some MT neurons are also involved in depth perception

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Computation in Neural Systems: Biological Vision

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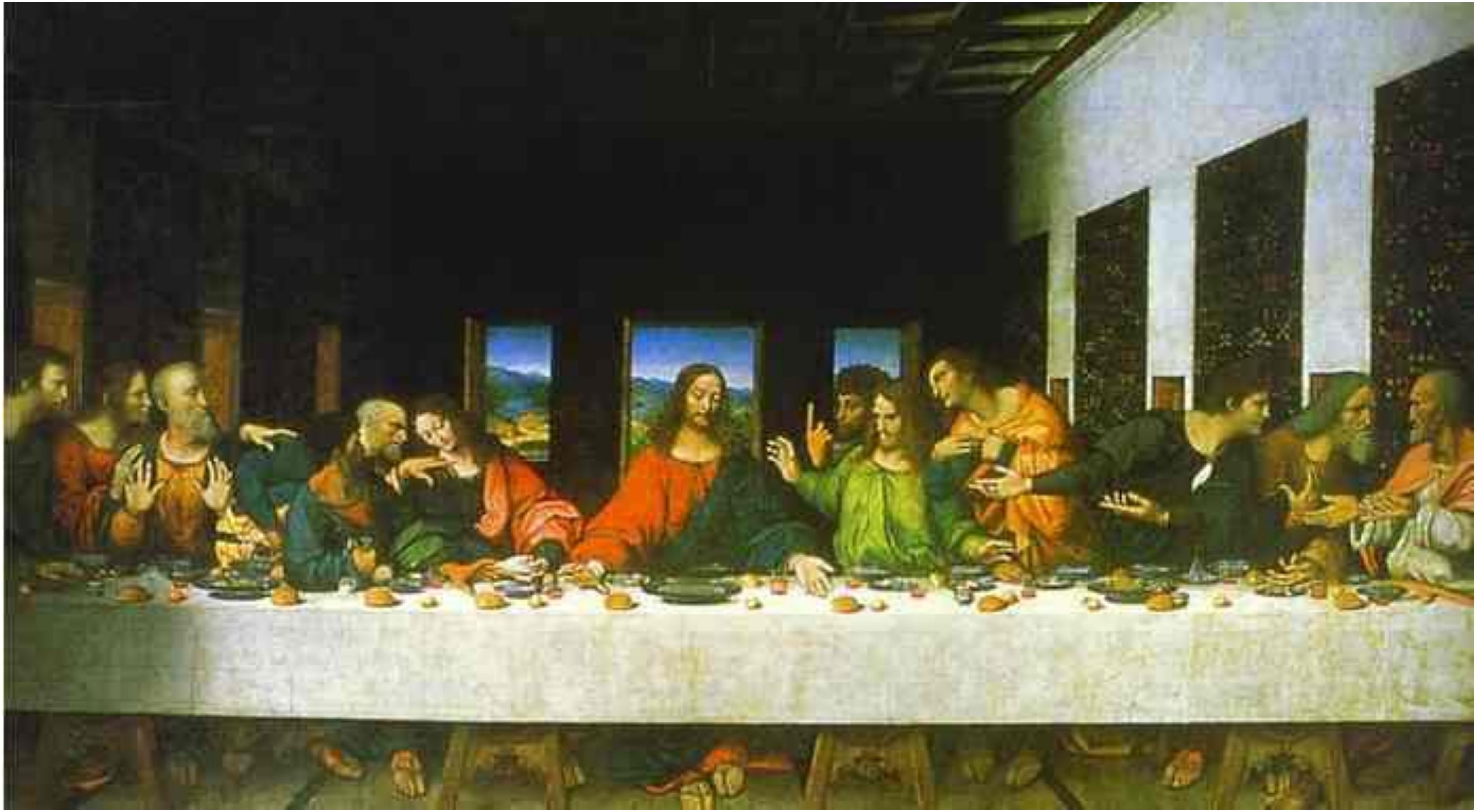
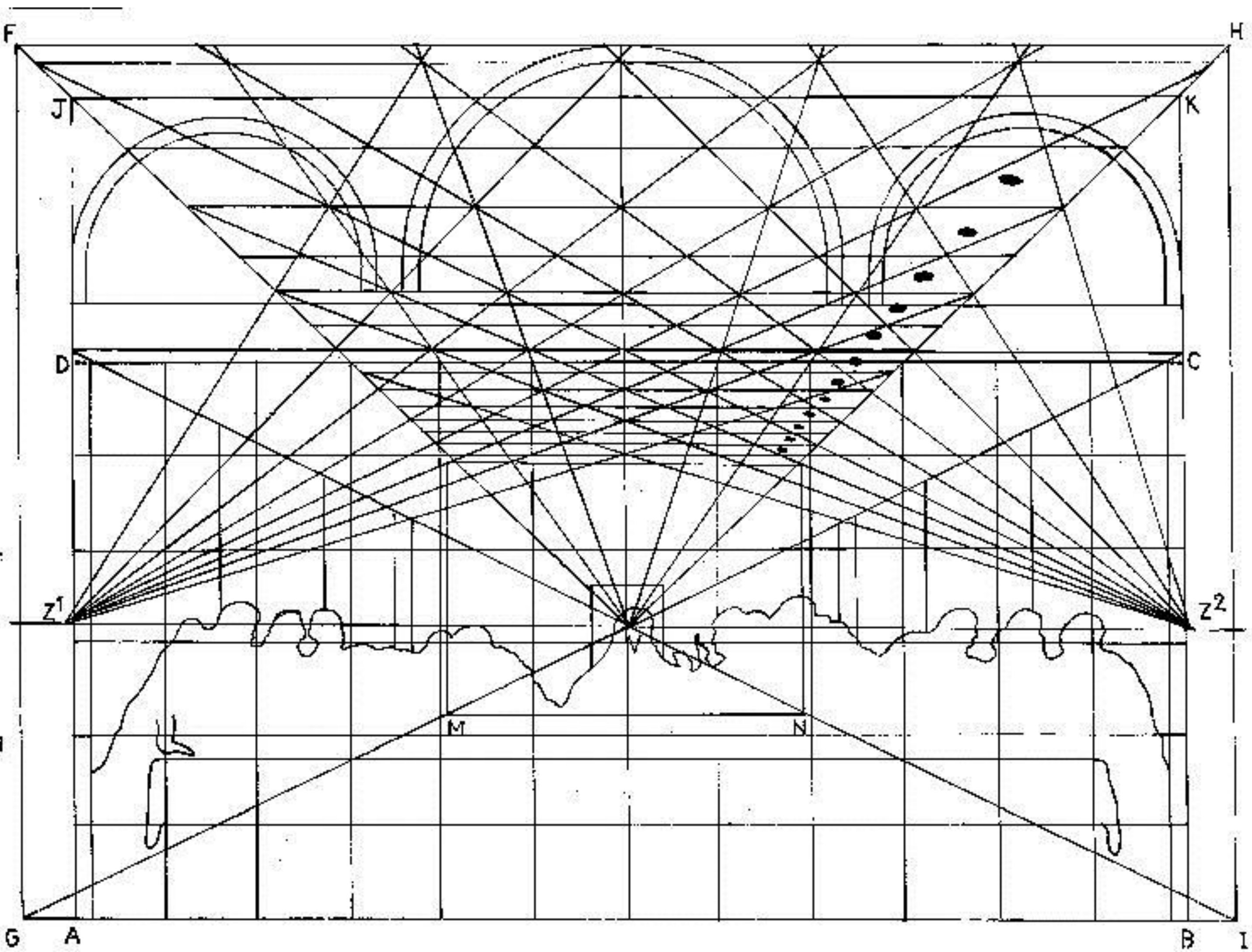
www.ini.unizh.ch/~kiper/comp_vis/index.html

cues for spatial location: convergence, shadows, "clarity" of objects (faraway things rather blurry), size of objects





F
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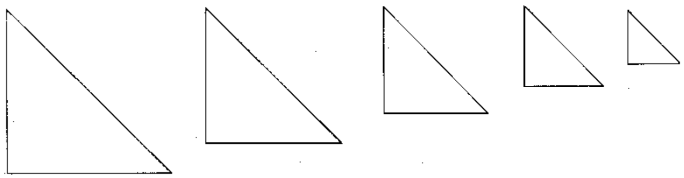
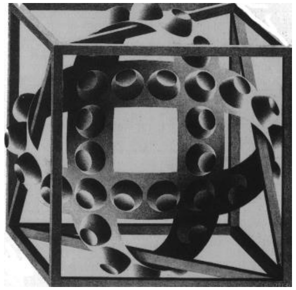
Cues to depth perception:



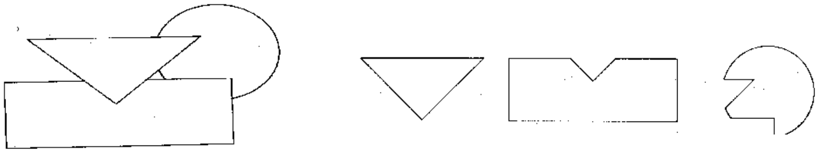
Size

Monocular depth cues:

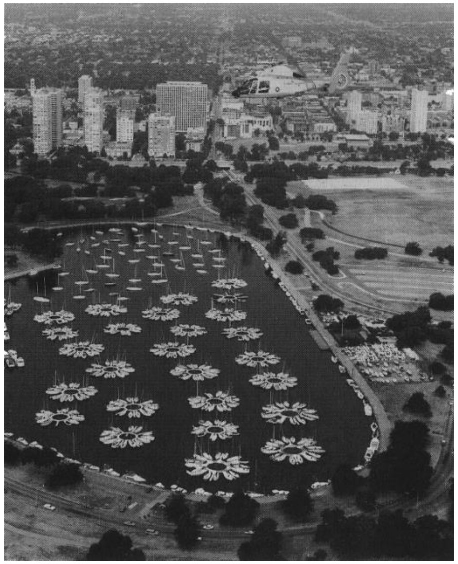
(those cues also work with one eye - two eyes are not necessary and the world will not break down)



Lighting and shadows



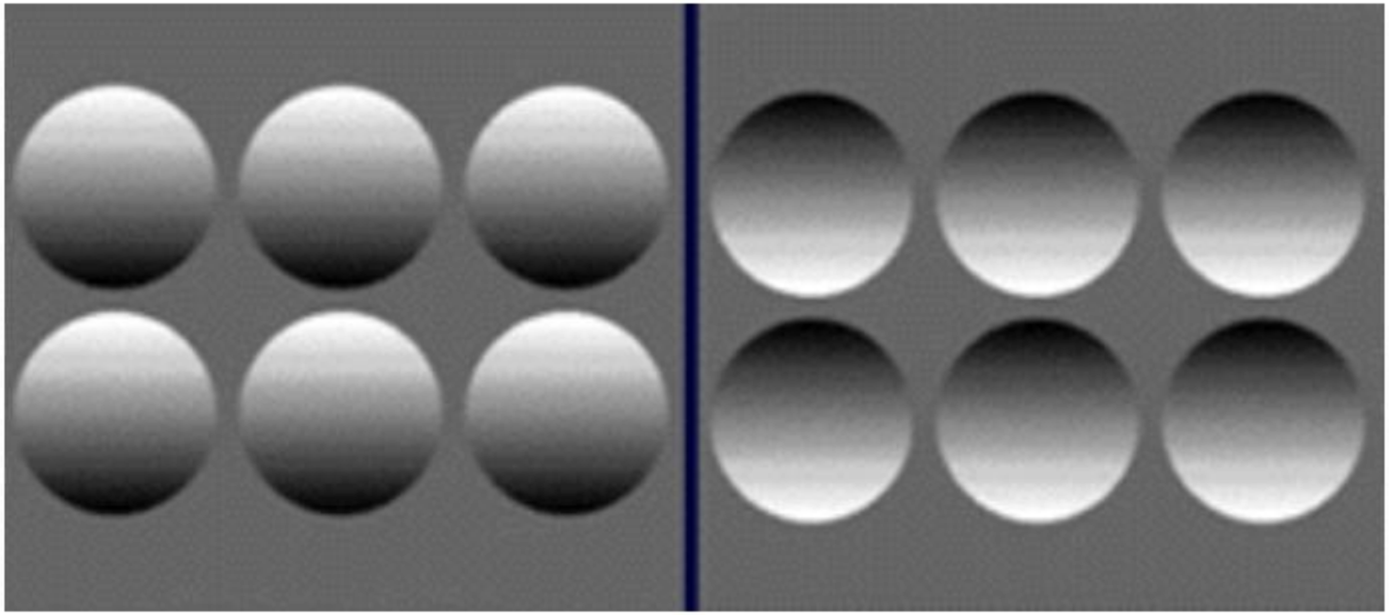
Interposition



Clarity and elevation

Perspective

shade cue - quite sophisticated. assumption of humans: light comes from above, therefore: left are "things that stick out of the wall", right are holes basically

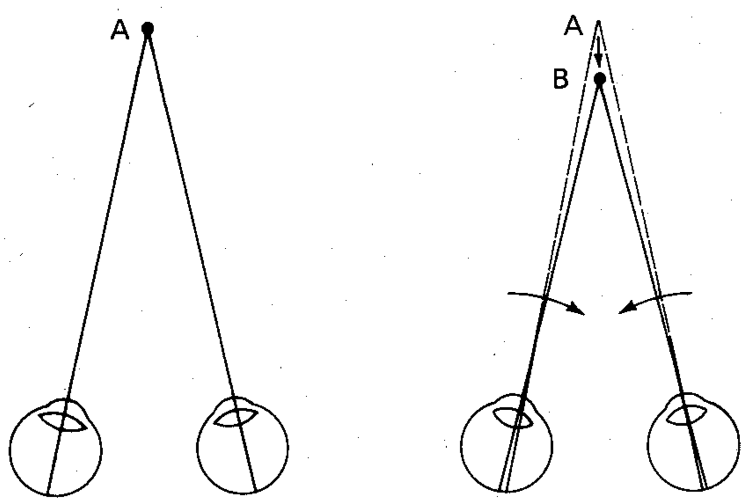


humans are not really good at this cue, but we get an angle information of the object and thus we can compute the distance (absolute distance - take observer at (0/0/0)). in a dark room, it is hard to measure the distance, but becomes a bit easier when the object moves in the dark, but still difficult. having light helps to find out if it moves closer etc.

Binocular depth cues:

(two eyes are needed to achieve this depth cue)

Convergence



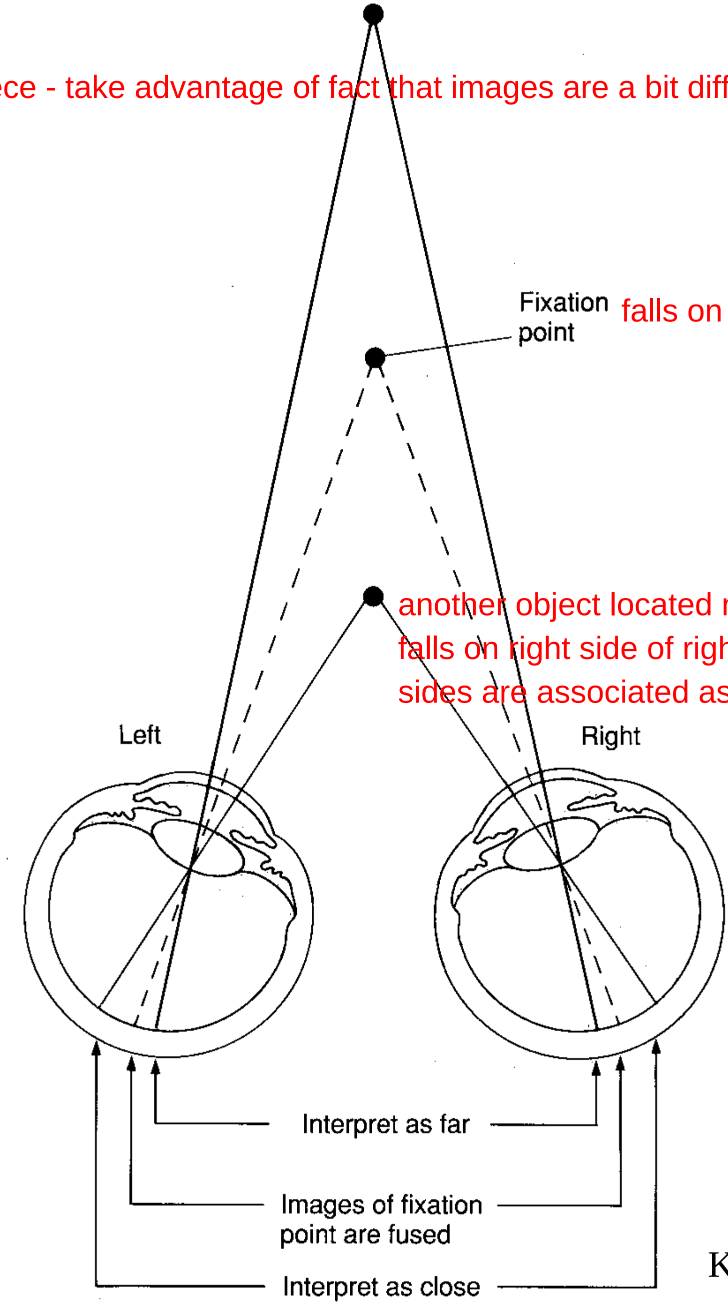
Stereopsis (binocular disparity)

humans dont use all cues as effectively as they could

Binocular disparity

we have two eyes looking at same scnece - take advantage of fact that images are a bit different on the eyes projected

this cue gives info on relative depth



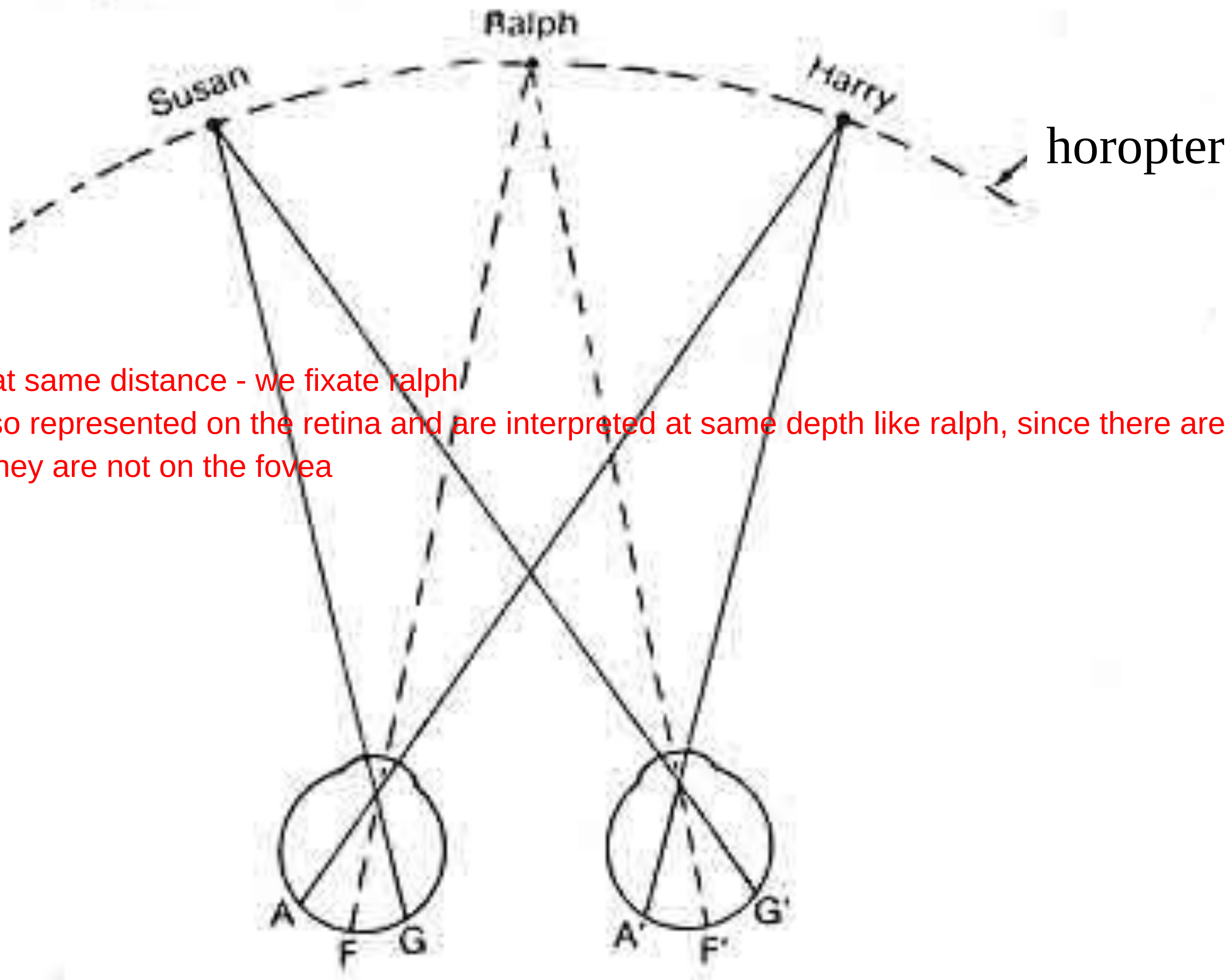
falls on fovea

another object located nearer: how is it projected on the retina? falls on right side of right eye and left side on left eye - these sides are associated as being closer by experience

Kandel, Schwartz, Jessell, 1991, 30.16

binocular disparity continued

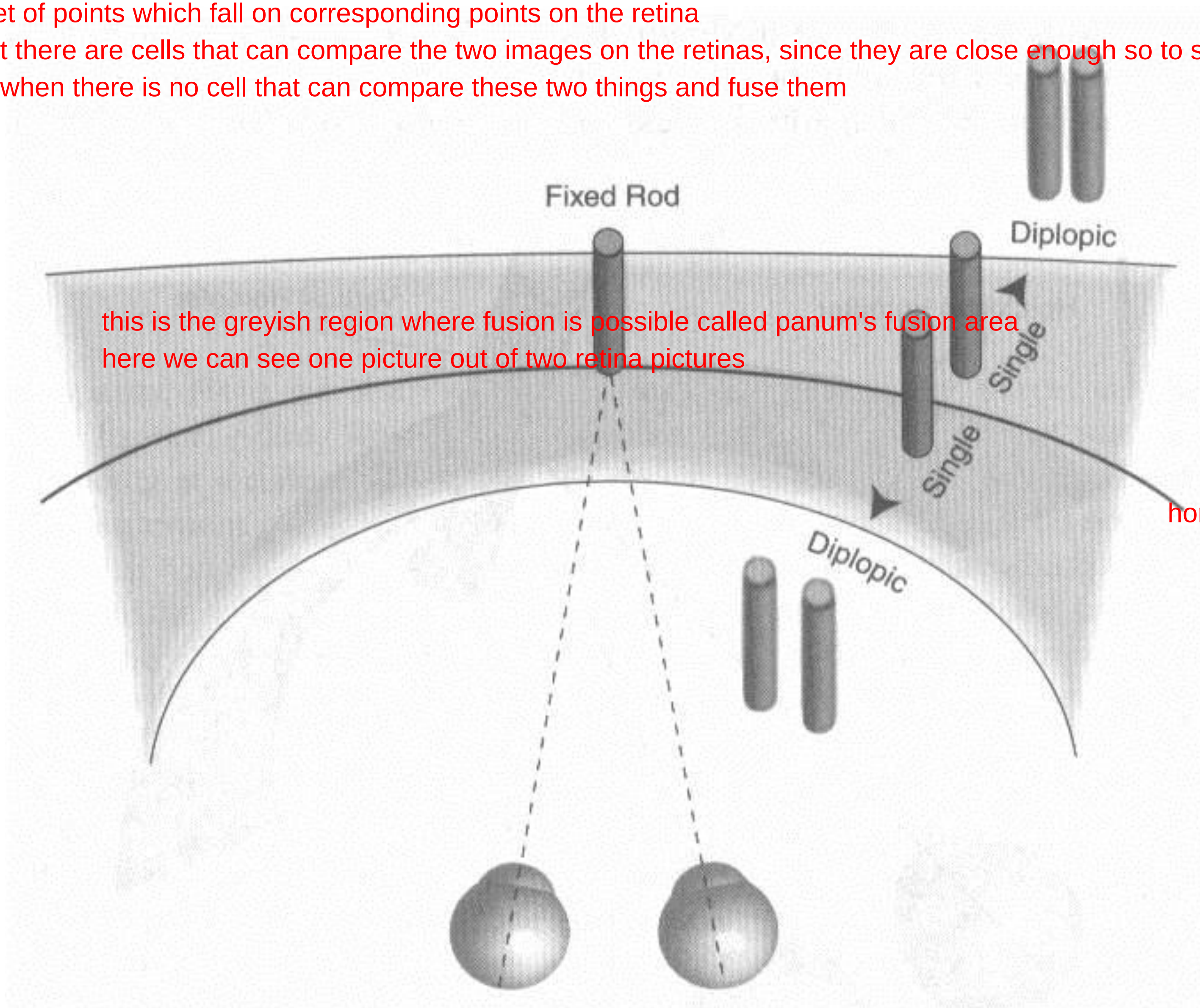
The horopter



those 3 points located at same distance - we fixate ralph
susan and harry are also represented on the retina and are interpreted at same depth like ralph, since there are cell that can combine these two pics even if they are not on the fovea

The horopter and Panum’s fusion area

the horopter: set of points which fall on corresponding points on the retina
we assume that there are cells that can compare the two images on the retinas, since they are close enough so to say.
we see double when there is no cell that can compare these two things and fuse them



this is the greyish region where fusion is possible called panum's fusion area
here we can see one picture out of two retina pictures

horopter (line)

precursor for 3D cinema

The Wheatstone stereoscope

for home use 3D

2 mirrors

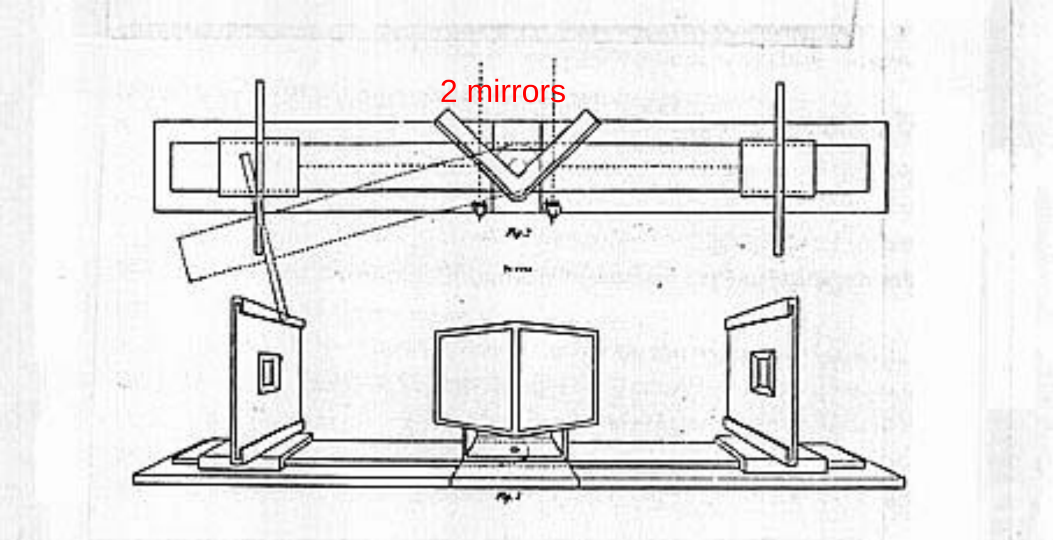
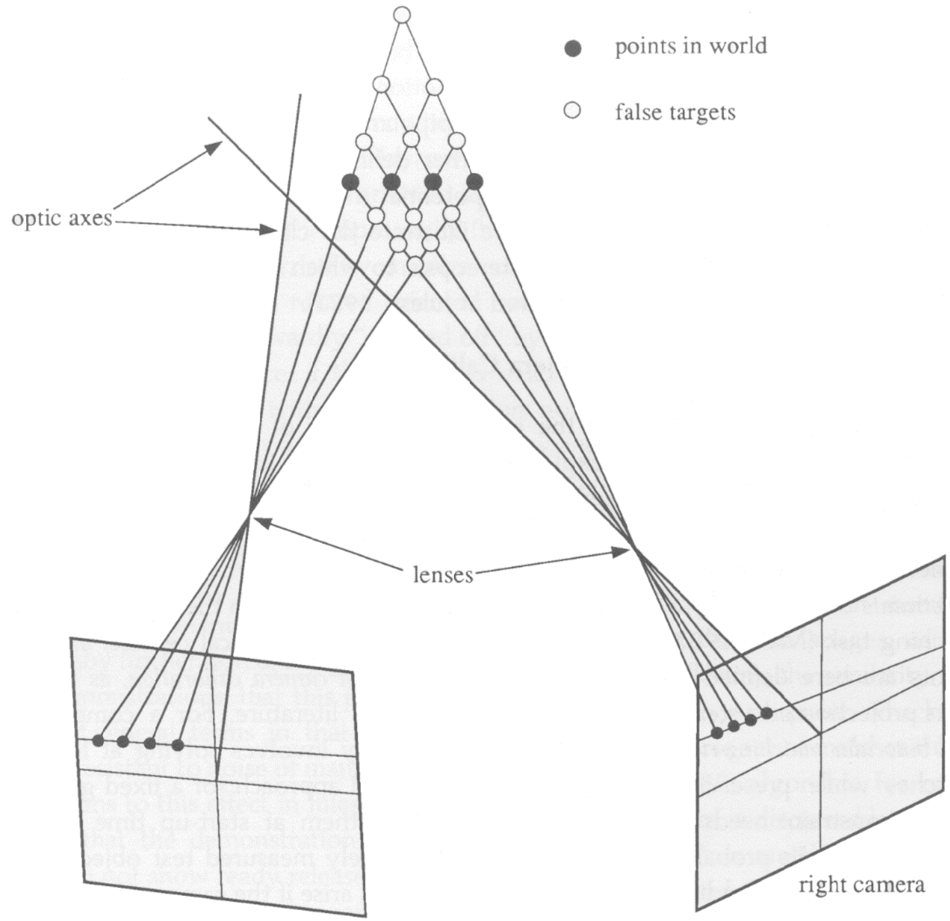


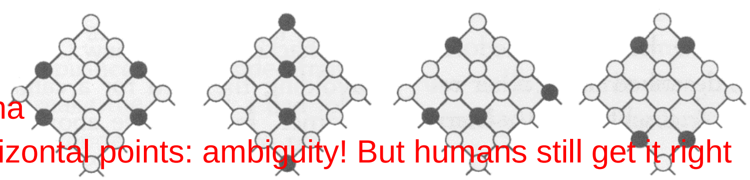
Diagram of the operation of the Wheatstone stereoscope.

The correspondence problem in stereopsis

it is not known how the correspondence problem is solved



these other possible patterns would be projected on the retina



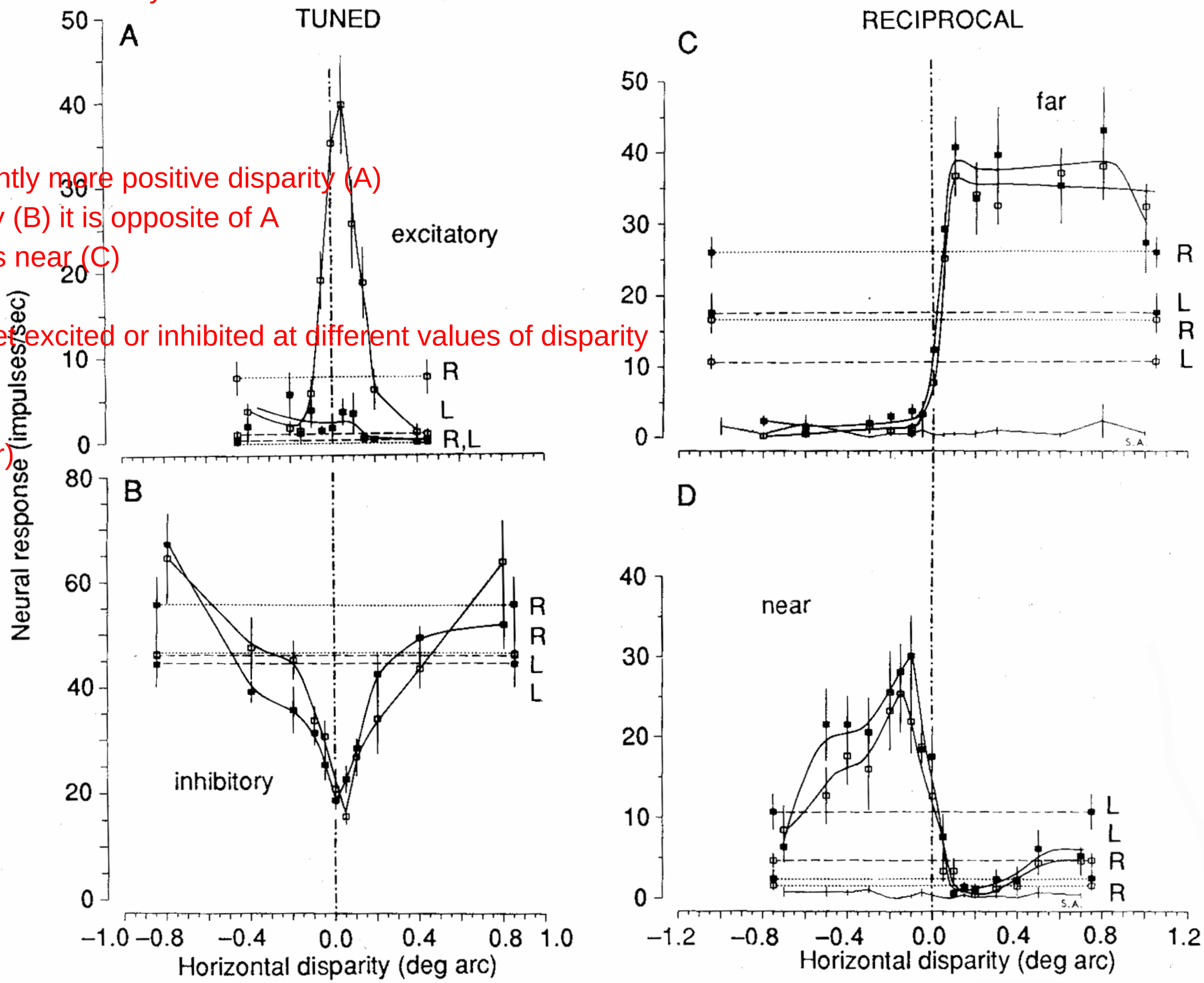
exactly like the 4 horizontal points: ambiguity! But humans still get it right using heuristics

Neurons tuned for binocular disparity (monkey V1)

lec: complicated slide, not necessary to understand all

some cells excite at a slightly more positive disparity (A)
inhibited by small disparity (B) it is opposite of A
gets inhibited when stuff is near (C)
D is opposite of C
these example neurons get excited or inhibited at different values of disparity

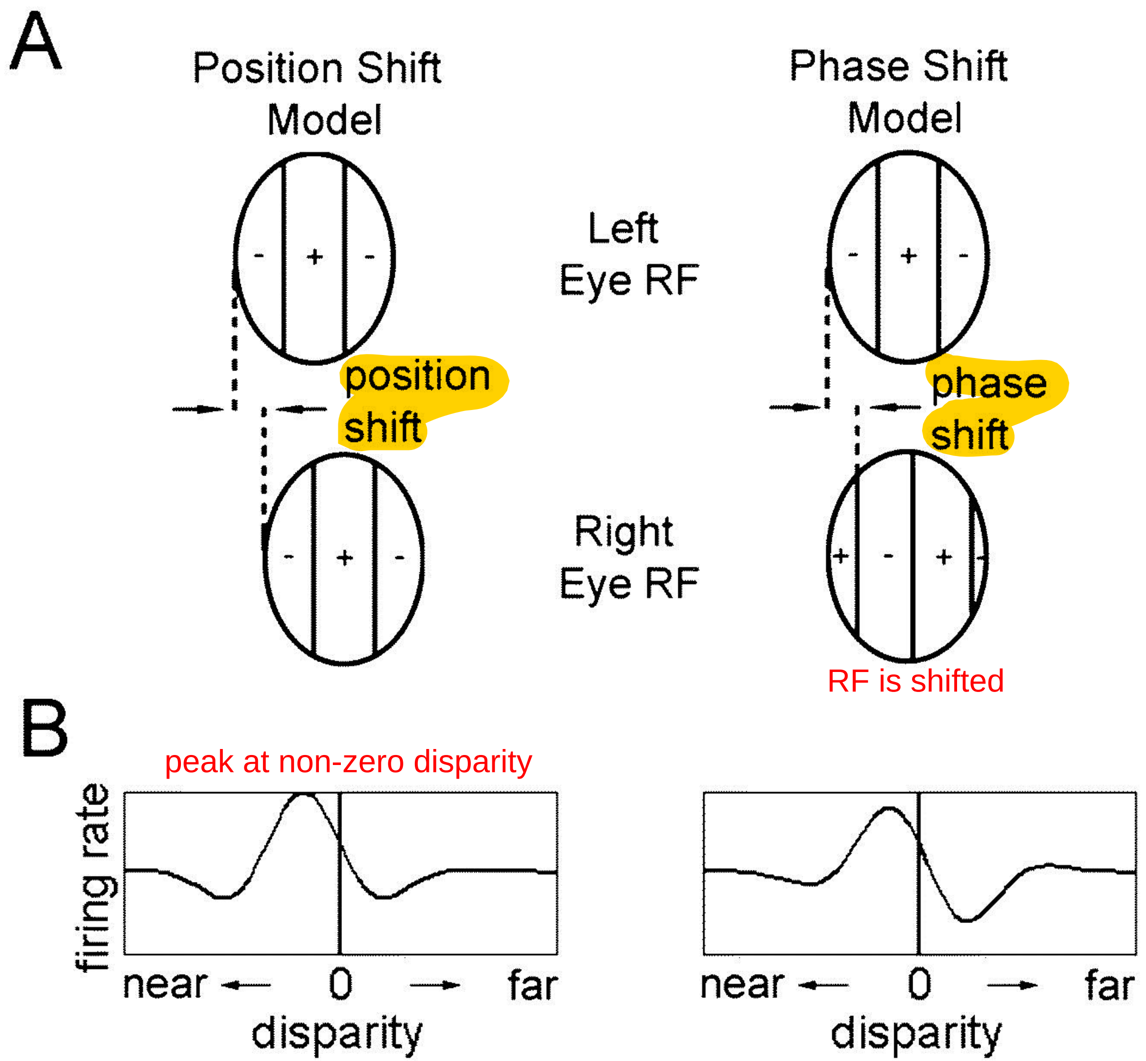
recorded are V1 neurons
(cells need to be binocular)



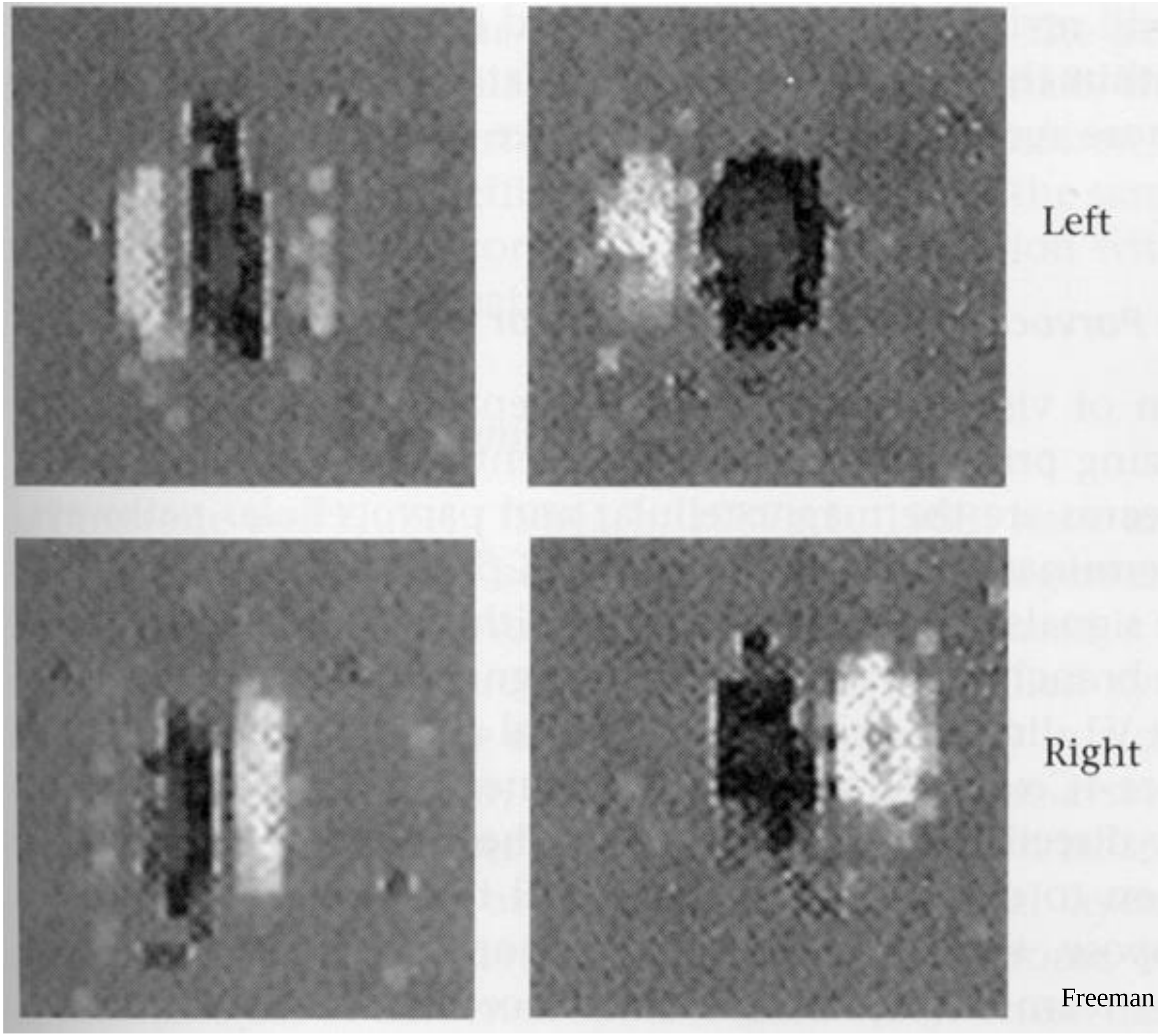
disparity = difference of locations of the two objects on retina
fixation point has disparity = 0 (fovea), but other points relative to it,, will have slightly different distances from fovea and thus we have disparity

Data from Poggio and Talbot, 1981. Spillmann, 1990, p325

both cases are equivalent
in reality, both cases occur (next slide)



Binocular receptive fields of disparity tuned neurons



Freeman and Ohzawa (1990)
in Wandell (1995)