# COGS 101A: Sensation and Perception

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Lecture 9:

Motion perception

# 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

Perceiving Depth (and size)

# This Class

Review of Depth Perception

Motion Perception (Lots of cool demos/illusions)

Tutis Vilis notes

http://www.med.uwo.ca/physiology/courses/sensesweb by Tutis Vilis, University of Western Ontario, Canada

# Apparent Motion

vary ISI for apparent motion demo

- ISI - interstimulus interval (time between stimuli)
- short ISI's (about less than 30msec) lights appear to flicker
- medium ISI's (about 60 msec) apparent motion
- long ISI's (longer than 200 msec) lights flash separately

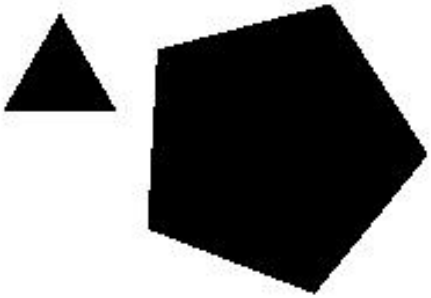
(these will vary depending on the separation distance)

Motion sensitive neurons in cortex have been seen to respond to apparent motion (that appears to pass through their receptive field) (comparable to that from **real motion**

We can also get apparent motion sensations in other modalities

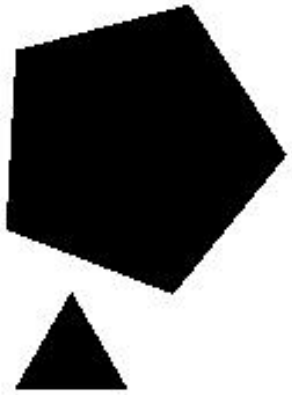
# Apparent Motion can have curved paths

Frame one:



# Apparent Motion can have curved paths

Frame two:



# Apparent Motion can have curved paths

Research from Thomas Shipley's lab (Temple University)

" Subjects were shown Frame 1 and Frame 2 in alternation For relatively long intervals, some subjects report seeing the triangle travel a curved path around the pentagon. For shorter intervals, generally the triangle appears to travel through the pentagon."

http://astro.temple.edu/ tshipley/research.html

# Motion Aftereffect

click on the figure for the demo

# Reichardt Motion Detector

demo

http://neurovision.berkeley.edu/Demonstrations/matthew/reichardt.html

book emphasizes the lateral inhibition, most people emphasize the time delays (need both for best motion discrimination)

# Detecting motion on the retina is not enough

What happens if the retinal image moves due to eye movements

**Corollary discharge theory** - movement commands to the eye are accounted for and their commanded retinal motion canceled

Four important experiments to test the corrolary discharge theory

- move your eyes with an afterimage (in a dark room)
  - ⋆ bleached patch stationary on the retina, eye moves - movement percept
- push on eyeball(gently) while fixating a spot
  - ⋆ eye muscles counteract pushing, no eye movement - movement percept
- track a moving objects (with your eyes)

- ⋆ no retinal slip, eyes move - movement percept

- paralyze eyes and have observer try to move his eyes
  - ⋆ eye movement command sent but no eye movement - movement percept

# The motion aperture problem

**The Motion Aperture Problem** In apertures, the direction of motion is ambiguous

click here

click here

Why are apertures a problem for the nervous system?

# The motion aperture problem

**The Motion Aperture Problem** In apertures, the direction of motion is ambiguous

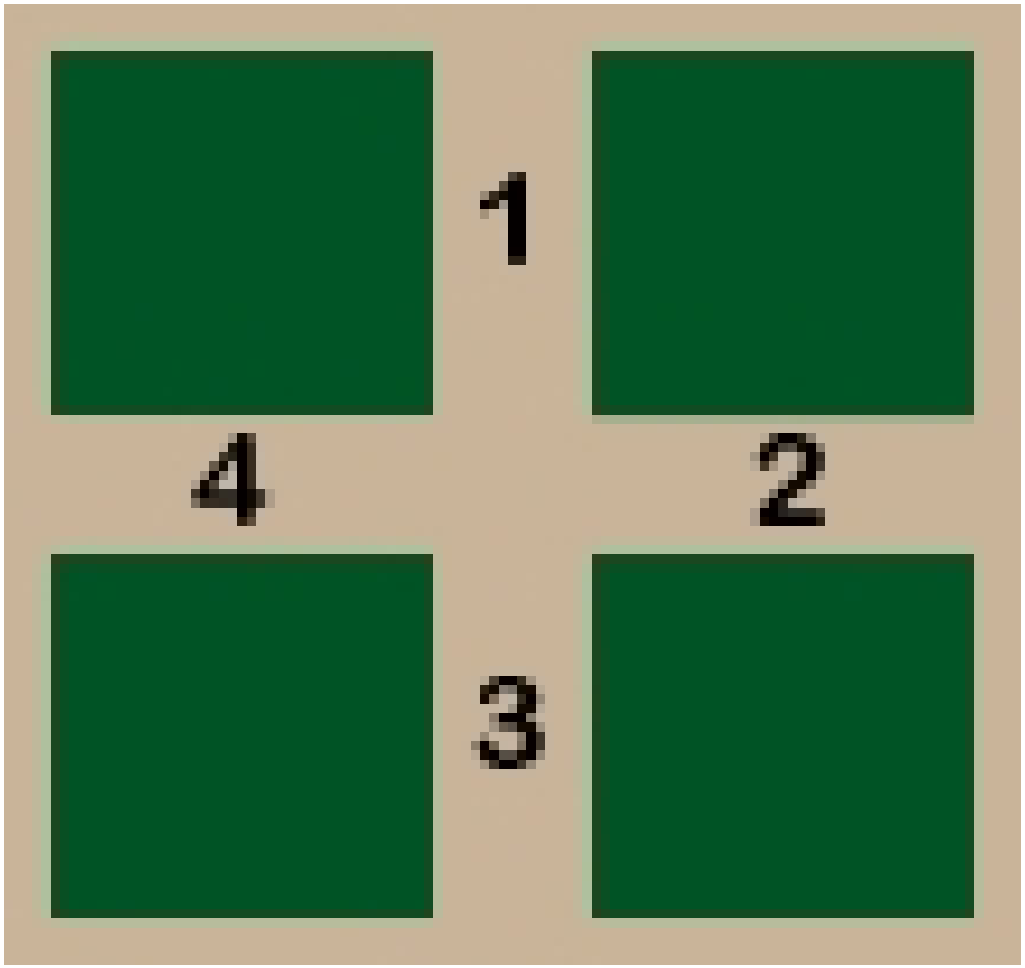
click here

click here

Why are apertures a problem for the nervous system?

Neurons see the world through apertures

# Another example of the aperture problem in action



# Physiology of Motion Processing

Complex cells in V1 respond to direction of motion.

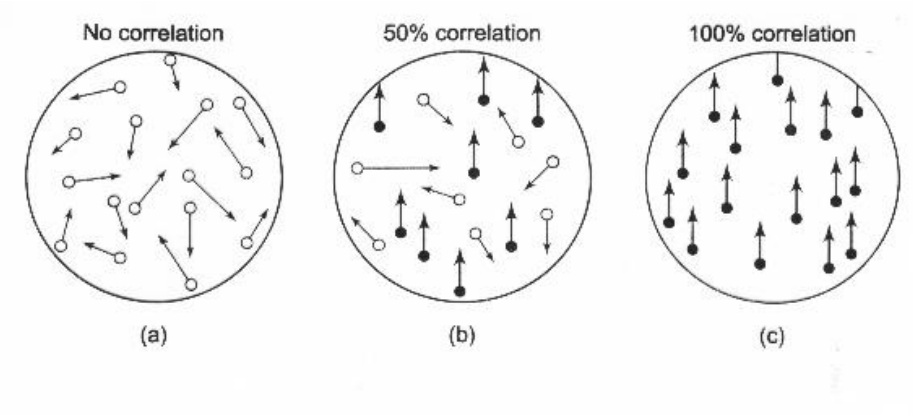
In MT there is a columnar organization of direction of motion. Similar preferred motion directions are in nearby columns.

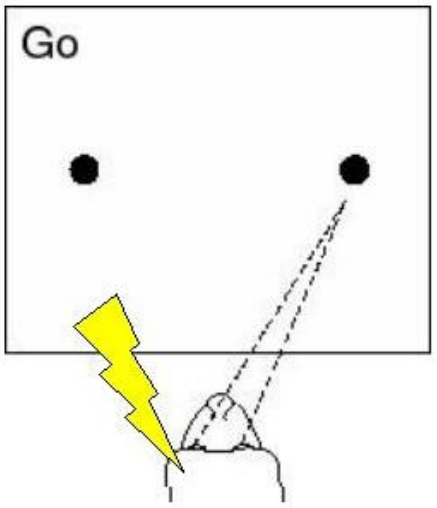
90% of cells in MT are direction sensitive

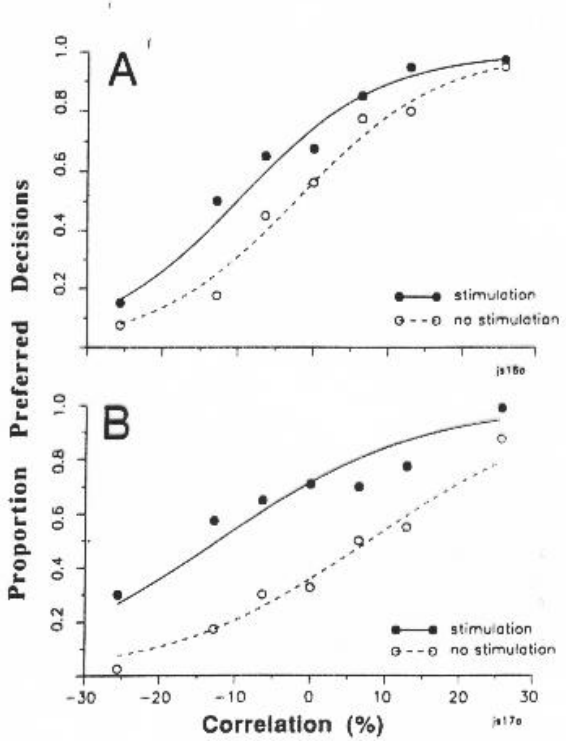
These cells are mostly fed by rods. Rods are good for motion detection because they have good temporal sensitivity, high convergence

Single cells in MT can discriminate the direction of motion the moving dot displays almost as well as the whole animal. (Match the psychometric function with the "neurometric" function)

# Physiological evidence for the importance of MT in motion processing


No correlation
50% correlation
100% correlation
(a)
(b)
(c)


Go


A
B
Proportion Preferred Decisions
0.2
0.4
0.6
0.8
1.0
stimulation
no stimulation
-30
-20
-10
0
10
20
30
Correlation (%)

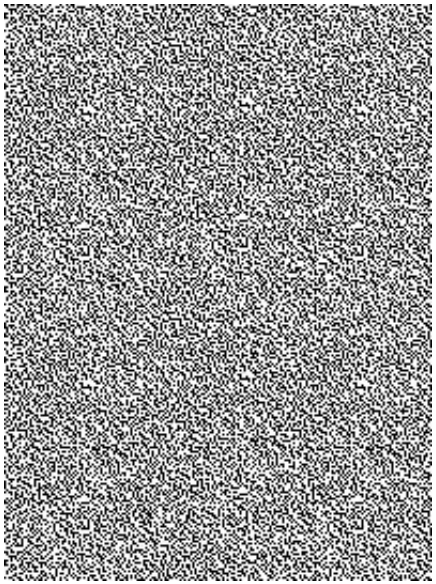
Remember that microstimulation in MT influences a monkey's perception of motion of moving-dot displays from Mike Shadlen and http://zeus.rutgers.edu/~ikovacs/SandP/prepI_3_1.html

# Optic flow

**Global optical flow** occurs when all elements in the image move (as when an observer moves through an environment)

MST neurons have been found to be sensitive to different optical flow patterns e.g. looming, rotation, translation (draw on board)

# Motion can distinguish figure from ground



http://www.tutkie.tut.ac.jp/ mich/kitazaki.hm.html

Image segmentation based on motion requires luminance cues demo

# Motion can give strong depth perception

**Structure from motion**

demo

# Biological Motion

biological motion demo

- You can tell species, male from female, emotions, and recognize familiar people
- Four month old infants prefer to watch biological motion over random dot motions
- fmri studies show activation in the Superior Temporal Sulcus (STS) in monkeys and humans

# Motion interactions

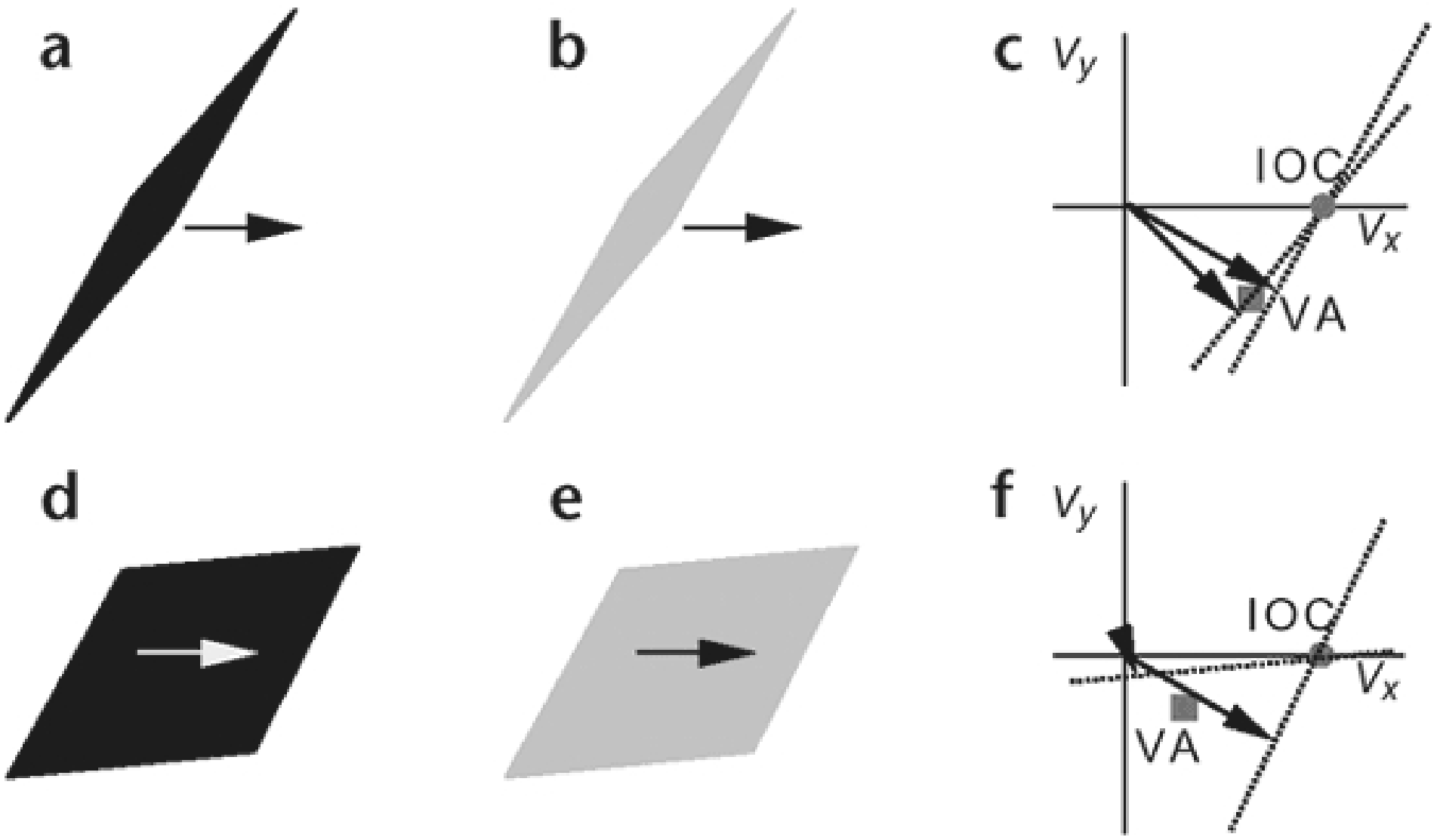
**induced movement** -illusion where movement of one object induces perception of movement of another object (e.g. moon with clouds racing by)

**motion capture** - Motion of one object brings non-moving texture (or color) along with it

Motion capture illusions

# Motion perception can be quite complicated

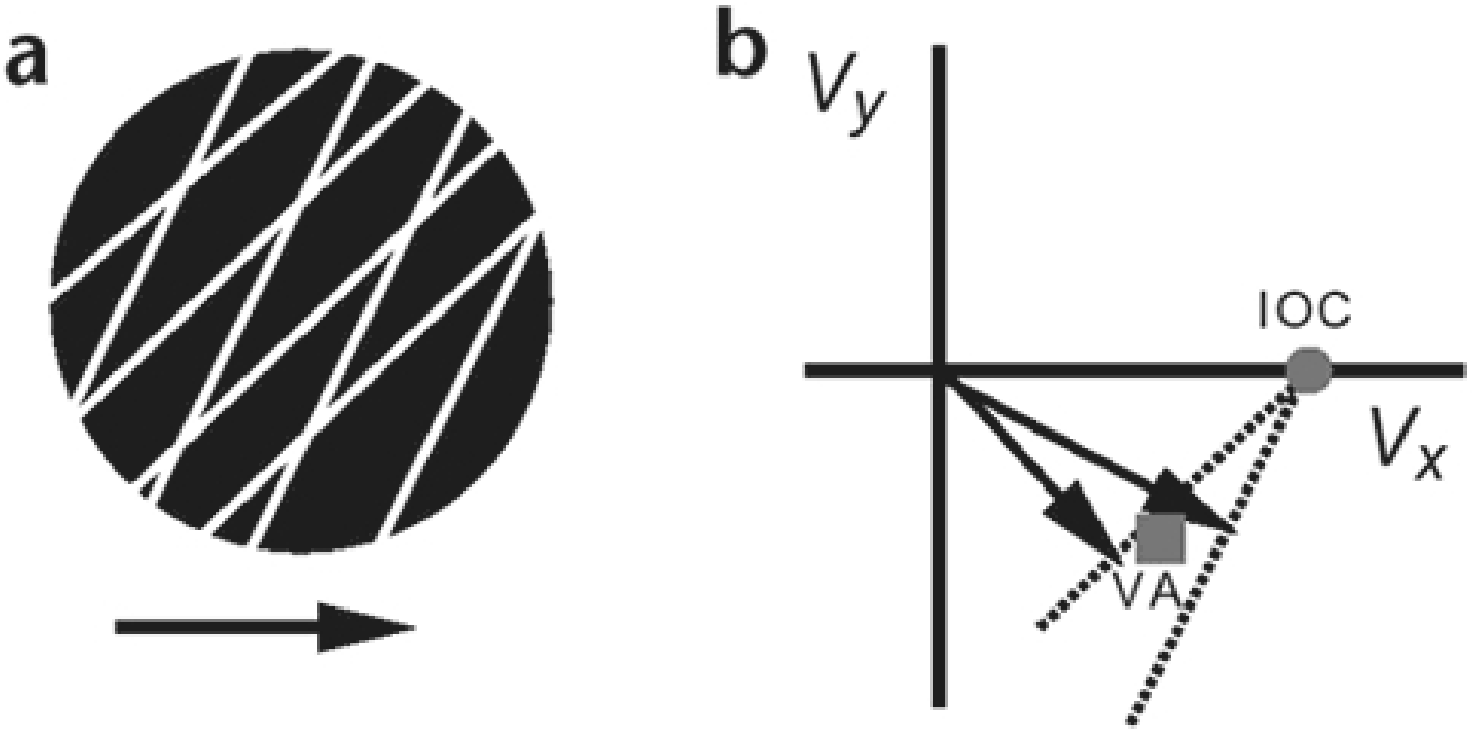
click on the figure for the demo


a
b
c
$V_y$
IOC
$V_x$
VA
d
e
f
$V_y$
IOC
$V_x$
VA

There is a very nice Bayesian computational model that explains the changing motion percept as a function of thickness and contrast. It is based on the idea that you are less certain about lower contrast motion and that you have a prior preference for slower motions

Weiss, Y.,Simoncelli, E. P. & Adelson, E. H., (2002) Motion illusions as optimal percepts Nat Neurosci 5 (6:598-604).

# Plaid motion




plaid motion component motion

Some MT neurons respond to the direction of the plaid motion (V1 cells do not)

# Remember motion can help depth perception

**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

# Tuesday

Don't forget to vote!