Fundamentals of Videonystagmography: Theory,Practice, and Clinical cases

Oculomotor tests: Saccades, Smooth pursuit, Optokinetic

Learner Outcomes

- After this course, participants will be able to identify and describe the different functional classes of eye movements and their significance in ocular motor control.
- After this course, participants will be able to describe various eye movement recording techniques to capture and analyze eye movements, enhancing diagnostic precision for vestibular and neurological disorders.
- After this course, participants will be able to explain how VNG protocols can be effective in facilitating the assessment, ongoing monitoring, and management of conditions affecting the vestibular system and eye movement regulation.

Dr Vishal Pawar

- **Specialist Neurologist**
- **Head of department, Vertigo clinic, Aster and Medcare clinic, Dubai**
- **SCE Royal college of physicians, UK (May 2017)**
- **Vestibular assessment and management (American Institute of Balance) (2018)**
- **Fellow of European Board of Neurology (2021)**
- **International vestibular diploma (2021)**
- **Assessment and Management of Vestibular disorders (Yenepoya university, Mangalore) (2022)**
- **35 publications and abstracts**
- **Contributed 2 book chapters on Vertigo**

Fundamentals of Videonystagmography: Theory,Practice, and Clinical cases

Oculomotor tests: Saccades, Smooth pursuit, Optokinetic

- Dr Vishal Pawar
- MBBS, DNB Medicine, DNB Neurology
- SCE Neurology (RCP, UK)
- Fellow of European Board of Neurology
- Specialist Neurologist
- Aster & Medcare clinics
- Discovery Gardens
- Dubai
- neurovishal@gmail.com

Outline of talk

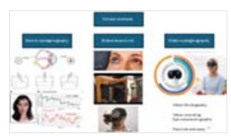
Why and how do eyes move?

Functional classes of eye movements

Eye movements recording techniques

VNG protocols

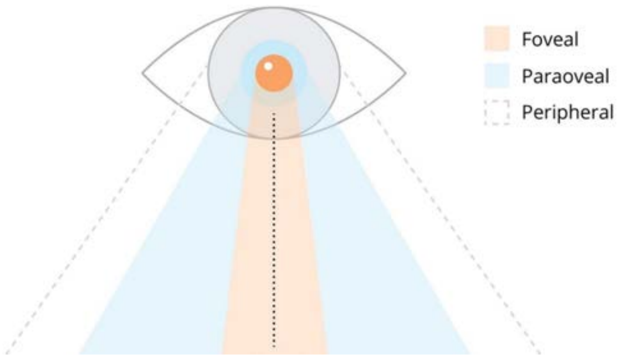
Saccades, Smooth pursuit, Optokinetic

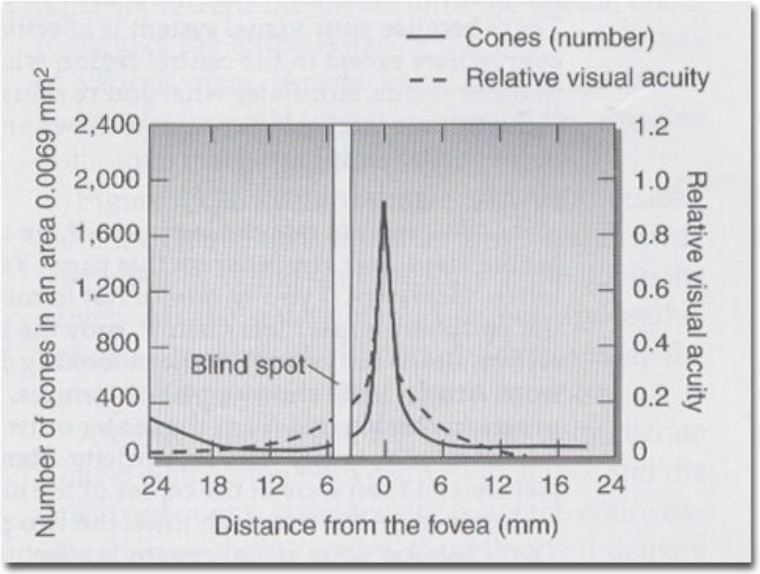


Why do eyes move?

Extra-ocular muscles are at service of vision

Clear vision





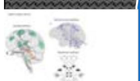
The peripheral retina is like a guard & when an object of regard falls upon it, it shouts 'who goes there ; & calls fovea to the spot.

How do eyes move?

Overview of ocular motor control

- Extra-ocular muscles are at service of vision
- Ocular motor nerves are at service of EOM
- Ocular motor nerves originate from Ocular motor nuclei
- They need inter-nuclear connections and supra-nuclear control
- Eye movements needs co-ordination with head movements
- Vestibulo-ocular relfex serves this function

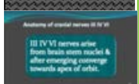
Ocular motor control



Supra-nuclear control

Internuclear control

- Medial longitudinal fasciculus
- Burst neurons
- Omnipause neurons
- Neural integrator



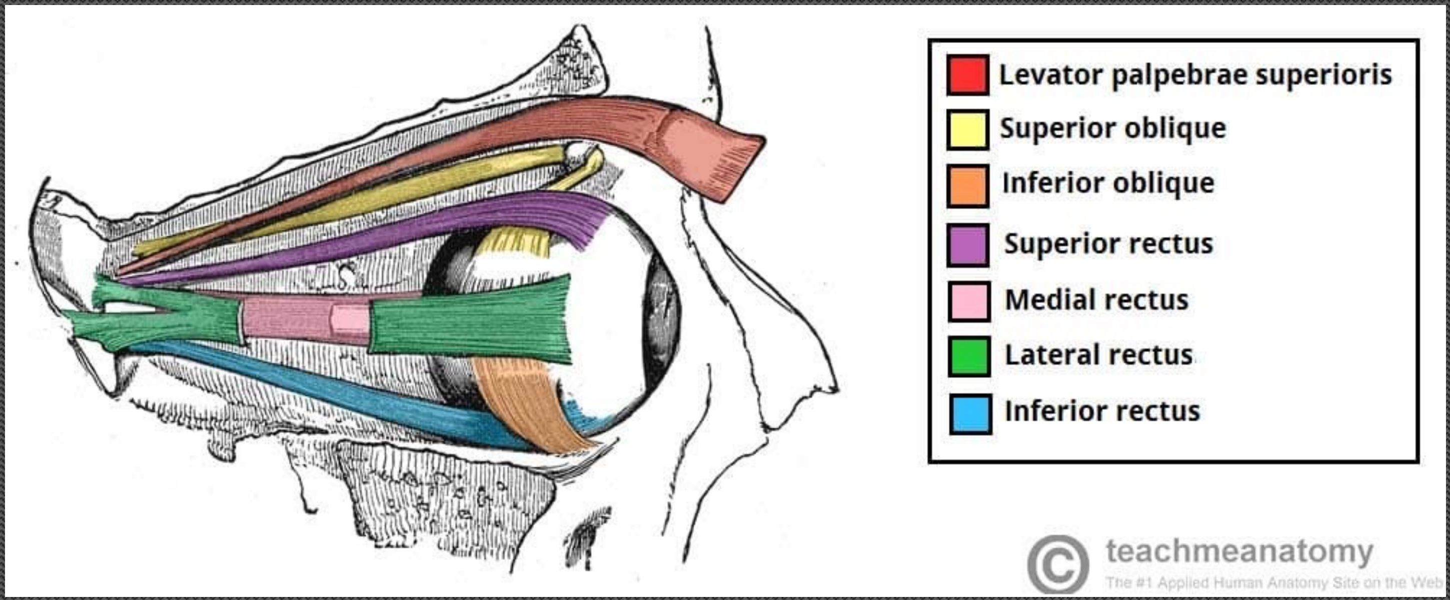
Infra-nuclear control

- Oculomotor nerve
- Trochlear nerve
- Abducens nerve

Extra-ocular muscles

Extra-ocular muscles

Extra-ocular muscles



Muscle acting on the lid

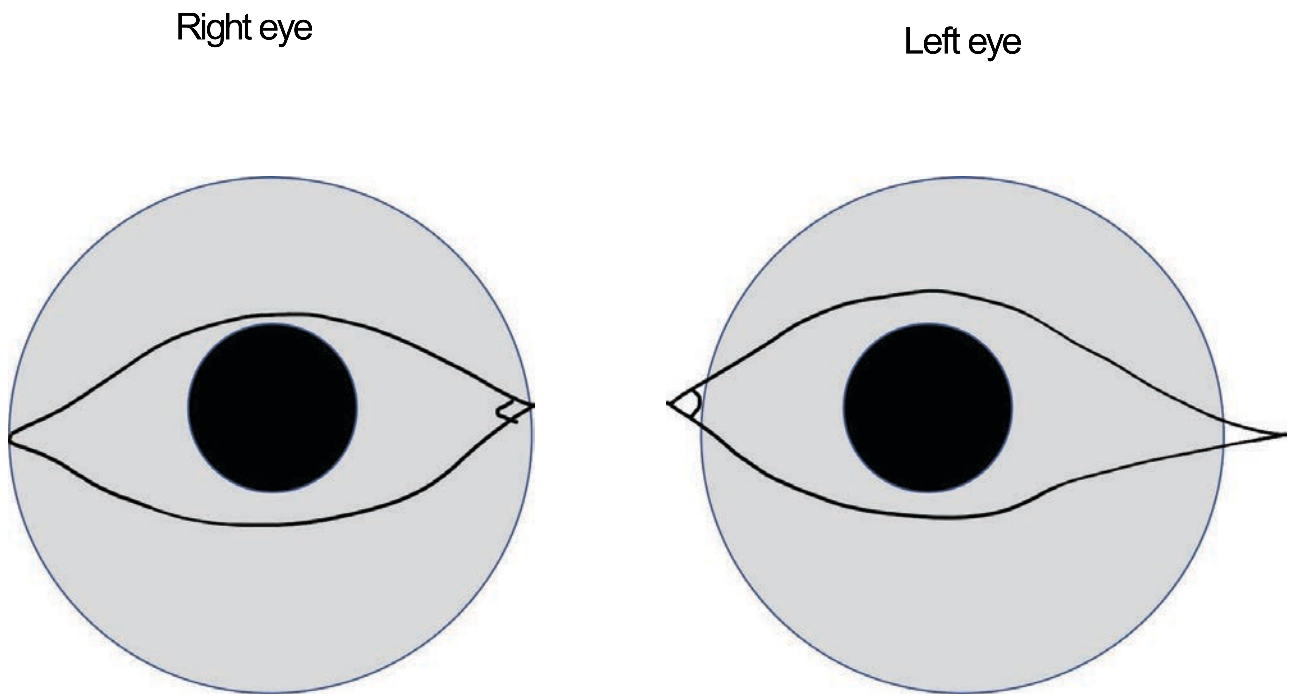
- Levator palpebrae superioris

Muscles acting on eyeball

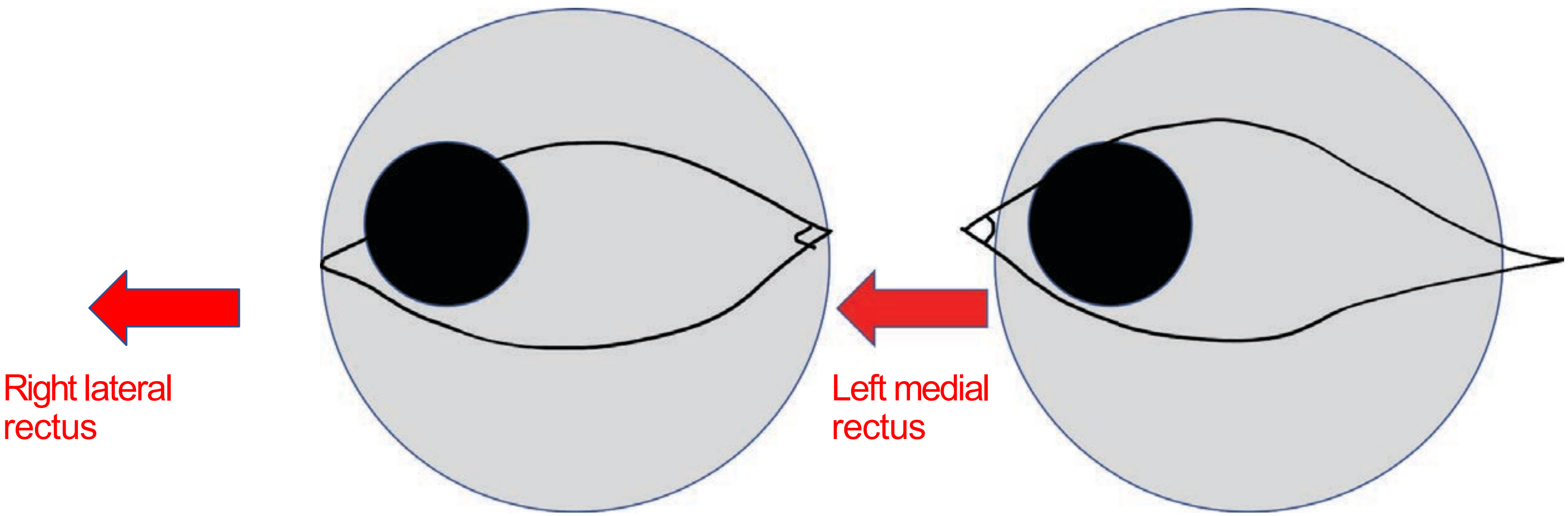
- Recti
  - Superior rectus
  - Inferior rectus
  - Medial rectus
  - Lateral rectus
- Obliques
  - Superior oblique
  - Inferior oblique

Muscle action

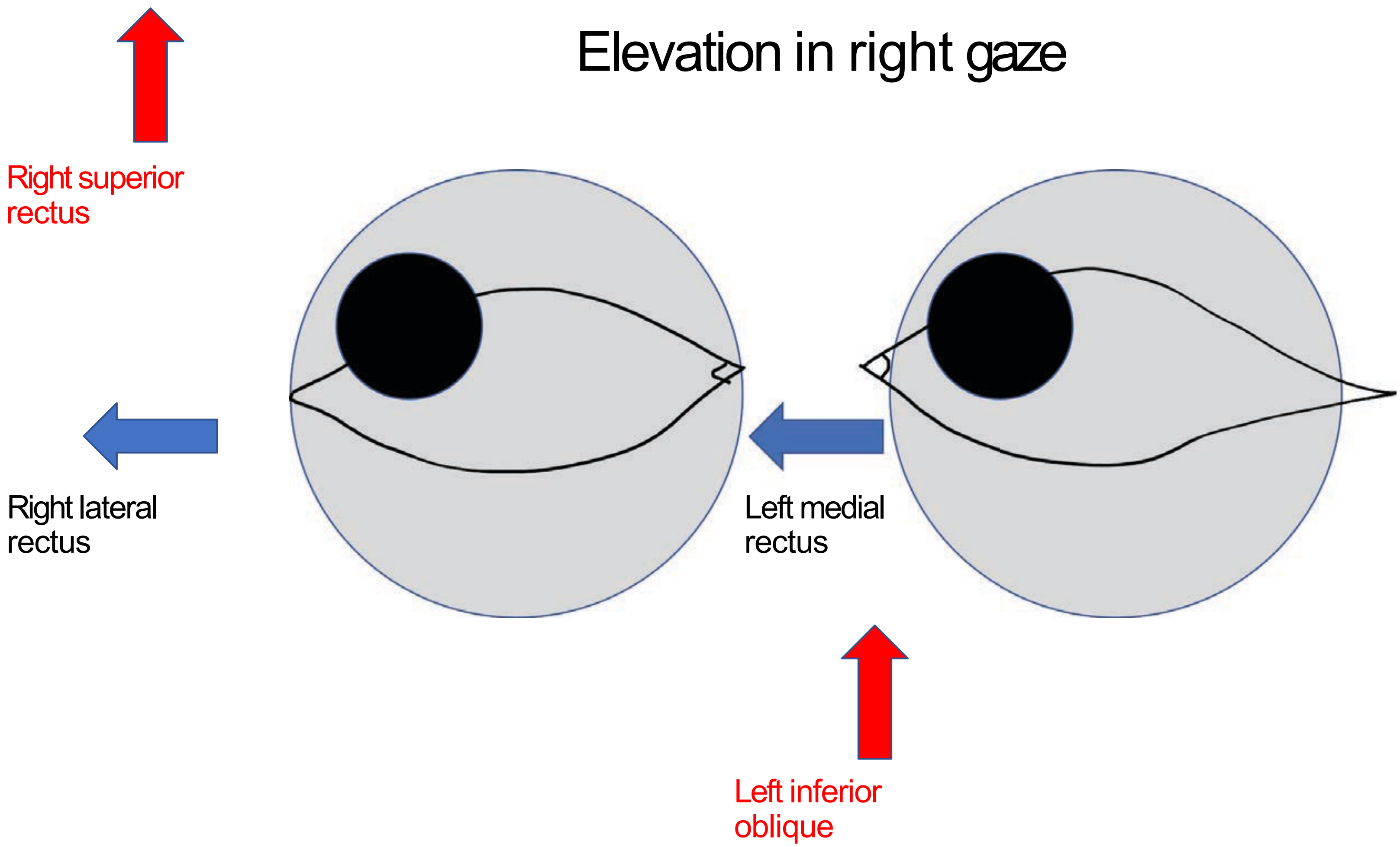
Primary action	Robust action seen in center gaze
Secondary action	Action seen in abduction, adduction, up and down
Tertiary action	Action seen in oblique gazes
Field of action	Major action seen when the eyeball is aligned to the muscle axis


Right eye
Left eye

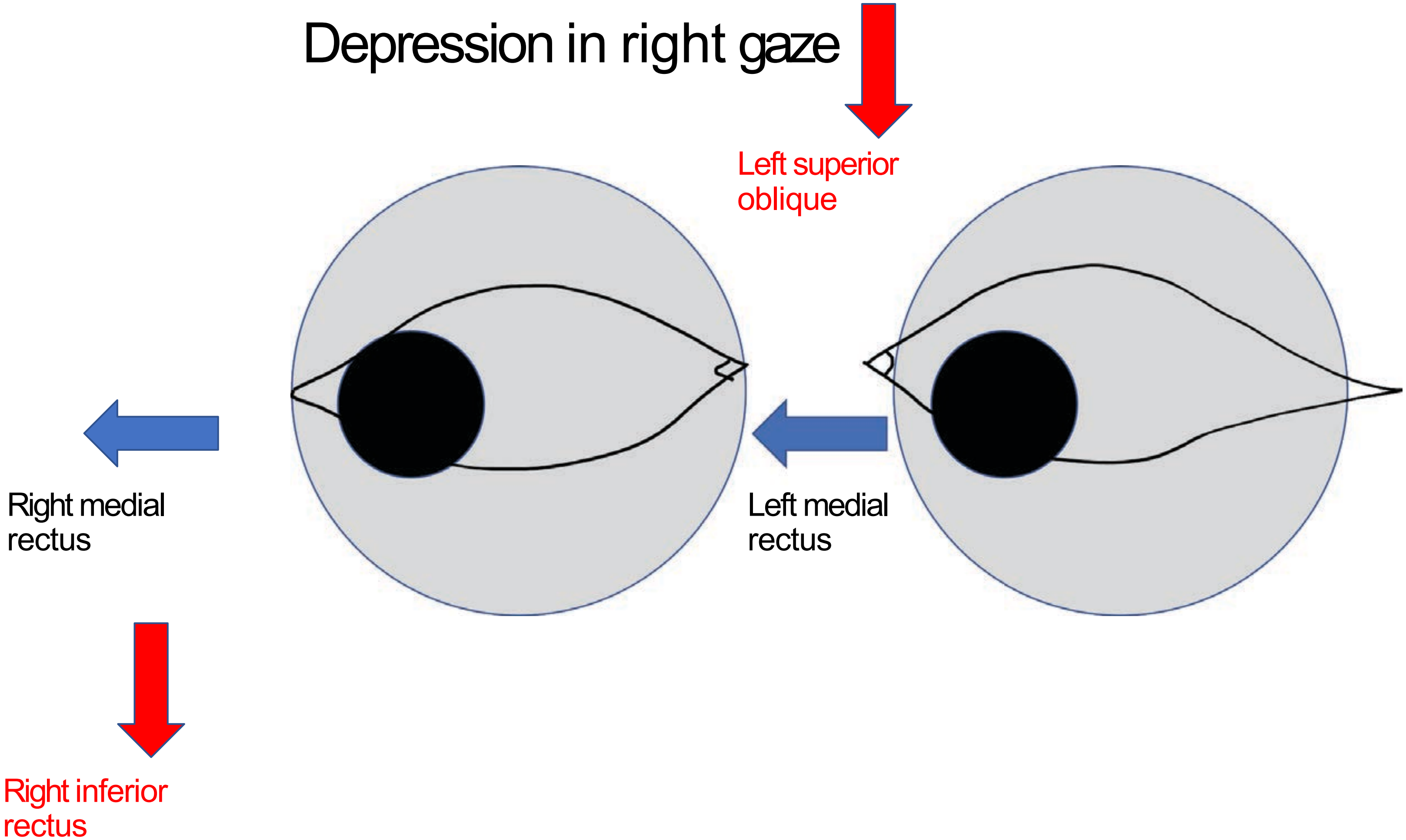
Right gaze

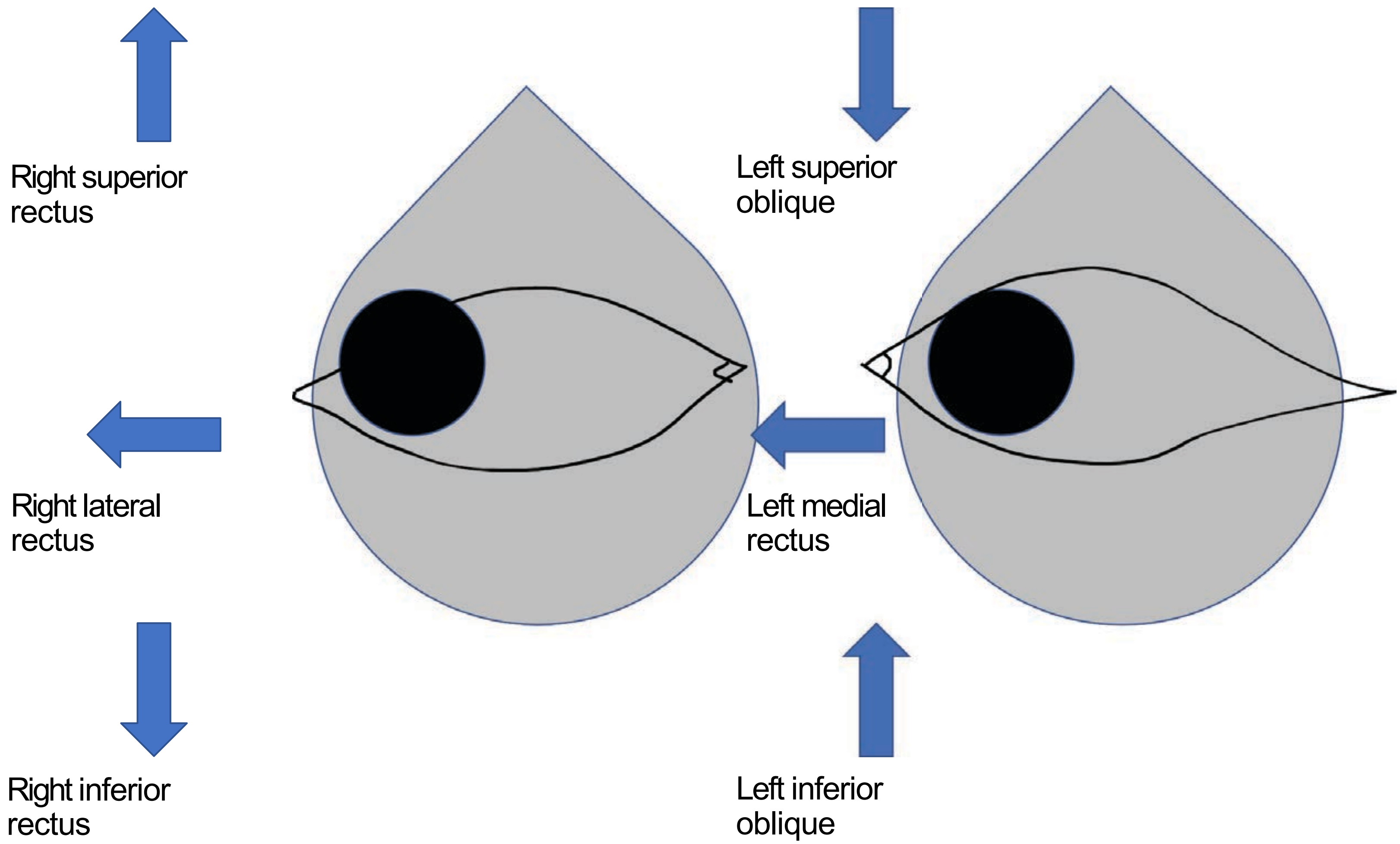


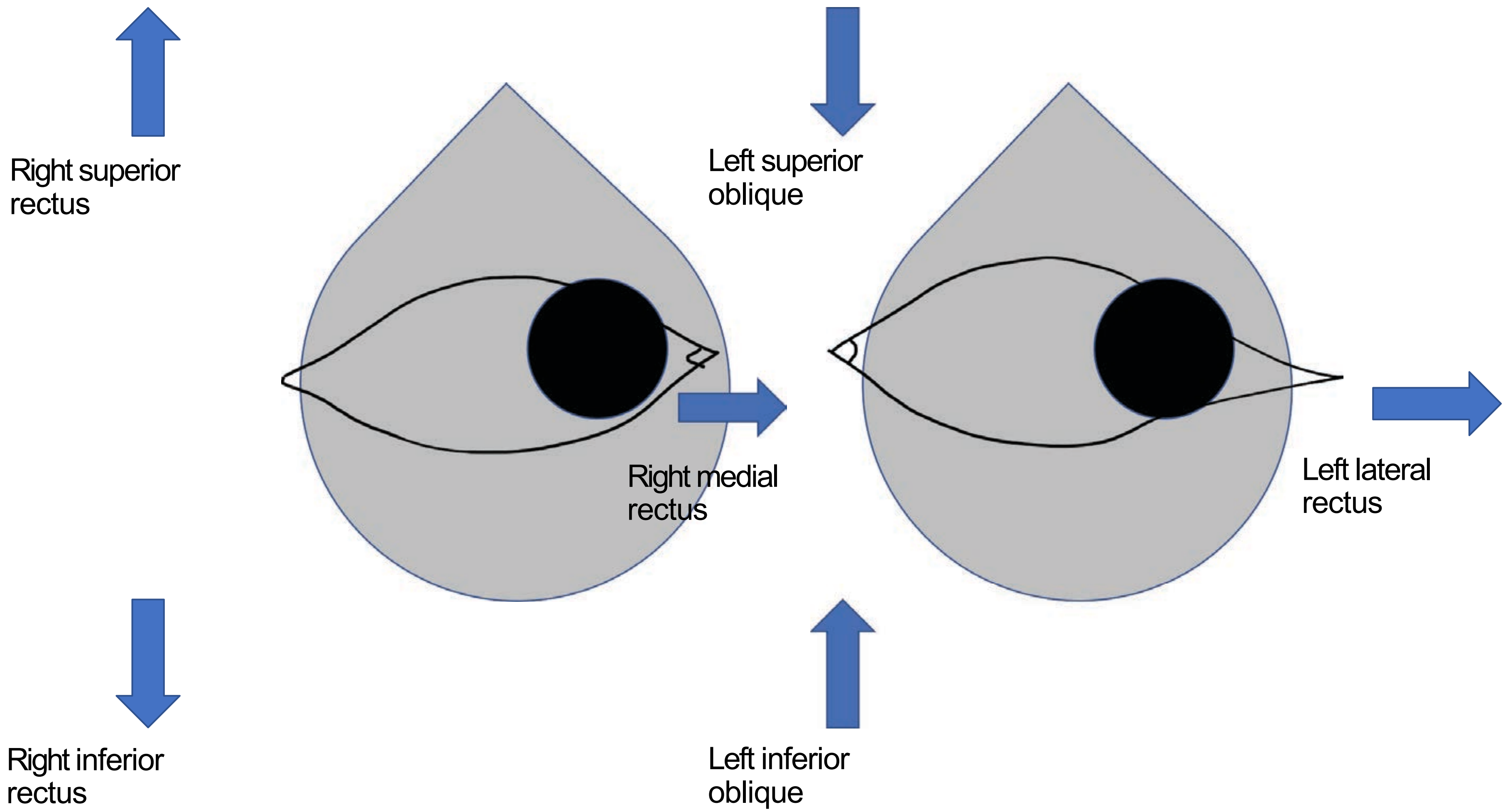
Elevation in right gaze

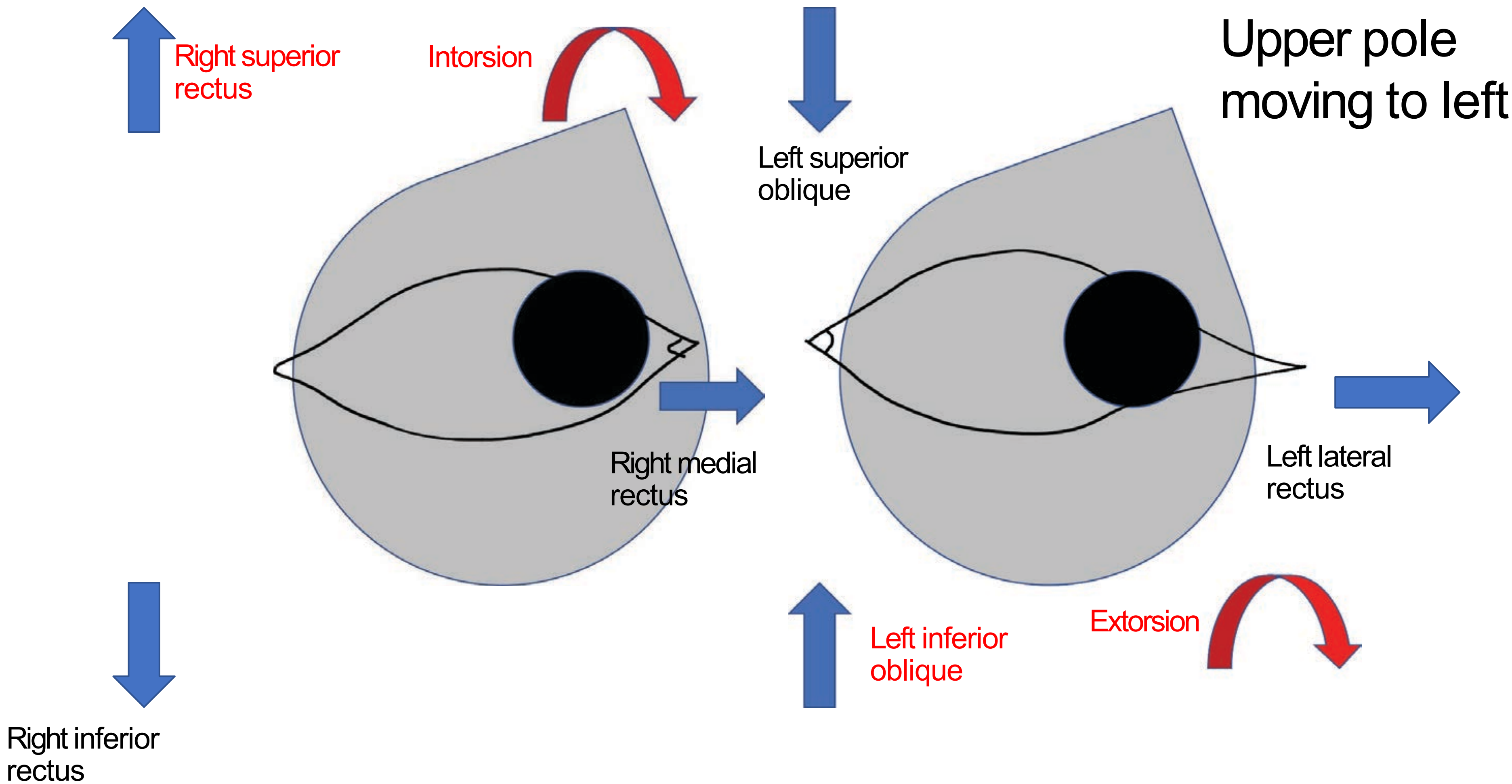


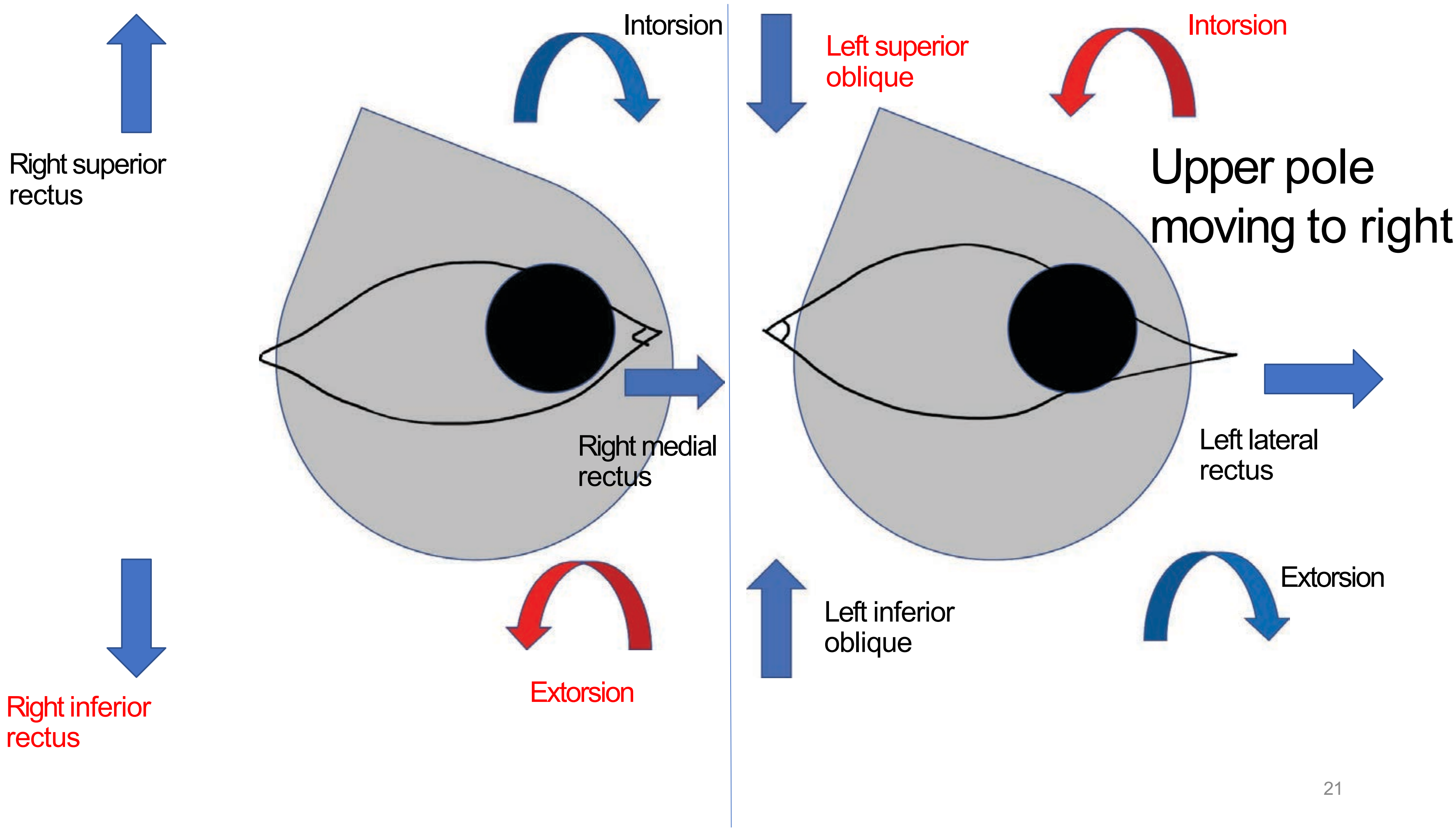
Depression in right gaze

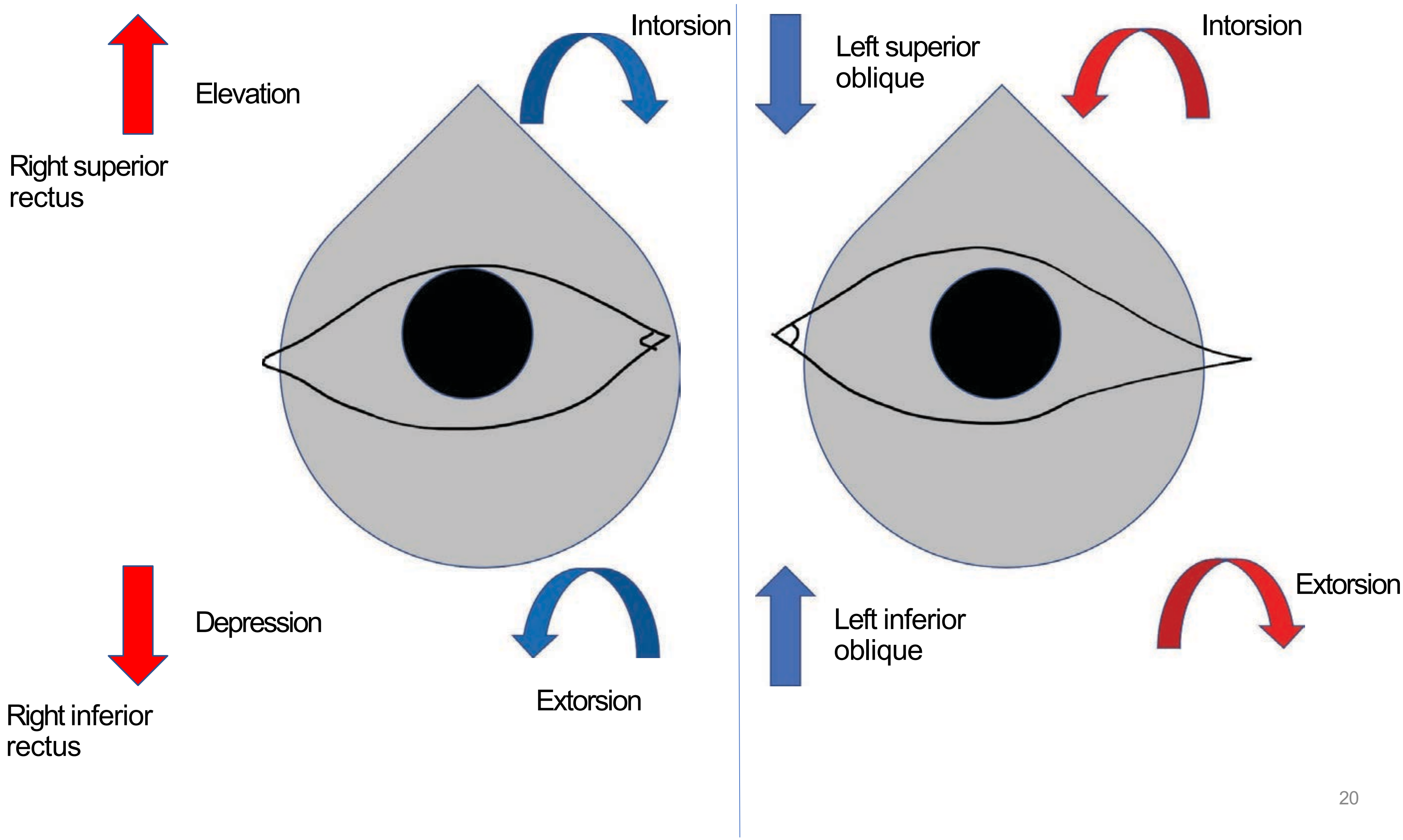



Right superior
rectus
Left superior
oblique
Right lateral
rectus
Left medial
rectus
Right inferior
rectus
Left inferior
oblique

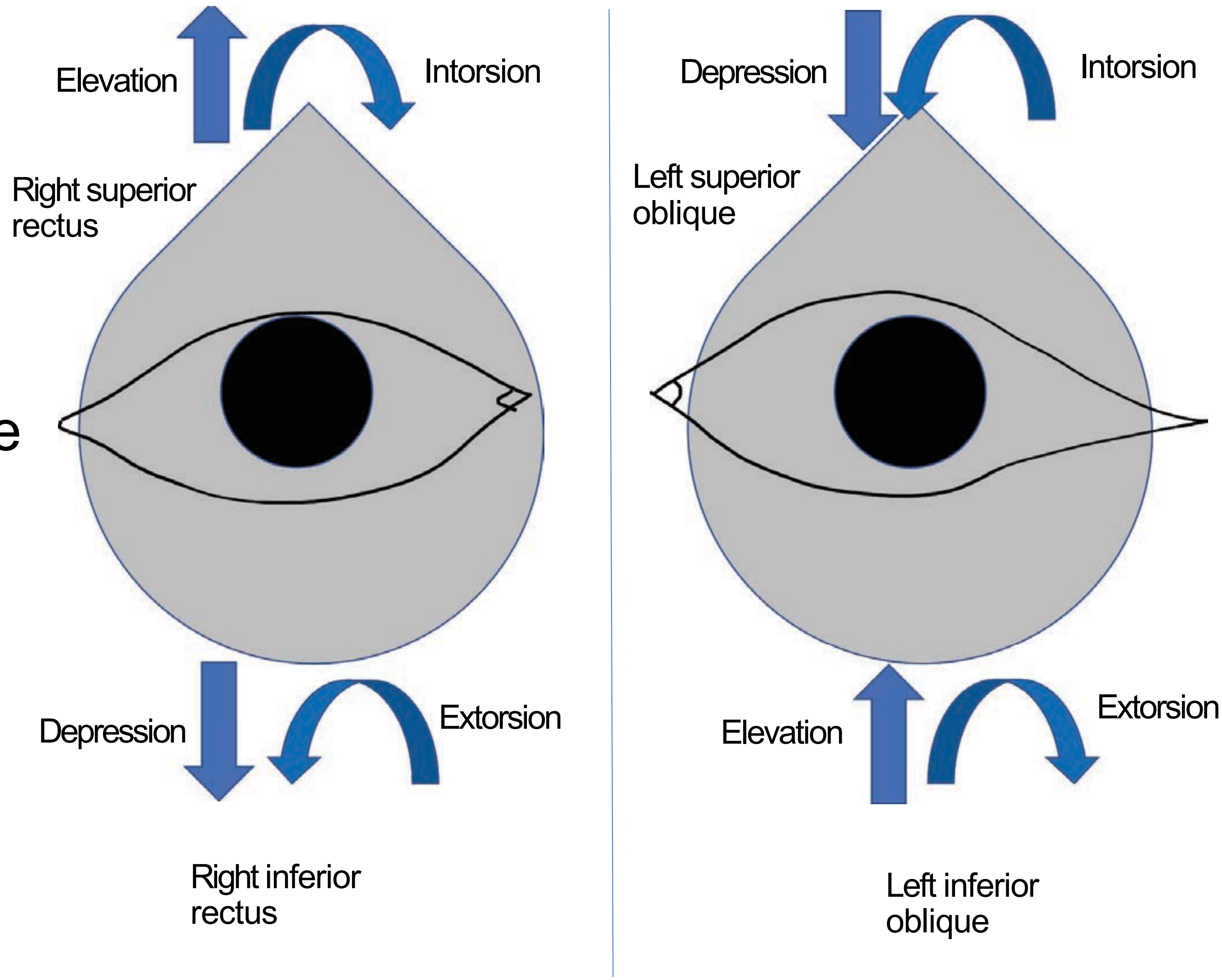

Right superior rectus
Left superior oblique
Right medial rectus
Left lateral rectus
Right inferior rectus
Left inferior oblique


Right superior rectus
Intorsion
Left superior oblique
Upper pole moving to left
Right medial rectus
Left lateral rectus
Right inferior rectus
Left inferior oblique
Extorsion

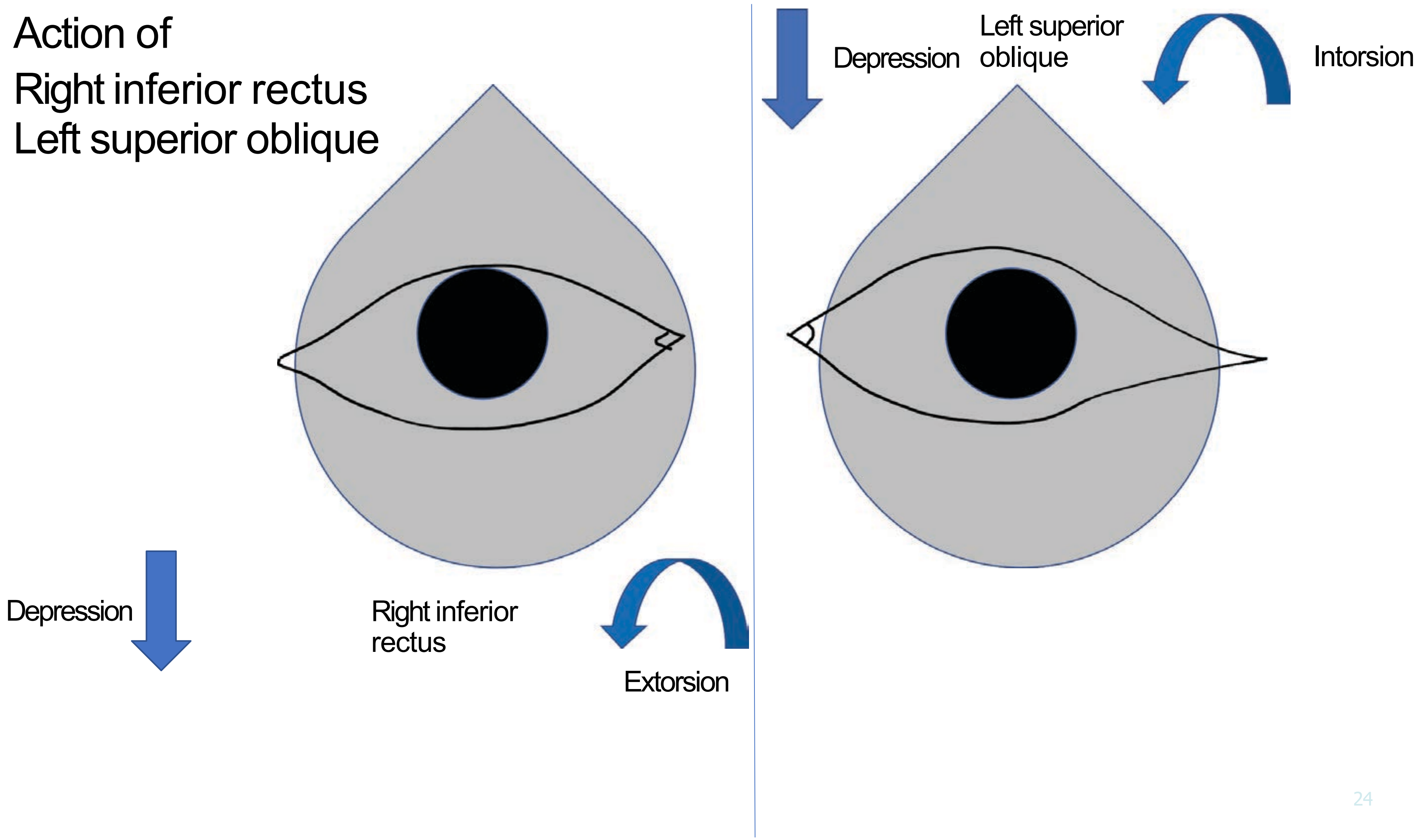

Intorsion
Right superior rectus
Right medial rectus
Right inferior rectus
Extorsion
Left superior oblique
Intorsion
Upper pole moving to right
Left lateral rectus
Left inferior oblique
Extorsion


Intorsion
Elevation
Right superior rectus
Depression
Right inferior rectus
Extorsion
Left superior oblique
Intorsion
Left inferior oblique
Extorsion

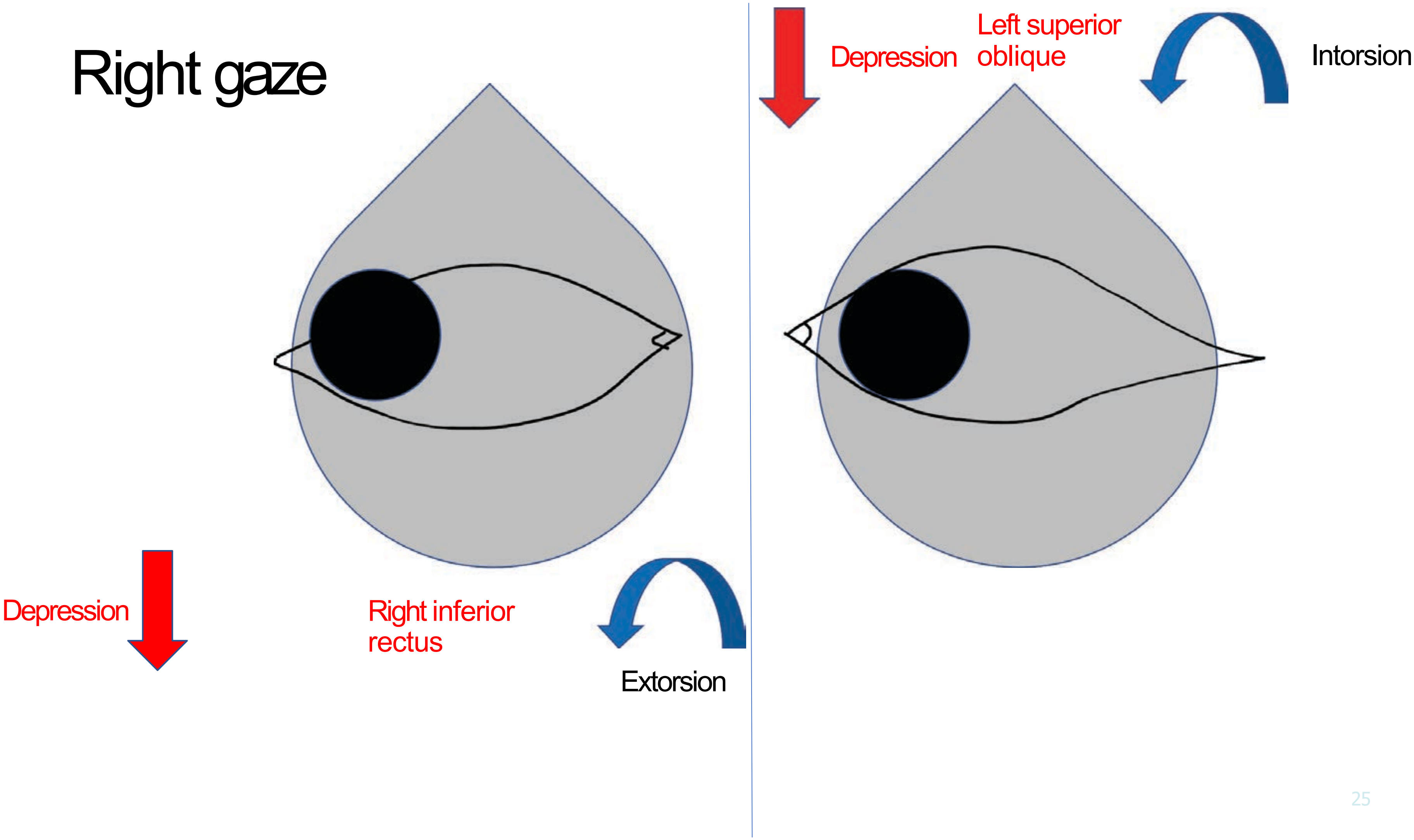
Center gaze


Elevation
Intorsion
Right superior
rectus
Depression
Extorsion
Right inferior
rectus
Depression
Intorsion
Left superior
oblique
Elevation
Extorsion
Left inferior
oblique

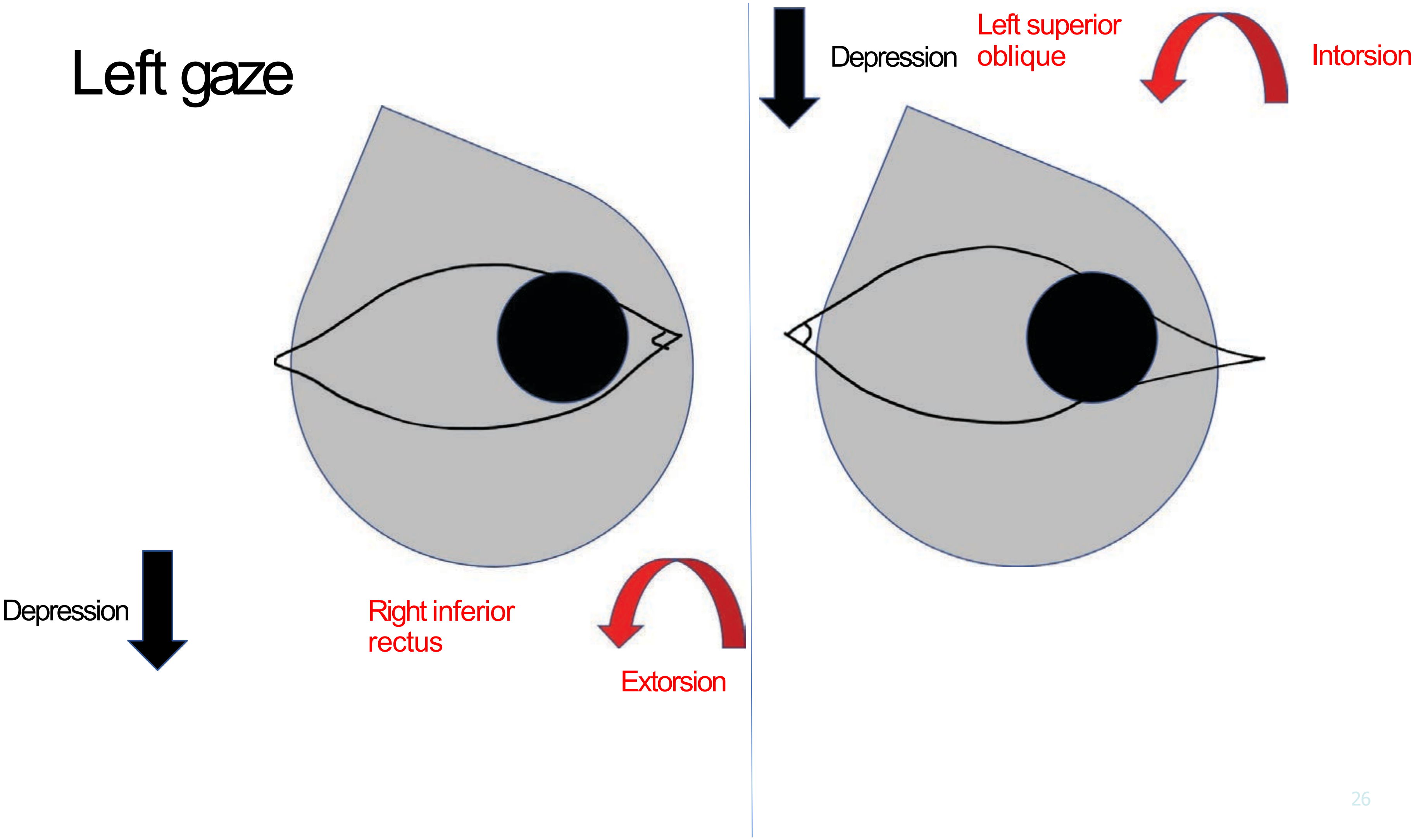
Action of
Right inferior rectus
Left superior oblique



Right gaze


Depression
Left superior oblique
Intorsion
Depression
Right inferior rectus
Extorsion

Left gaze

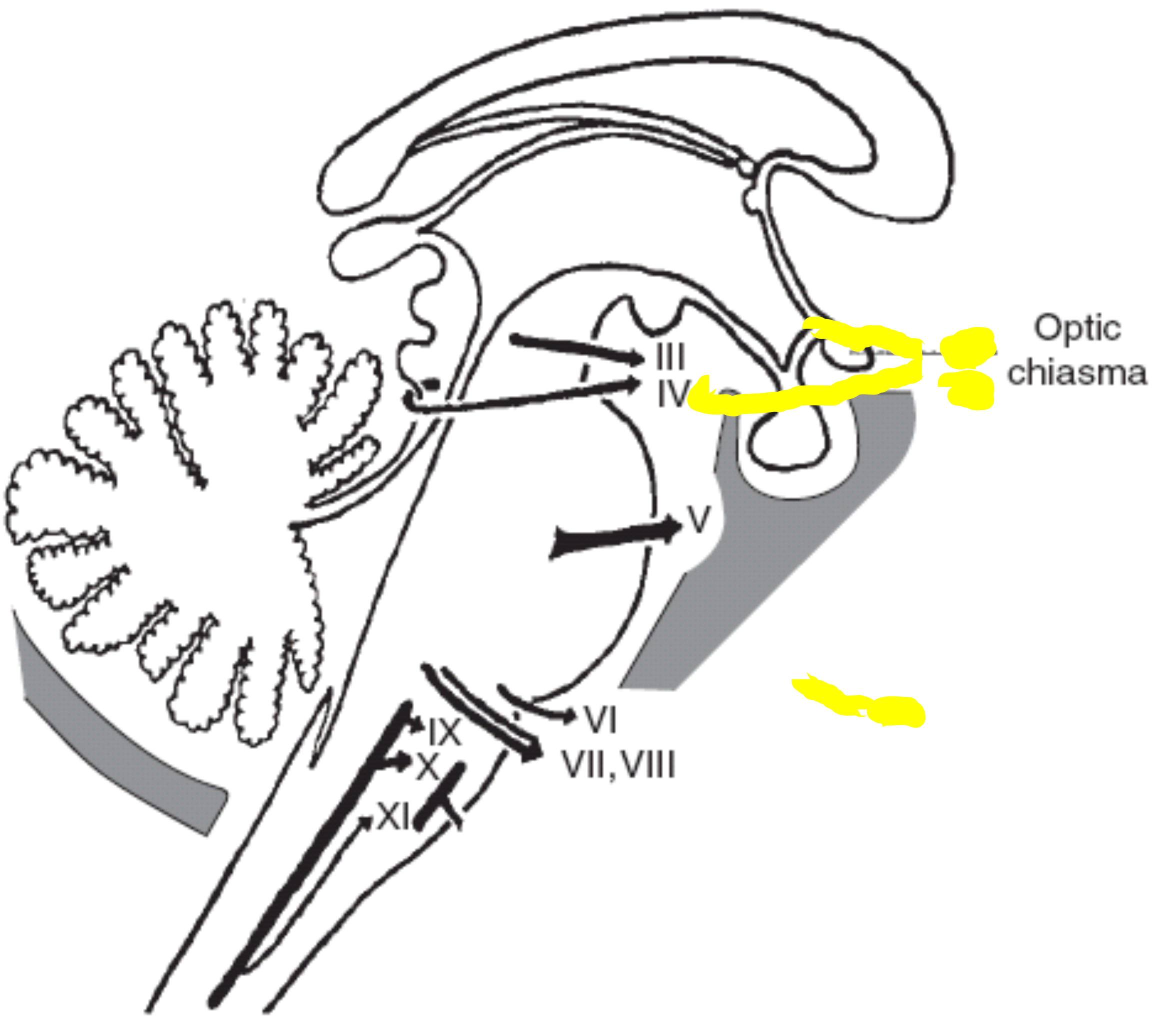

Depression
Left superior
oblique
Intorsion
Depression
Right inferior
rectus
Extorsion

Actions of the extraocular muscles (see also Fig. 14-5)

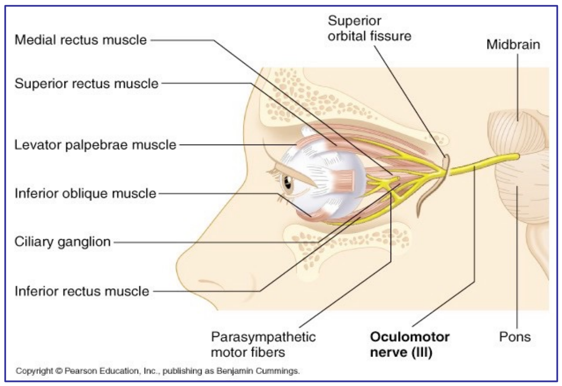
MUSCLE	PRIMARY ACTION	SECONDARY ACTION	OCULOMOTOR NERVE
Medial rectus	Adduction	—	III
Lateral rectus	Abduction	—	VI
Superior rectus	Elevation	Intorsion	III
Inferior rectus	Depression	Extorsion	III
Superior oblique	Intorsion	Depression	IV
Inferior oblique	Extorsion	Elevation	III

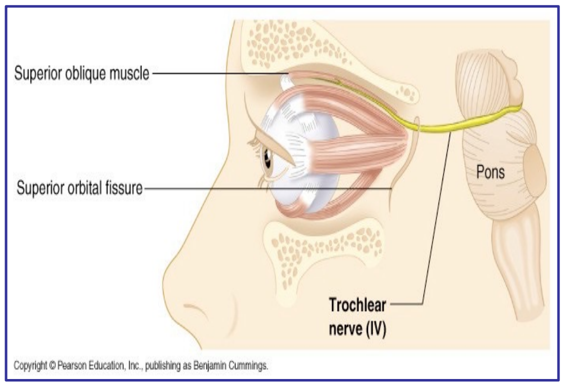
Anatomy of cranial nerves III IV VI

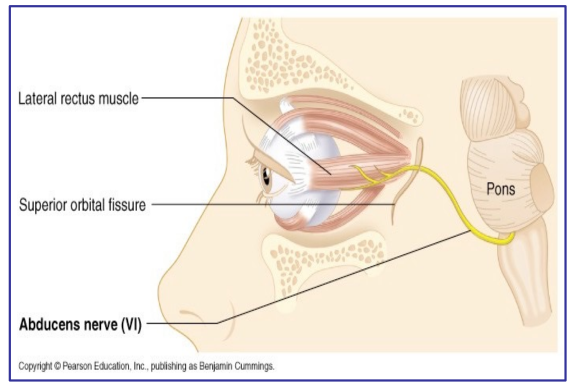
III IV VI nerves arise from brain stem nuclei & after emerging converge towards apex of orbit.


Optic
chiasma
III
IV
V
VI
VII, VIII
IX
X
XI

Ocular motor control







SO4

LR6

Innervation

III
- All extra-ocular muscles except LR6,SO4

IV
- Superior oblique

VI
- Lateral rectus

Oculomotor and ocular motor are not same

Oculomotor means third cranial nerve

Ocular motor means III, IV, VI cranial nerves

Internuclear pathways

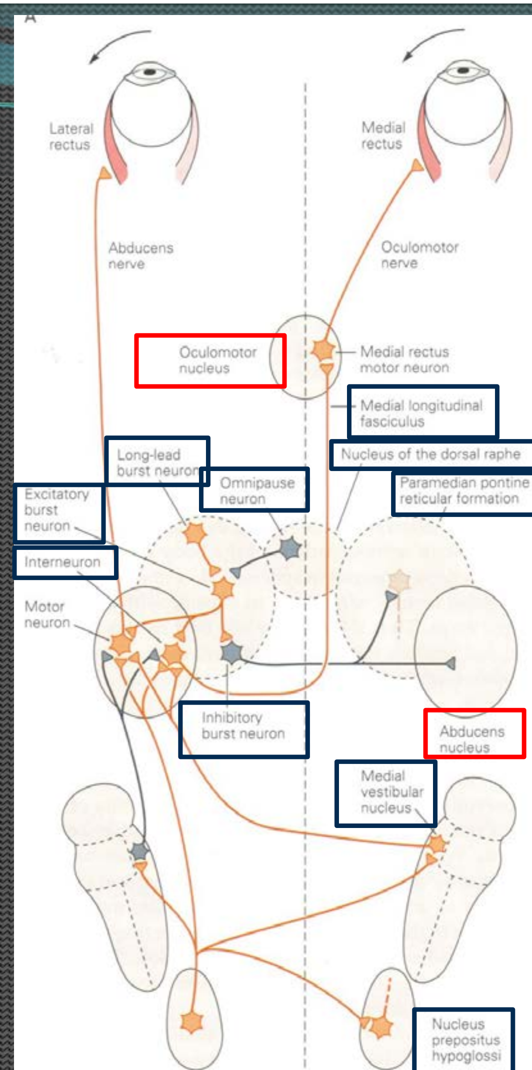
Supranuclear

Internuclear

- MLF
- Omnipause neurons
- EBN, IBN
- NI

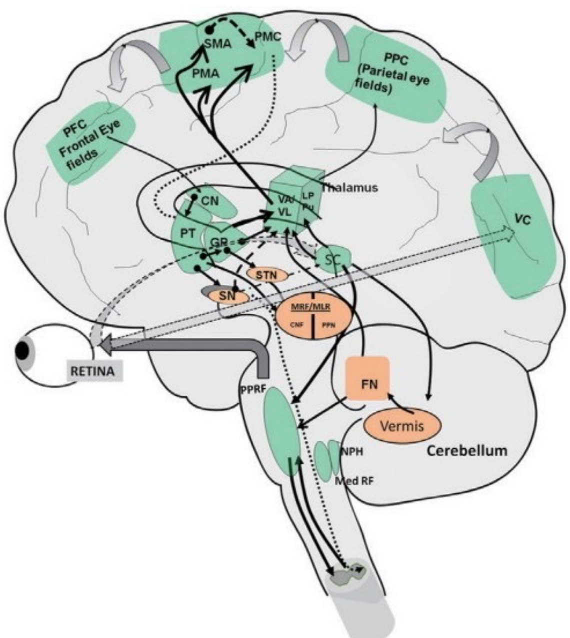
Nuclear

- III, IV, VI

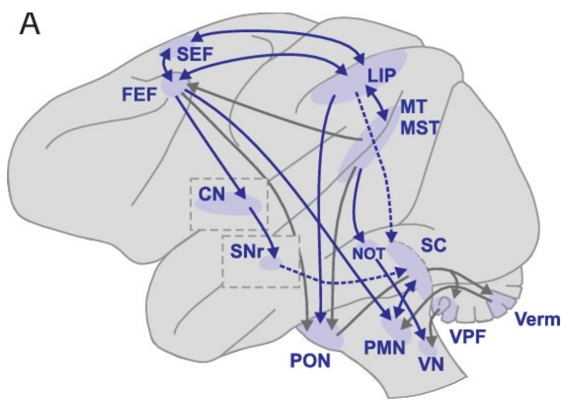


Supra-nuclear control

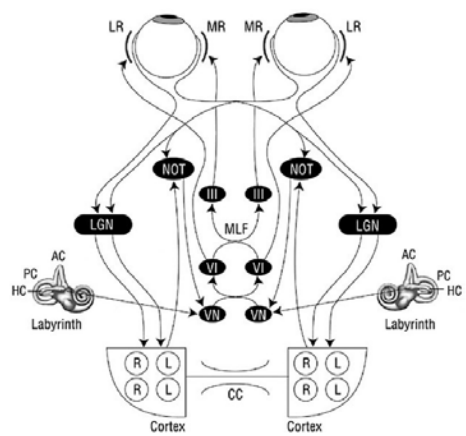
Saccade pathway



Smooth pursuit pathway



Optokinetic pathway



Purpose of eye movements

Hold images of the visual world steady on the retina during brief head rotations or translations (linear movements)

Hold the image of a stationary object on the fovea by minimizing ocular drifts

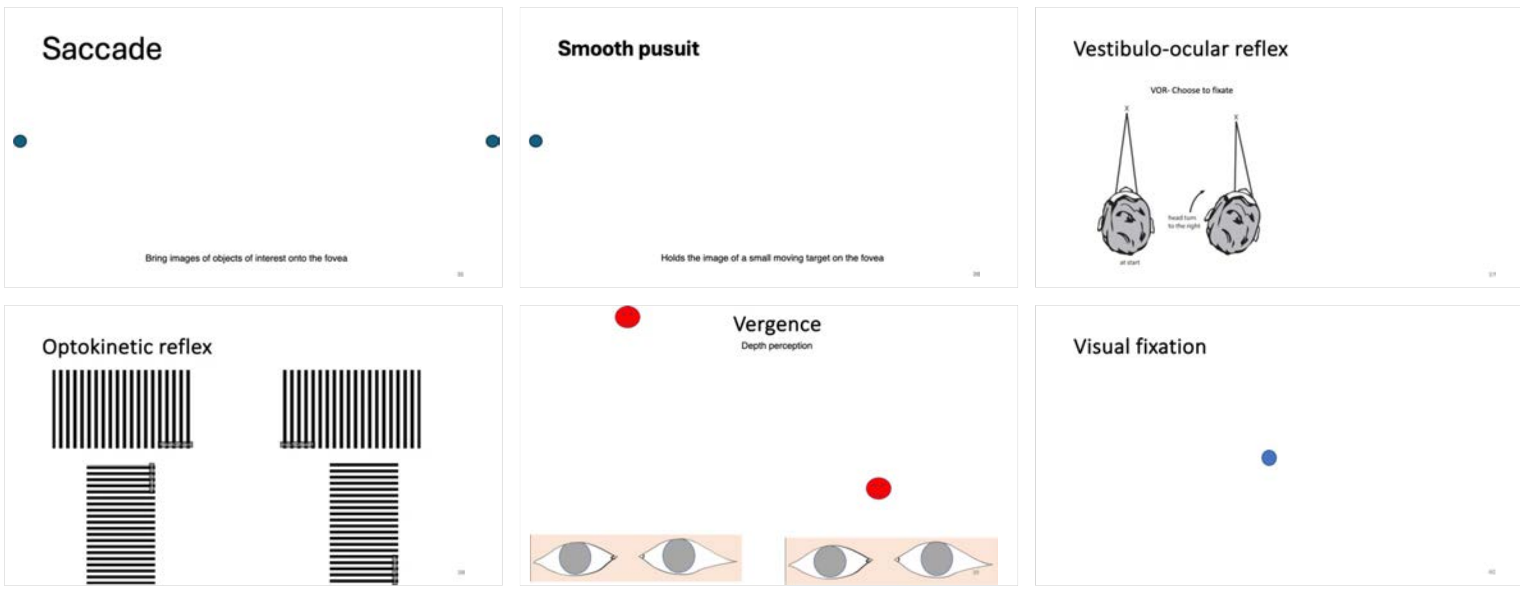
Hold images of the visual world steady on the retina during sustained head rotation or translations

Hold the image of a small moving target on the fovea; or holds the image of a small target on the retina that is close to the head, during linear motion (translation); with optokinetic responses, aids gaze stabilization during sustained head rotation

Bring images of objects of interest onto the fovea

Move the eyes in opposite directions so that images of a single object are placed or held simultaneously on the fovea of each eye

Functional classes of eye movements



Saccade

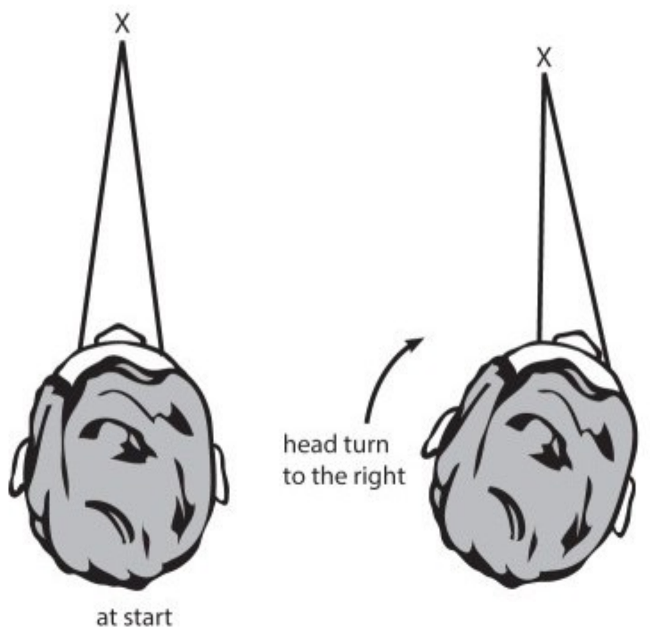
Bring images of objects of interest onto the fovea

Smooth pusuit

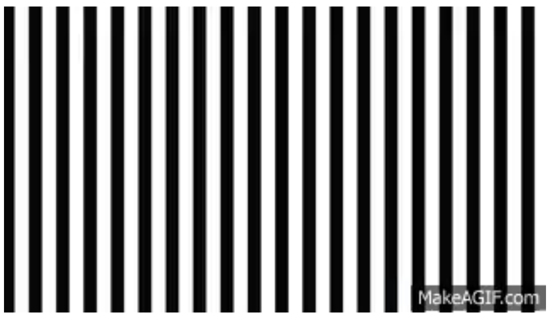
Holds the image of a small moving target on the fovea

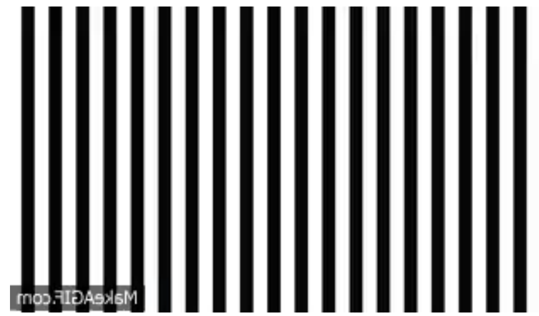
Vestibulo-ocular reflex

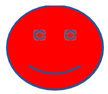
VOR- Choose to fixate



Optokinetic reflex

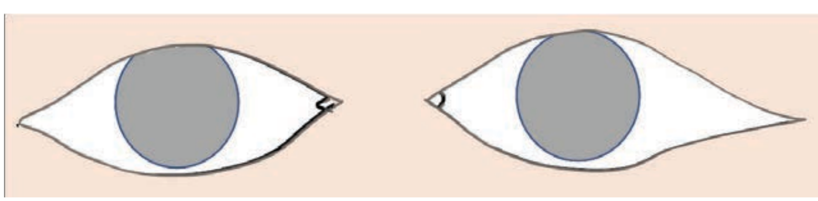


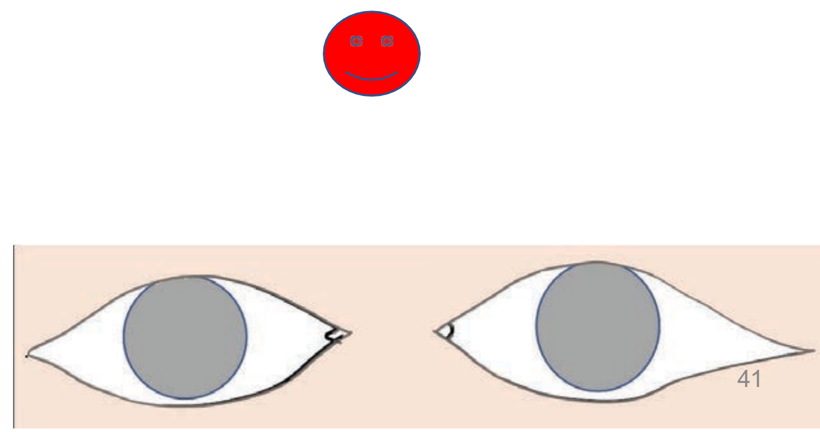




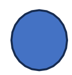
Vergence

Depth perception





Visual fixation



Functional classes of eye movements

Saccades	Bring images of objects of interest onto the fovea
Smooth pursuit	Holds the image of a small moving target on the fovea
VOR	Holds images of the visual world steady on the retina during brief head rotations or translations
OKR	Holds images of the visual world steady on the retina during sustained head rotation or translations
Vergence	Moves the eyes in opposite directions so that images of a single object are placed or held simultaneously on the fovea of each eye
Visual Fixation	Holds the image of a stationary object on the fovea by minimizing ocular drifts

Gaze-shifting

Saccades

Smooth pursuit

Vergence

Gaze-stabilization

VOR

OKR

Visual Fixation

Vestibular

Shorter latency (<15 ms)
Fatigable

VOR

Visual

Longer latency (>70 ms)
No fatigue

Saccades

Smooth pursuit

OKR

Vergence

Visual Fixation

Conjugate

Dys-conjugate

Saccades

Smooth pursuit

VOR

OKR

Vergence

Visual Fixation

Foveal

Retinal

Saccades

Smooth pursuit

VOR

OKR

Vergence

Visual Fixation

Can inhibit

Saccades

Smooth pursuit

VOR

OKR

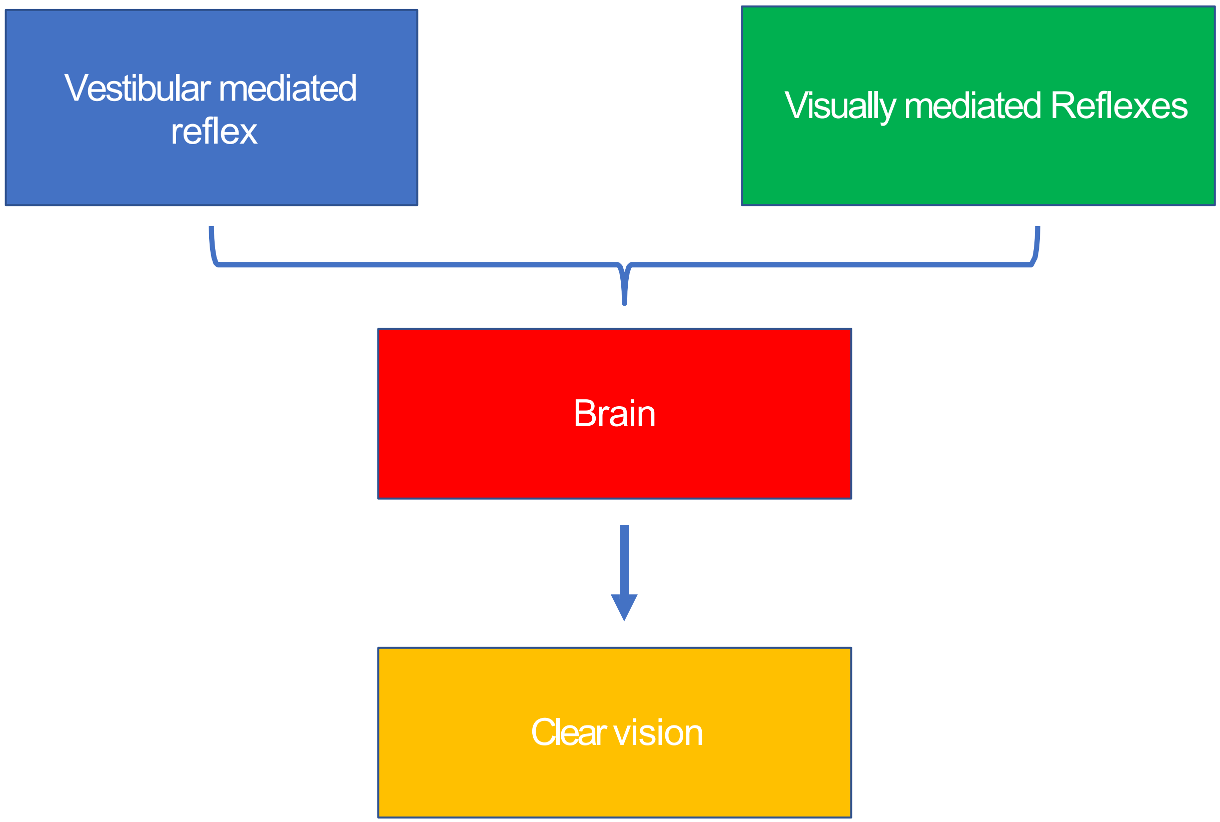
Vergence

Visual Fixation

Involuntary saccades – Fast phase of all nystagmus

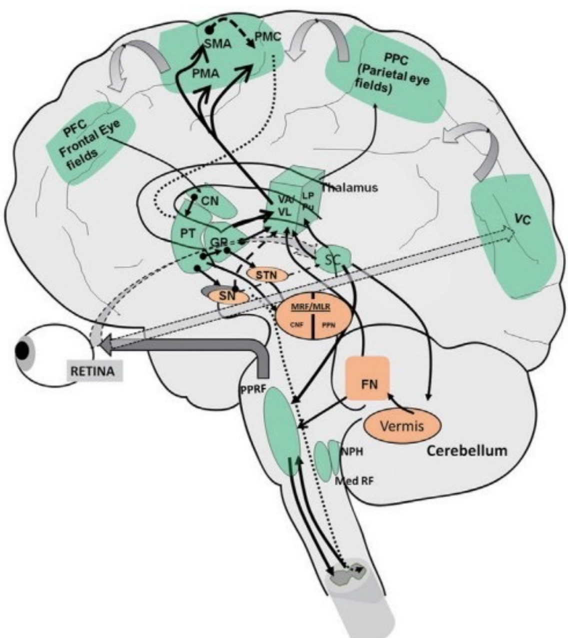
	Voluntary	Reflexive
Saccades	Yes	Yes
Smooth pursuit	Yes	Largely
VOR		Yes
OKR		Yes
Vergence	Yes	Largely
Visual Fixation	Visual Fixation	

Quick phase of OKN, VOR
Reflex visual,
Reflex auditory

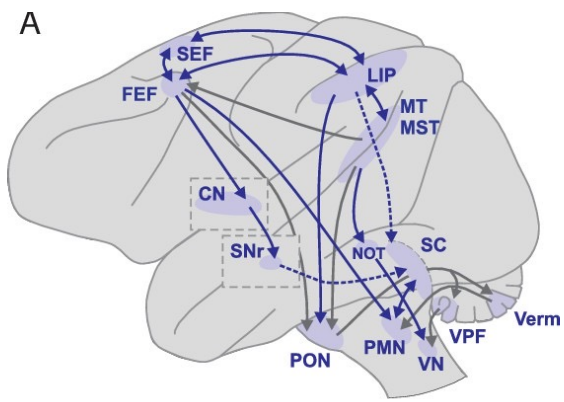

Vestibular mediated reflex
Visually mediated Reflexes
Brain
Clear vision

Why to study eye movements?

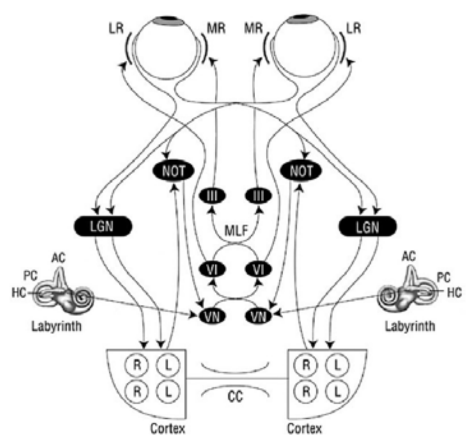
Saccade pathway



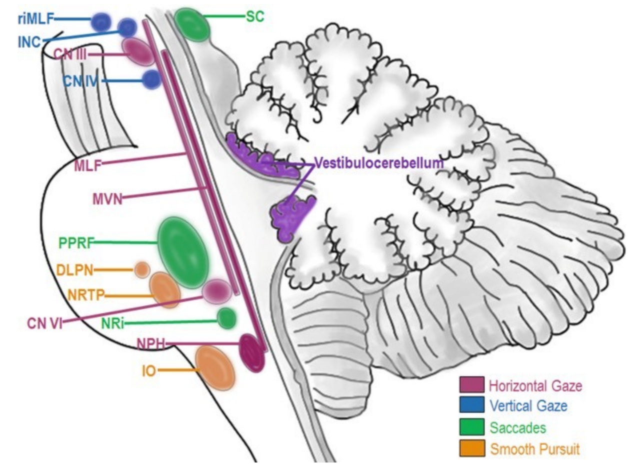
Smooth pursuit pathway



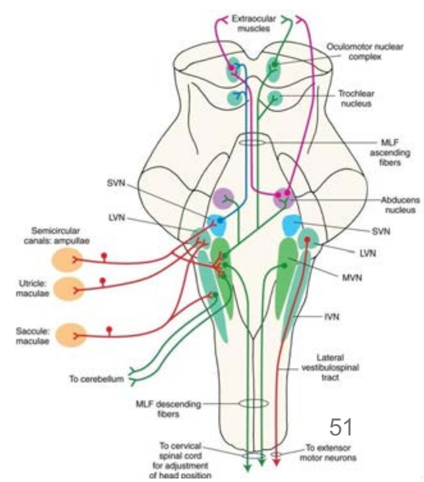
Optokinetic pathway



Brainstem control

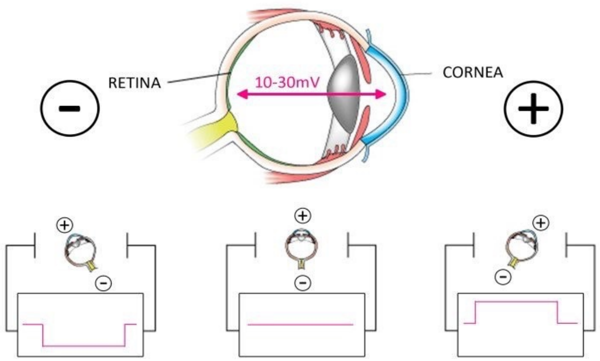


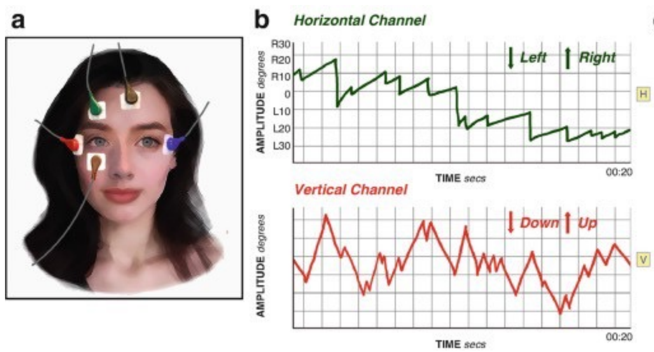
Vestibulo-ocular reflex



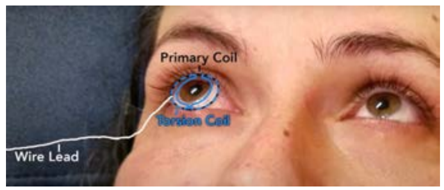
Clinical methods

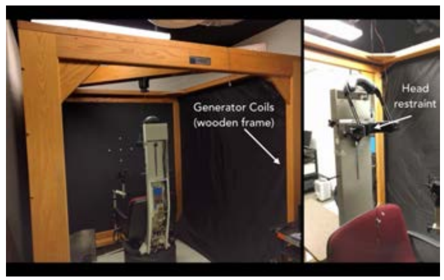
Electro-nystagmography





Scleral search coil





Video-nystagmography

Video-Oculography

Video-recording
Eye movement graphs

Practical and easy

Comparison of Eye Movement Recording Techniques

Feature	Electro-nystagmography (ENG)	Video-nystagmography (VNG)	Scleral Search Coil (SSC)
Method	Measures electrical potential generated by eye movement	Tracks eye movement with a video camera	Tracks eye movement with a magnetic field and coil placed on the sclera
Accuracy	Moderate	High	Highest
Portability	High	Moderate	Low
Cost	Moderate	Moderate	High
Data captured	Primarily horizontal and vertical eye movements	Horizontal, vertical, and torsional eye movements	All eye movements (horizontal, vertical, torsional, and 3D rotations)
Limitations	Susceptible to electrical interference, requires skin contact with electrodes	Limited by camera resolution and field of view, requires good head stabilization	Requires specialized equipment and expertise, invasive procedure (placing coil)
Applications	Assessing vestibular function, diagnosing nystagmus, monitoring for neurological conditions	Similar to ENG, plus evaluation of gaze instability and smooth pursuit	Research on eye movement control, studying vestibular function in detail

NE

Nick name for Video-oculography is

Video-nystagmography

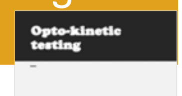

VNG Plus module
VNG Basic module
VideoScope module
OCULOMOTOR
VIDEO-FRENZEL
POSITIONAL & CALORIC

Protocol in VNG

Saccades

Smooth pursuit

Optokinetic testing



Centre gaze testing in light

Gaze testing in light

Testing without fixation

Head shaking nystagmus

Positional testing

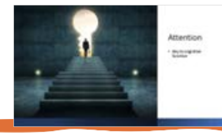
Hyperventilation nystagmus

VOR suppression testing

Caloric testing

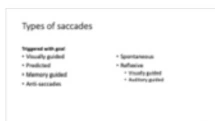
Rotary chair

Saccadic system

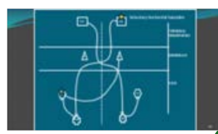


PURPOSE

TYPES



PATHWAYS

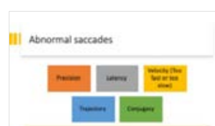


ROLE OF ATTENTION

HOW TO TEST

MECHANICAL PROPERTIES

LESIONS



Purpose

- To place on the fovea objects of interest, which often have first been registered by the peripheral retina

Saccadic eye movements are also used to inspect a complex scene, such as a painting.

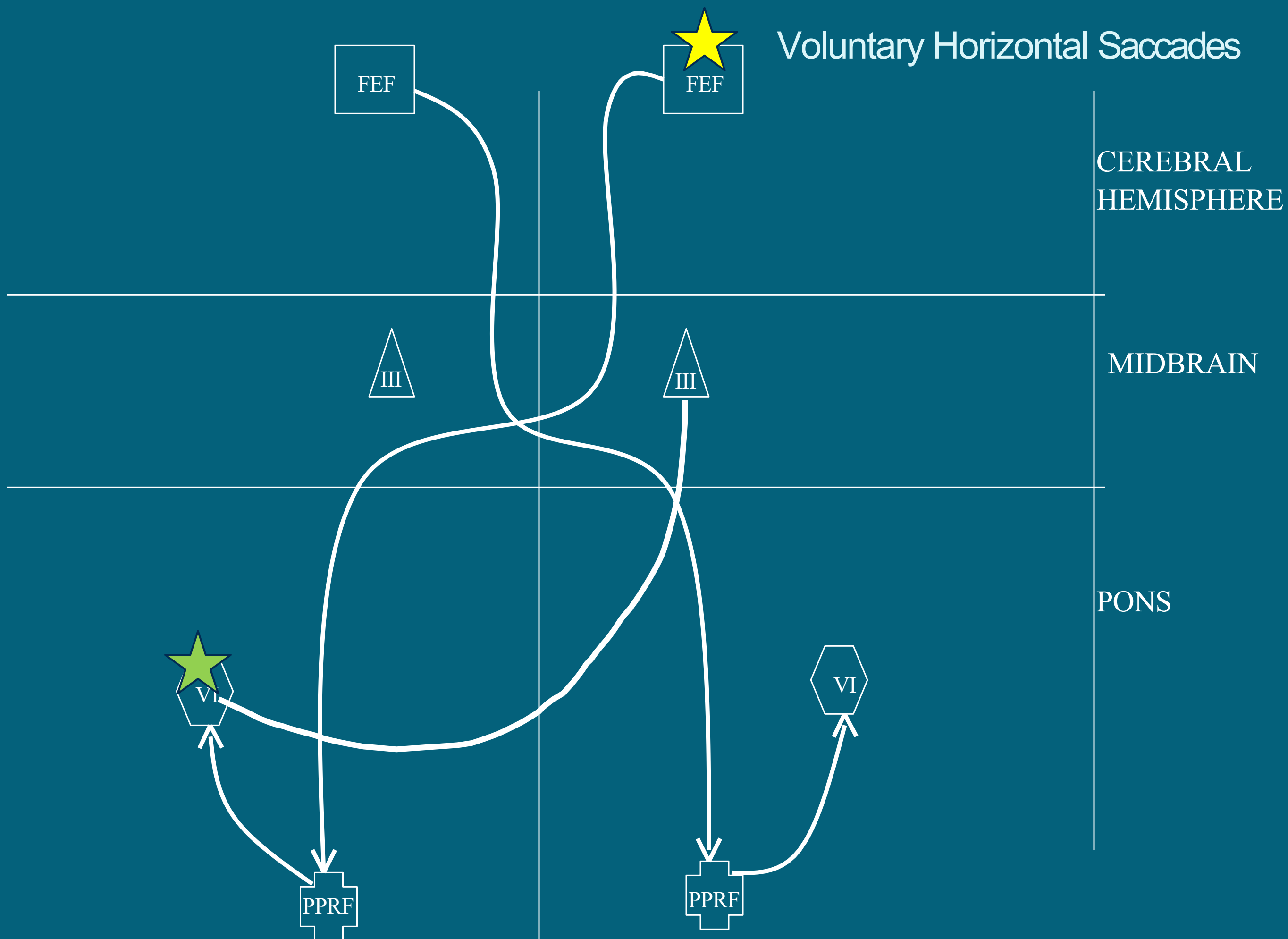
Types of saccades

Triggered with goal

- Visually guided
- Predicted
- Memory guided
- Anti-saccades

- Spontaneous
- Reflexive
  - Visually guided
  - Auditory guided

Voluntary Horizontal Saccades



Saccade control

- Right FEF – Left saccade
- Left FEF – Right saccade
- Both FEF/ SC- Vertical saccade

Attention

- Key to cognitive function

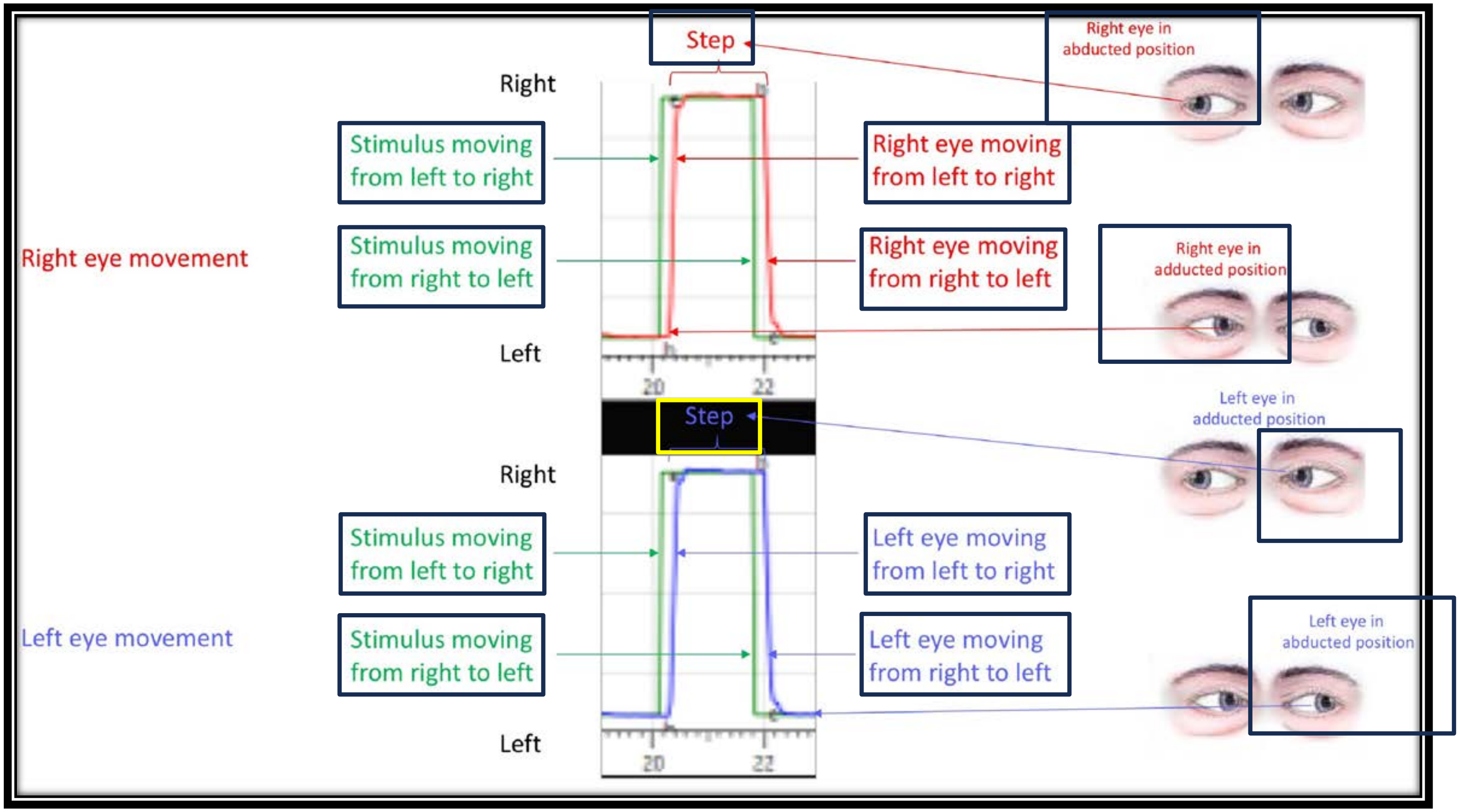
Pre-requisite for VNG test

Mechanical properties of Saccades

Brain makes use of sensory map of the visual environment and the coordinates of the orbit

Desired position and Actual position

Calculate the pulse and step


Step
Right eye in
abducted position
Right
Stimulus moving
from left to right
Right eye moving
from left to right
Right eye movement
Stimulus moving
from right to left
Right eye moving
from right to left
Right eye in
adducted position
Left
20
22
Step
Left eye in
adducted position
Right
Stimulus moving
from left to right
Left eye moving
from left to right
Left eye movement
Stimulus moving
from right to left
Left eye moving
from right to left
Left eye in
abducted position
Left
20
22

Pulse or Phasic discharge or Velocity command

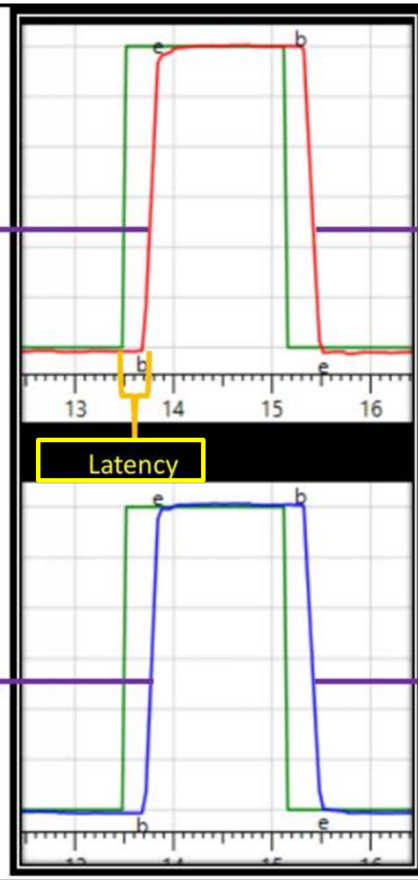
Right LR

Pulse for abduction of right eye

Pulse for right gaze

Left MR

Pulse for adduction of left eye



Pulse for adduction of right eye

Pulse for left gaze

Pulse for abduction of left eye

Overcomes the resistance of orbital tissues
And inertia of the globe

Pulse-slide-step

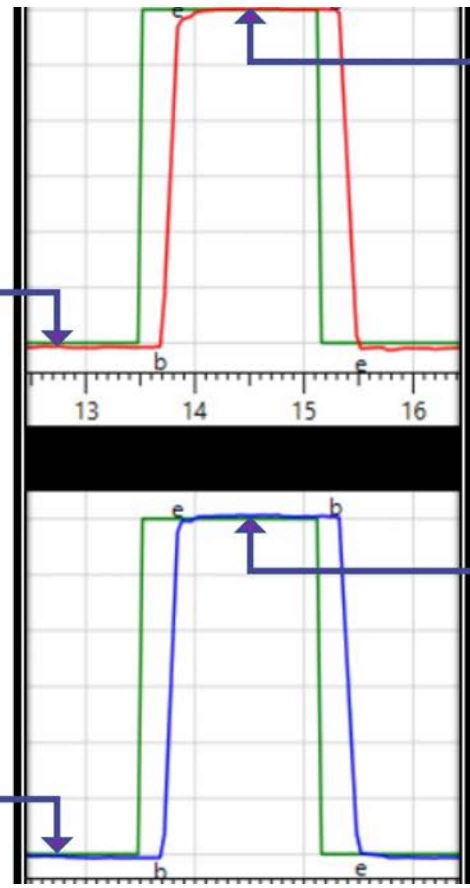
The transition between the end of the pulse and the beginning of the step is actually not abrupt but gradual

Step or Tonic discharge
Or Position command

Step for right eye adduction

Step for left gaze

Step for left eye abduction



Step for right eye abduction

NPH and MVN
NI for Horizontal gaze

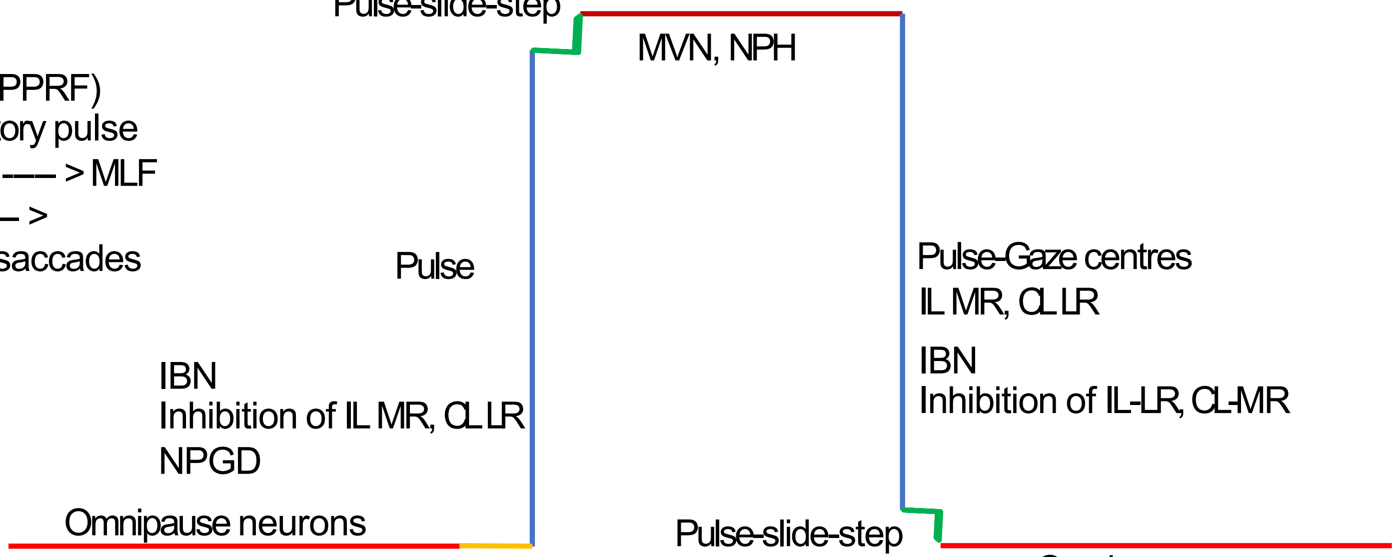
Step for right gaze

Step for left eye adduction

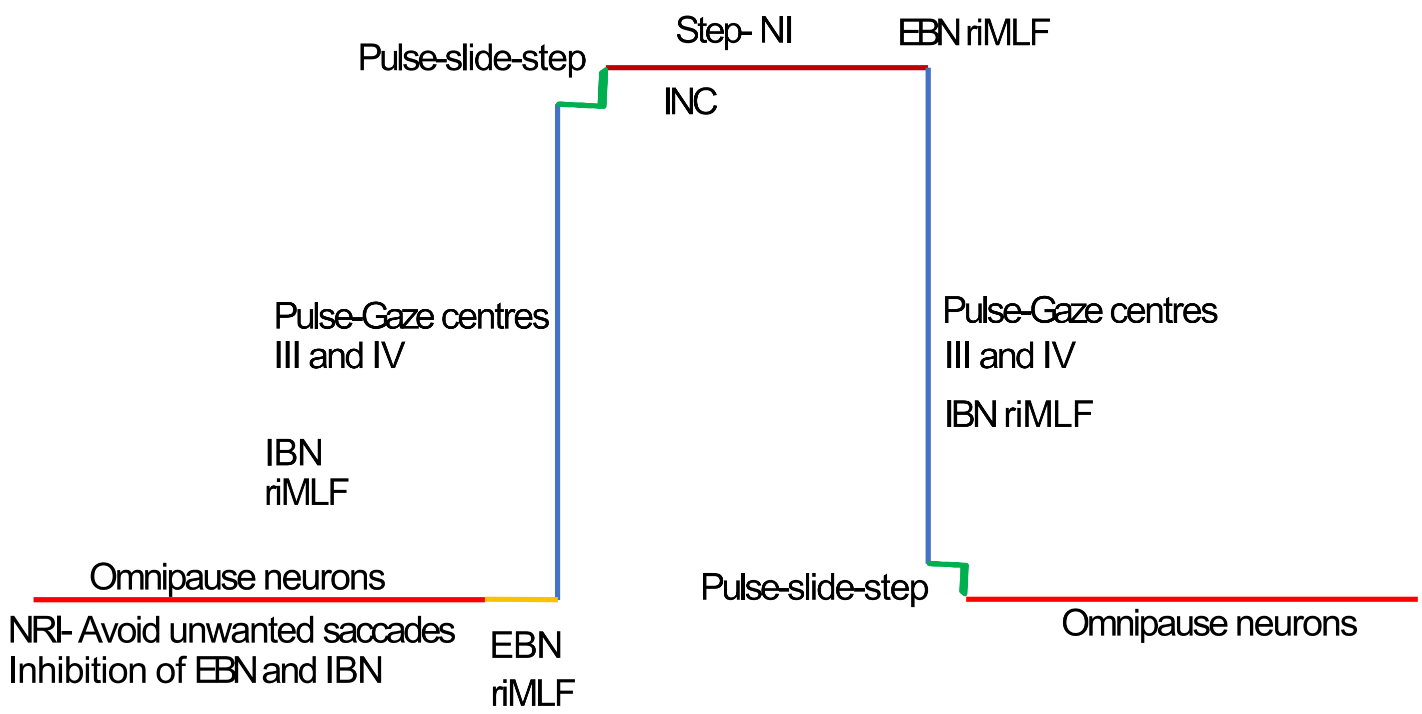
Overcoming the elasticity of the orbital tissues
Keeps the eye in the new position

Horizontal saccades

EBN (Right PPRF)
—- > Excitatory pulse
—– > IL VI —– > MLF
— >CL MR— >
Horizontal saccades



Vertical saccades



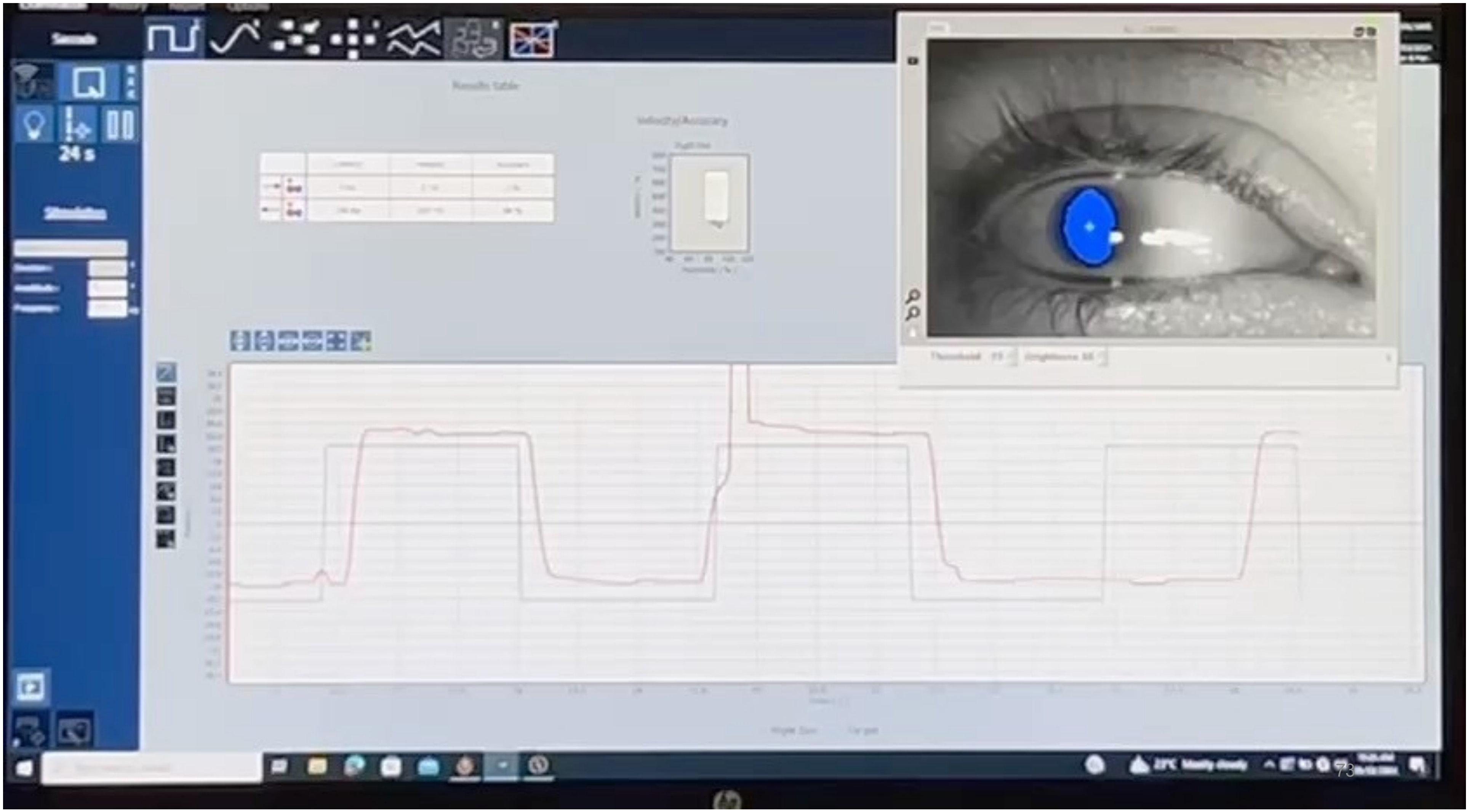
	Horizontal (Caudal pons)	Vertical and torsional (Rostral mesencephalon)	Function	Clinical signs
				Ocular flutter **Opsoclonus** Slow saccades (SCA3)

Cerebrum

- Decides when & where to move

Brainstem

- Determines how to move the eye

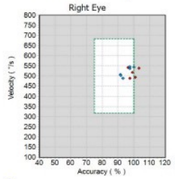

Saccade
24 s

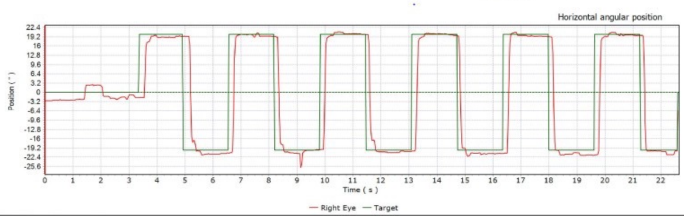
Results table

Calibration: Visual

		Latency	Velocity	Accuracy
→		167 ms	516 °/s	100 %
←		155 ms	521 °/s	95 %

Velocity/Accuracy





Module: Saccade

Test: Open 6 Hor.

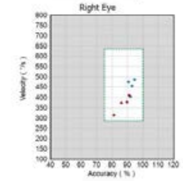
Date: 30/11/2023 - 19:56

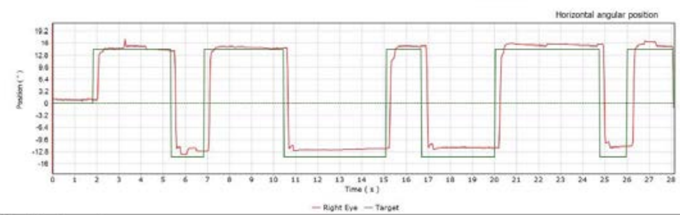
Results table

Calibration: Visual

		Latency	Velocity	Accuracy
→		232 ms	368 °/s	87 %
←		202 ms	456 °/s	93 %

Velocity/Accuracy



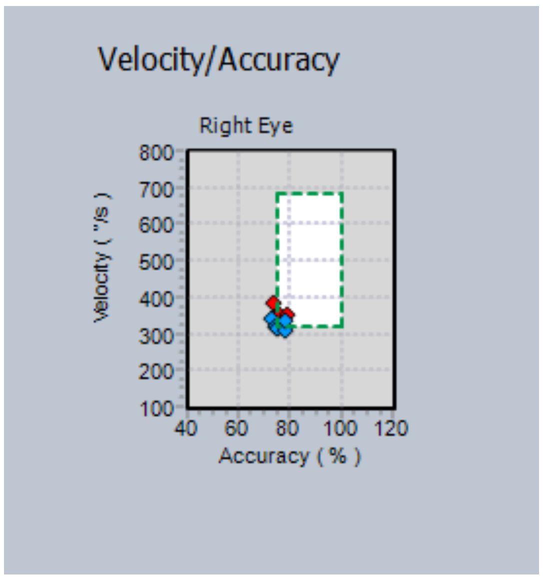


Module: Saccade

Test: Random Freq. Vert.

Date: 14/12/2023 - 19:44

Velocity :-300 to 700^0 / Sec
Precision-80 to 100
Latency-<200 ms



		Latency	Velocity	Accuracy
		180 ms	344 °/s	76 %
		170 ms	322 °/s	76 %

Abnormal saccades

- Precision
- Latency
- Velocity (Too fast or too slow)
- Trajectory
- Conjugacy

Saccade Parameter	Clinical Significance	Causes of Abnormalities	Pathogenesis
Latency	Increased latency may indicate dysfunction **in cortical or subcortical areas responsible for initiating saccades.**	Neurodegenerative diseases (e.g., Parkinson's disease, Huntington's disease), cognitive slowing, frontal eye field or basal ganglia lesions.	**Delayed initiation of saccades** due to impaired transmission of neural signals from cortical areas or basal ganglia involved in the planning and execution of eye movements.
Precision	Imprecision (dysmetria) suggests issues with the **cerebellum or its pathways**, affecting the ability to accurately target visual objects.	Cerebellar ataxia, multiple sclerosis, brainstem lesions affecting the ocular motor system.	Disruption in the cerebellar control of eye movements leads to **overshooting or undershooting of the target**, reflecting the cerebellum's role in fine-tuning and error correction of motor actions.
Velocity	Decreased velocity can indicate **brainstem or ocular motor nerve dysfunction.** Consistently high velocity may not be as common but could suggest compensation mechanisms.	Myasthenia gravis, oculomotor nerve palsy, brainstem stroke, peripheral neuropathies.	**Impaired neural signal transmission or muscle weakness** affecting the rapid muscle contractions required for swift eye movements. In cases of brainstem lesions, disruption of the paramedian pontine reticular formation or pathways can affect saccadic speed.

Slower saccades

Elderly

Drowsy

Inattentive

Medicated

Cortical lesions

FEF

- Involves Non-visual guided intensional saccades
- Spares visually guided intensional saccades

PEF

- Visually guided saccades
- Spares non-visual saccades

Unilateral parietal lesions

- Increased saccade latencies
- Hypometric contralateral saccades
- Saccadic slowing

BL Parietal lesions

- Acquired ocular motor apraxia
- Visual > Voluntary

BL FP lesions

- Both Visual and Voluntary

FEF and SC

- Saccade to CL side

Smooth pursuit

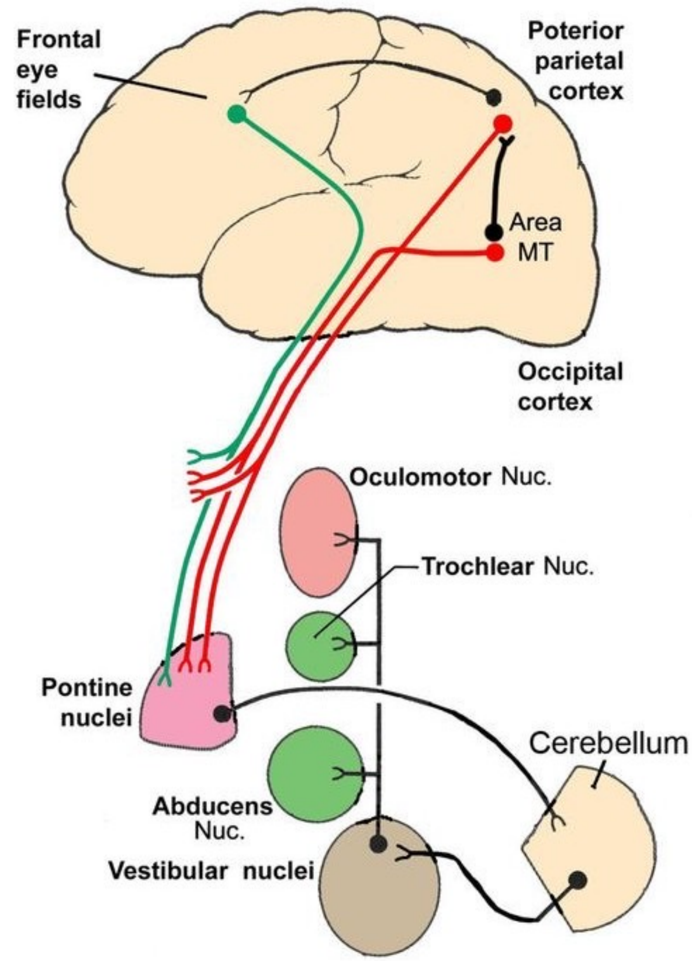
- Object of regard – Fovea or macula
- Retinal slip – Major stimulus
- Detected by visual system
- OK drum or tape – Smooth pursuit and Saccade
- Velocity upto – 30-40 degrees per second
- Faster moving objects- Saccades

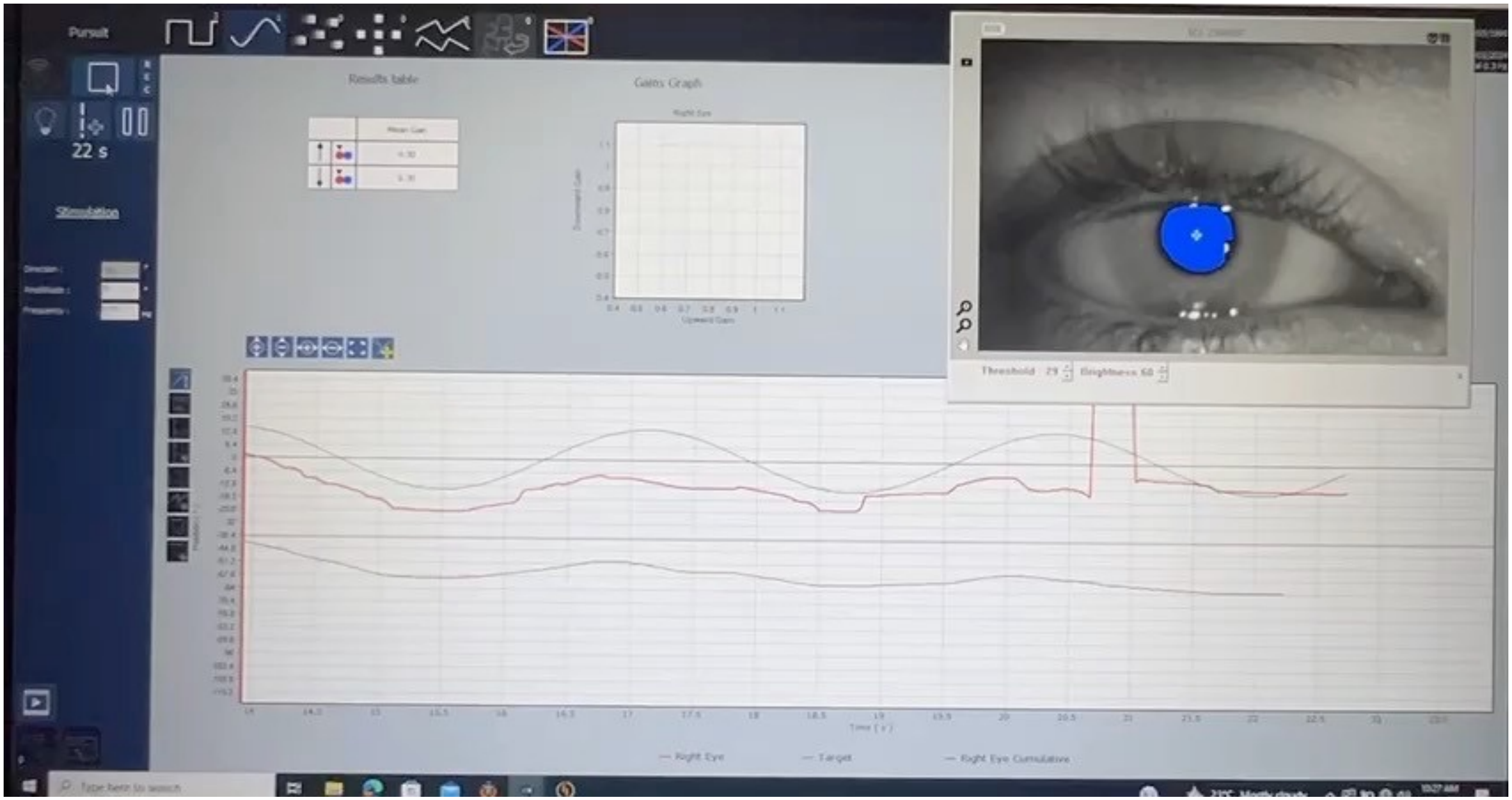
- Excess head motion or Excess object motion

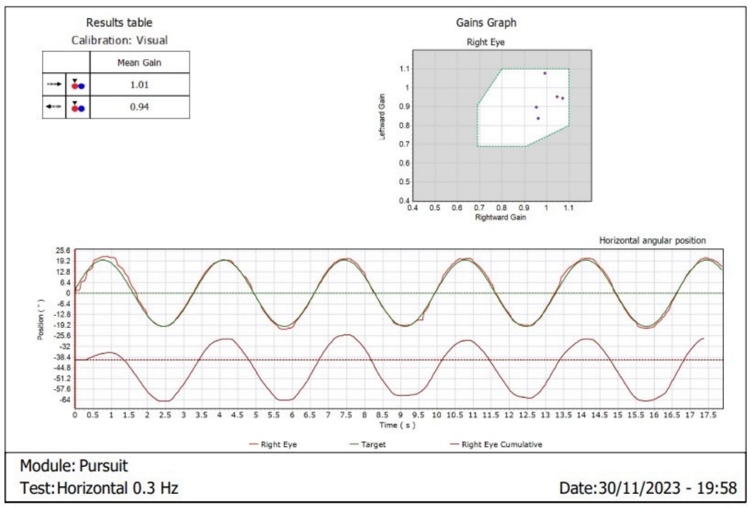
Retinal slip- The image moves off the fovea of the retina, resulting in visual blurring

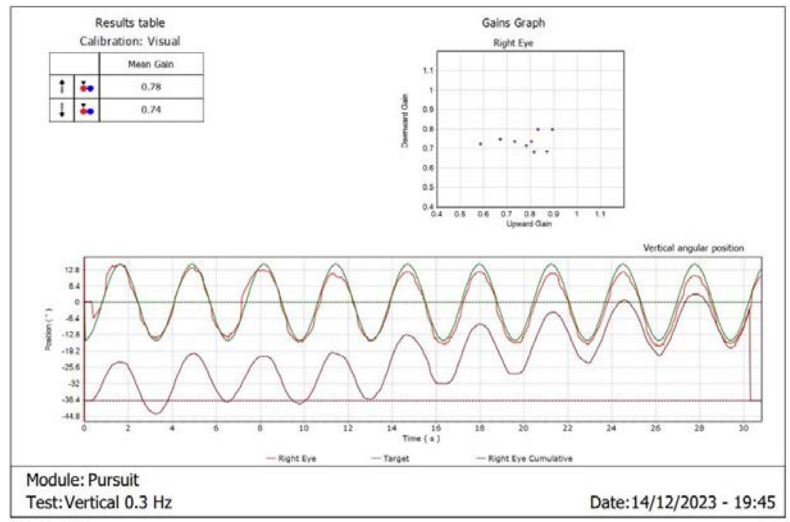
Control of Smooth Pursuit Eye Movements

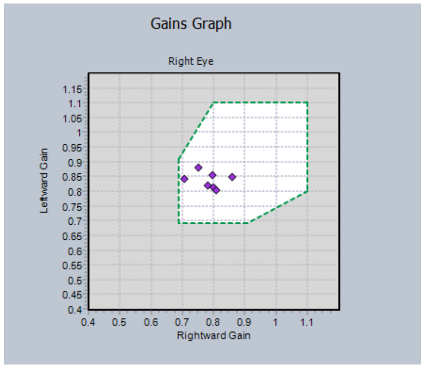
video

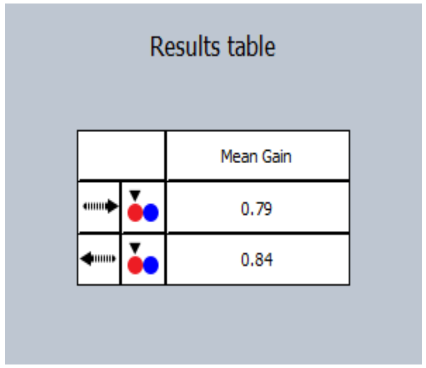



Pursuit
22 s
Stimulation
Results table
Gains Graph
Threshold 29
Brightness 60

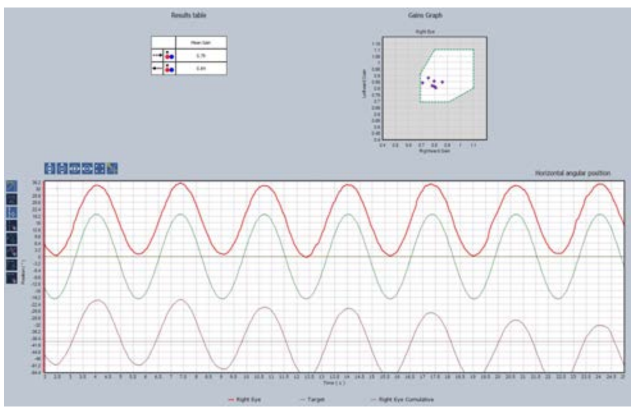

Results table
Calibration: Visual
Mean Gain
1.01
0.94
Gains Graph
Right Eye
Leftward Gain
Rightward Gain
Horizontal angular position
Position (°)
Time (s)
Right Eye
Target
Right Eye Cumulative
Module: Pursuit
Test: Horizontal 0.3 Hz
Date: 30/11/2023 - 19:58


Results table
Calibration: Visual
Mean Gain
0.78
0.74
Gains Graph
Right Eye
Downward Gain
Upward Gain
Vertical angular position
Position (°)
Time (s)
Right Eye
Target
Right Eye Cumulative
Module: Pursuit
Test: Vertical 0.3 Hz
Date: 14/12/2023 - 19:45





Normal Mean gain:-0.8 to 1.1



Abnormality	Pathogenesis	Potential Causes
Saccadic Intrusions	Disruption in the smooth control of eye movements, leading to unintended saccades.	Central nervous system disorders, lesions in the brain areas controlling eye movements.
Reduced Gain	The eyes move slower than the target, indicating inefficiency in processing visual motion or ocular motor dysfunction.	Vestibular dysfunction, cerebellar disorders, brainstem lesions, visual processing disorders.
Asymmetry in Pursuit	Unequal ability to pursue targets in diff erent directions, indicating unilateral impairment.	Unilateral vestibular loss, lesions in one hemisphere affecting ocular motor control, unilateral cerebellar dysfunction.
Catching-Up Saccades	Corrective saccades made when the eyes fall behind the moving target, indicating a delay in eye movement initiation or speed.	Cerebellar disorders, brainstem dysfunction, vestibular system disorders.
Back-Up Saccades	Corrective saccades made when the eyes overshoot the target, similar to catching-up saccades but in the opposite direction.	Less common, but can be associated with dysfunction in the cerebellum or brainstem.
Gaze-Evoked Nystagmus during Pursuit	Induction of nystagmus when attempting to maintain gaze on a moving target, indicating abnormal vestibular or ocular motor response.	Vestibular disorders, central nervous system lesions, medication effects, cerebellar dysfunction.
Pursuit Intermittency	Interruption of smooth pursuit by phases of fixation or loss of tracking, indicating issues with maintaining continuous visual tracking.	Neurodegenerative diseases, attentional disorders, lesions affecting visual motion processing areas.

Impaired SP

Impaired VOR suppresion

Hemispherotomy

Lesions in SP pathway

Supra-tentorial

- Frontal lesions- Predictable IL SP
- Dorsomedial Frontal cortex
- Bilateral Occipital lesions- Abolish SP
- Parietal lesions- Reduce the amplitude and velocity of IL SP
- UL Posterior cerebral cortex
  - Unidirectional deficit of SP
  - Bidirectional deficit
- Near area 19,37,39
- Occipito-temporal area
- Internal capsule
- Posterior thalamic hemorrhage

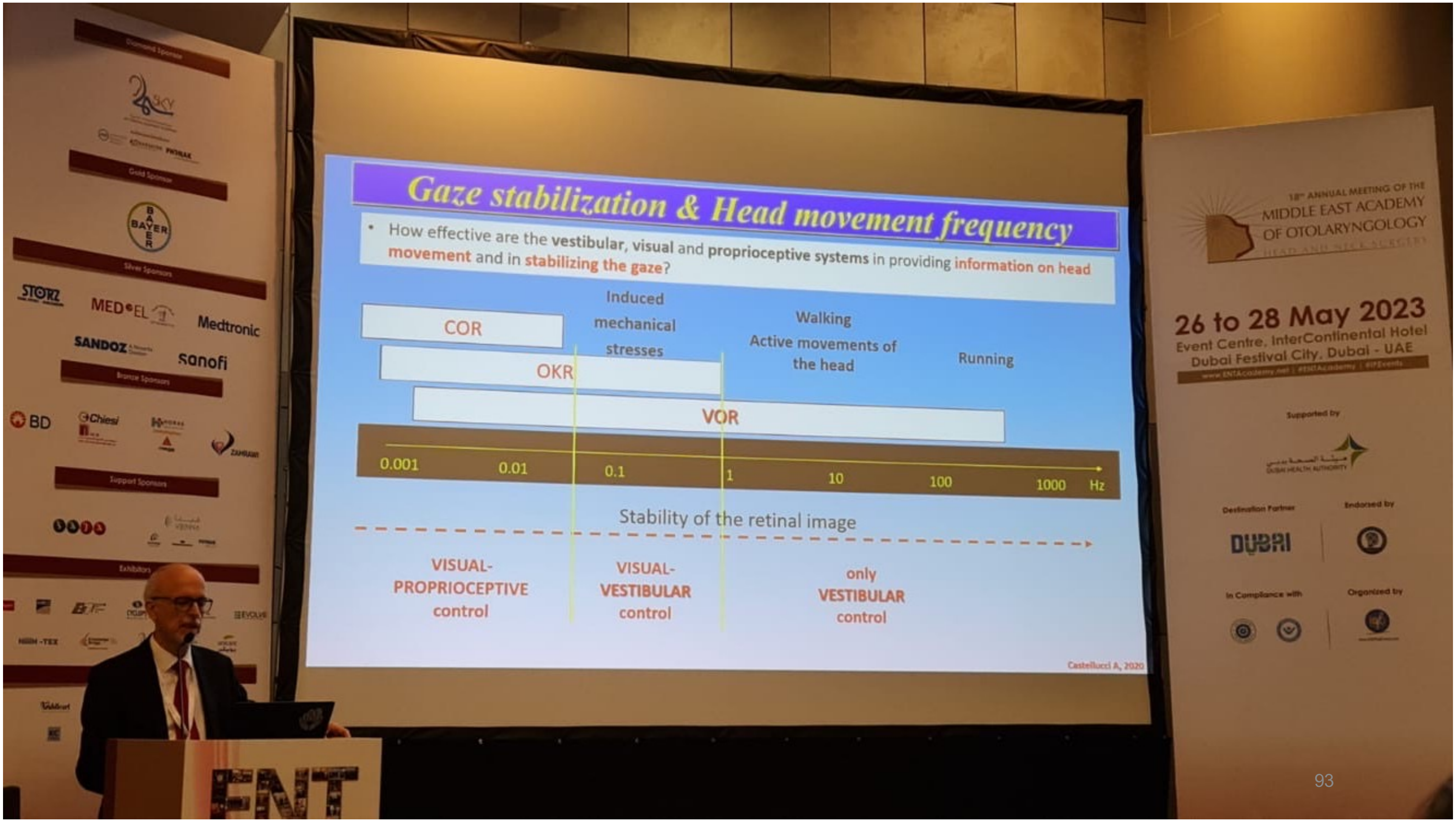
Infra-tentorial

- Posterior fossa lesions
- UL MB lesions
- Basal pontine lesions
- Paramedian middle pontine infarct- Impaired SP (DLPN, NRTP) with bilateral horizontal GEN (PMT)
- MLF lesions (Vertical SP)

Sustained attention

Migraine	Sleepy patient	Drugs	Disseminated disorders
			• PSP • Huntington's disease • Gerstmann-Straussler-Scheinker disease • HIV related disease

Opto-kinetic testing


Gaze stabilization & Head movement frequency
How effective are the vestibular, visual and proprioceptive systems in providing information on head movement and in stabilizing the gaze?
COR
OKR
VOR
Induced mechanical stresses
Walking
Active movements of the head
Running
0.001
0.01
0.1
1
10
100
1000
Hz
Stability of the retinal image
VISUAL-PROPRIOCEPTIVE control
VISUAL-VESTIBULAR control
only VESTIBULAR control
Castellucci A, 2020
MIDDLE EAST ACADEMY OF OTOLARYNGOLOGY
26 to 28 May 2023
Event Centre, InterContinental Hotel
Dubai Festival City, Dubai - UAE
DUBAI
Medtronic
sanofi
STORZ
BD
ENT

OKR

VOR fatigues after 30 seconds

Different system required for gaze stability with continuous head motion in the same direction

Opto-kinetic Nystagmus

Ocular stabilisation system

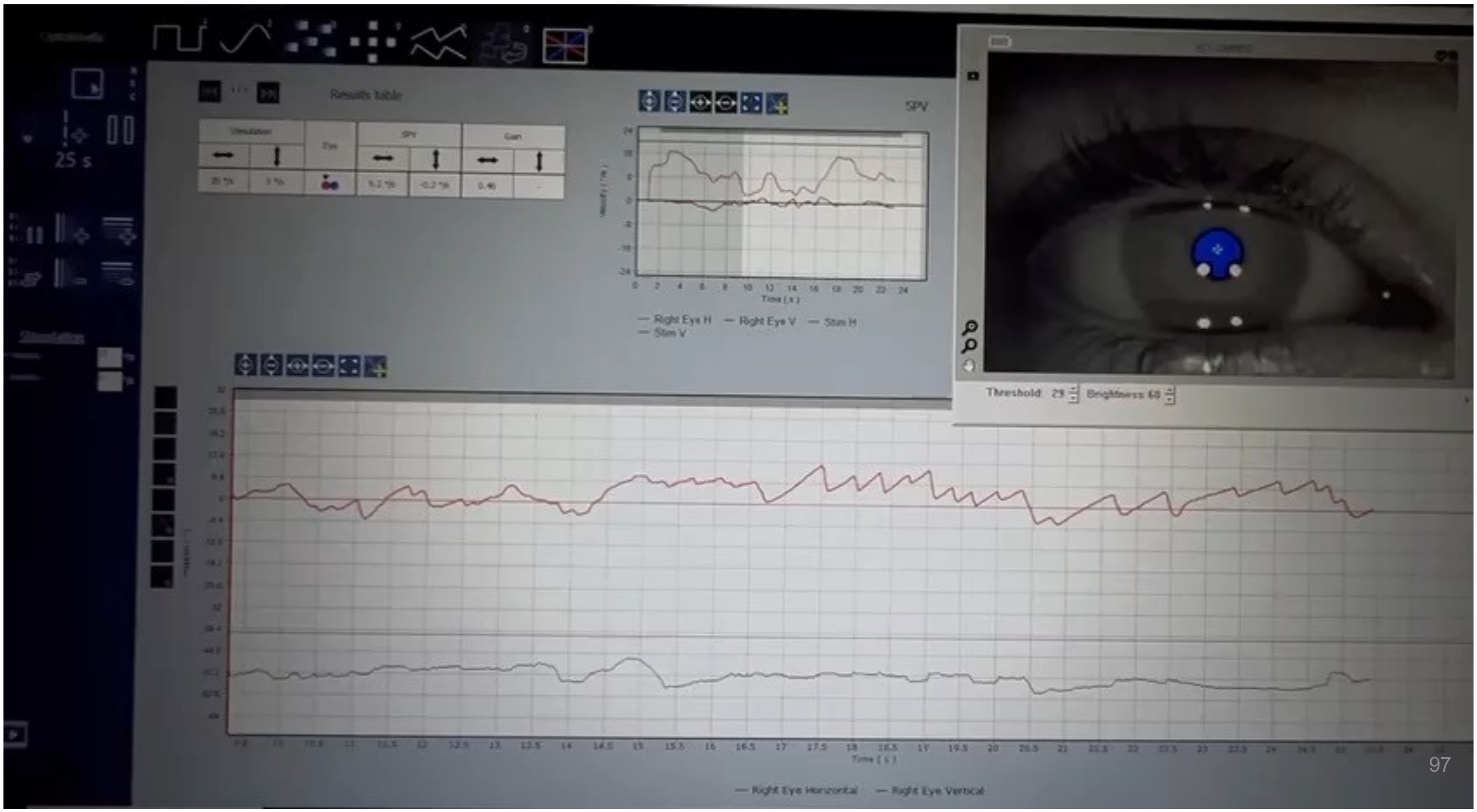
Succession of moving stimulus
(Optic flow)

Rhythmic oculomotor response (Nystagmus)

Combination of pursuit and saccades

Railway nystagmus or parade nystagmus

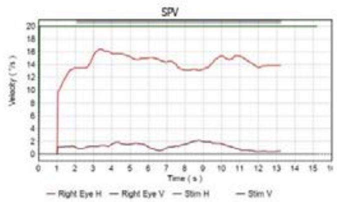
It allows the tracking of targets in succession

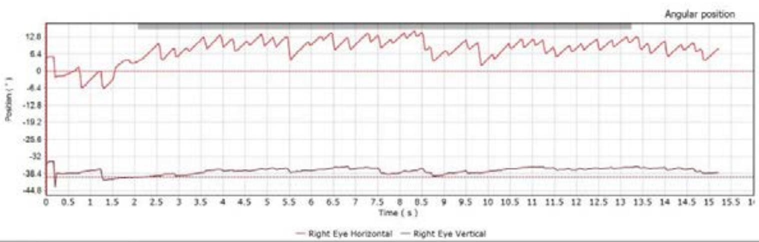

Results table
SPV
Right Eye H
Right Eye V
Stim H
Stim V
Time (s)
Threshold 29
Brightness 60
Right Eye Horizontal
Right Eye Vertical

Results table

Calibration: Default

Stimulation		Eye	SPV		Gain	
↔	↕		↔	↕	↔	↕
20 °/s	0 °/s		14.5 °/s	1.2 °/s	0.73	-





Module: Optokinetic

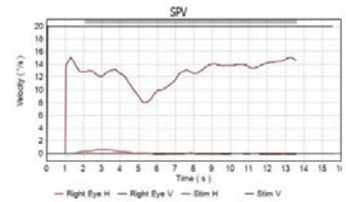
Test: Horizontal 20 deg/s

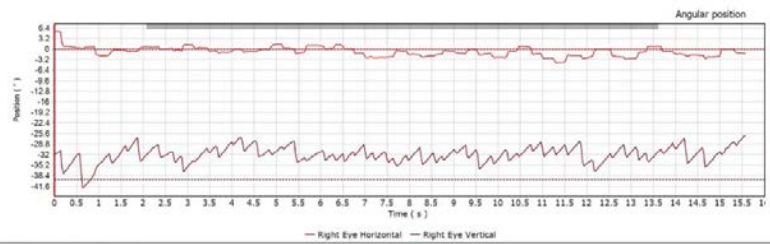
Date: 11/10/2023 - 19:34

Results table

Calibration: Default

Stimulation		Eye	SPV		Gain	
↔	↕		↔	↕	↔	↕
0 °/s	20 °/s		0.1 °/s	12.6 °/s	-	0.63

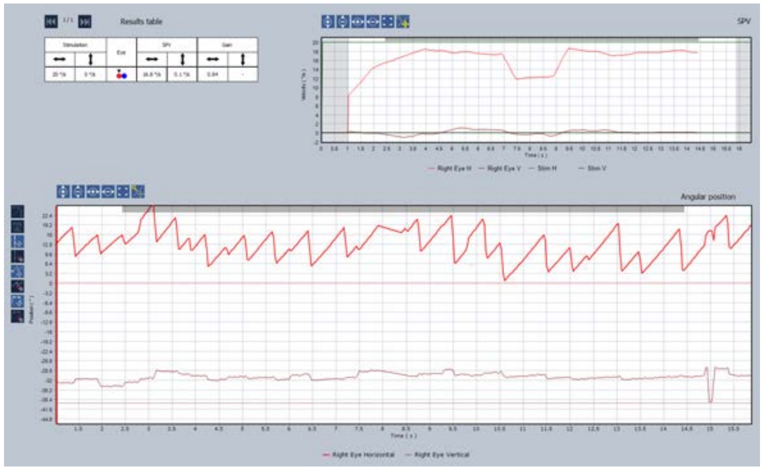


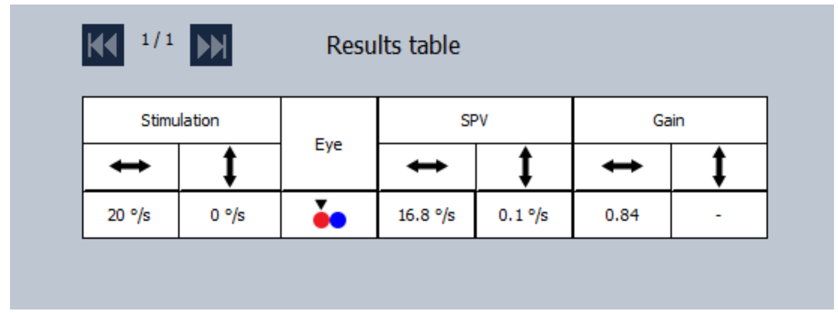


Module: Optokinetic

Test: Vertical 20 deg/s

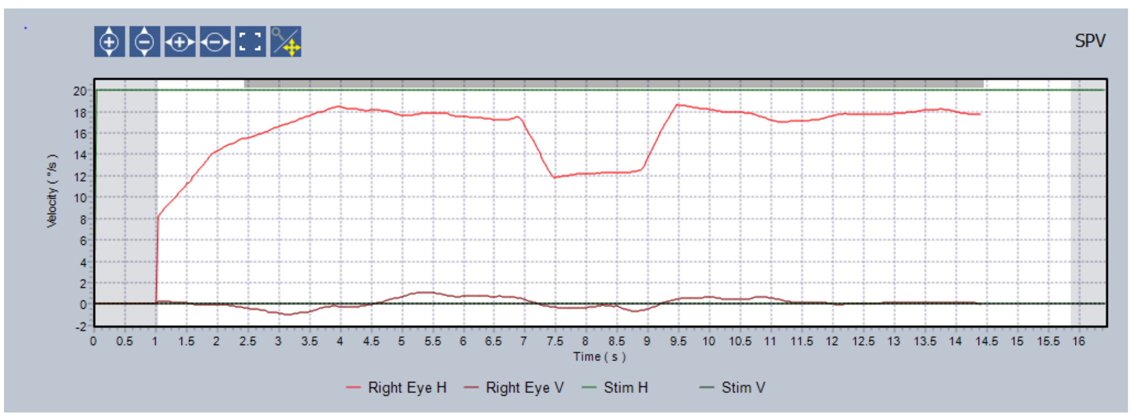
Date: 11/10/2023 - 19:35

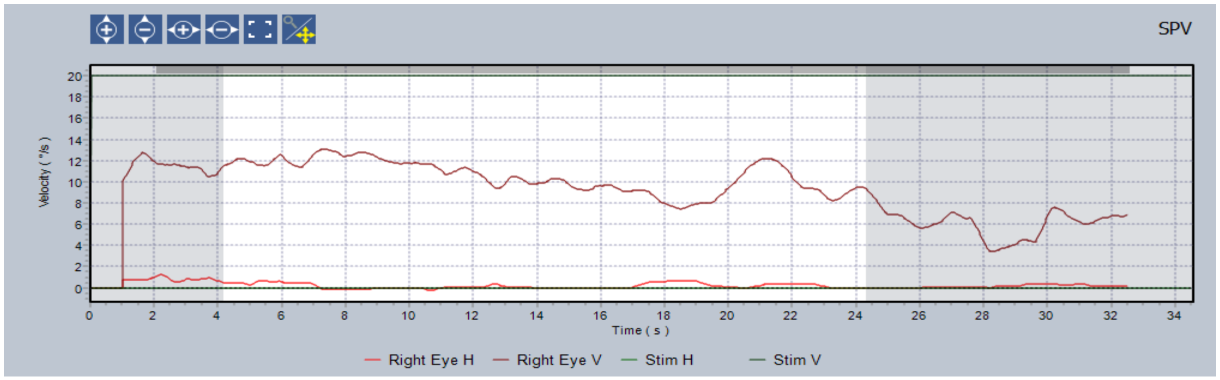


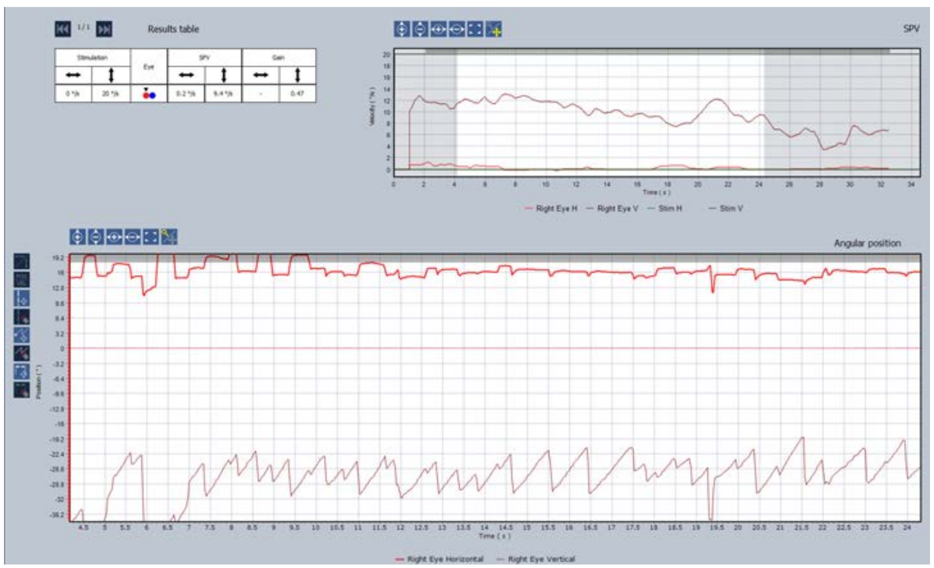

1 / 1

Results table

Stimulation		Eye	SPV		Gain	
↔	↕		↔	↕	↔	↕
20 °/s	0 °/s		16.8 °/s	0.1 °/s	0.84	-







Stimulation		Eye	SPV		Gain	
↔	↕		↔	↕	↔	↕
0 °/s	20 °/s		0.2 °/s	9.4 °/s	-	0.47

Clinical significance

- Anterior visual pathway defects – Reduce OK response
- Parieto-occipital lesion, PSP
- UL vestibulopathy- Directional prepondarance
- Visual acuity in infants (4-6 months)
- Psychogenic blindness, Reduced LOC
- Reversed OKN- Congenital nystagmus
- Subtle INO
- Convergence retraction nystagmus due to forced upward saccade in perinaud's syndrome

Purpose of eye movements

Hold images of the visual world steady on the retina during brief head rotations or translations (linear movements)
Hold the image of a stationary object on the fovea by minimizing ocular drifts
Hold images of the visual world steady on the retina during sustained head rotation or translations
Hold the image of a small moving target on the fovea; or holds the image of a small target on the retina that is close to the head, during linear motion (translation); with optokinetic responses, aids gaze stabilization during sustained head rotation
Bring images of objects of interest onto the fovea
Move the eyes in opposite directions so that images of a single object are placed or held simultaneously on the fovea of each eye


VERTIGO CLINIC
When you seek balance in every movement
#LiveBetter
Aster

academia
COURSE
Fundamentals of Videonystagmography: Theory, Practice, and Clinical Cases
SPEAKER
Dr. Vishal Pawar
ONLINE SESSIONS:
6 MAR
5 pm CET • 8 pm GST
20 MAR
5 pm CET • 8 pm GST
3 APR
6 pm CEST • 8 pm GST
IN-PERSON HAND-ON SESSION:
8 JUN • 08:30 am – 05:30 pm, Dubai (UAE)
PRE-REGISTER NOW!

Thank you

neurovishal@gmail.com

+971553377067