

Physiology of vision_4

Neurophysiology

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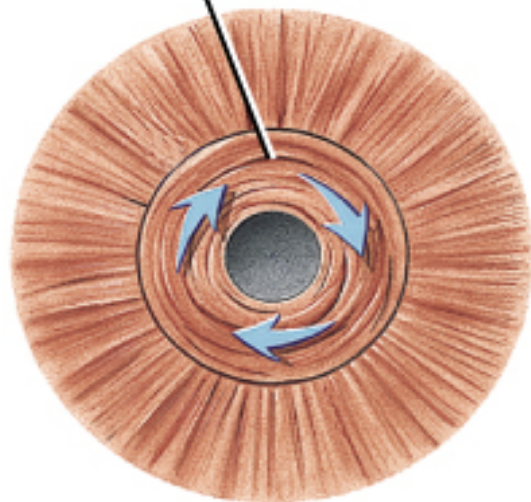
2017/2018

Pupil reflexes and accomodation



IL TARSIVUS (nocturnal primate)

Circular muscles contract



Bright light

Pupil



Normal light

Radial muscles contract



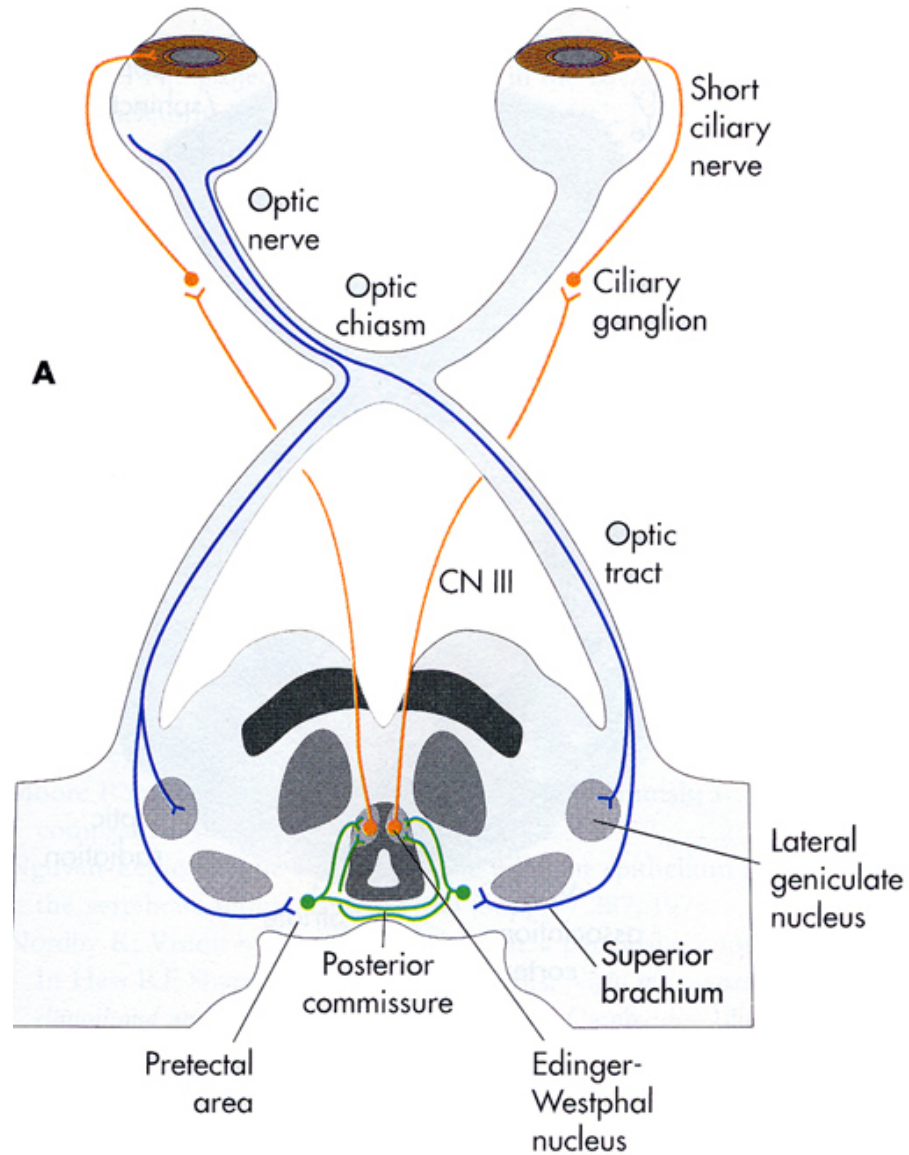
Dim light

Anterior views

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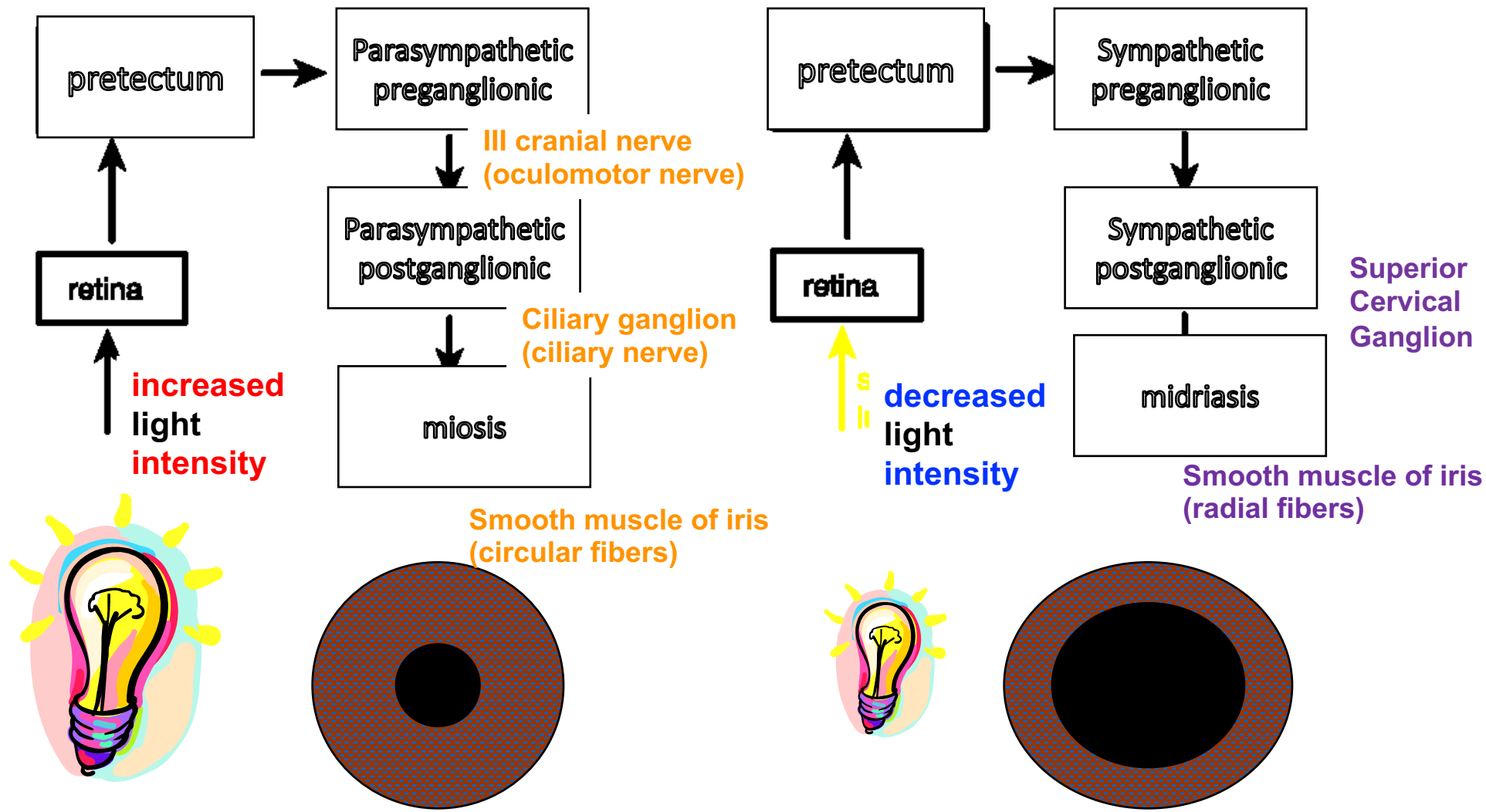
Smooth muscle

Pretectum (midbrain)



Pretectum and hypothalamus receive from specific GCs with melanopsin as photopigment

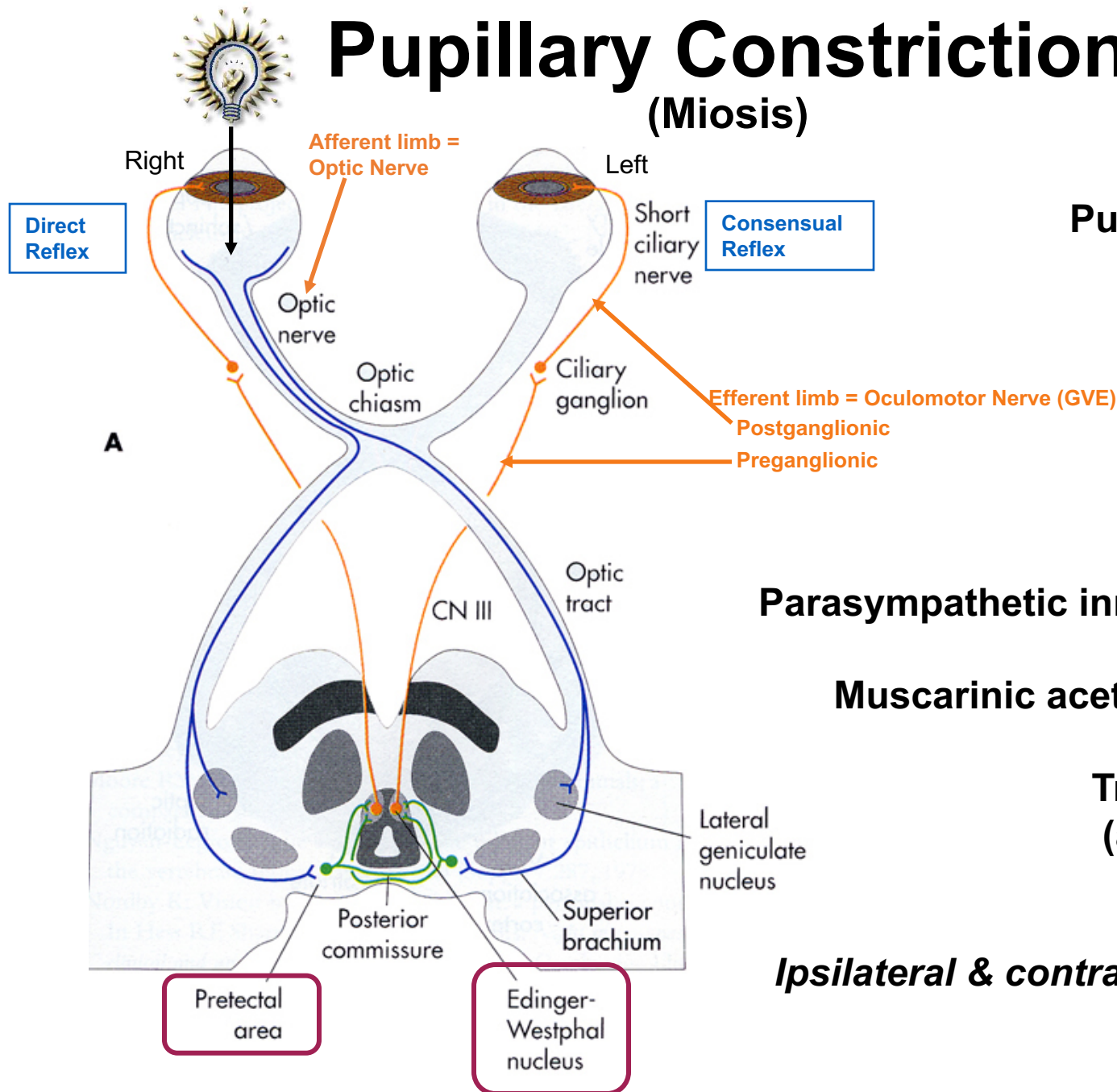
Response to luminance changes (not to luminance contrast)



Photic reflex - direct - consensual

Pupillary Constriction (Miosis)

Pupillary Light Reflex



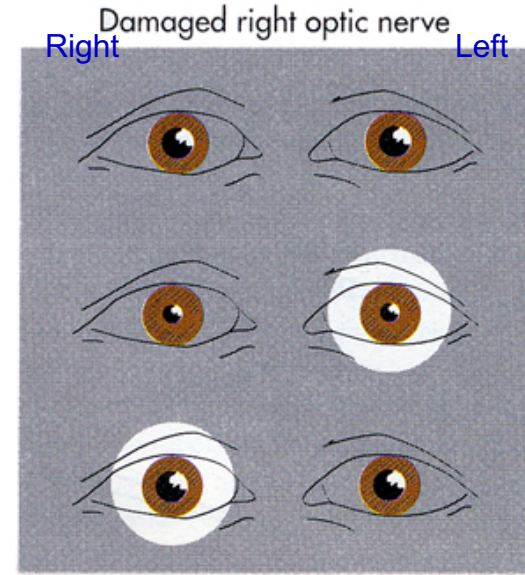
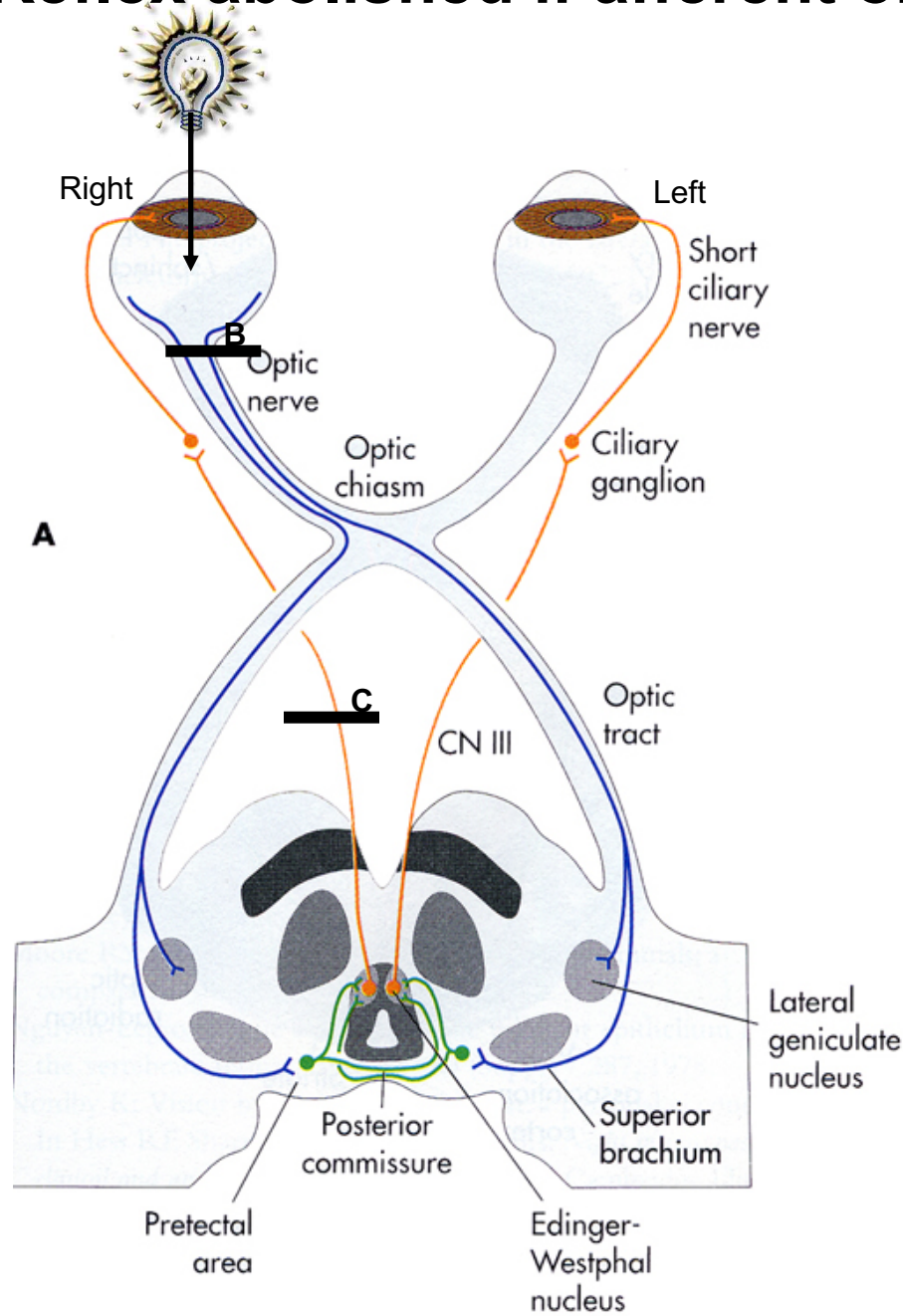
Parasympathetic innervation of the eye

Muscarinic acetylcholine receptors

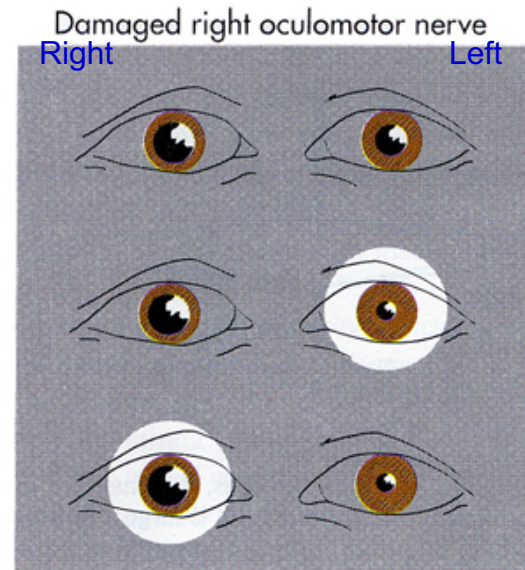
Trigger constriction
(antagonist: atropin)

Ipsilateral & contralateral efferent limb

Reflex abolished if afferent or efferent is damaged.



Afferent
defect



Efferent
defect

Pupillary Dilation (Mydriasis)

Decreased light to pupil

Severe pain
Strong emotional stimulus

Cortex,
Thalamus &
Hippocampus

Hypothalamus
(CNS control center
for ANS)

Reticular
Formation

Reticulospinal
fibers

Dilation of pupil
(dilator iris)

(post-ganglionic
sympathetic)

Superior
Cervical
Ganglion

(pre-ganglionic
sympathetic)

Preganglionic
**Sympathetic
Neurons** in
Thoracic Cord
(T1-T2)

Sympathetic innervation of the eye

Horner's Syndrome

- Pupillary Constriction
- Ptosis
- Flushed & Dry Skin

- Loss of Sympathetics
- Lesion can be in **CNS** or **PNS**
- Deficits ipsilateral to lesion

Miosis

Parasympathomimetics

Cholinergics

Nicotine

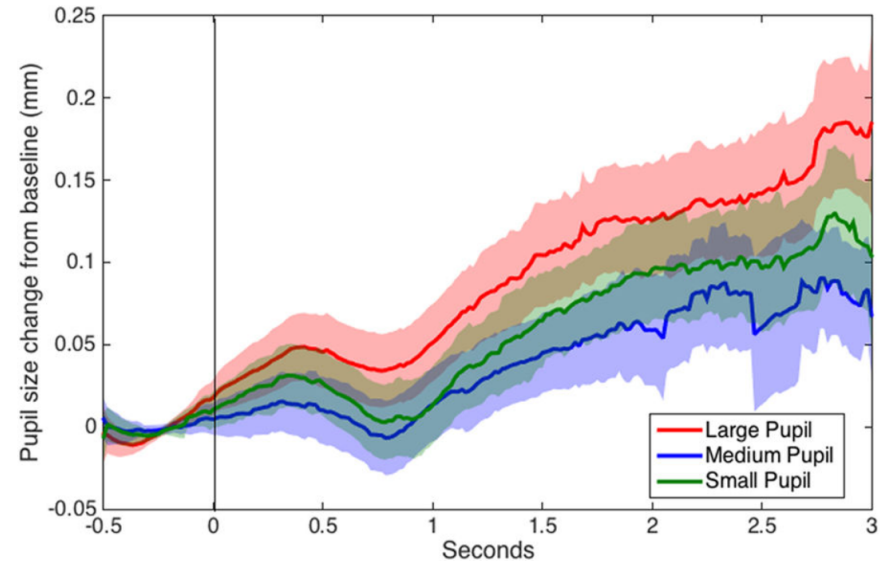
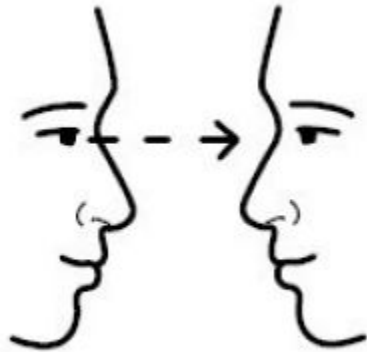
Mydriasis

Anticholinergics

Opiates

Sympathomimetics

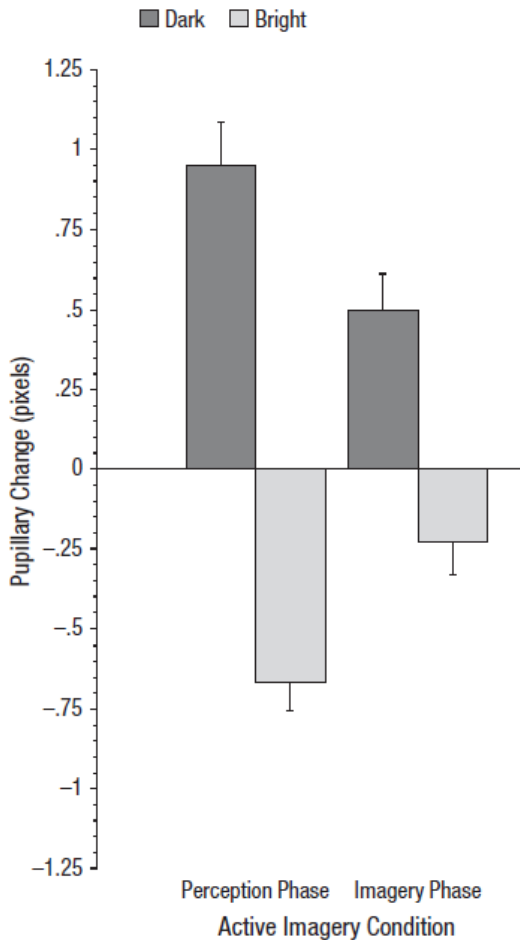
Pupil size in psychophysiology



Fawcett et al 2017

Pupil size is contagious...

Pupil size in psychophysiology



Pupil size is modulated by imagery

Accommodation (or “Near”) Reflex

1. Initiated by shift in gaze from far to near.

2. Three components:

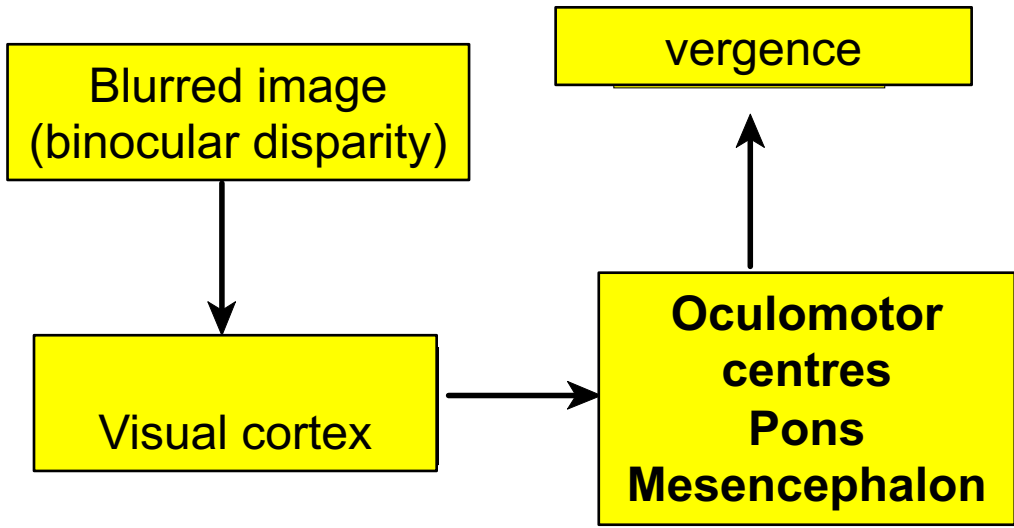
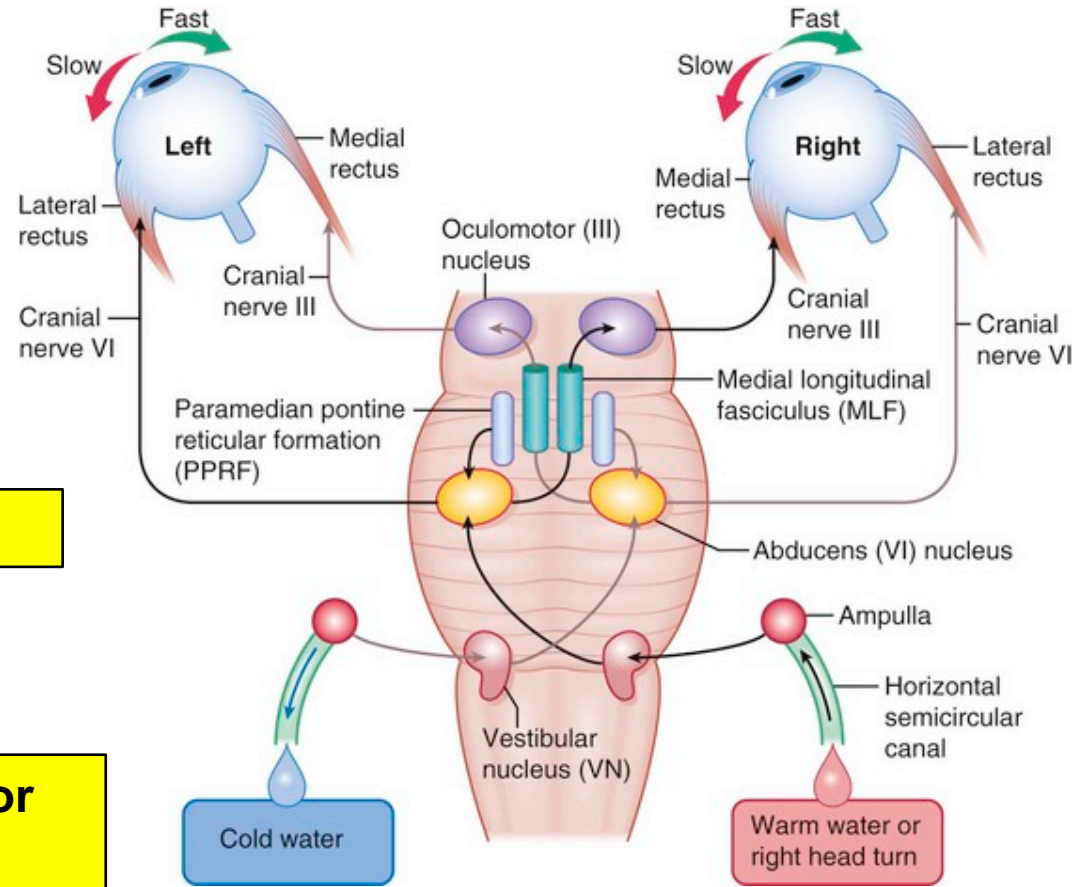
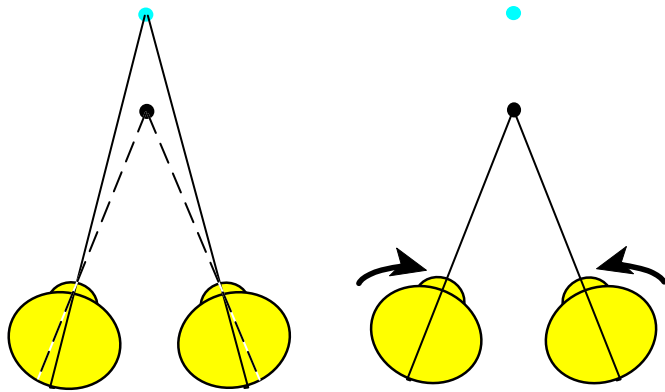
Ocular convergence
Pupillary constriction
Lens thickening (*ciliary nerve*)

3. Efferent limb: Oculomotor

4. Afferent limb & Central Connections:

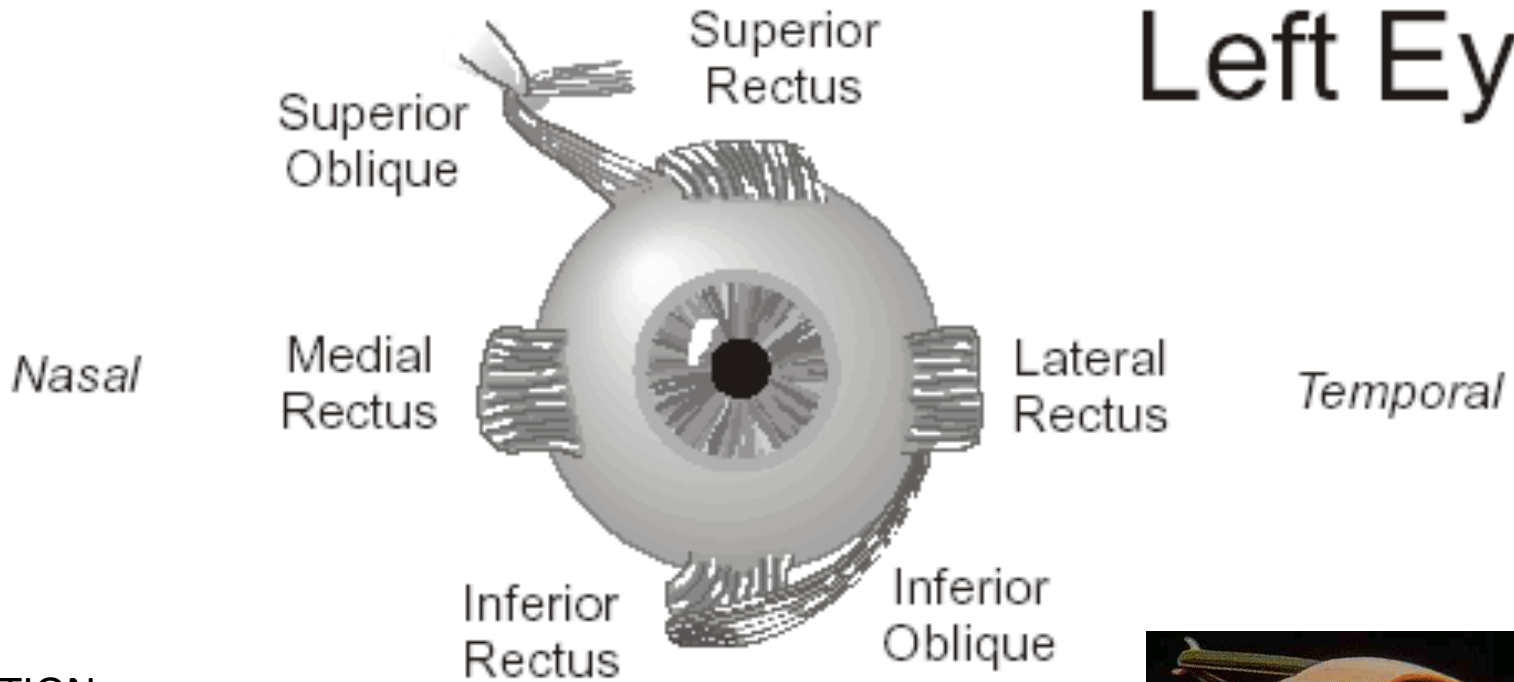
Optic nerve ⇒ Optic tract ⇒ Lateral Geniculate Nucleus ⇒ Optic Radiation
⇒ Primary Visual Cortex ⇒ Association Visual Cortex ⇒ Optic Radiation ⇒
Br. of Superior Colliculus ⇒ Superior Colliculus ⇒ Oculomotor Nuclei ⇒
Oculomotor Nerve

Ocular convergence



The mobile eye

Left Eye



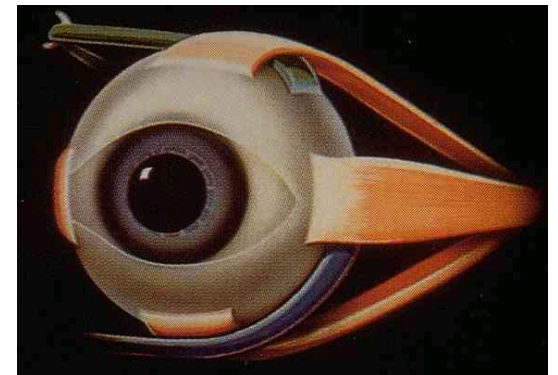
ADDUCTION → nose

ABDUCTION ← nose

VERTICAL M

TORSIONS

Extraocular muscles (skeletal)



The mobile eye

Some half billion years ago, the mobile eye compensated an annoying by-product of a moving organism: it reduced the blur caused by retinal slip.

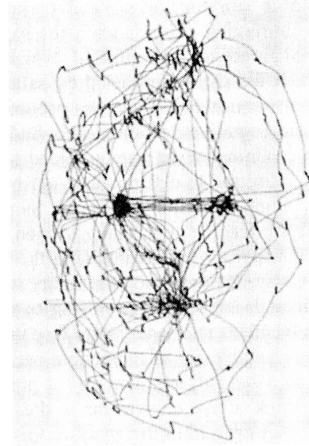
This *stabilization* function is accomplished by the **VOR**
Stabilization of the image on the retina.



The mobile eye

Visual exploration of the world is mediated by rapid shifts of the gaze (on average 2-5 per second) that direct the high-acuity foveal region to certain parts of the visual field. This *exploration* (or *visual search*) function is accomplished by **saccades**.

Saccades maximize **fixation** time.



Secondo il sondaggio di Repubblica.it il progetto di un terzo polo proposto da Casini pescherebbe il 22% dei voti dall'Unione e il 27% dalla Cdi di MARCO BRACCIONI
TABELLE: ELETTORI DEL GRANDE CENTRO / LEADER

Quando l'Europa è senza frontiere vent'anni in giro con Erasmus
L'INCHIESTA. Il programma per gli universitari ha già portato in giro per la Ue oltre un milione e mezzo di studenti, fino a ispirare film e racconti. Oggi il via alle celebrazioni di F. PACE / **LA MAPPA NELLA UE**
LE STORIE: "Io, per caso nello studio di Napolitano"

Epifani e Angeletti contestati a Mirafiori "Guiglielmo, non è la nostra Finanziaria"
Per i leader di Cgil e Uil assemblea difficile nello storico stabilimento Fiat. Gli operai contestano una scelta che considerano arrendevole nei confronti del governo. **Abbiamo scoperto con Berlusconi facciamolo pure ora"**

Pil, l'istat conferma le stime "L'Italia cresce almeno dell'1,7%"
Per l'Istituto di statistica il prodotto interno lordo italiano nel terzo trimestre è cresciuto dello 0,3%

FOTOGRAFIA BELLA SPECIALE SULLA KERMESSA

SPY CALCIO
I numeri dei tifosi Juve sempre prima ma in calo di F. BIANCHI

CELEBRITA'
Lollobrigida, nozze annullate "Ho rotto con Javier Rigau per colpa della stampa"

STAR CONTROL
Si sciolgono le feste di "Fruccia al Paratutto" Britney, i discorsi finali

TROVACINEMA
Le uscite della settimana Cartoon, horror, commedia e il ritorno di "Ecce Bombo"

REPUBBLICA TV
Littizzetto e Fiorello che si spartolano

ARBITRI DELLA GIORNATA
Gerusalemme
— M. O. : OLME
RAPPORTO BAF
VEDO DIVERS.

METEO
Scegli la città

BORSA
Mib 30 +0,28
Midex +0,10
Cerca il titolo

OROSCOPO
Scegli il segno

RSS

Types of eye movements

Gaze-holding reflexes

VOR

OKR

Gaze-shifting movements

Saccades

Smooth pursuit eye movements

Vergence

Plus:

Fixational eye movements (microsaccades, tremor, drift)

N.B. Gaze direction depends on the combined action of eye and head movements!

1) Saccades Voluntary and involuntary, fast e ballistic with change of the fixation point

2) Smooth pursuit Slower movements to keep a moving stimulus on the fovea – under voluntary control – only for moving stimuli

3) Convergence Maintains the visual axes on the point of fixation when it moves near or far - only not consensual

4) Vestibular Reflex (VOR) When the head rotates, eyes rotate in the opposite direction to stabilize the focus on the retina (visual stimulus is not needed).

5) Optokinetic reflex (OKR) VOR does not work well for long and persistent movements. OKR is activated when images slip on a large retinal portion and produces the perception of movement.

Miniature eye movements

- Micro-saccades (<0.4 deg)
- Tremor (30-100 Hz)
- Drift (<0.1 deg/s)

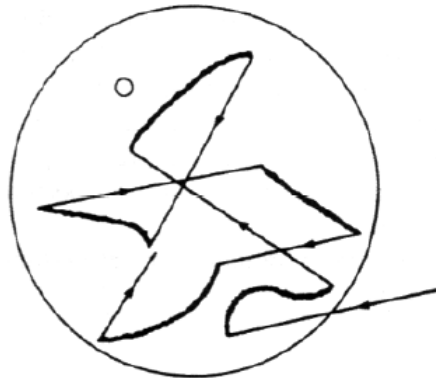
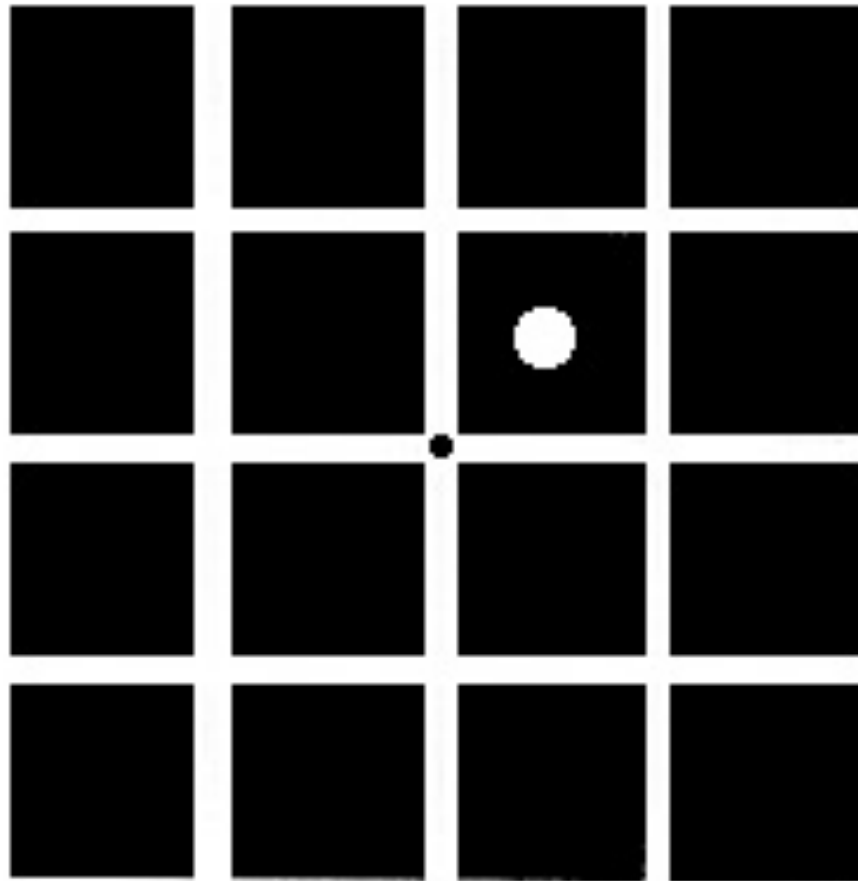


Fig. 6.8 Movimenti oculari in miniatura durante le fissazioni. Cerchio piccolo: distanza fra due coni nella fovea. Il cerchio grande ha un diametro di 0.17° (fonte: Pritchard, 1964)

Miniature eye movements



Saccades

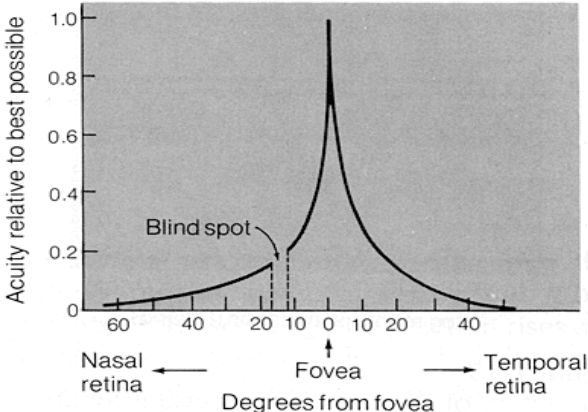
Two functions:



Two functions:

Foveating

Orienting

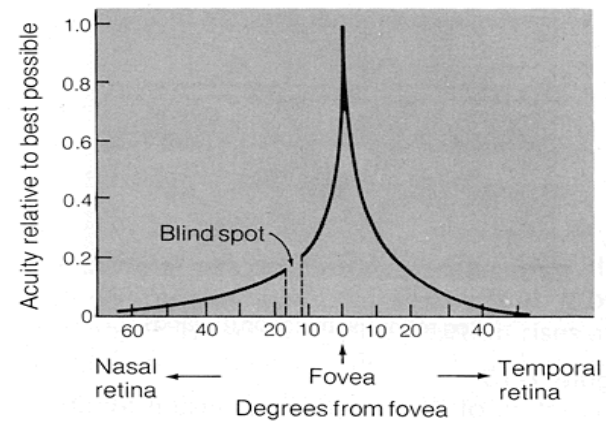
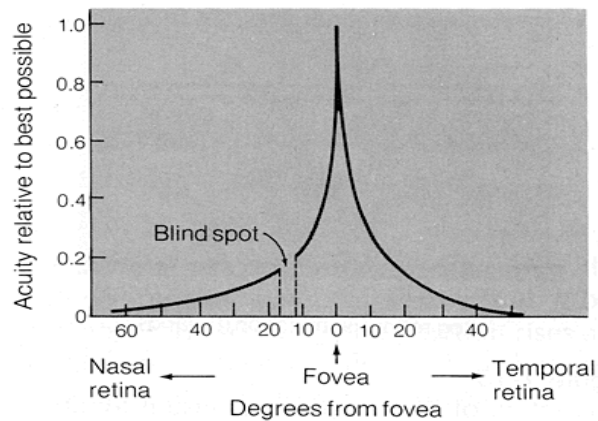




Two functions:

Foveating

Orienting

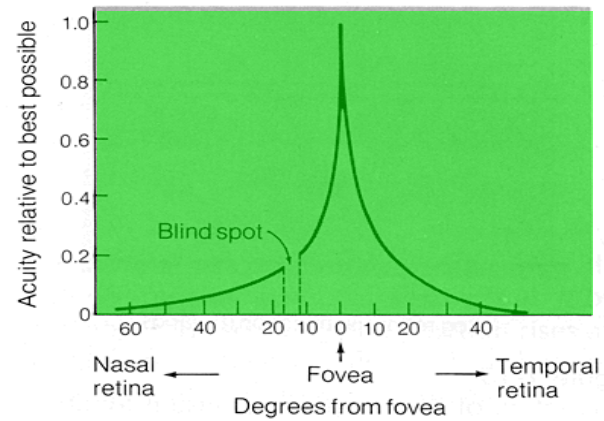
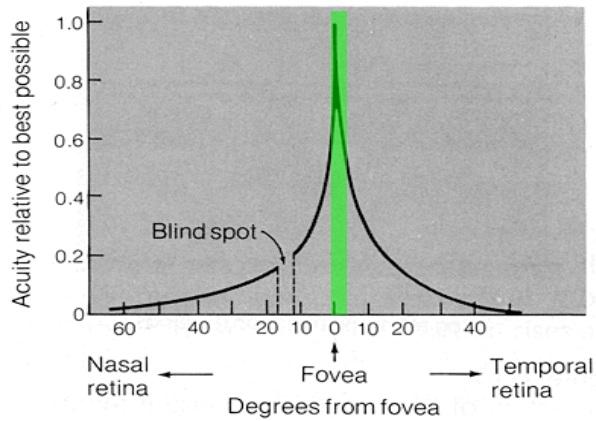




Two functions:

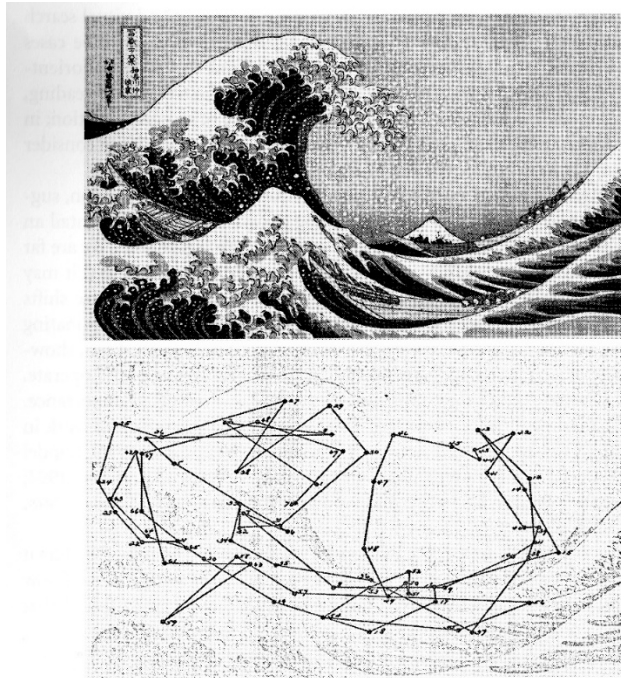
Foveating

Orienting



Saccades

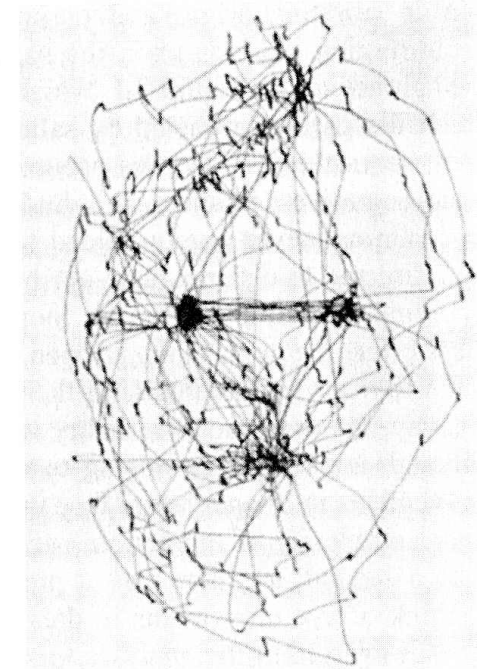
We scan the visual world with sequences of alternating saccades and fixations



Buswell, 1935



Yarbus, 1967



Saccades

We scan the visual world with sequences of alternating saccades and fixations

Motor unit recruitment in the biceps brachii of older adults during a fatiguing contraction

Integrative Physiology

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Department of Integrative Physiology, University of Colorado, Boulder, USA

859.14

Introduction

The decline in the force capacity of motor units during a fatiguing contraction is accompanied by a progressive increase in the duty to the motor axon pool (Bigland-Ritchie et al., 1985) that results in a smaller motor unit size and a greater decrease in discharge rate of some motor units (Fadiga et al., 1989) or the cessation of discharge in others (Capozzini et al., 2003).

The discharge characteristics of newly recruited motor units can vary during a fatiguing contraction (Doherty and Clonus, 1989). For example, Riley et al. (2010) found that the discharge characteristics of a newly recruited motor unit in the biceps brachii were influenced by the difference between the target force and recruitment threshold of the motor unit. The difference was attributed to the synaptic input received by the motor axon pool (Riley et al., 2007).

Purpose

To compare the discharge characteristics of motor units in the biceps brachii that were recruited during matched submaximal contractions performed by young and old adults.

1. Experimental setup

2. Sample ramp contraction

3. Sample sustained contractions, large and small difference

4. Motor unit and task characteristics

	Small DM (n = 13)	Large DM (n = 22)	P-value
EMG RT (% MVC)	20.7 ± 7.43	21.7 ± 6.07	n.s.
Force RT (% MVC)	19.8 ± 9.08	18.8 ± 6.09	n.s.
Target force (% MVC)	54 ± 2.7	53.9 ± 2.9	0.99
Recruitment force (% MVC)	6.8 ± 4.96	5.2 ± 3.78	0.029
Task duration (s)	252 ± 173	306 ± 106	n.s.
Task recruitment (%)	75 ± 17.4	62 ± 8.02	n.s.

5. Time to recruitment for sustained contractions

6. Discharge characteristics at recruitment

7. Discharge characteristics across contraction time

Summary

In contrast to young adults, discharge characteristics of recruitment for old adults were similar for both small and large differences between target force and recruitment threshold.

The old adults exhibited no recruitment discharge pattern.

These data suggest that the adaptation of synaptic input during sustained contractions differs for young and old adults.

References

Bigland-Ritchie, P., Stulen, F., and Knaflitz, M. (1985). The effect of fatigue on the recruitment of motor units in the biceps brachii muscle of man. *Journal of Neurophysiology*, 53, 100-110.

Capozzini, M., and Clonus, R. (2003). The effect of fatigue on the recruitment of motor units in the biceps brachii muscle of man. *Journal of Neurophysiology*, 89, 100-110.

Doherty, D., and Clonus, R. (1989). The effect of fatigue on the recruitment of motor units in the biceps brachii muscle of man. *Journal of Neurophysiology*, 61, 100-110.

Fadiga, L., Fattori, P., and Petrosini, F. (1989). The effect of fatigue on the recruitment of motor units in the biceps brachii muscle of man. *Journal of Neurophysiology*, 61, 100-110.

Riley, P., and Enoka, R. (2010). The effect of fatigue on the recruitment of motor units in the biceps brachii muscle of man. *Journal of Neurophysiology*, 103, 100-110.

Riley, P., and Enoka, R. (2007). The effect of fatigue on the recruitment of motor units in the biceps brachii muscle of man. *Journal of Neurophysiology*, 97, 100-110.

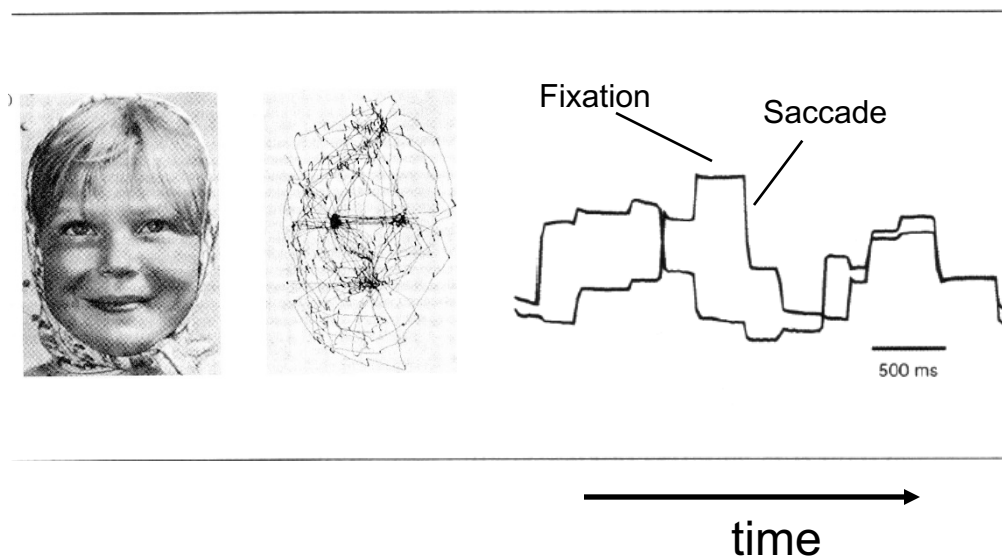
Acknowledgements

The authors thank Dr. John Doherty for providing the data used in this study.

Support by NIAAGP10016 to R.M. Enoka
DOI: 10.1152/jn.00000.2010

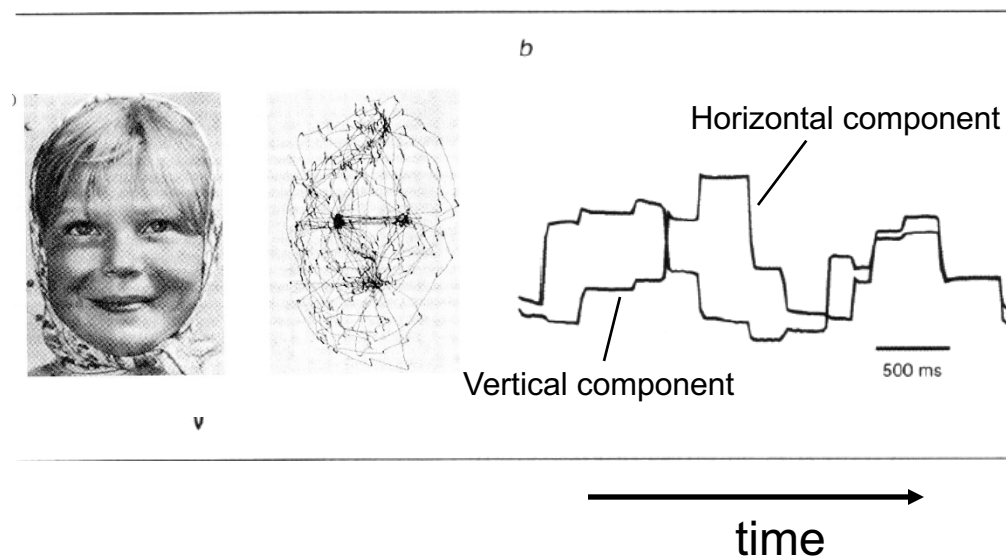
Saccades

We scan the visual world with sequences of alternating saccades and fixations

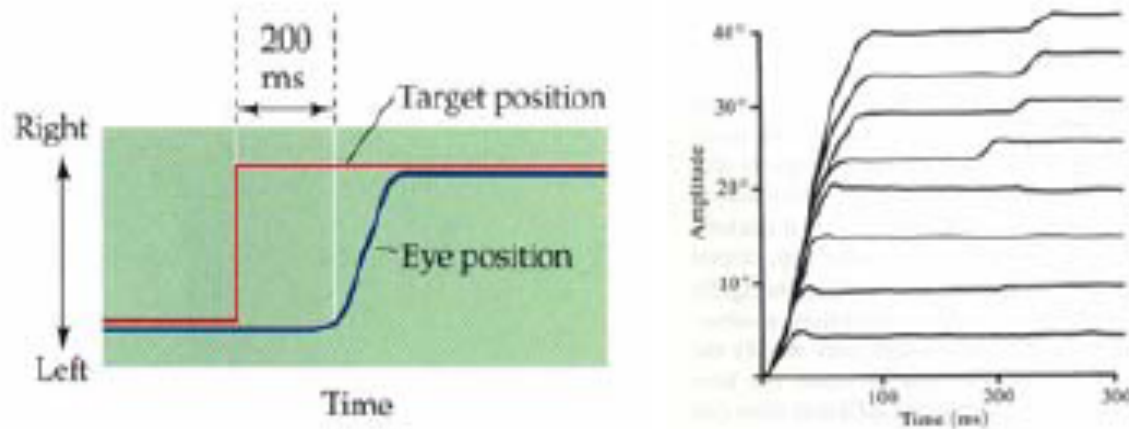


Saccades

We scan the visual world with sequences of alternating saccades and fixations



SACCADES



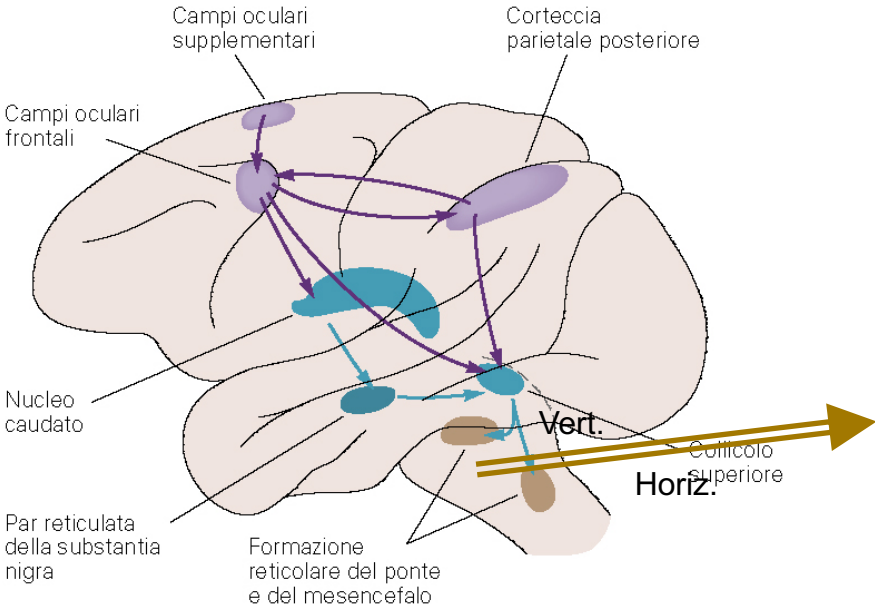
Under the control of 3 areas:

Voluntary saccades – frontal ocular fields (Brodmann's area 8)

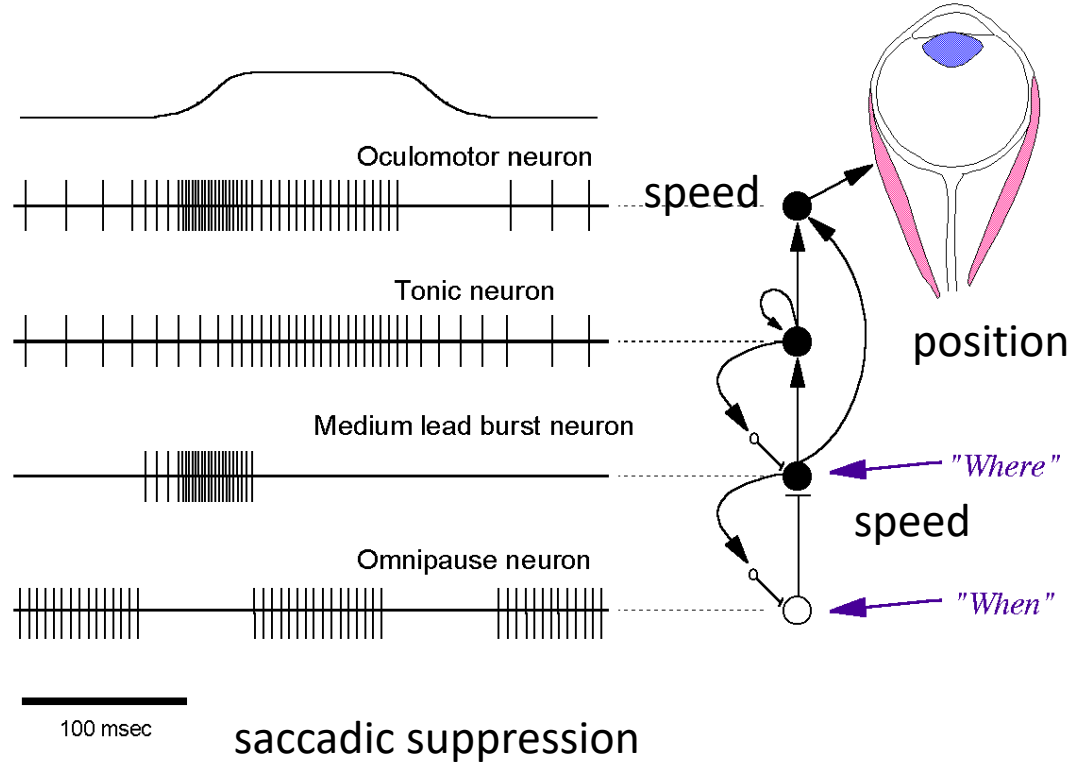
Involuntary saccades to complex stimuli – parietal lobe (Brodmann's area 7)

Involuntary saccades to simple stimuli – superior colliculus

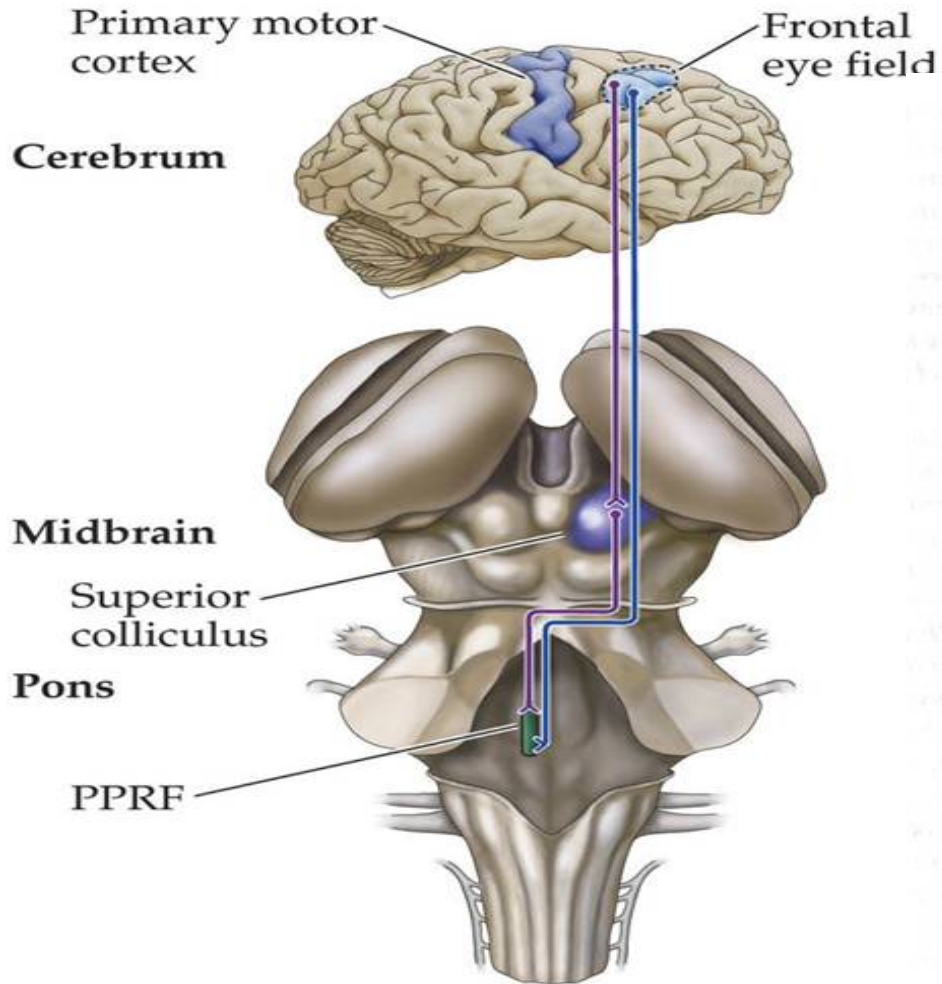
Saccades



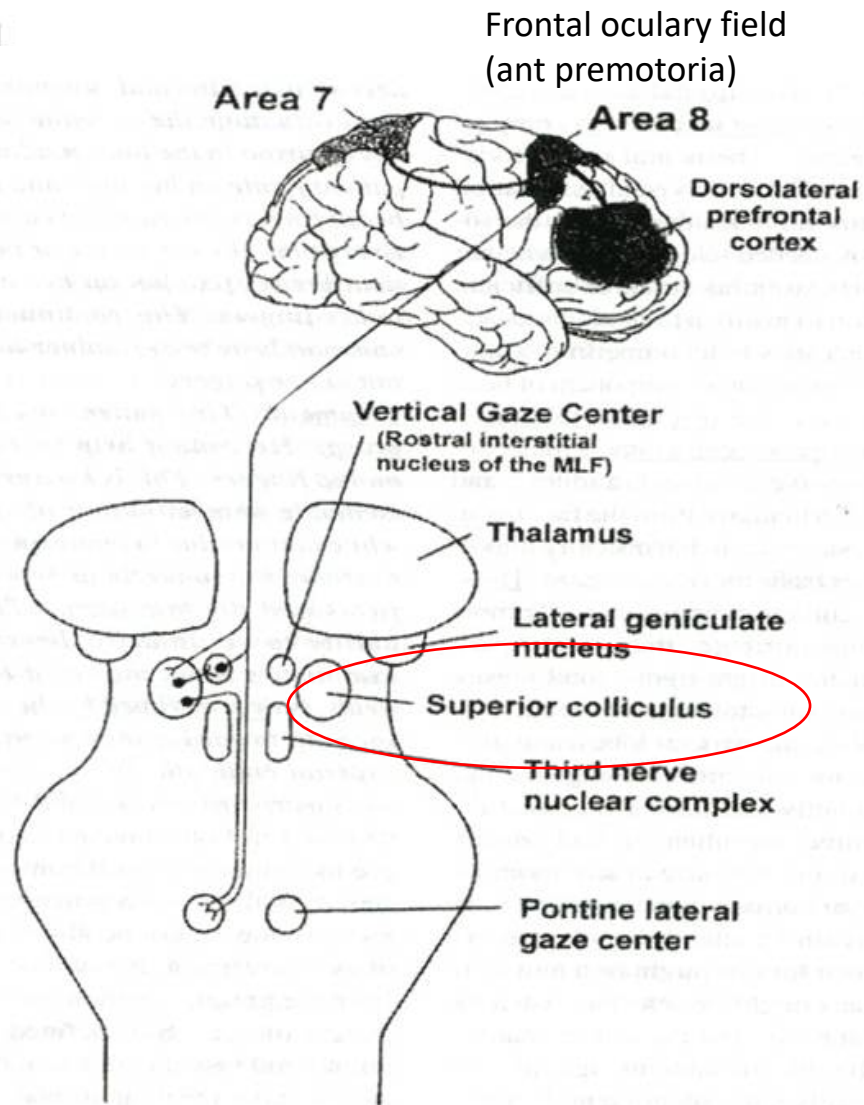
Brainstem Saccade Generator



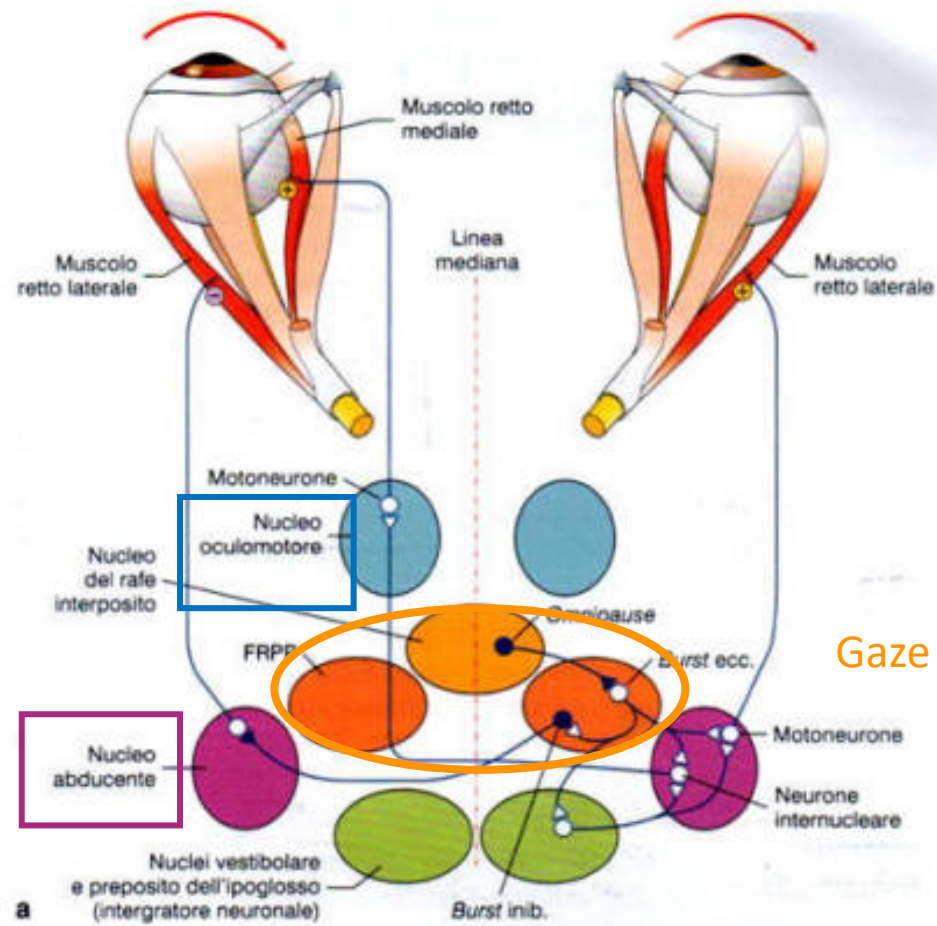
Voluntary saccades



Involuntary saccades

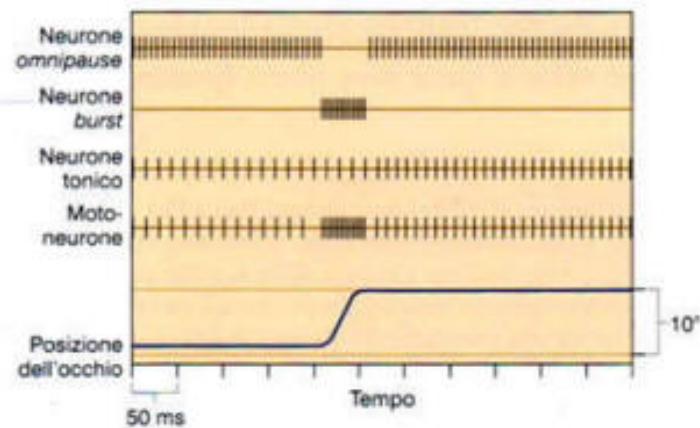


Movement vs contralateral space



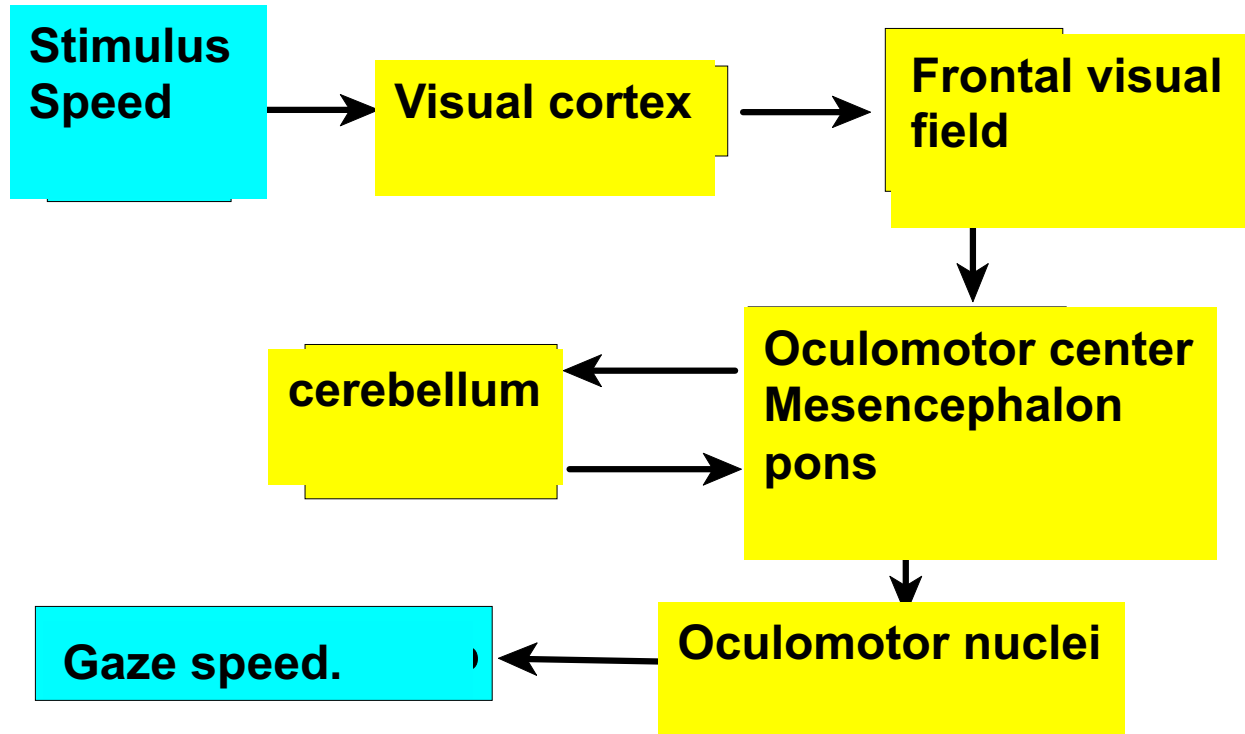
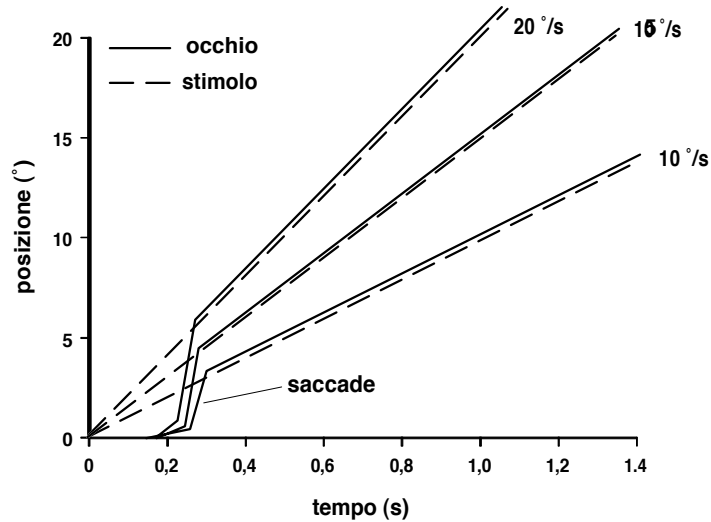
Gaze center- brainstem

a



b

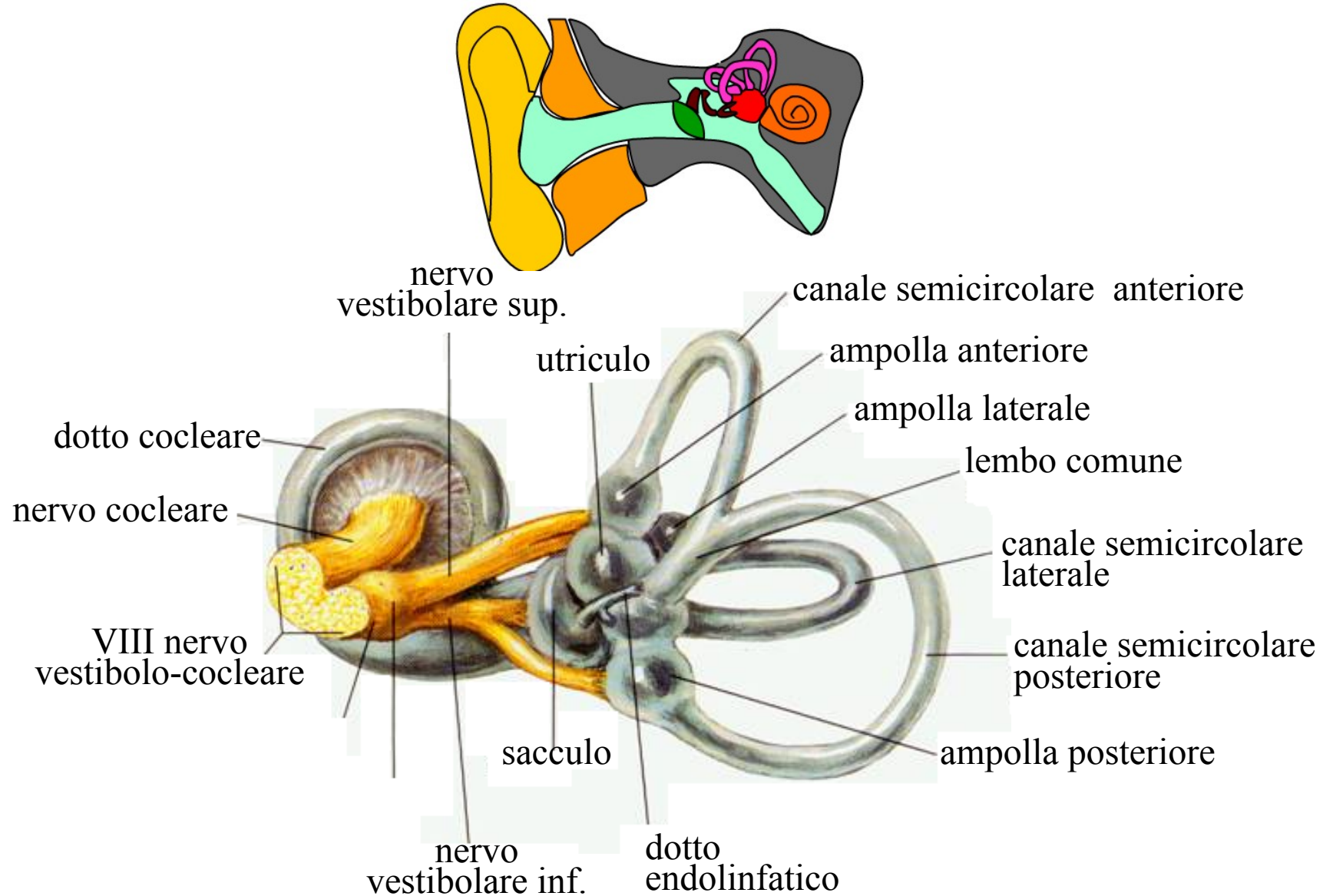
SMOOTH PURSUIT MOVEMENT



No colliculus

VOR

The vestibular system – inner ear



Semicircular canals

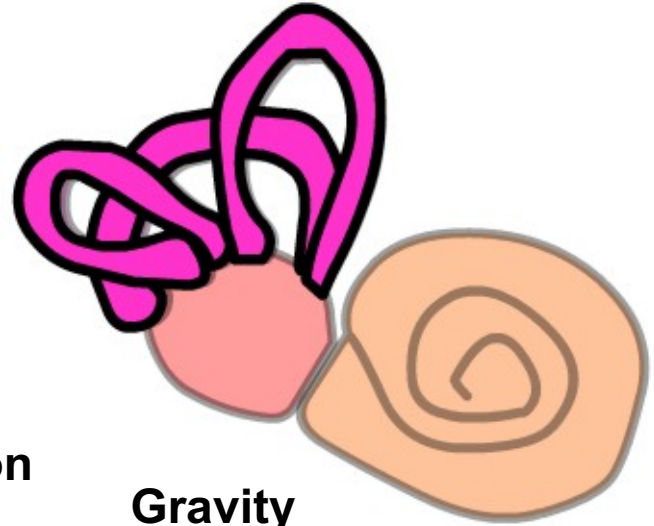
Angular acceleration
(rotational movements)



Otoliths

Linear acceleration

Linear acceleration

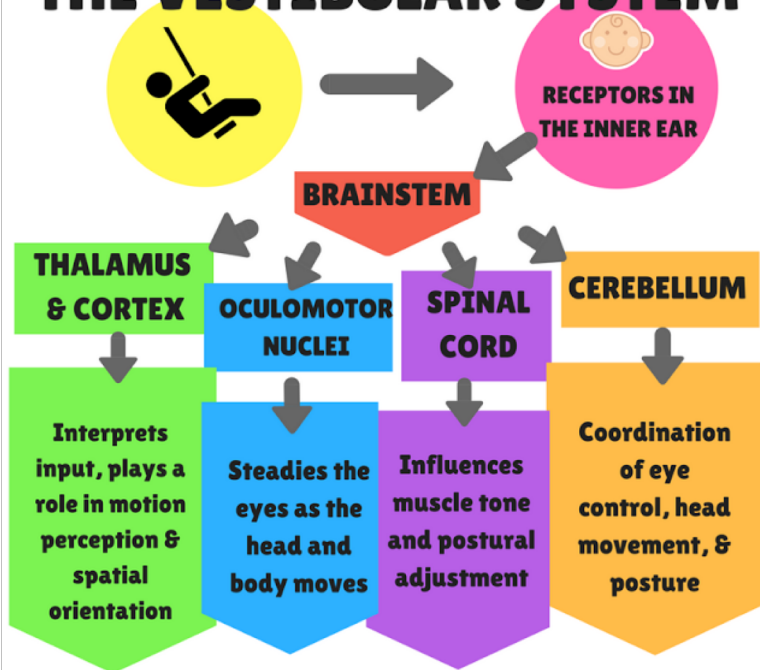


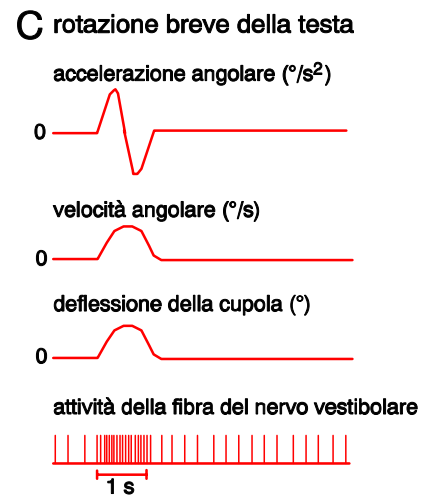
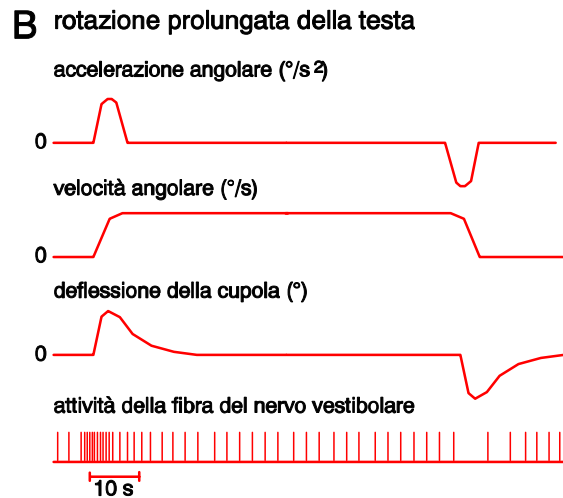
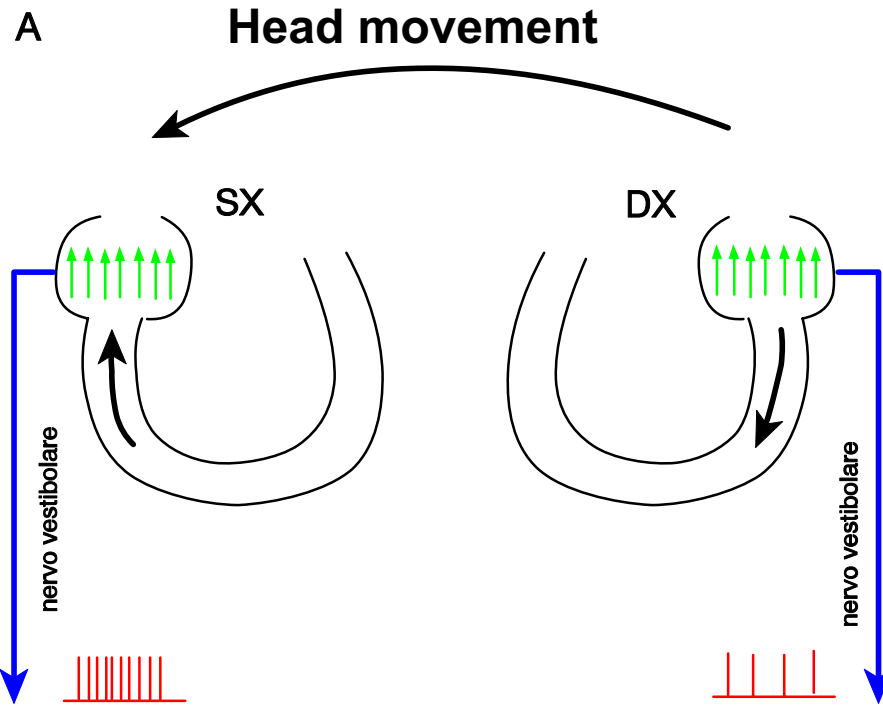
Gravity

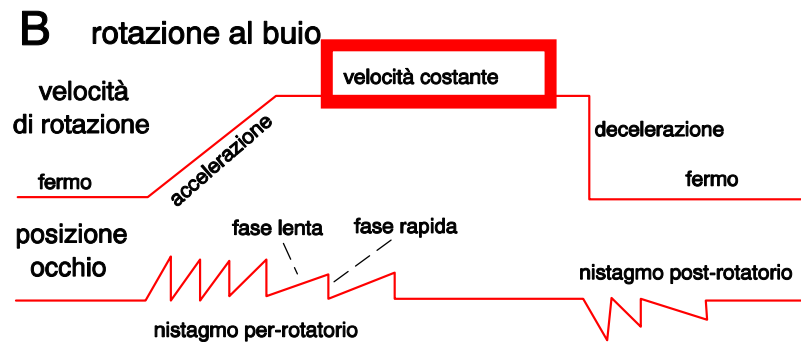
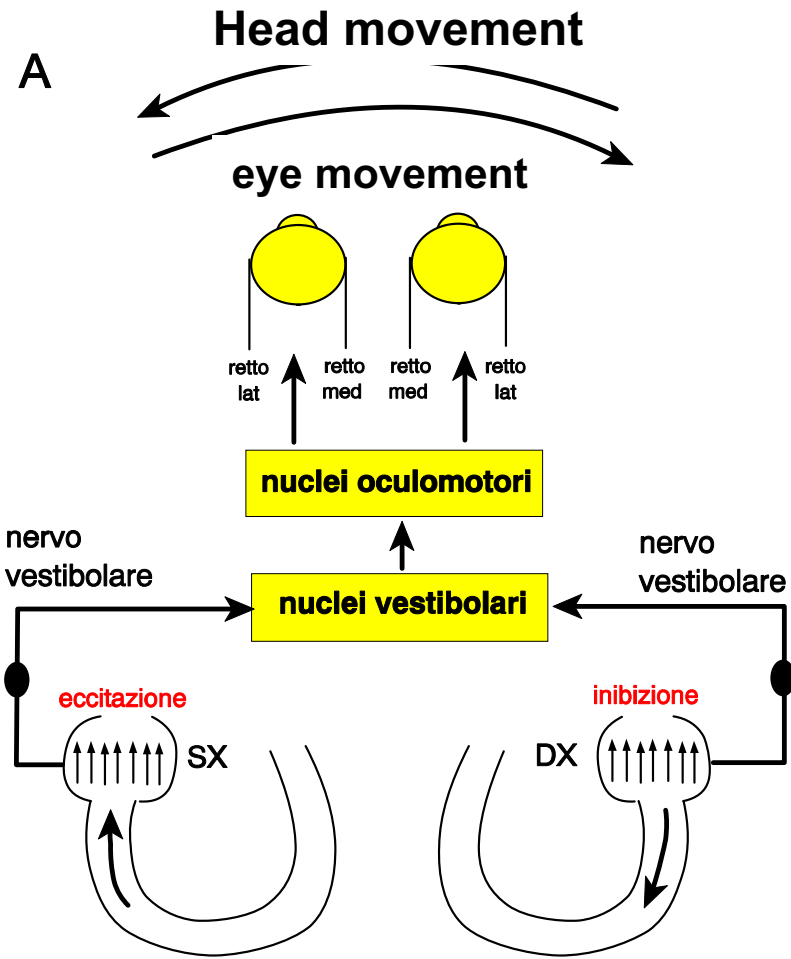




THE VESTIBULAR SYSTEM

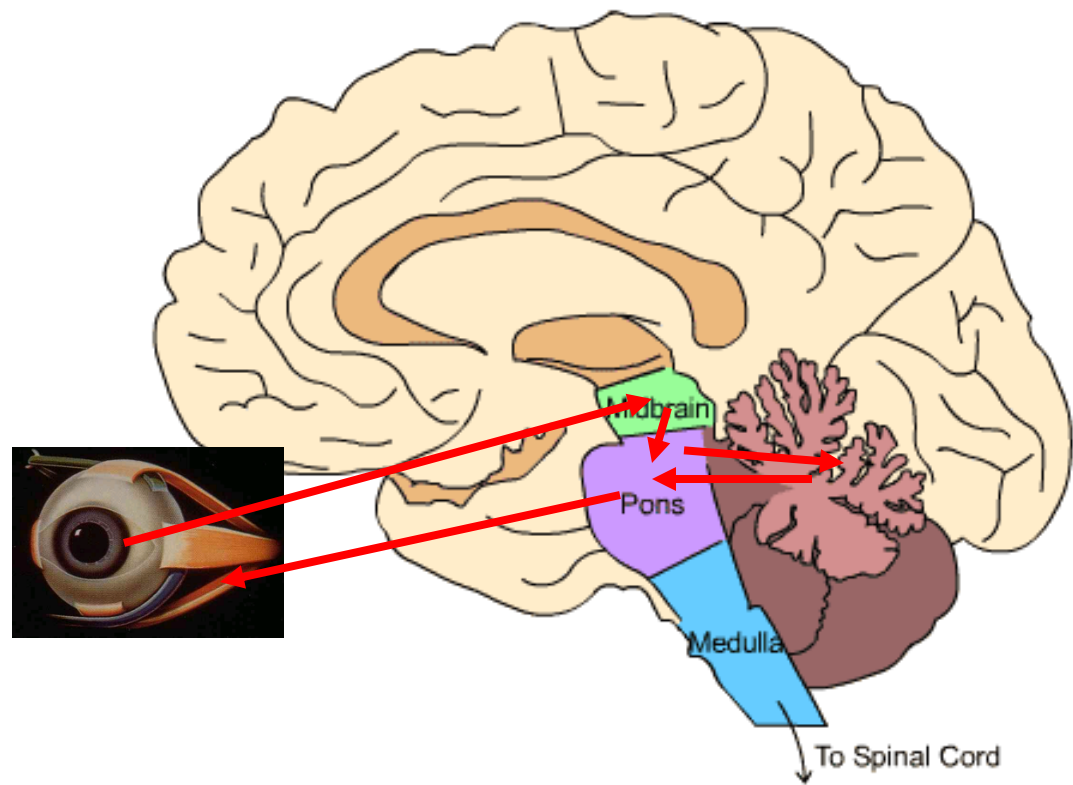
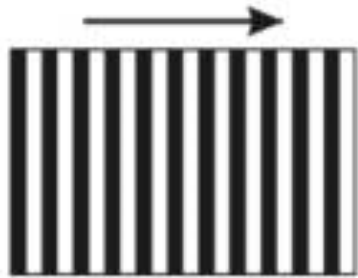




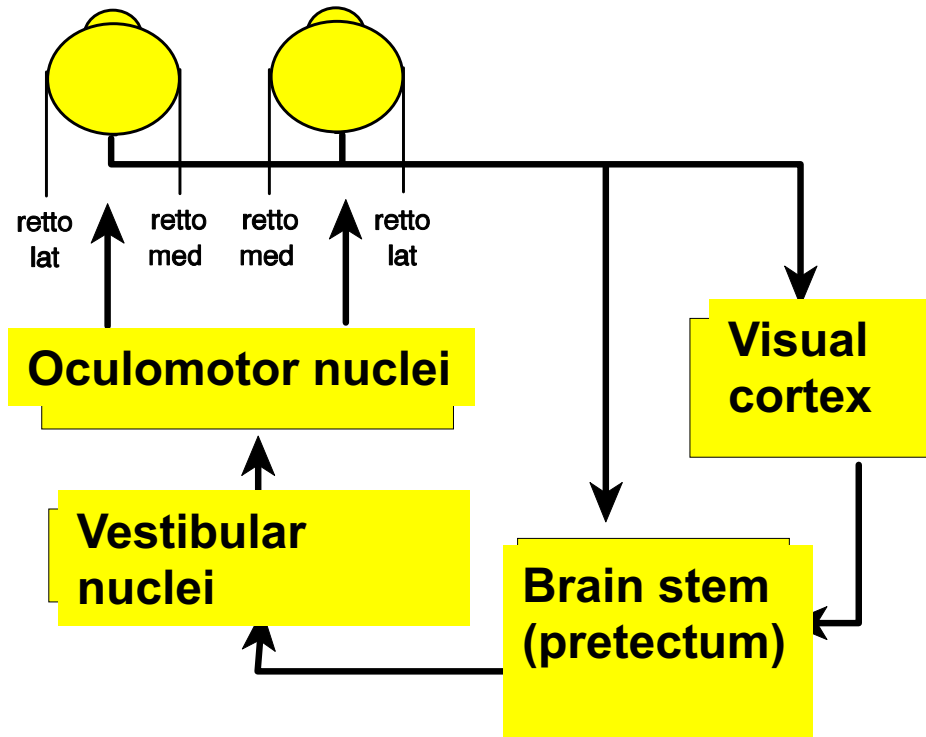
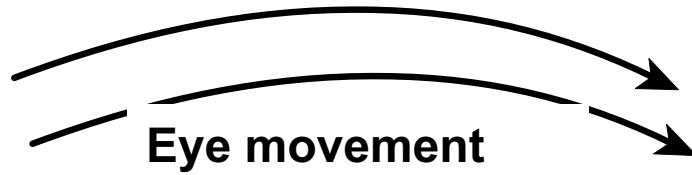


The Optokinetic Reflex

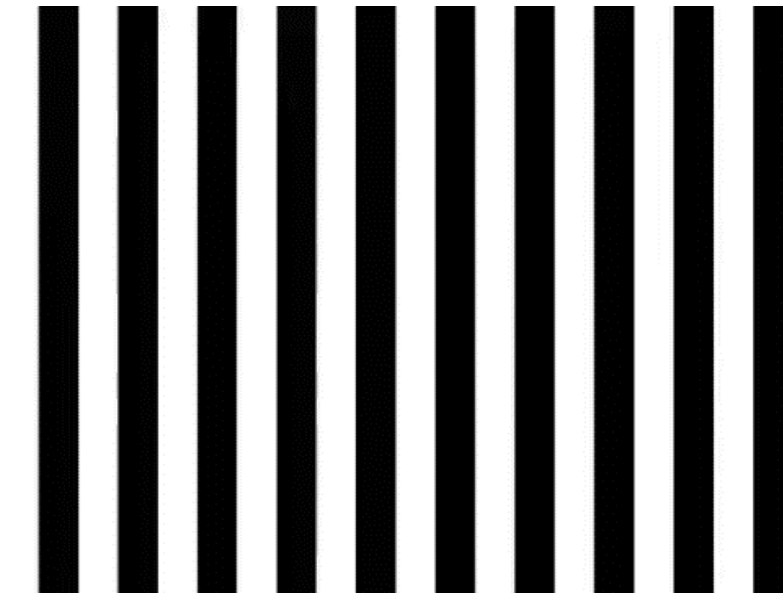
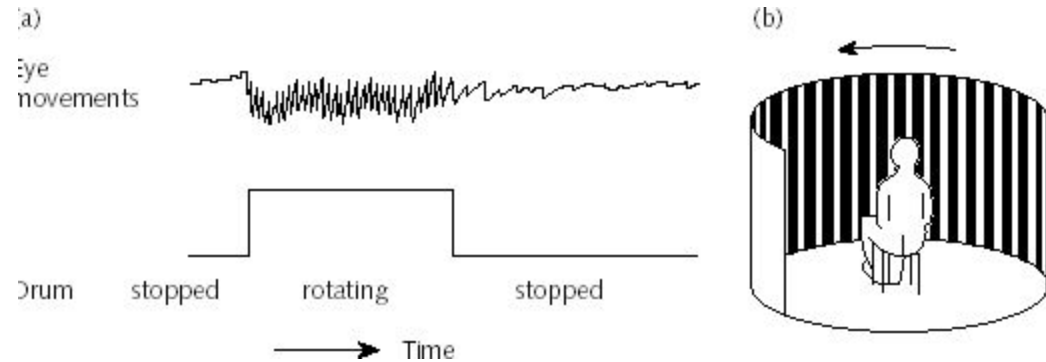
OKR



Movement of the visual scene

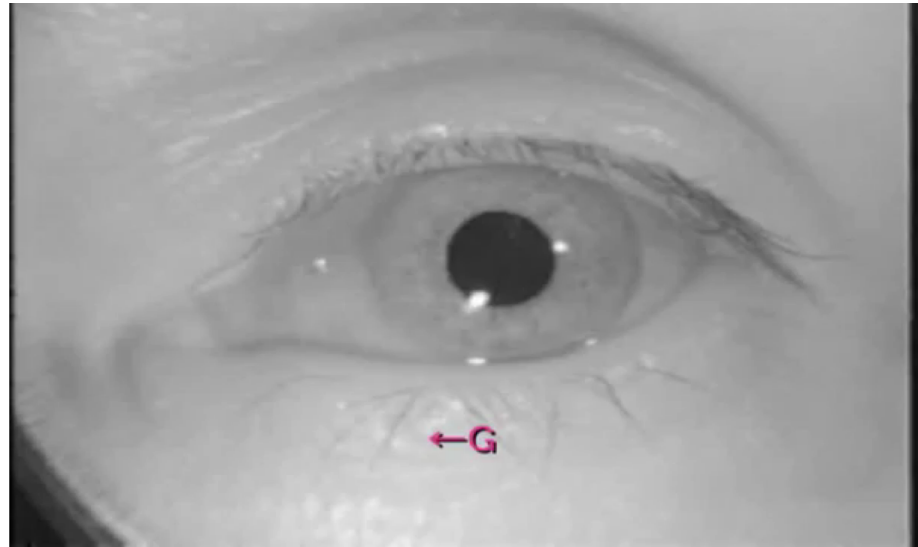


The Optokinetic Reflex

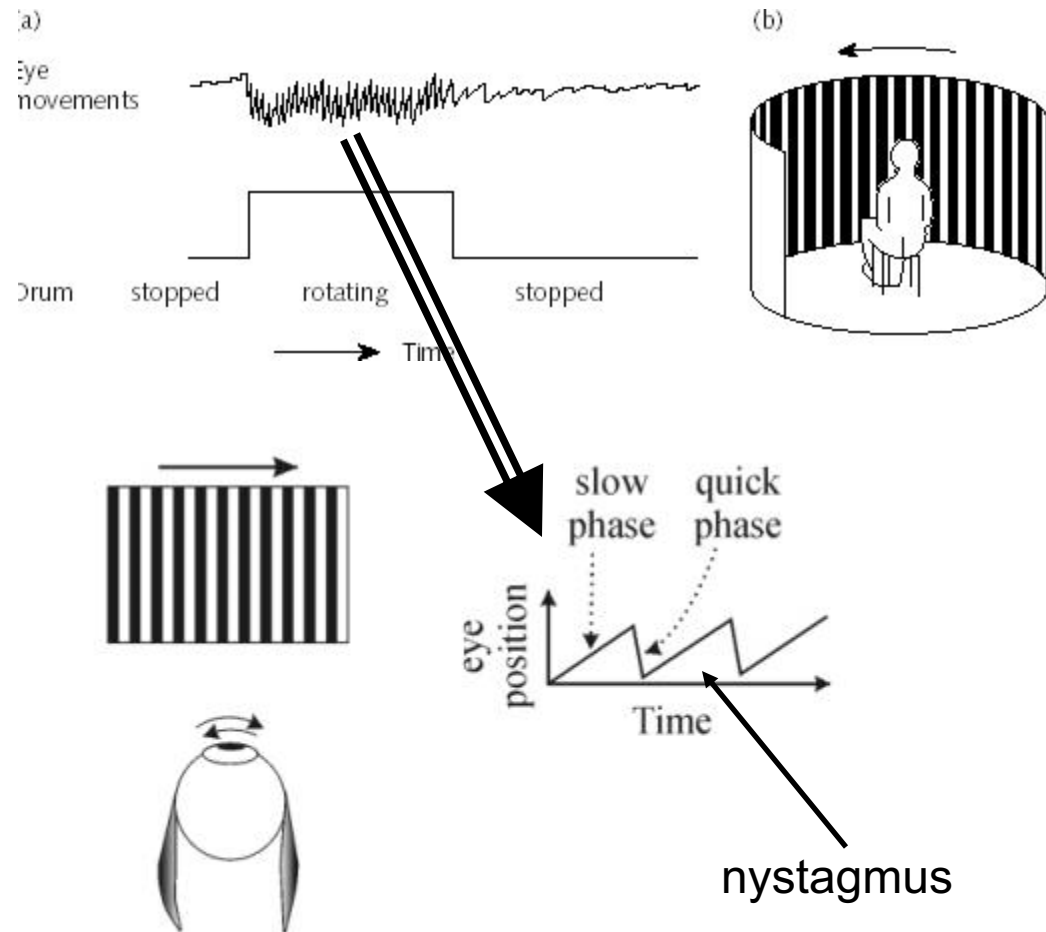


The Optokinetic Reflex

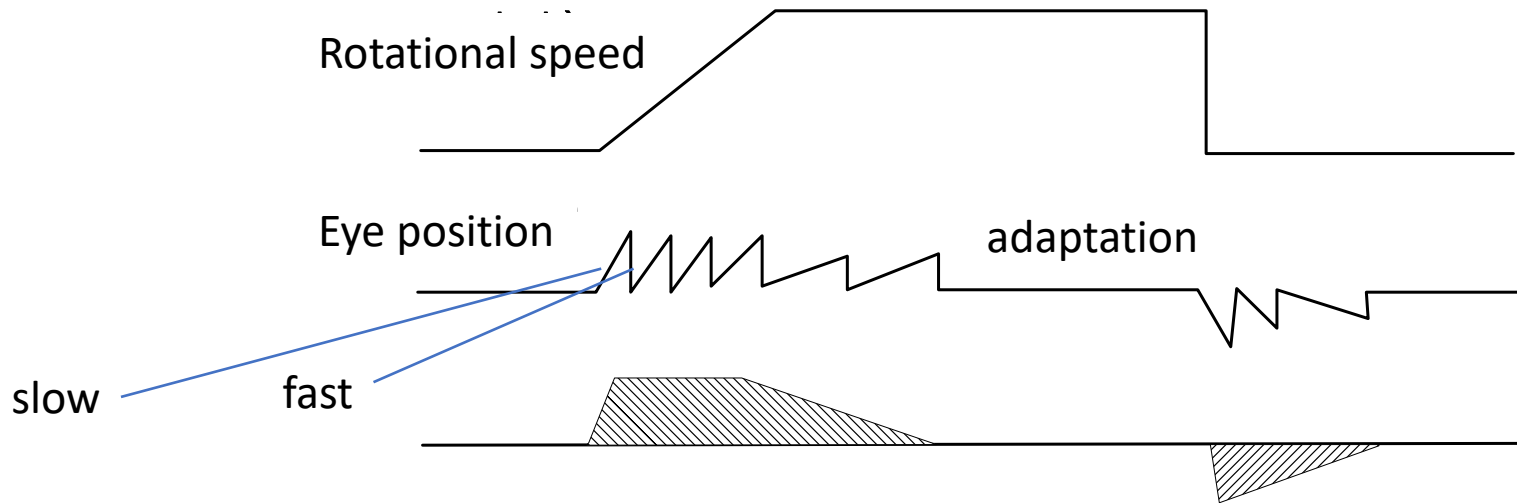
Nystagmus



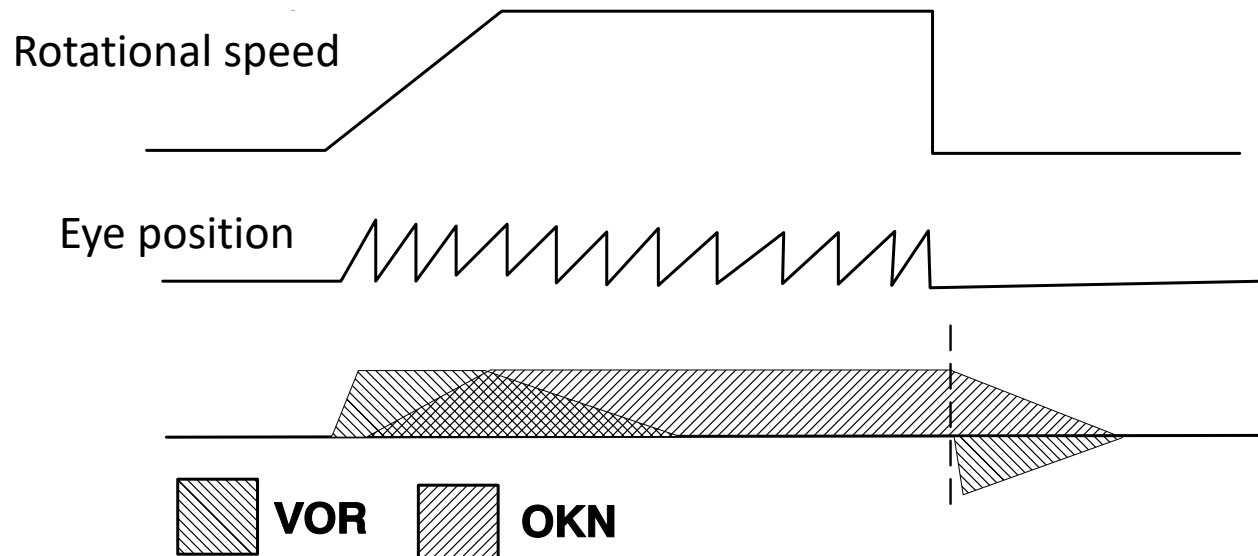
The Optokinetic Reflex



Rotation in the darkness



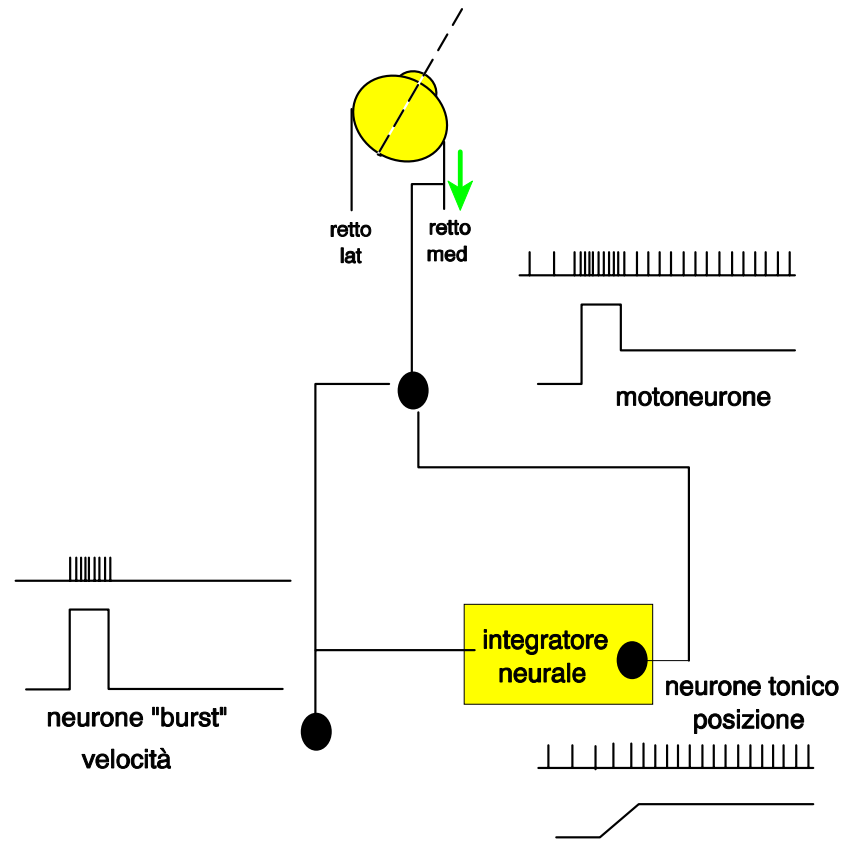
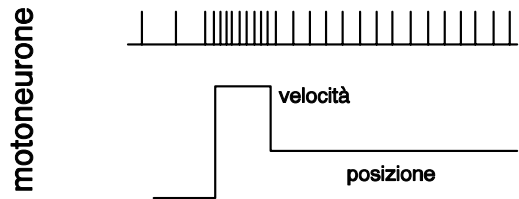
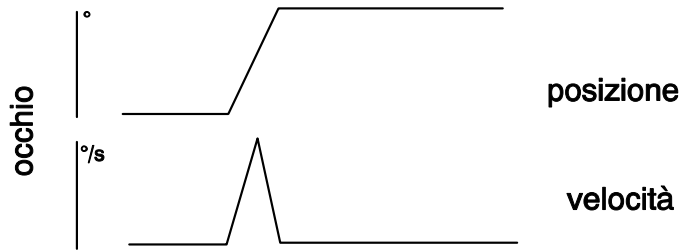
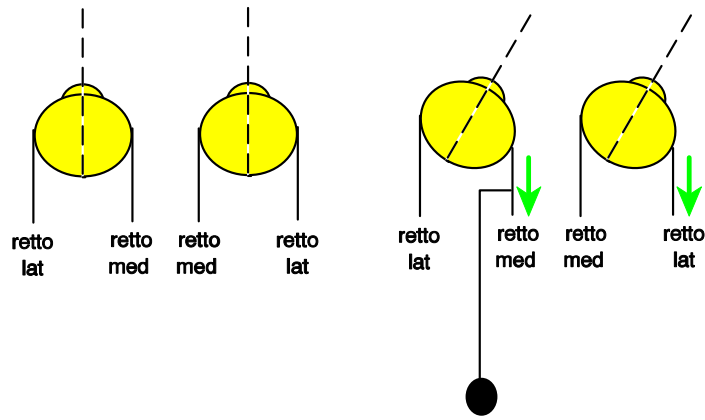
Rotation under illumination



Saccades

We scan the visual world with sequences of alternating saccades and fixations





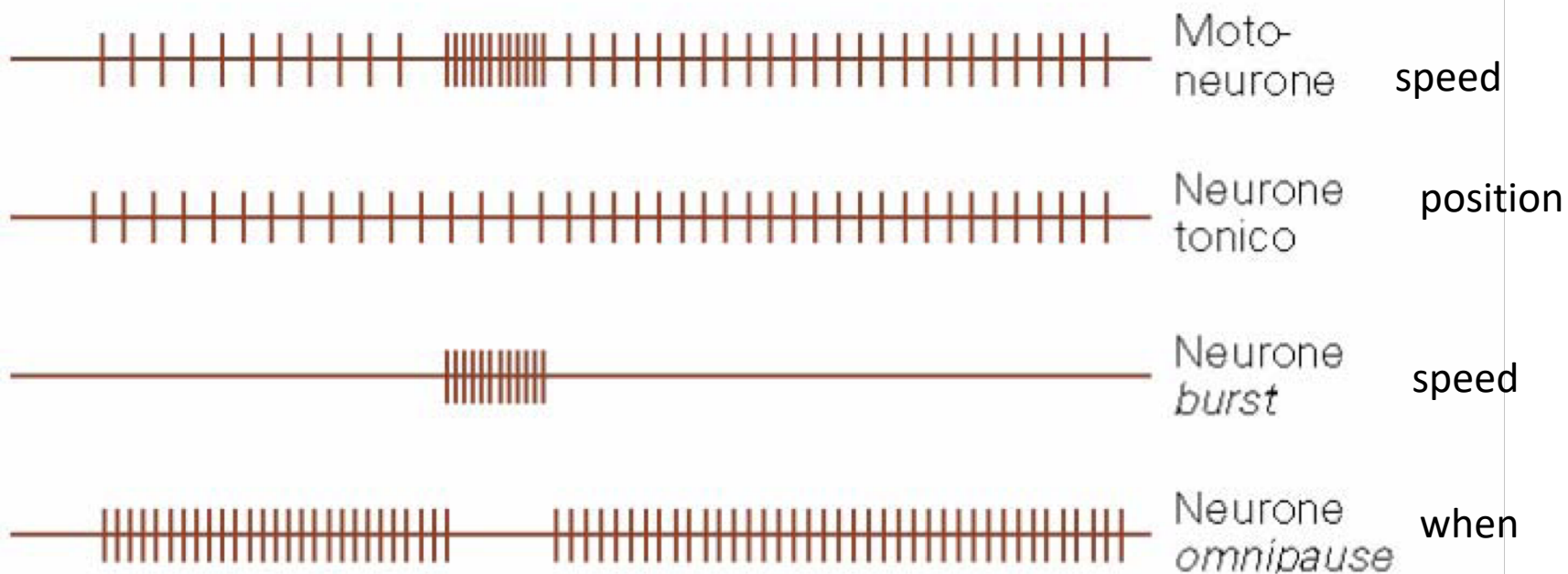
Pontine gaze center

B

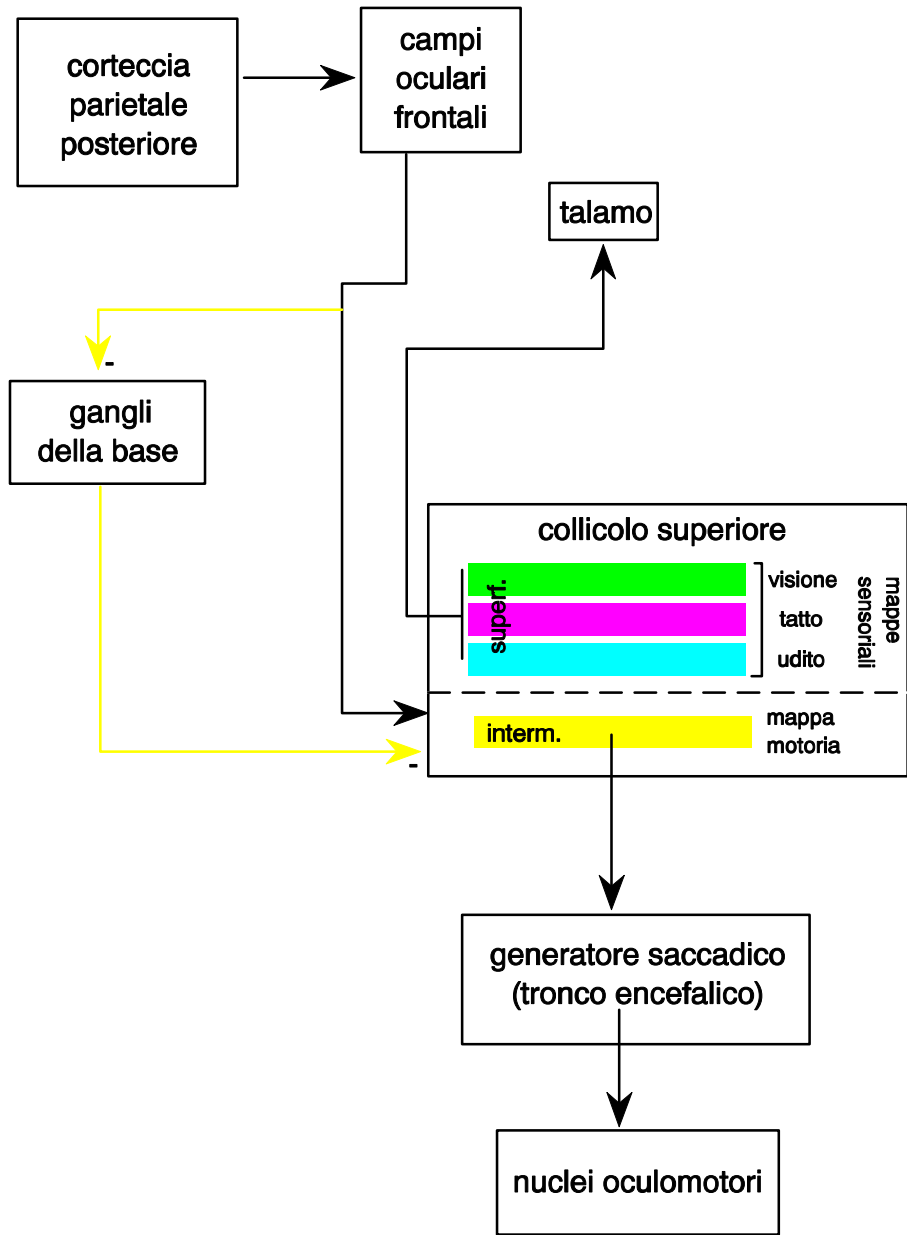
Posizione dell'occhio

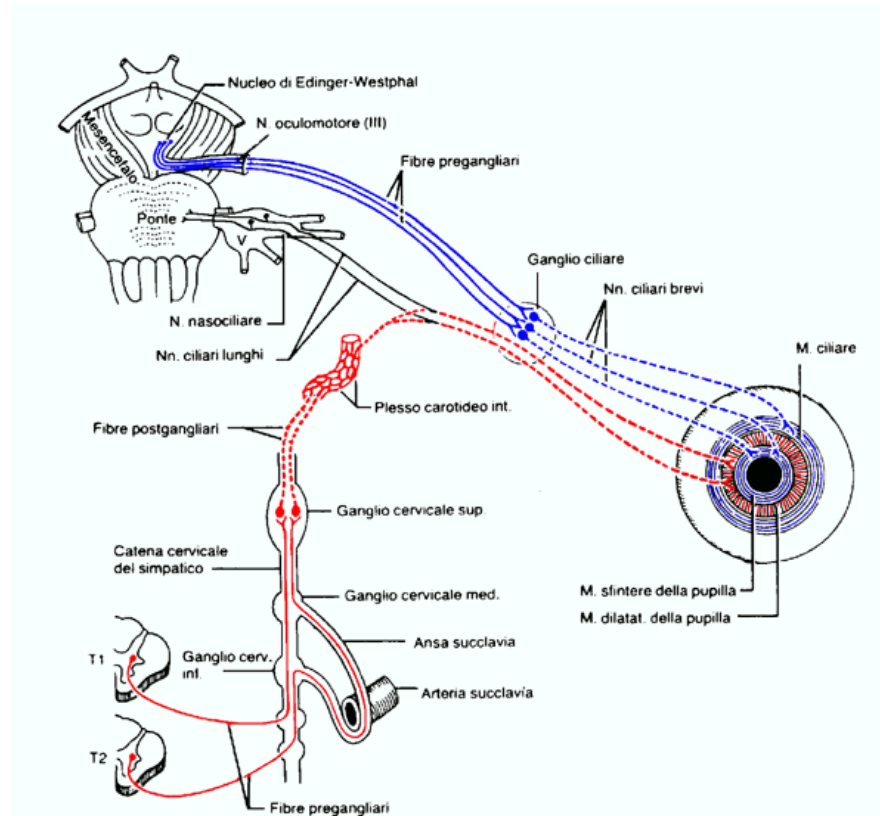
10°

50 ms



Saccadic suppression

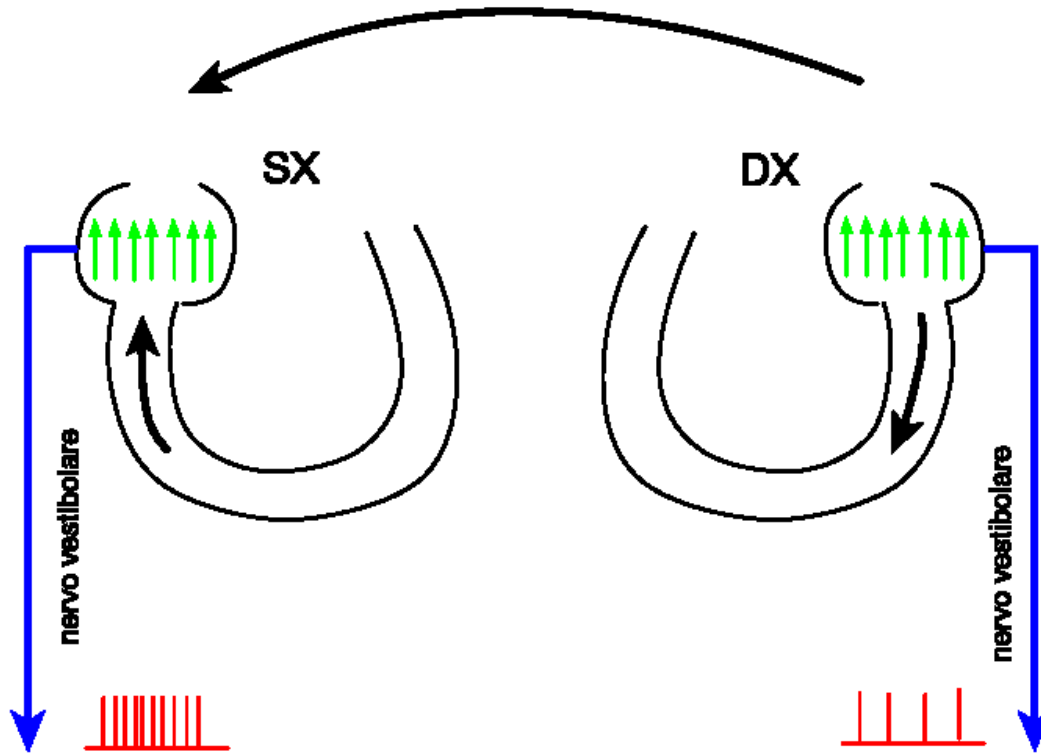




18. Innervazione ortosimpatica (rosso) e parasimpatica (blu) della muscolatura intrinseca dell'occhio. Le fibre il cui corpo cellulare si trova nel ganglio del trigemino (V) forniscono l'innervazione sensitiva alla cornea, all'iride ed alla corioide.
 Da "Enciclopedia Medica Italiana", USES.

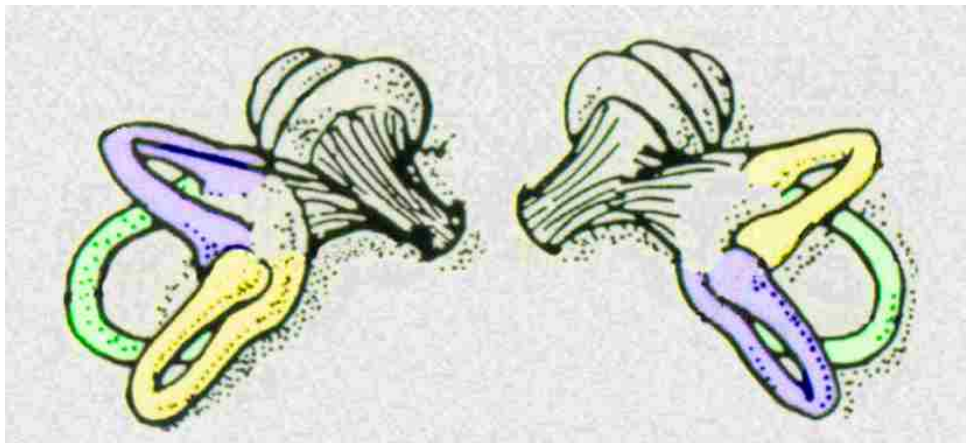
A

movimento della testa



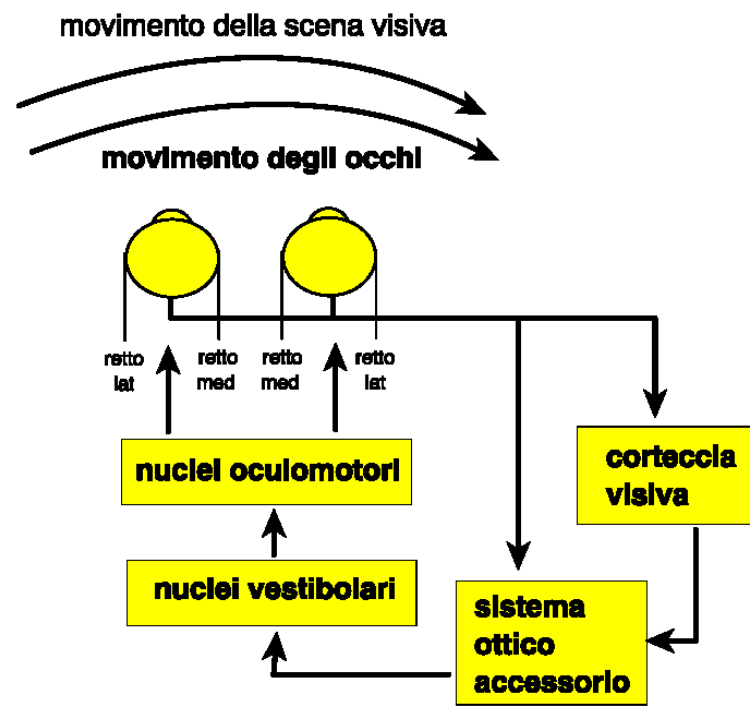
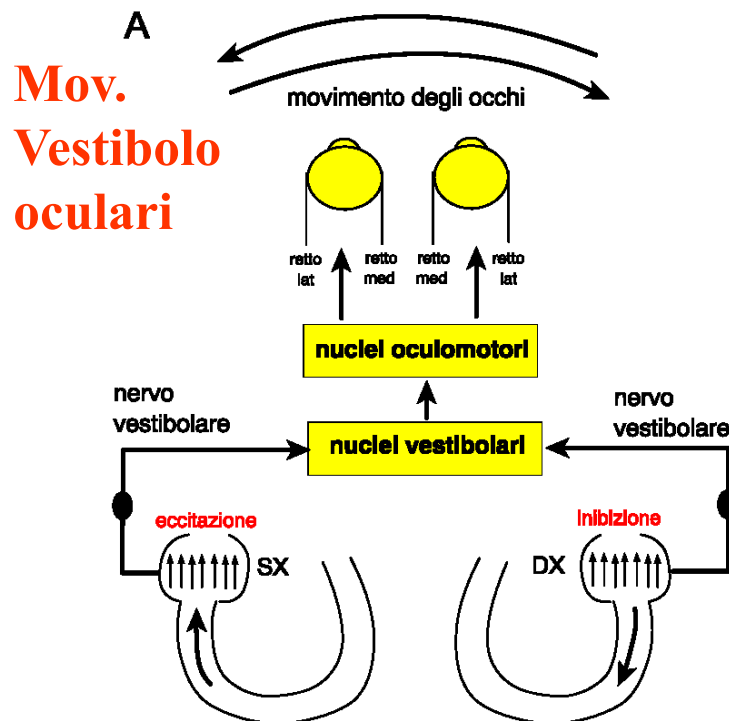
Rotazione testa in una direzione:

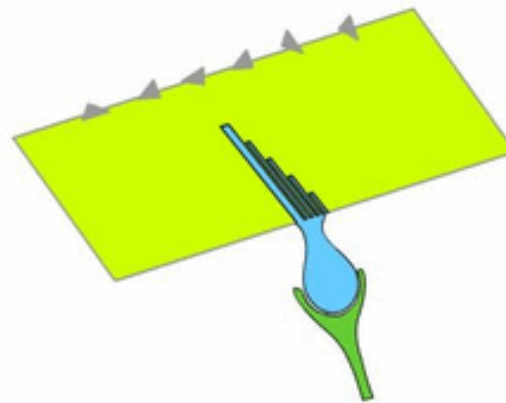
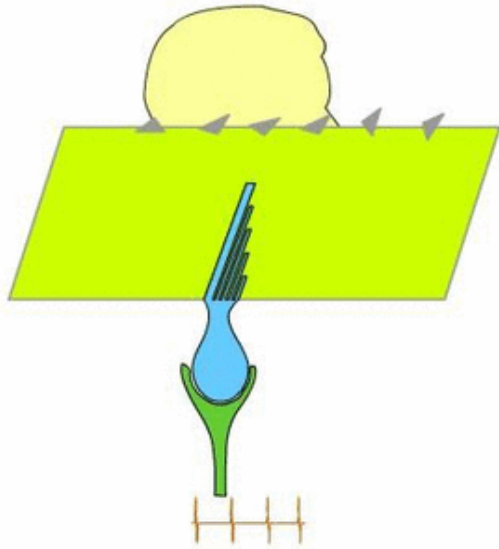
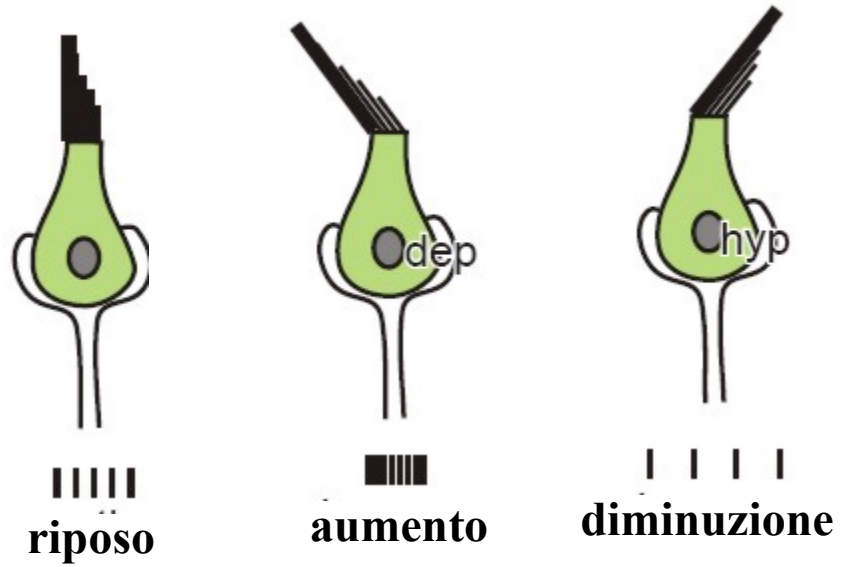
Attiva le cellule cigliate di un lato
Inibisce le cellule cigliate dell'altro

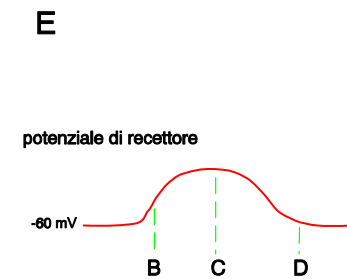
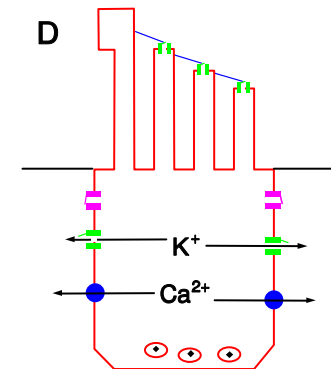
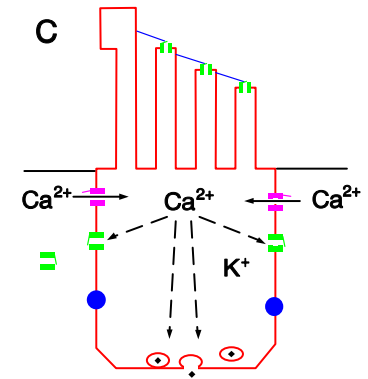
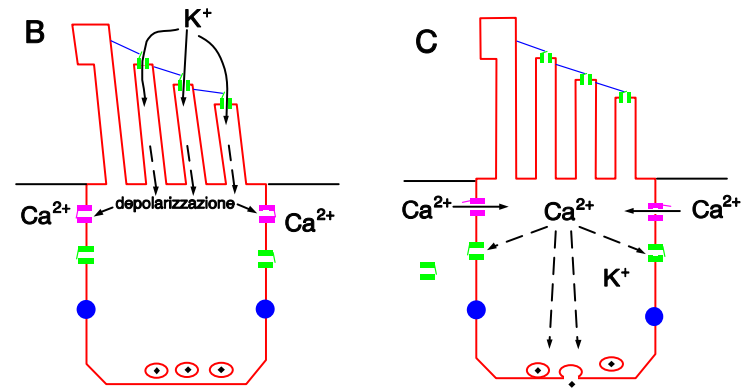
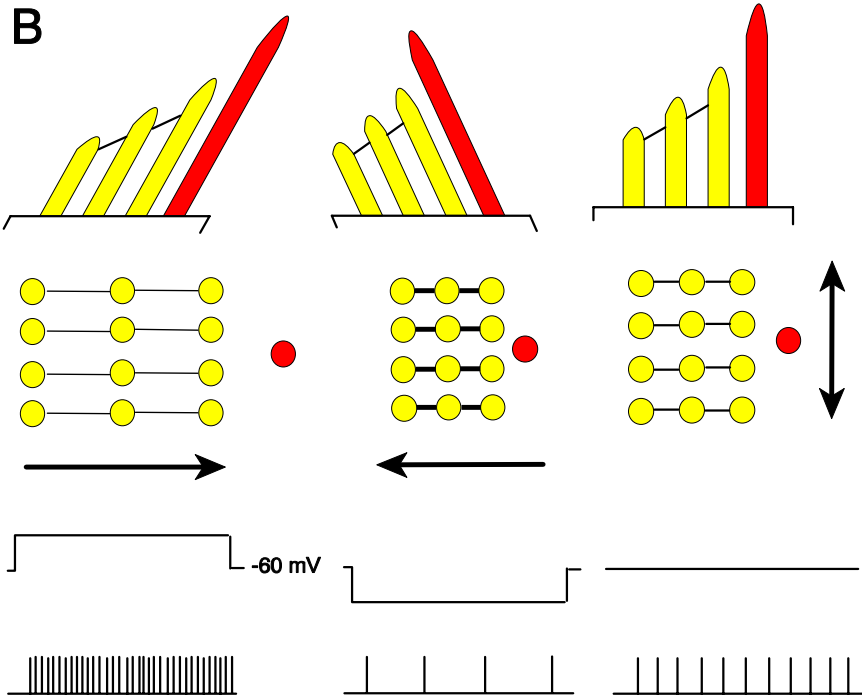
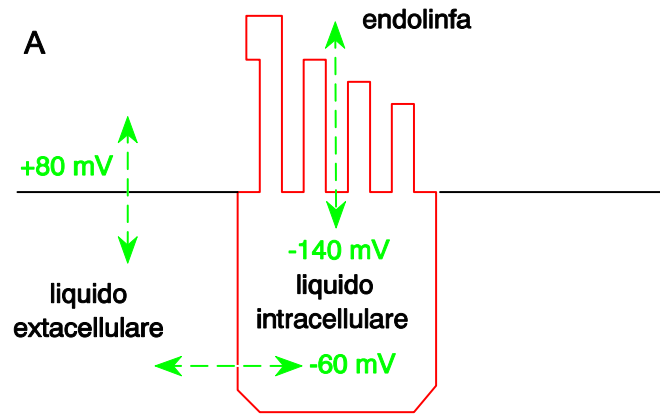
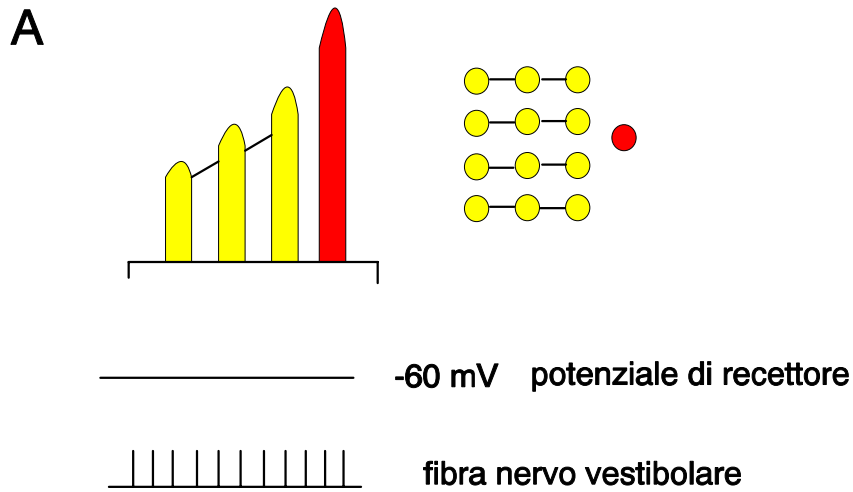


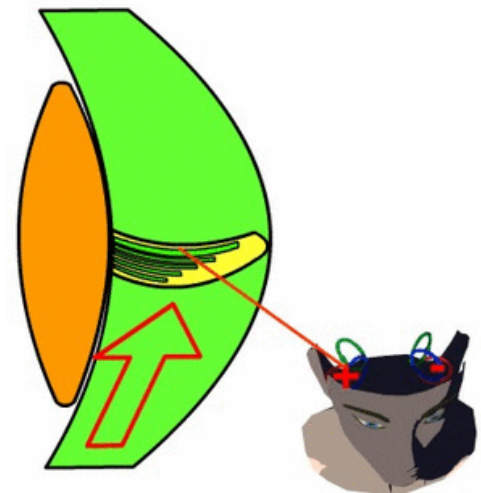
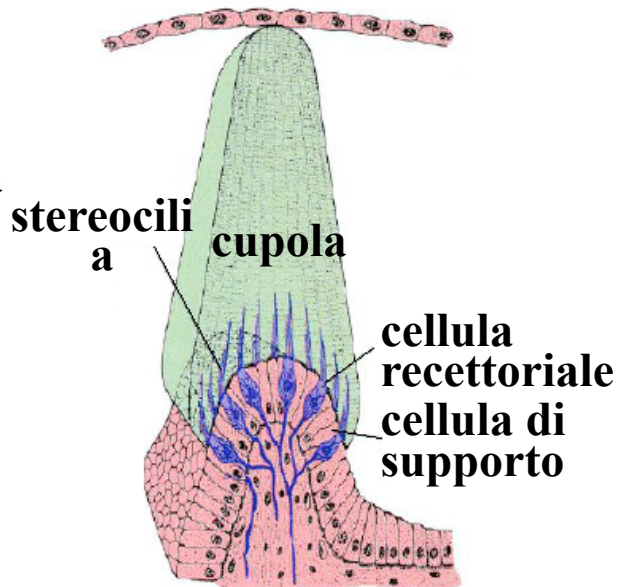
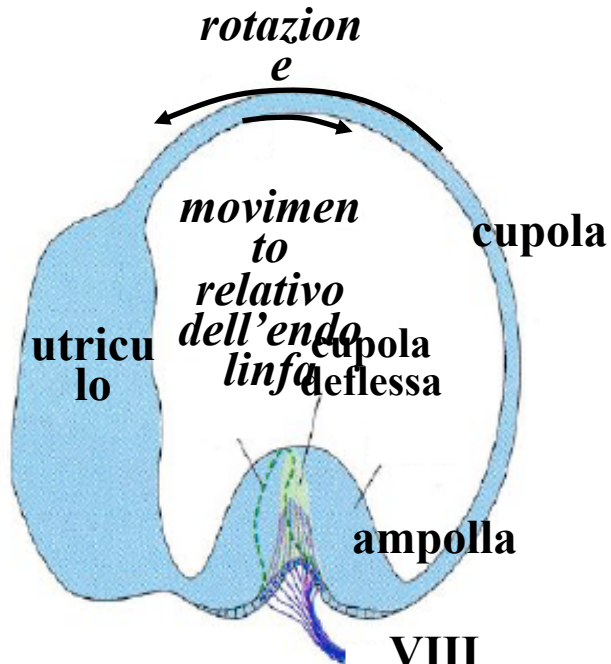
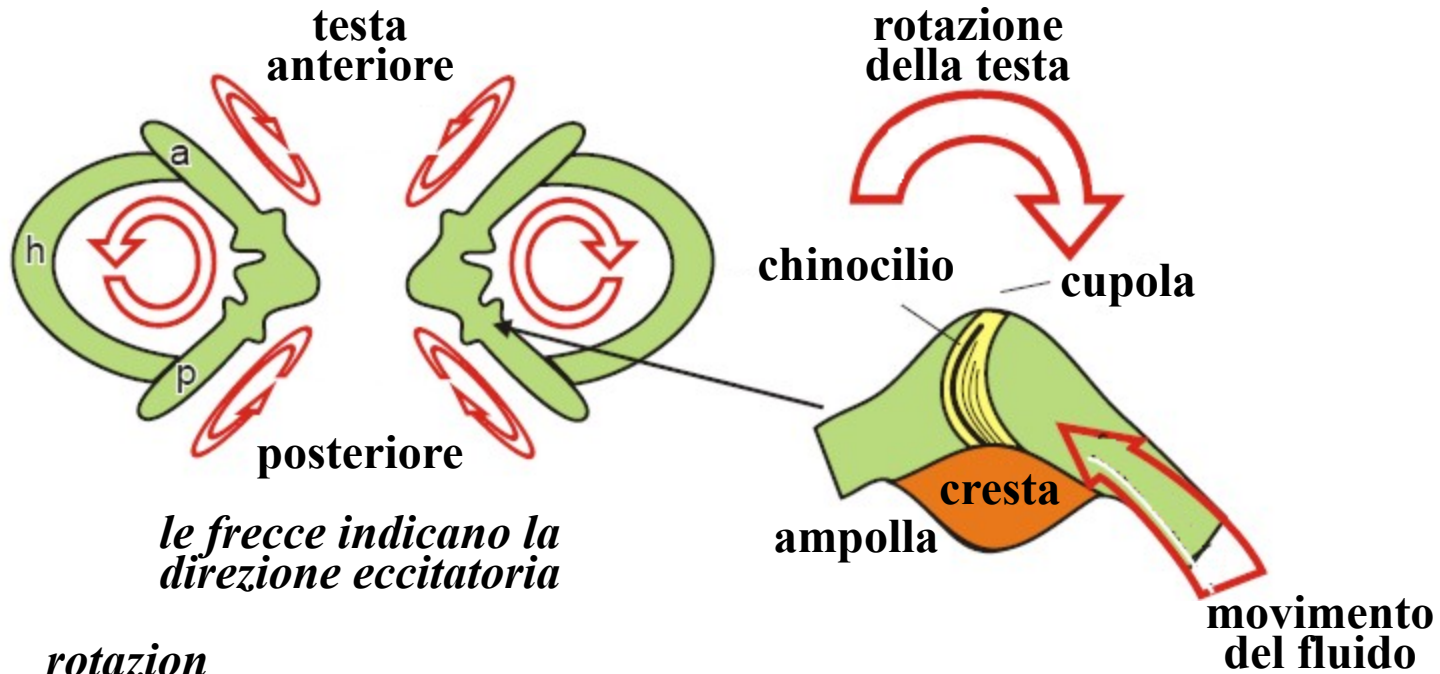
Movimenti vestibolo – oculari e movimenti optocinetici

- operano **congiuntamente** per **mantenere stabile lo sguardo** (es. durante movimento della testa)
- più antichi filogeneticamente, **involontari**
- **vestibolo-oculari**: tramite informazioni dal **sistema vestibolare**: **azione rapida**
- **optocinetici**: tramite informazioni dal **sistema visivo**: **azione lenta**









VIII
NC

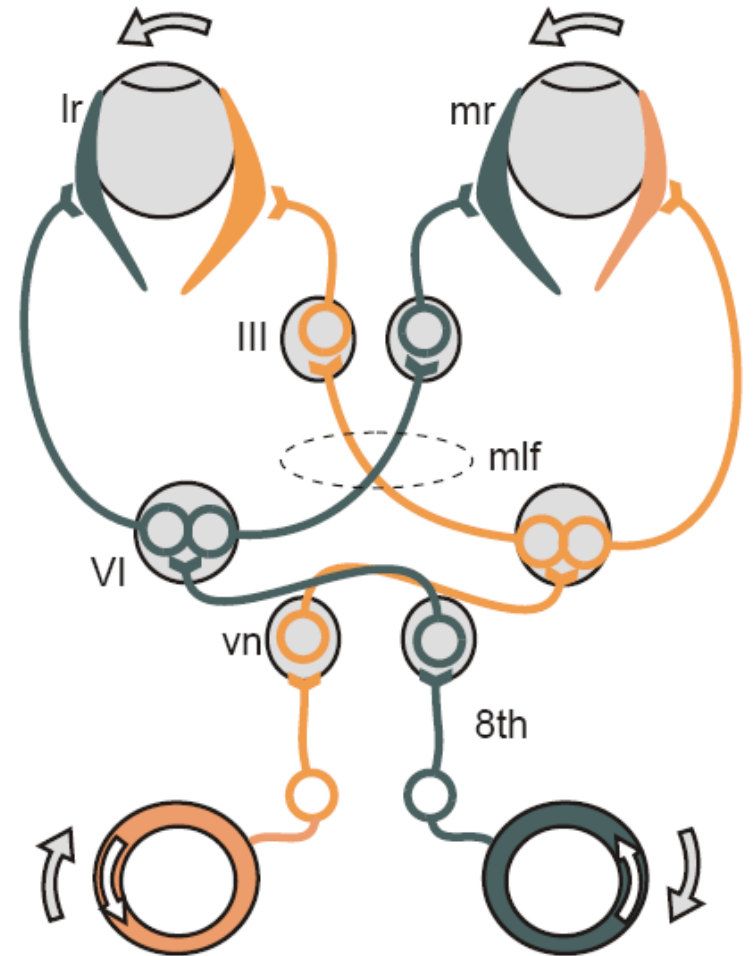
Sequenza degli eventi:

- La testa ruota a destra
- Le cellule ciliate del canale orizzontale di destra si depolarizzano, quelle di sinistra iperpolarizzano.
- L'attività dei neuroni vestibolari afferenti di destra aumenta, mentre quella di sinistra diminuisce
- L'attività del nucleo vestibolare destro aumenta, quella del sinistro diminuisce
- I nervi cranici (motoneuroni ai muscoli extraoculari) VI di sinistra e III di destra diventano più attivi, mentre il III di sinistra e il VI di destra diventano meno attivi.
- I muscoli extraoculari retto laterale sinistro e retto mediale destro si contraggono, mentre il retto mediale sinistro e il retto laterale destro si rilassano.
- Entrambi gli occhi ruotano verso sinistra.

flessione della testa



attività delle fibra del nervo vestibolare



iperpol.

depol.

A riposo (testa ferma), l'attività tonica dei canali destro e sinistro si bilancia.