COGS 101A: Sensation and Perception

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UCSD

Lecture 7:

Lightness Perception (finishing chapter 6) and Depth (Chapter 7)

Course Information

- Class web page: http://cogsci.ucsd.edu/ desa/101a/index.html
- Professor: Virginia de Sa
  - ⋆ I'm usually in Chemistry Research Building (CRB) 214 (also office in CSB 164)
  - ⋆ Office Hours: Monday 5-6pm
  - ⋆ email: desa at ucsd
  - ⋆ Research: Perception and Learning in Humans and Machines

For your Assistance

TAS:

- Jelena Jovanovic OH: Wed 2-3pm CSB 225
- Katherine DeLong OH: Thurs noon-1pm CSB 131

IAS:

- Jennifer Becker OH: Fri 10-11am CSB 114
- Lydia Wood OH: Mon 12-1pm CSB 114

Course Goals

- To appreciate the difficulty of sensory perception
- To learn about sensory perception at several levels of analysis
- To see similarities across the sensory modalities
- To become more attuned to multi-sensory interactions

Grading Information

- 25% each for 2 midterms
- 32% comprehensive final
- 3% each for 6 lab reports - due at the end of the lab
- Bonus for participating in a psych or cogsci experiment AND writing a paragraph description of the study

You are responsible for knowing the lecture material and the assigned readings. Read the readings before class and ask questions in class.

Academic Dishonesty

The University policy is linked off the course web page.

You will all have to sign a form in section

For this class:

- Labs are done in small groups but writeups must be in your own words
- There is no collaboration on midterms and final exam

Last Lecture

Color vision

This Class

Perceiving Depth (and size)

Consider the problem of Depth Perception

How do we perceive depth from two 2-dimensional retinas?

Cues for Depth

- oculomotor cues - sensing the position of your eyes and tension in the eye muscles
- monocular cues - cues available to even a single eye
- binocular cues - additional cues from using both eyes together

Oculomotor Cues

convergence - the eyes must move inwards to look at close objects

accommodation - the ciliary muscles pull on the zonules of Zinn to make the lens rounder to focus closer objects.

Monocular Cues

(accomodation) is one

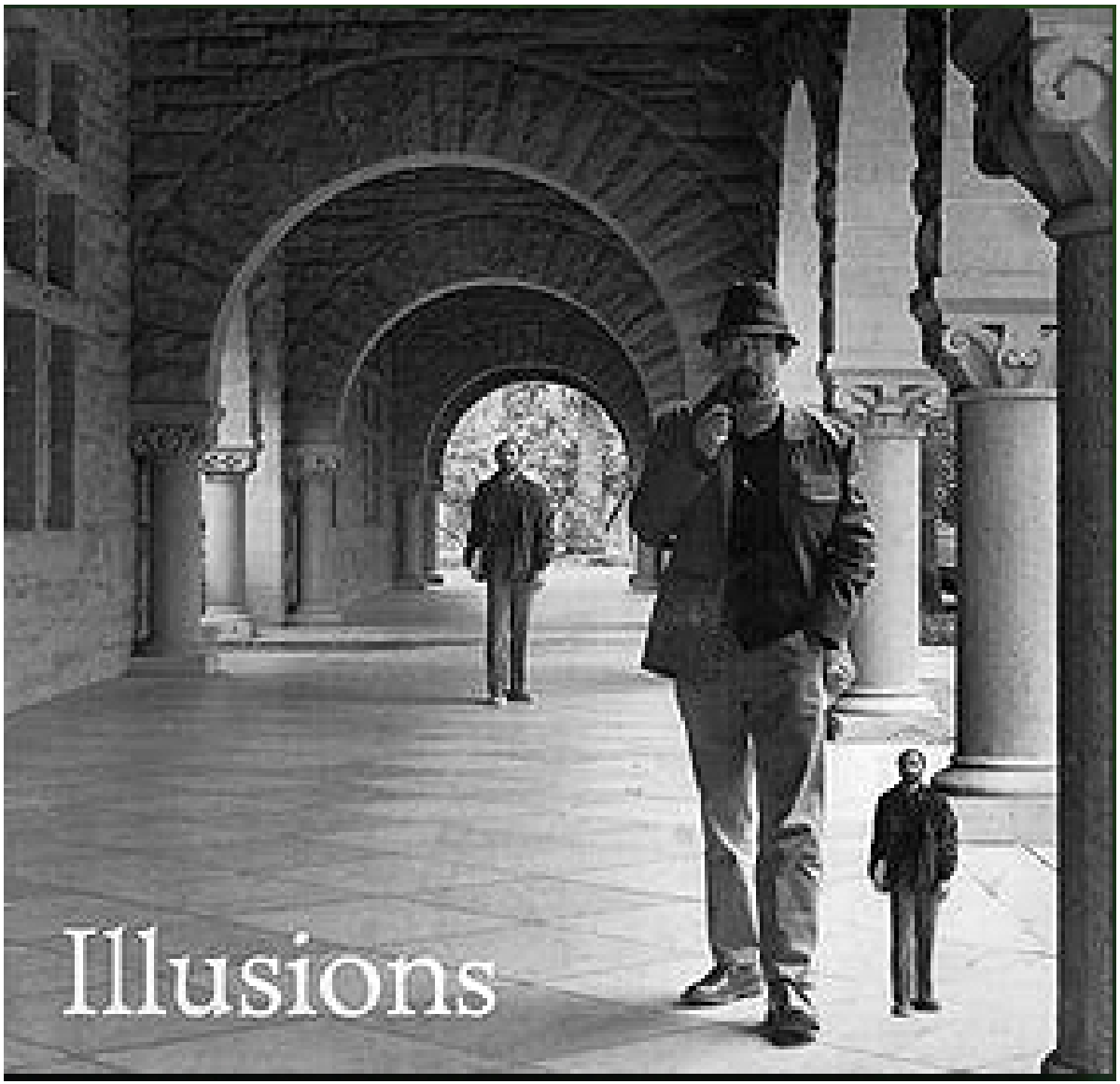
Pictorial Cues

- occlusion
- relative height - objects below the horizon seem farther if they are higher, objects above the horizon seem farther when they are lower
- cast shadows
- relative size
- familiar size (dime,quarter,nickel example from book) -fairly weak compared to other depth cues

- atmostpheric perspective - farther objects look fuzzier

- linear perspective - convergence of parallel lines into the distance

- texture gradient - texture elements get smaller and more closely spaced in the distance


Illusions

http://www.olemiss.edu/courses/psy214/Readings/Illusions/ImageSizeAdjustmentTheo

Monocular Cues cont'd

Movement Produced Cues

- motion parallax-more distant objects move more slowly as we walk by looking to the side (but not tracking any in particular)

- deletion and accretion

Binocular Depth Cues

binocular disparity - the difference in the images to the two eyes

How does binocular disparity lead to depth perception? **stereopsis** is the term for depth perception derived from binocular disparity

corresponding retinal points - places on the two retinas that connect to the same place in cortex (very roughly overlapping points if you slid the retinas on top of each other)

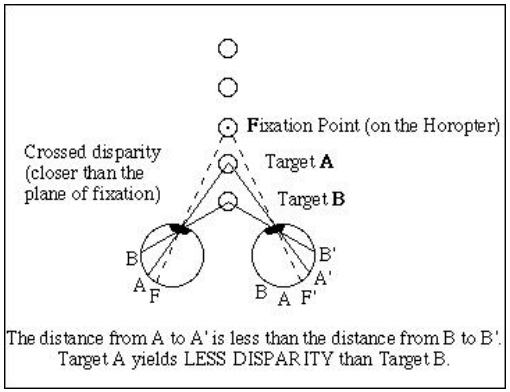
horopter - curve in space that falls on corresponding points on the two retinas (includes the fixation point)

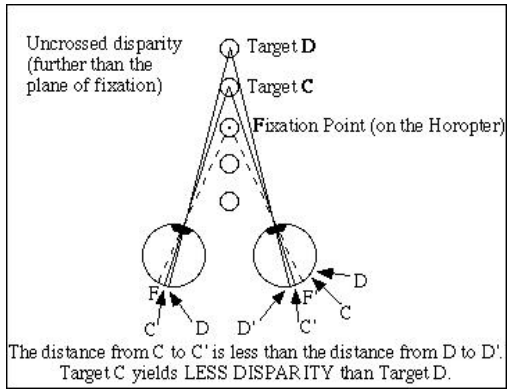
All other points fall at noncorresponding points.

angle of disparity- visual angle between image on one retina and the corresponding point (on the same retina) from the image on the other retina.

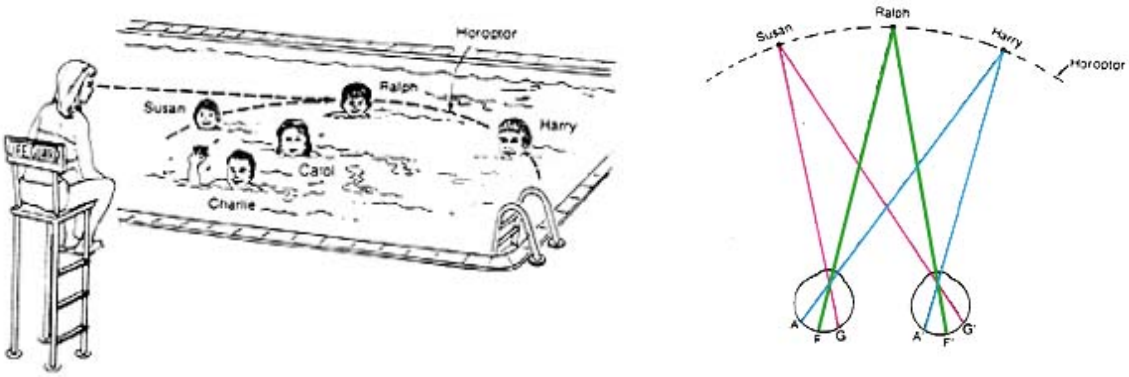
crossed disparity- for objects located closer than the horopter their images move towards the sides of the retinas

uncrossed disparity- for objects located farther than the horopter, their images move inward on the retinas





The farther away objects are the more inward the retinal images move and the greater the disparity



http://www.cquest.utoronto.ca/psych/psy280f/ch7/horopter.html

stereograms or stereoscopic pictures present two different images to the left and right eyes (taken from cameras separated by a distance about equal to that between the eyes).

To prove that disparity creates stereopsis

random dot stereogram – random dot patterns in which the left eye has a shift of some of the pixels relative to the right (different disparity for different matching pixels)

This stimulus is important because we have removed all other cues to depth

Physiological evidence for disparity sensitivity

Neurons in V1, V2 and MT have been found to be disparity tuned. Your textbook shows disparity preferences ranging from -5 degrees to 5 degrees

Microstimulation has also been used to show that disparity sensitive cells impart depth information

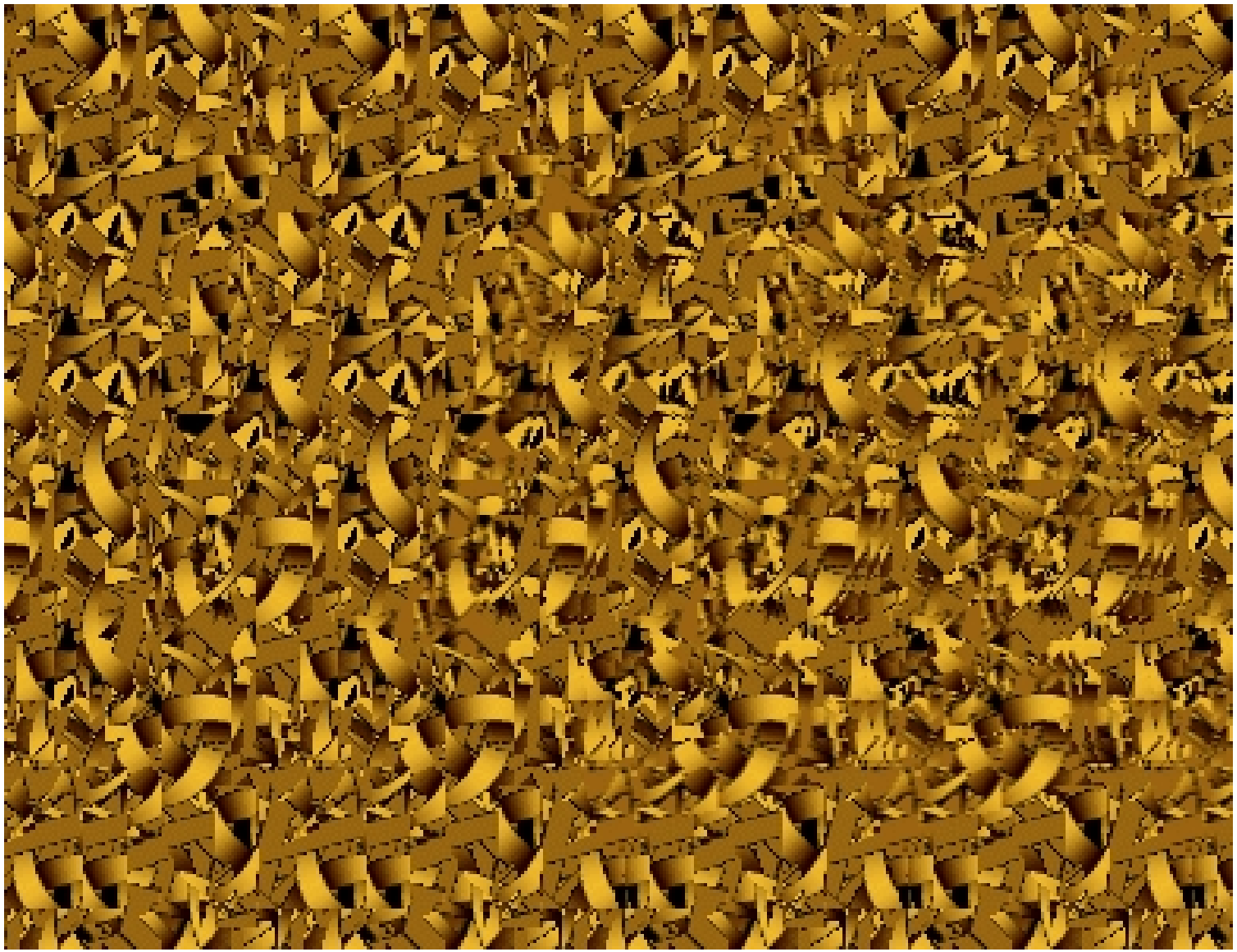
correspondence problem - how to match up points in the image on one retina with the image on the other retina

This is a difficult computational problem that has not been fully solved in computers

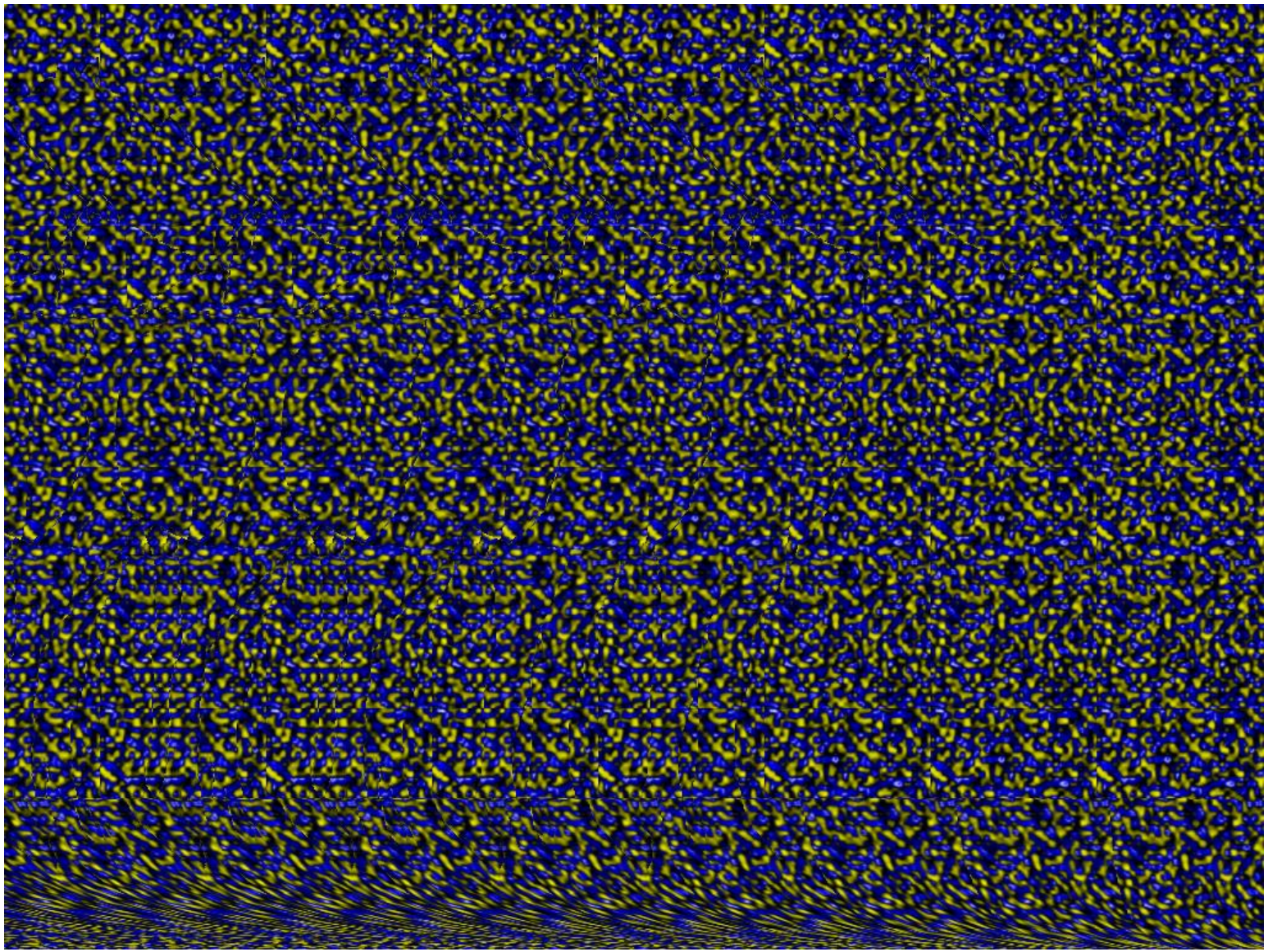
The next page shows an example of an **autostereogram** or single image random dot stereogram **SIRDS**

Example SIRDS

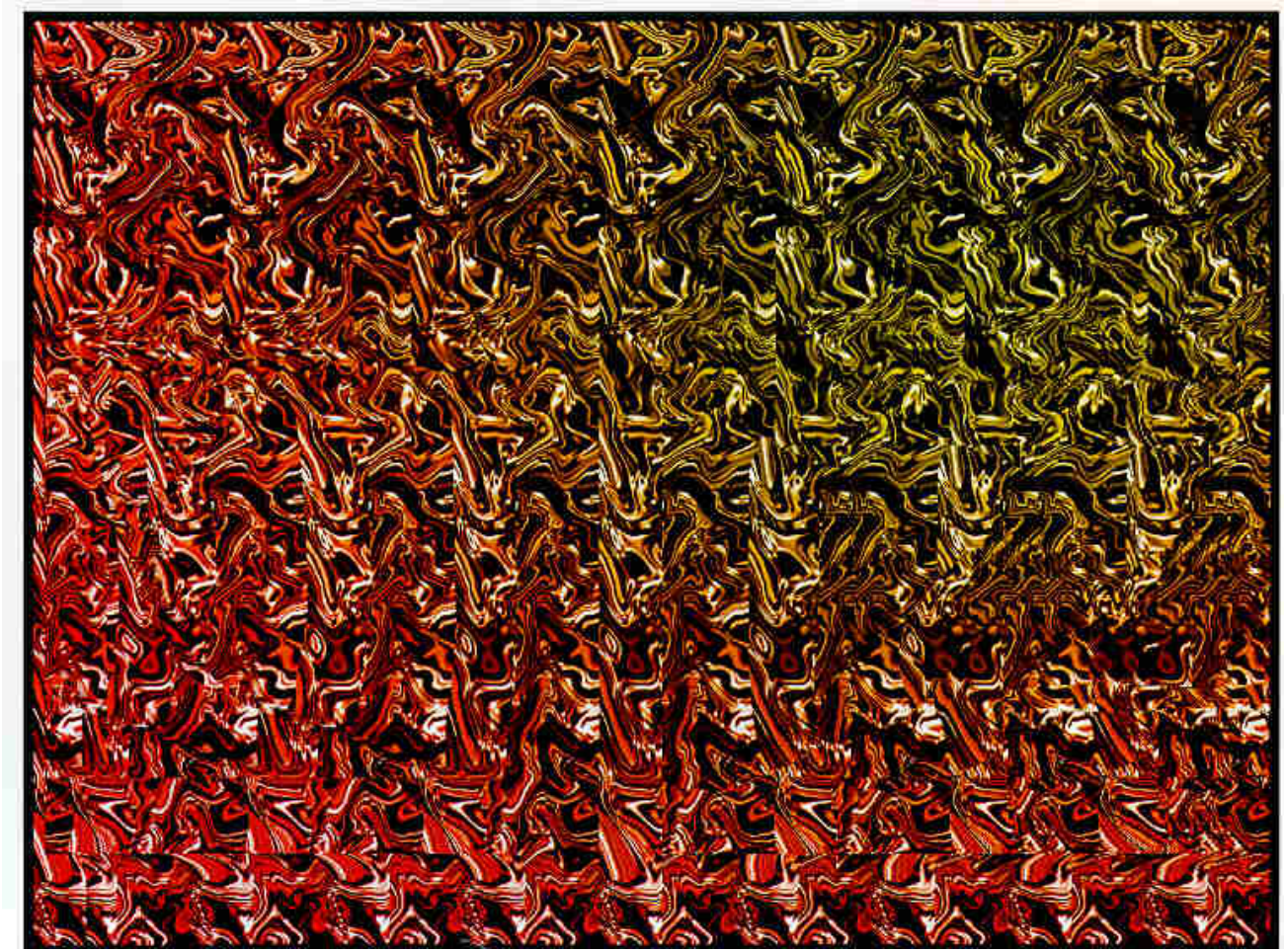
Try to look through them and be patient



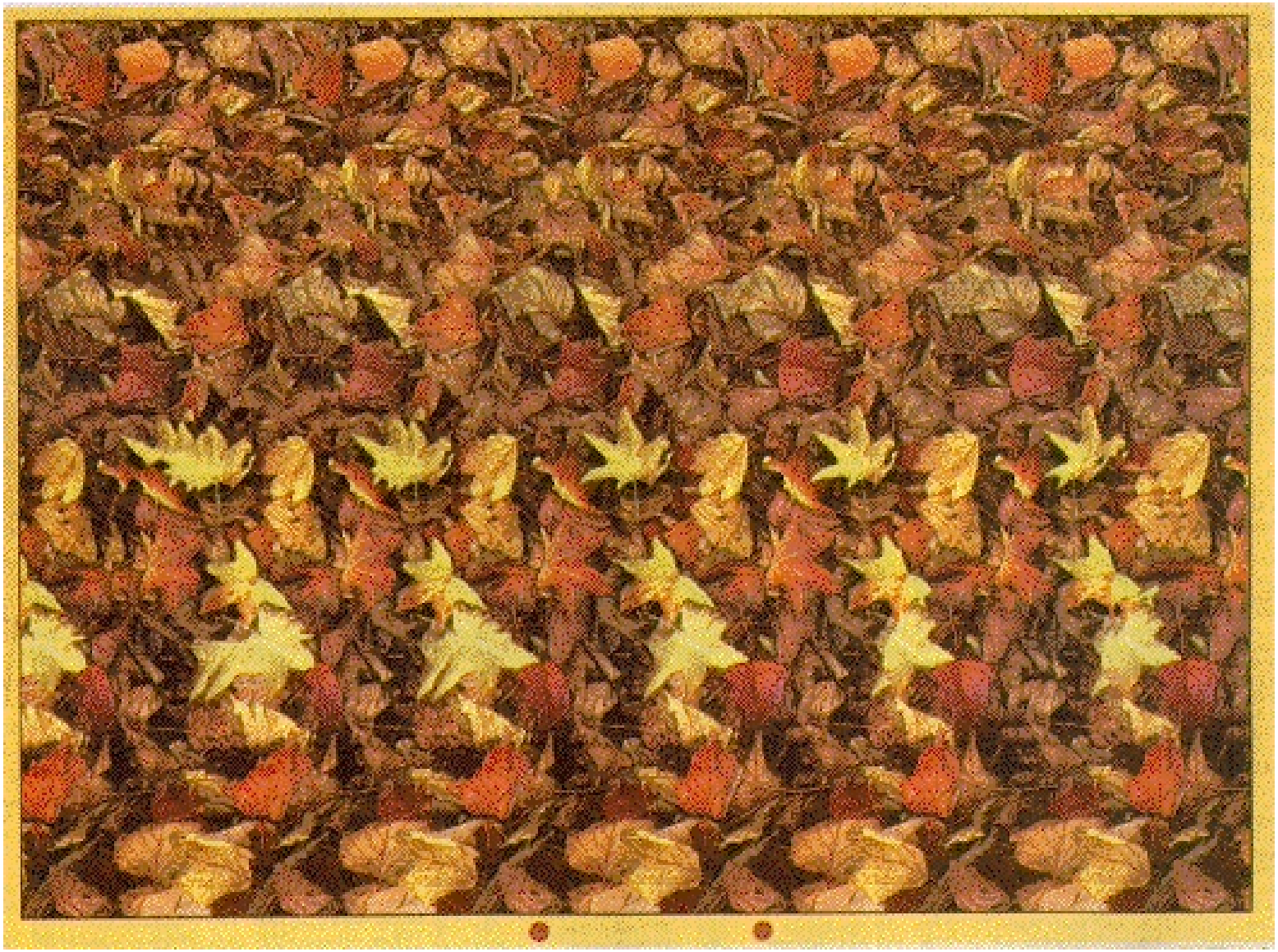
http://www.econet.it/stereogrammi/imgstereo/rid_0.gif



http://www.rhythm.com/ keith/autoStereoGrams/horsecolor.jpg

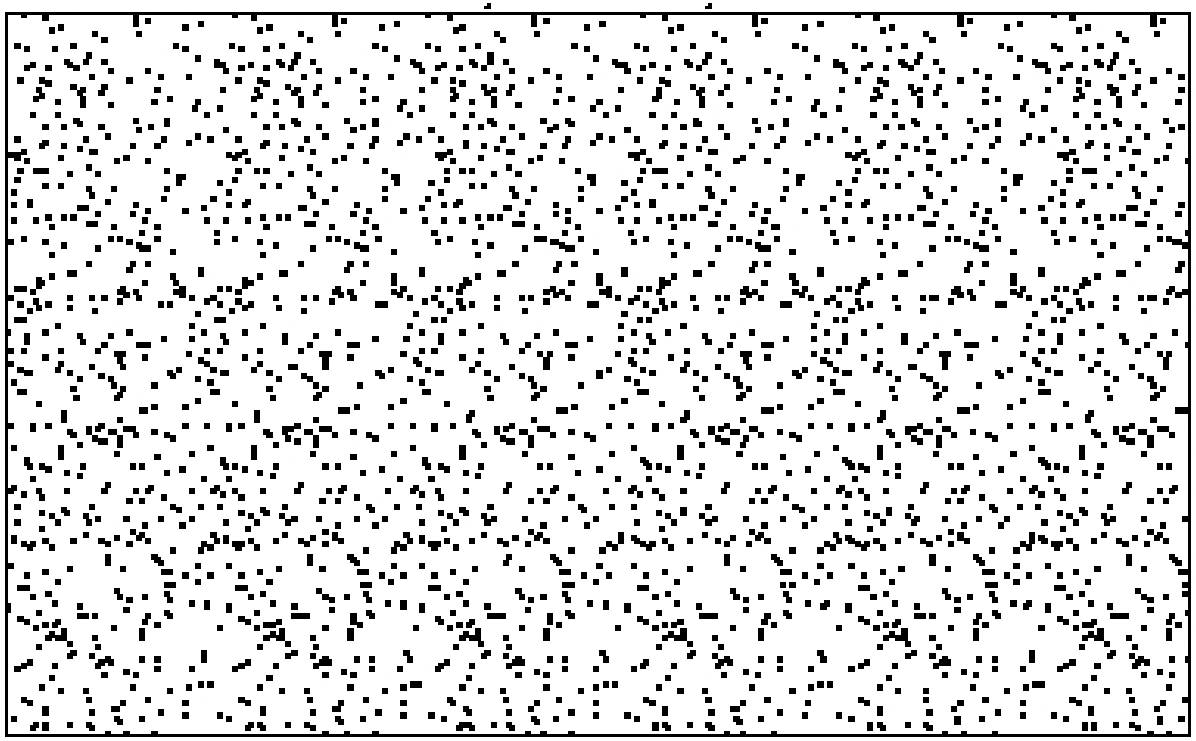


http://www.psych.utah.edu/psych3120-classroom/rds.jpg



http://shanenj.tripod.com/stereo.html

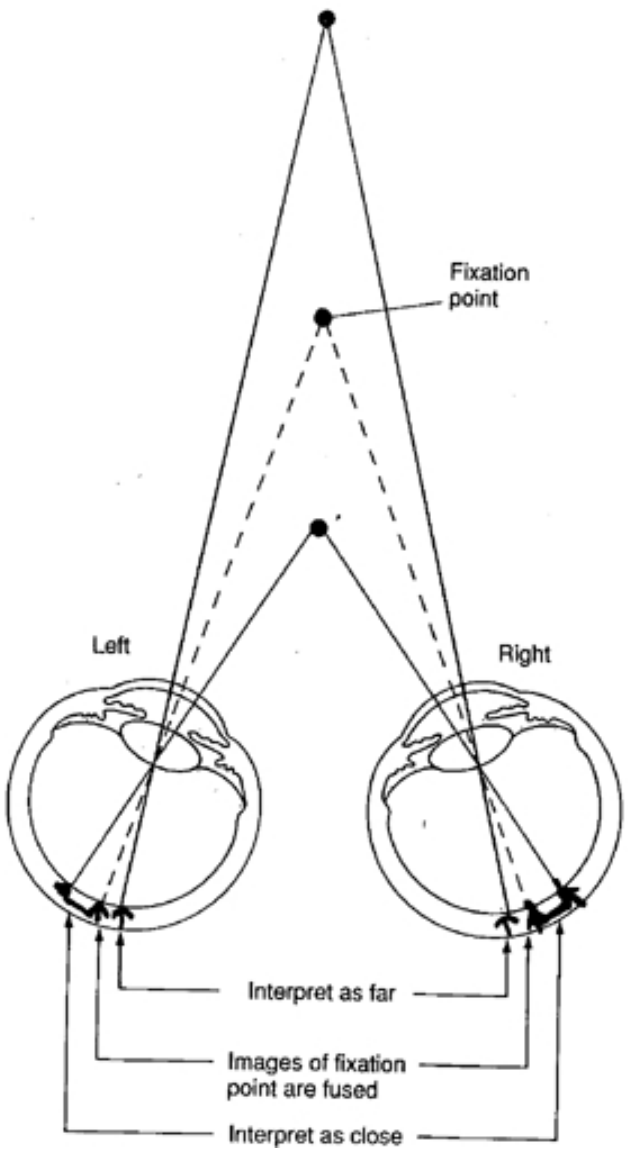
Here's an animated one



../87/animwave.jpg

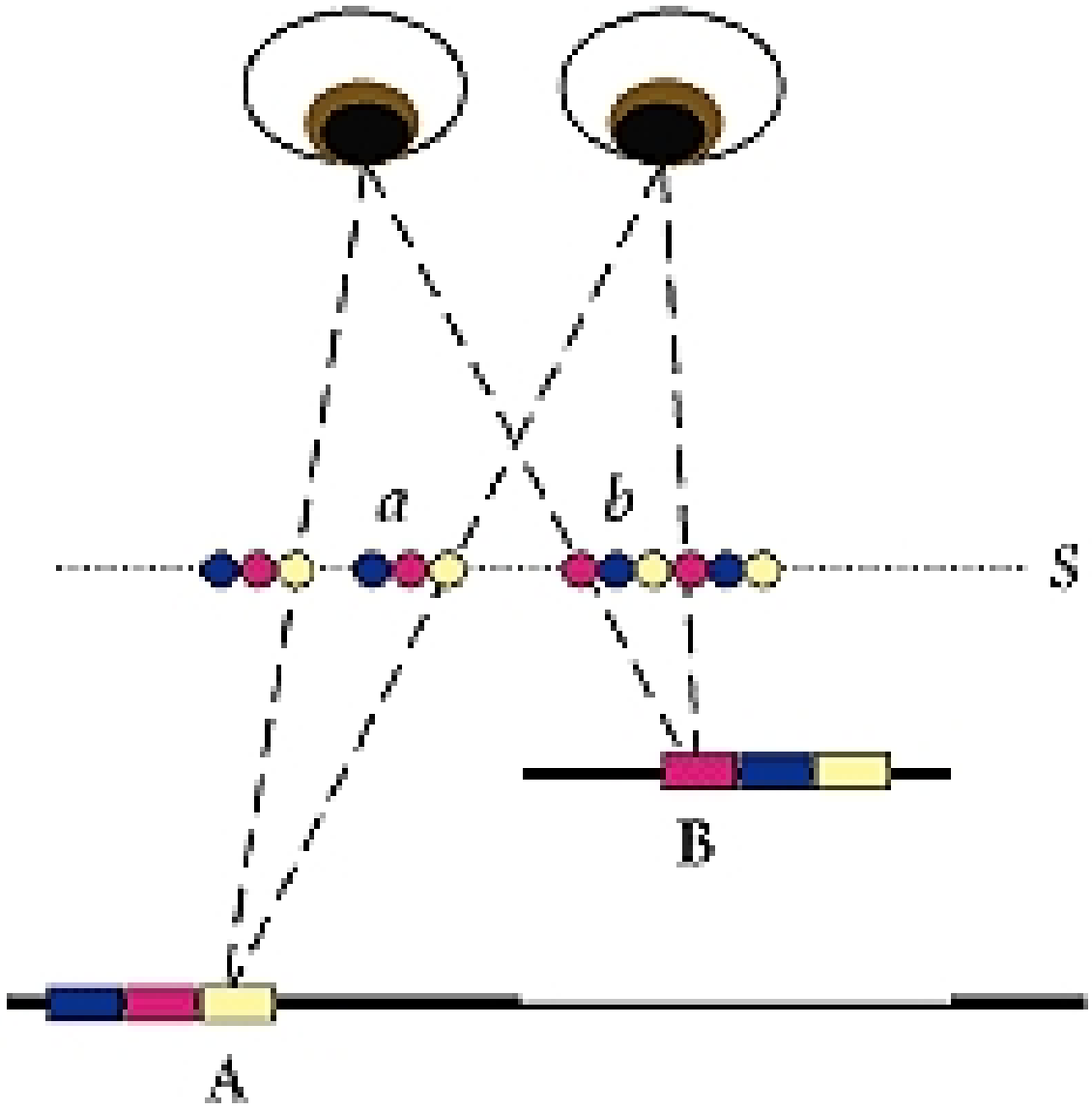
http://www.imm.dtu.dk/ uniaaa/MagicEye/MagicEyeAnim.html

How does stereo vision work?


Fixation point
Left
Right
Interpret as far
Images of fixation point are fused
Interpret as close

http://www.science.mcmaster.ca/Psychology/psych2e03/lecture6/focal.gif

How do SIRDS work?


a
b
S
B
A

http://www.microsoft.com/mind/0197/sirds/sirds.asp

How do SIRDS work?

Figure 3. Stereogram Geometry

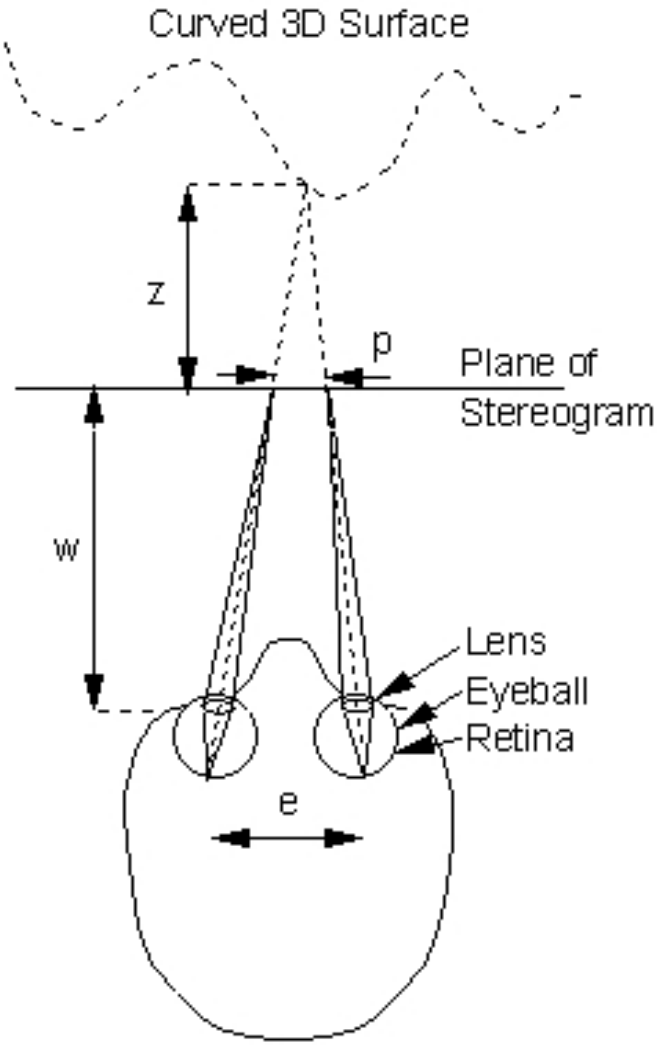
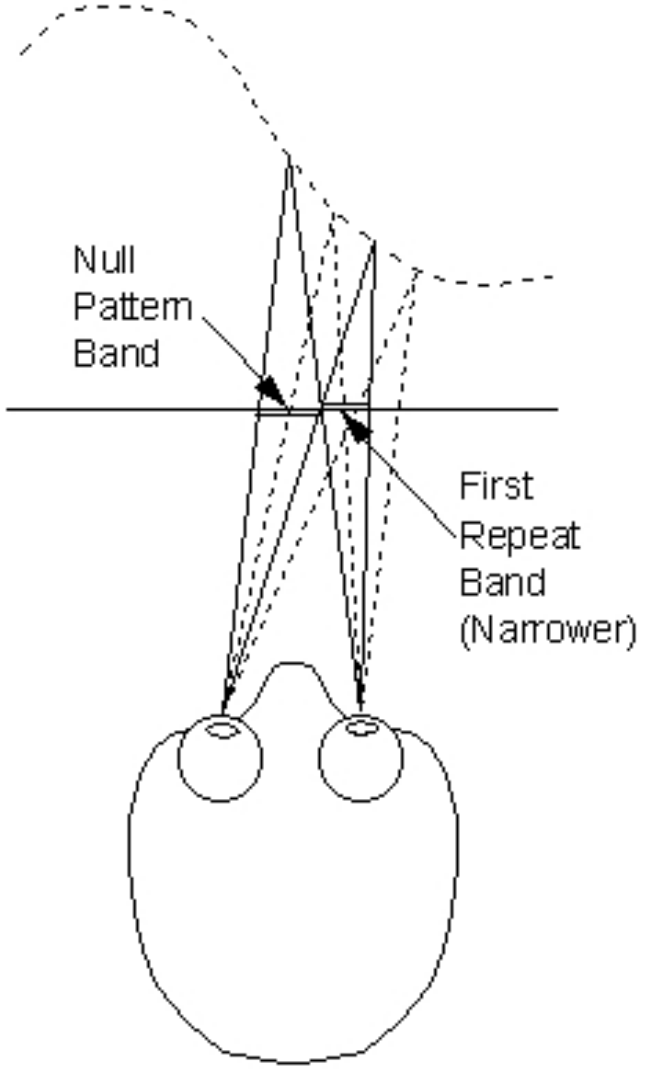


Figure 4. Scanning Across The Stereogram



http://www.science.mcmaster.ca/Psychology/psych2e03/lecture6/autostereo/stertxt.h

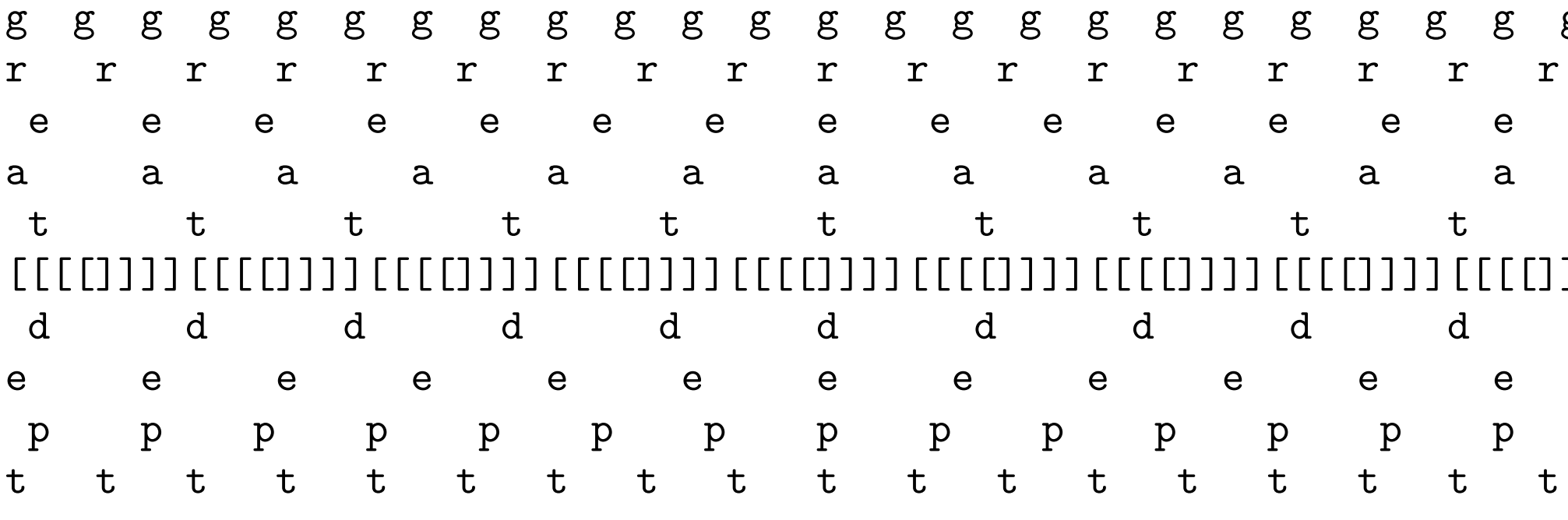
Example text ones

```
From: dthomas@bbx.basis.com (Dave Thomas)

O   O
n   n   n   n   n   n   n   n   n   n   n   n   n   n   n   n
f    f    f    f    f    f    f    f    f    f    f    f    f
e   e   e   e   e   e   e   e   e   e   e   e   e   e   e   e
a    a    a    a    a    a    a    a    a    a    a    a    a
a   a   a   a   a   a   a   a   a   a   a   a   a   a   a   a
r    r    r    r    r    r    r    r    r    r    r    r    r
r   r   r   r   r   r   r   r   r   r   r   r   r   r   r   r
```

Example text ones

From: dthomas@bbx.basis.com (Dave Thomas)



h h h h h h h h h h h h h h h h h h h h h h h

Random dot stereograms

How do they work?

For more details (and code)

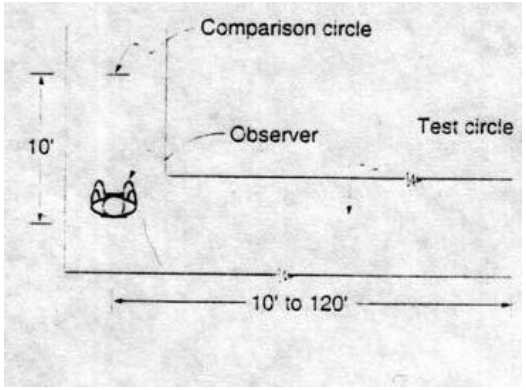
Good References for more details

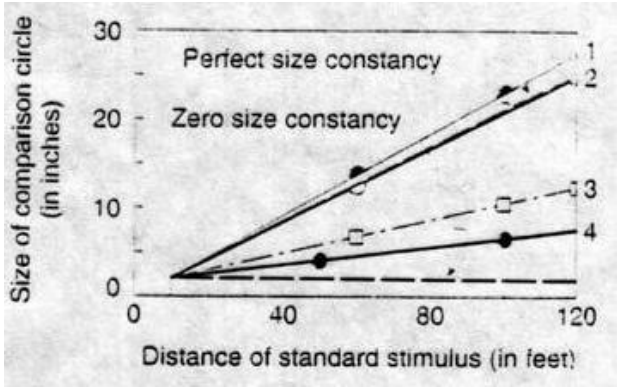
http://www.techmind.org/stereo/sintro.html
http://www.microsoft.com/mind/0197
http://www.science.mcmaster.ca/Psychology/psych2e03/lecture6/psych.2e03.lecture6.
http://www.ccc.nottingham.ac.uk/ etzpc/nz/sirds/general.html#Subject1

Perceiving Size

Perceiving size correctly requires good depth perception. Why?

Holway and Boring Experiment





Results: when depth perception good, subjects judge size appropriately

As depth cues were removed – subjects gradually changed to matching visual angle (size on the retina) (2-one eye, 3-and thru peekhole, 4-and with draped hallways)

http://faculty.plattsburgh.edu/wendy.braje/424/sizeout.html

(the sun and the moon look the same size because we can't sense the difference in depth between them)

size constancy - the ability to accurately sense size at different distances despite differences in amount of retina covered

size constancy coin demo

Size-distance Scaling

size-distance scaling

$$S = K(R \times D)$$

S - perceived size

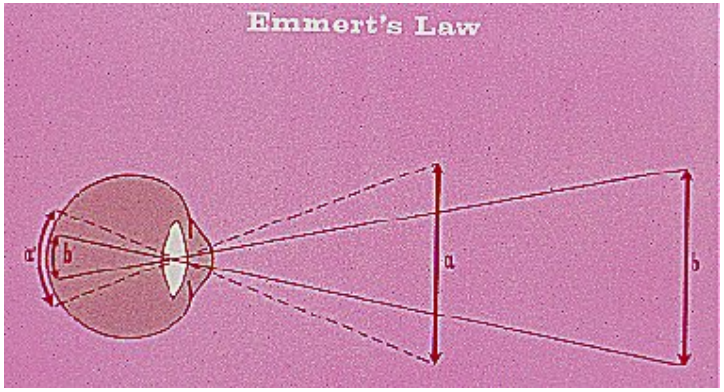
R - size on the retina

D - perceived distance

K- constant

Emmert's Law

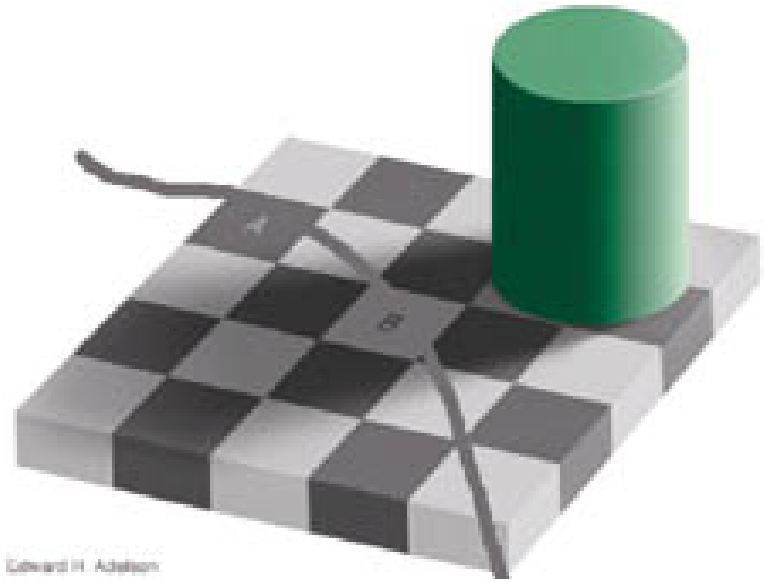
Stare at a circle (60 seconds) and then look away to see the afterimage. After look at a faraway wall and a near surface. The farther away an afterimage is seen, the larger it looks. This follows directly from the Size-distance scaling equation. (note the size of the bleached area on the retina always stays the same)



http://alpha.furman.edu/ einstein/general/sandpdemo/eye.htm

And now a continuation of the color lecture – lightness perception

Lightness Perception can be very complicated



Great Lightness perception demos)

Rolling/bouncing ball demo by Dan Kersten et. al.

Next Class

Perceiving Depth and Size (Chapter 7)