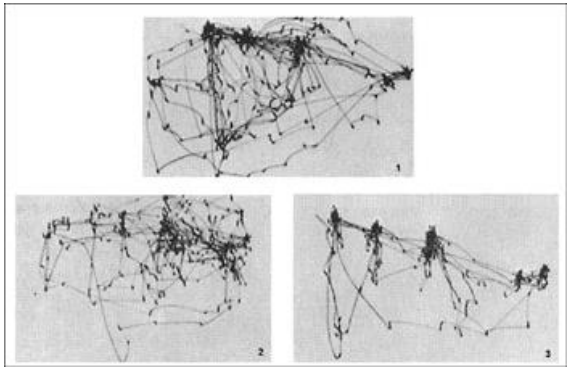
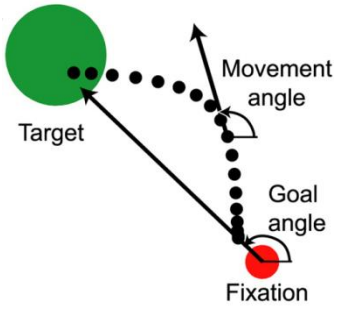
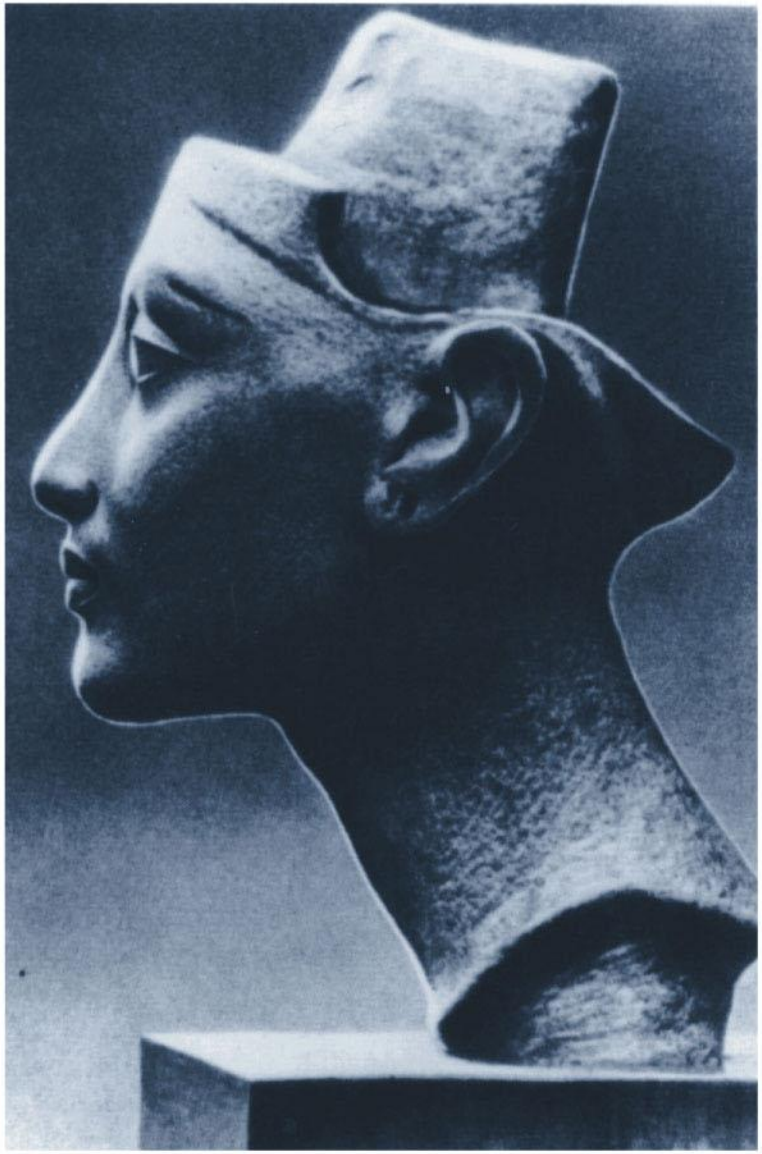
Sensorimotor Integration

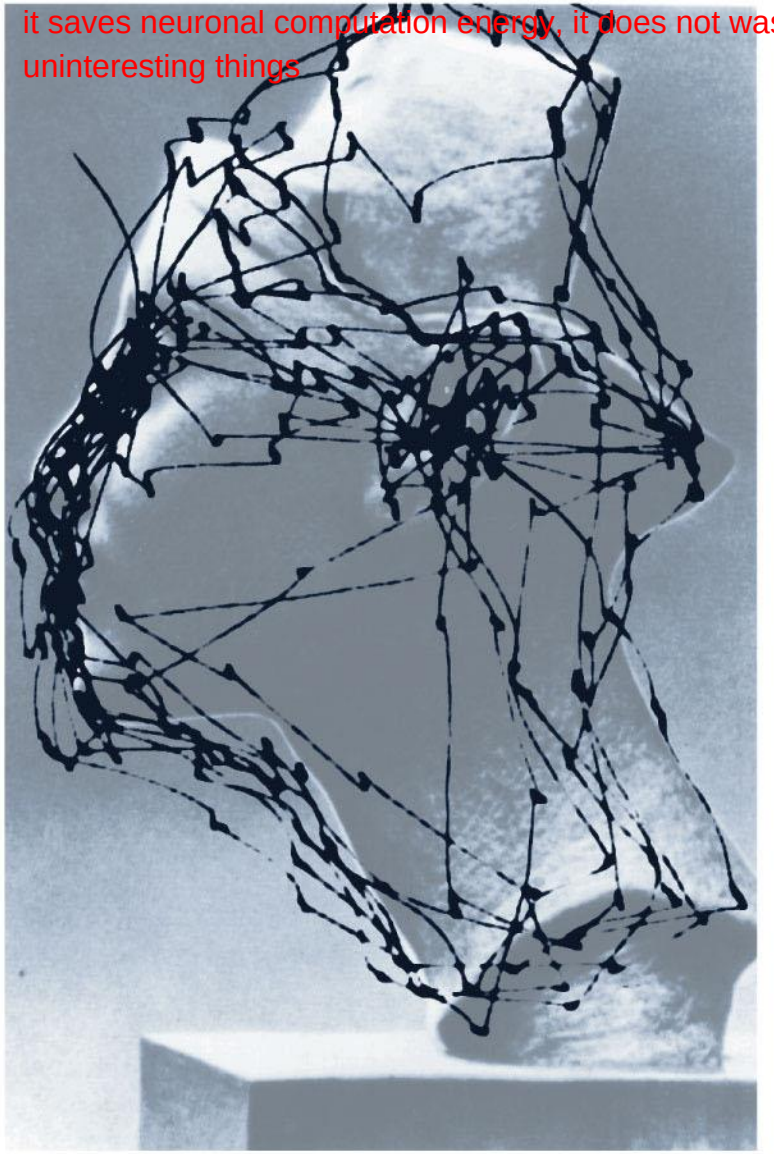
Eye Movements





1. Function and Organization of the Oculomotor System
2. Types of Eye Movements
3. Neural Control of VOR and Gaze Shifting

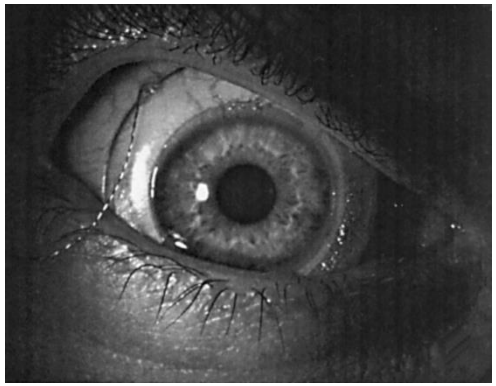


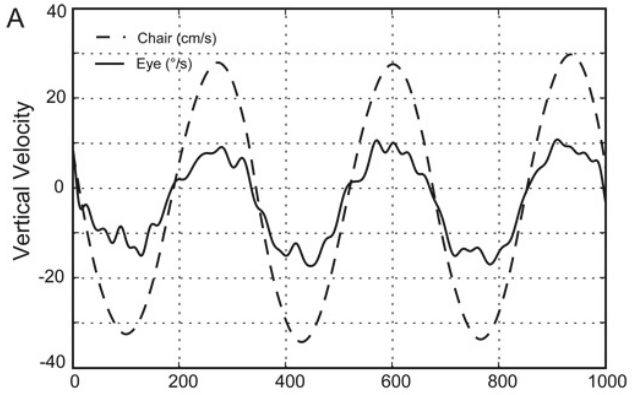


thats how we look at a face and analyze it. the brain picks it itself. it saves neuronal computation energy, it does not waste time on uninteresting things

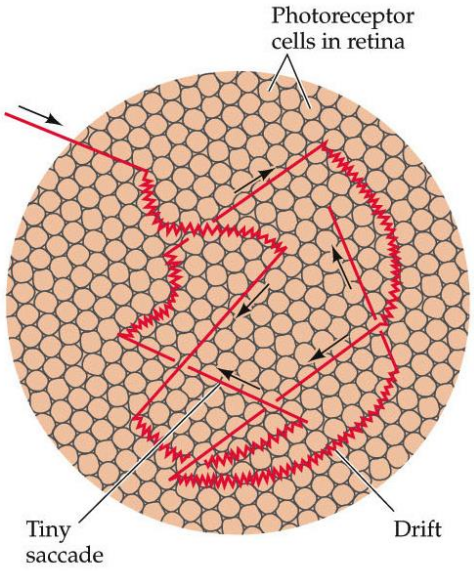
salient stimuli: stimuli that are interesting and highly analyzed (here nose, eyes and ear)

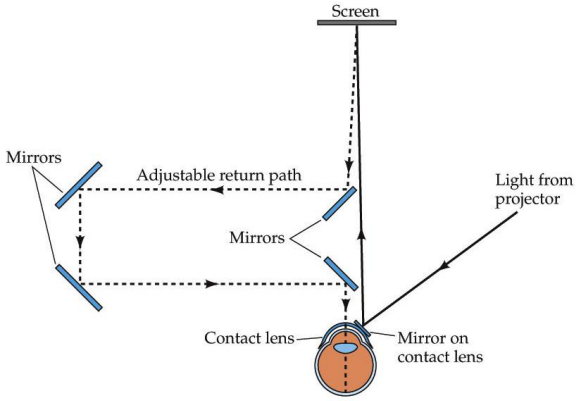
Recording Eye Movements

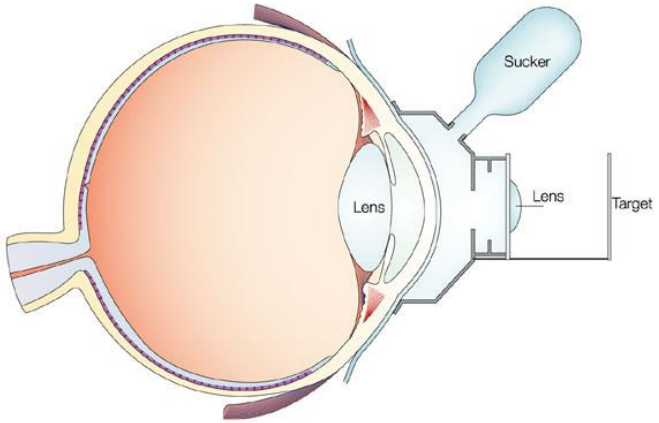




Stabilizing Eye Movements







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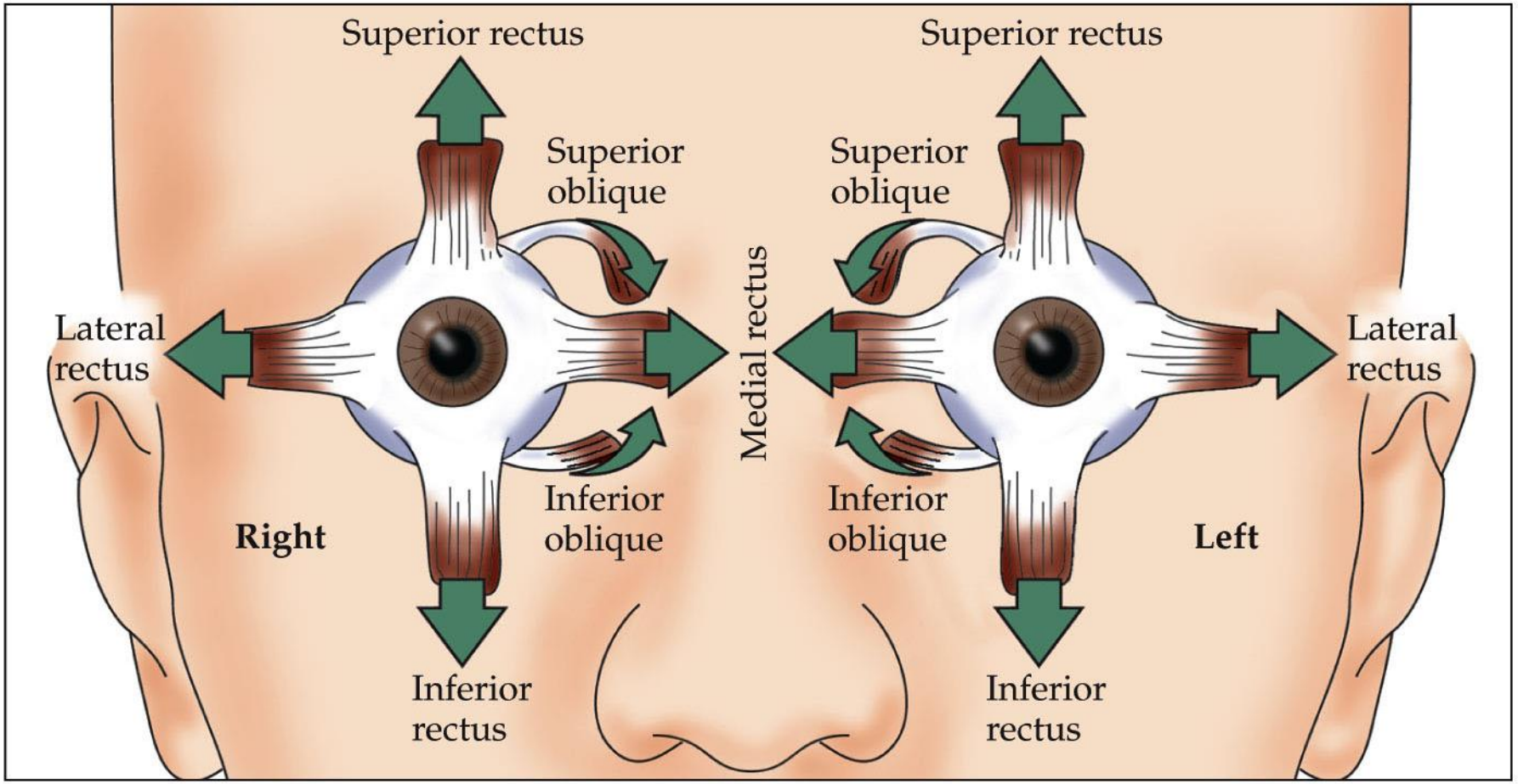
many animals dont actually have a fovea. humans focus always with the fovea since it has the highest concentration of photoreceptors => highest resolution

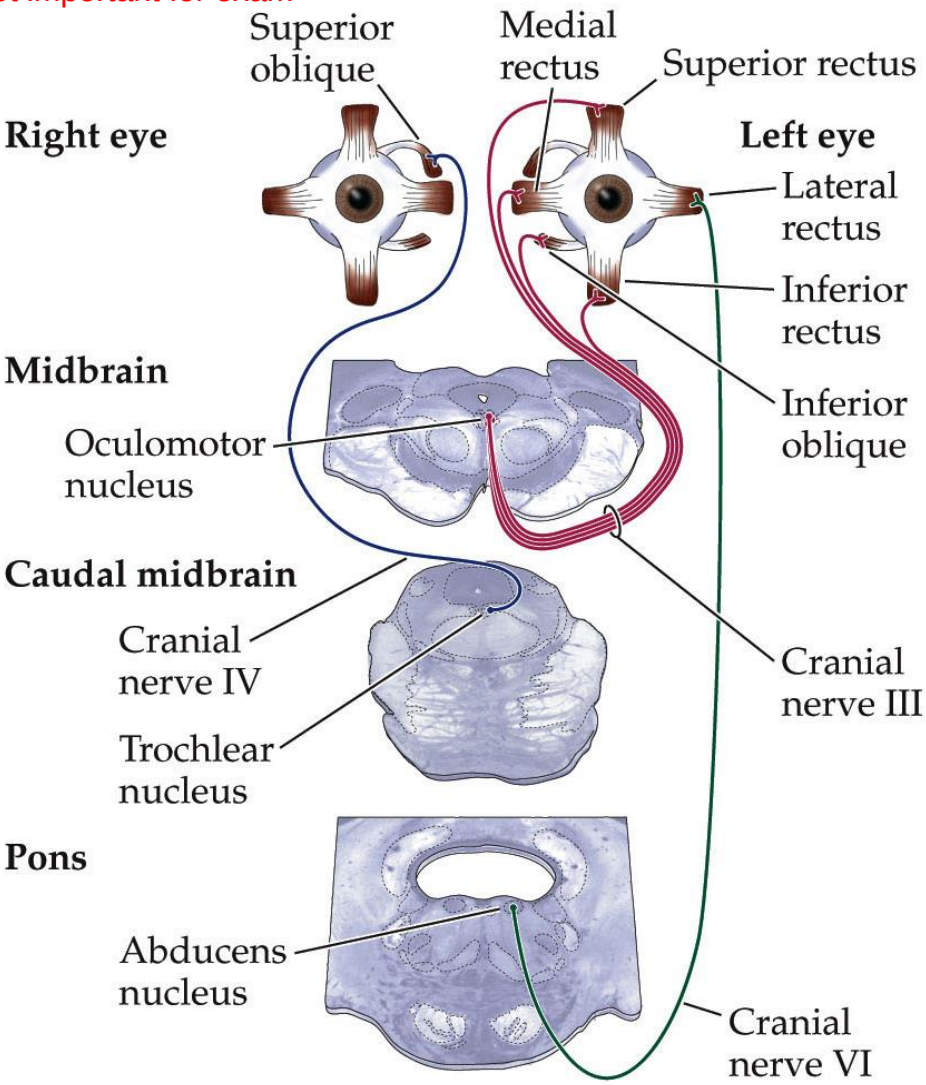
those are the fastest muscles (in the eyes) and they cannot fatigue (basically)
control is very precise



3 antagonistic muscle pairs: lateral and medial rectus
superior and inferior rectus
superior and inferior oblique

the way it's controlled

lec: names not important for exam

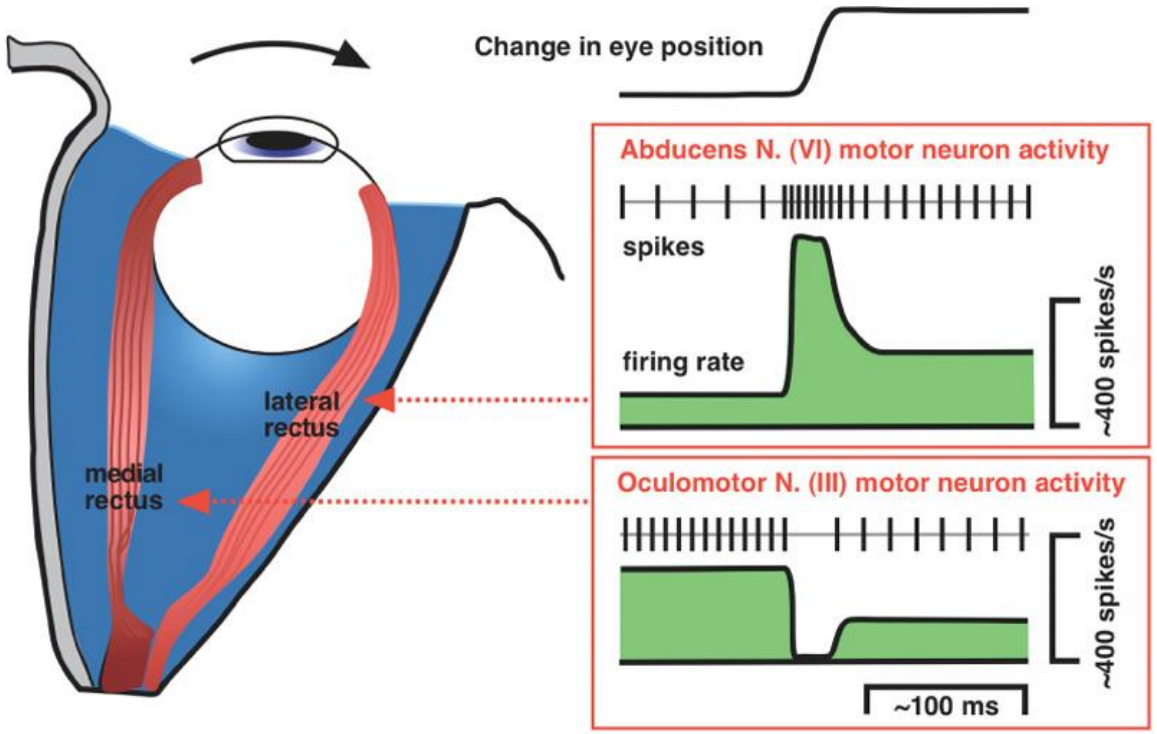


CN III:
medial, superior, inferior rectus
Inferior oblique

CN IV:
superior oblique

CN VI:
lateral rectus

CN III also innervates *levator palpebrae superioris* and parasympathetic from Edinger-Westphal nucleus (pupil constriction)


Change in eye position
lateral rectus
medial rectus
Abducens N. (VI) motor neuron activity
spikes
firing rate
~400 spikes/s
Oculomotor N. (III) motor neuron activity
~400 spikes/s
~100 ms

Types of Eye Movements:

Stabilizing:

1. Vestibulo-ocular Movements (VOR)
2. Optokinetic Eye Movements (OKR)

reflexes (not under conscious control)

Shifting:

3. Saccades
4. Smooth Pursuit
5. Vergence

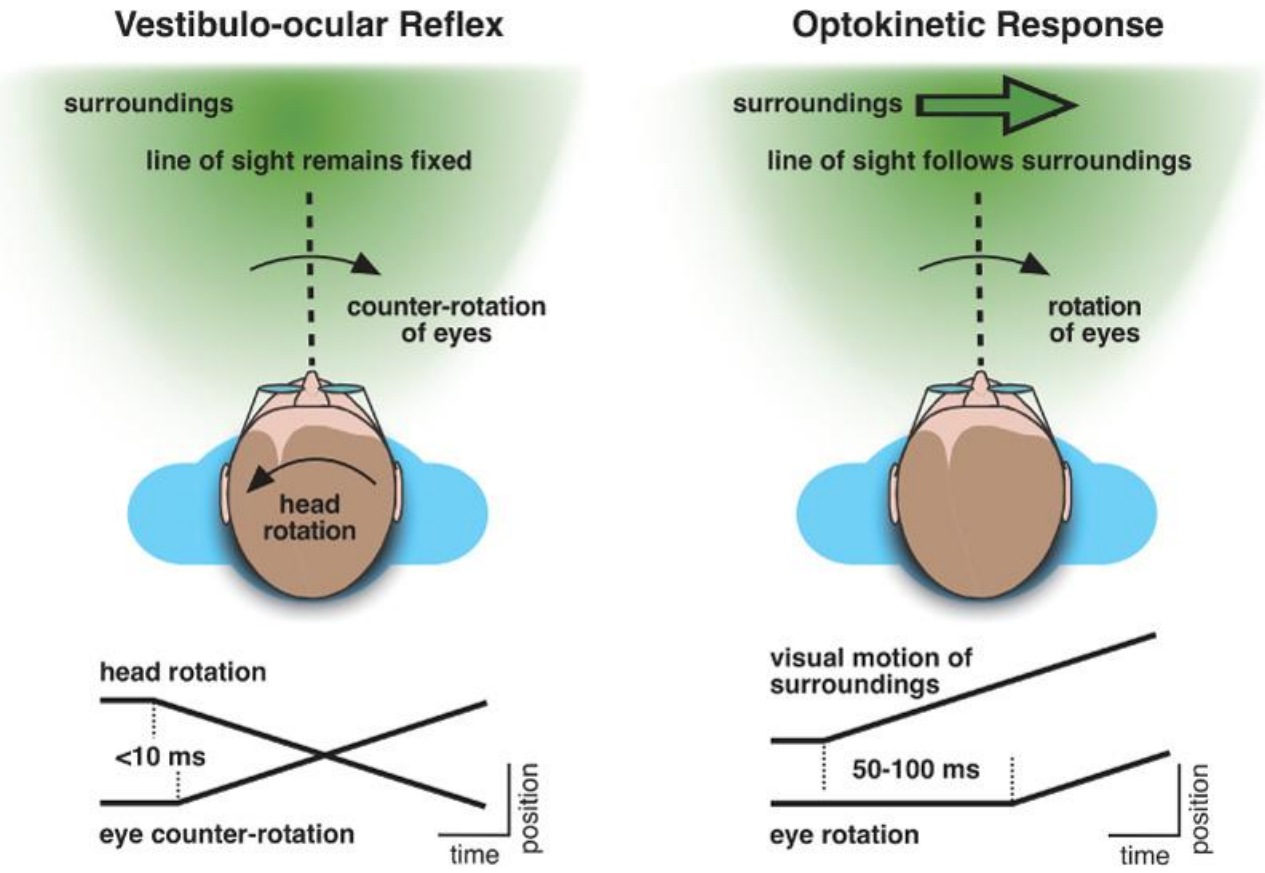
conscious control

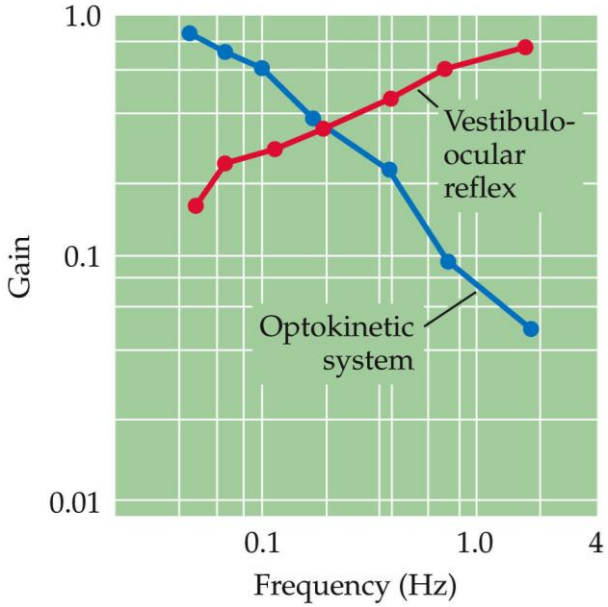
saccades: fast movements when you look left/right => nearly no information to brain during the movement called saccadic depression
smooth pursuit: just following an object. imagination of following a movement: doesnt work normally, looks like saccades then
vergence: object somes nearer or farther away (change in distance). How much vergence is used by eyes correlates with how far away an object is

Stabilizing Eye Movements

high speeds (efficitent)

small speed (efficient)

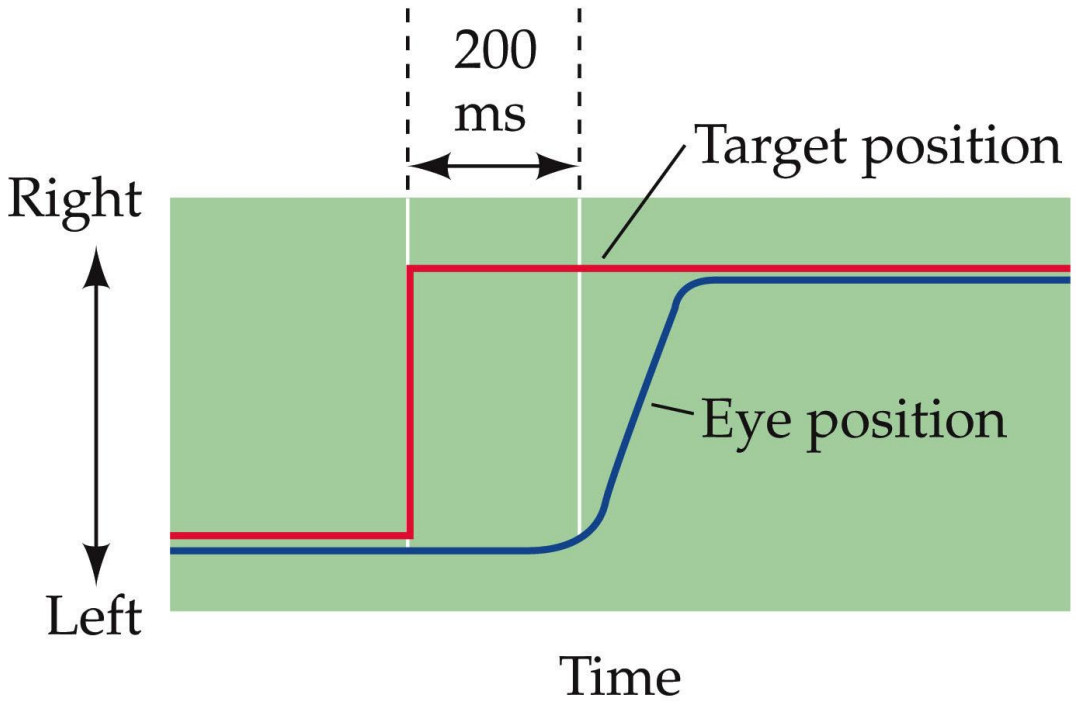




gain: eyes follow at the right speed the object = 1

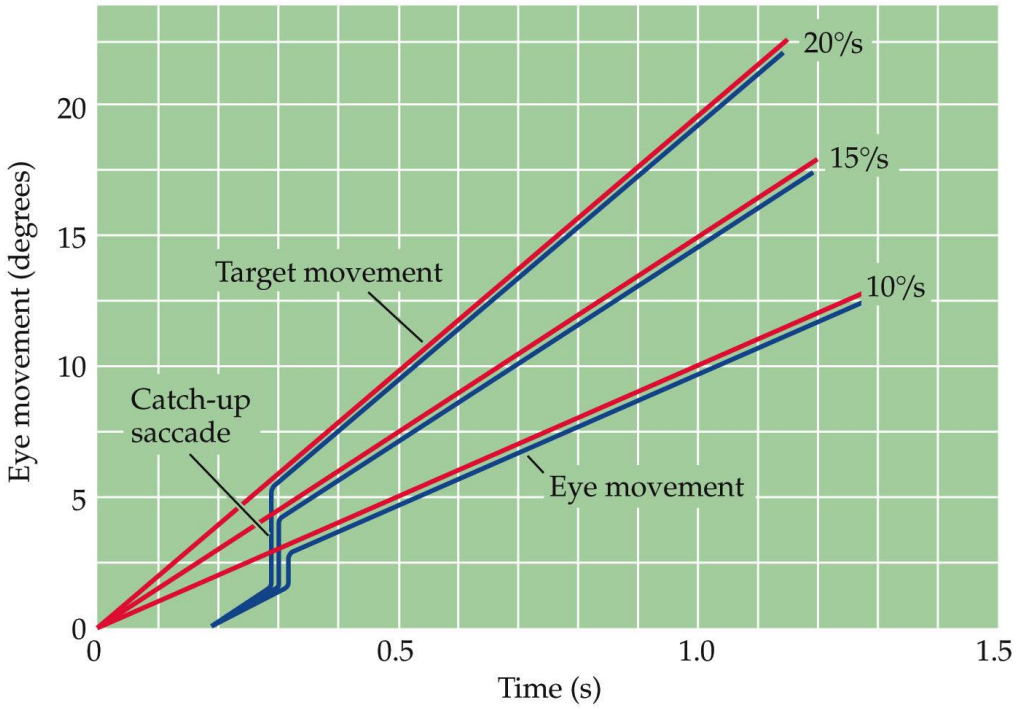
obj moves twice as fast as eyes can follow => gain > 1

Saccadic Eye Movements

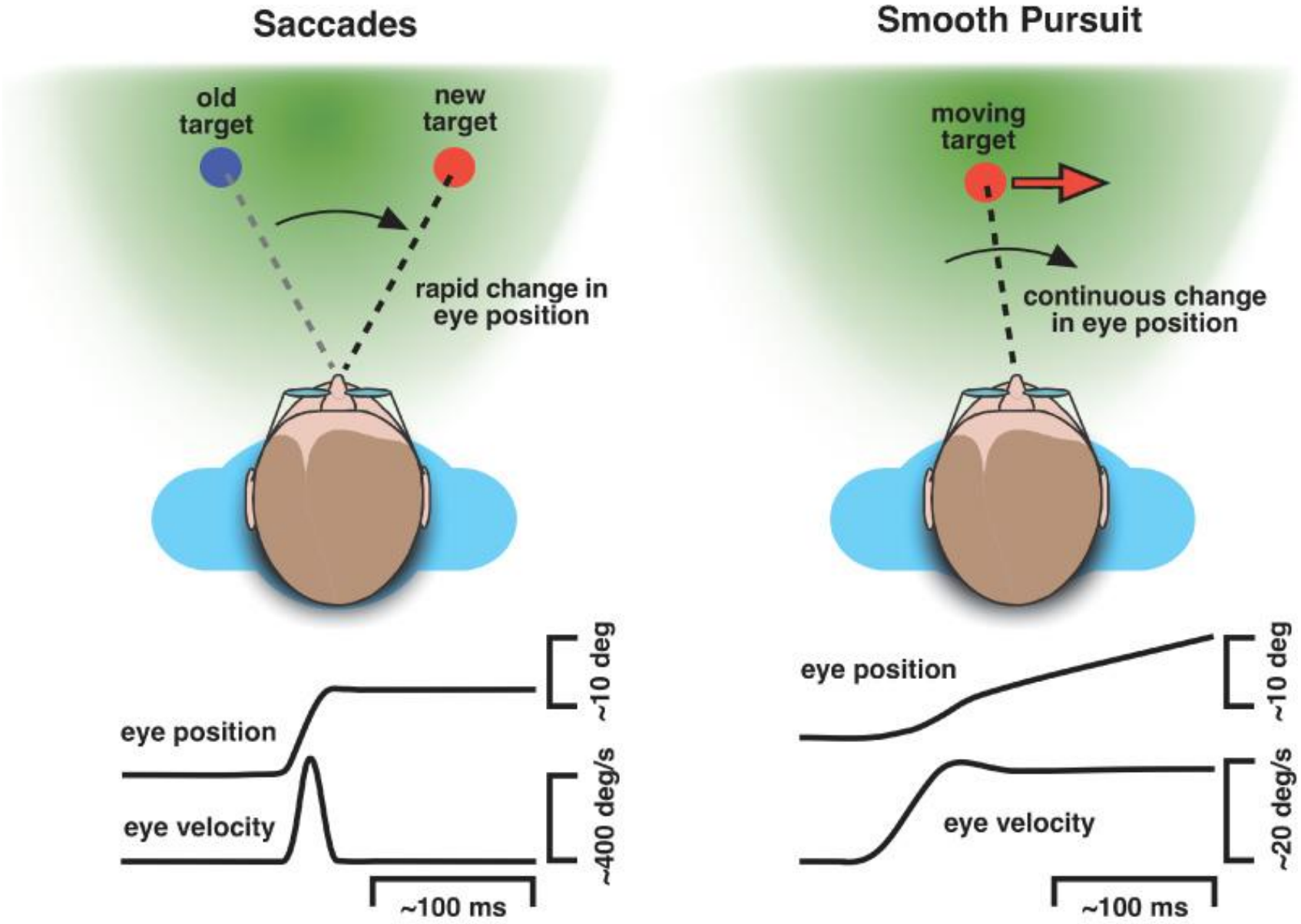


balistic, used in gaze shifting (foveation)

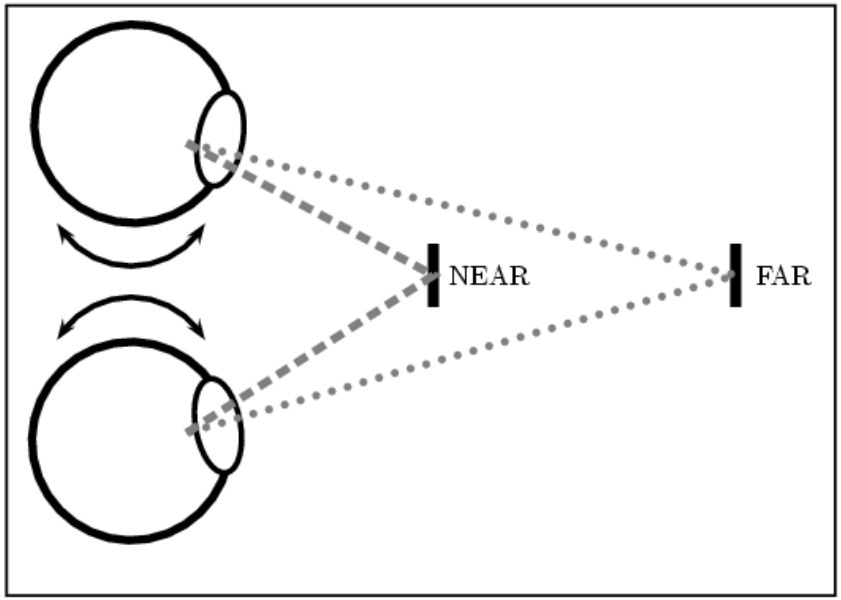
Smooth Pursuit Movements



maintains foveation, voluntary but difficult without visual target

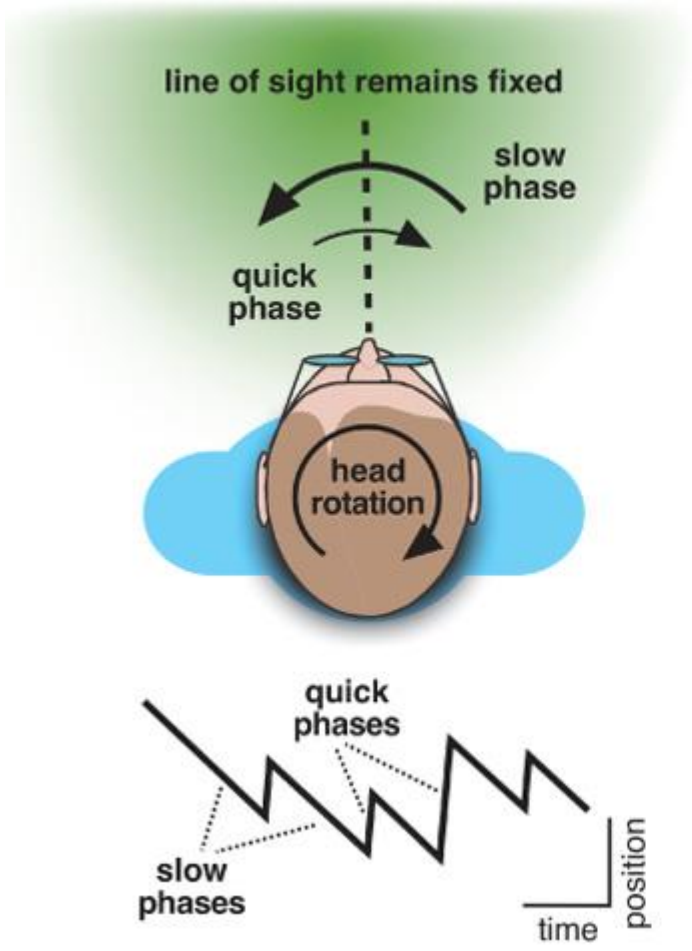

Saccades
old target
new target
rapid change in eye position
eye position
eye velocity
~10 deg
~400 deg/s
~100 ms
Smooth Pursuit
moving target
continuous change in eye position
eye position
eye velocity
~10 deg
~20 deg/s
~100 ms

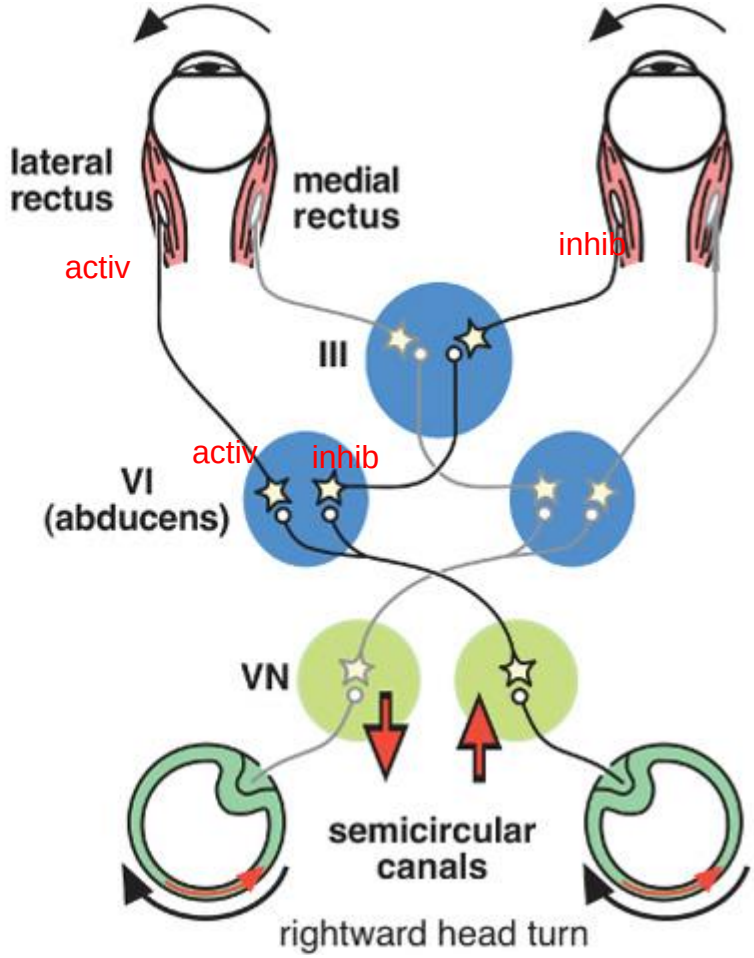
Vergence Movements



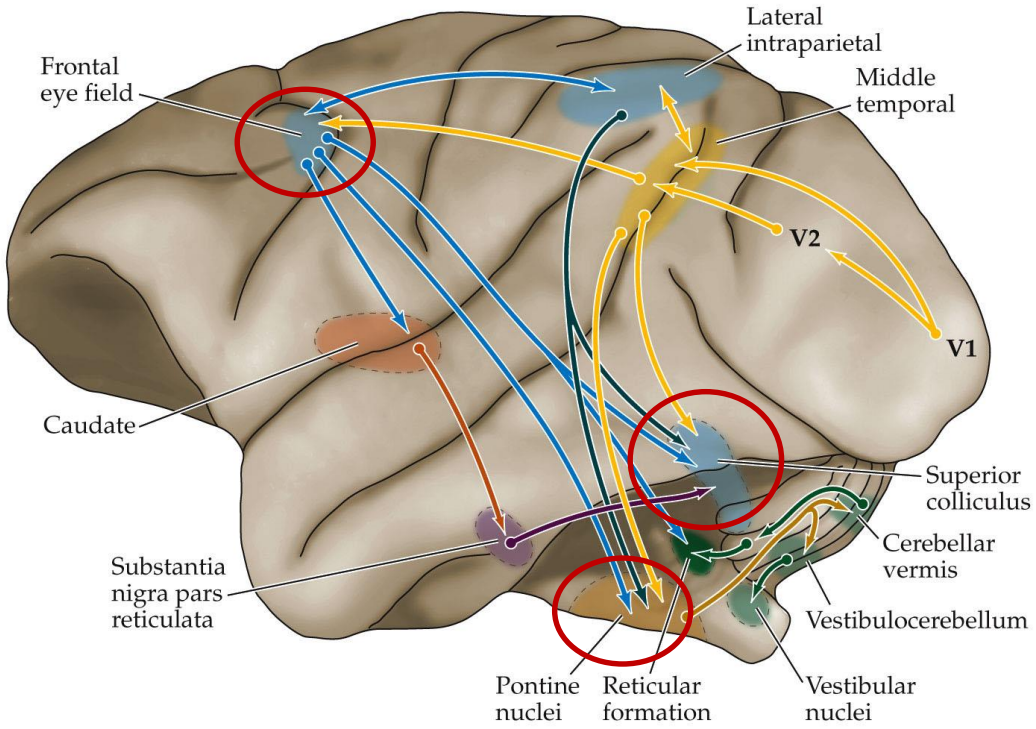
Disconjugative eye movements

Neuronal Control of the Vestibular Ocular Reflex

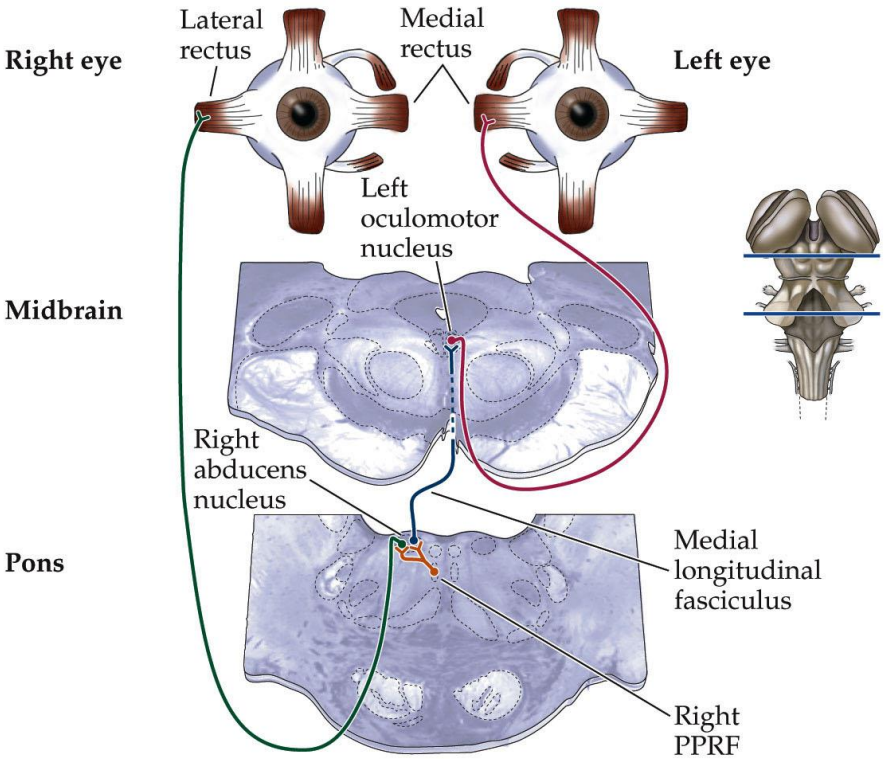




Neuronal Control of Gaze Shifting Eye Movements



How to move the eyes to the right



2 gaze shifting centers:

lec: dont learn that name

PPRF (paramedian pontine reticular formation) horizontal gaze shifts

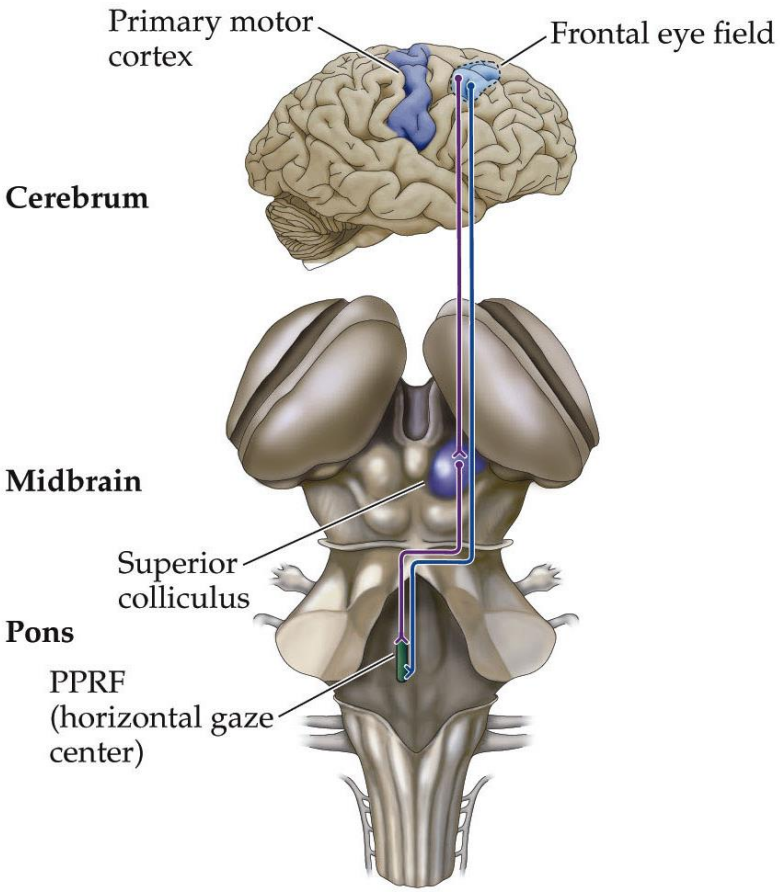
Rostral interstitial nucleus vertical gaze shifts

"An Unexpected Visitor"

"Give the ages of the people."

"Surmise what the family had been doing before the arrival of the unexpected visitor."

What guides eye movements?

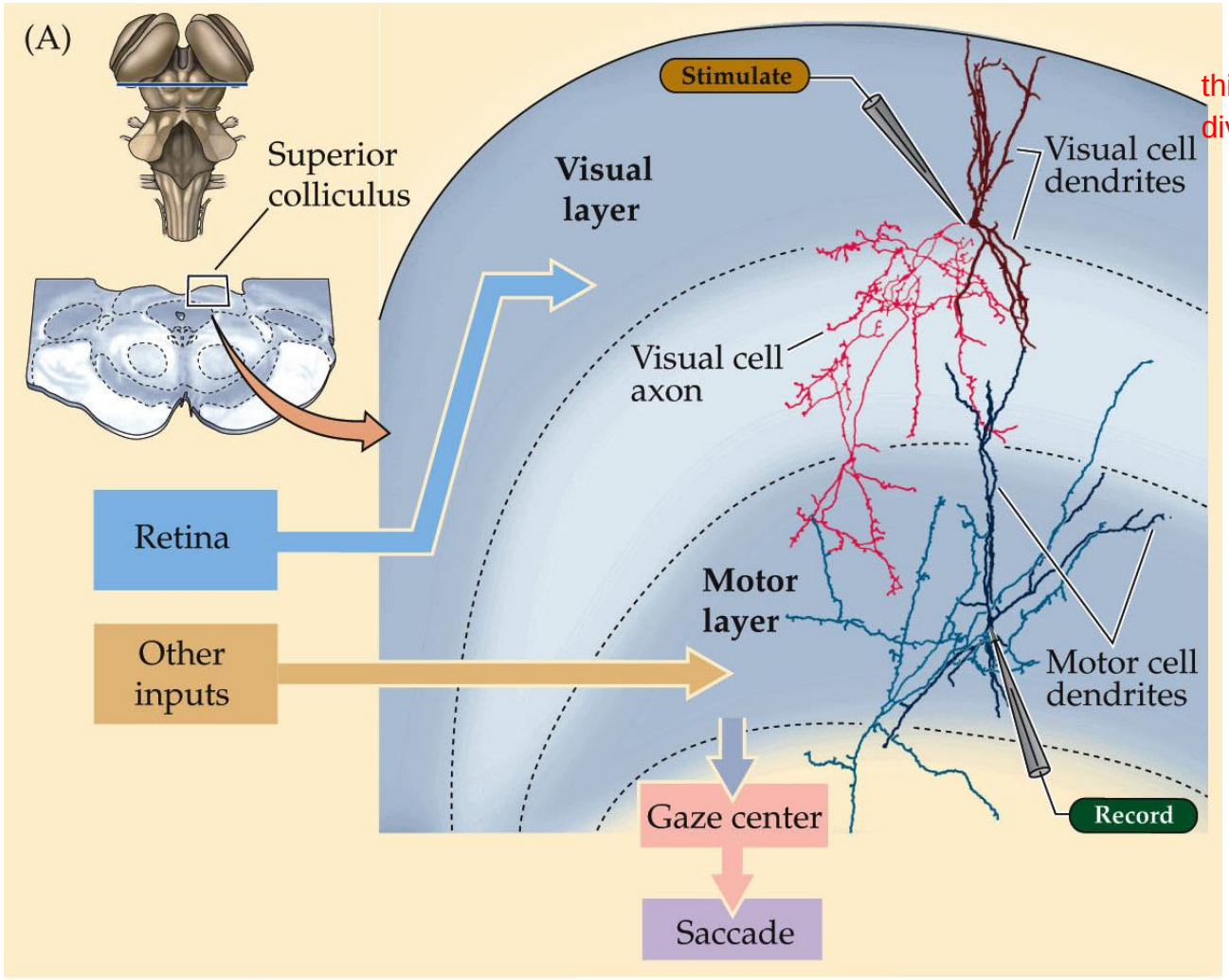


Superior Colliculus

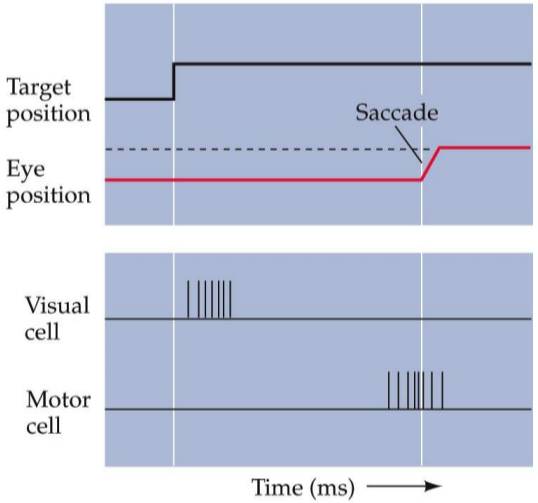
Frontal eye field (Brodmann 8)

The Superior Colliculus Integrates (Multimodal) Sensory Input and Motor Output

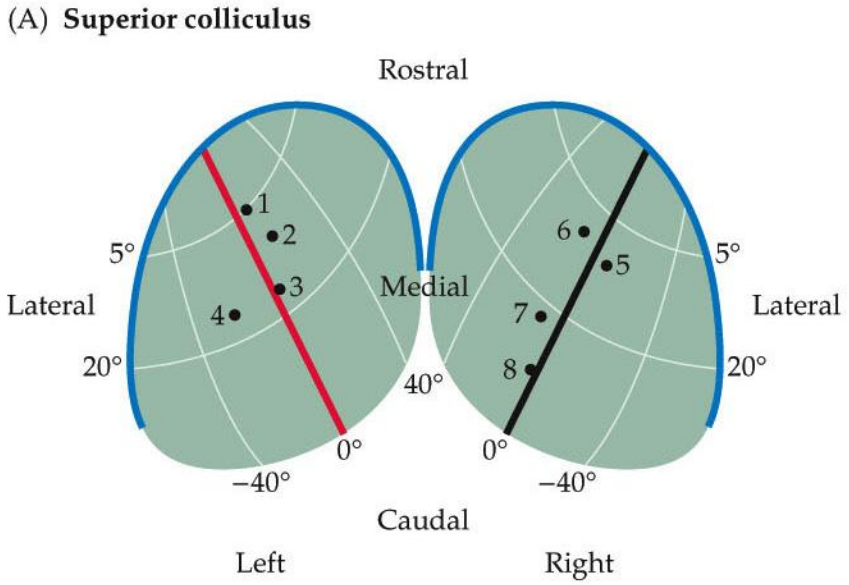
superior colliculus important before there was a cortex even in humans still, but cortex also took over some functions

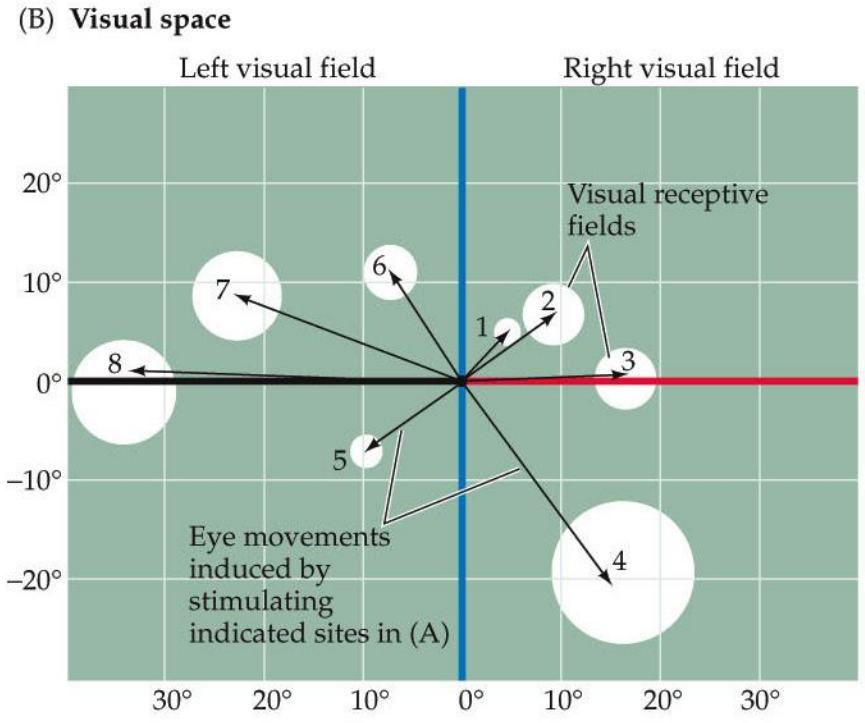


this is the superior colliculus in layers divided



Sensory and Motor Map in the Superior Colliculus are Aligned

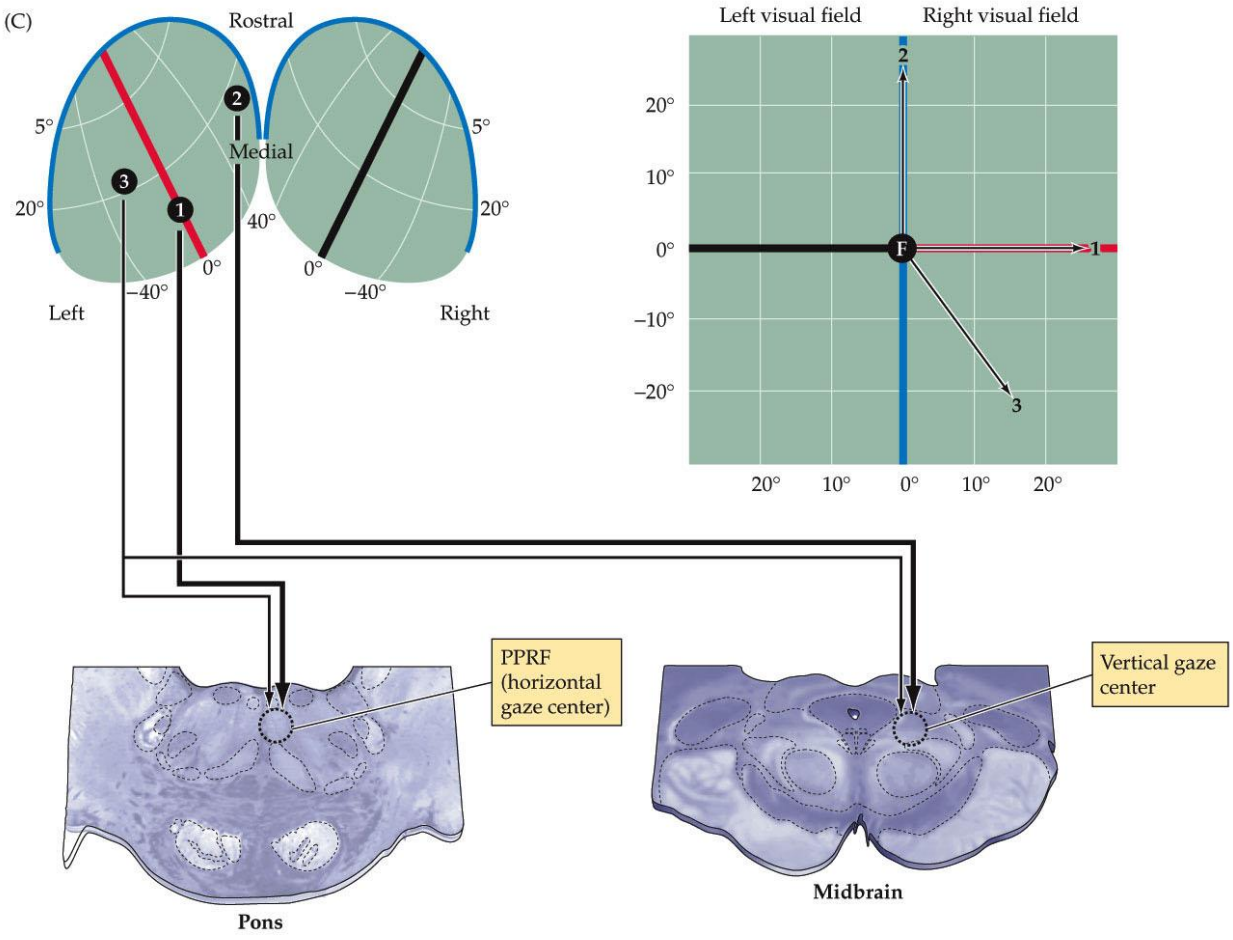




red line: stimulation leads to horiz movement
1: up and right, 4: down and left

Electric stimulation of point 8 gives eye movement to the left
Light stimulation of position 0°/30 ° yield activation of recording electrode on point 8

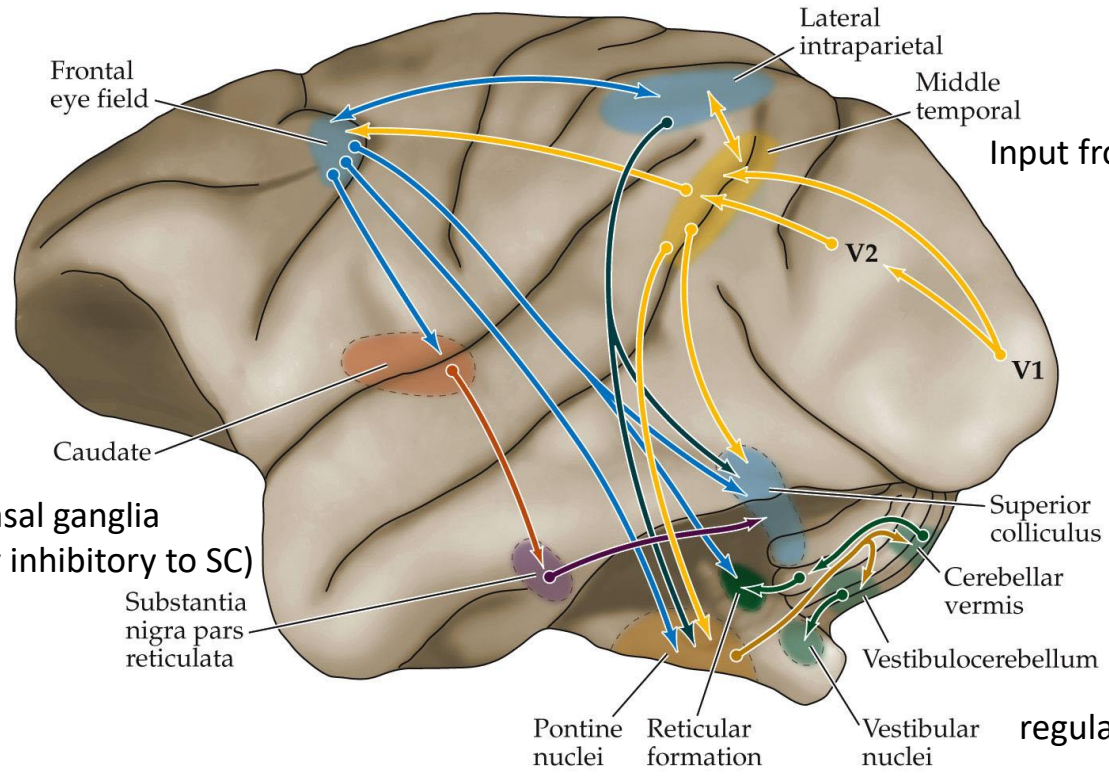
Projections from the deep layers of the Superior Colliculus to the Gaze Centers Initiate Appropriate Eye Movements



voluntary movement:
information from PFC

…. and you thought this was complicated?

Frontal eye field is part of premotor cortex
gets direct input from SC



Input from dorsal visual stream

Fine control from basal ganglia
(mostly inhibitory to SC)

regulatory feedback with cerebellum
via SC, pontine nuclei
and vestibular nuclei

cerebellum: check if movements are done right. the developing brain has to practice the movements

PD: not a perfect eye movement control like healthy people