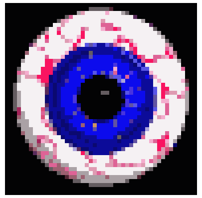
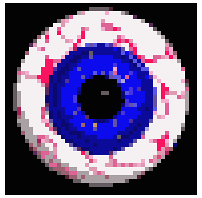
Crown 85: Visual Perception:
A Window to Brain and Behavior





Lecture 7: Processing of Motion and Depth

lecture 7 outline

Crown 85 Winter 2016

Visual Perception: A Window to Brain and Behavior

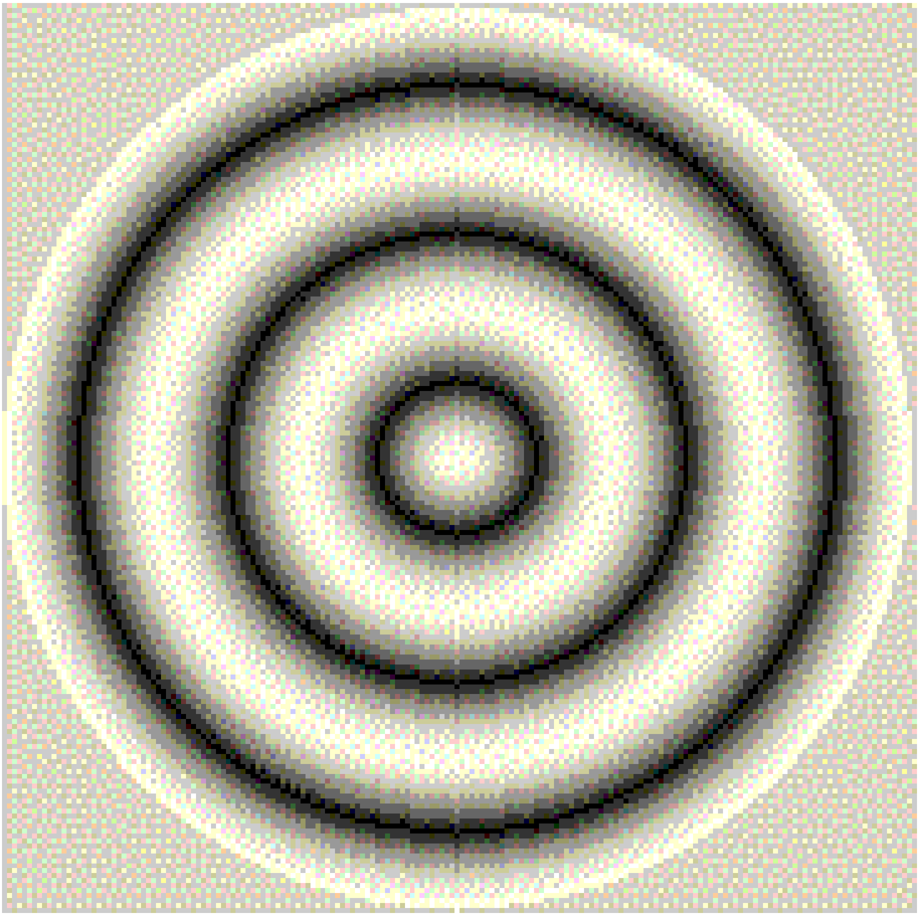
Lecture 7 Perception of Motion and Depth

OVERVIEW: In the final two lectures we will discuss how the visual system enriches perception by adding the dimensions of depth, motion, and color to the canvas of visual information. These lecture will bring more *psycho* in our treatment. Although we will not be able to be as definitive in assigning specific neural networks, we will connect perceptions to the kinds of information processing which neurons can accomplish. Artists are perhaps the most astute "viewers" of the visual world. In the second part of lecture 8 we will look a visual illusion and how artists recognize and take account of visual information processing in their works.

Reading: Joy of Perception and Joy of Perception
Eye, Brain, and Vision and Eye, Brain, and Vision

Looking: Biological Motion
Spiral Motion Adaptation (needs JAVA)

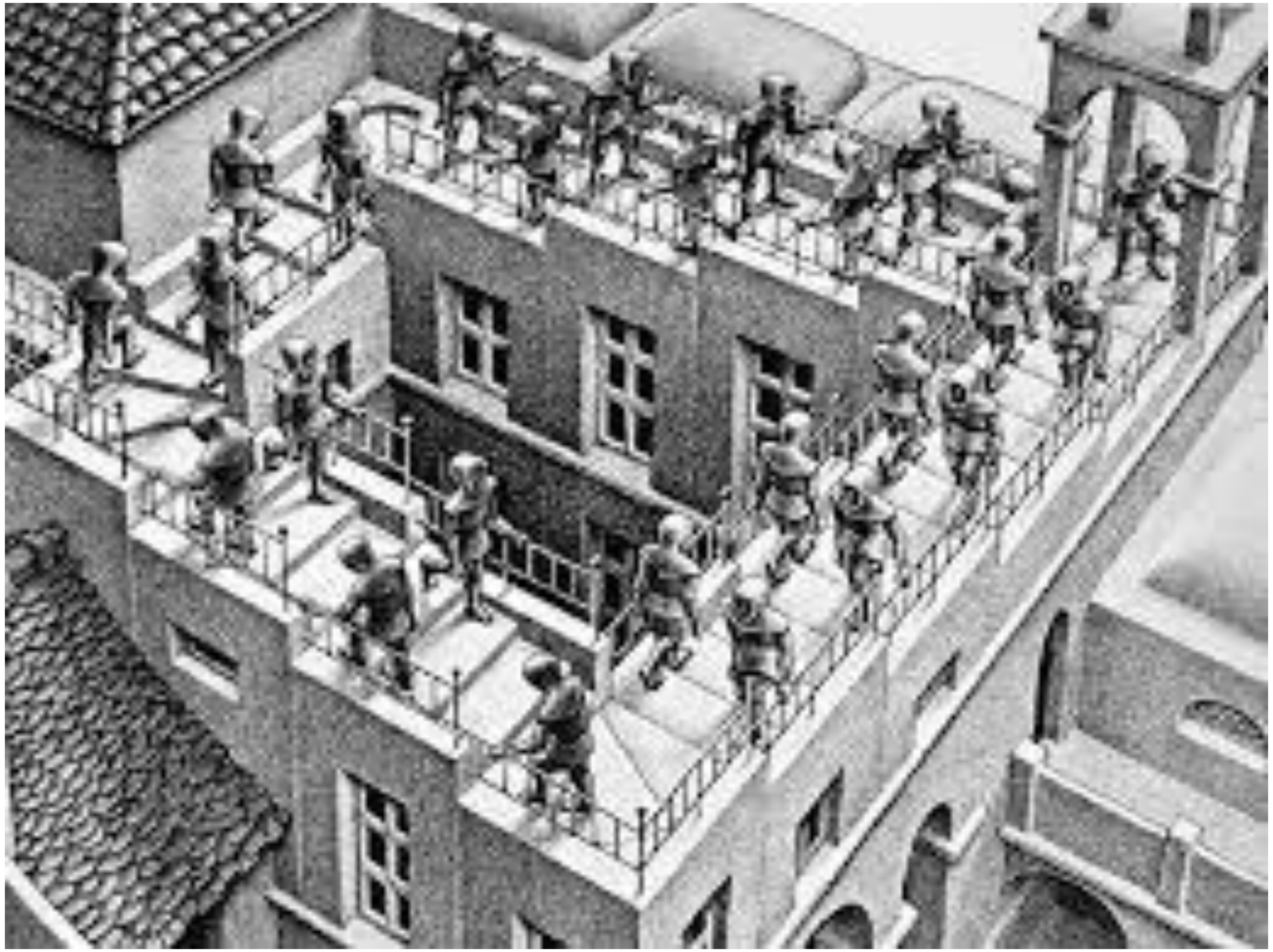
temporal (motion, on-off)



depth

color

art and illusion

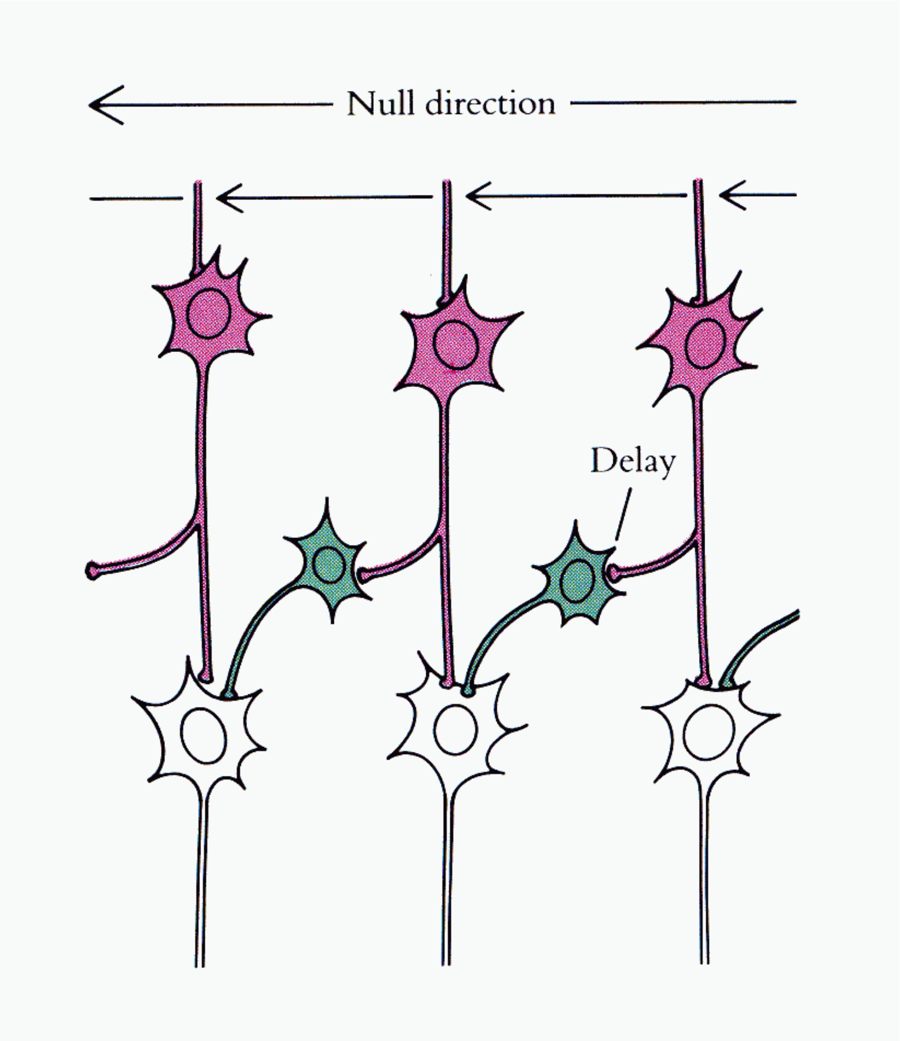


from outline

1. How might a simple neural network in the cortex signal direction of motion?

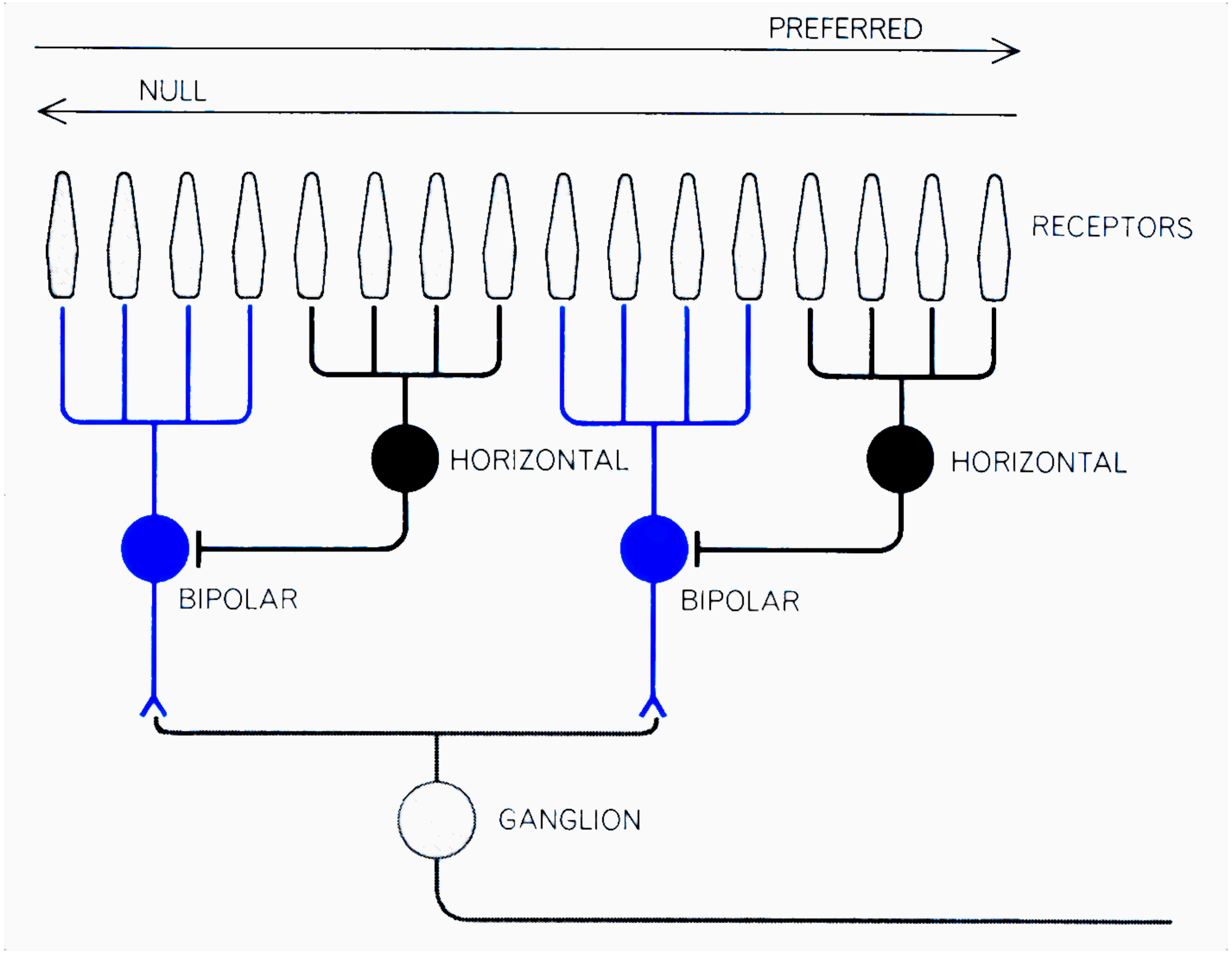
2. Know the following terms related to eye movements:
    a. vestibular-ocular eye movements
    b. conjugate eye movements
    c. vergence eye movements
    d. smooth pursuit eye movements
    e. saccades
    f. tremor
    g. saccadic suppression
    h. nystagmus

motion detector network

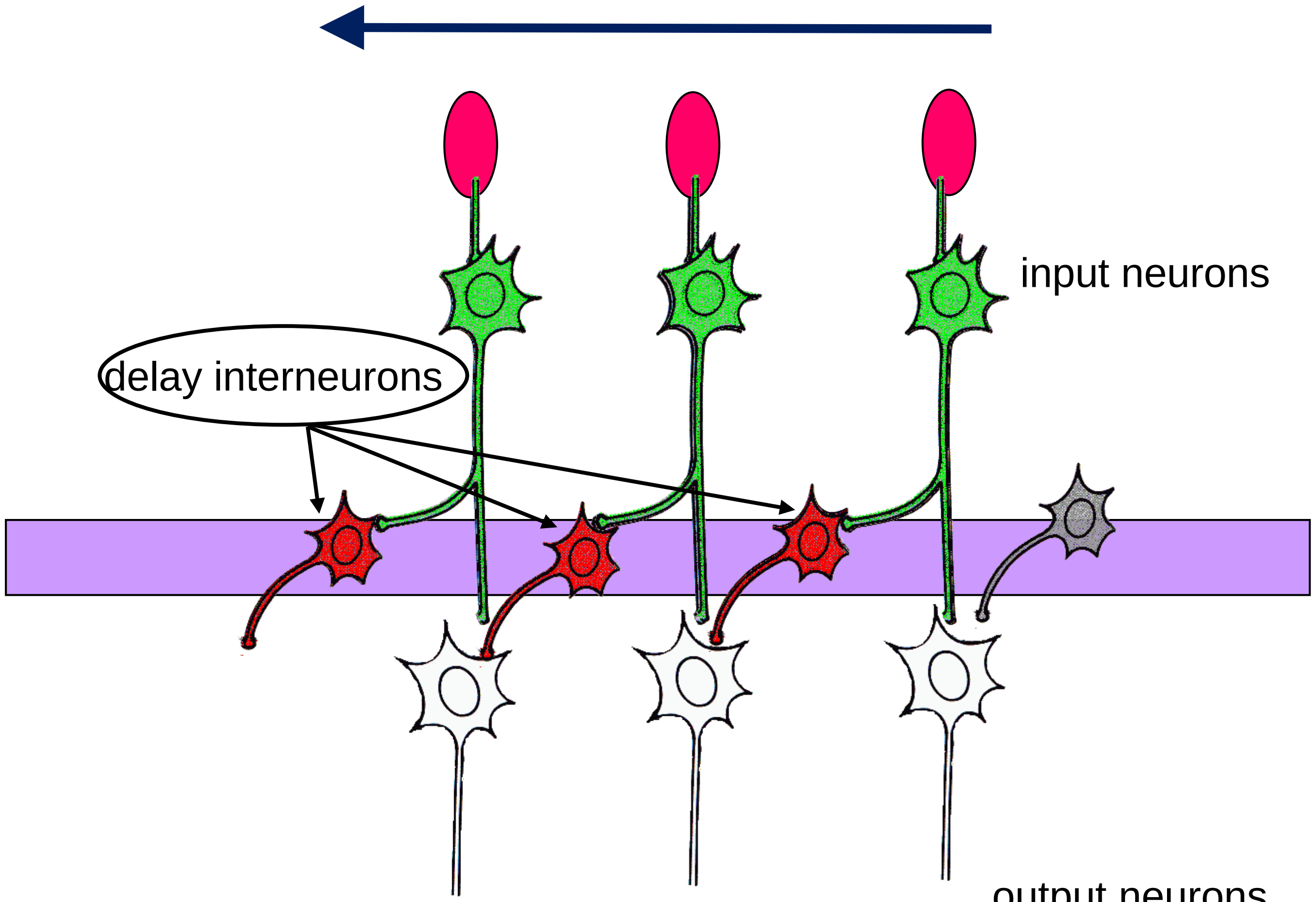


from: **Eye, Brain, and Vision**, by D.Hubel, p19.

neuron selective for direction of motion

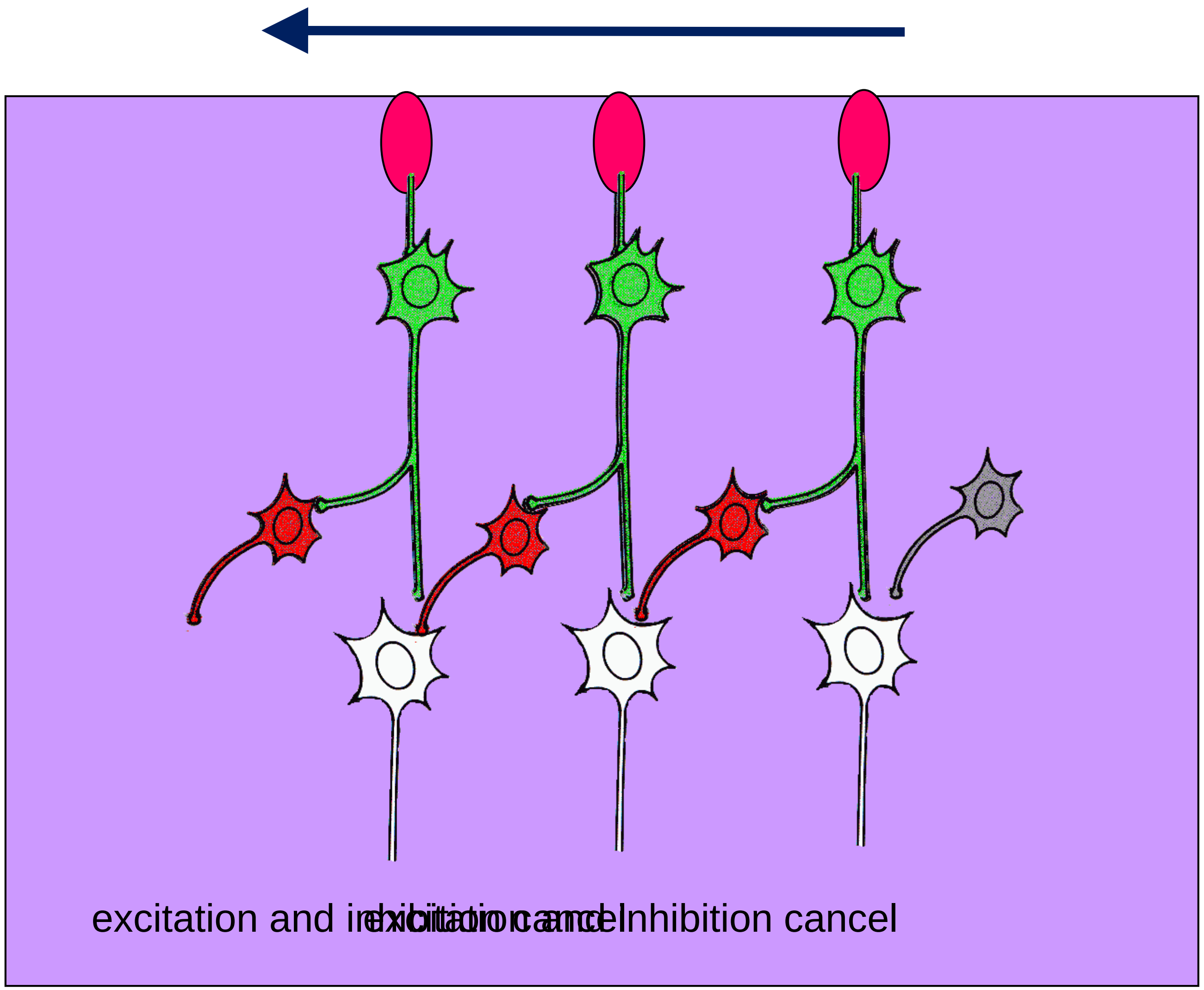


null direction



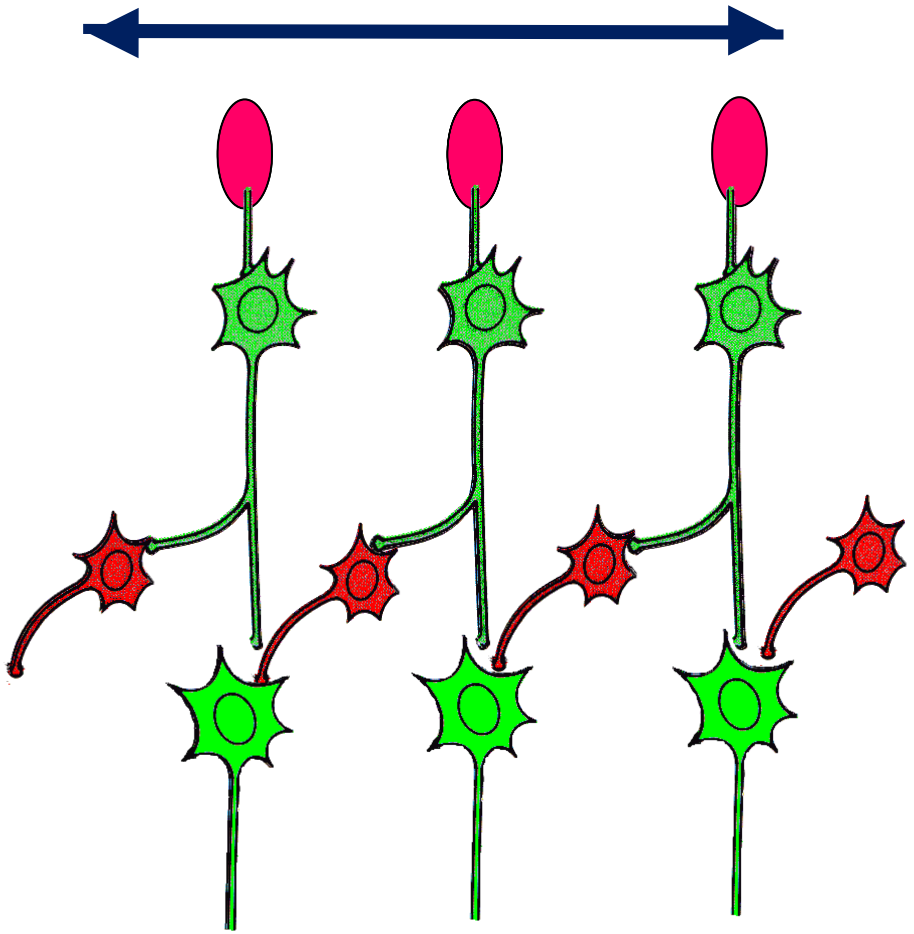
excitation and inhibition cancel
excitation and inhibition cancel

null direction



nada

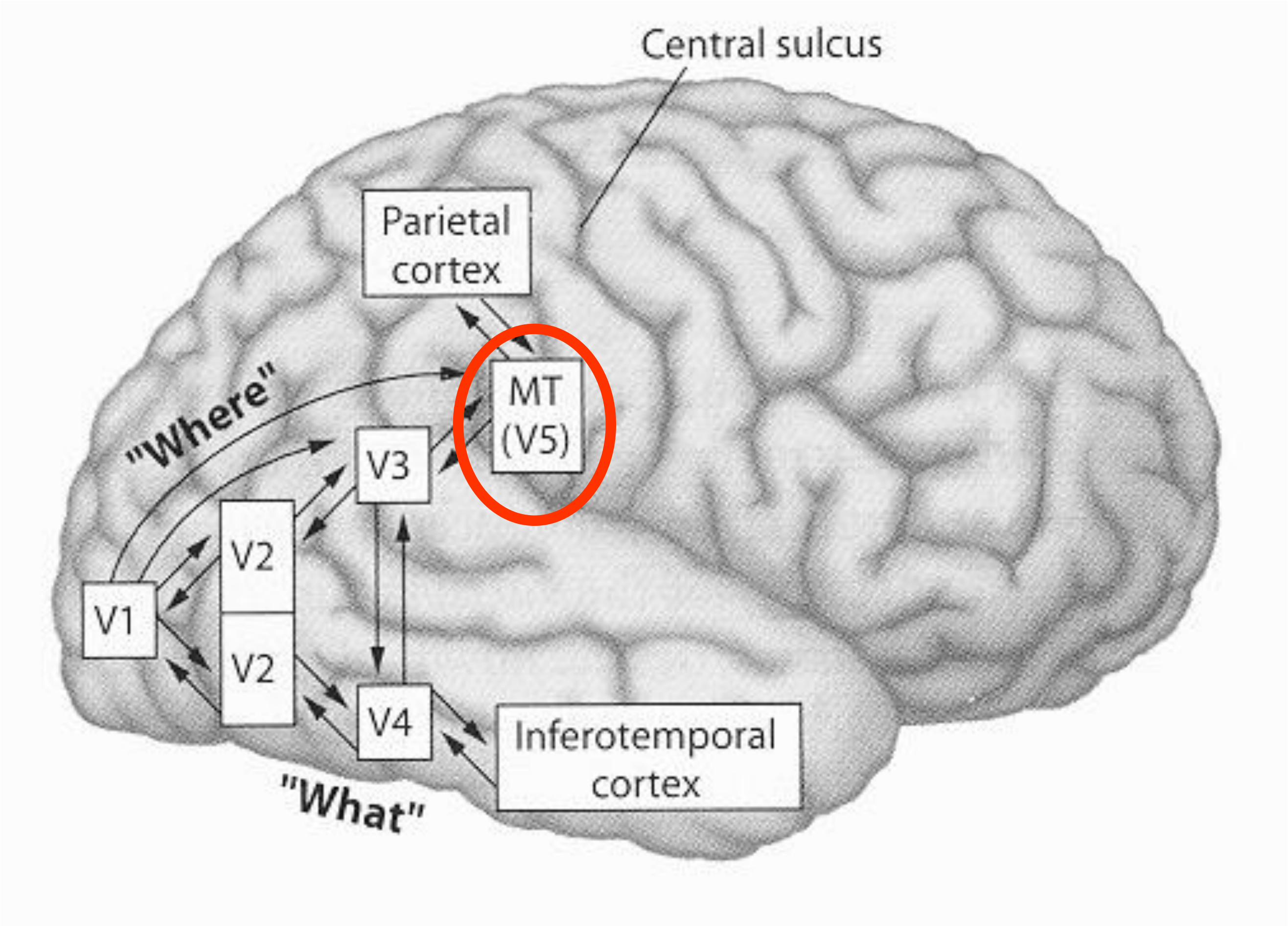
preferred direction



fires before inhibition
fires before inhibition
fires before inhibition

neurons fire

motion: MT (parietal pathway; mangocellular input)



from outline

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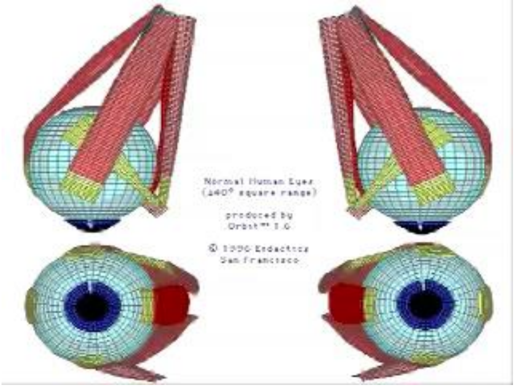
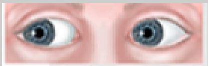


	Eye Movements	Eye Movements Report	~February 4th

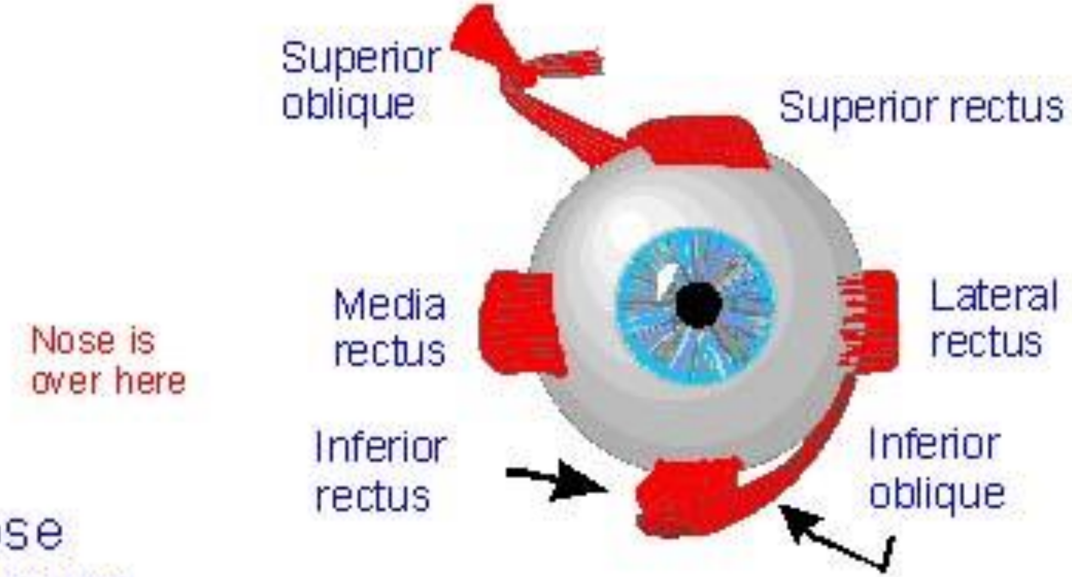
Eye Movements

•••

Ian Rapoport

Muscles!!!

- Medial rectus moves the eye towards the nose
- Lateral rectus moves the eye away from the nose
- Superior rectus moves the eye up
- Inferior rectus moves the eye down
- Superior oblique rotates the eye so that the top of the eye moves towards the nose.
- Inferior oblique rotates the eye so that the top of the eye moves away from the nose

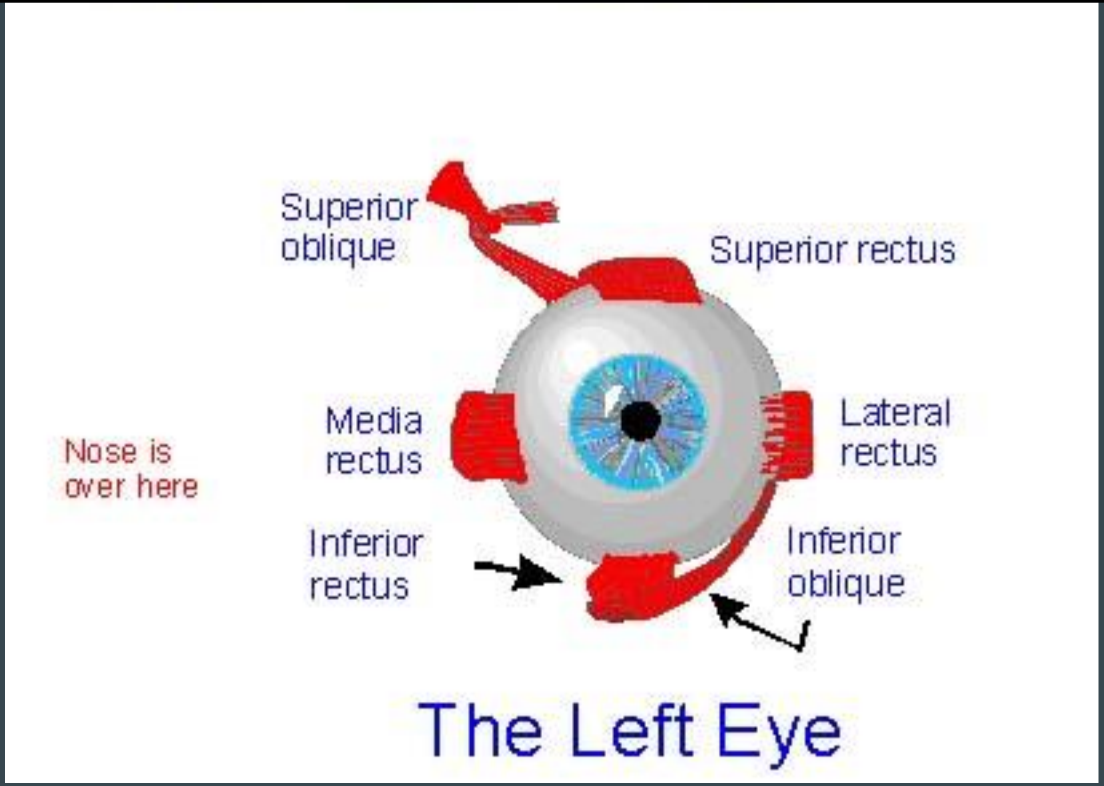


The Left Eye

http://www.yorku.ca/eye/muscle.htm

conjugate eye movements

- basic eye movements when the angle between the eyes do not change
- left, right, up, down
- essentially both eyes are looking in the same direction

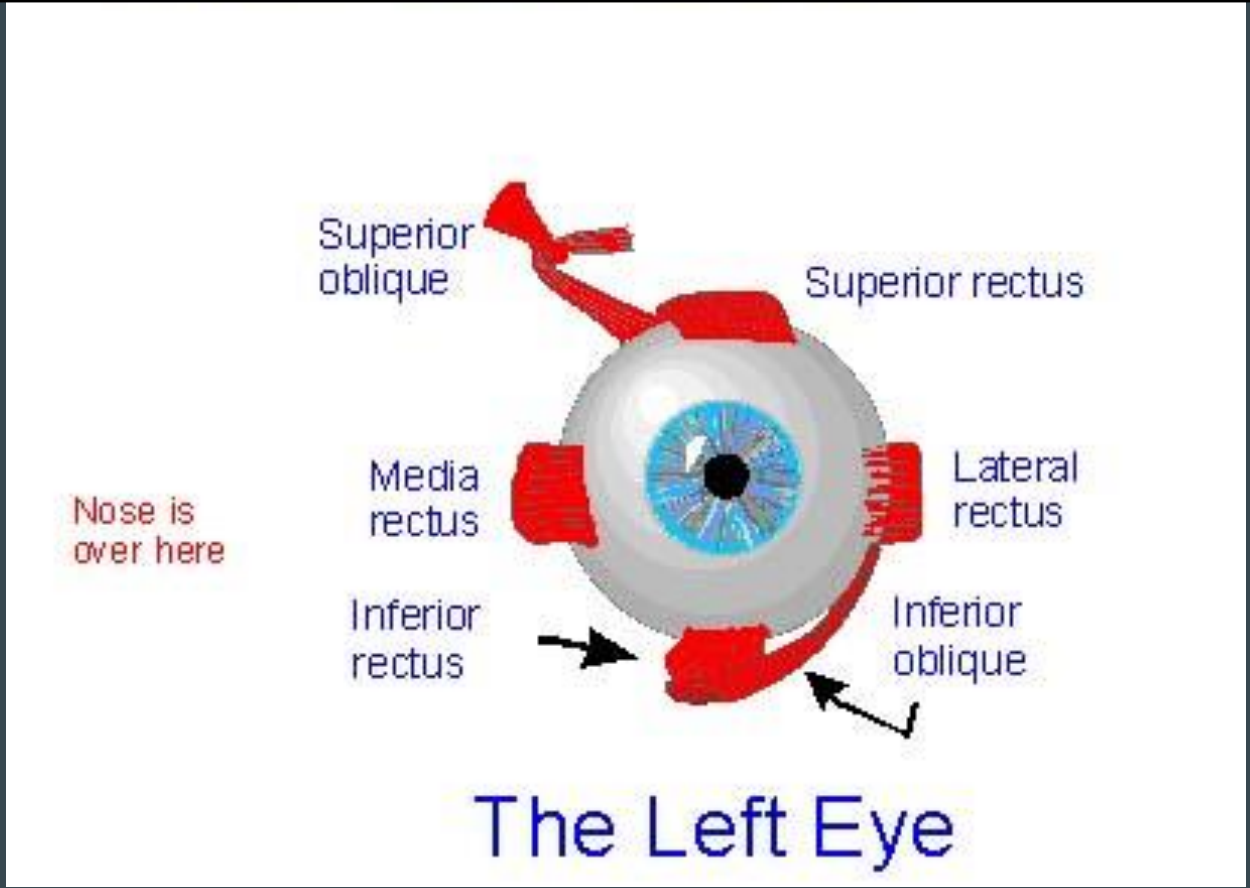


vergence eye movements

basic eye movements when the angles between the eyes DO change

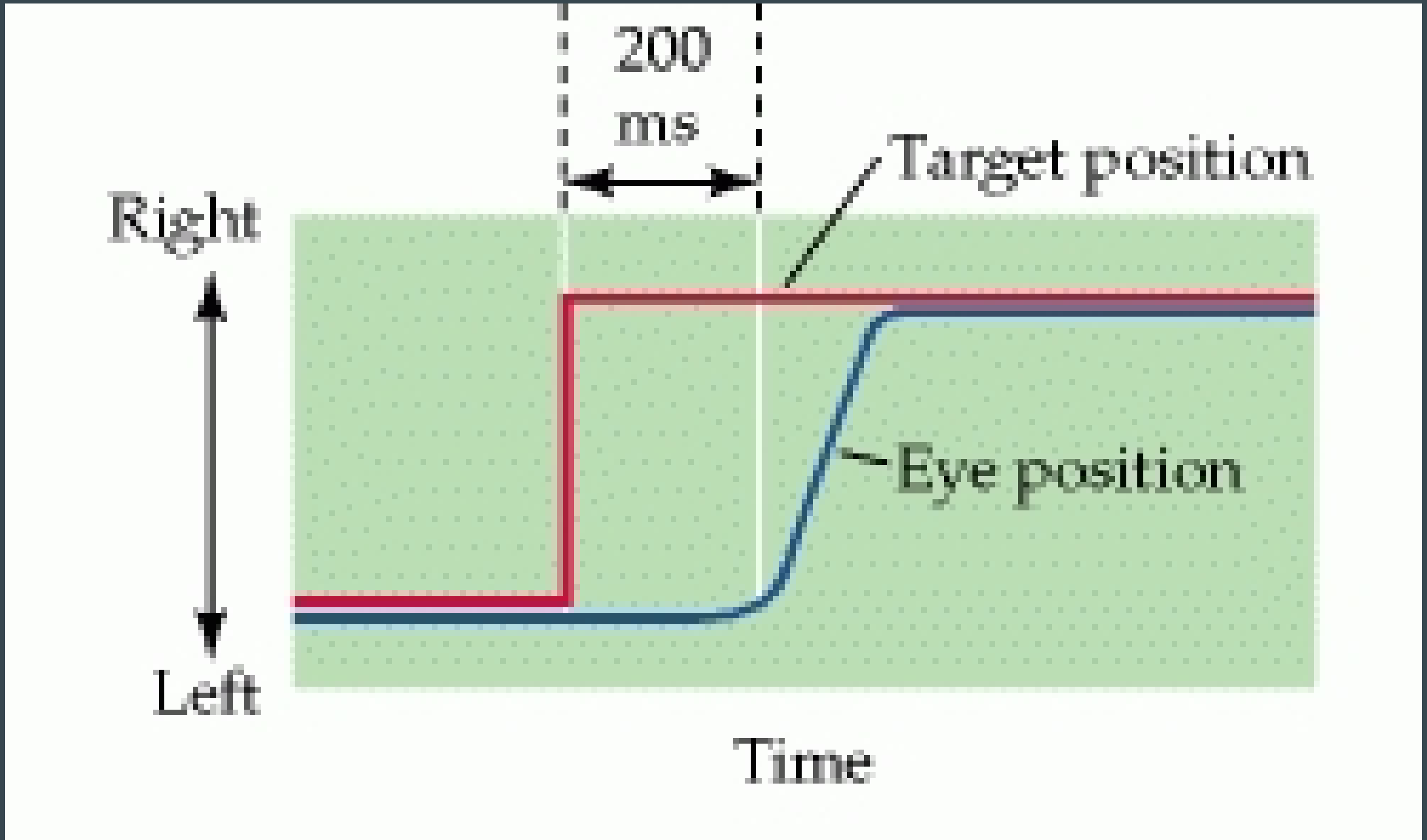
focus on your finger and move your finger closer to your face and then further away (good job!)

essentially eyes are looking in different directions



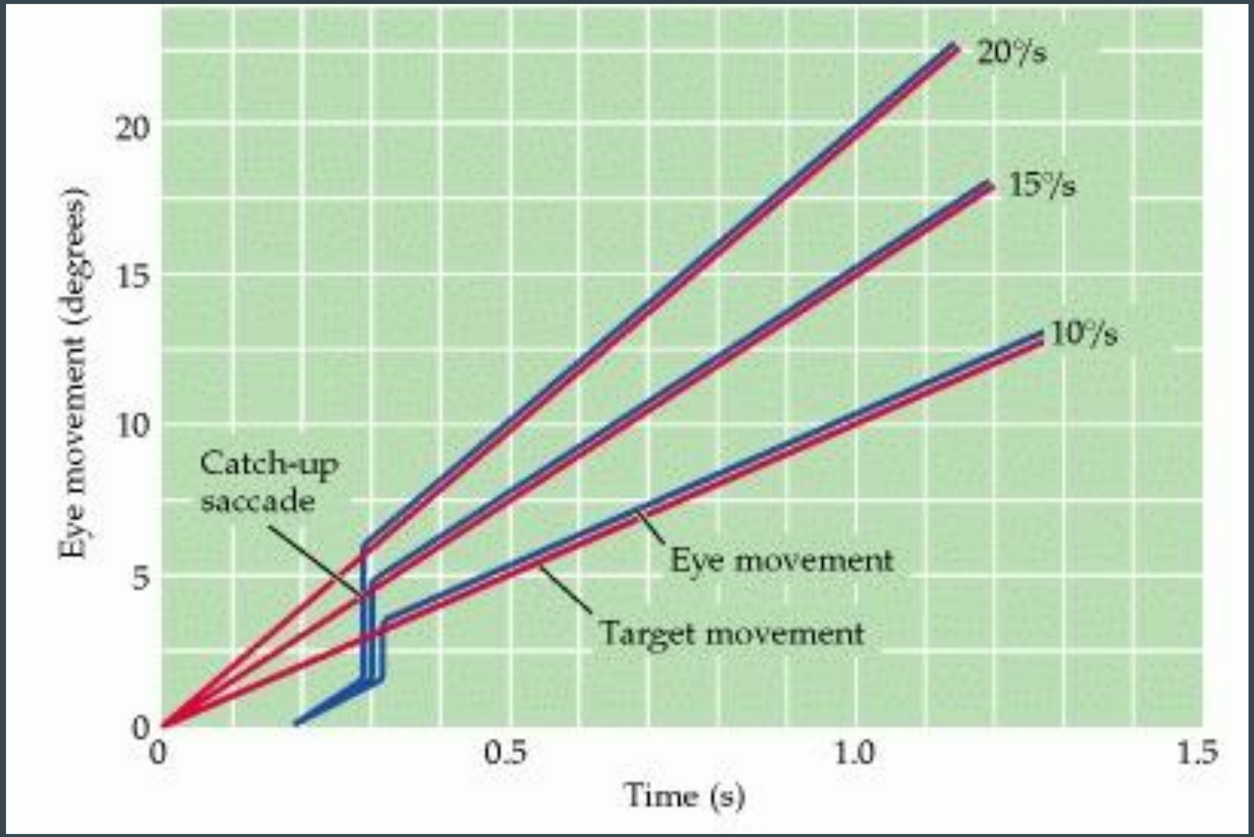
saccades

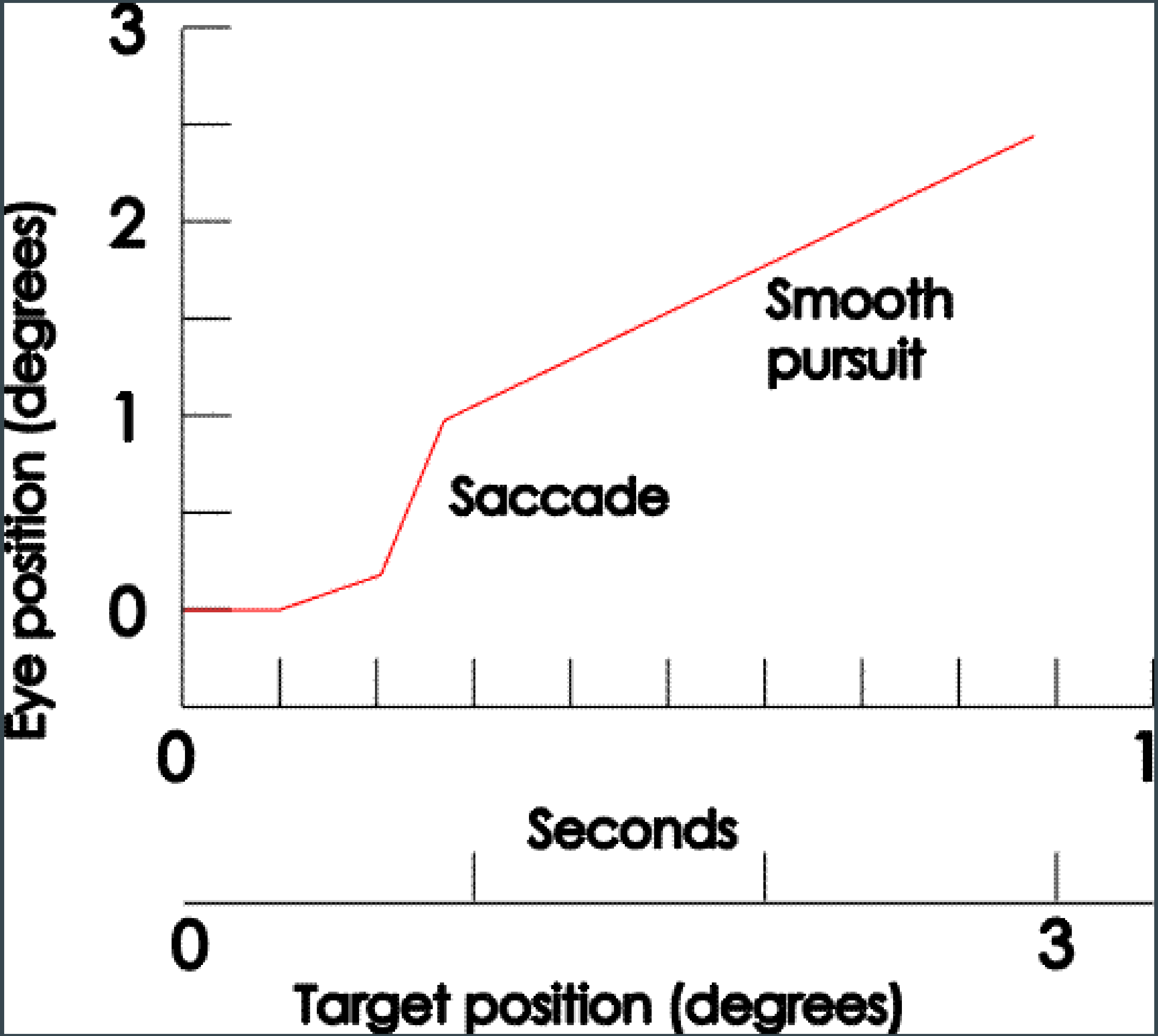
- quick eye movements from one point to another
- look at one thing! now look at another! awesome possum!
- http://www.ncbi.nlm.nih.gov/books/NBK10991/



smooth pursuit eye movements

- slow tracking movements that keep a moving image focused on the retina
- basically whenever you watch something that is moving
- http://www.ncbi.nlm.nih.gov/books/NBK10991/





http://www.yorku.ca/eye/eyemove.htm

vestibular-ocular eye movements

- stabilizing eye movements relative to the head and outside world
- vestibular system detects changes in head movement and produces corrective eye movements
- eye moves in opposite direction of head so image doesn't slip
- focus on something and move your head around
- CONGRATULATIONS!!! YOU JUST MADE A VESTIBULAR-OCULAR EYE MOVEMENT!!!

tremor

involuntary eye movements caused by muscle contractions

twitching basically

saccadic suppression

- when the brain does not acknowledge eye movements
- when you make a saccadic movement, your brain is not processing the image of everything between point A and B
- also happens when you blink

nystagmus

eye condition

inability of eyes to hold steady image, results in eye tremors or involuntary eye movements

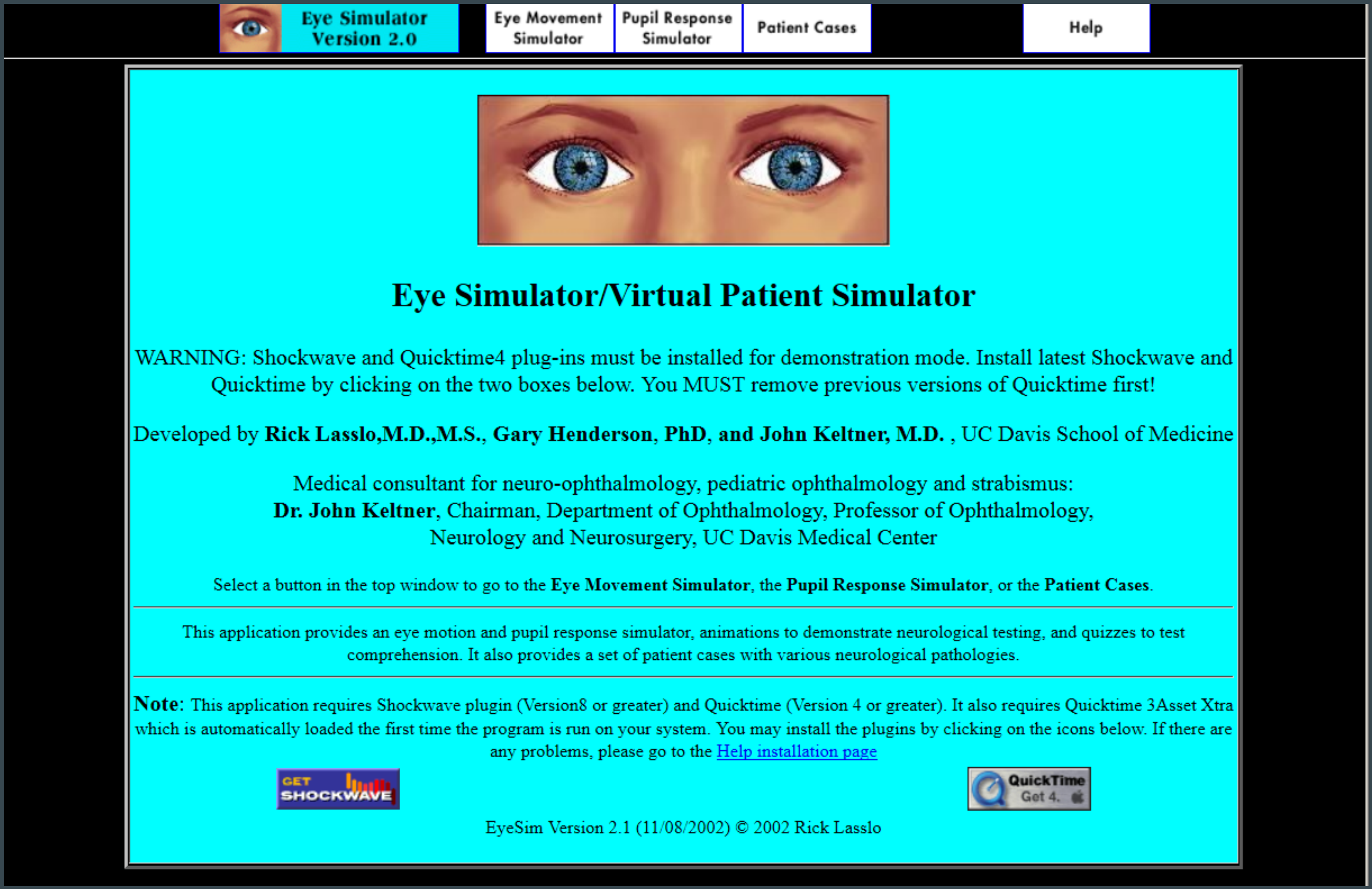
can be inherited or sometimes temporary

on your own time spin around in a chair and then try to focus on something, that spiny image is nystagmus

http://giphy.com/gifs/eye-medical-school-student-fI7fFVWr5t3c4

HEY CHECK THIS OUT?

https://cim.ucdmc.ucdavis.edu/eyerelease/Interface/TopFrame.htm



3. When the eye moves and an object is stationary the image of the object moves across the retina. When an object moves and the eye is stationary the image of the object moves across the retina. Understand the how both the inflow and outflow theories could provide sufficient information to distinguish between these two situations. What experiments show that the visual system actually employs the outflow (corollary discharge) information?

Object Movement vs Eye Movement

Inflow–Outflow Theory Report

~February 2nd

Inflow-Outflow Theory

Ben Smith

Eye movement vs. Object movement

- Eye fixed: object moves across loci
  - Afferent signals
- Eyes pursue moving target:
  - Still perceive movement
  - Efferent signals
- How to distinguish?

Inflow theory

- Sherrington
- Eye muscle signals sent to brain
- Cancel out retinal movement signals
- But, muscle signal slower → jolt

Outflow theory

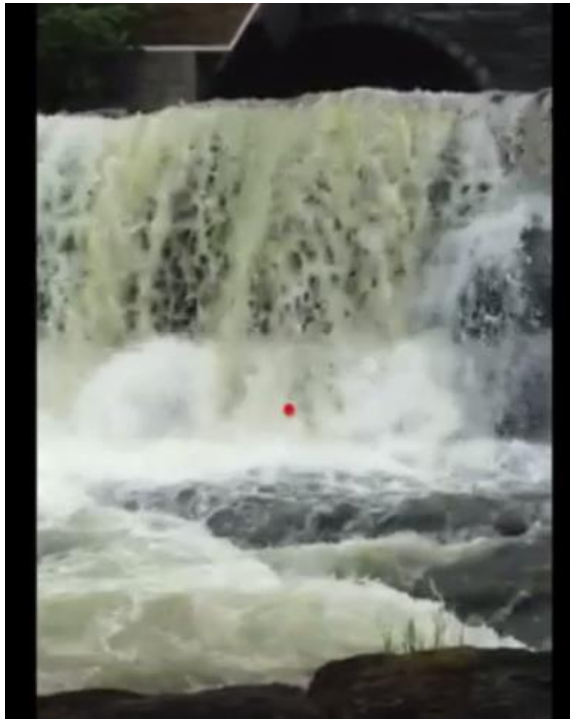
- Helmholtz
- Corollary signal sent to “comparator”
- Dominant theory

- Corollary discharge model

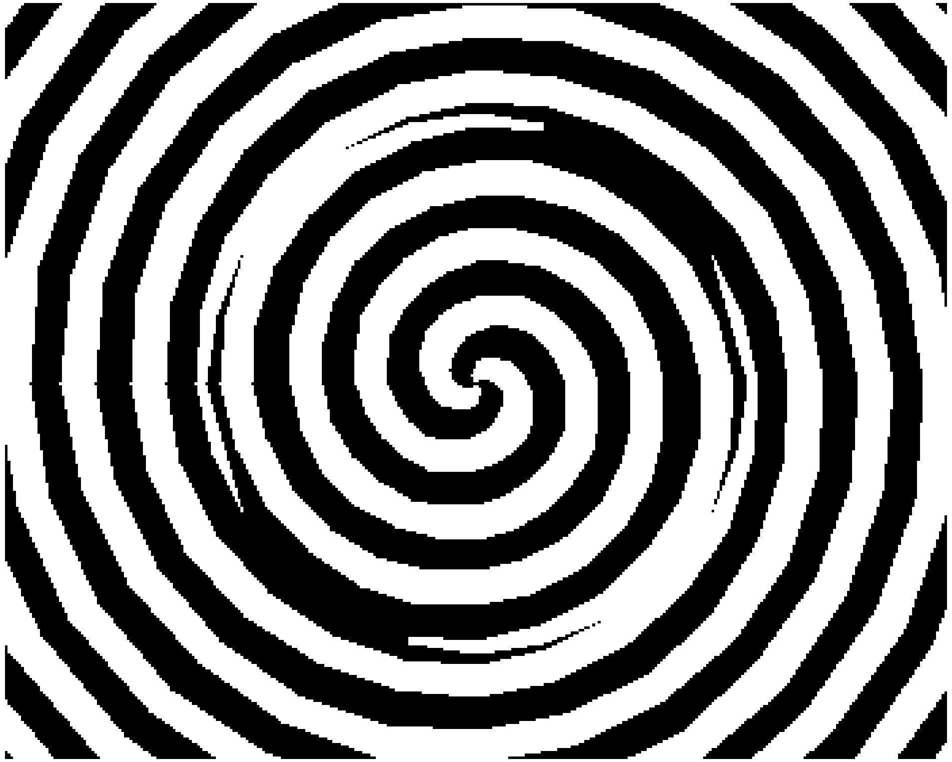
4. What is the explanation of spiral motion adaptation and the waterfall effect?

https://lindavernon.files.wordpress.com/2012/02/img071.jpg

http://www.mtv.com/news/1923605/niagara-falls-honeymoon/



https://www.youtube.com/watch?v=qLDKcZB8Eaw



[adaptation to spiral motion]

5. What is ‘common fate’ in regard to the visual system’s ability to utilize motion to extract perceptual grouping?

Common Fate a Gestalt Principle	Common Fate Report	~February 4th

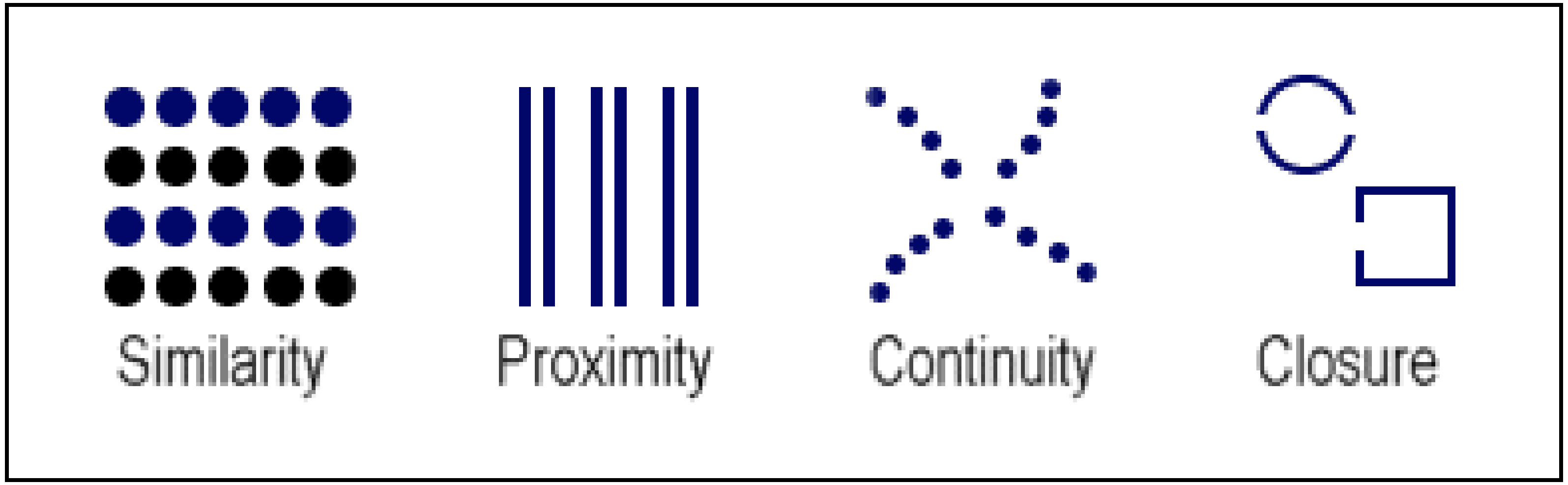
Common Fate and Motion Perception

Madeleine Buckley

Gestalt Principles of Grouping

Human perception that organizes images into patterns

Proximity, Similarity, Closure, Good Continuation, Common Fate, Good Form



Common Fate

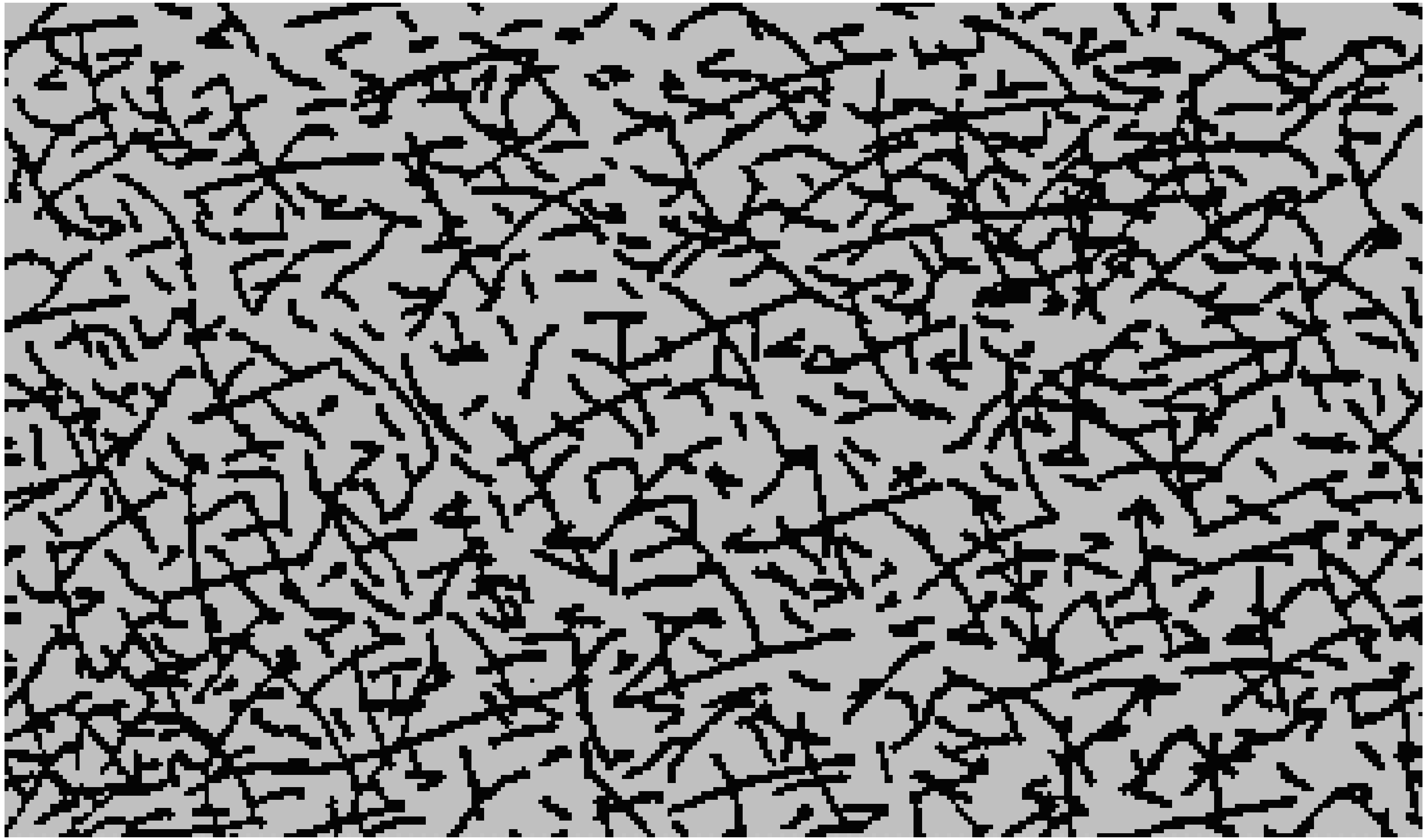
Grouping of objects moving in the same direction

The same motion-selective neurons will fire for these objects and not for the background images

Examples

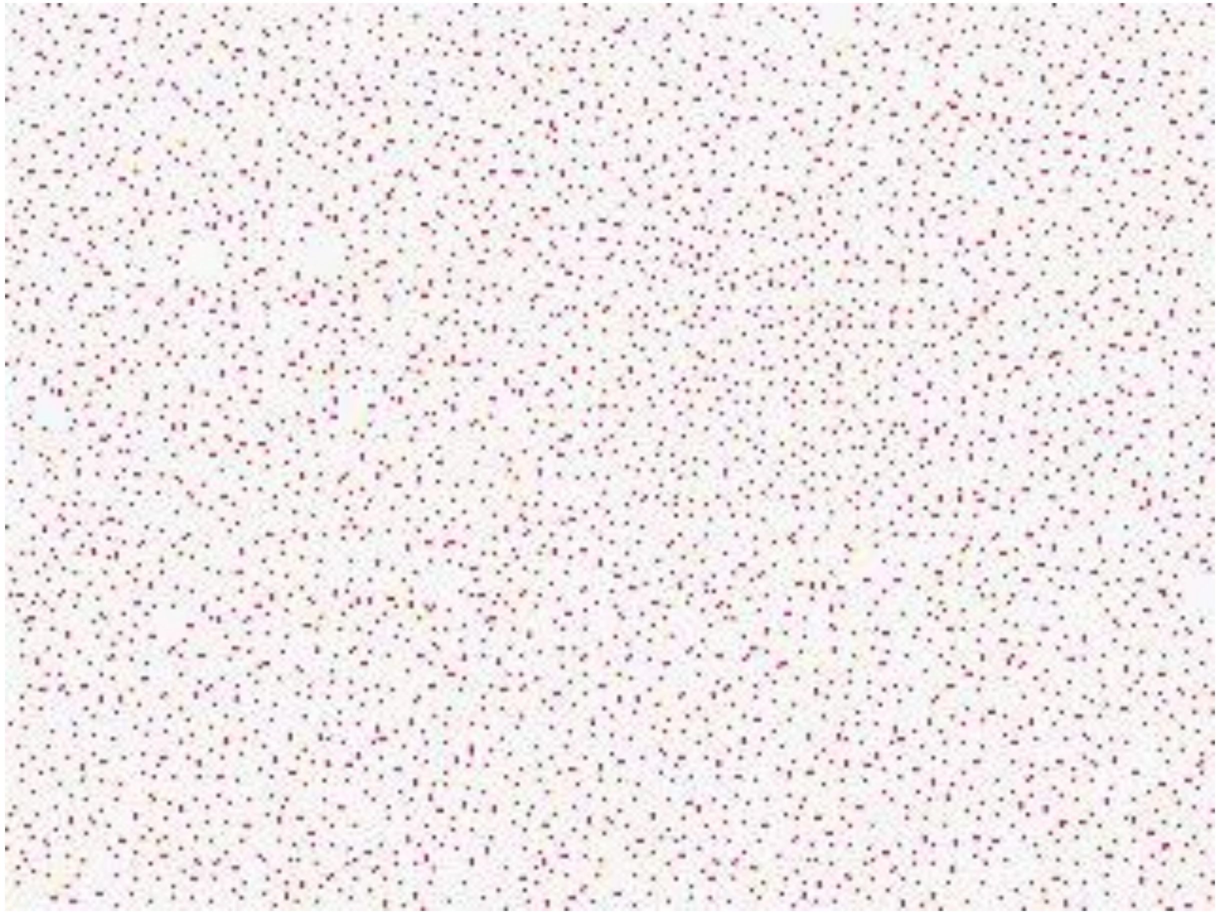
http://switkes.chemistry.ucsc.edu/teaching/CROWN85/Movies/DOTS3.mp4

http://psylux.psych.tu-dresden.de/i1/kaw/diverses%20Material/www.illusionworks.com/html/hidden_bird.html



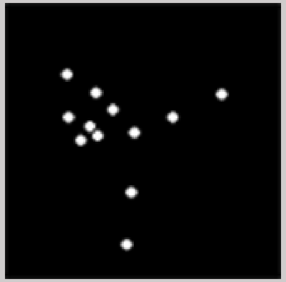
http://www.illusionworks.com

more common fate



biological motion

6. What is ‘biological motion’ and how does it require the visual system to extract information about both form and motion? Which pathway, parietal or temporal, is implicated in the perception of biological motion

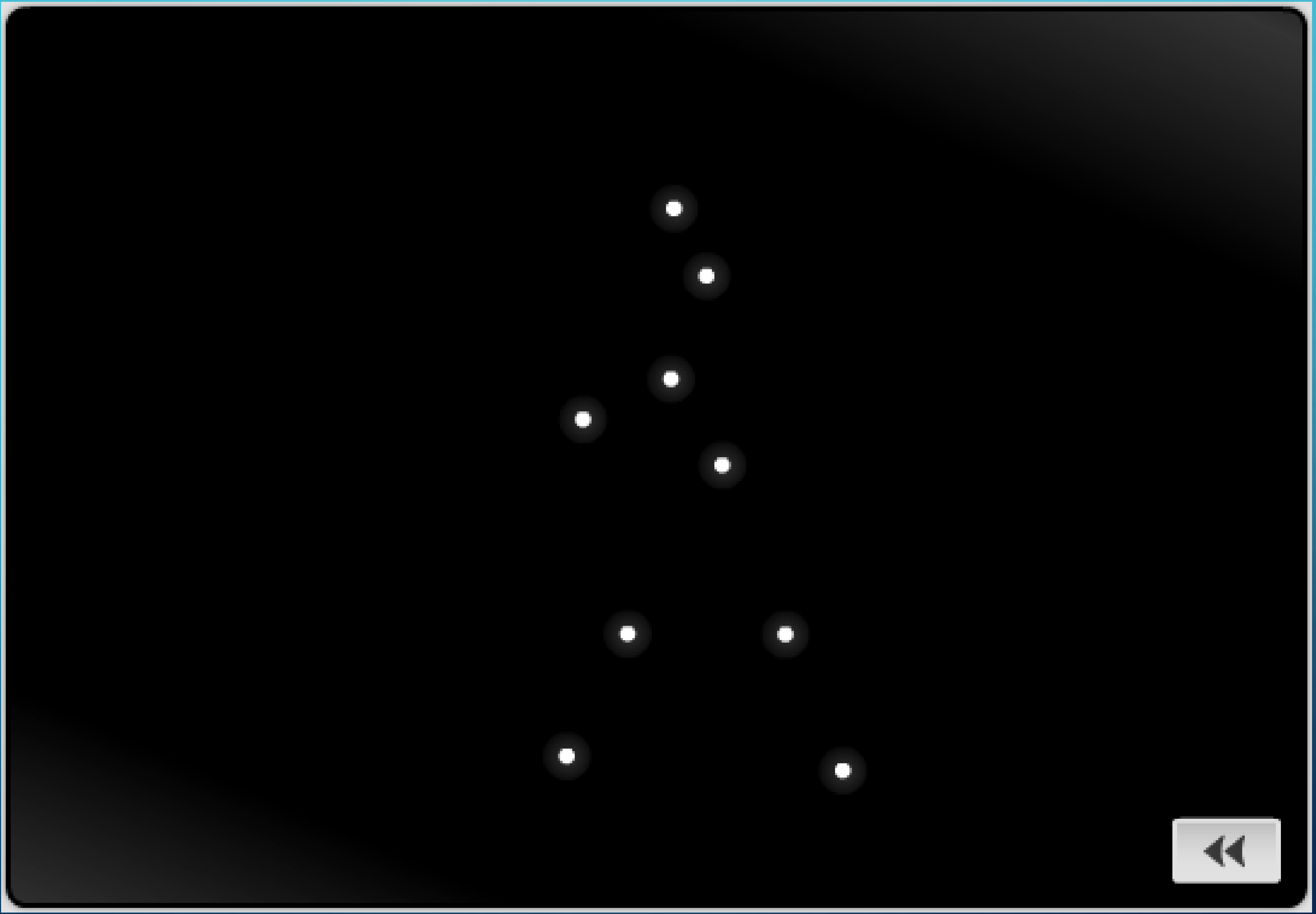
	Biological Motion	Biological Motion Report	~February 4th

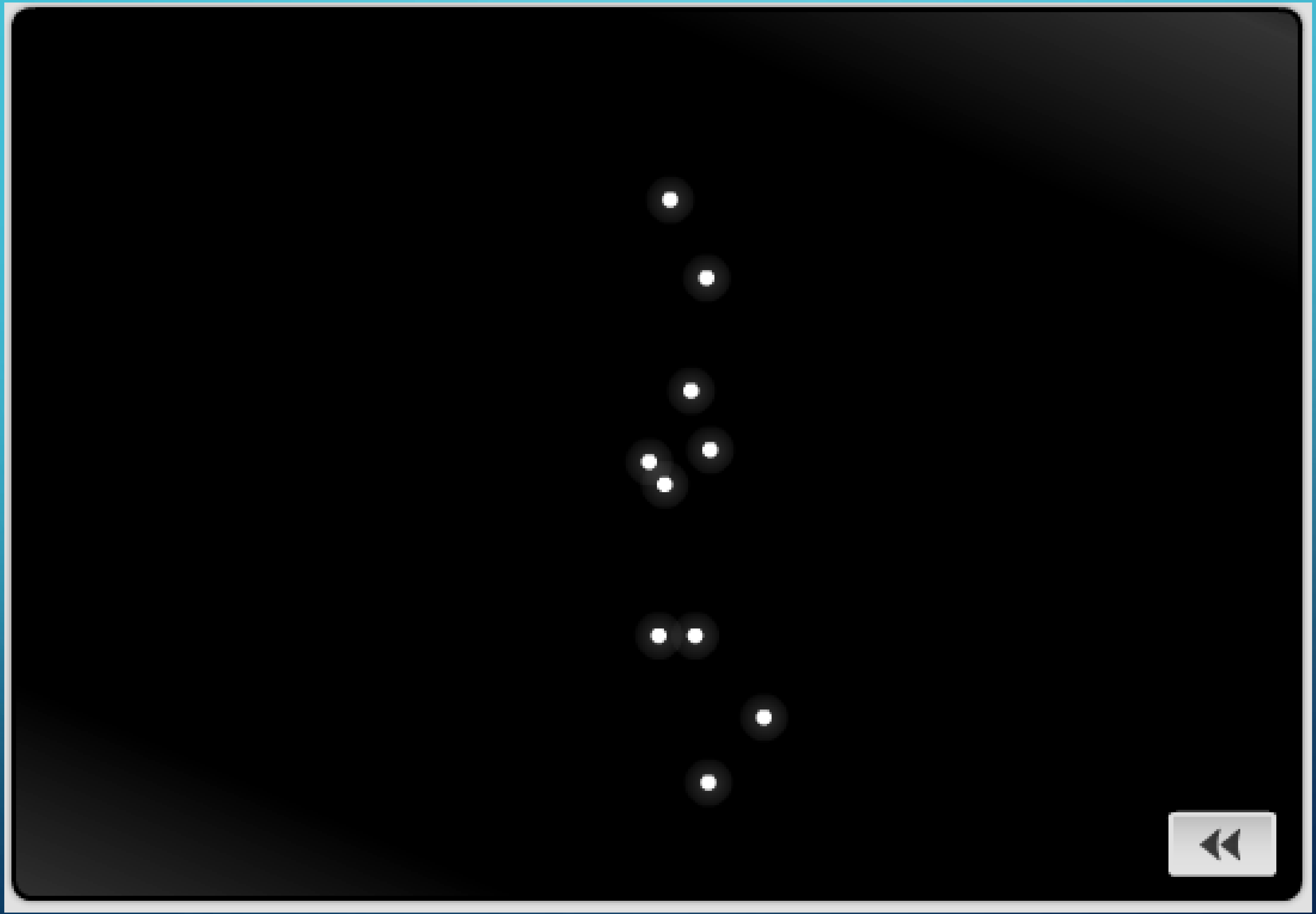
BIOLOGICAL MOTION

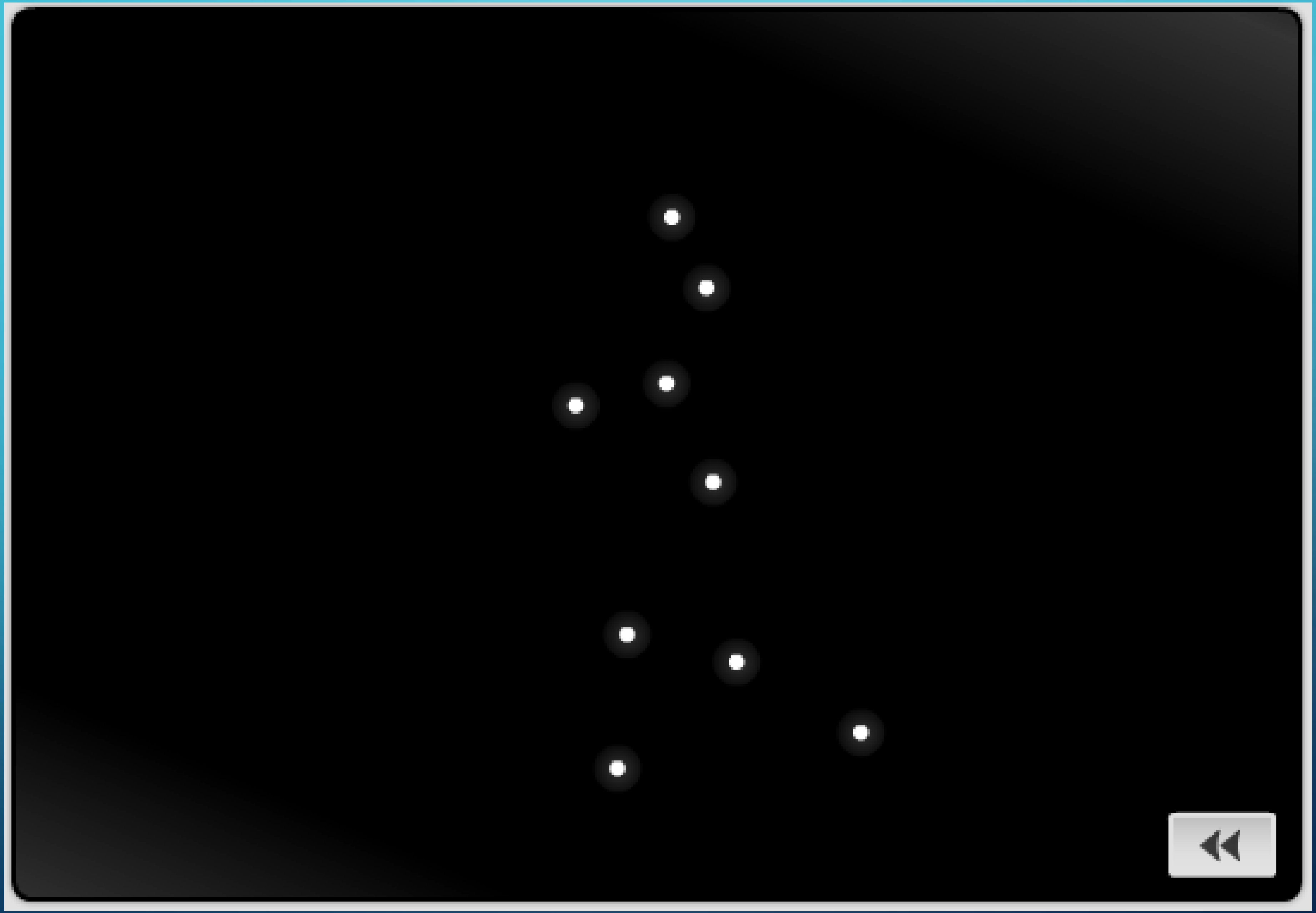
~ WHAT IS ‘BIOLOGICAL MOTION’

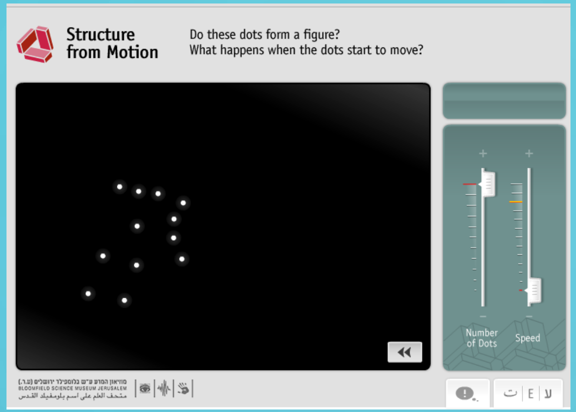
~ AND HOW DOES IT REQUIRE THE VISUAL SYSTEM TO EXTRACT INFORMATION ABOUT BOTH FORM AND MOTION?

~ WHICH PATHWAY, PARIETAL OR TEMPORAL, IS IMPLICATED IN THE PERCEPTION OF BIOLOGICAL MOTION



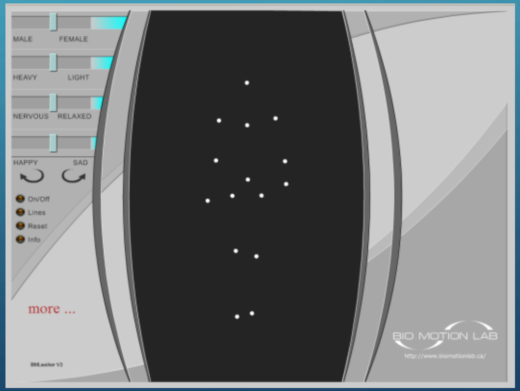




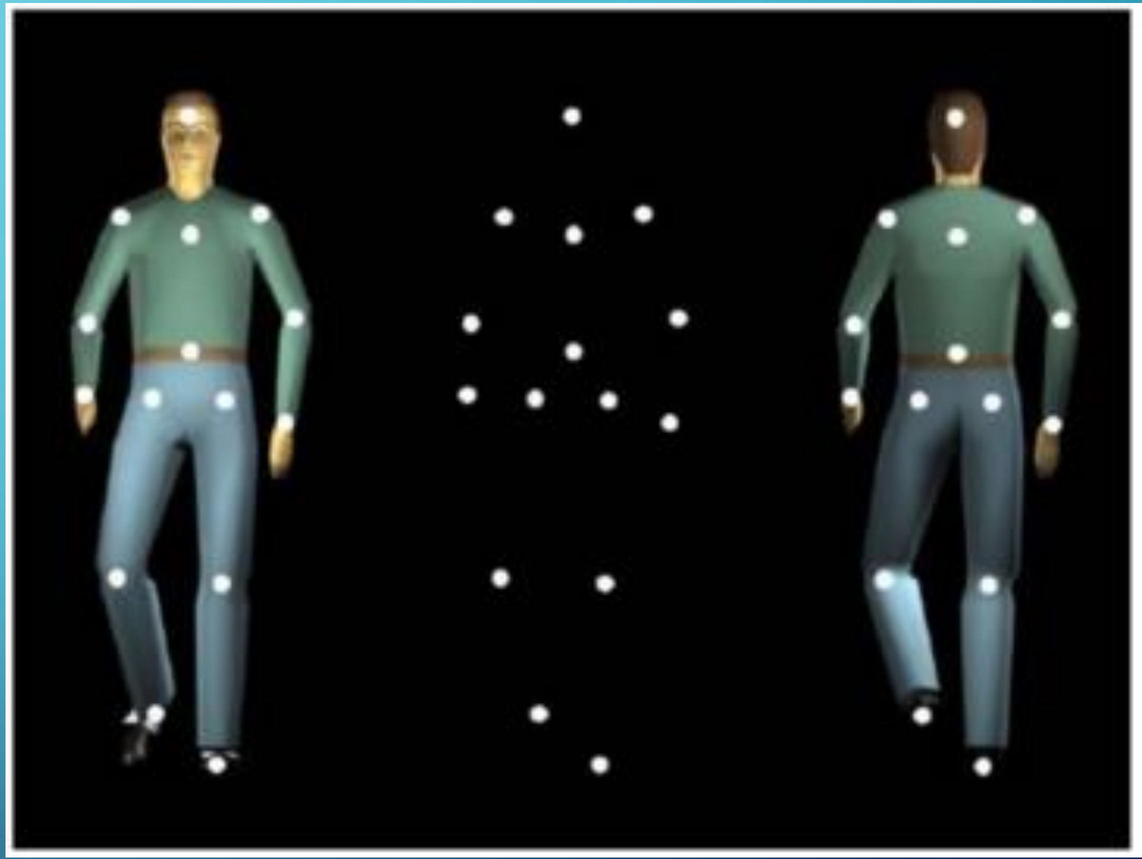


[HTTPS://BRAIN.MADA.ORG.IL/BIOMOTION/BIOMOTIONWEB.SWF](https://brain.mada.org.il/biomotion/biomotionweb.swf)

[HTTP://WWW.BIOMOTIONLAB.CA/DEMOS/BMLWALKER.HTML](http://www.biomotionlab.ca/demos/bmlwalker.html)



Gunnar Johansson (1911–1998) was a Swedish psychophysicist. He was interested in the Gestalt laws of motion perception in vision. He is best known for his investigations of biological motion.



FORM AND/OR MOTION

What does "recognizing" biological motion involve?

- Brain mechanisms that involve form?
- Brain mechanisms that involve motion?

VENTRAL-TEMPORAL

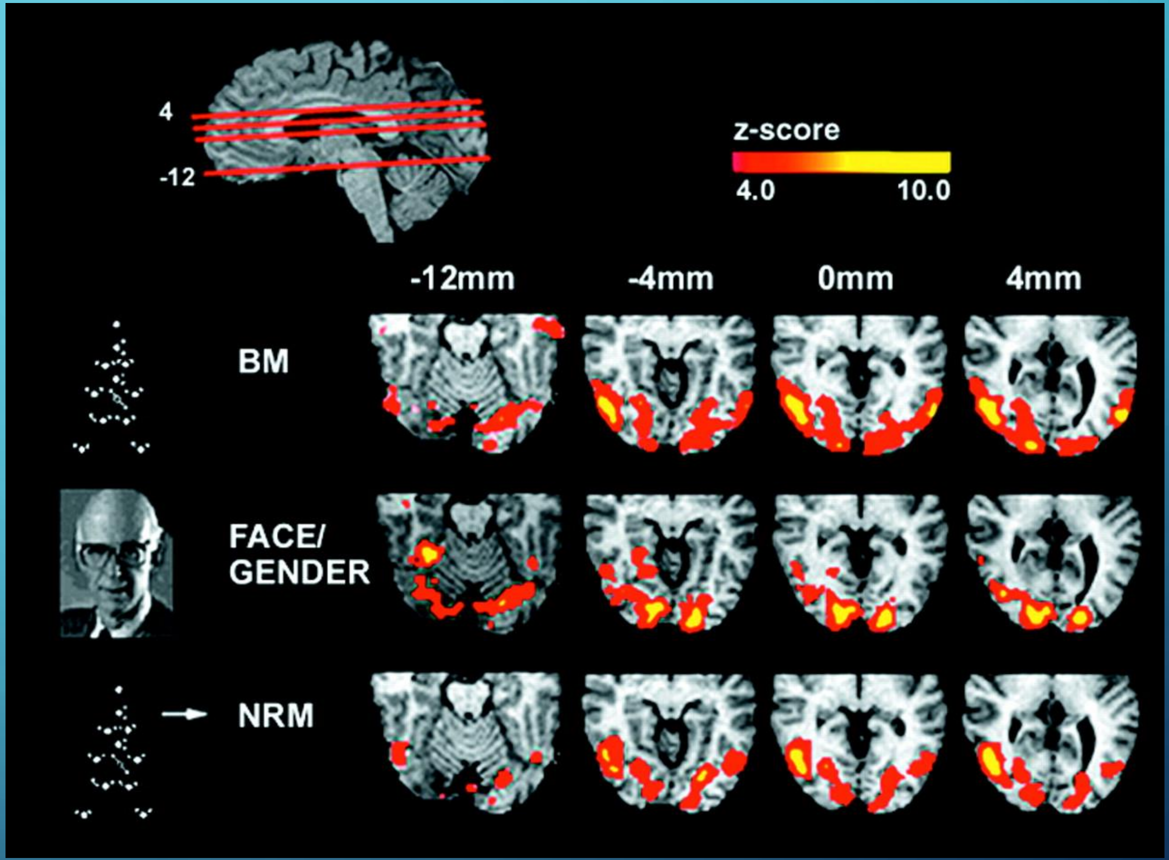
DORSAL-PARIETAL

FMRI STUDY OF NON-RIGID MOTION, FORM, AND BIOLOGICAL MOTION

Biological motion:
both ventral and dorsal

Face/Gender identification:
ventral

non-rigid motion (no form):
dorsal (e.g. MT)



Lucia M. Vaina et al. PNAS 2001;98:11656-11661

CLINICAL OBSERVATIONS

had dorsal, MT lesion used ventral path

such as patients LM and AF , who were impaired on many aspects of visual motion perception to the extent that they are referred to as almost or completely "**motion-blind**," **can reliably recognize human actions in point-light displays**.

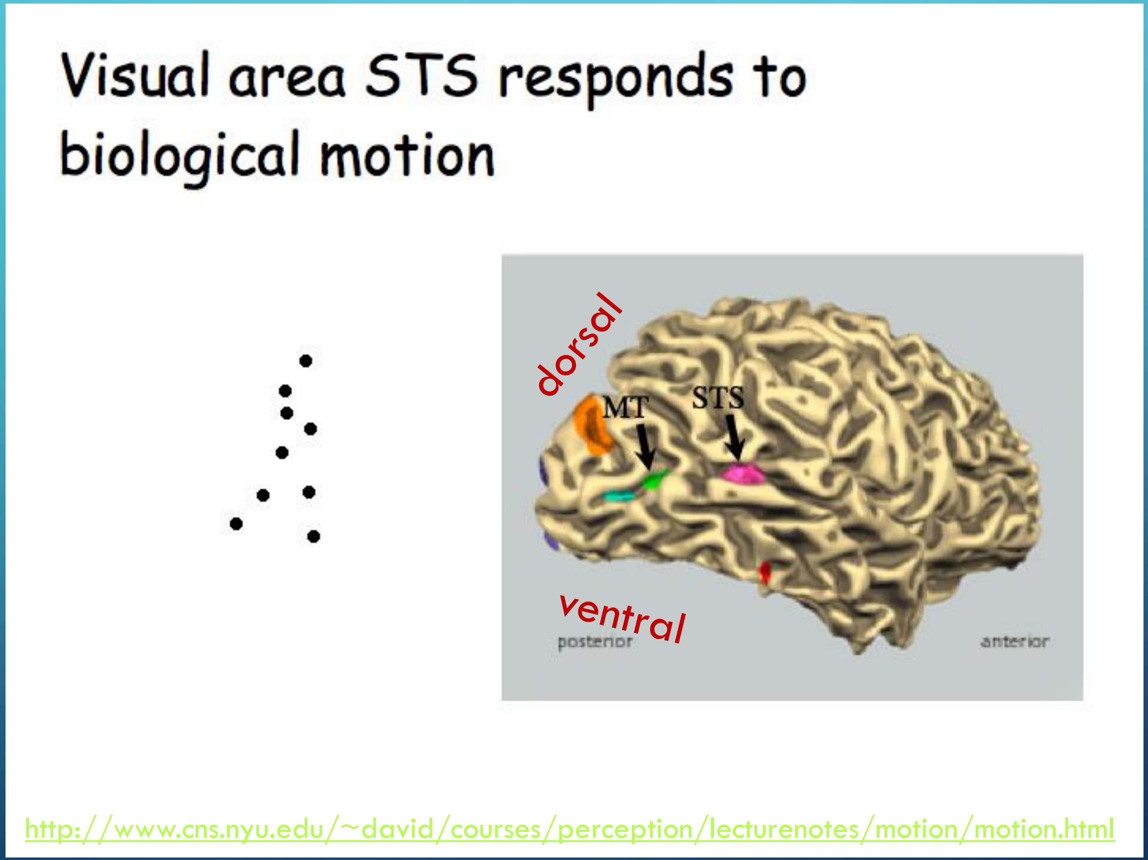
had ventral lesion used dorsal path

Similarly surprising, patient EW, **with bilateral ventral lesions** involving the posterior temporal lobes , suffered from prosopagnosia and object agnosia, **but could easily and correctly recognize BM**. Thus, inputs from the ventral pathway to STP were not fully available, and we suggest that this patient mostly relied on the dorsal pathway

EITHER (BOTH) STREAM ACTIVATES SUPERIOR TEMPORAL SULCUS

Thus, we conjecture that, whereas form and face stimuli activate primarily the ventral system and motion stimuli primarily the dorsal system, recognition of

BM stimuli may activate both systems as well as their confluence in STS



7. What is the flicker-fusion rate?

How rapidly a light can be turned on and off before the percept becomes that of continuous illumination.

depends on brightness and scotopic or photopic, color, size of source, etc.

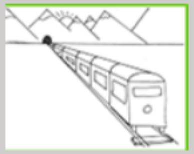
- Incandescent lights 120 Hz (cycles/sec)
- CRT monitors ~60 Hz
- Old time movies (‘flicks’) recorded at 24 Hz, show each frame twice = 48 Hz

8. In the real world what are clues which the brain uses to determine depth?
   a. monocular
   b. binocular

9. What are Julsez patterns and what do they show about depth perception?

monocular clues :

James Petnic, Crown 85

	Monocular Cues to Depth	Monocular Cues Report	~February 4th

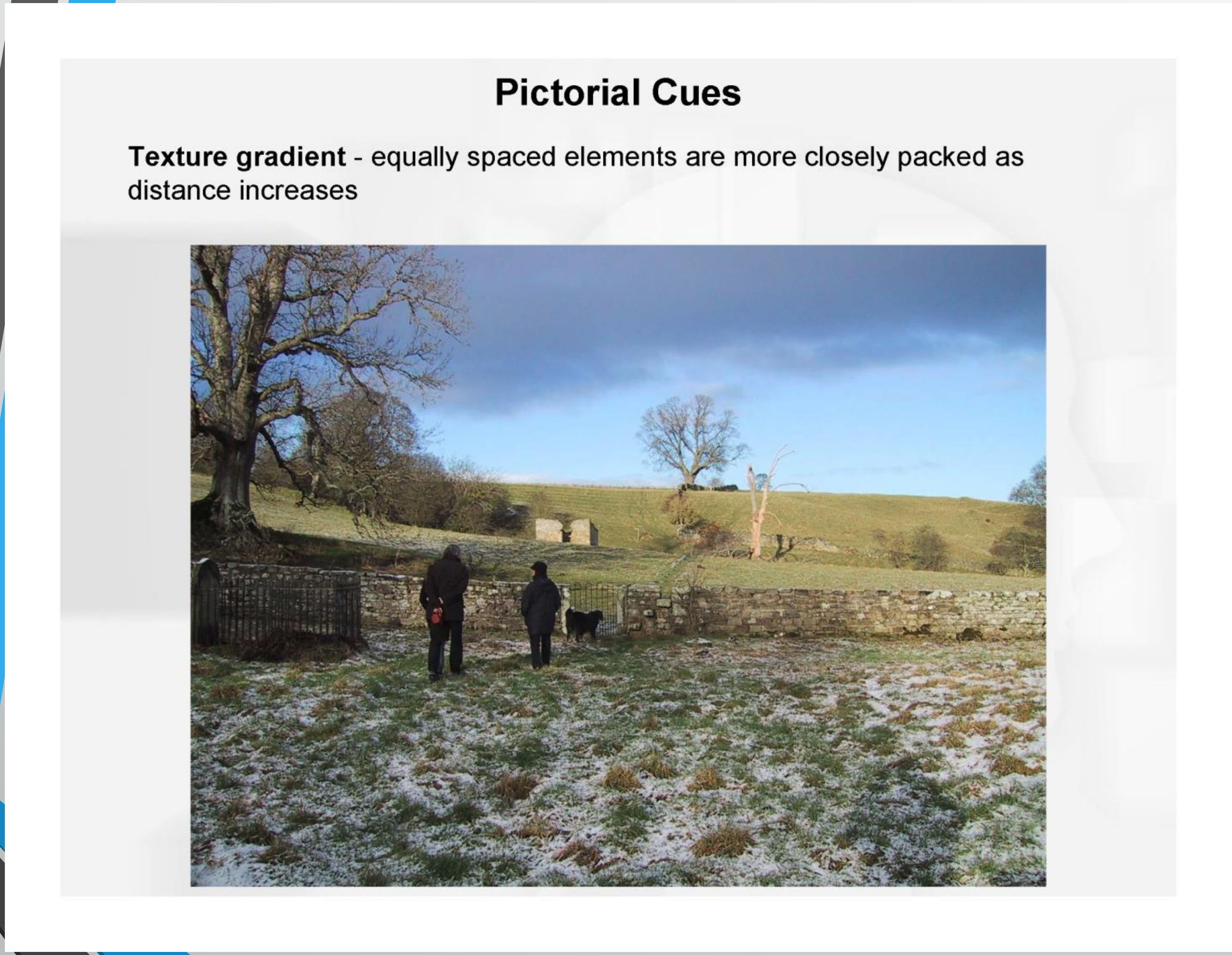
monocular clues– perspective & texture, size

Pictorial Cues

- **Relative size** - when objects are equal size, the closer one will take up more of your visual field
- **Perspective convergence** - parallel lines appear to come together in the distance
- **Familiar size** - distance information based on our knowledge of object size

from: University of Washington Psychology 333

monocular clues– perspective & texture



taken from: University of Washington Psychology 333

monocular clues– occlusion, height in picture

Pictorial Cues

Occlusion - when one object partially covers another
Relative height - objects that are higher in the field of vision are more distant

from: University of Washington Psychology 333

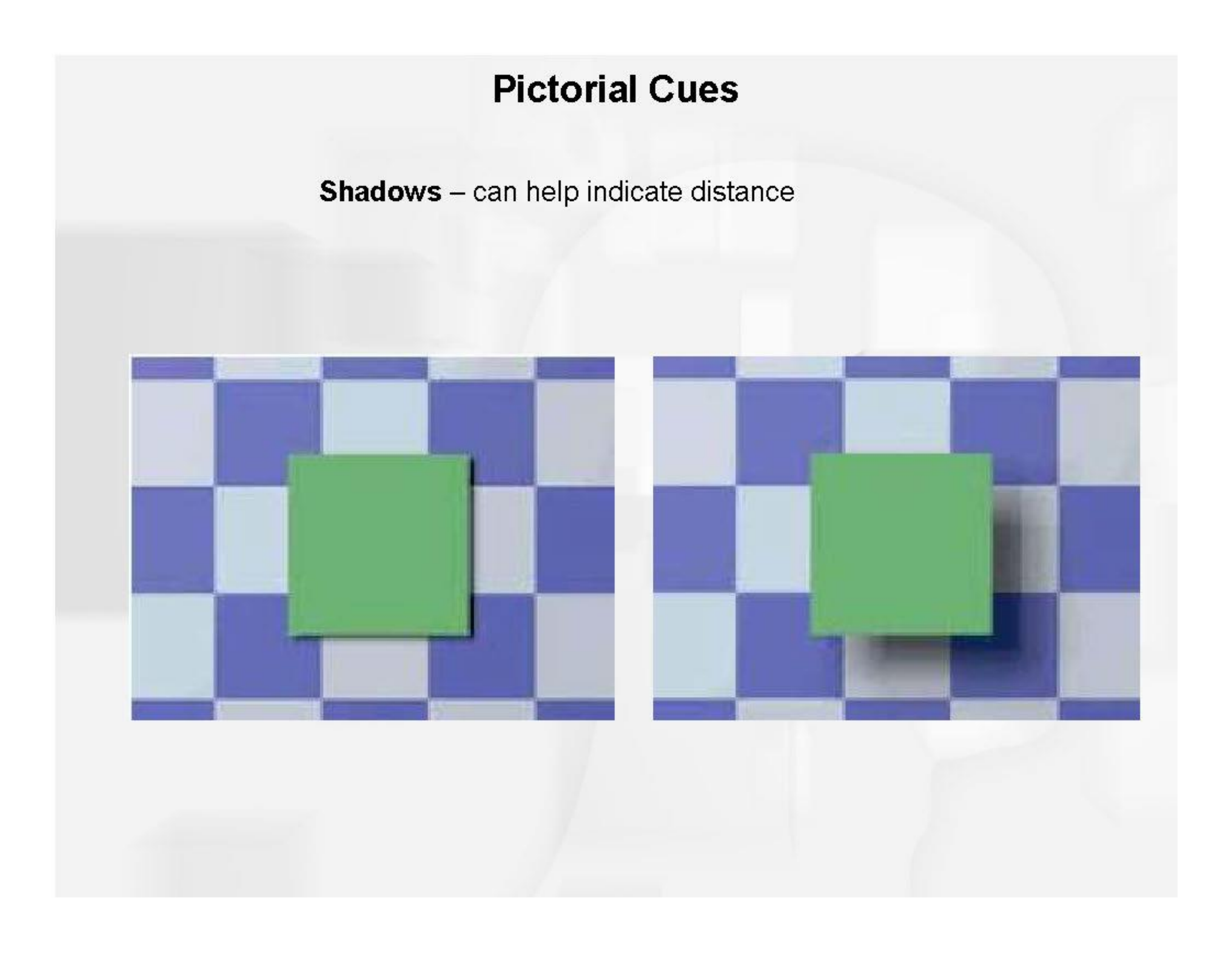
monocular clues– aerial or atmospheric perspective

Pictorial Cues

- **Atmospheric perspective** - distance objects are fuzzy and have a blue tint

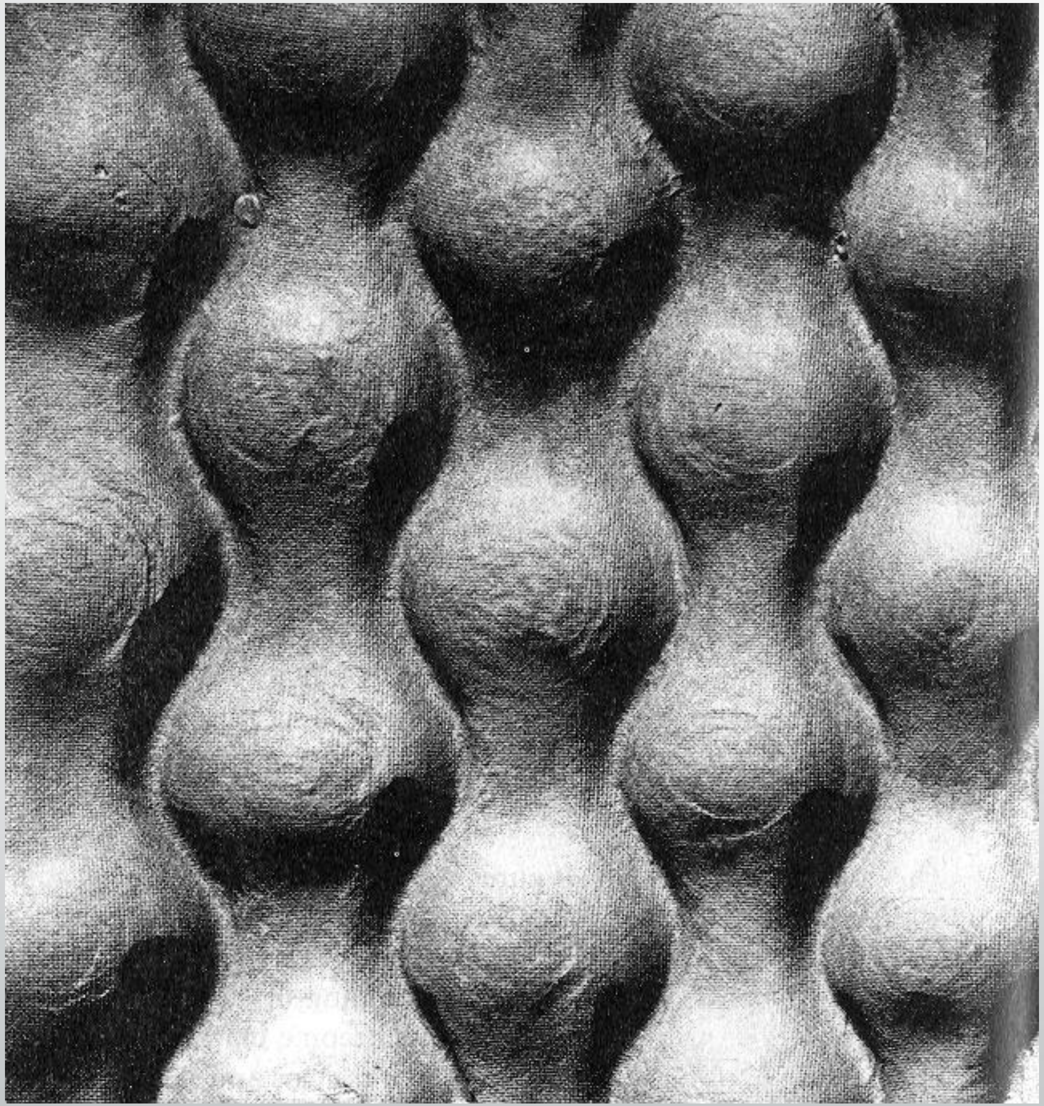
from: University of Washington Psychology 333

monocular clues– shadows



from: [University of Washington Psychology 333]

depth, monocular clue: shadow



monocular clues– motion

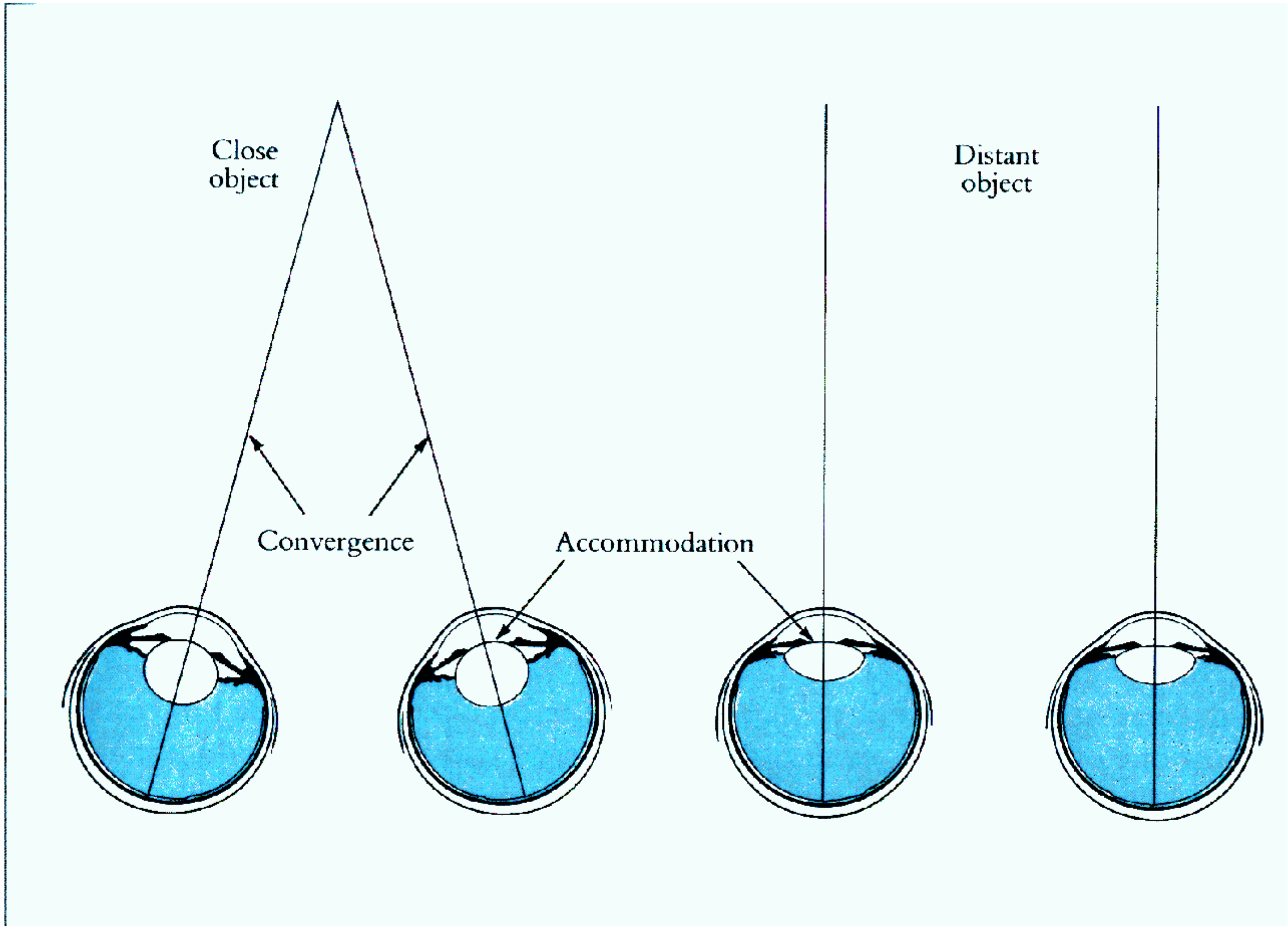
Motion-Produced Cues

- **Motion parallax** - close objects in direction of movement glide rapidly past but objects in the distance appear to move slowly
- **Deletion and accretion** - objects are covered or uncovered as we move relative to them
  - Also called occlusion-in-motion

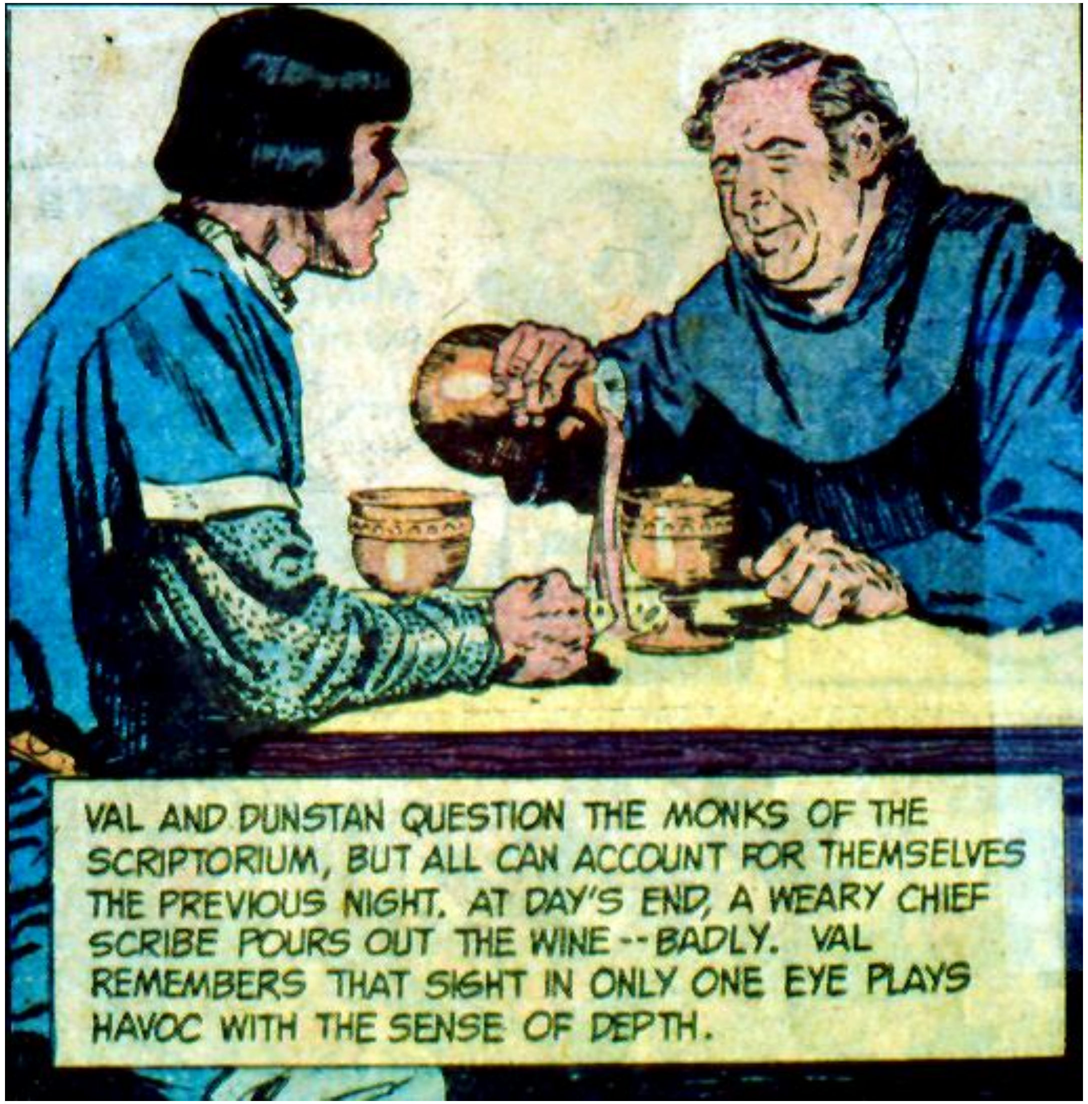
taken from: University of Washington Psychology 333

Examples

depth, binocular clues (oculomotor) : convergence and accommodation



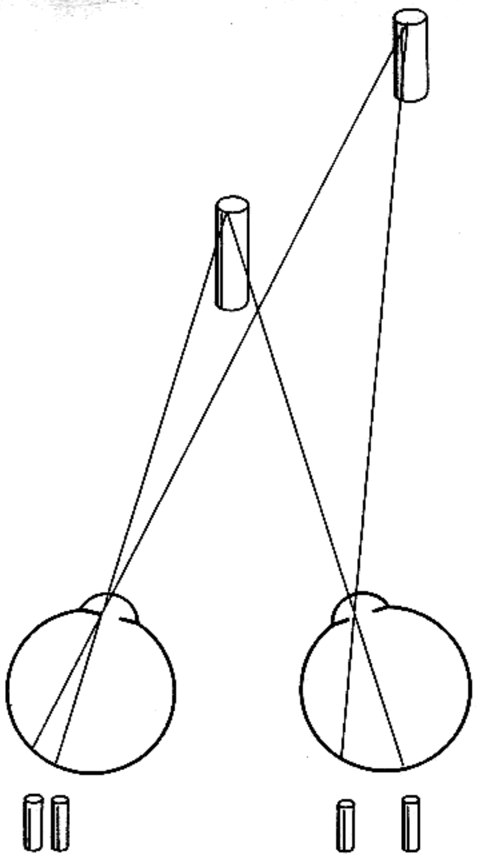
BAD JOKE !!


VAL AND DUNSTAN QUESTION THE MONKS OF THE SCRIPTORIUM, BUT ALL CAN ACCOUNT FOR THEMSELVES THE PREVIOUS NIGHT. AT DAY'S END, A WEARY CHIEF SCRIBE POURS OUT THE WINE--BADLY. VAL REMEMBERS THAT SIGHT IN ONLY ONE EYE PLAYS HAVOC WITH THE SENSE OF DEPTH.

depth, binocular clue: disparity

depth, binocular clue: disparity

disparity



from: *Perception, The World Transformed* (1979)
by L. Kaufman, Oxford (New York), p 208.

Figure 7-16. The images of two rods on the left retina are closer together than the corresponding images on the right retina. This difference in separation is the relative binocular disparity of the images. If the left and right eyes were to view such pictures, the observer would see two rods in depth.

more disparity

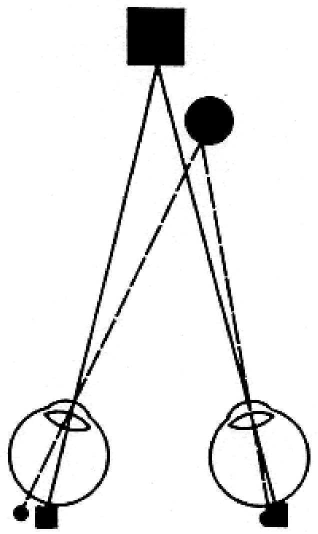
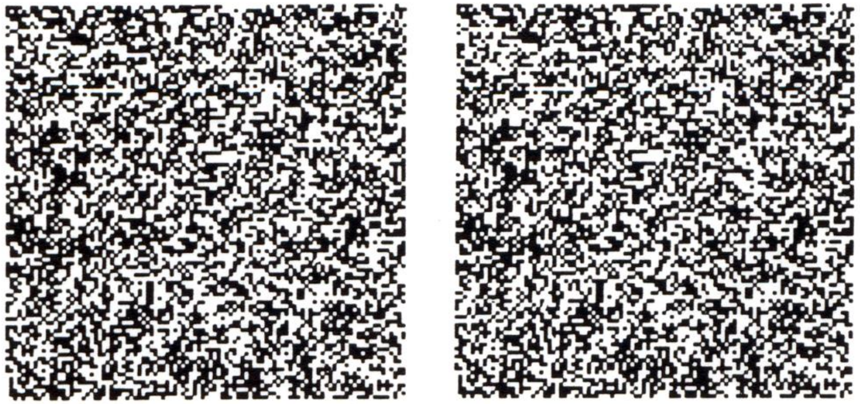


Fig. 11.18. Binocular disparity. The square and circle are imaged quite close together on the right retina, but are imaged considerably farther apart on the left retina. If observer fixates on square, there must be a disparity in the retinal locations of the image of the circle.

Julsez patterns: depth with disparity as only clue

construction of Julsez ppatterns

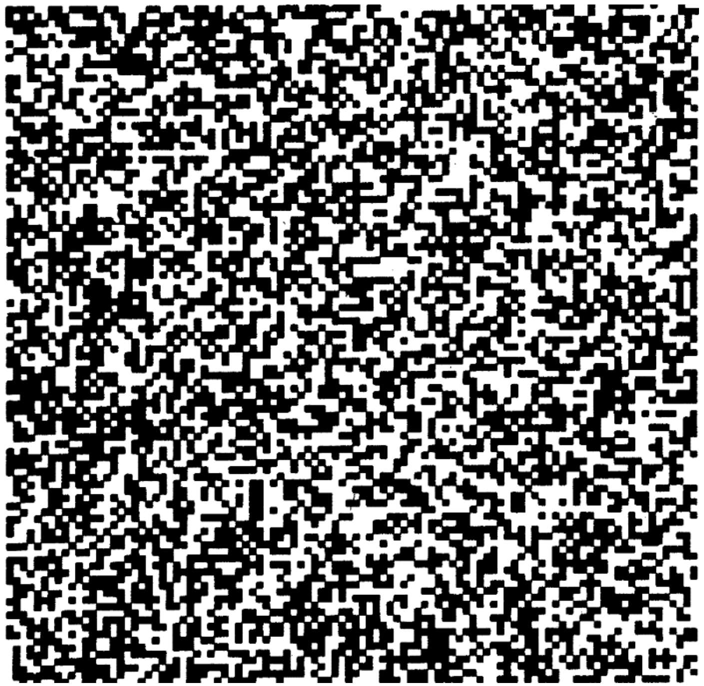
Figure 7-21. The random dot stereogram invented by Julesz. The two halves of the stereogram are identical except that a central portion of one half is shifted toward one side, as illustrated in the accompanying letter matrices.

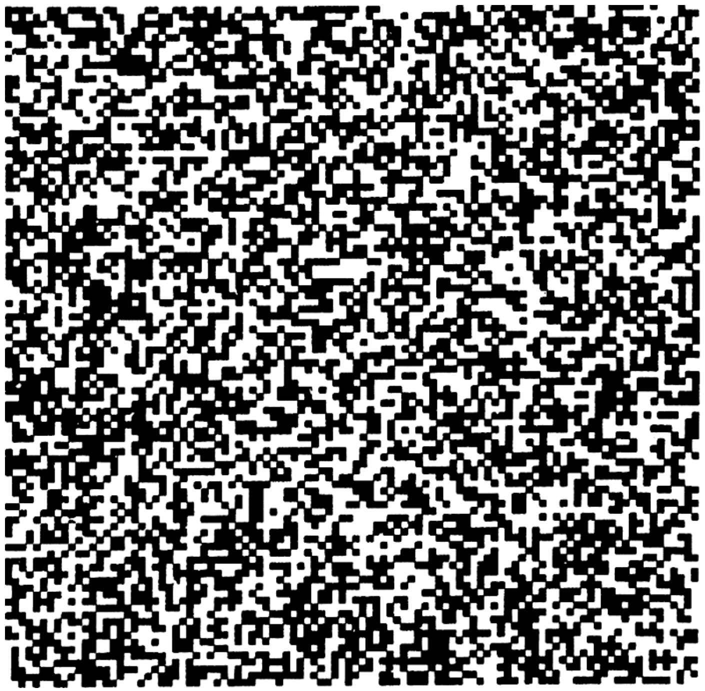


1	0	1	0	1	0	0	1	0	1
1	0	0	1	0	1	0	1	0	0
0	0	1	1	0	1	1	0	1	0
0	1	0	Y	A	A	B	B	0	1
1	1	1	X	B	A	B	A	0	1
0	0	1	X	A	A	B	A	1	0
1	1	1	Y	B	B	A	B	0	1
1	0	0	1	1	0	1	1	0	1
1	1	0	0	1	1	0	1	1	1
0	1	0	0	0	1	1	1	1	0

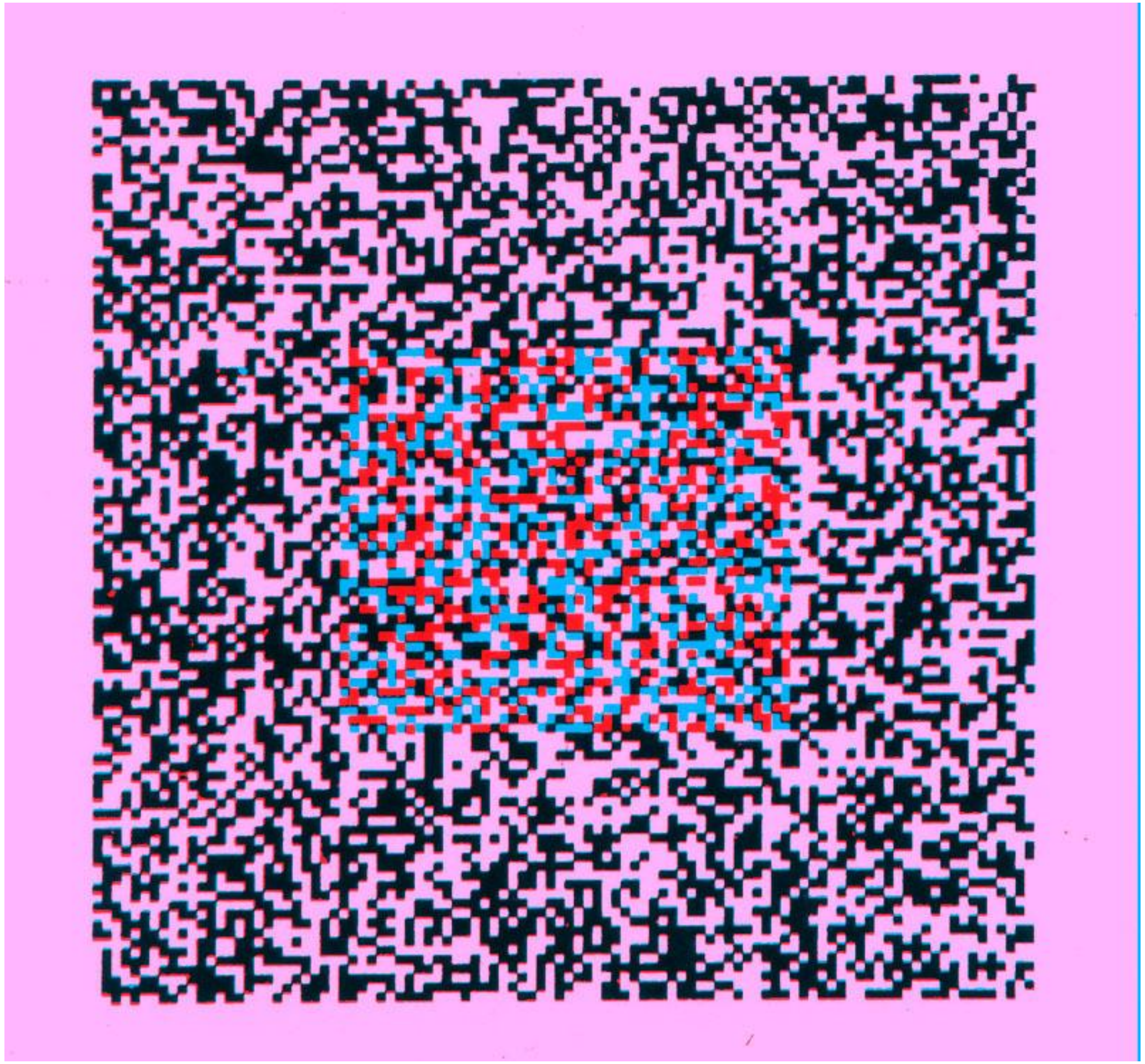
1	0	1	0	1	0	0	1	0	1
1	0	0	1	0	1	0	1	0	0
0	0	1	1	0	1	1	0	1	0
0	1	0	A	A	B	B	0	0	1
1	1	1	B	A	B	A	0	0	1
0	0	1	A	A	B	A	0	1	0
1	1	1	B	B	A	B	0	0	1
1	0	0	1	1	0	1	1	0	1
1	1	0	0	1	1	0	1	1	1
0	1	0	0	0	1	1	1	1	0

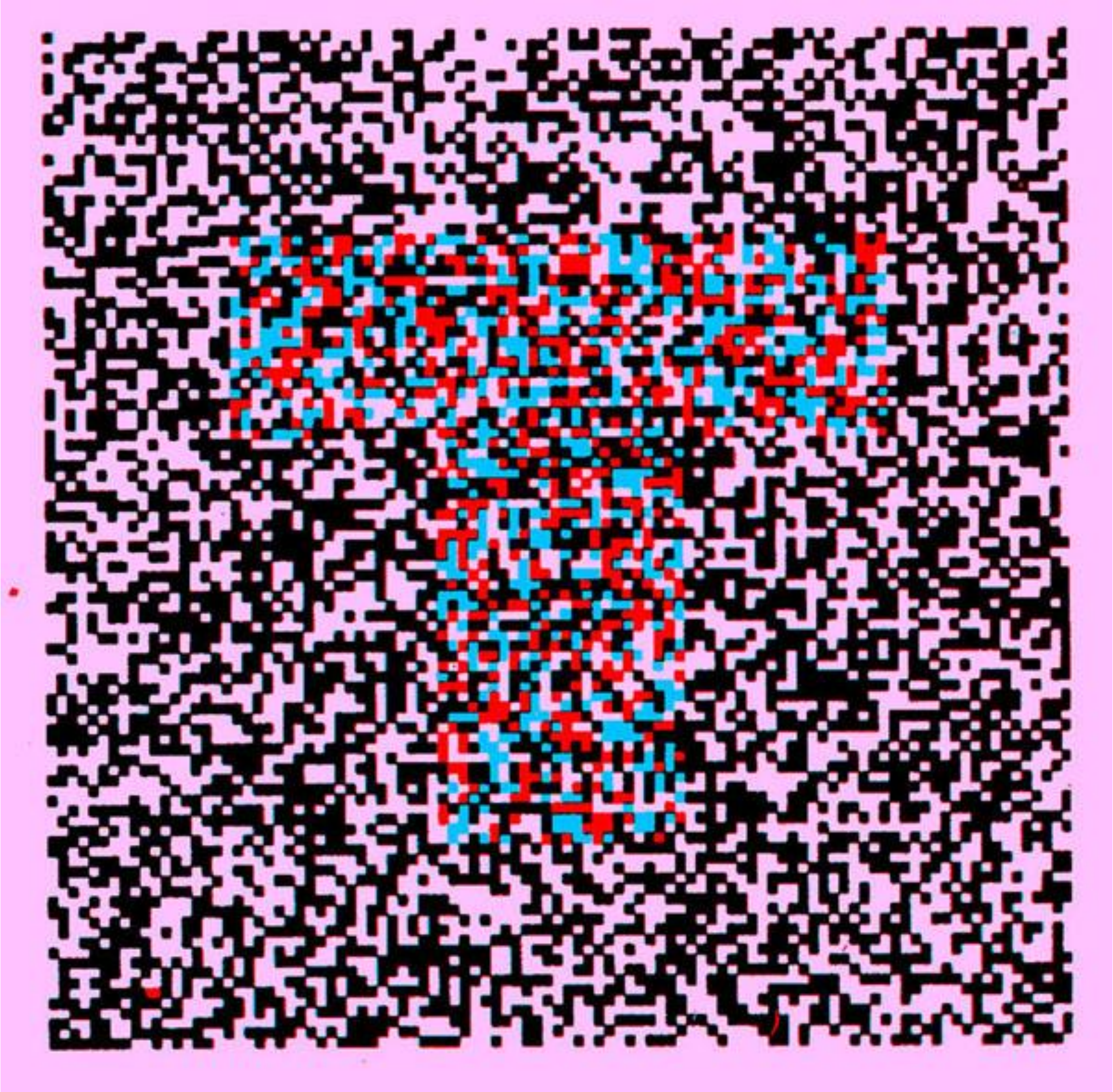
construction of Julsez patterns

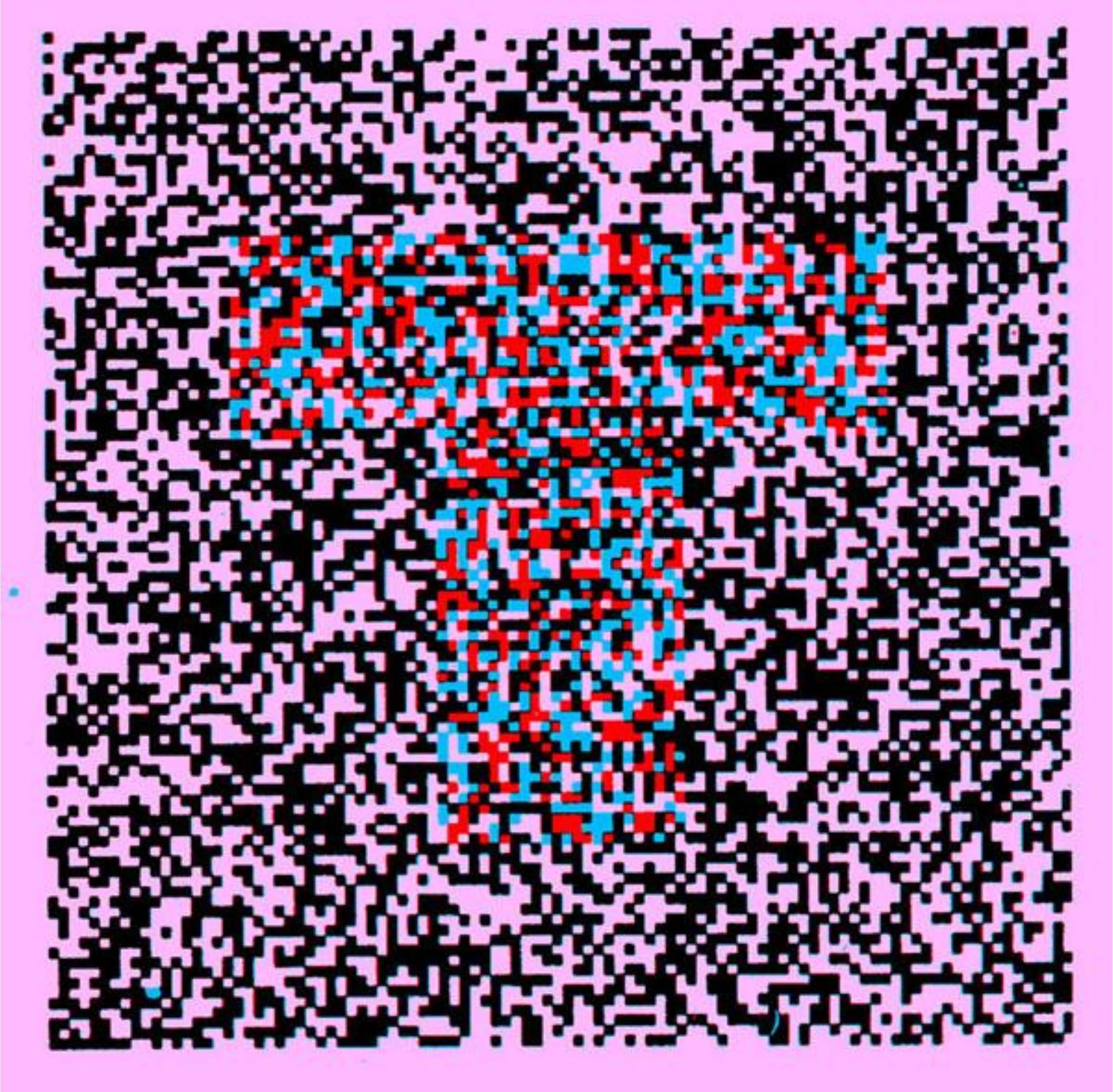


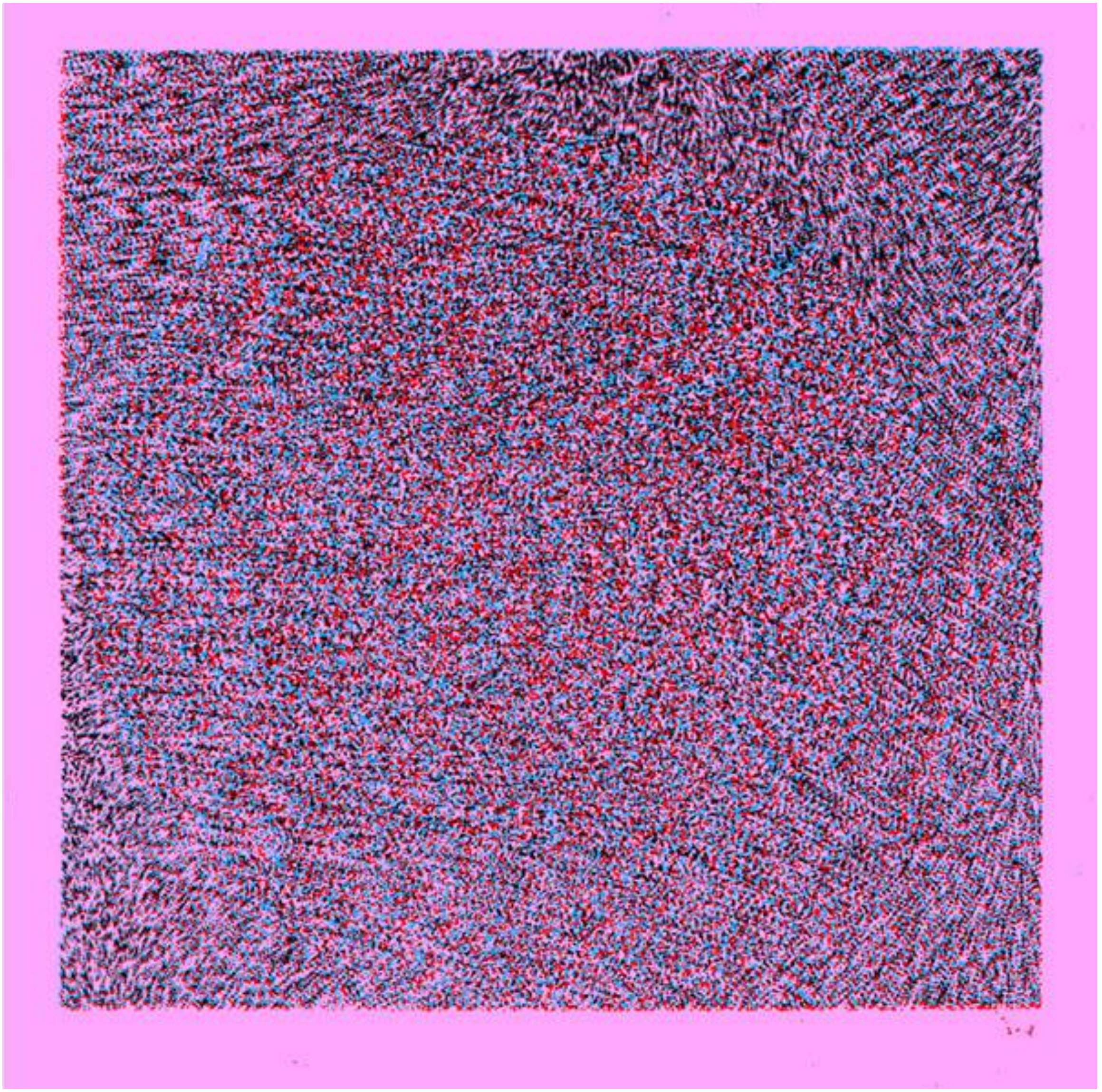


views for differing eyes









from lecture outline: DEPTH

✓ 8. In the real world what are clues which the brain uses to determine depth?

   a. monocular

   b. binocular

✓ 9. What are Julsez patterns and what do they show about depth perception?

FINIS