

# OCULOMOTOR mechanisms involved in FIXATING images in fovea

***Saccadic system***

***Convergence system***

***Smooth pursuit system***

***Visual fixation with gaze holding***

***VOR and suppression of VOR by Visual Fixation***

***Optokinetic system***

# Gaze stabilization achieved by



Convergence system



SPS - smooth pursuit system



OPK-Optokinetic system



SC- saccadic system system



Gaze holding system

- *these reflex systems are facilitated by the OCULOMOTOR system*
- *cerebellum fine tunes the oculomotor response*
- *cortical / subcortical centers modify the response*

# OCULOMOTOR mechanisms involved in FIXATING images in fovea



***Saccadic system***



***Convergence system***



***Smooth pursuit system***



***Visual fixation with gaze holding***



***Vestibulo Ocular Reflex***



***Suppression of VOR  
by Visual Fixation***

# Evaluating the oculomotor system



# Supranuclear OCULOMOTOR centers in the brain

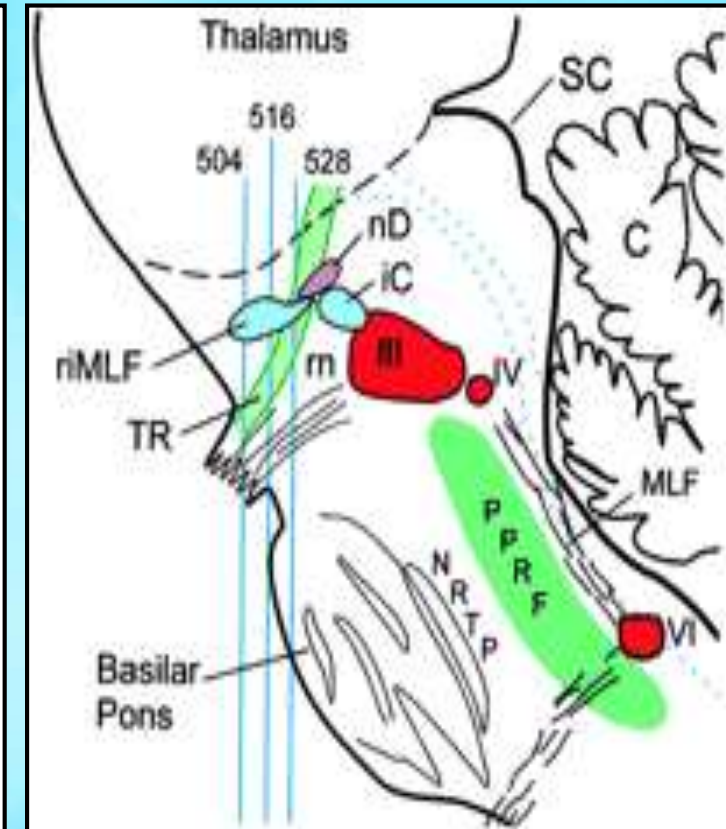
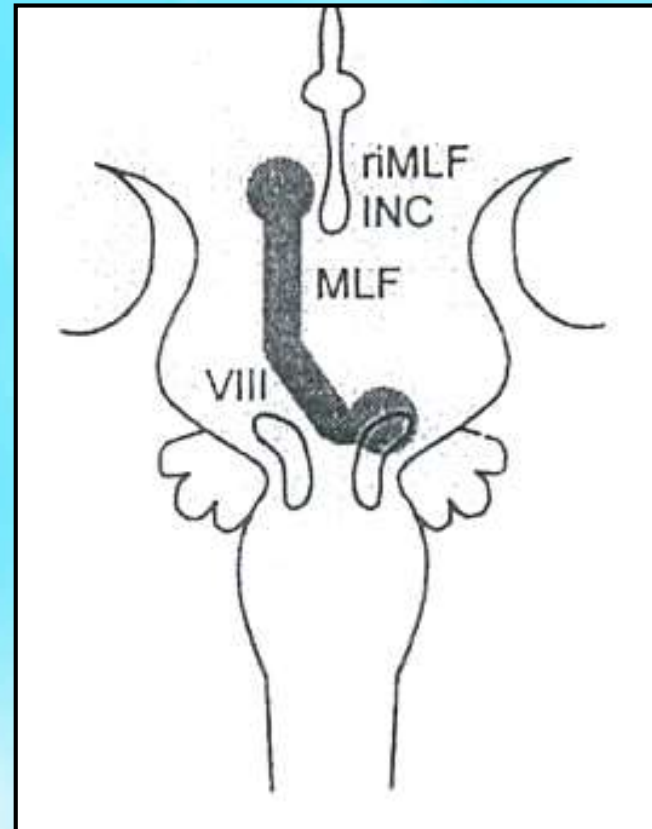
**rMLF** - Rostral interstitial nucleus of medical longitudinal fasciculus (upper midbrain)

**INC** - Interstitial nucleus of Cajal (upper midbrain)

**PPRF** - Paramedian Pontine Reticular Formation

**NPH** - Nucleus Praepositus Hypoglossi

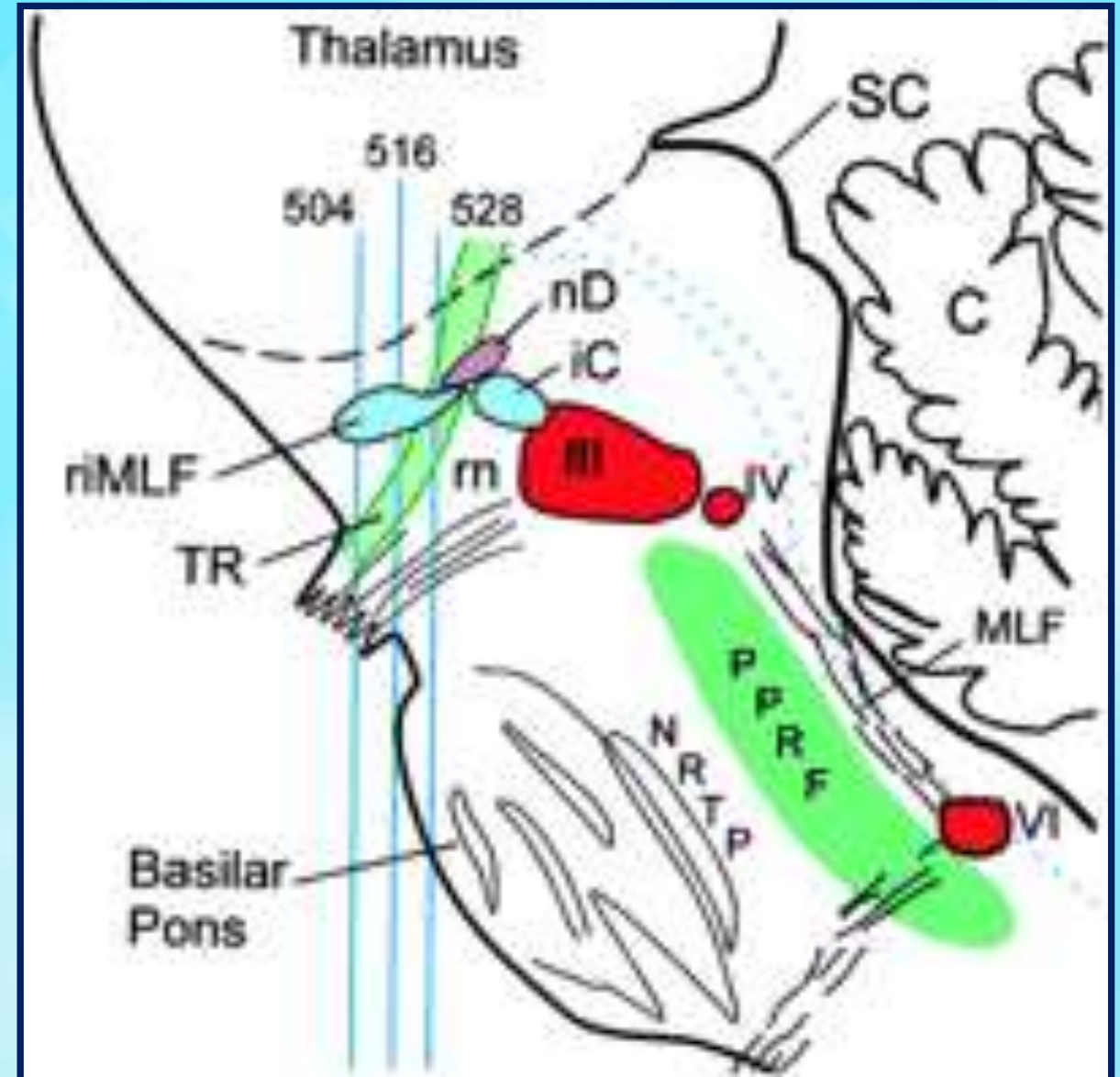
**PC** - Posterior Commissure (connects the rMLF of 2 sides)



***All structures have SPECIFIC functions***

# Functions of the Oculomotor centers

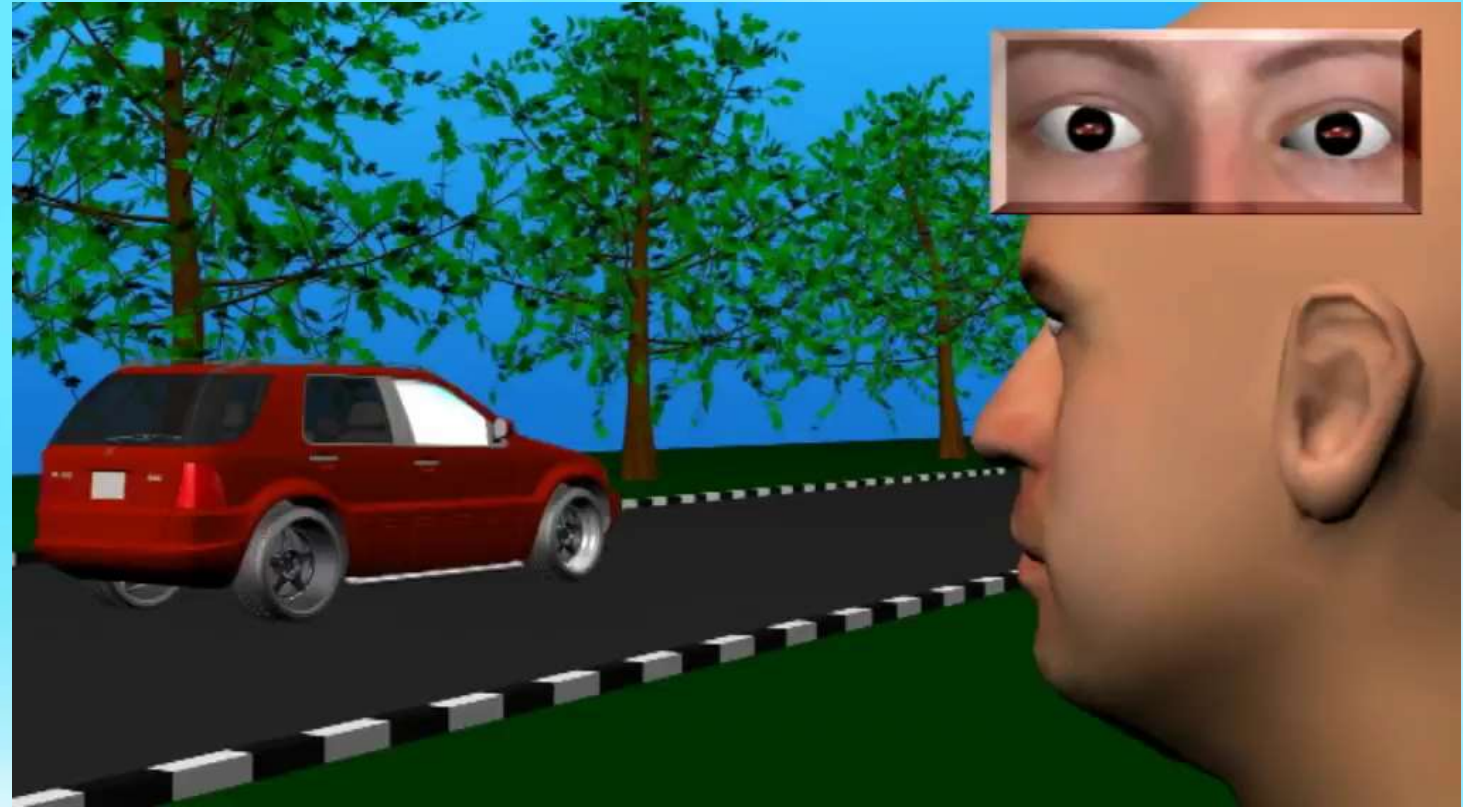
- *rMLF* - Vertical saccades
- *PPRF* - horizontal saccades
- *INC* - gaze holding in vertical axis
- *NPH* - gaze holding in horizontal axis
- *PC* - abnormal convergence nystagmus



# Vestibulo-ocular reflex (VOR)

**Stabilize images in the fovea**

- *when the target moves*
- *when the head moves*

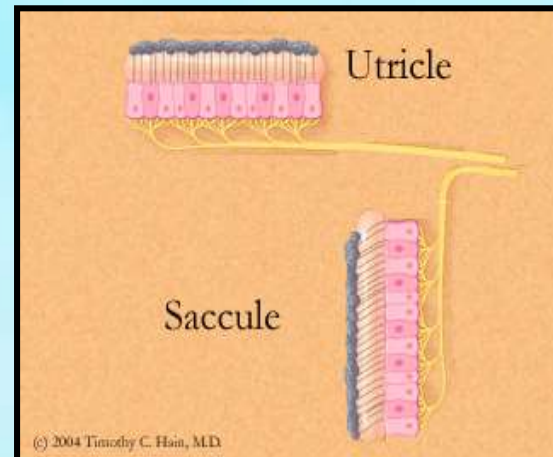
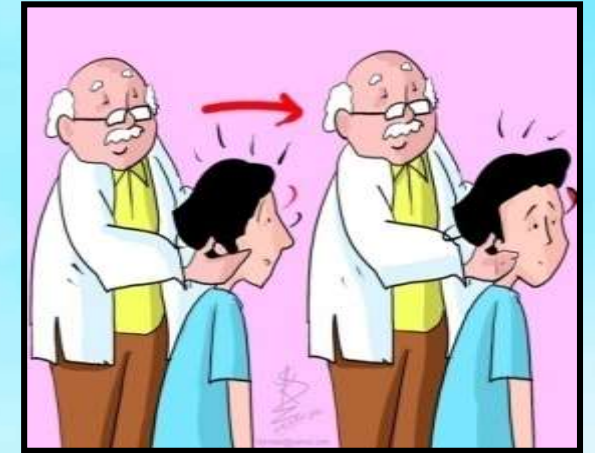


**- achieved by**

- 1) moving eyes smoothly in the direction of the target when head is stationary but target moves, and opposite to the movement of the target when target is stationary but head moves;*
- 2) moving eyes at a speed which is equal to the speed of the target/ head movement*

# Maintenance of VOR

- All 6 semicircular canals are involved through ampulo-ocular reflex evaluated clinically by the HEAD IMPULSE TEST and documented precisely by the **Video Head Impulse test (VHIT)**
- Otolith organs (utricle & saccule) of both sides involved through maculo-ocular reflex evaluated by **ocular VEMP** and **cervical VEMP**





# Smooth Pursuit System (SPS)

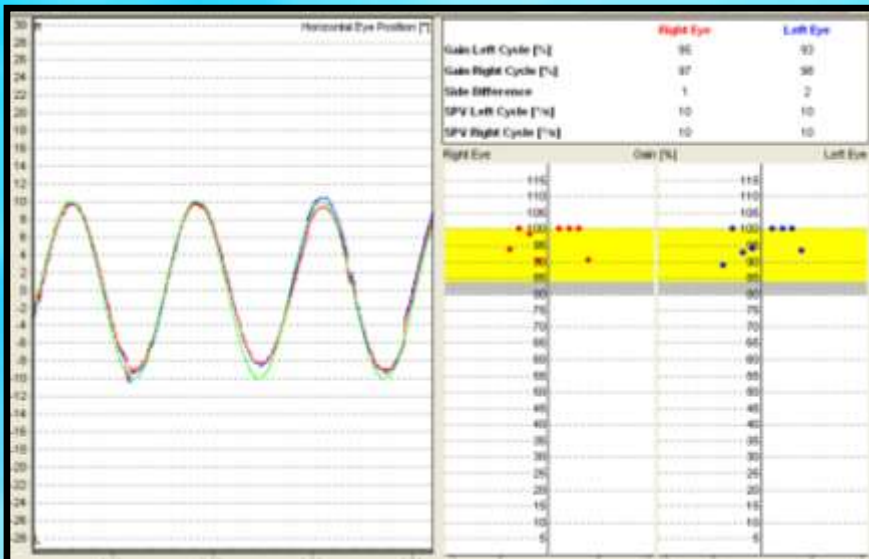
- for stabilizing the image of a visual target moving smoothly and continuously at a speed less than 1.2Hz on a predictable trajectory e.g.
  - *a bird flying across the sky*
  - *swinging pendulum*

Evaluated clinically by SMOOTH TRACKING TEST and documented precisely by **Pendulum tracking test**

Normal SPS



Abnormal SPS



# Defects in SPS indicate that

- If SPS is defective, gain is too low to keep image of a smoothly moving target in the fovea and eyes compensate this by corrective saccades, hence saccades are obtained in smooth tracking

## Anatomical areas involved :-

- Visual cortex
- Extrapyrarnidal system
- Dorsolateral pontine nuclei
- Cerebellum
- Oculo-motor nuclei

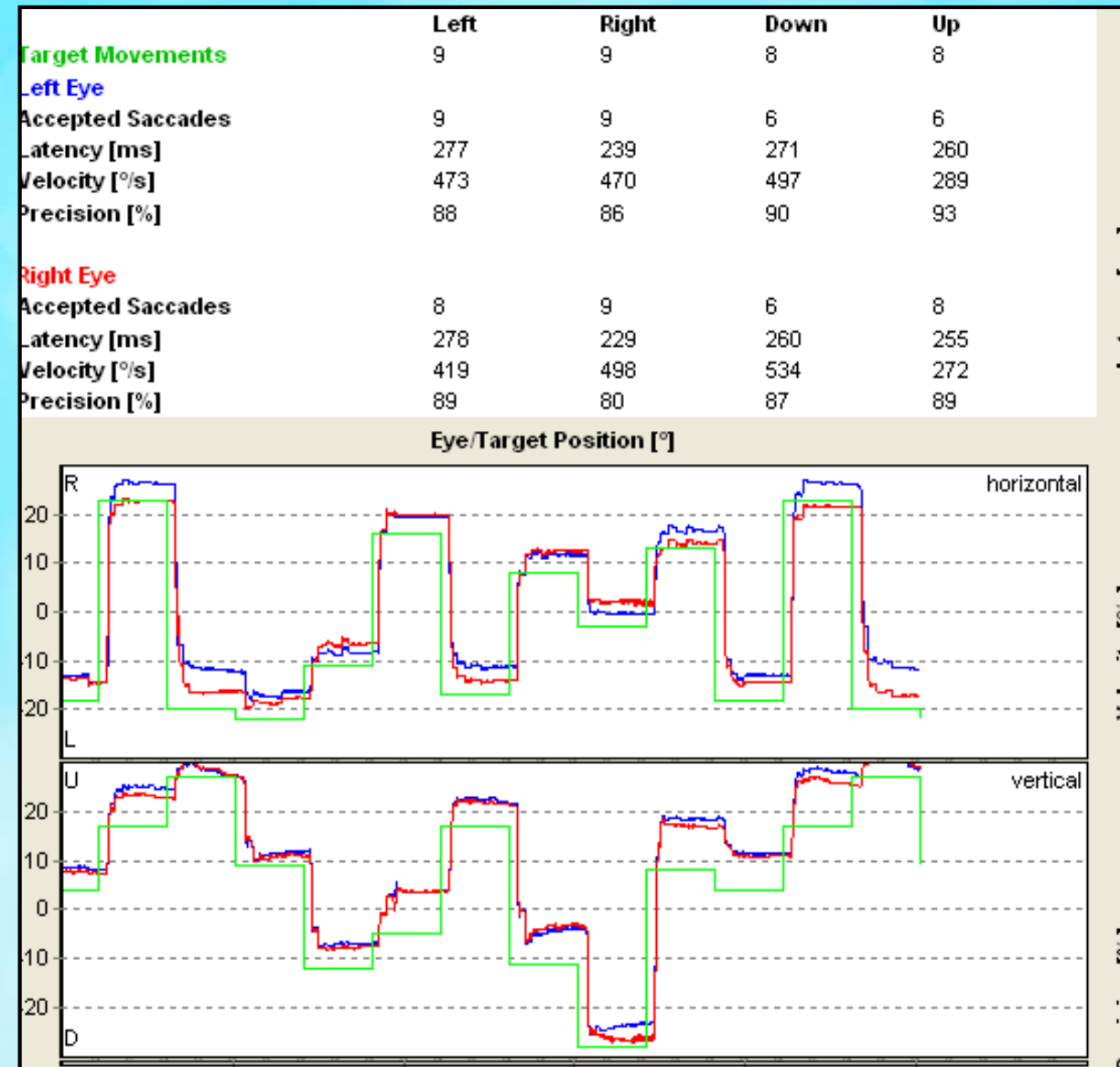
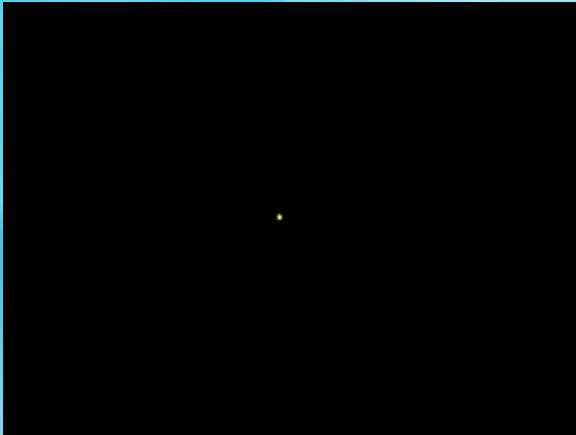
## Other faculties involved :-

- Alertness
- Age
- Drugs

**Hence SPS defects do not allow topographical / etiological diagnosis but indicates that there is a disorder in the oculomotor / central vest system.**

# Saccadic System (SS)

- for stabilizing image of a visual target at the end of the visual field in the fovea by a rapid single eye movement.
- facilitates visual tracking when SPS fails and when speeds are more than 1 Hz.
- Tested clinically by SACCADE TEST and documented by **VNG saccade test**



# Perfection of saccade determined by

- Velocity of the saccadic eye movement
- Conjugacy of eye movement
- Latency of the movement
- Accuracy / precision with which the eyes fixate the image on the fovea.

	Left	Right	Down	Up
<b>Target Movements</b>	9	9	8	8
<b>Left Eye</b>				
Accepted Saccades	9	9	6	6
Latency [ms]	277	239	271	260
Velocity [°/s]	473	470	497	289
Precision [%]	88	86	90	93
<b>Right Eye</b>				
Accepted Saccades	8	9	6	8
Latency [ms]	278	229	260	255
Velocity [°/s]	419	498	534	272
Precision [%]	89	80	87	89



Normal Saccade



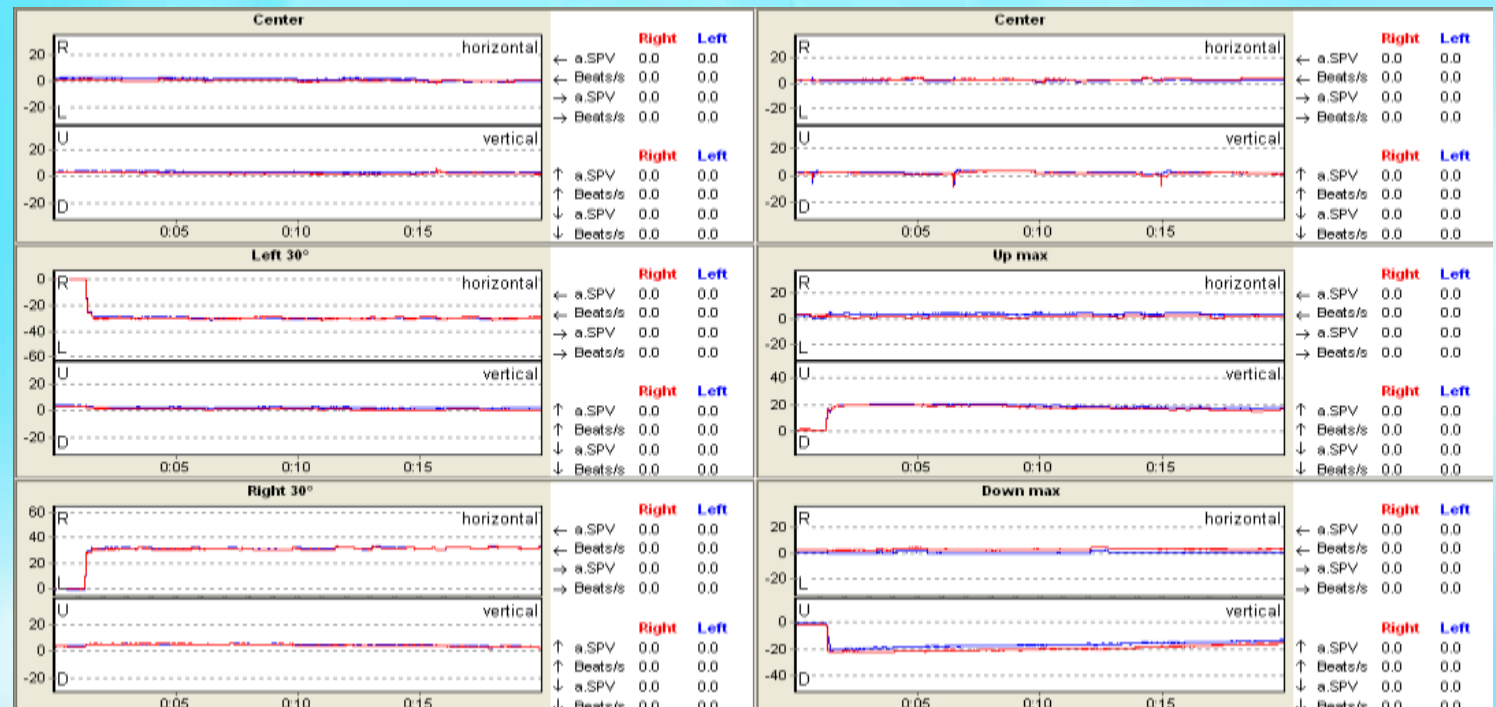
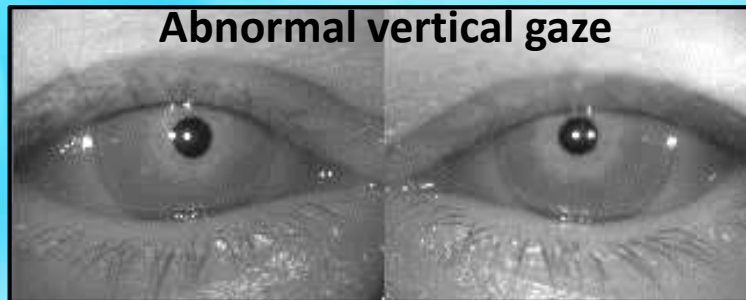
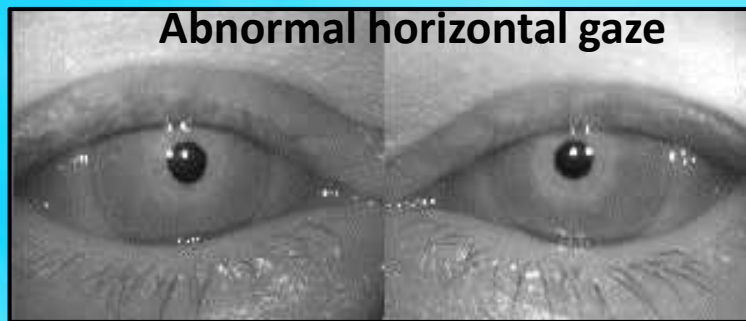
Abnormal Saccade

# Saccadic System disorders

Examination Finding	Inference
Slowing of saccades/hypometria	<ul style="list-style-type: none"><li>• Intoxication</li><li>• Neurodegenerative disorders</li></ul>
Slowing of horizontal saccades	<ul style="list-style-type: none"><li>• suggests brain-lesions usually in ipsi PPRF (paramedian pontine reticular formation)</li></ul>
Slowing of vertical saccades	<ul style="list-style-type: none"><li>• suggests mid-brain-lesions usually in riMLF (rostral interstitial medial longitudinal fasciculus) like Progressive Supranuclear Palsy</li></ul>
Slowing of adducting saccades	<ul style="list-style-type: none"><li>• suggests inter nuclear ophthalmoplagia</li></ul>
Hypermetric saccades	<ul style="list-style-type: none"><li>• suggests cerebellum (vermis) lesions or lesions in the cerebellar pathway, e.g. Wallenberg's syndrome due to damage to the inferior cerebellar peduncle</li></ul>

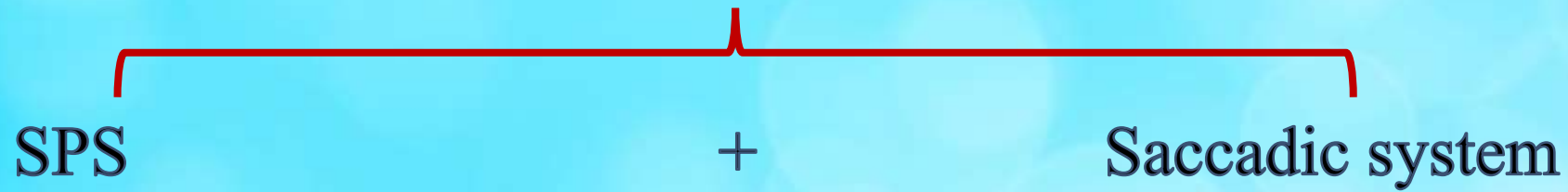
# VISUAL FIXATION *sub-served by gaze function*

- for maintaining the stable position of gaze after saccadic system has placed image of target at periphery of the visual field on the fovea tested clinically by clinical GAZE TEST and precisely documented by VNG gaze test



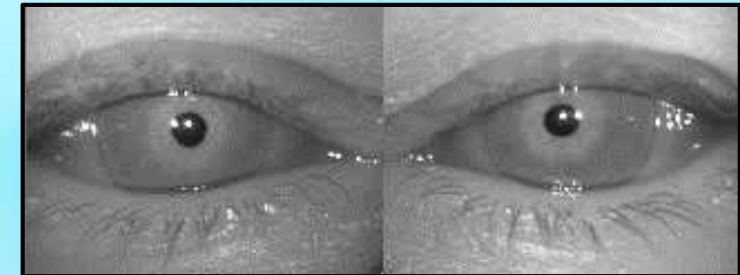
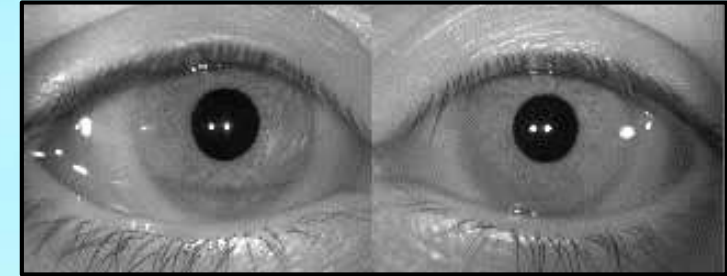
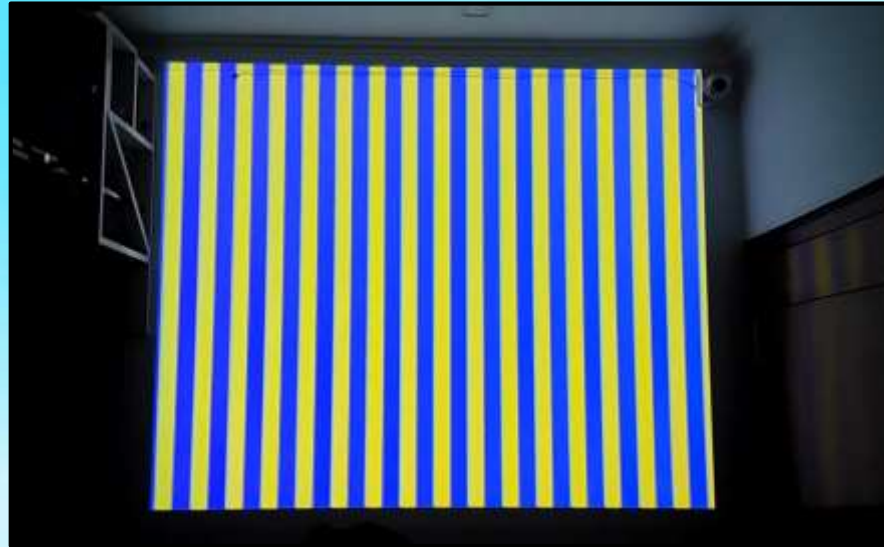
*Normal persons can hold the gaze, but in central vestibular disorders GAZE HOLDING FUNCTION is JEOPARDISED*  
INC controls gaze holding in vertical axis & NPH - gaze holding in horizontal axis

# Optokinetic System (OPK): *combination of*



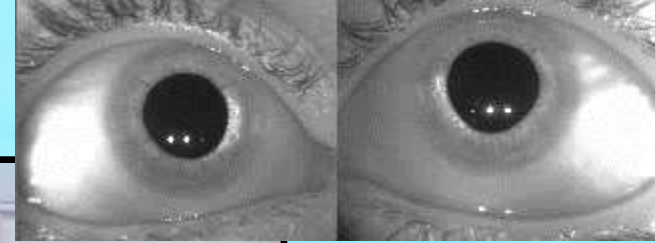
## Stabilizes gaze when :-

- a) the entire visual field moves
- b) repeated movements of a visual target across a stationary subject's visual field
- c) moving the subject in a stationary visual field
- d) both visual field & subject are moving



# Optokinetic system

- for gaze fixation during movement of the entire visual field



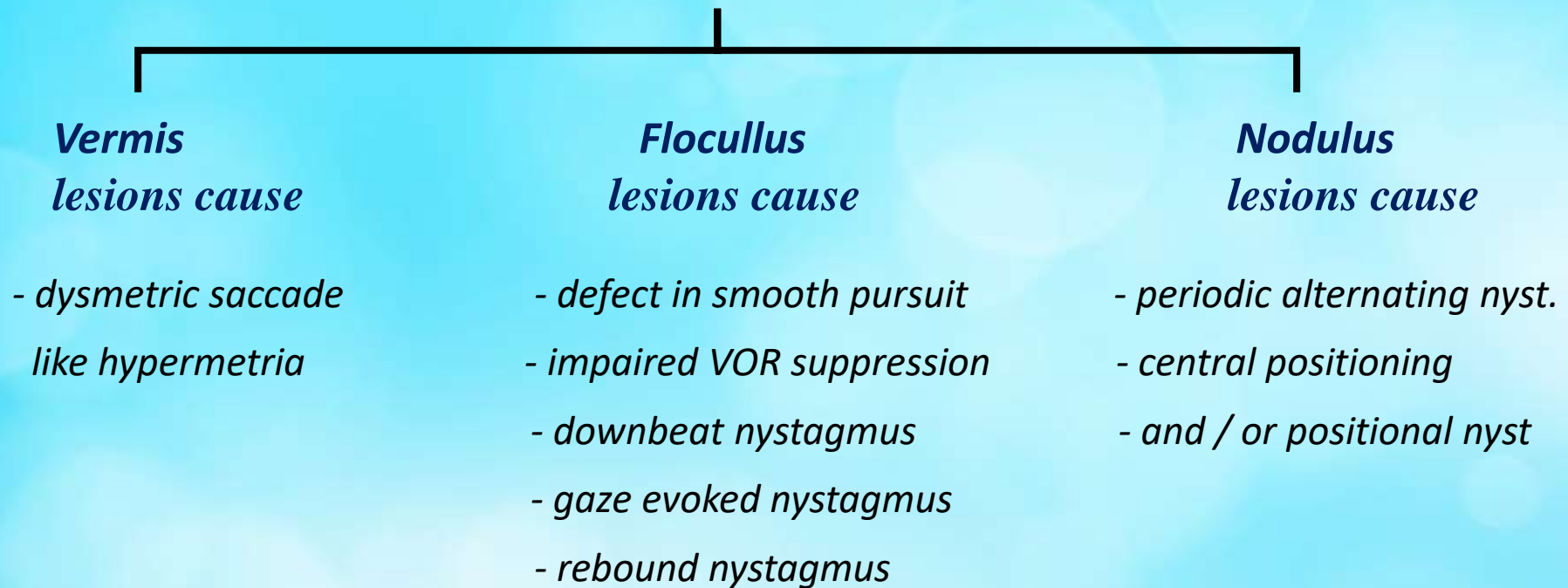


**VNG test evaluates all the oculomotor functions**

**VNG OCULOMOTOR TESTS**

# CEREBELLAR lesions

- *cerebellum basically has an inhibitory function*
- *most balance disorders are due to problems in Floculus*
- *usually ipsiversive lesions*



**This is only the OPTIC / VOR manifestation of a cerebellar lesion; cerebellar defects also have manifestation in the skeletal muscles / VSR**