Motion Perception
Chapter 8

Lecture 14

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Sensation & Perception (PSY 345 / NEU 325)
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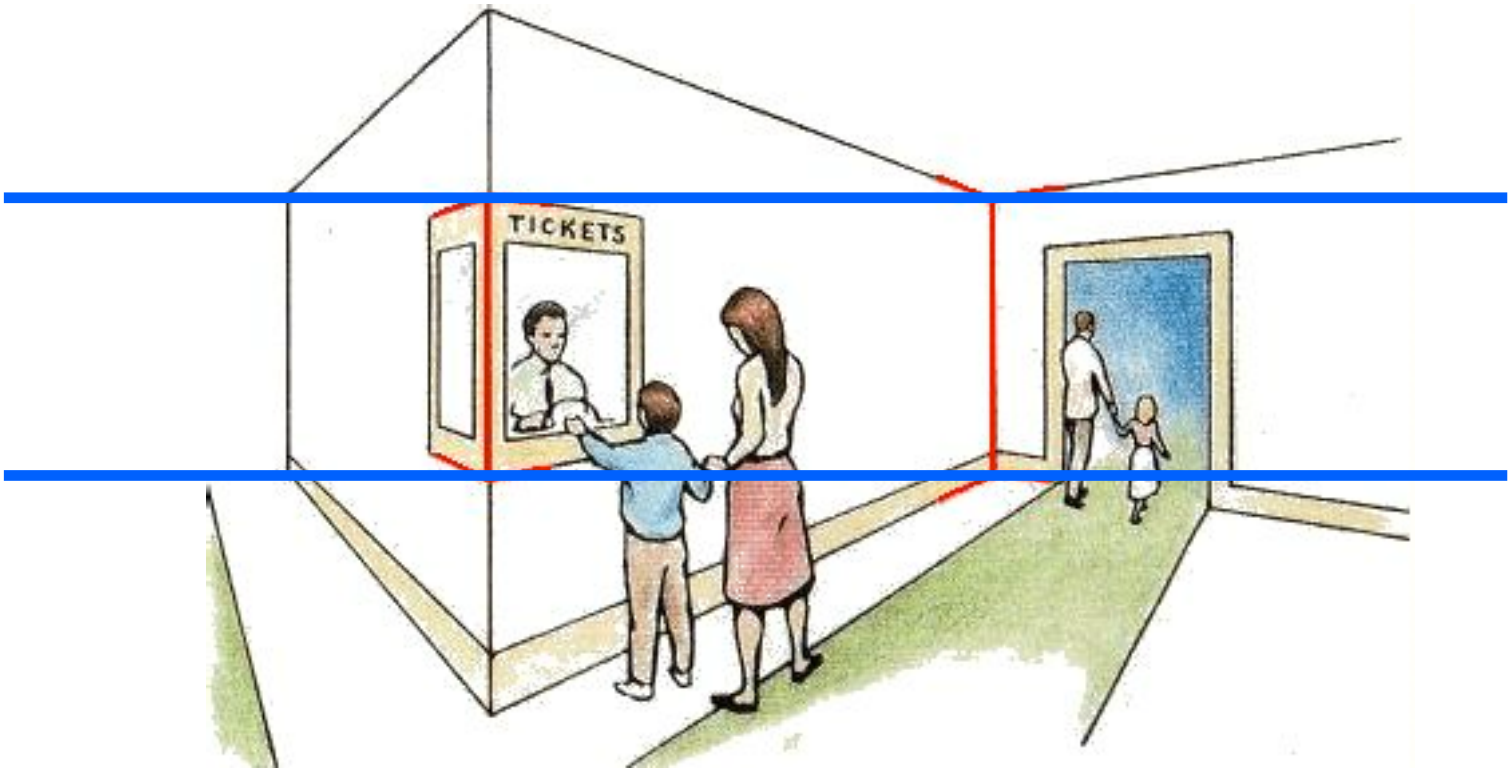
countering the depth-from-focus cue

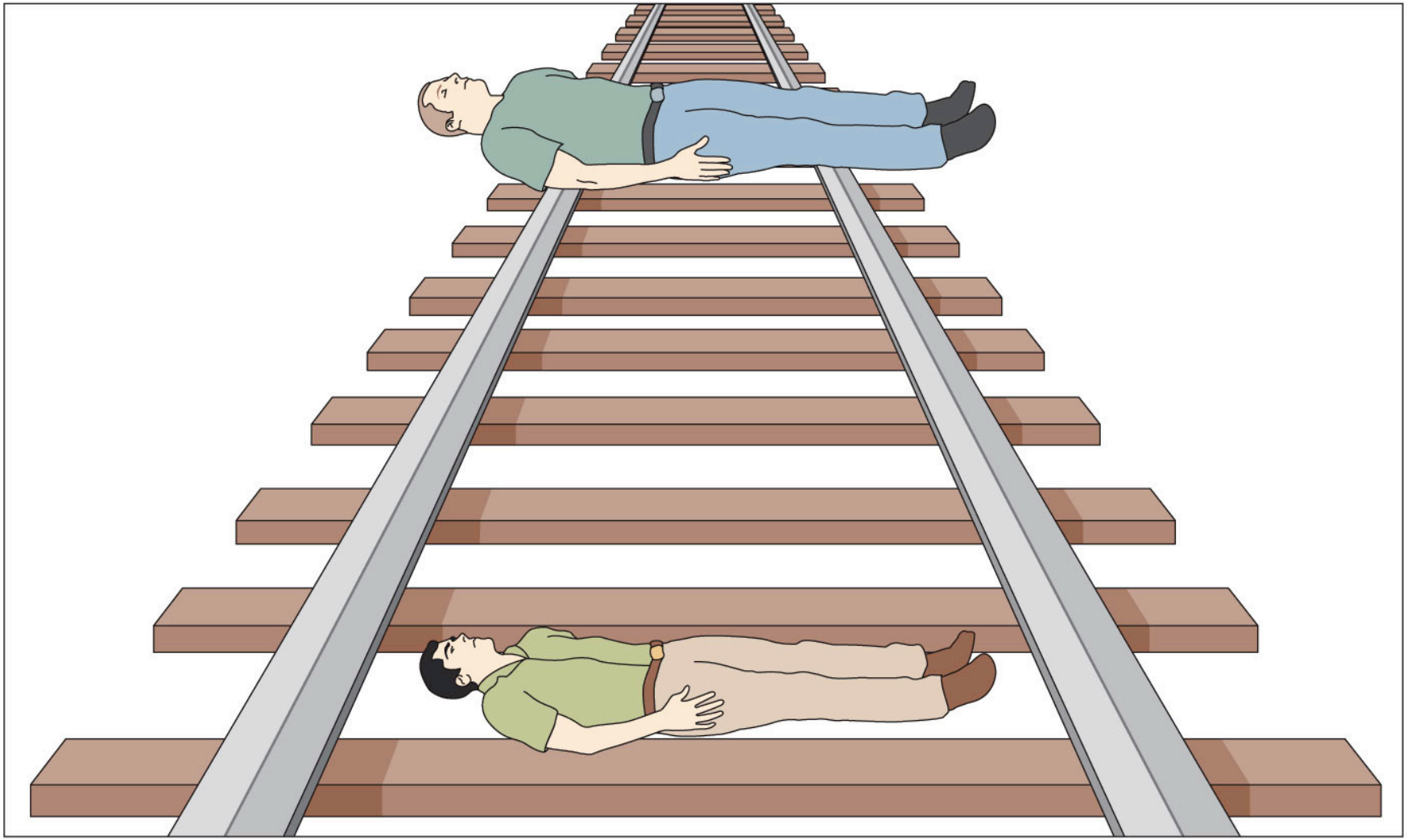
Depth Illusions



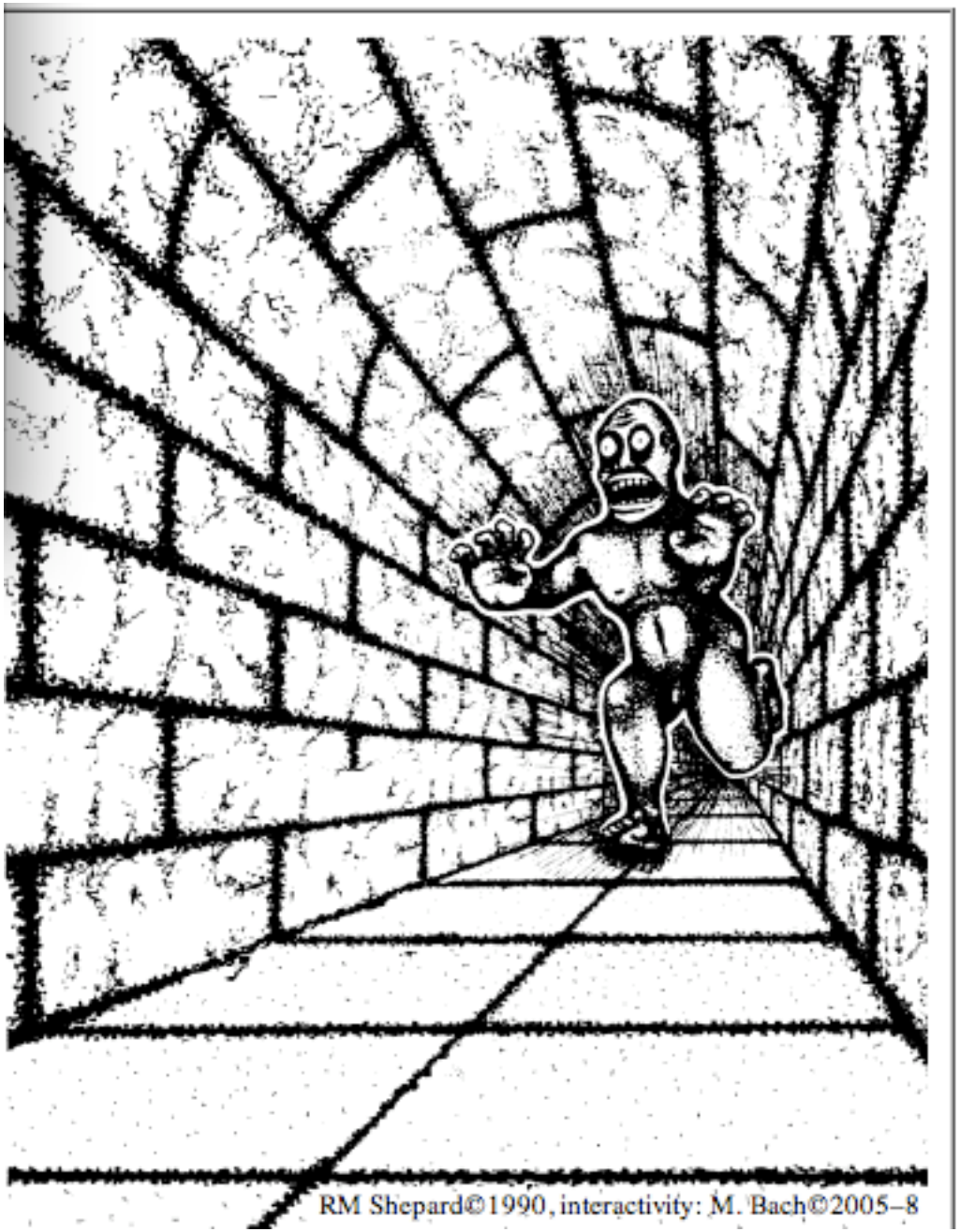
Müller-Lyer Illusion

http://www.michaelbach.de/ot/sze_muelue/index.html

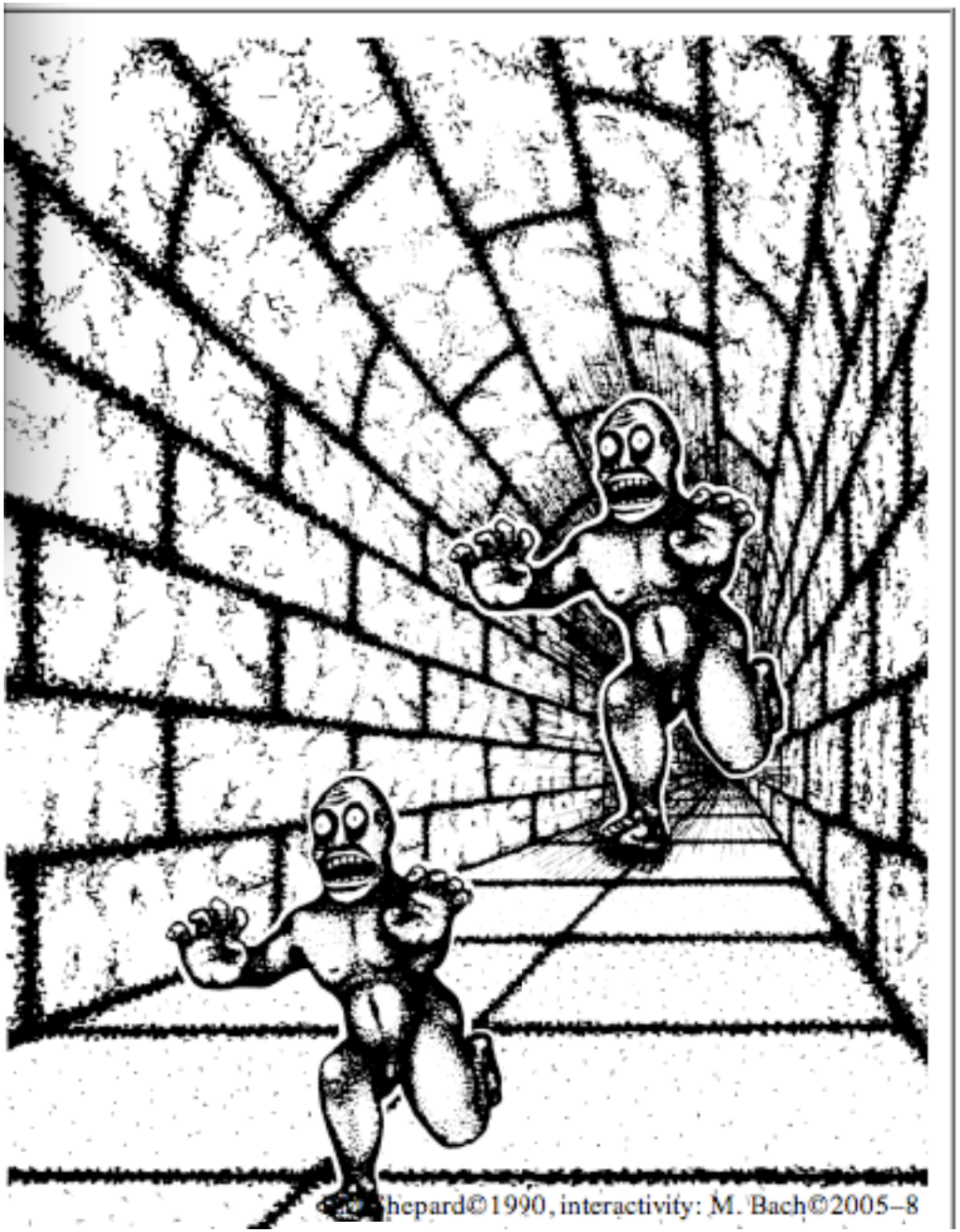
figures are the same size



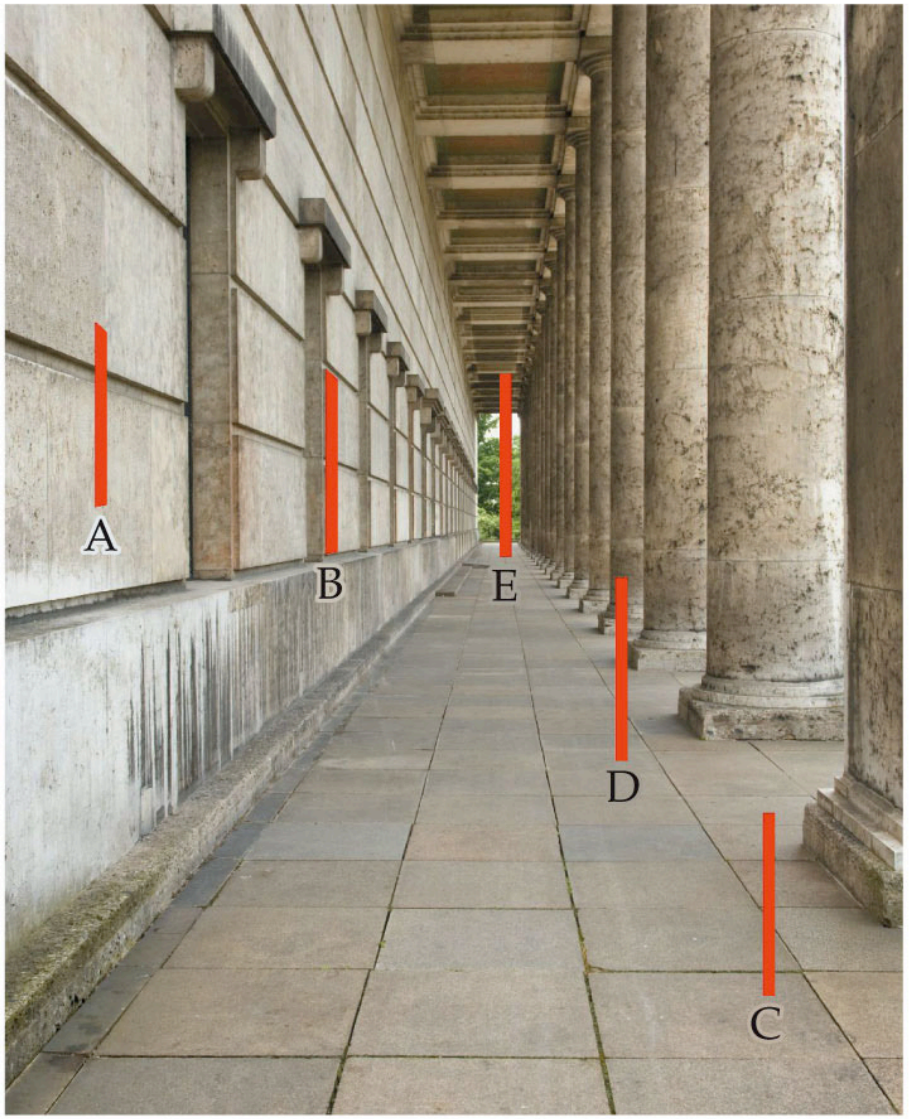
“Terror Subterra”

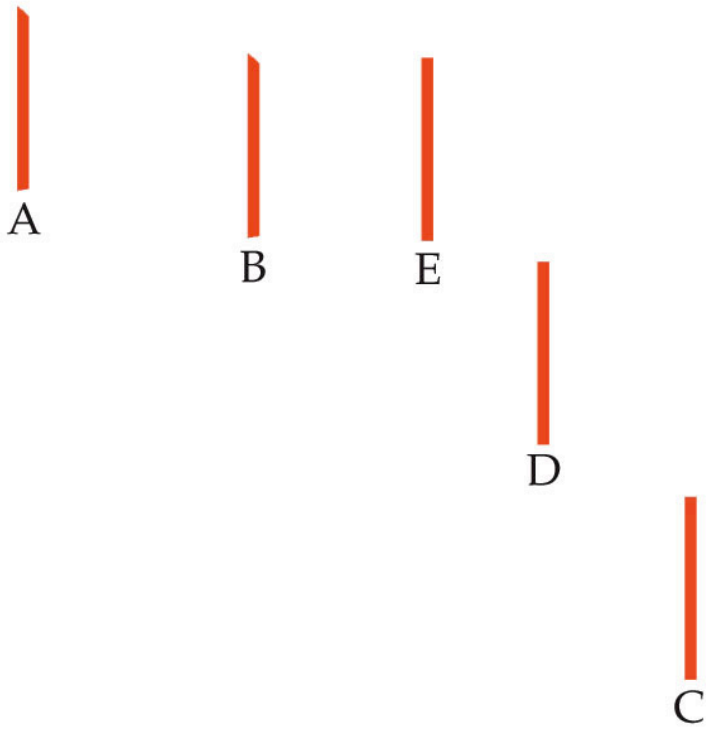


“Terror Subterra”



red lines are all the same length

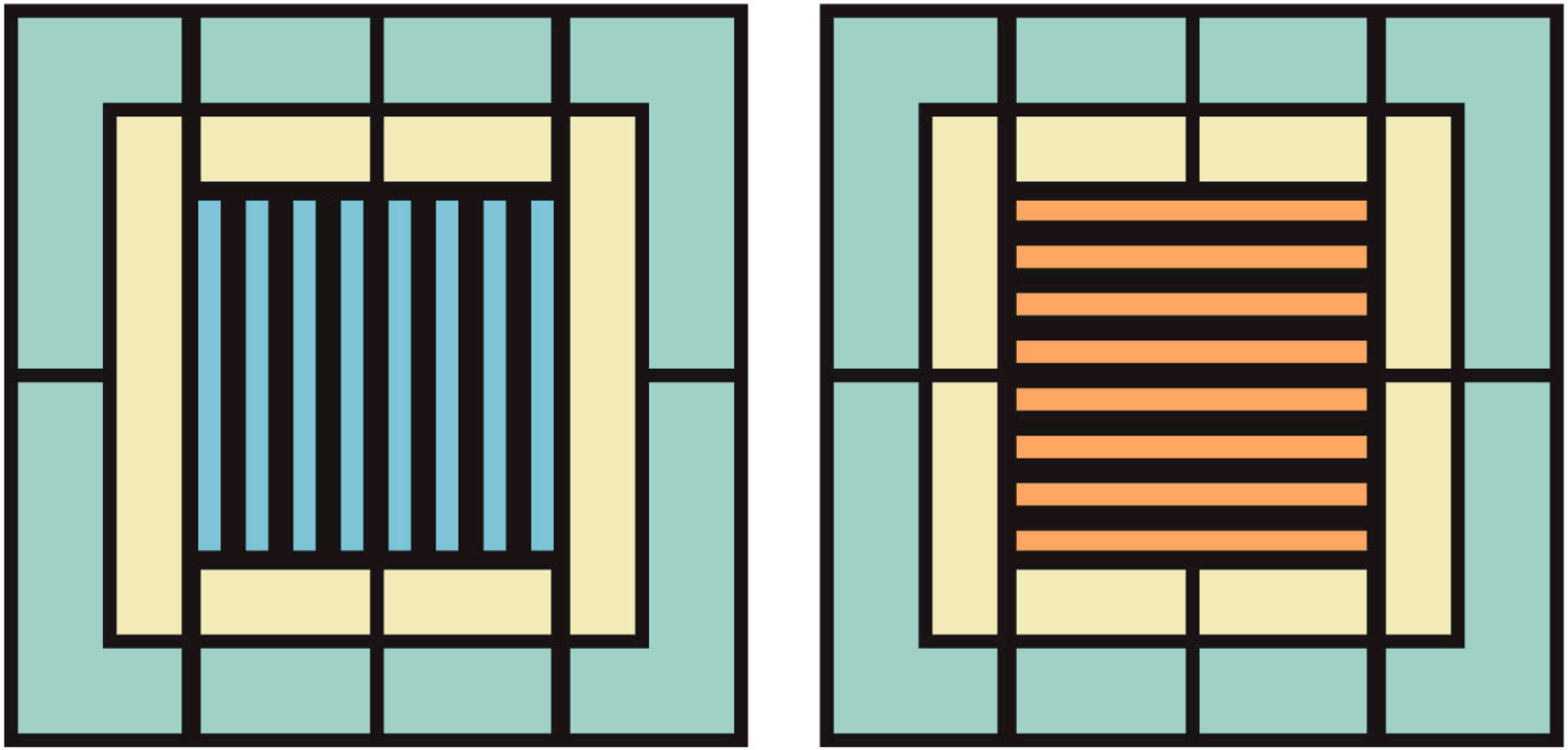




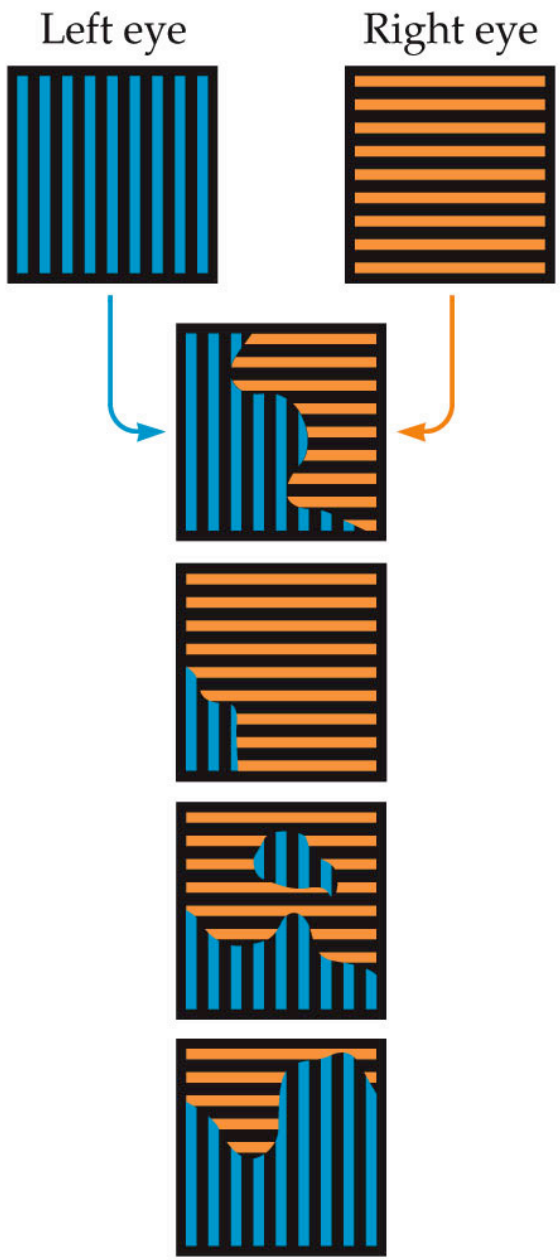
Depth / Size illusion

- all 3 cars take up the same space in the image + on your retina!

Binocular Rivalry



Two stimuli battle for dominance of the percept

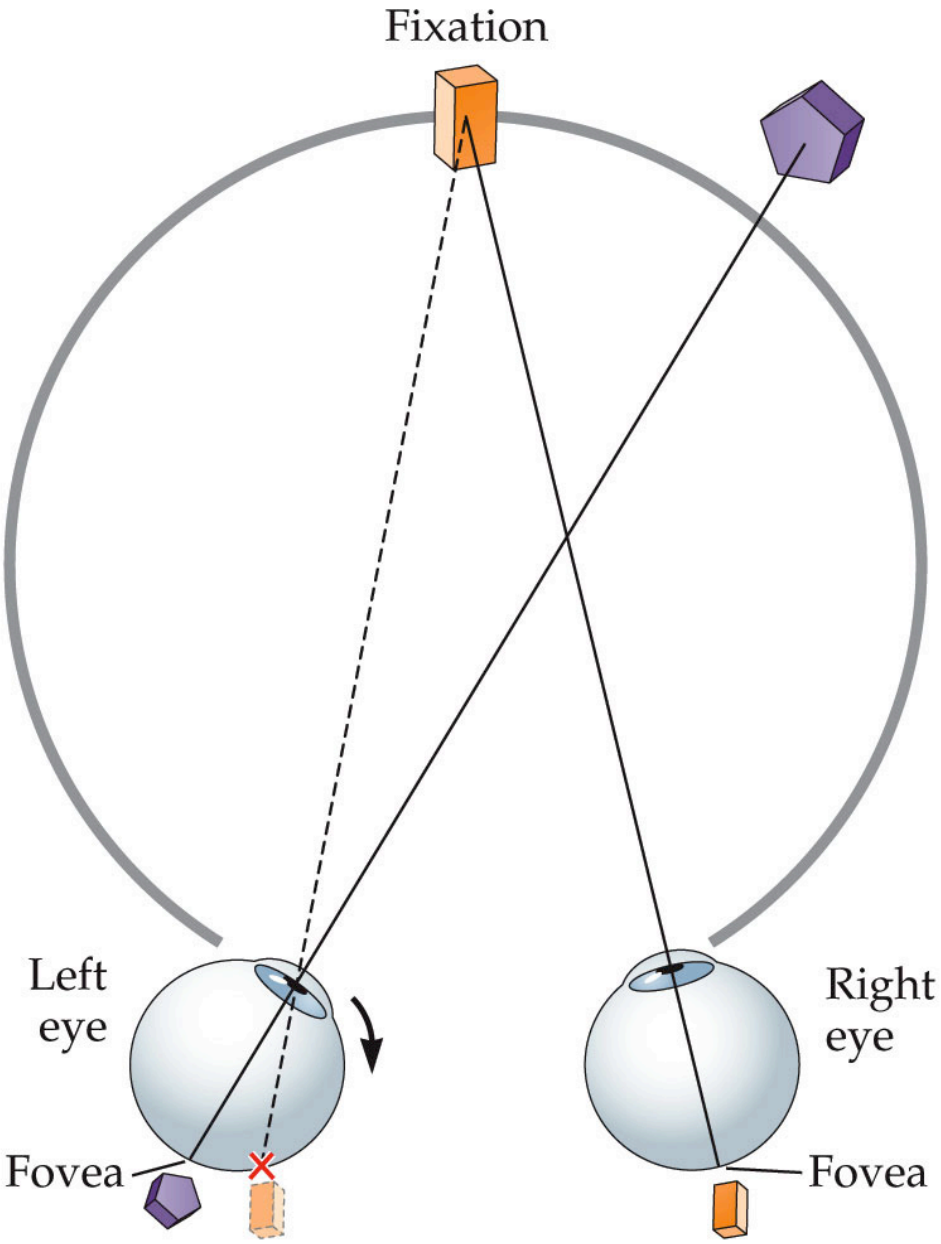


Defects in Stereopsis

Strabismus

- eyes are not aligned, so different images fall on the fovea
- If not corrected at an early age, stereopsis will not develop

stereoblindness: inability to use binocular disparity as a depth cue.



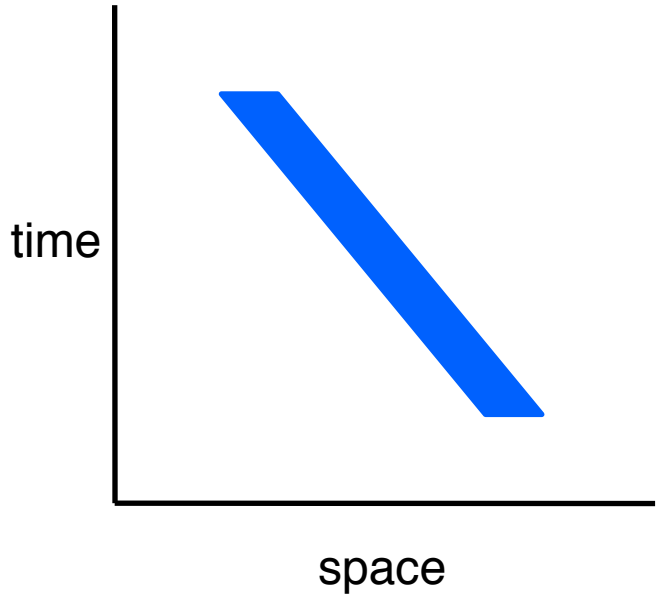
Chapter 6 Summary:

- monocular depth cues
- binocular depth cues (vergence, disparity)
- horopter
- crossed / uncrossed disparities
- free fusing
- random dot stereogram
- stereoscope
- “correspondence problem”
- panum’s fusional area
- strabismus / stereoblindness
- binocular rivalry (in book)

Motion Perception
Chapter 8

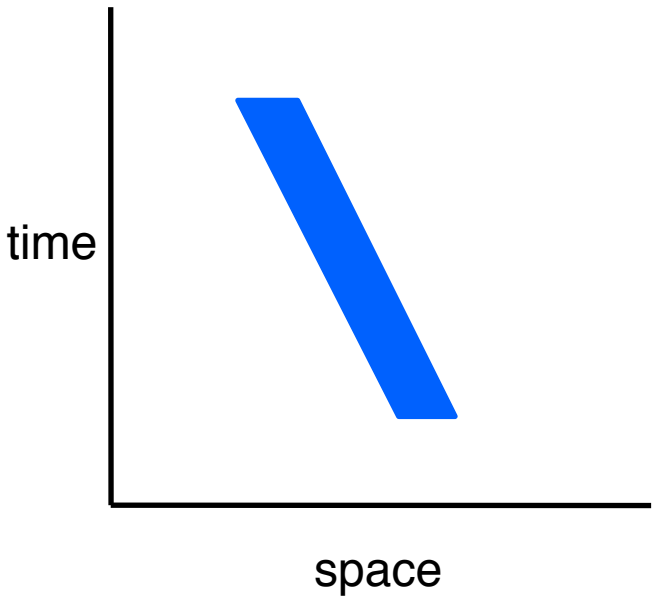
Main point of this chapter:

Motion = Orientation in Space-Time

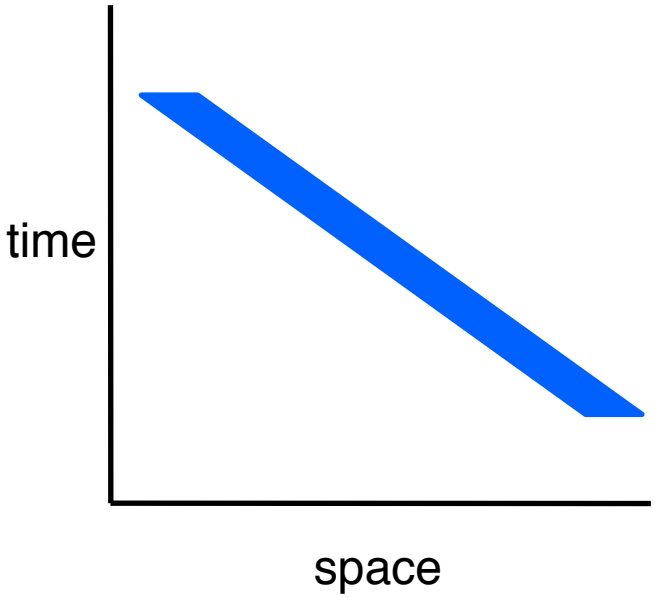


which motion is faster?

slow

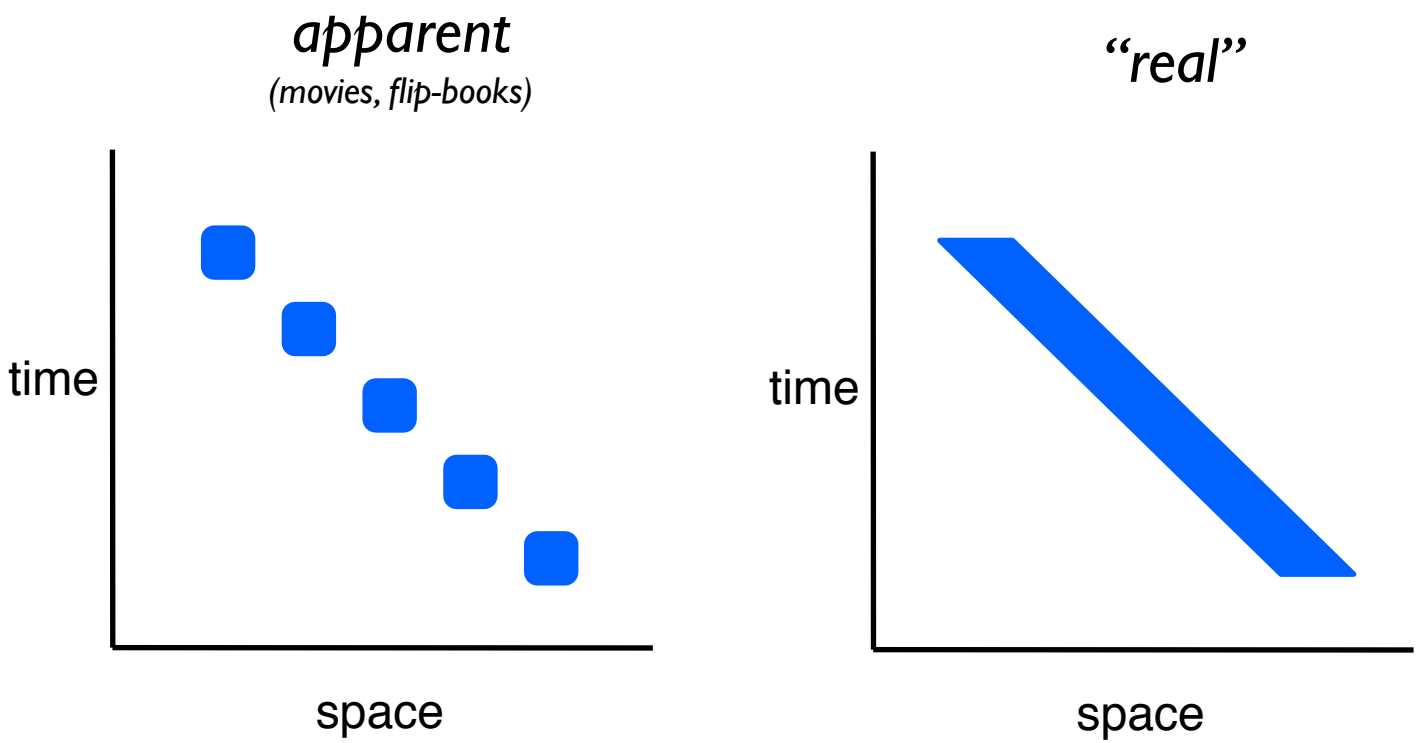


fast



Real vs. Apparent motion

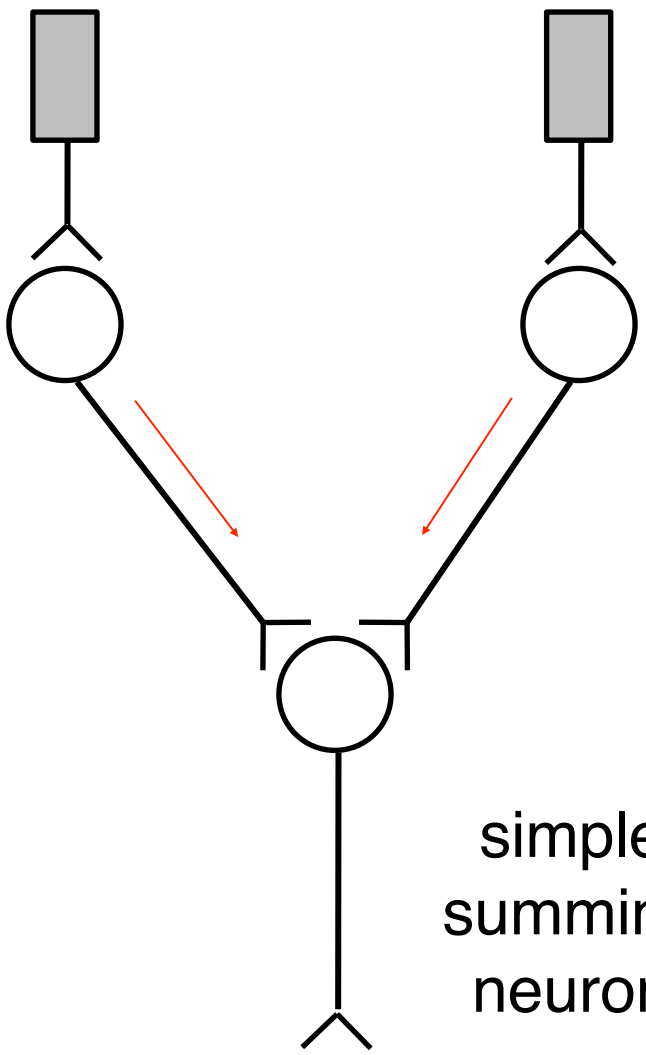
Apparent motion - motion percept that results from rapid display of stationary images in different locations



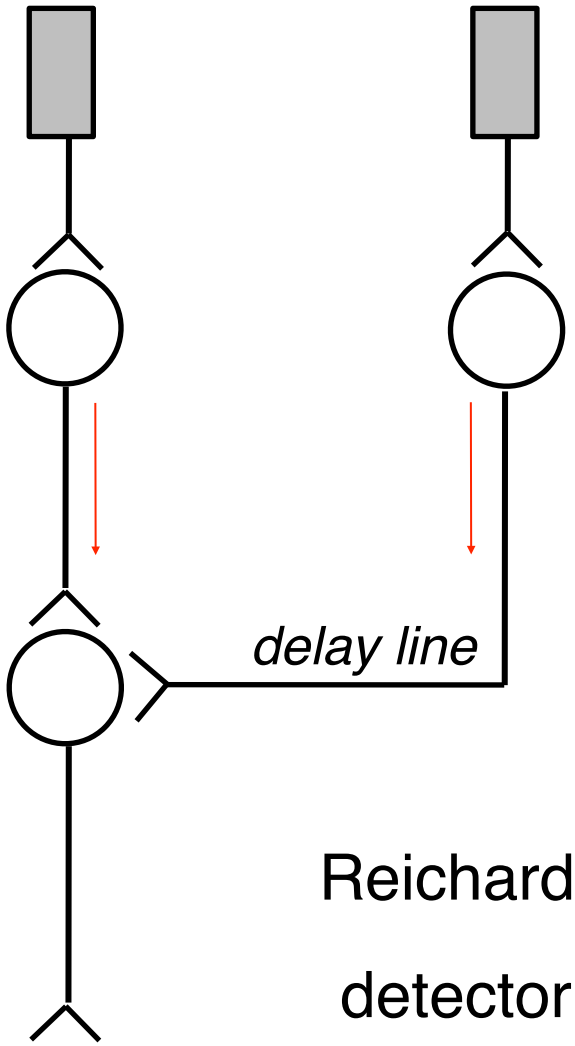
Q: why don't we notice the difference?

How does the nervous system encode motion?
What makes a Motion Receptive Field?

Answer: a surprisingly simple neural circuit called a *"Reichardt detector"*



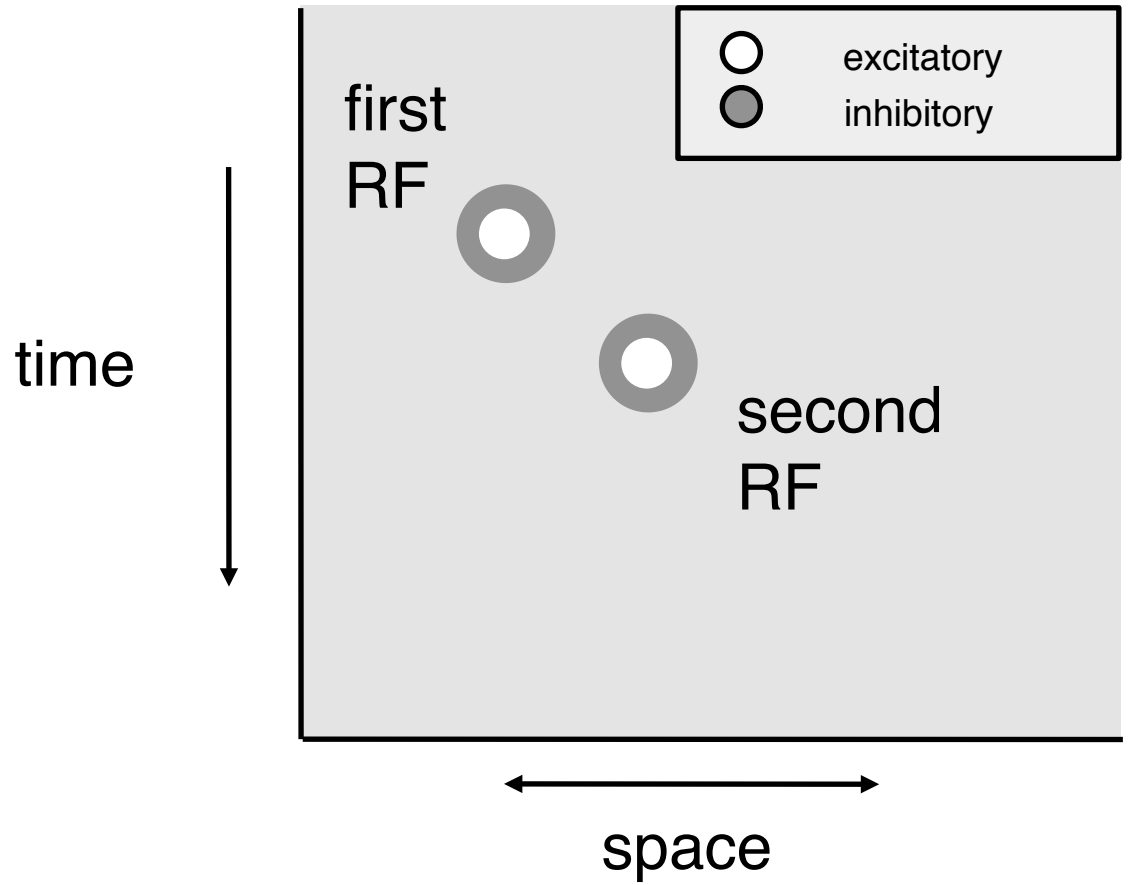
simple
summing
neuron



Reichardt

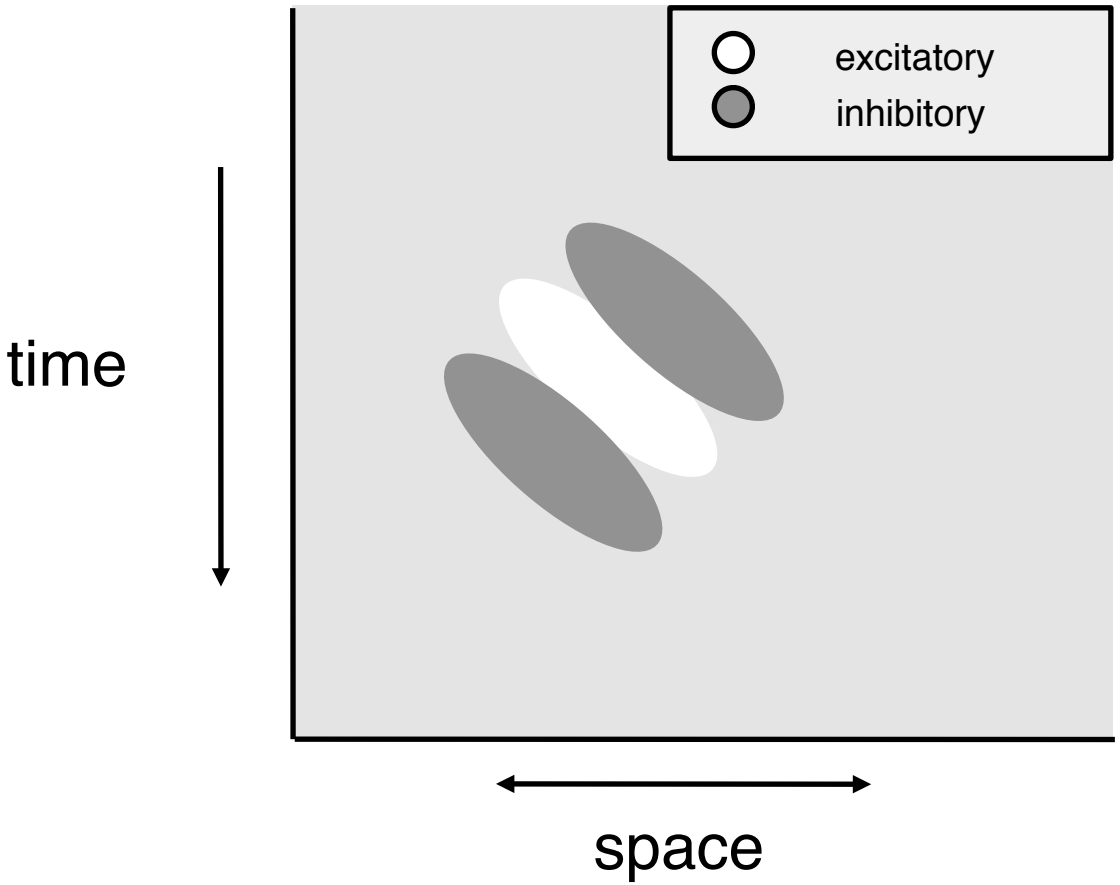
detector

Reichardt detector in space-time



2nd neuron has a spatially separated Receptive Field (RF), and a shorter temporal delay

Smoother Reichardt detector



Like an oriented V1 receptive field, but oriented in space-time!

Reichardt detectors respond to real and apparent motion

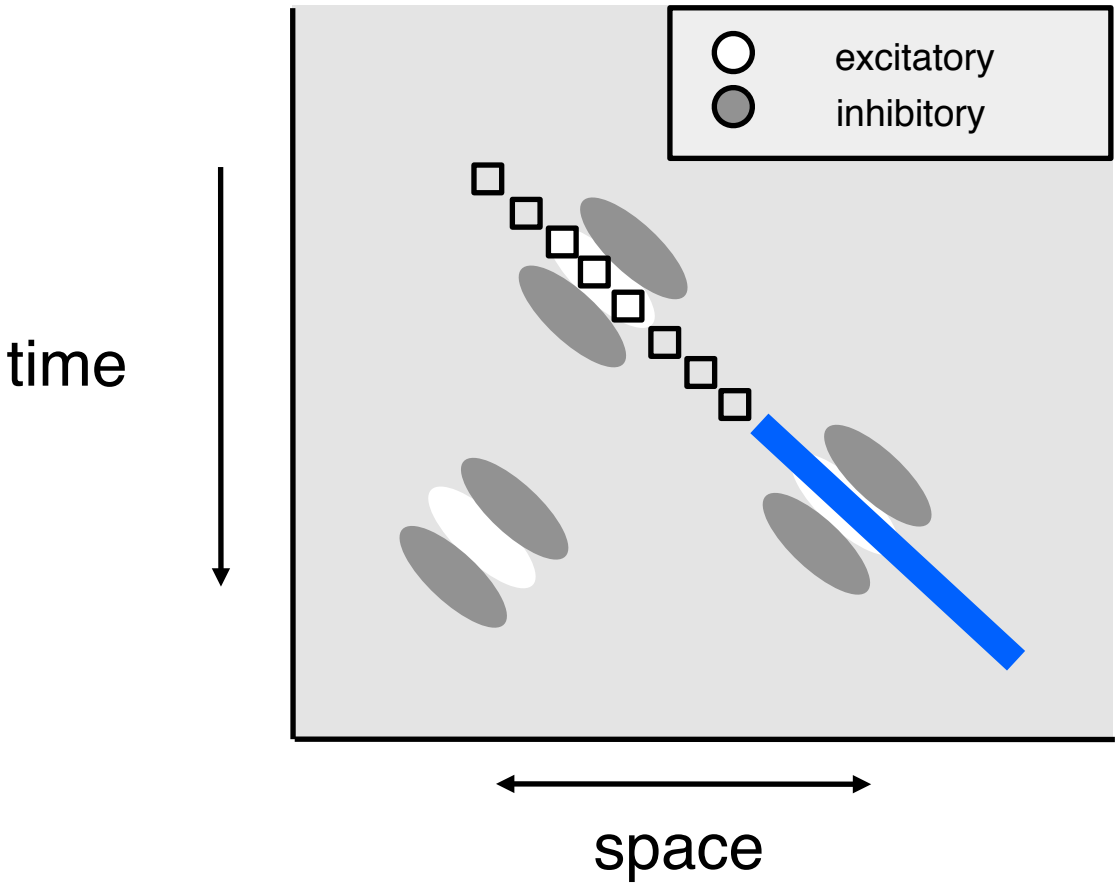


Figure 7.3 Constructing a neural circuit for the detection of rightward motion (Part 1)

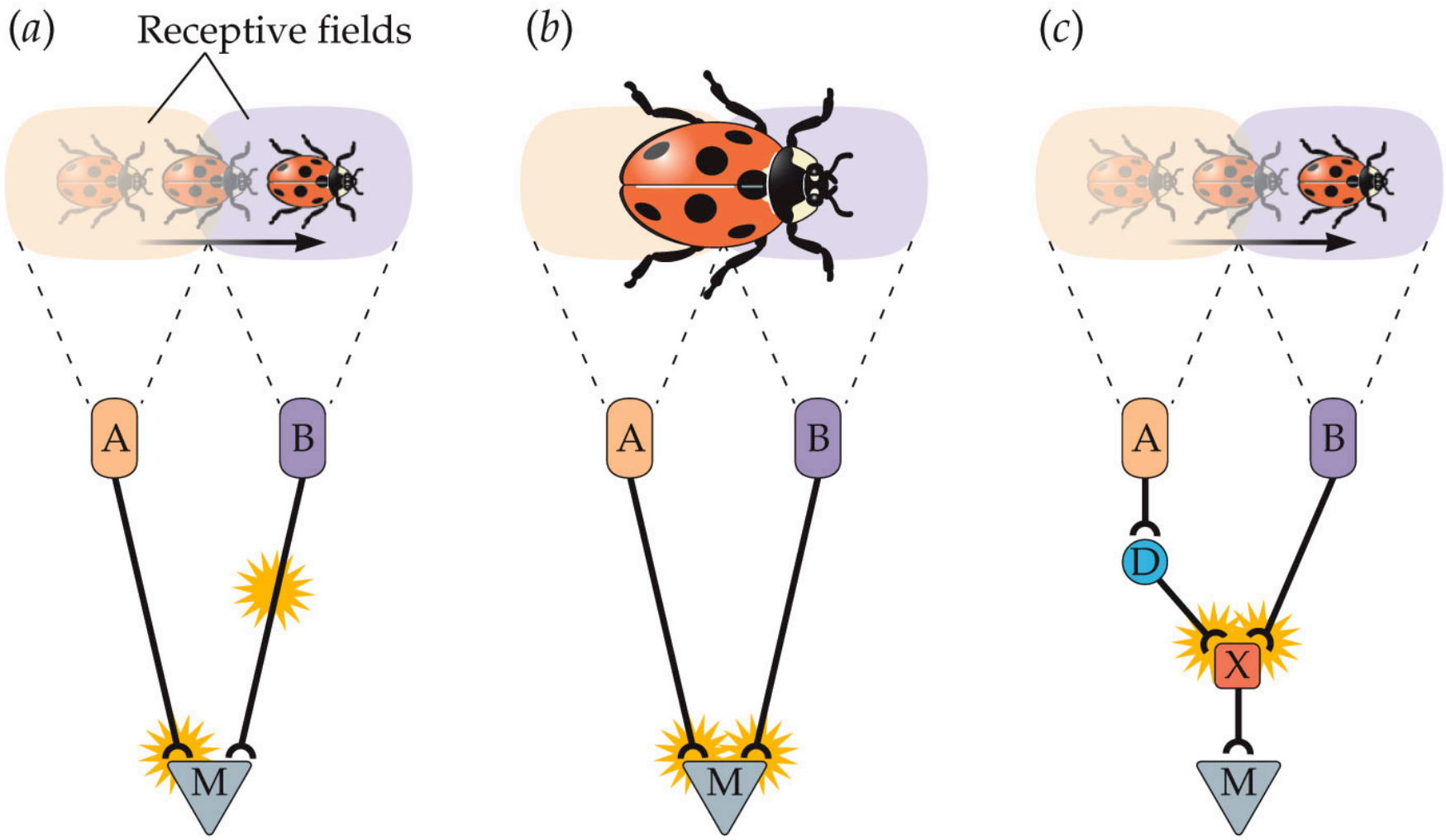
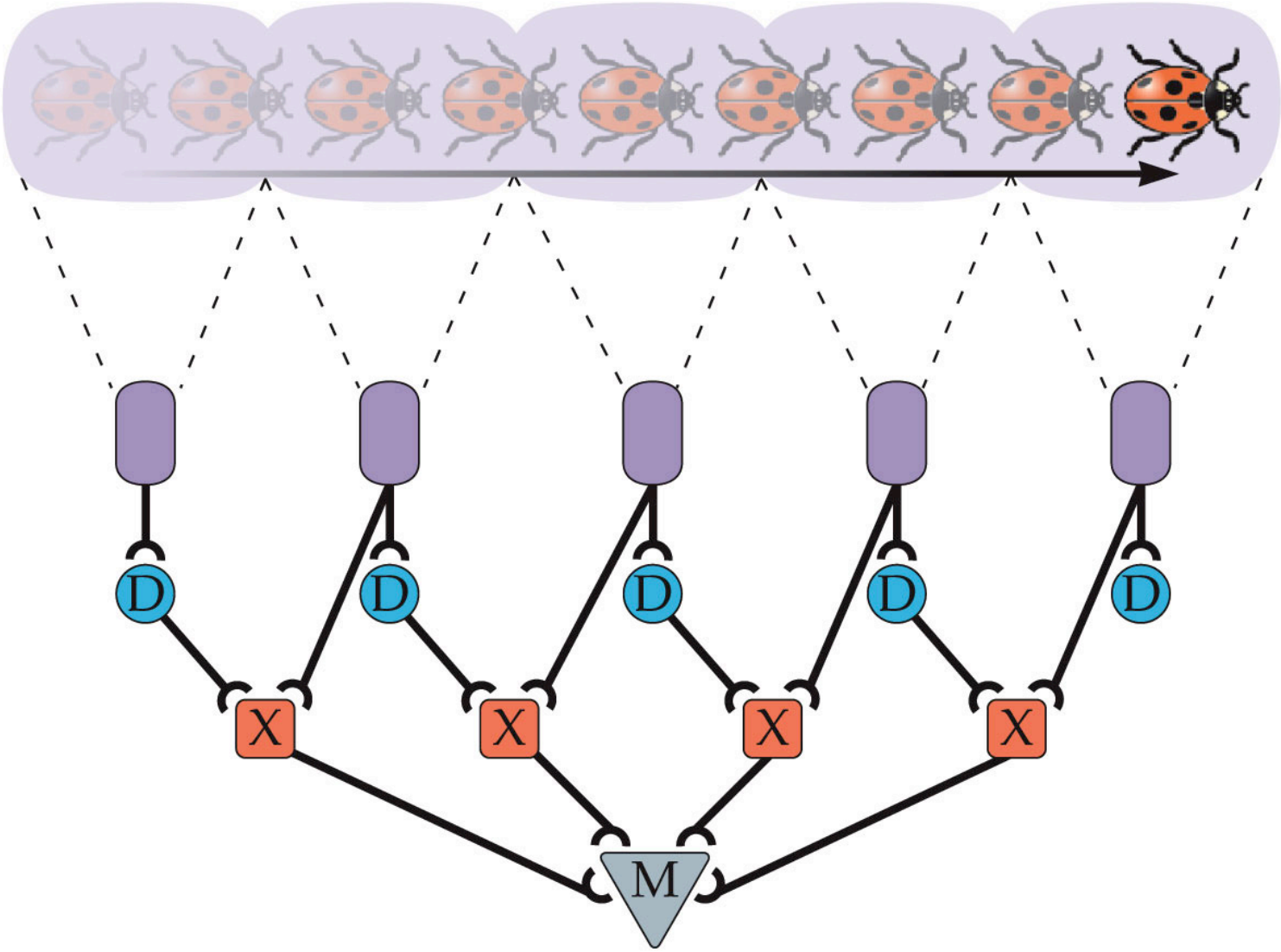
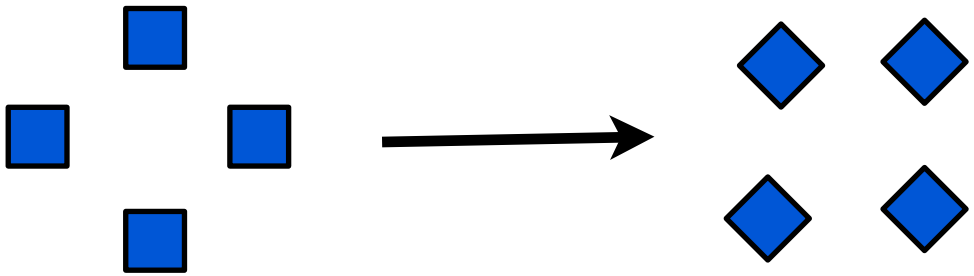


Figure 7.3 Constructing a neural circuit for the detection of rightward motion (Part 2)



Correspondence problem (motion):

• problem of knowing the correspondence between features in successive frames
(which points in frame 1 are the same objects in frame 2?)



Clockwise or Counter-clockwise rotation?

http://sites.sinauer.com/wolfe3e/chap8/correspondenceF.htm (web demo)

- **Aperture problem**:
  when a moving object is viewed through an aperture, the direction of motion may be ambiguous

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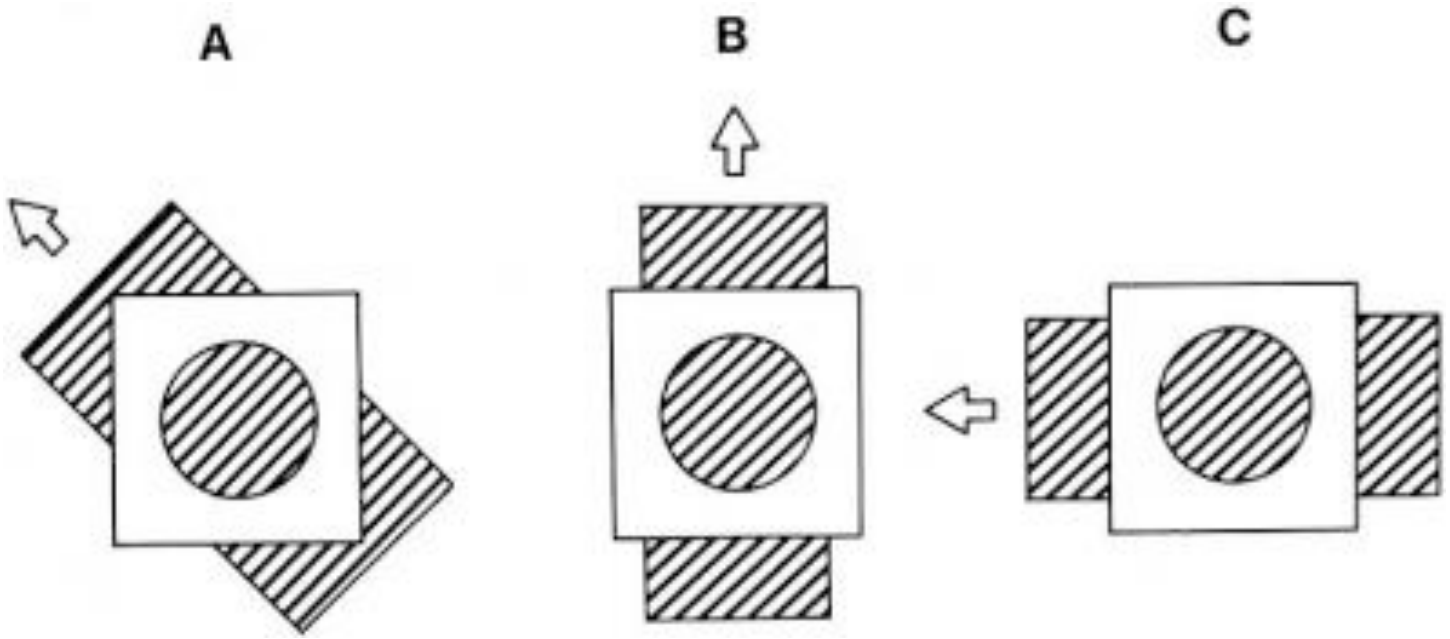
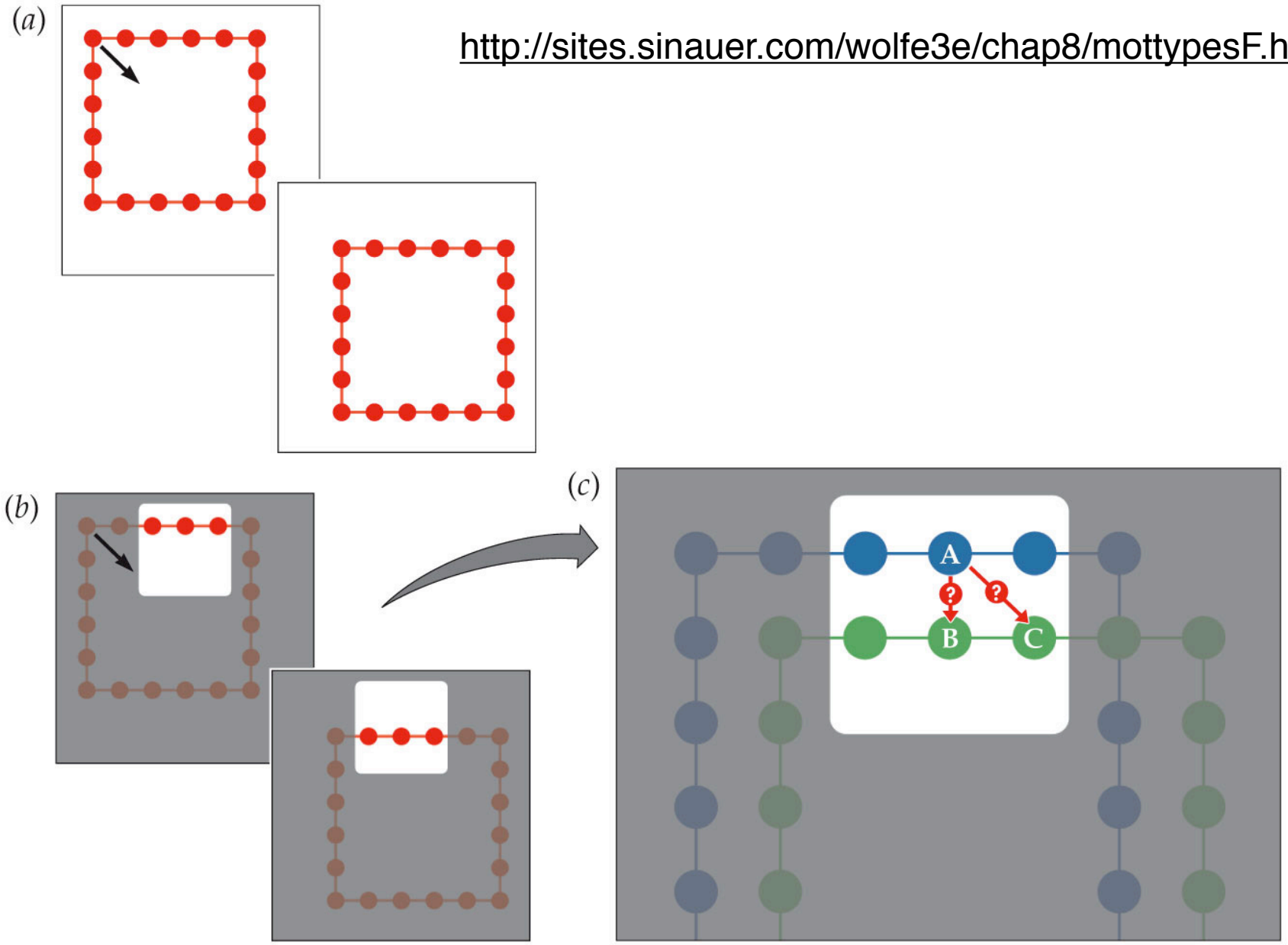


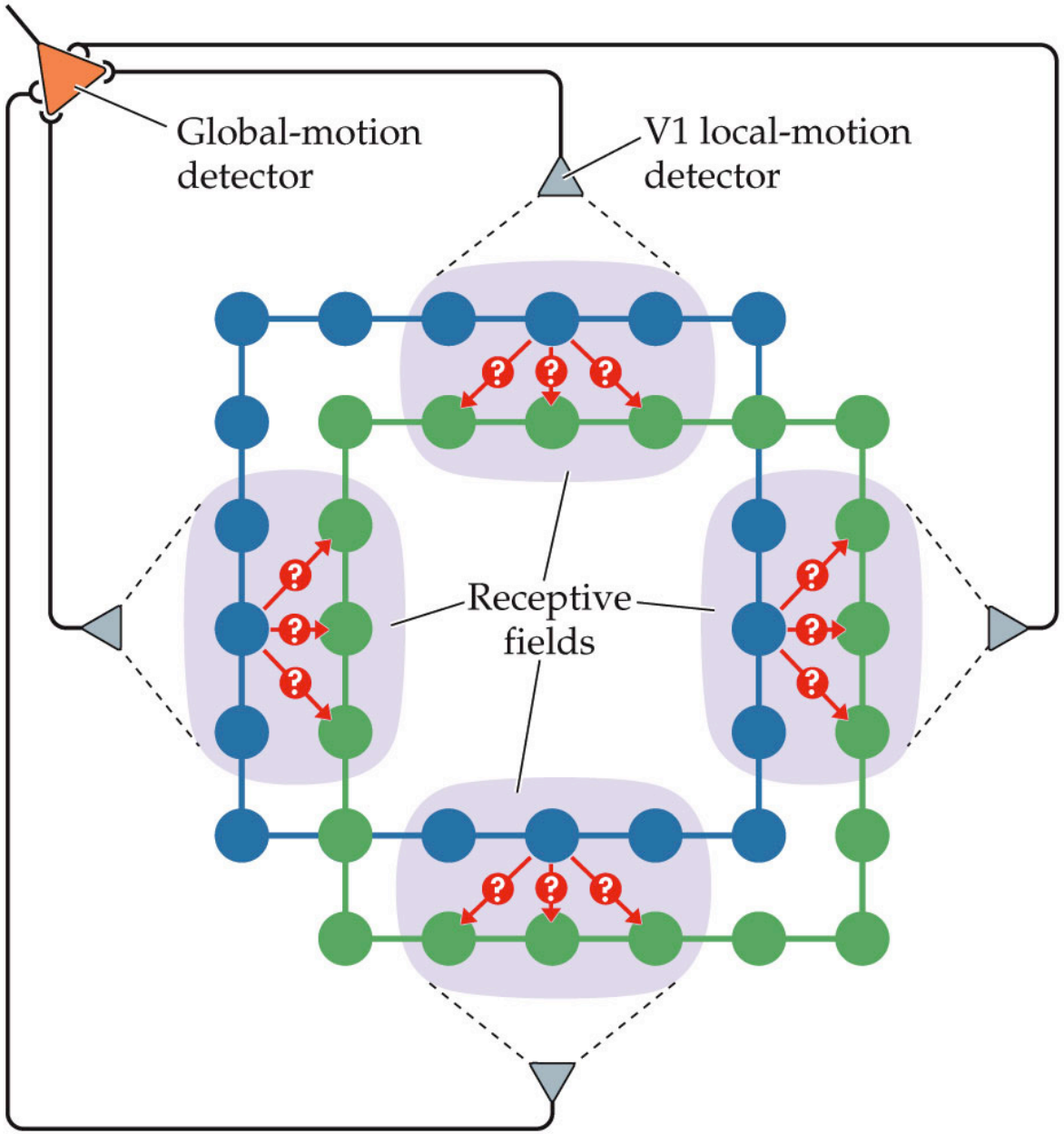
- this is a problem because each *neuron* only sees the scene through a small aperture (its receptive field!)
- how can the brain figure out the "global" direction of motion?

aperture problem / correspondence problem

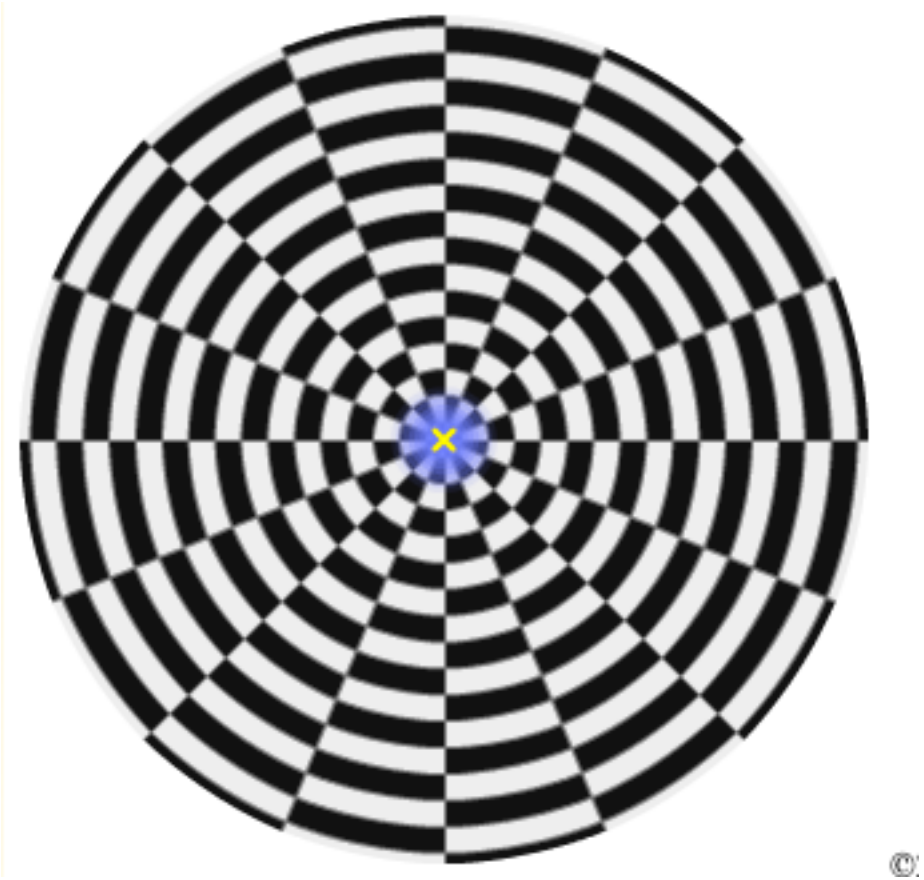


http://sites.sinauer.com/wolfe3e/chap8/mottypesF.htm

building a global motion detector



Motion aftereffect (MAE): The illusion of motion that occurs after prolonged exposure to a moving stimulus



http://www.michaelbach.de/ot/mot-adapt/index.html

Motion after-effect

- Always gives rise to motion in the *opposite* direction of the adapting motion
- Also known as: **"waterfall illusion" -** stare at a waterfall; stationary objects will then appear to move upwards.
- evidence for "opponent channels" in processing motion

Computation of Visual Motion

Interocular transfer: The transfer of an effect (such as adaptation) from one eye to another

- MAE: exhibits interocular transfer

  What does this tell us about where in the brain motion is computed?

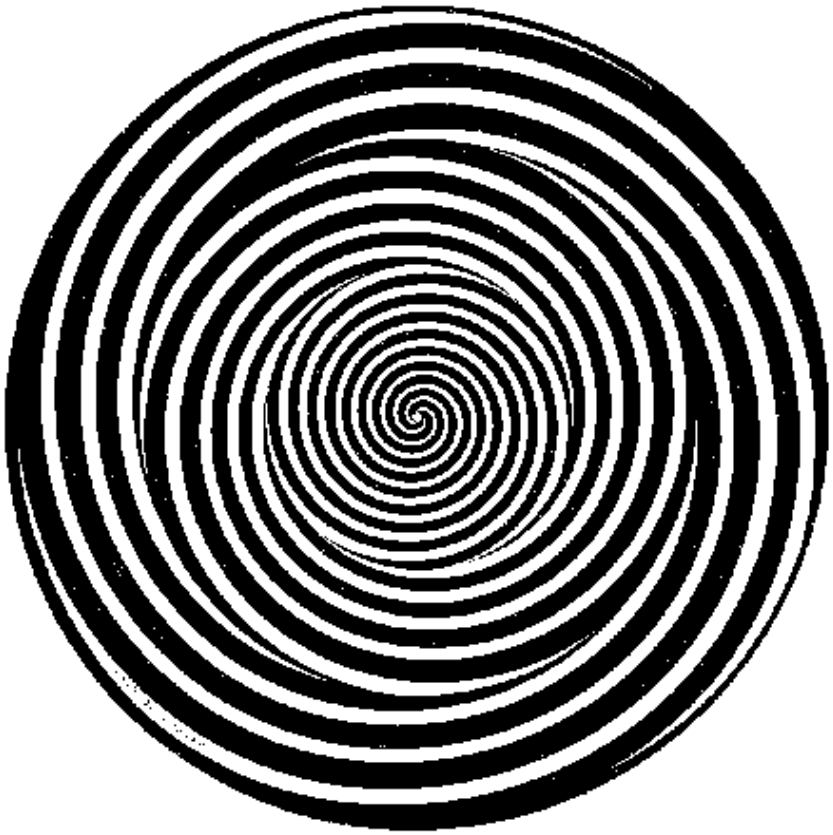
- Remember: Input from both eyes is combined in area V1
- Motion seems to be computed in **area MT** (middle temporal area)

Interocular transfer: The transfer of an effect (such as adaptation) from one eye to another

- MAE: exhibits interocular transfer

Q: What does this tell us about where in the brain motion is computed?

- Remember: Input from both eyes is combined in area V1



“Motion After-Effect”

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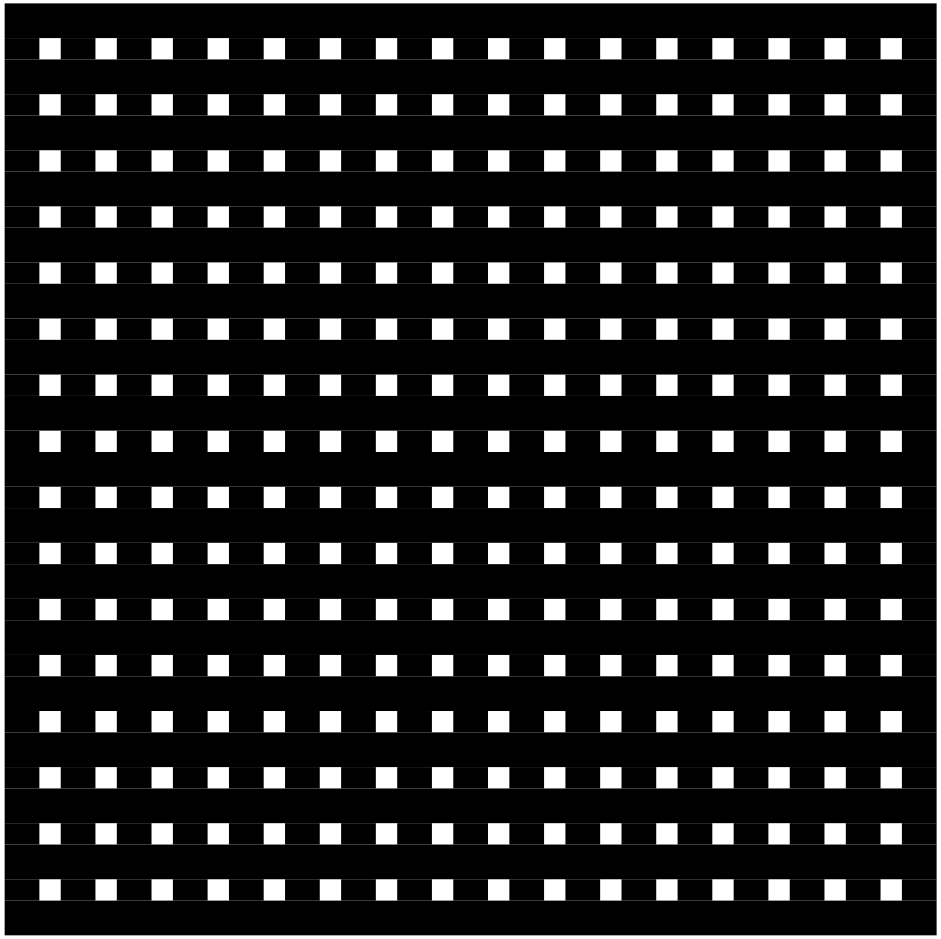
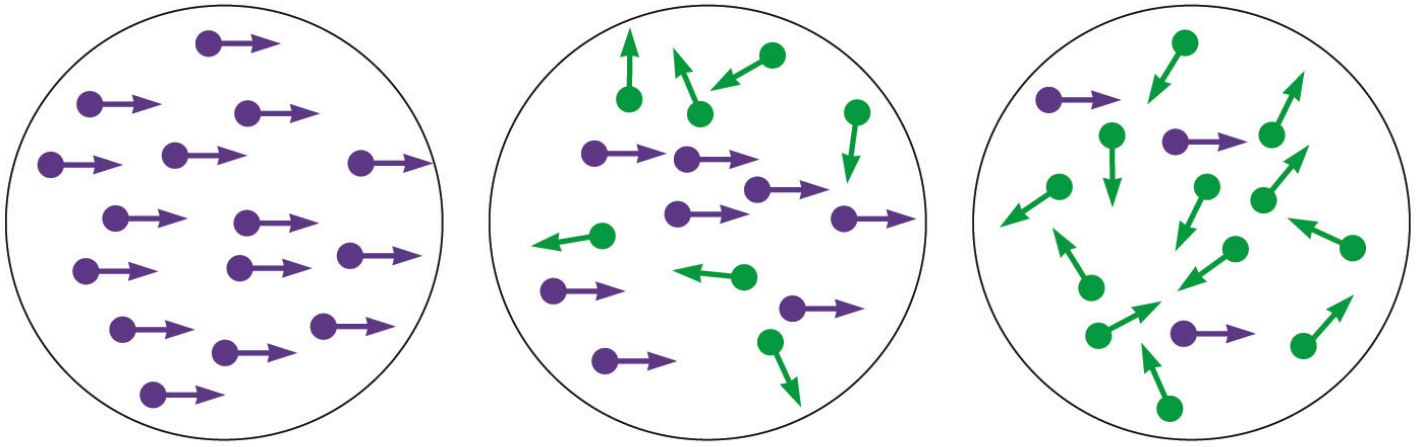


Computation of Visual Motion

Newsome and Pare (1988) conducted a study on motion perception in monkeys

- Trained monkeys to respond to dot motion displays
- **Area MT** of the monkeys was lesioned
- Result: Monkeys needed about ten times as many dots to correctly identify direction of motion

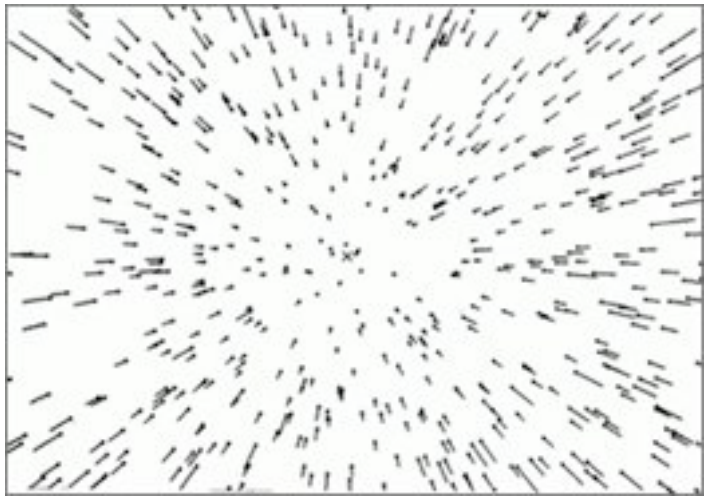


(*a*) 100% (*b*) 50% (*c*) 20%

Q: How do we use motion information to navigate?

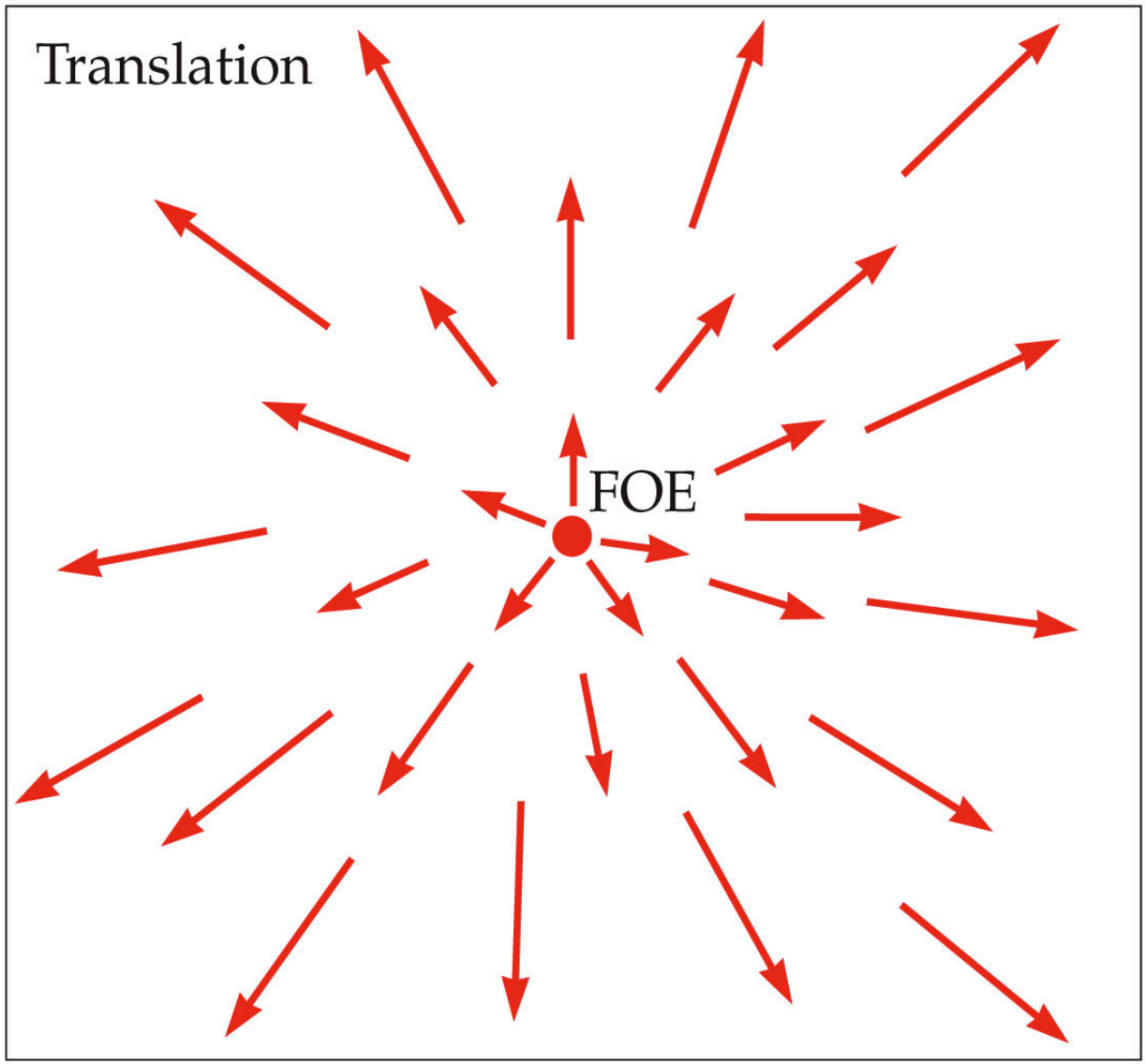
- **Optic flow**: the local velocity at each point in an image
- We experience "optic flow" fields as we move through the world

Example of pilot landing a plane: "Radial expansion"



optic flow field

Focus of expansion (FOE): point in the center of the horizon from which, when we are in motion, all points in the perspective image seem to emanate



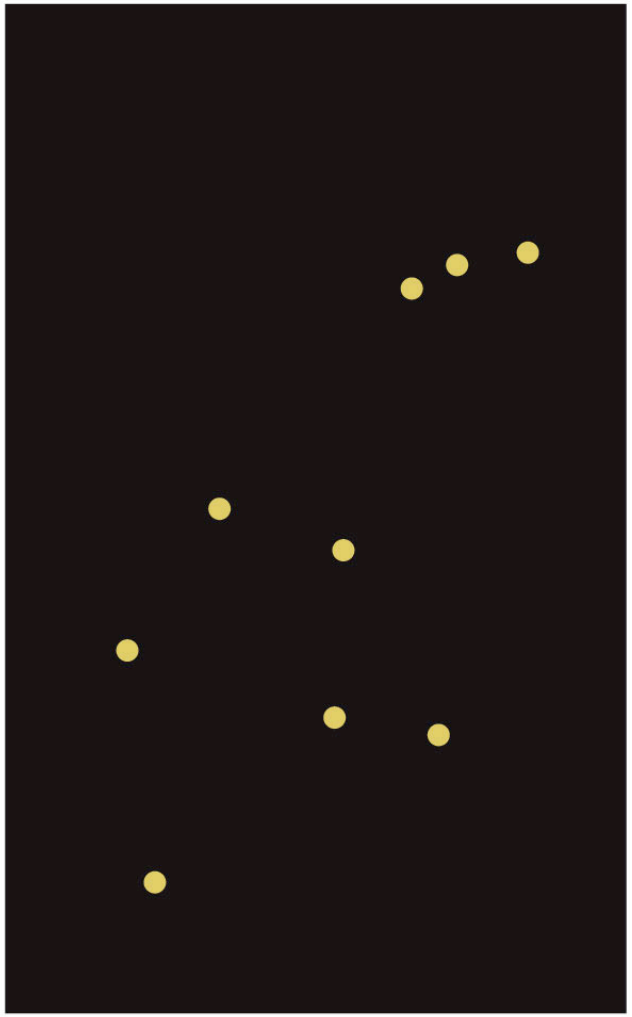
- one aspect of optic flow
- tells the observer which way they are heading

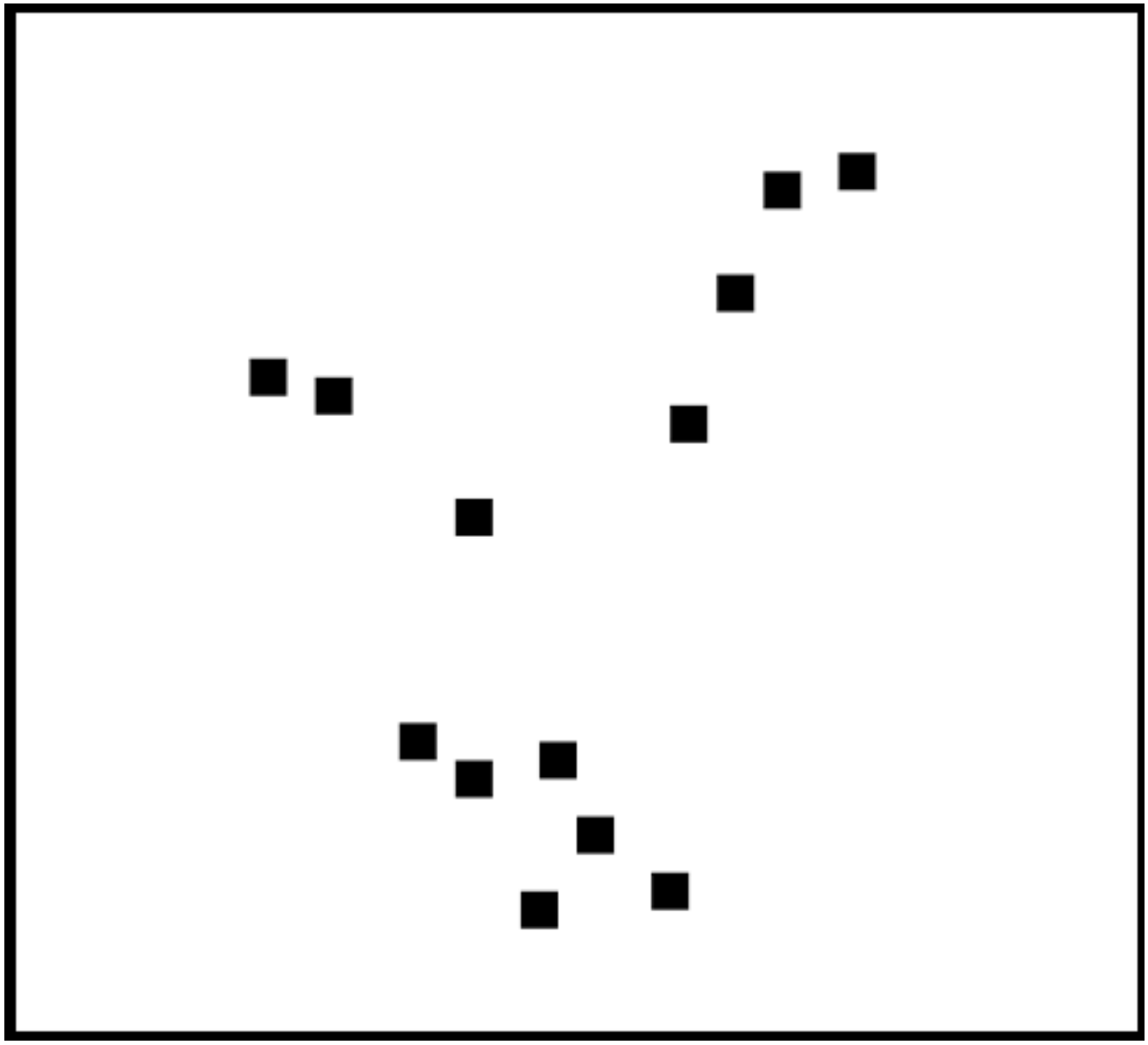
Using Motion Information

Biological motion: The pattern of movement of all animals

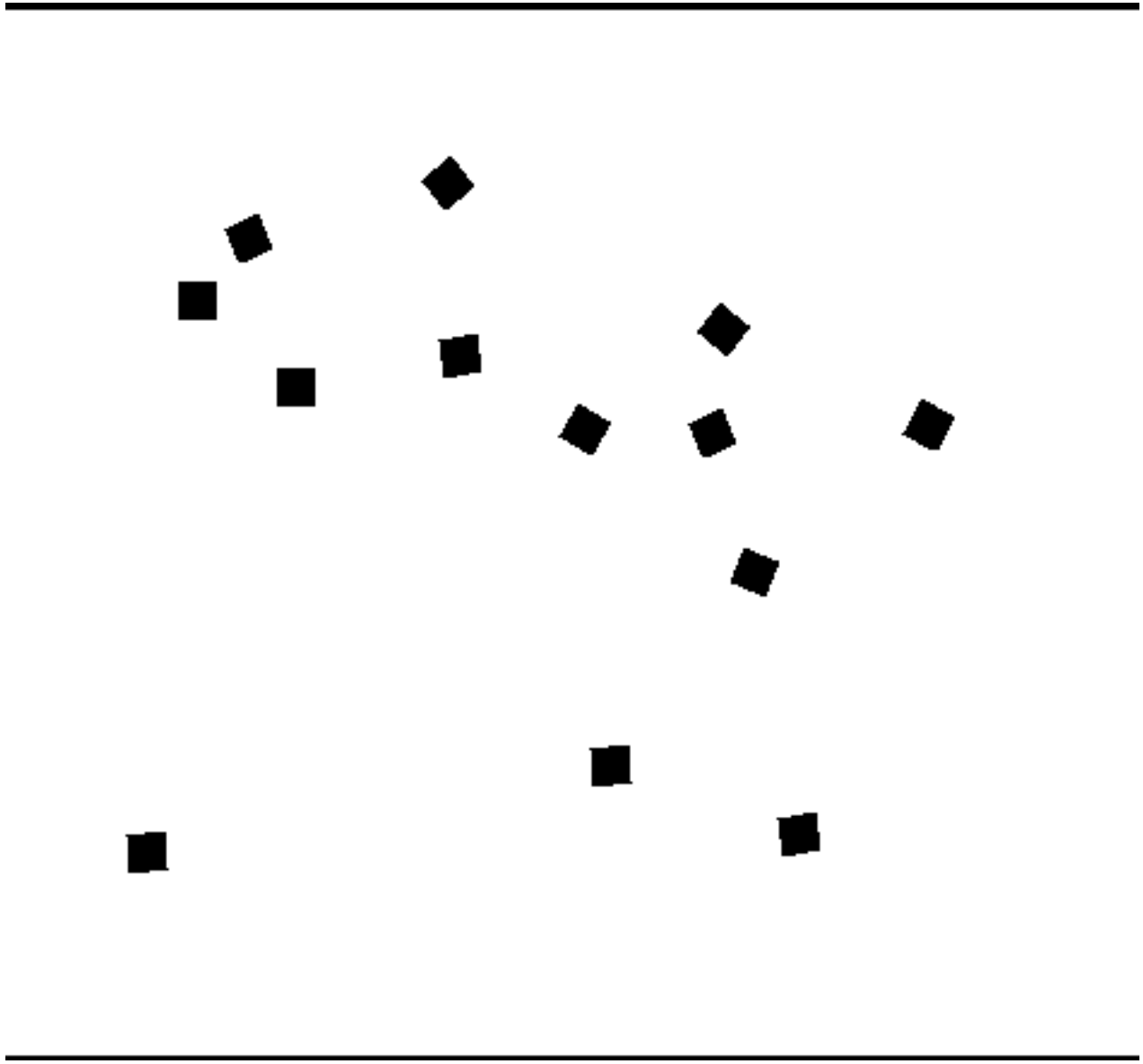
(a)

(b)





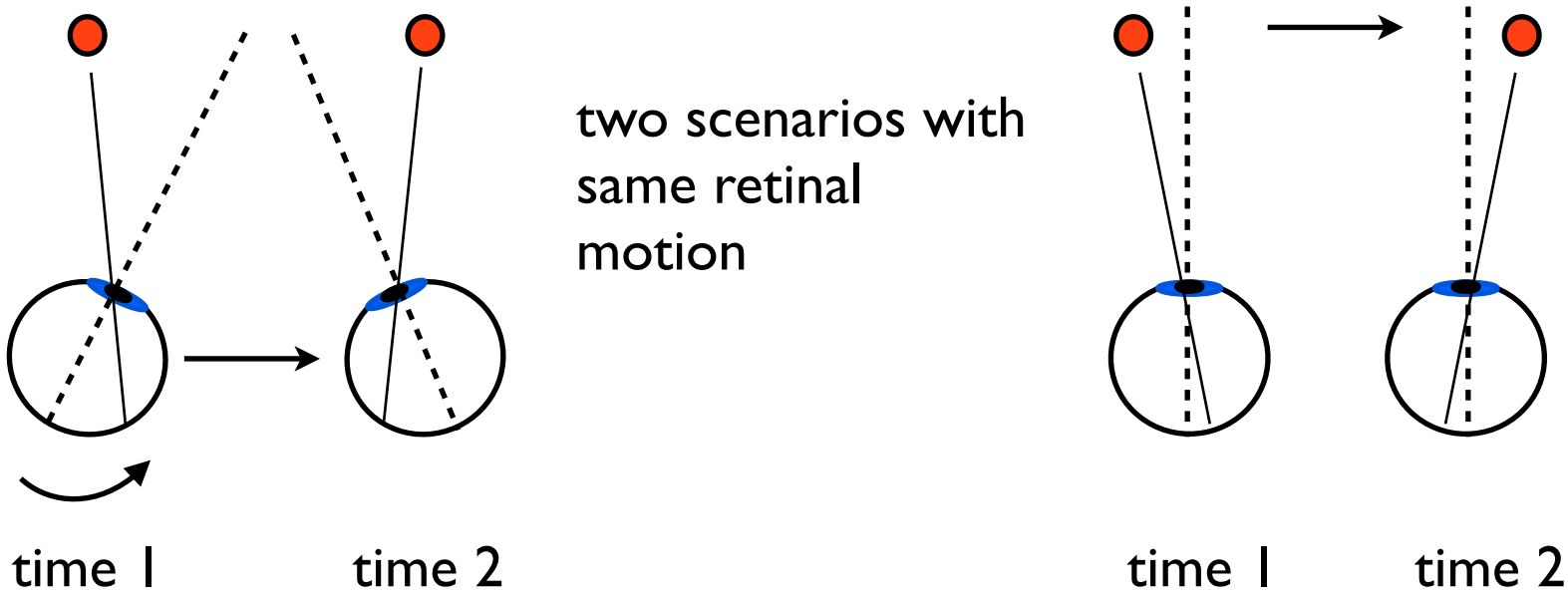
Biological motion



non-biological motion

Eye movements: also give rise to retinal motion.

• important to distinguish motion due to eye movements from motion due to moving objects!



Eye Movements

- **Smooth pursuit** - eyes smoothly follow a moving target
- **Saccade** - rapid movement of the eyes that changes fixation from one location to another
- **Vergence** - two eyes move in opposite directions, as when both eyes turn towards the nose
- **Reflexive** - automatic / involuntary (e.g., vestibular)

Smooth pursuit vs. saccadic eye movements

in-class experiment

Partner up!

Saccadic suppression - reduction of visual sensitivity during a saccade

Test it out yourself: Look closely in a mirror and shift your gaze from one eye to the other. You will never see the eyes moving.

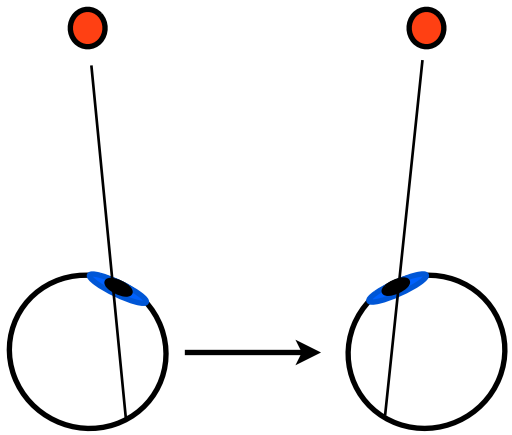
(But you will see the motion if you watch a friend.)

How do we discriminate motion due to eye movements vs. object movements?

Comparator: compensates for retinal motion due to eye movement

- receives a copy of the order issued by the motor system to the eyes, and subtracts the *expected motion* from the retinal motion

object motion = eye motion - retinal motion



Two scenarios with same retinal motion