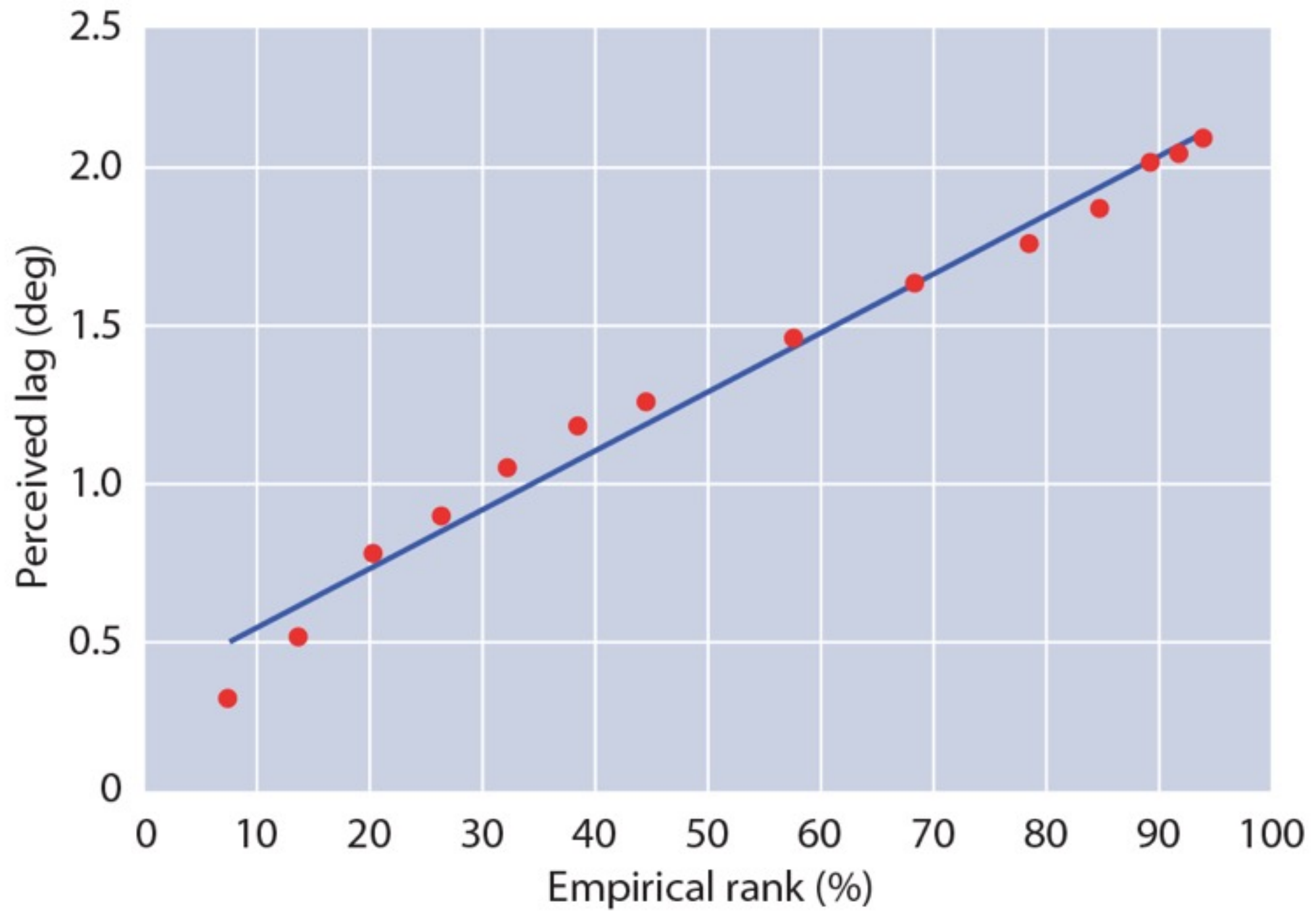
(A)



(B)



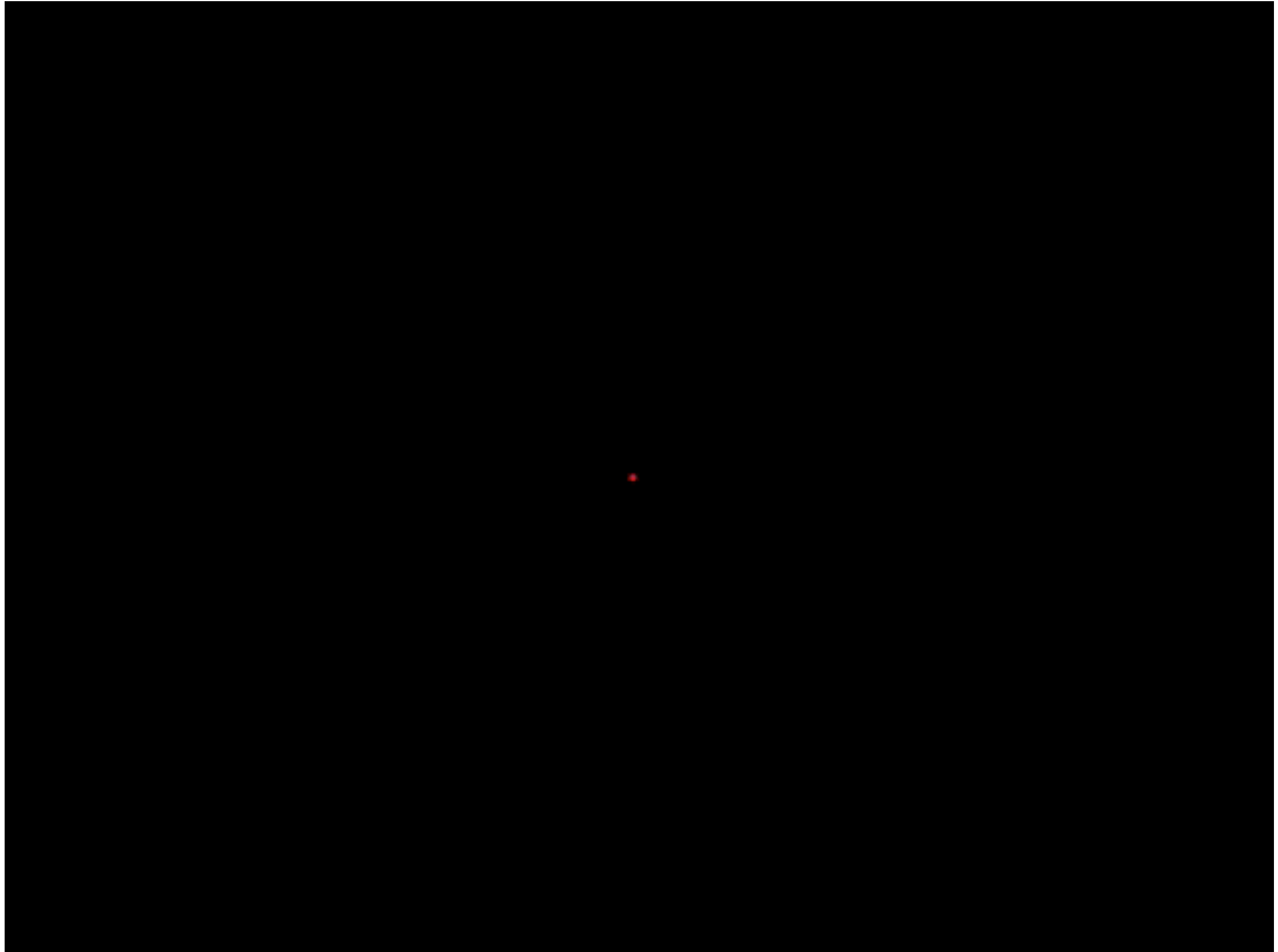
Frequency of stimulus occurrence (physical)

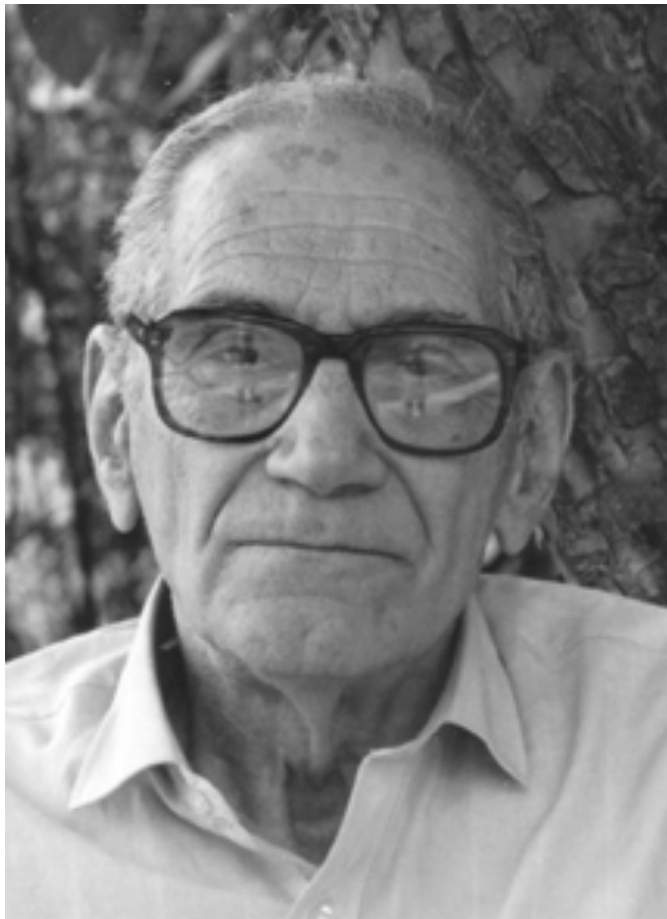


Comparison with perception

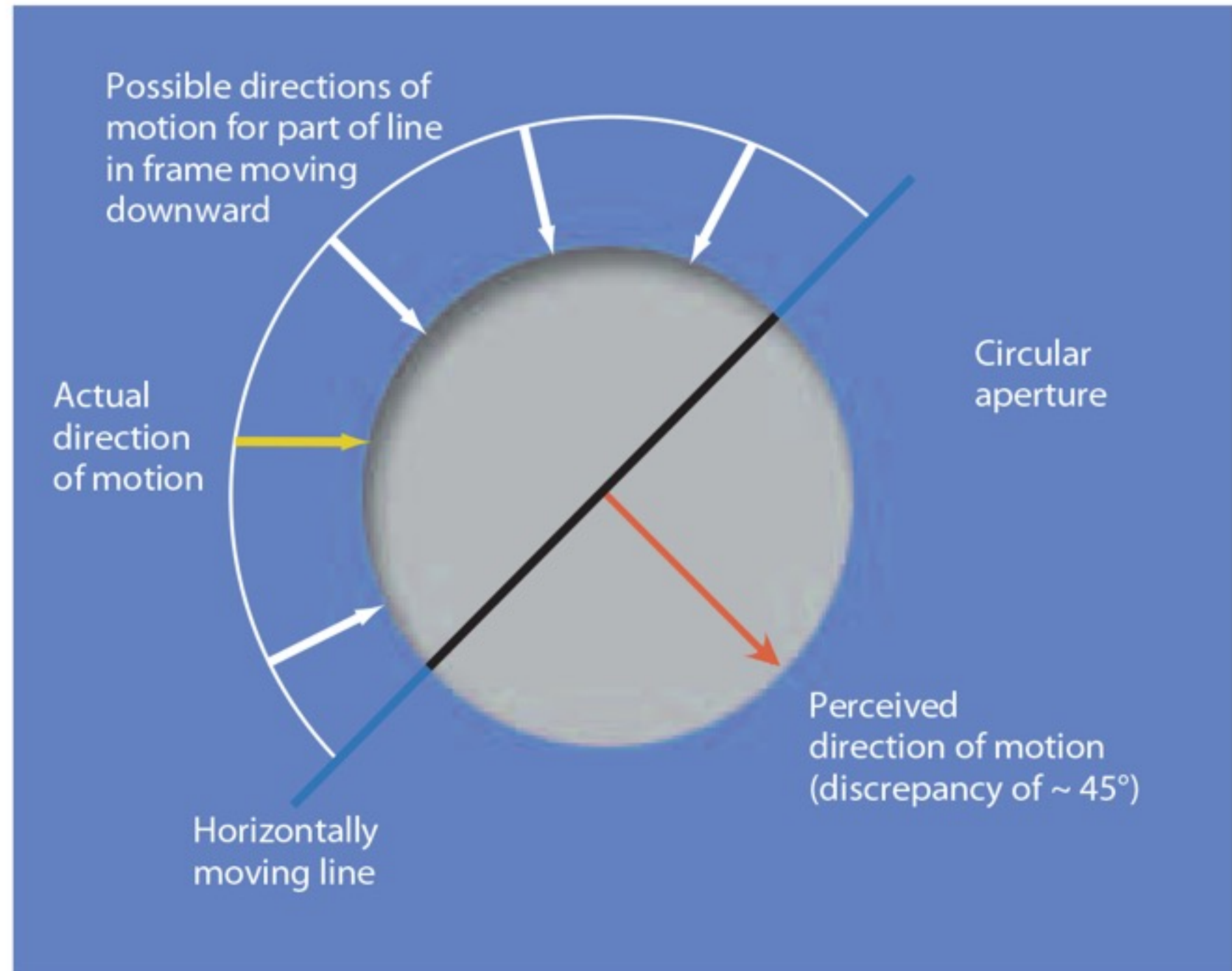
Lesson 8. Perceived Direction: Aperture Effects

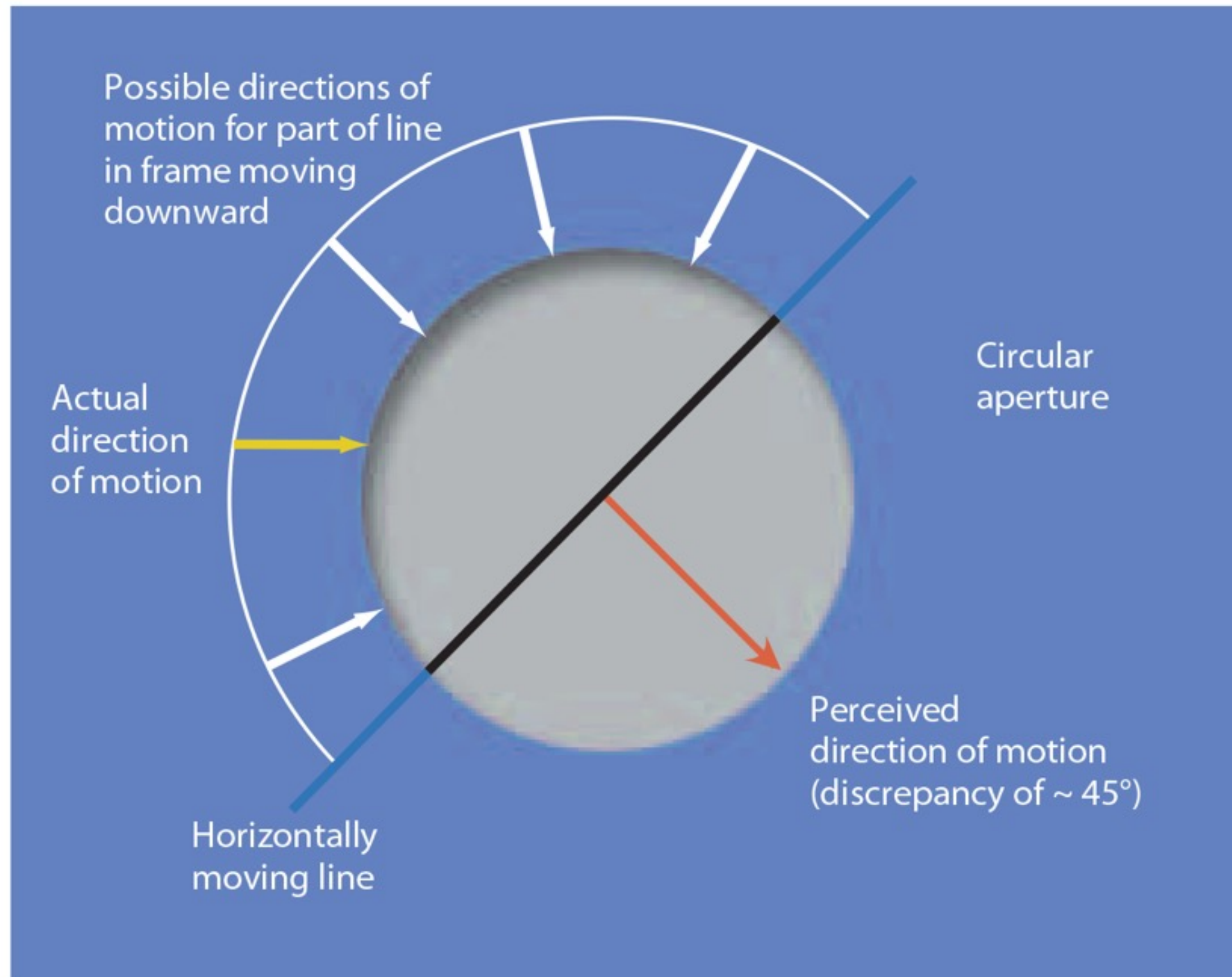
The effect of an aperture on the direction of motion seen

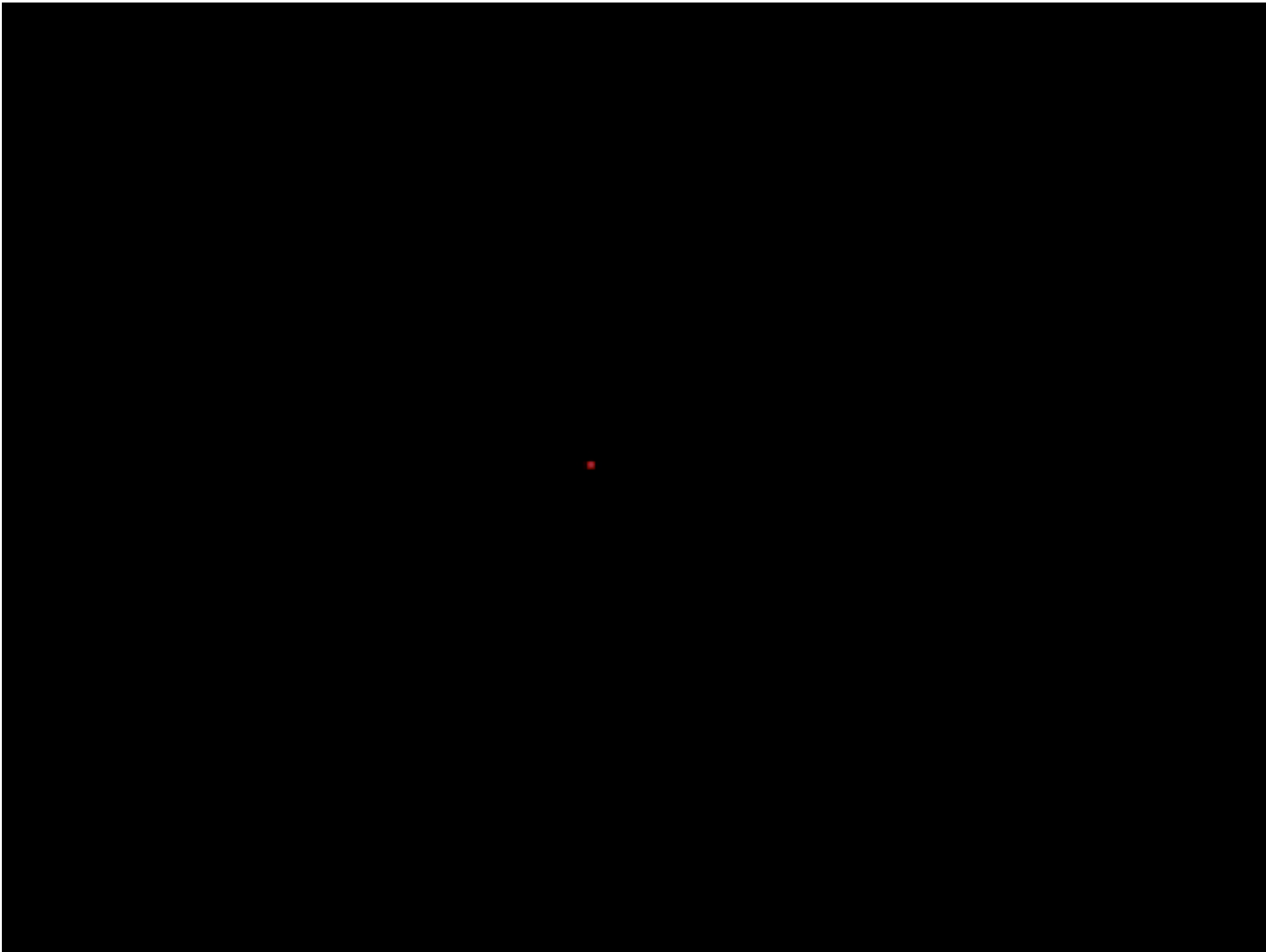




Hans Wallach
(1904–1998)

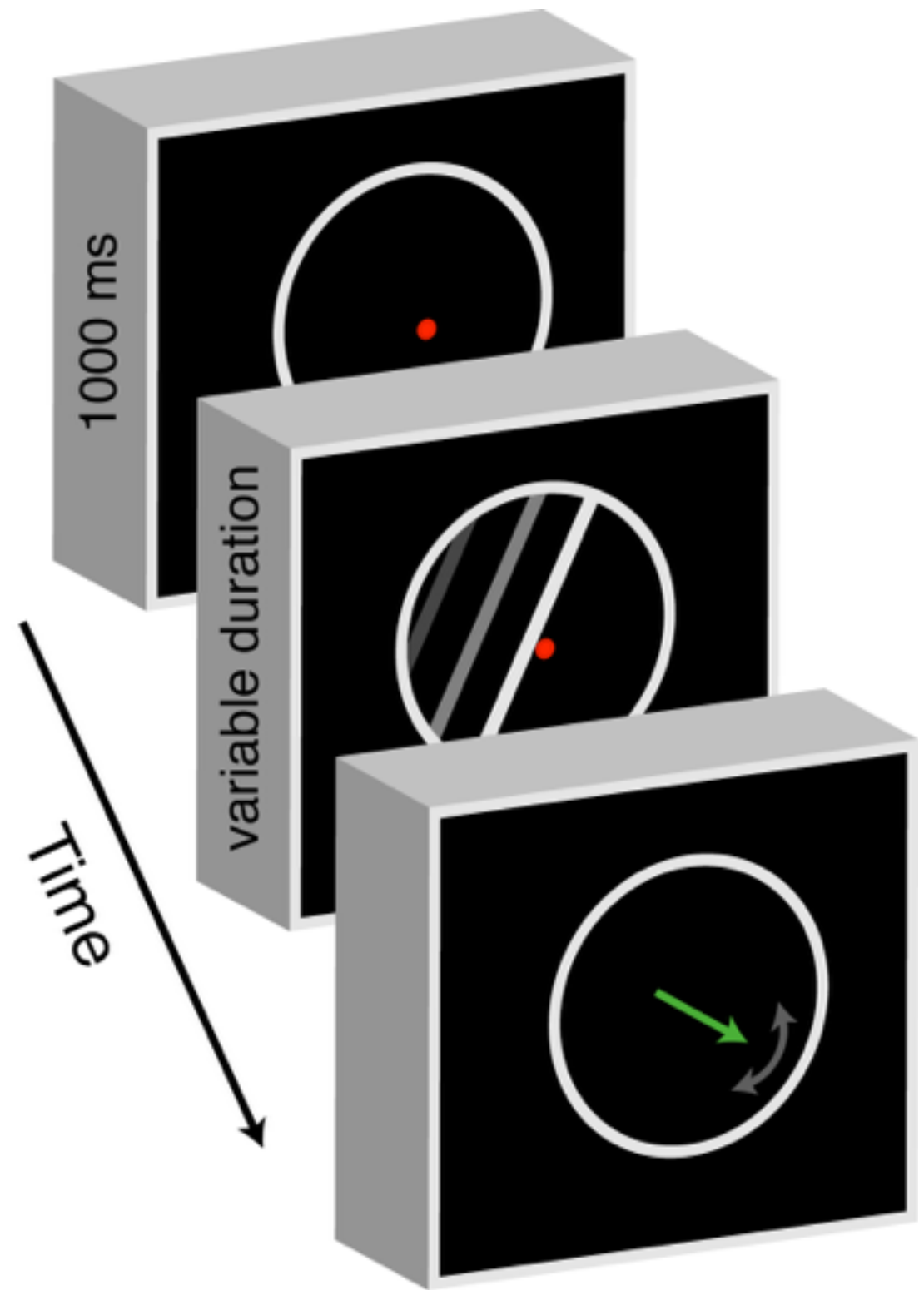




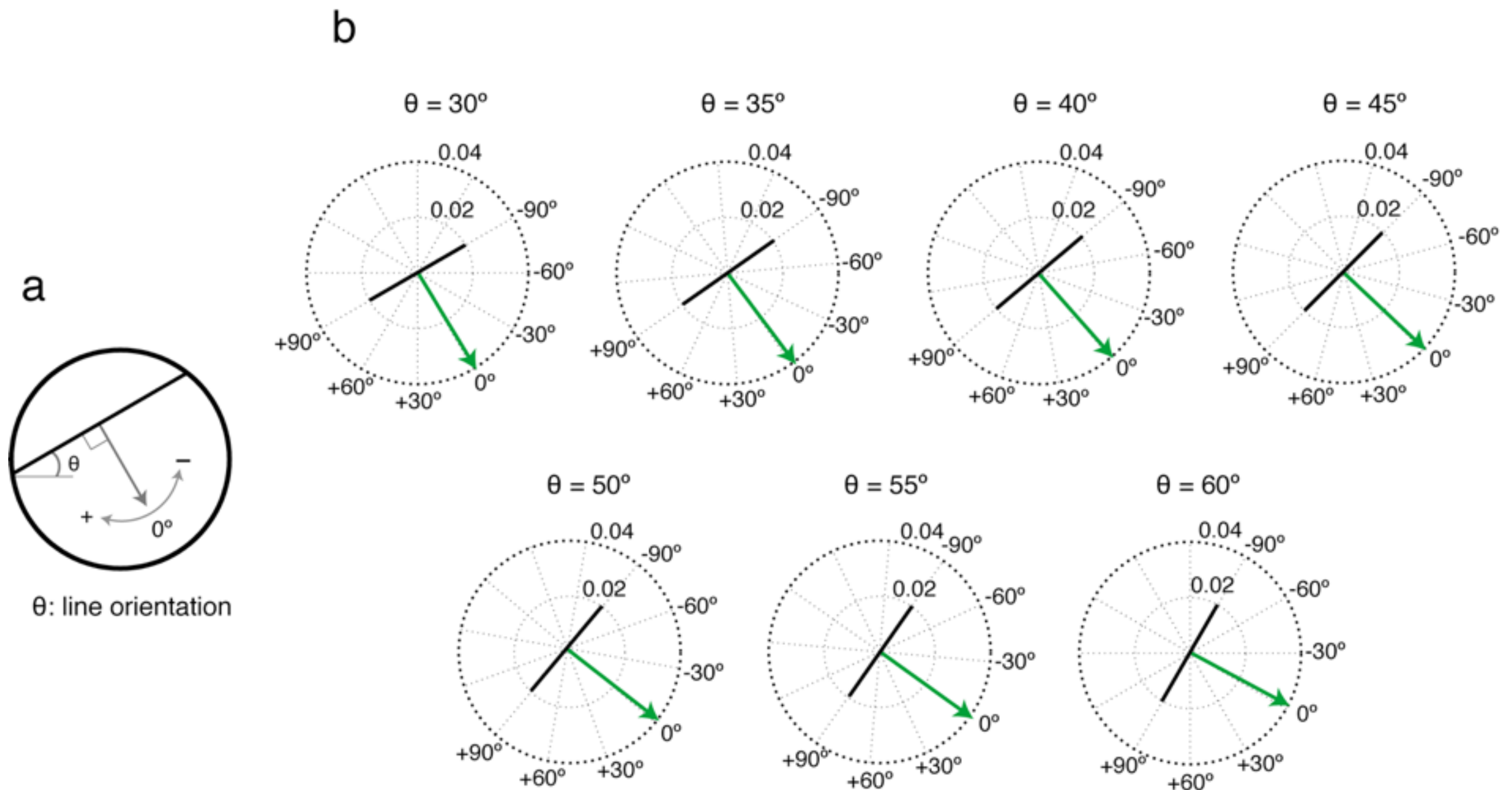


Lesson 9. An Empirical Explanation

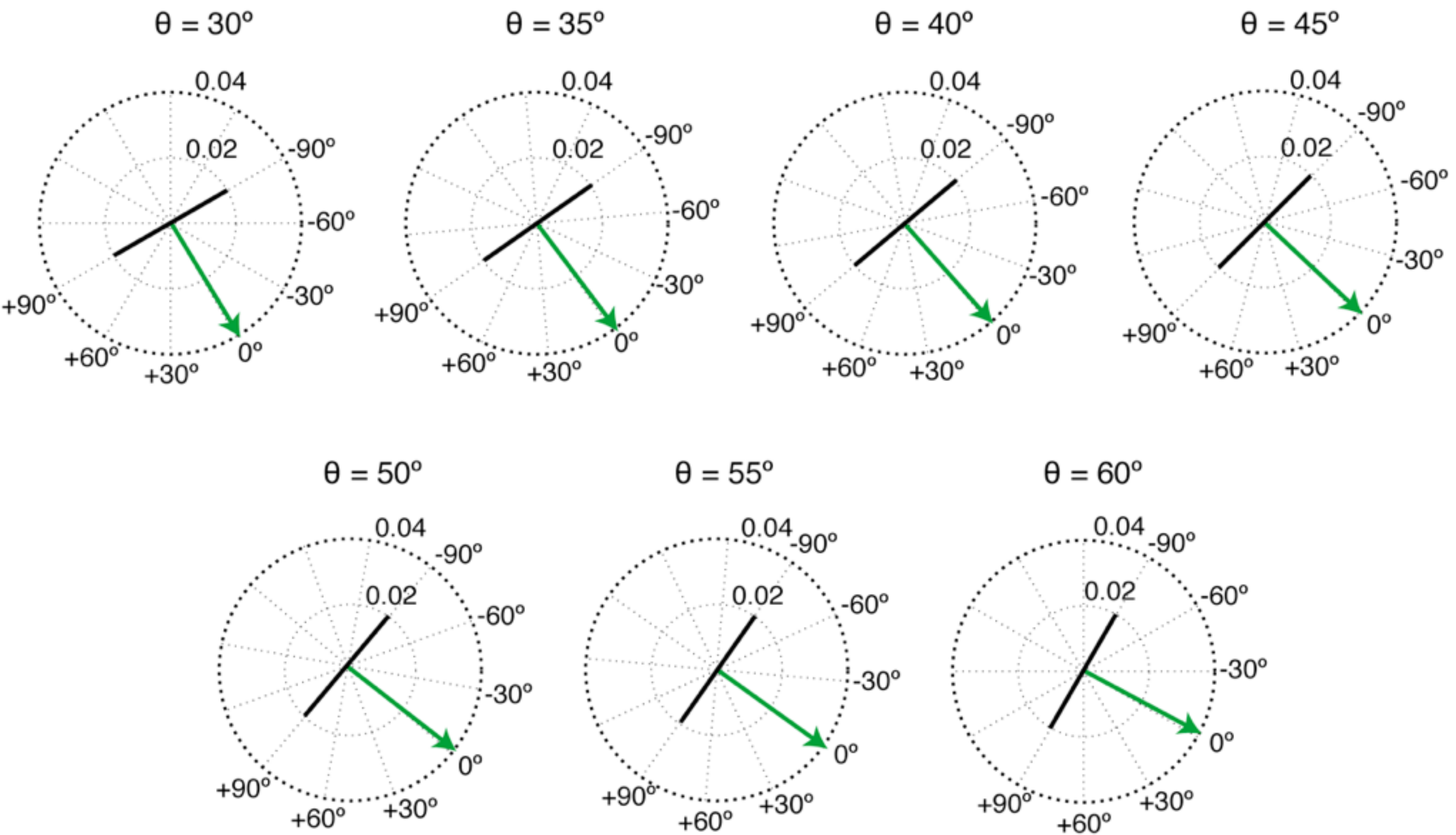
Step 1:
Determine
the
directions
people see
when a given
aperture is
applied



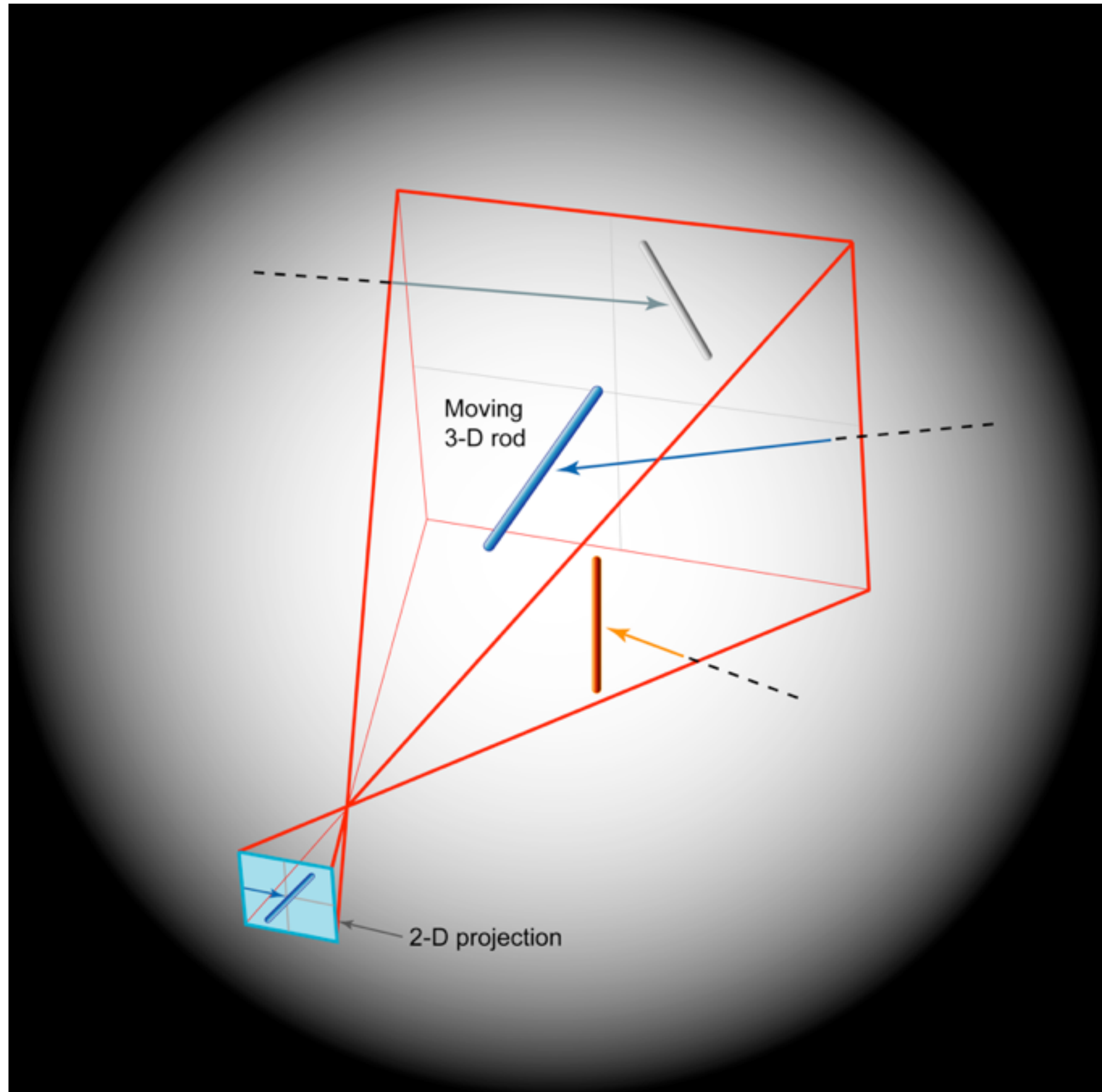
Directions of motion reported in psychophysical testing for a circular aperture



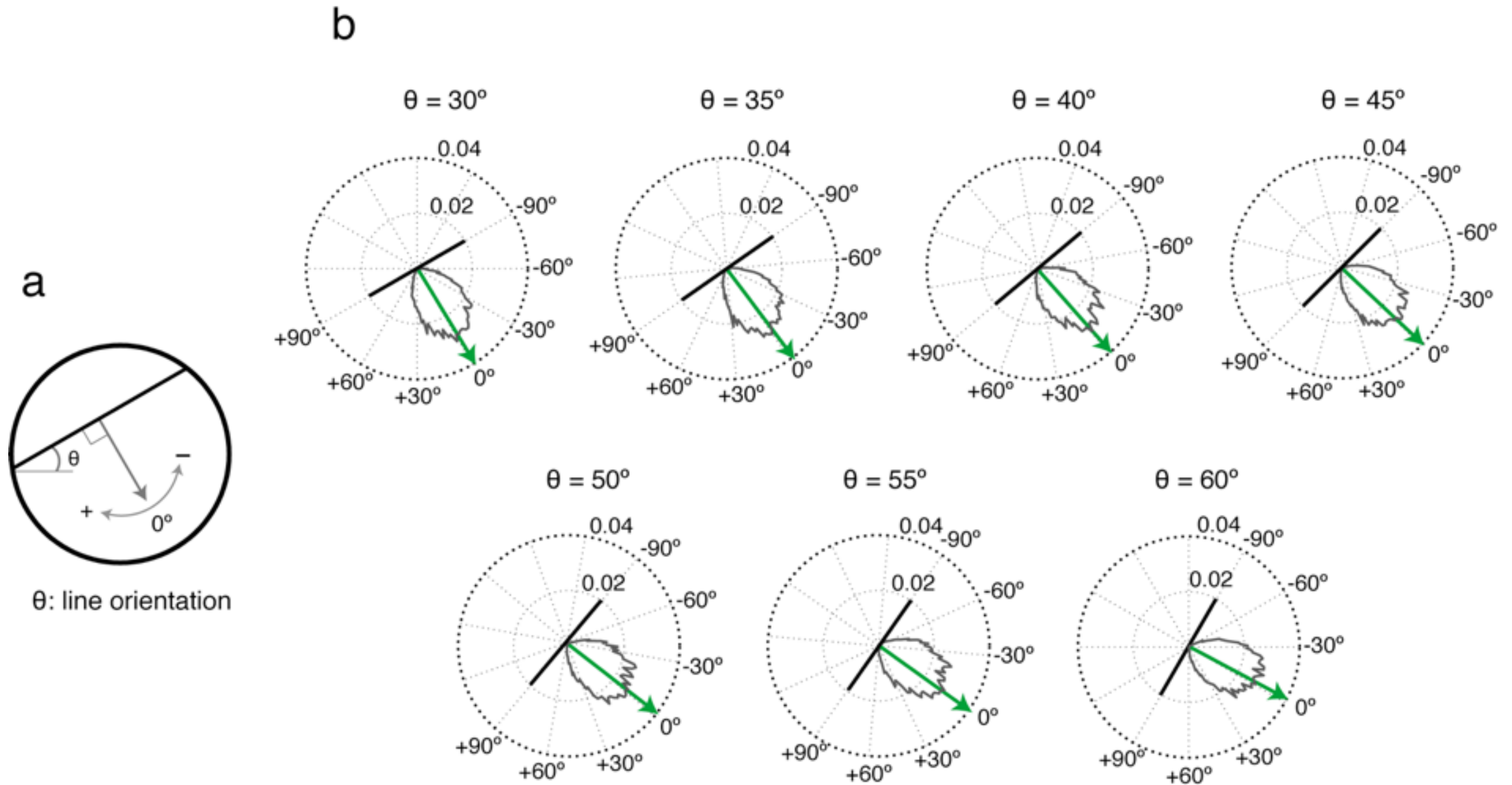
b



Step 2:
Collect the
relevant
empirical
data about
lines
projecting
onto the
retina
through an
aperture

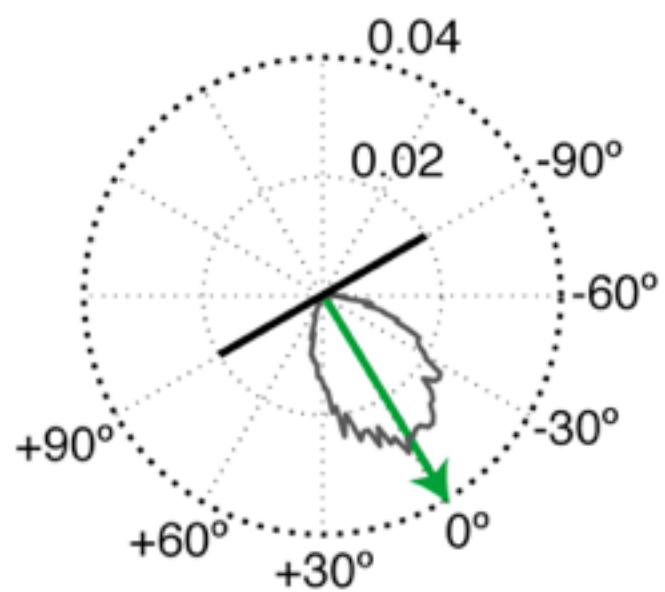


Human experience with projected directions through the aperture

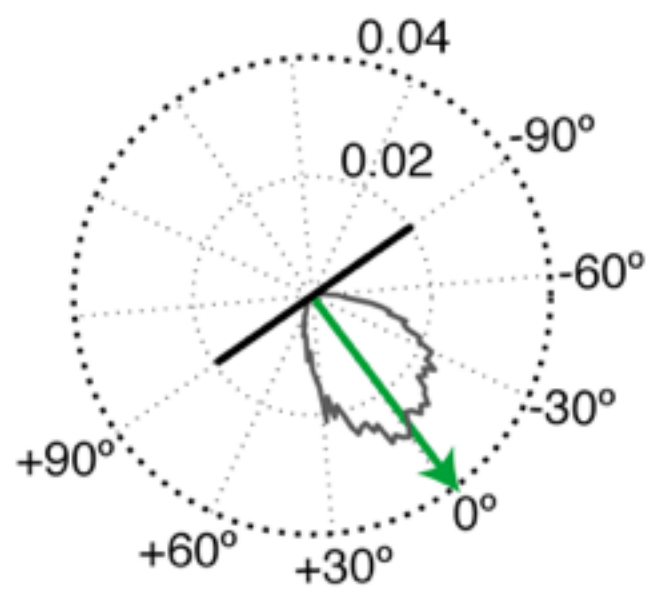


b

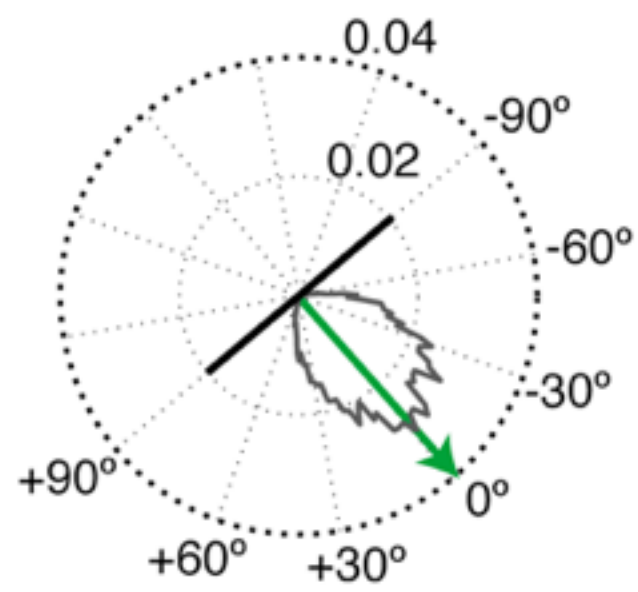
$\theta = 30^\circ$



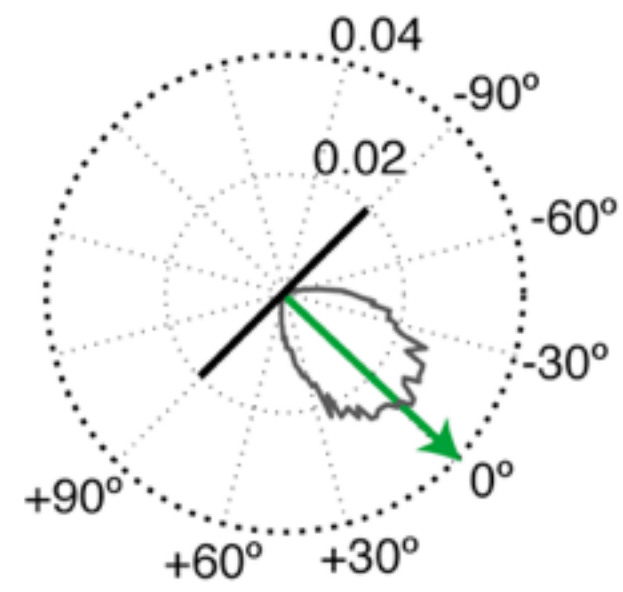
$\theta = 35^\circ$



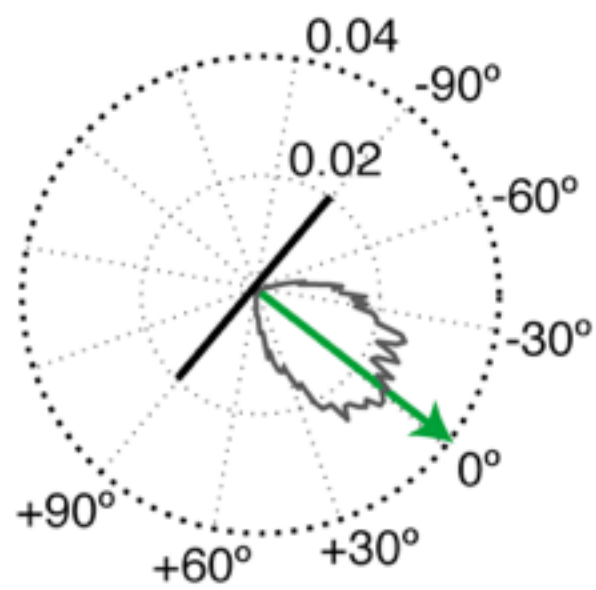
$\theta = 40^\circ$



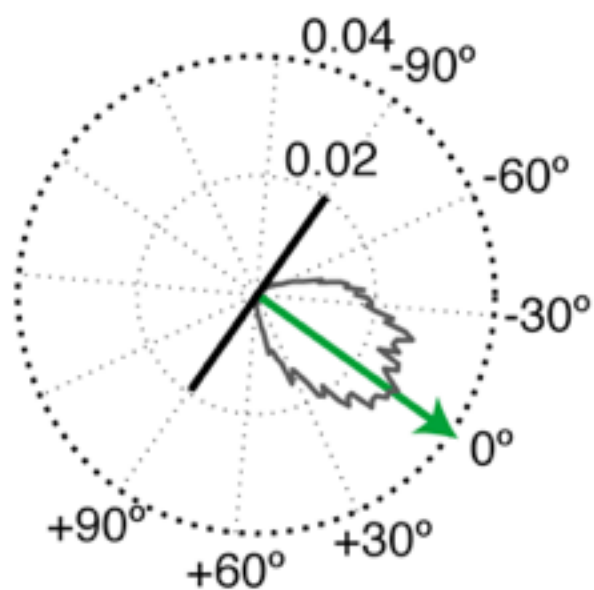
$\theta = 45^\circ$



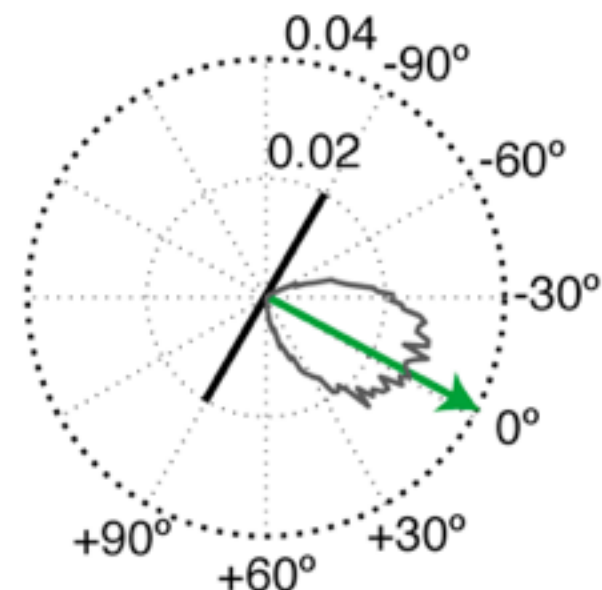
$\theta = 50^\circ$



$\theta = 55^\circ$

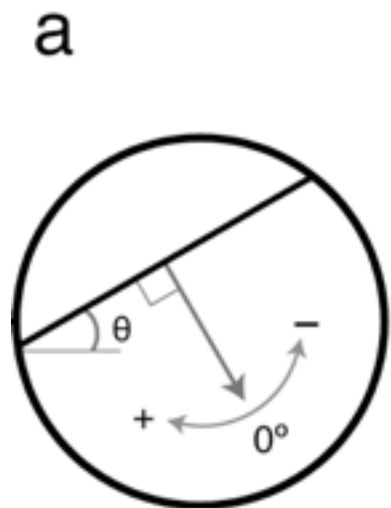


$\theta = 60^\circ$

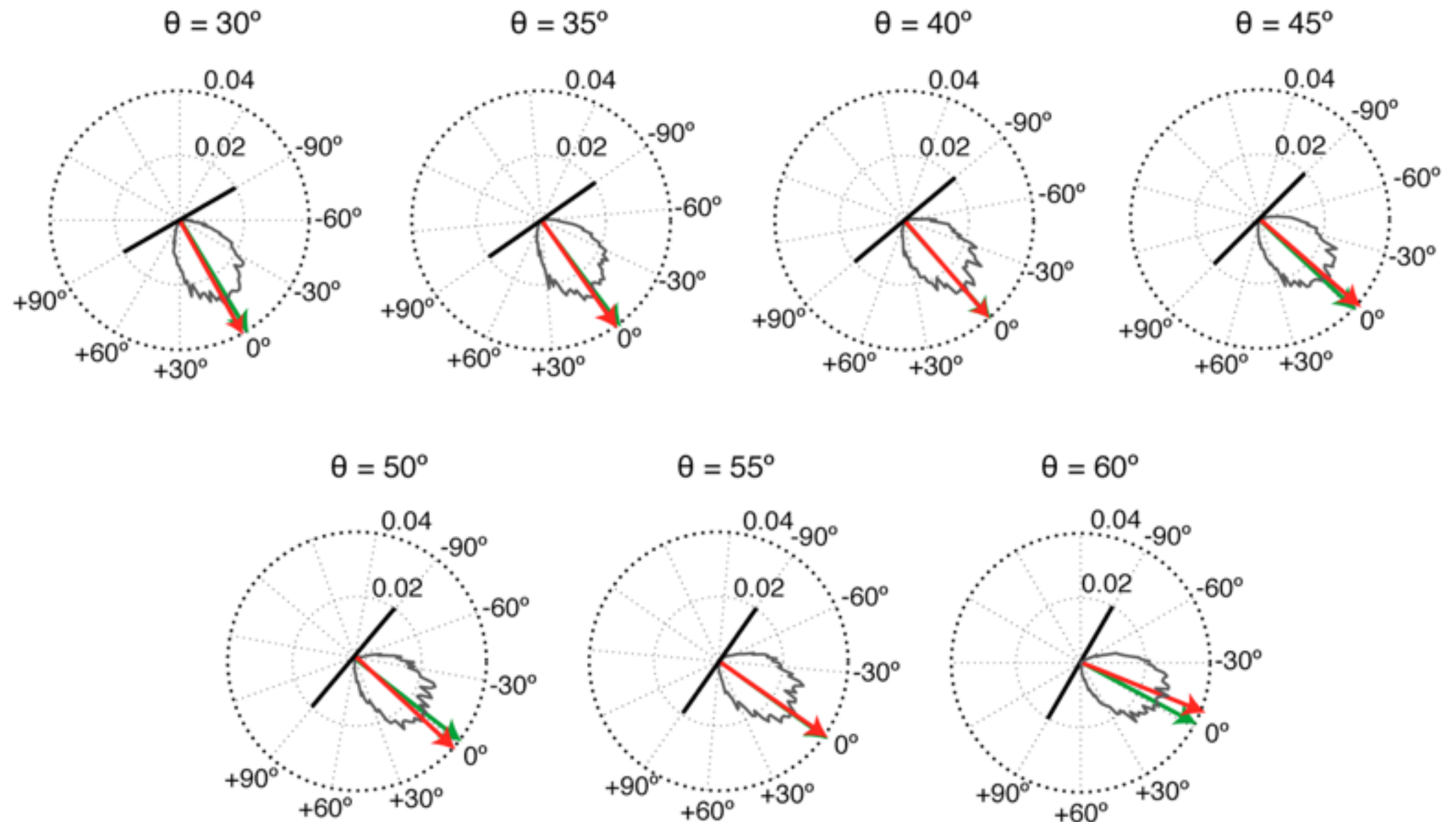


Step 3: Compare the psychophysical results with the frequency of directions experienced

b

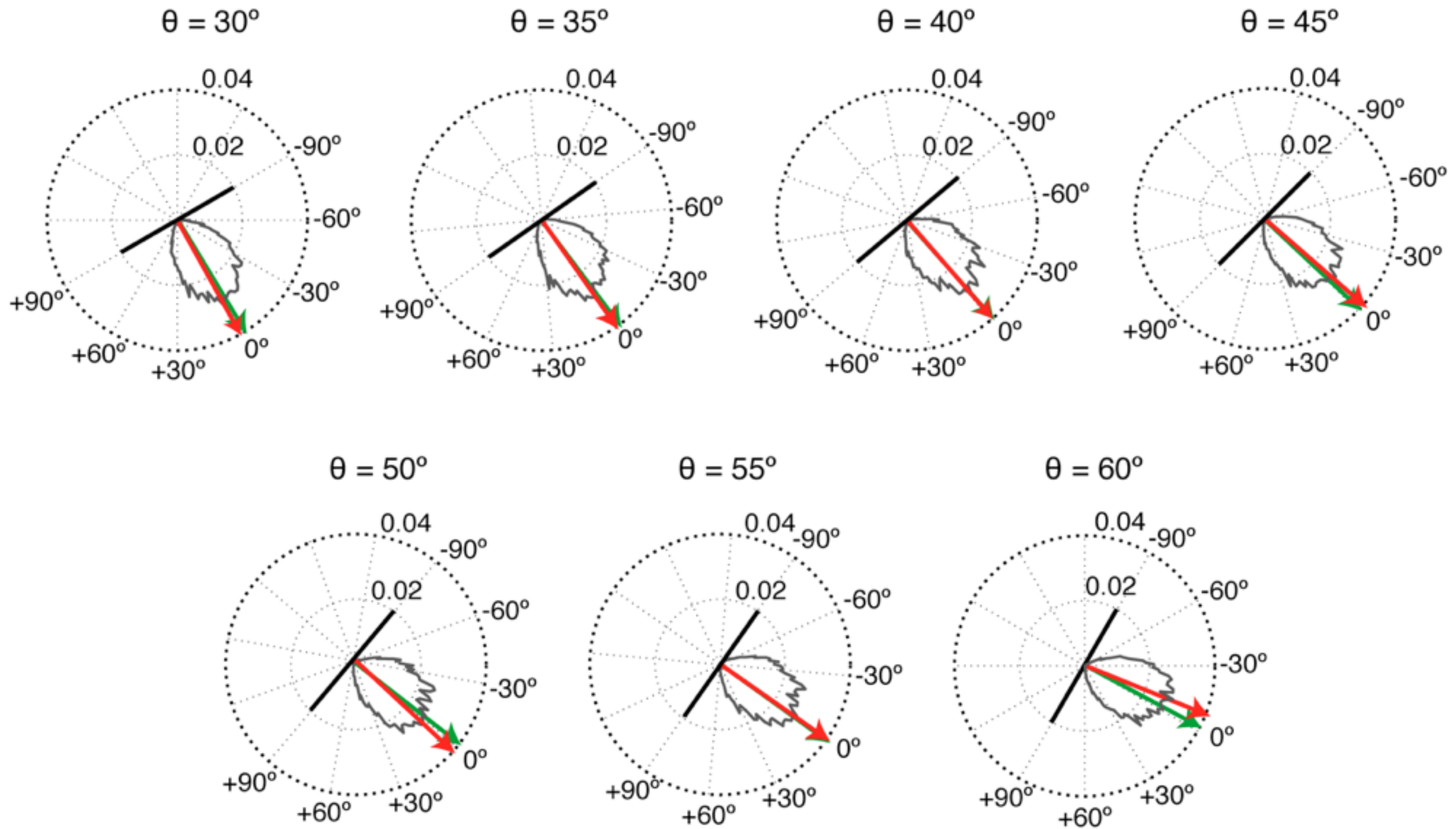


θ : line orientation



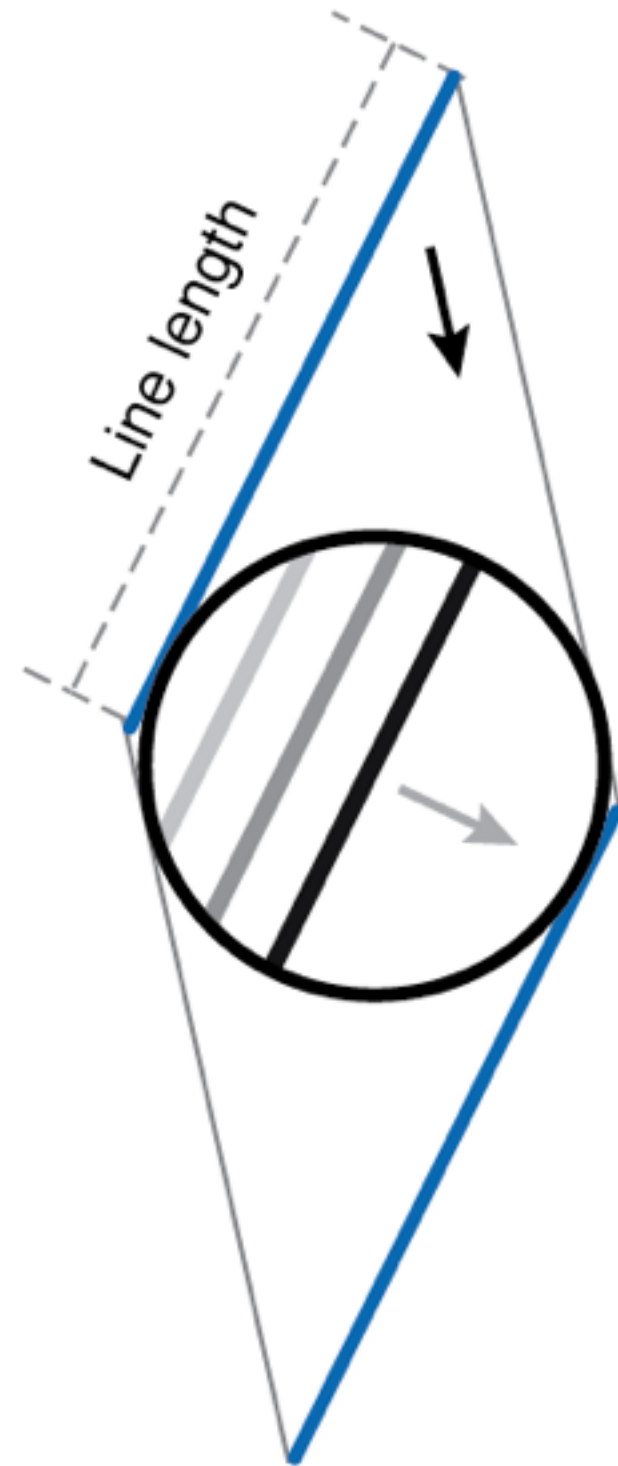
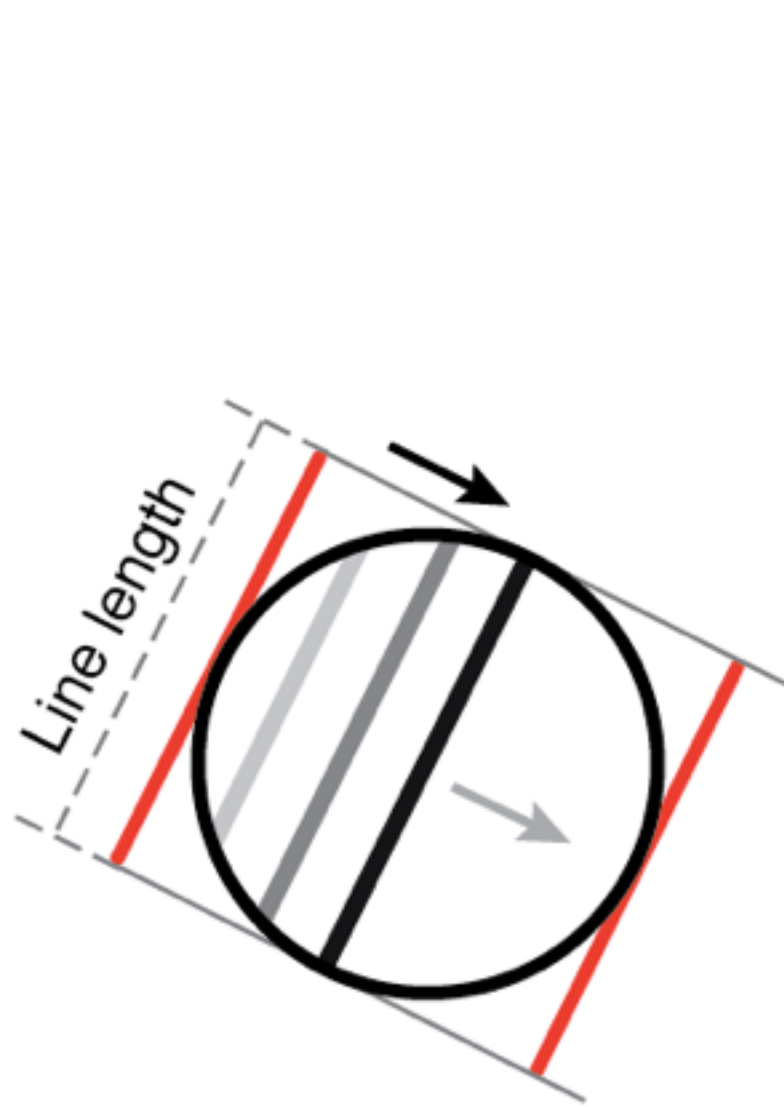
Upshot: The mode of the probability distributions of projected directions closely accords with perceived direction

b



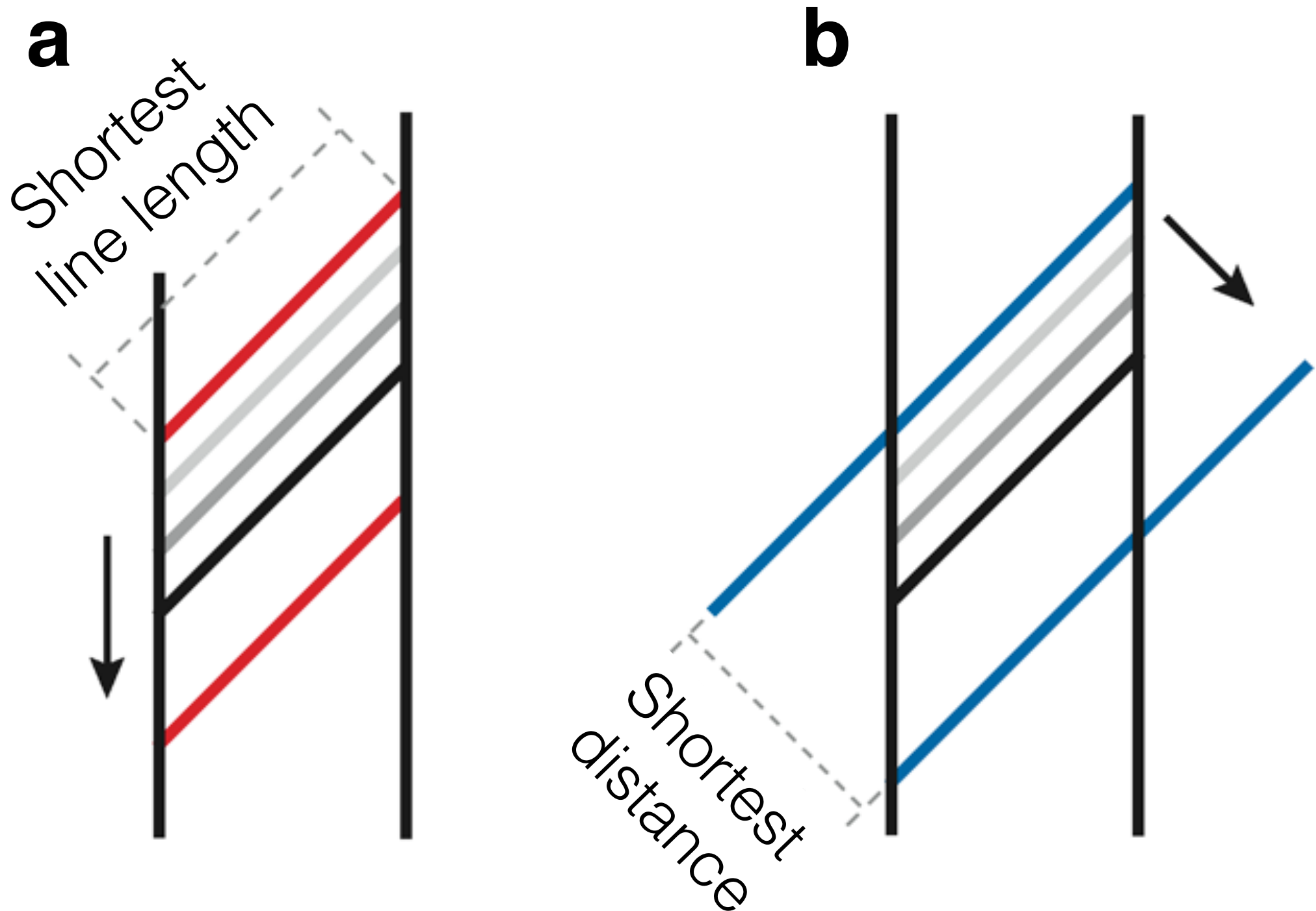
Upshot: The mode of the probability distributions of projected directions closely accords with perceived direction

This bias arises because lines moving orthogonally to their orientation will satisfy the aperture more often than lines moving in any other direction.



Thus the prevalent projected direction of lines moving in a circular aperture is orthogonal to the line; this is what humans will always have experienced.

The same argument applies
to any other aperture



Summary of the Main Points

- Motion perception is not well understood
- The flash-lag and related effects offer an important insight into the problem of perceived speed
- Aperture effects offer an important insight into the problem of perceived direction
- Given the inverse problem, an empirical explanation based on accumulated experience is the most feasible account

Credits

Angel Falls, CC BY 2.0 Eric Cleves Kristensen, flickr.com

Dale Purves, R. Beau Lotto. *Why We See What We Do Redux*, Sinauer Associates Inc. 2011

- Flash-lag phenomenon, pg. 159
- Projected image on image plane over time, pg. 161
- Testing the flash-lag effect, pg. 162
- Frequency of occurrence of the speeds of moving objects projected onto the retina, pg. 160
- Frequency of stimulus occurrence (physical), pg. 163
- Comparison with perception, pg. 164

The effect of an aperture on the direction of motion seen, ©2014 Dale Purves

Hans Wallach, *Annual Review of Psychology*, 1987.38:1-39

Effect of aperture on perceived direction of motion, Dale Purves, R. Beau Lotto. *Why We See What We Do Redux*, Sinauer Associates Inc. 2011, pg. 171

Credits, Cont.

The effect of an aperture on the direction of motion seen, ©2014 Dale Purves

Sung K, Wojtach WT, Purves D (2009) An empirical explanation of aperture effects Proc Natl Acad Sci, 106 (1): 298-303.

- Determine the directions people see when a given aperture is applied
- Directions of motion reported in psychophysical testing for a circular aperture

Collect the relevant empirical data about lines projecting onto the retina through an aperture, Wojtach WT et al (2008), An Empirical Explanation of the Flash-Lag Effect, Proc Natl Acad Sci, 105 (42): 16338-16343

Sung K, Wojtach WT, Purves D (2009) An empirical explanation of aperture effects Proc Natl Acad Sci, 106 (1): 298-303.

- Human experience with projected directions through the aperture.
- Compare the psychophysical results with the frequency of directions experienced.
- Biased distributions of directions of lines projected through apertures

Other apertures, ©2014 Dale Purves