ELECTRONYSTAGMOGRAPHY

HANDBOOK of Balance Function Testing

Gary P. Jacobson
Craig W. Newman
Jack M. Kartush

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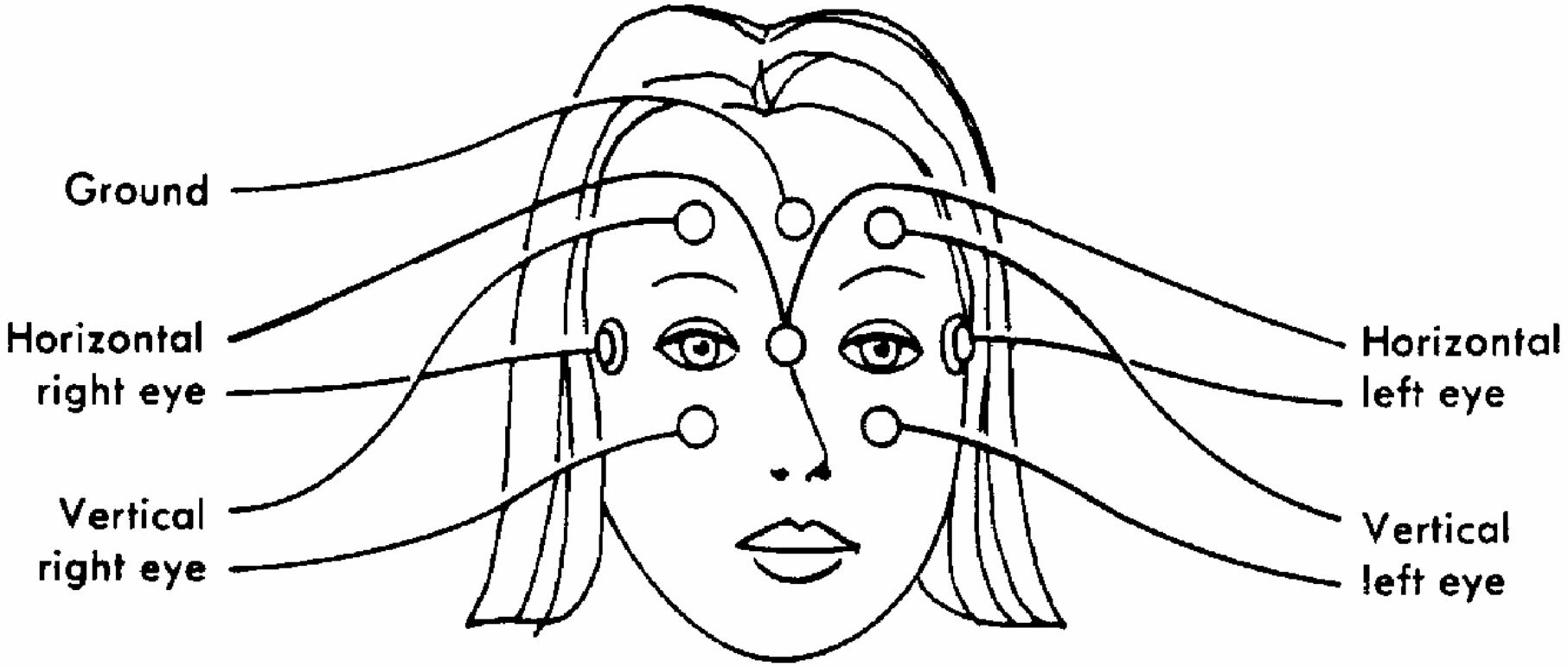
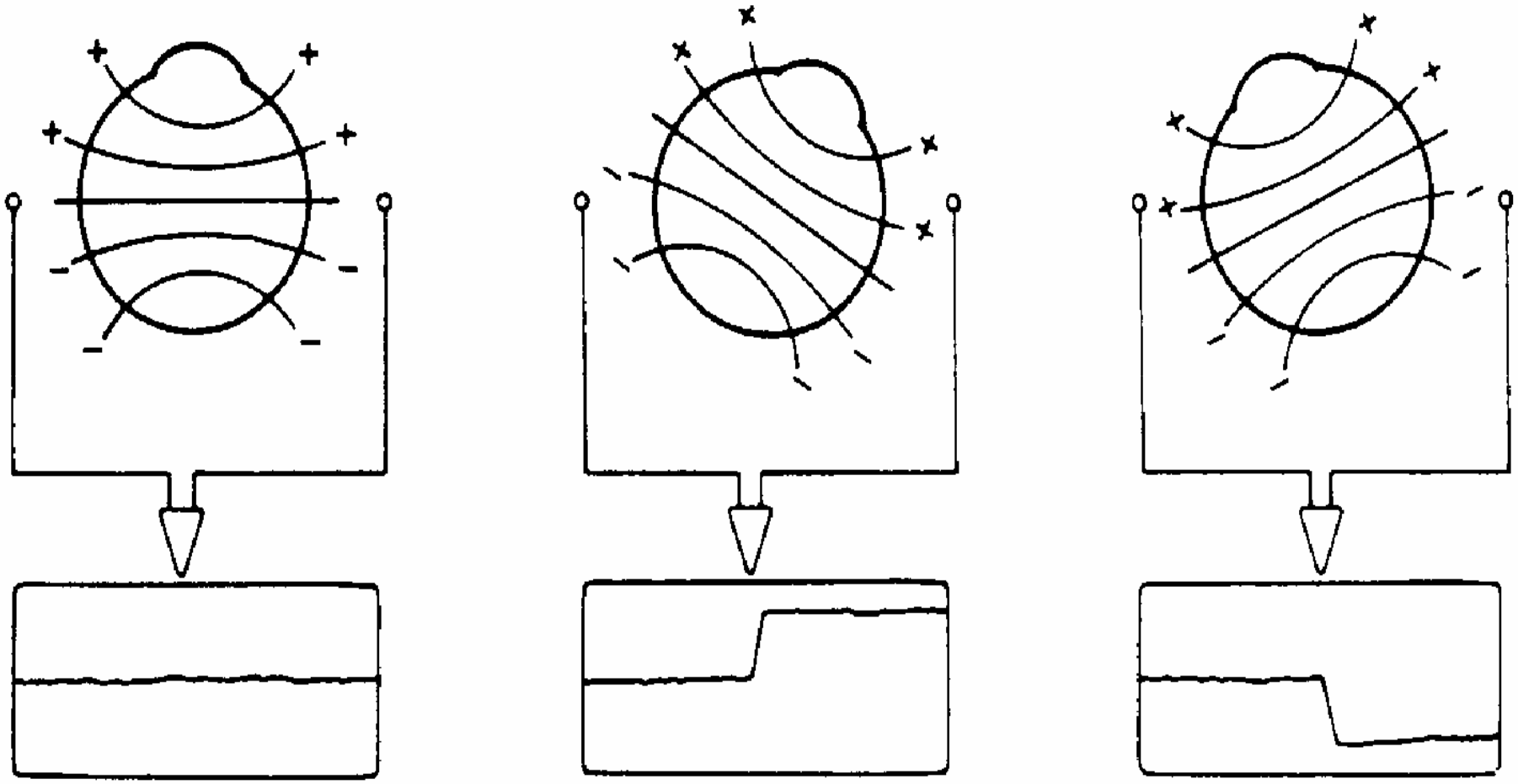
ELECTRONYSTAGMOGRAPHY

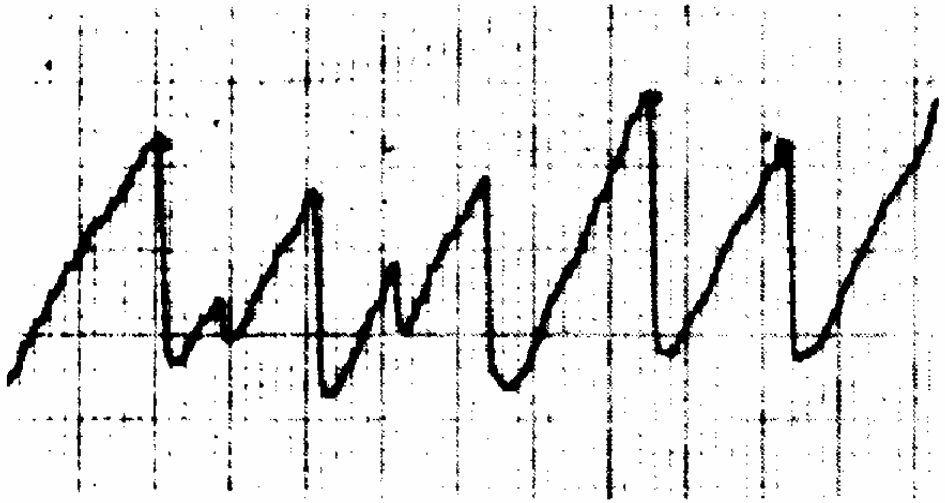
ENG measurements based on the presence of the *corneoretinal potential*

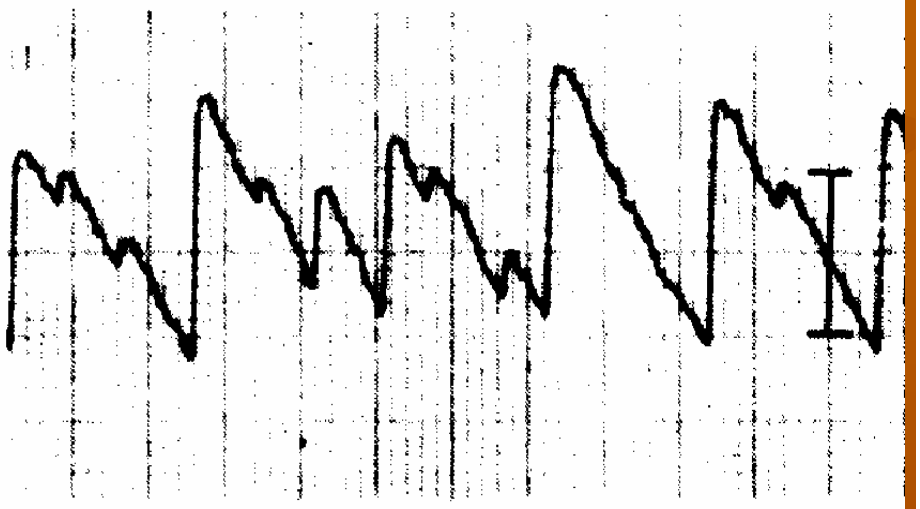
Cornea has a positive pole

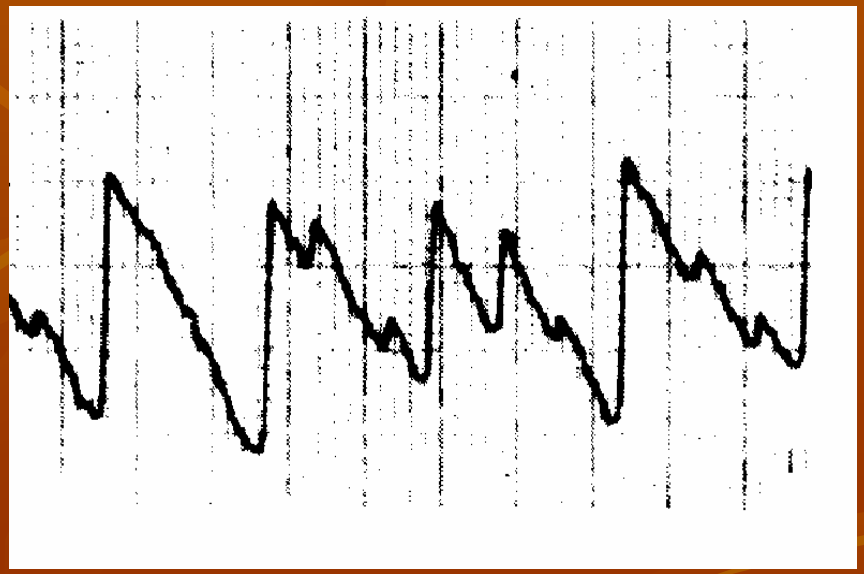
Retina has a negative pole

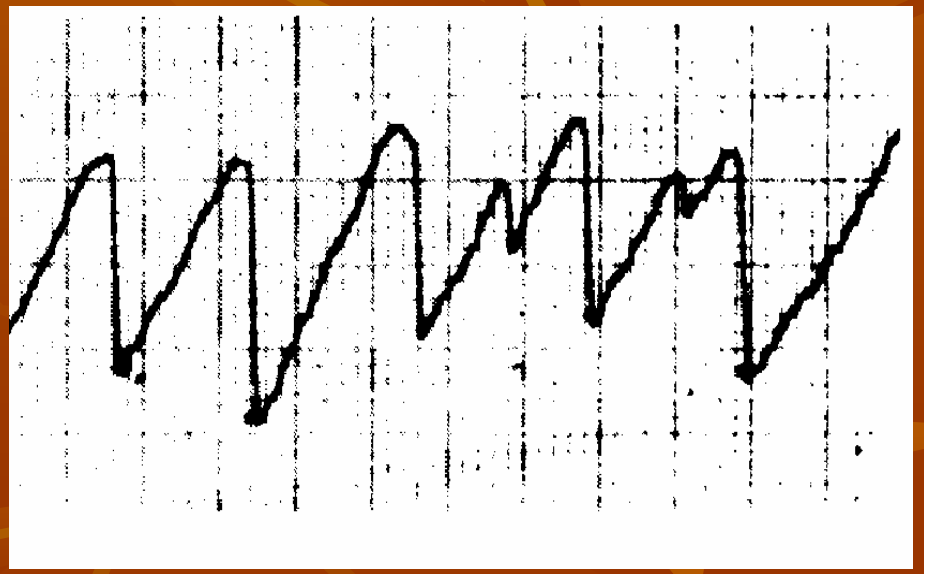

Ground
Horizontal
right eye
Vertical
right eye
Horizontal
left eye
Vertical
left eye











ELECTRONYSTAGMOGRAPHY

Essentially ENG consists of 3 parts

- oculomotor evaluation
  - Calibration
  - Gaze
  - Fixation
  - Saccade
  - Tracking (Pursuit)
  - Optokinetic
- positioning/positional testing
- caloric stimulation.

History

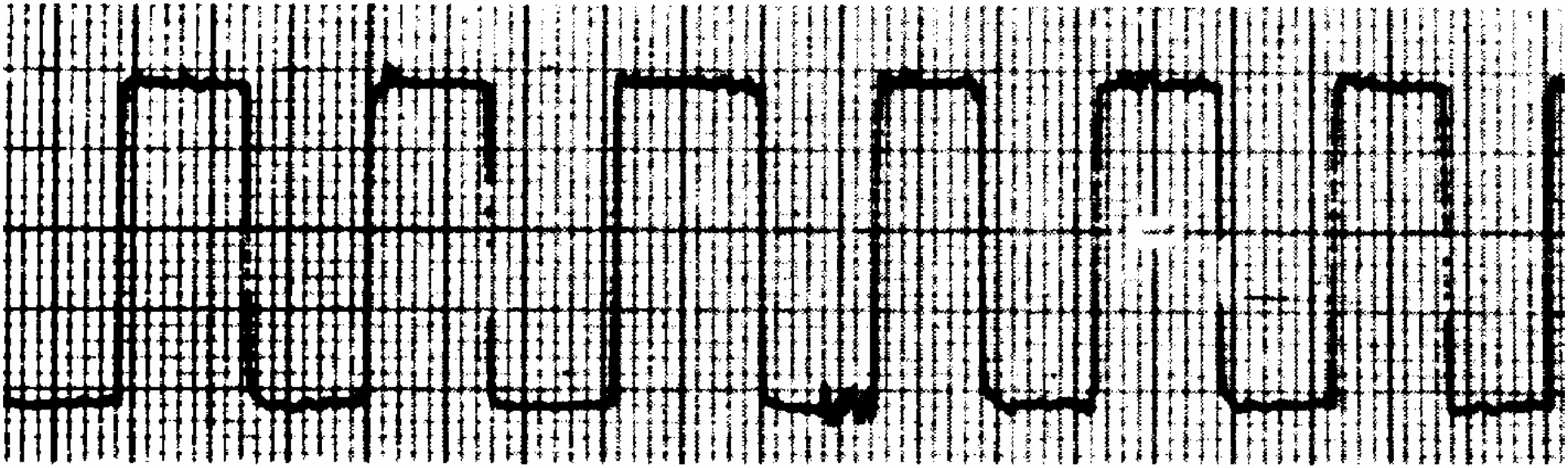
- Stop all medications 24-72 h prior to testing
- 72 hours Alcohol (agonist or antagonist)
- Any medications taken should be clearly noted on the test results
- limit food intake prior to examination
- arrange for transportation after the examination

Examination

- Large perforations
  - increase air stimulation above expectation
  - cooling effect for warm (evaporation).
- cerumen must be removed
- Middle ear fluid affects stimulation

Saccades (calibration)

- Dots on the wall or ceiling
- center and 10°, 20°, and 30° off center
- patient to look back and forth between the dots
- head fixed



Gaze

spontaneous nystagmus

nystagmus in the absence of stimulation

- presence or absence of spontaneous nystagmus
- presence, absence, or exacerbation of nystagmus with addition of off-center gaze
- fixation suppression of spontaneous nystagmus

Gaze Test

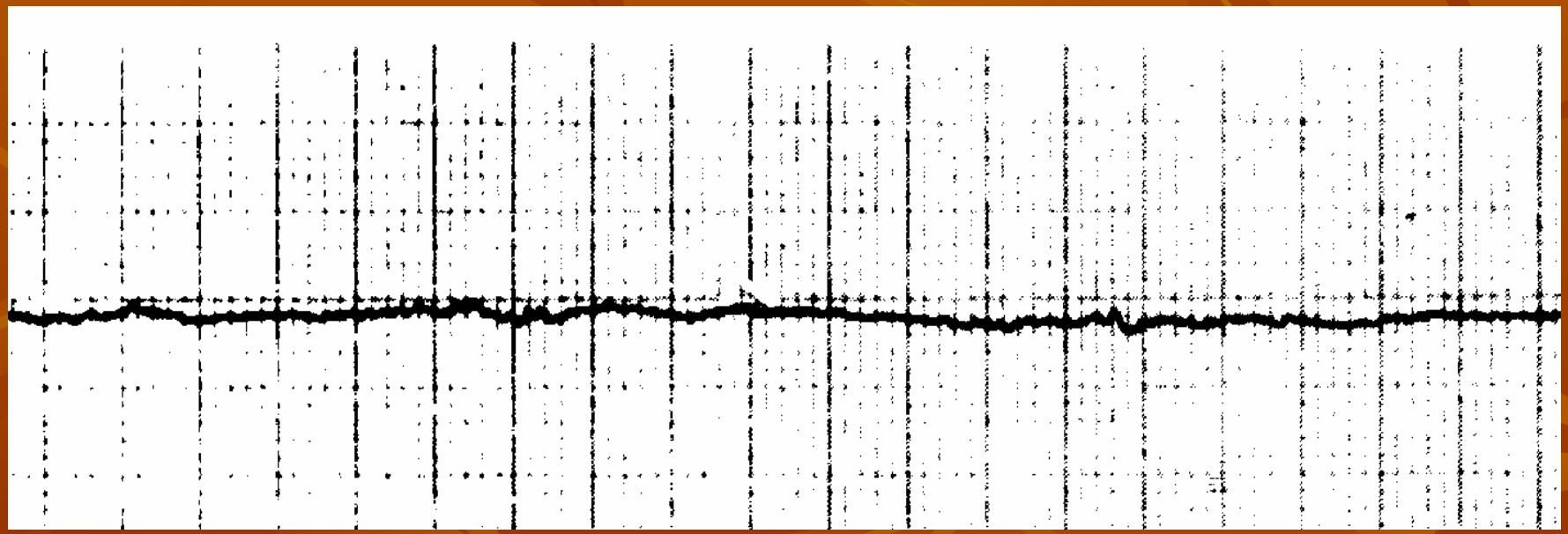
- Nystagmus present with eyes open and enhanced by eye closure - lesion is peripheral
- Nystagmus is enhanced with ocular fixation and reduced by eye closure - lesion is central

Administration

- For gaze testing
  - the patient is instructed to look straight ahead and then to fixate on a target 30° to the right, left, up, and down.
  - Fixation is maintained for approximately 30 seconds in center gaze and 10 seconds in eccentric gaze.
- Spontaneous nystagmus (eliminating suppression)
  - eyes open in a dark room
  - eyes closed.
  - mental tasks (eg, answering questions, counting by twos).

Gaze

- Normal gaze position - patient is able to maintain position with eyes open and closed



Spontaneous nystagmus

- Either central or peripheral pathology.
- with eyes open is always diagnostically significant.
- Peripheral indicators
  - Horizontal or horizontal rotary
  - Suppressed by visual fixation
  - Nondirection changing
  - Exacerbated by gazing in the direction of the fast phase*
- Central indicators
  - Vertical
  - Not suppressed by fixation
  - Direction changing

Alexander's law

- Nystagmus increases when the patient gazes in the direction of the fast phase.
- Nystagmus decreases or disappears when the gaze in the direction of slow phase.
- This pattern is often seen in peripheral vestibular disorders and occasionally in central disorders.

Unilateral gaze-paretic nystagmus

- Nystagmus only occurs with eccentric gaze in one direction.
- Elicited nystagmus beats in the direction of the gaze.
- consistent with CNS pathology

Bilateral gaze-paretic nystagmus

- right gaze→ right-beating nystagmus
- left gaze → left-beating nystagmus
- suggests CNS pathology

Bruns nystagmus

- Combination of
  - Unilateral gaze-paretic nystagmus
  - Vestibular nystagmus
- Asymmetrical nystagmus in both directions of a gaze
- associated with extra-axial mass lesions on the side of the gaze-paretic nystagmus

Ewald law

- Eyes always move in the plane of the canal being stimulated and in the direction of endolymph flow
- Ampulopetal in HSCC causes greater response than ampulofugal
- Ampulofugal in vertical SCCs cause greater response than ampulopetal

Resting (firing) level is 1.0 Hz→ can not be <0 but can be high as 10 Hz

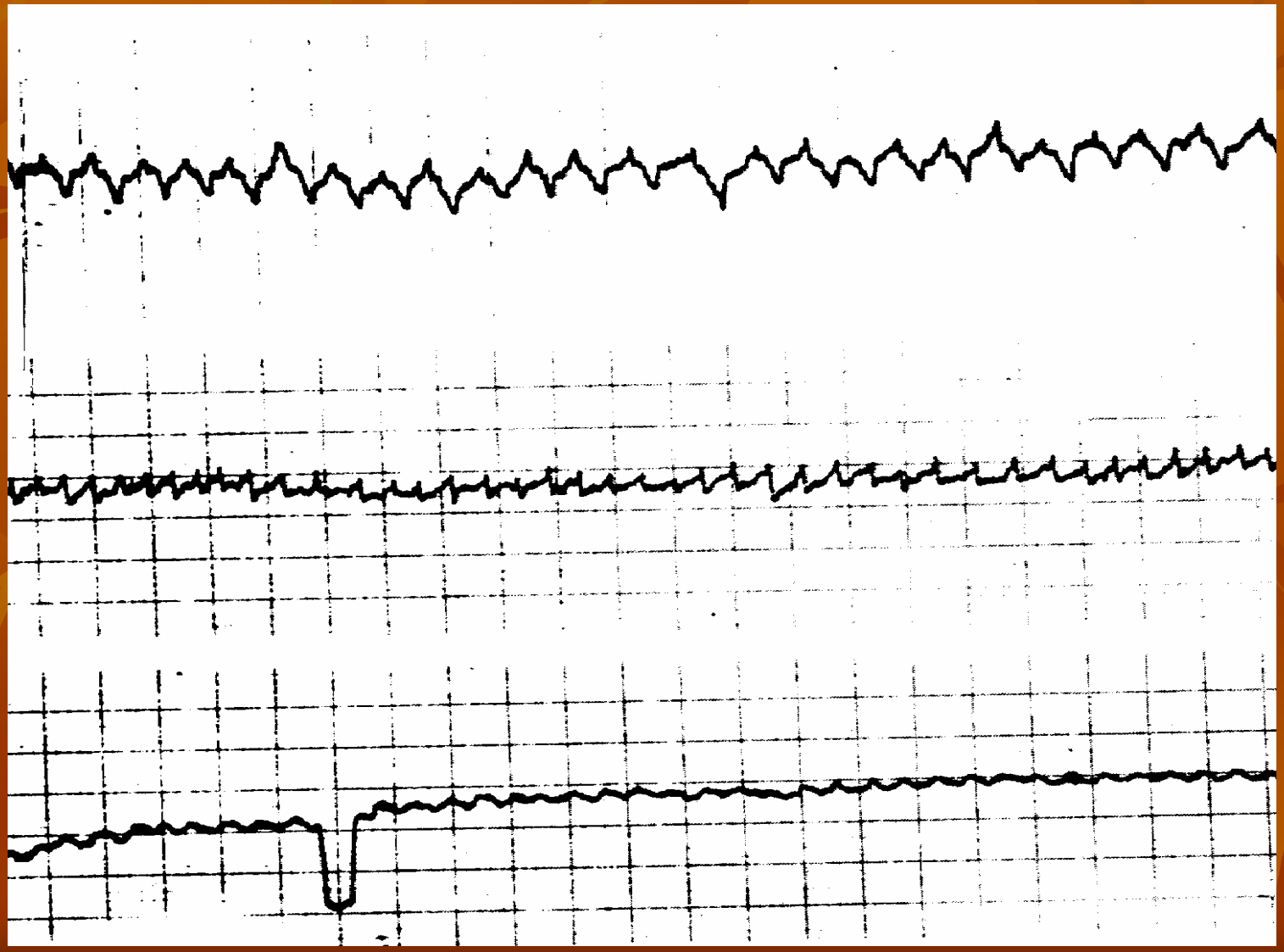
Fixation

- Congenital nystagmus
- Gaze-Evoked Nystagmus
- Rebound nystagmus
- Square-wave jerks

Congenital nystagmus

- Spiky appearance
- increases with lateral gaze.
- decrease in velocity or completely disappear with eyes closed

Congenital Gaze Findings



Gaze-Evoked Nystagmus

- Drift of the eye which is only present for certain directions of gaze
- EOG recordings, any persistent nystagmus for ocular displacements < 30 degrees is abnormal
- **Causes of Gaze-evoked nystagmus**
  - **Medication**
  - **Brainstem or cerebellar disorder**
  - **Normal variant**
  - **Ocular muscle fatigue**
  - **Congenital nystagmus**

Rebound nystagmus

- Burst of nystagmus
- begins when the eyes are returned to center gaze.
- lasting 5 seconds
- brainstem or cerebellar lesions

Square-wave jerks

- the most common abnormality with eyes closed.
- healthy patients
- increasing frequency with increasing age.
- abnormal if
  - In young patients
  - more frequently than 1 per second
  - eyes open.
- suggestive of a cerebellar disorder.

Fixation suppression

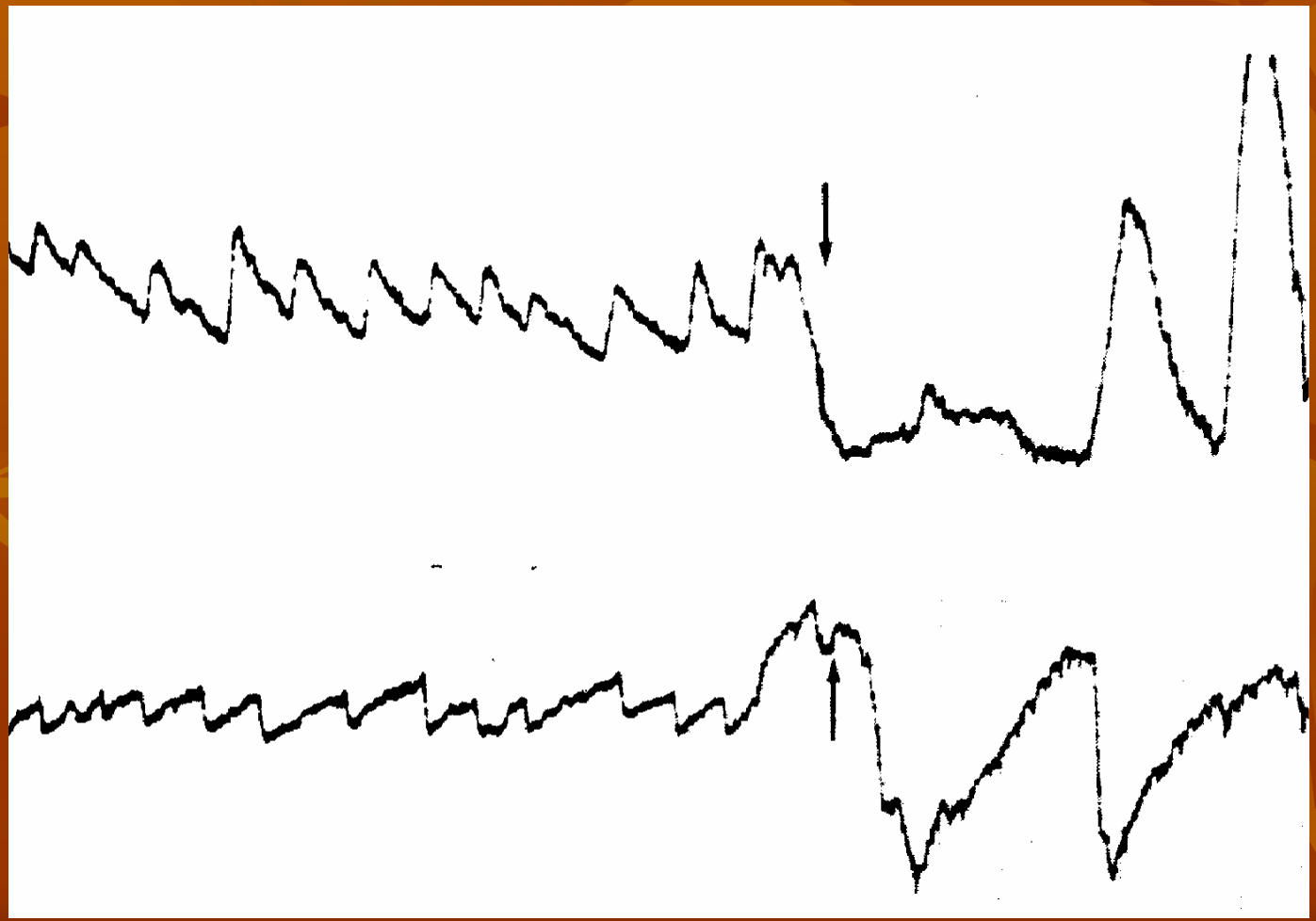
- For peripheral lesions, nystagmus that is evident with eyes closed or in the dark should be suppressed by visual fixation.
- If not CNS pathology is possible.

Peripheral Gaze Findings

Gaze Findings With CNS Lesion

- Nystagmus may be horizontal, vertical, rotatory
- May demonstate variation in amplitude
- If cause by a stable pathology, it declines slowly in time
- Enhanced by ocular fixation
- If horizontal, most often bilateral (bidirectional)

CNS Gaze Findings



Saccades Interpretation

- Accuracy
- Latency
- Velocity

Accuracy

- Normal or basal ganglia pathology
  - Hypometric – undershoots
- CNS pathology
  - Ocular flutter - spiky overshoot
- Cerebellum
  - Hypermetric overshoot then a correction.
  - Multistep saccades undershoots then multiple saccades
  - Postsaccadic drift (Glissade) eye drifting after saccade.
- PICA
  - Pulsion :pulling to left or right after vertical saccades.

Latency

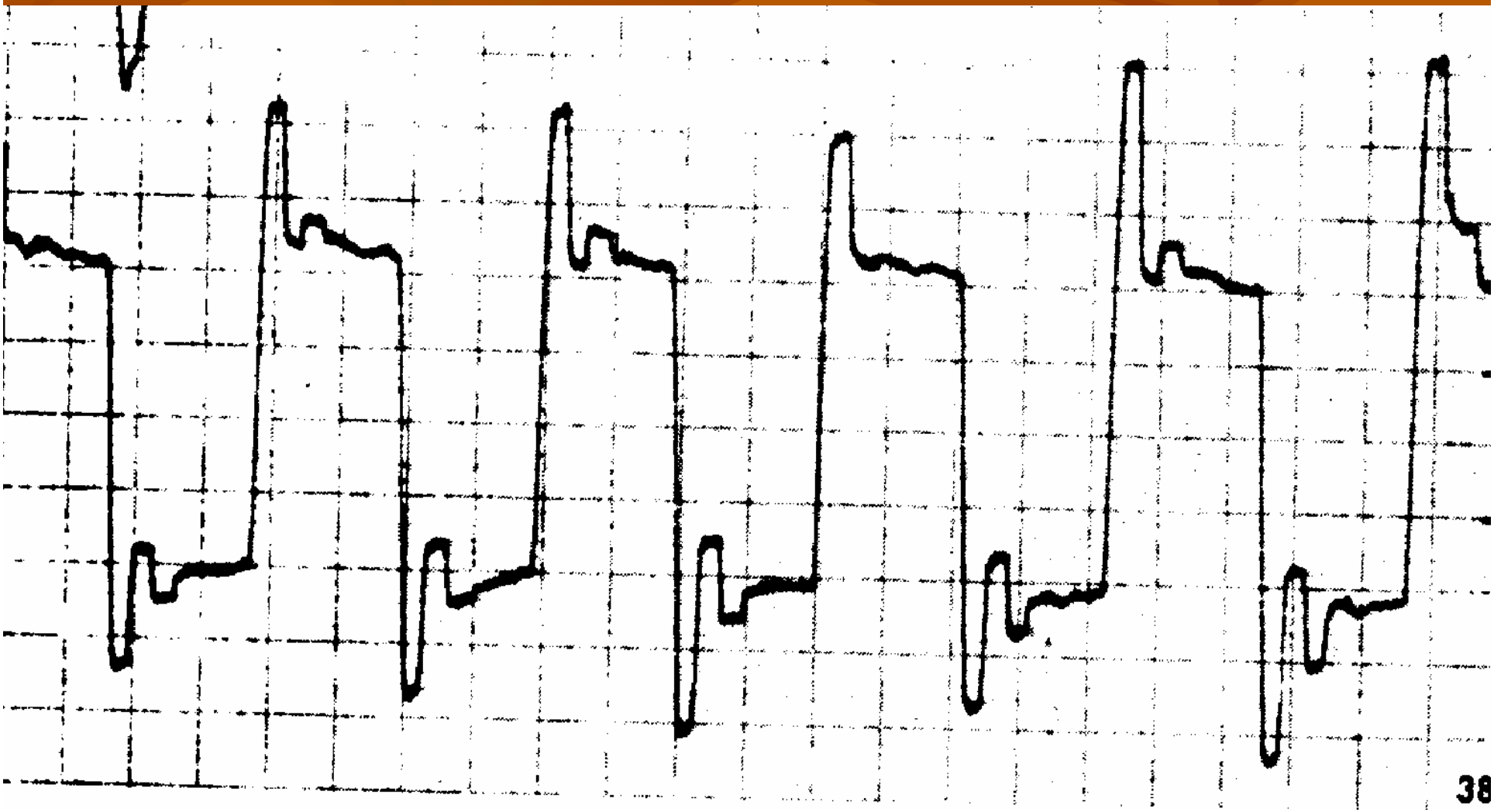
- Short latency
  - artifact
  - patient anticipating the position of the target.
  - suggestive of CNS pathology.
- Asymmetrical latencies
  - occipital
  - parietal cortex.

Velocity

- Saccadic slowing
  - drug effects.
  - CNS degenerative conditions, basal ganglia pathology, and cerebellar disorders.
  - ocular disorders, including oculomotor weakness,
- Abnormally fast saccades
  - artifact and may be due to technical difficulties.
  - CNS
  - ocular pathology
- Asymmetrical velocity - between the eyes or between directions.
  - ocular nerve
  - muscle pathology (ie, lesions or palsies).
  - CNS pathology may also be indicated. A lesion in the MLF

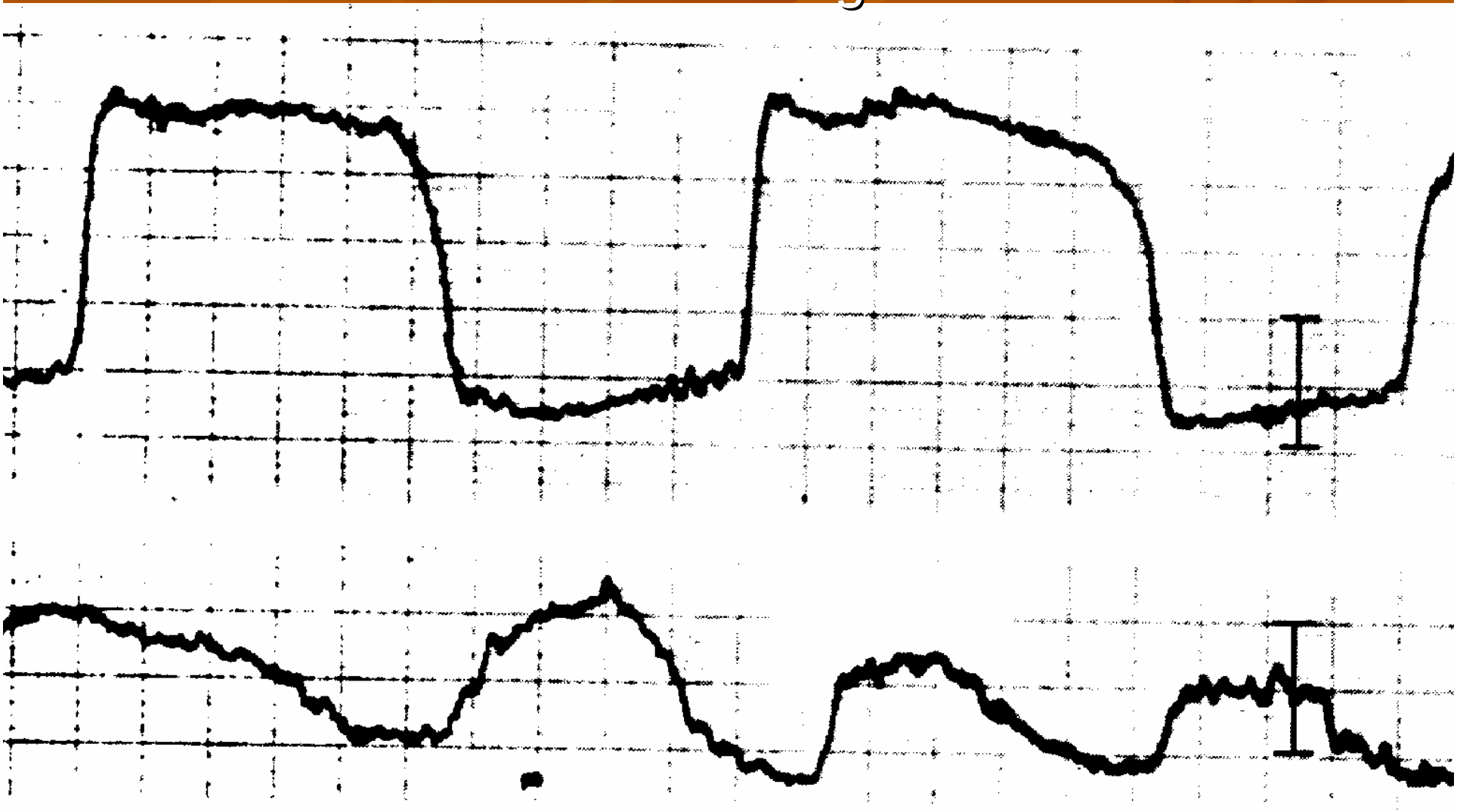
Saccadic Abnormalities

Overshoot



Saccadic Abnormalities

Saccadic Slowing



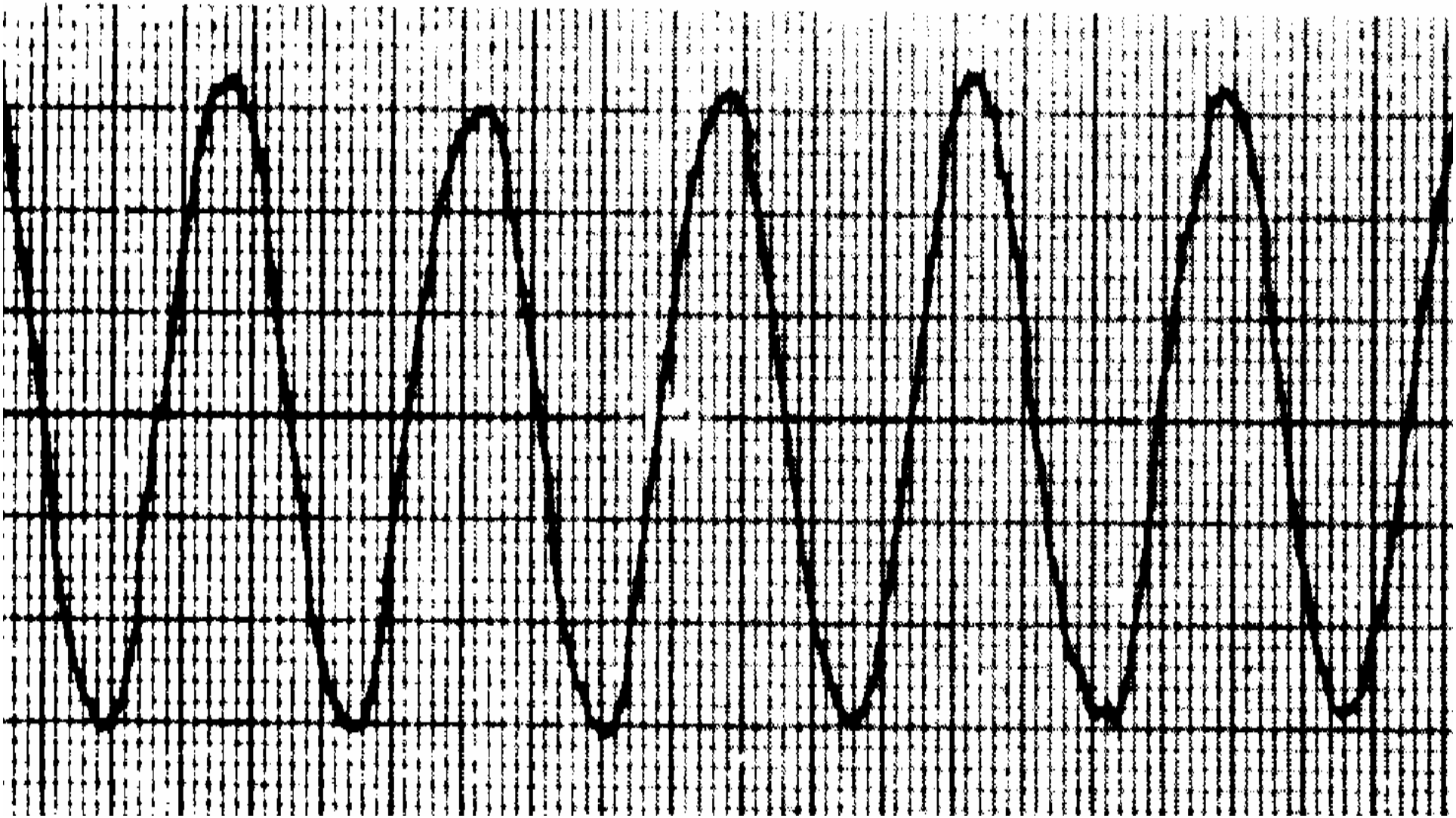
Smooth pursuit tracking

- follow a sinusoidal moving target with eyes only.
- Tracking targets within the visual field
- interpreting with care in geriatric and pediatric
- affected by attention and patient cooperation.

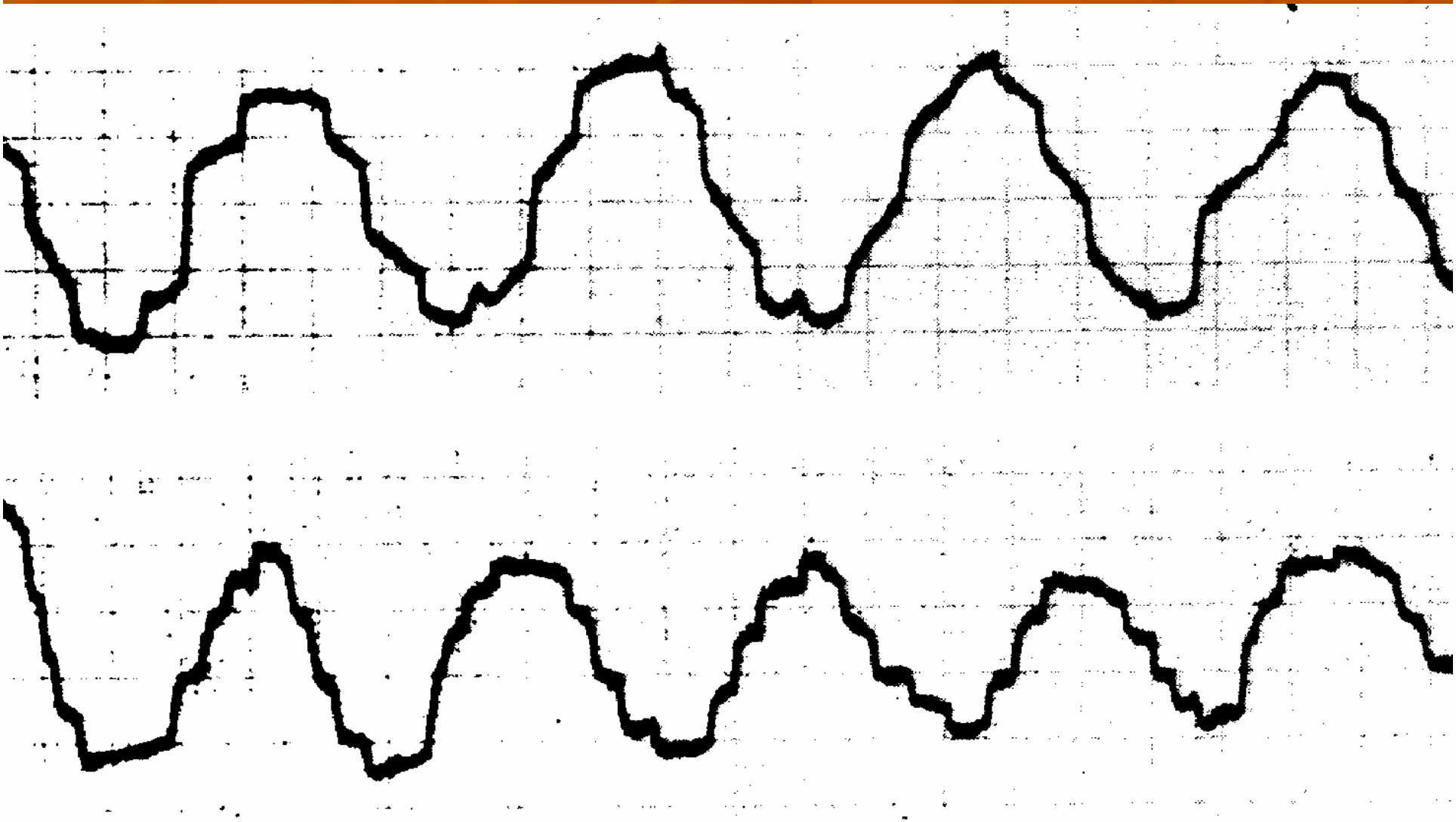
Interpretation

- results should resemble a smooth sinusoid.
- Breakup of movement → CNS pathology.

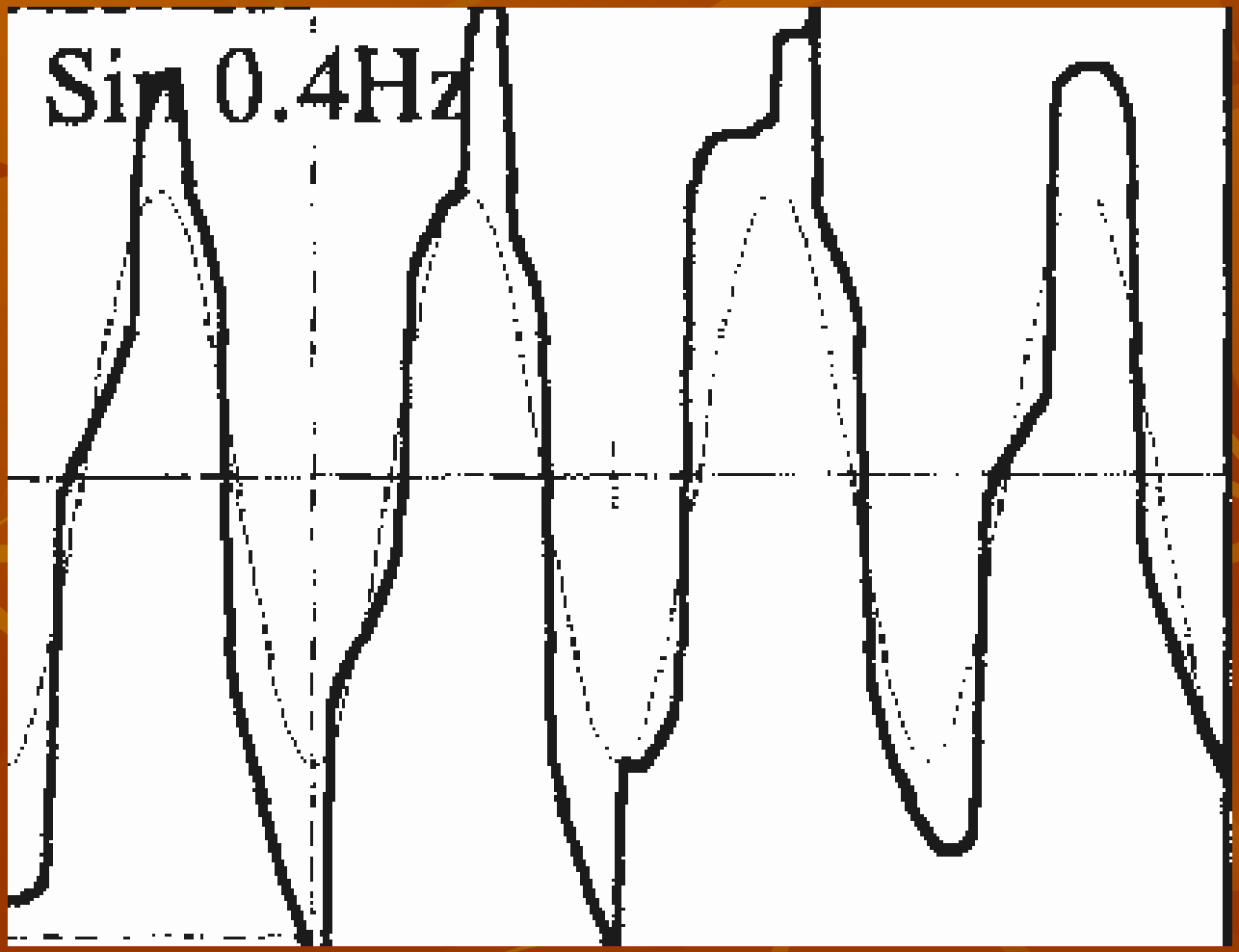
Tracking Test: Normal



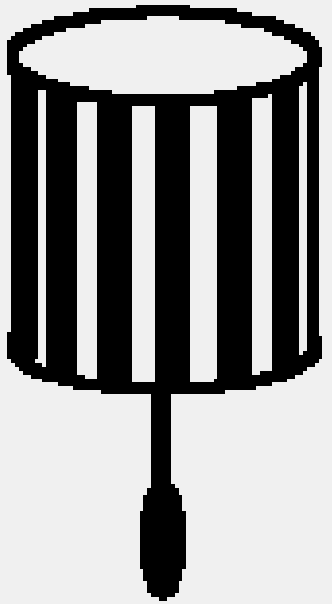
Tracking Test: Abnormal



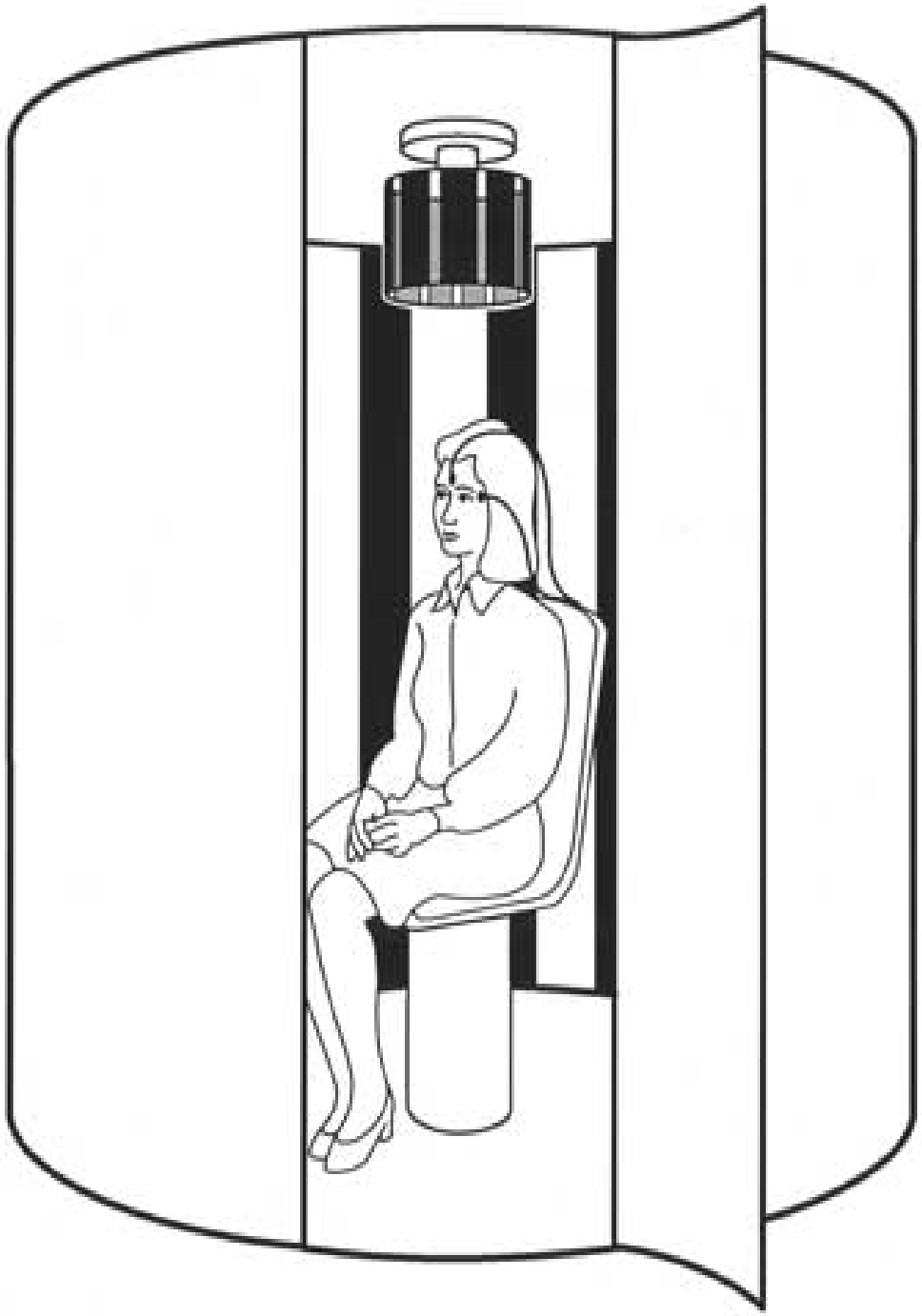
impaired pursuit in patient with a cerebellar lesion



Optokinetic

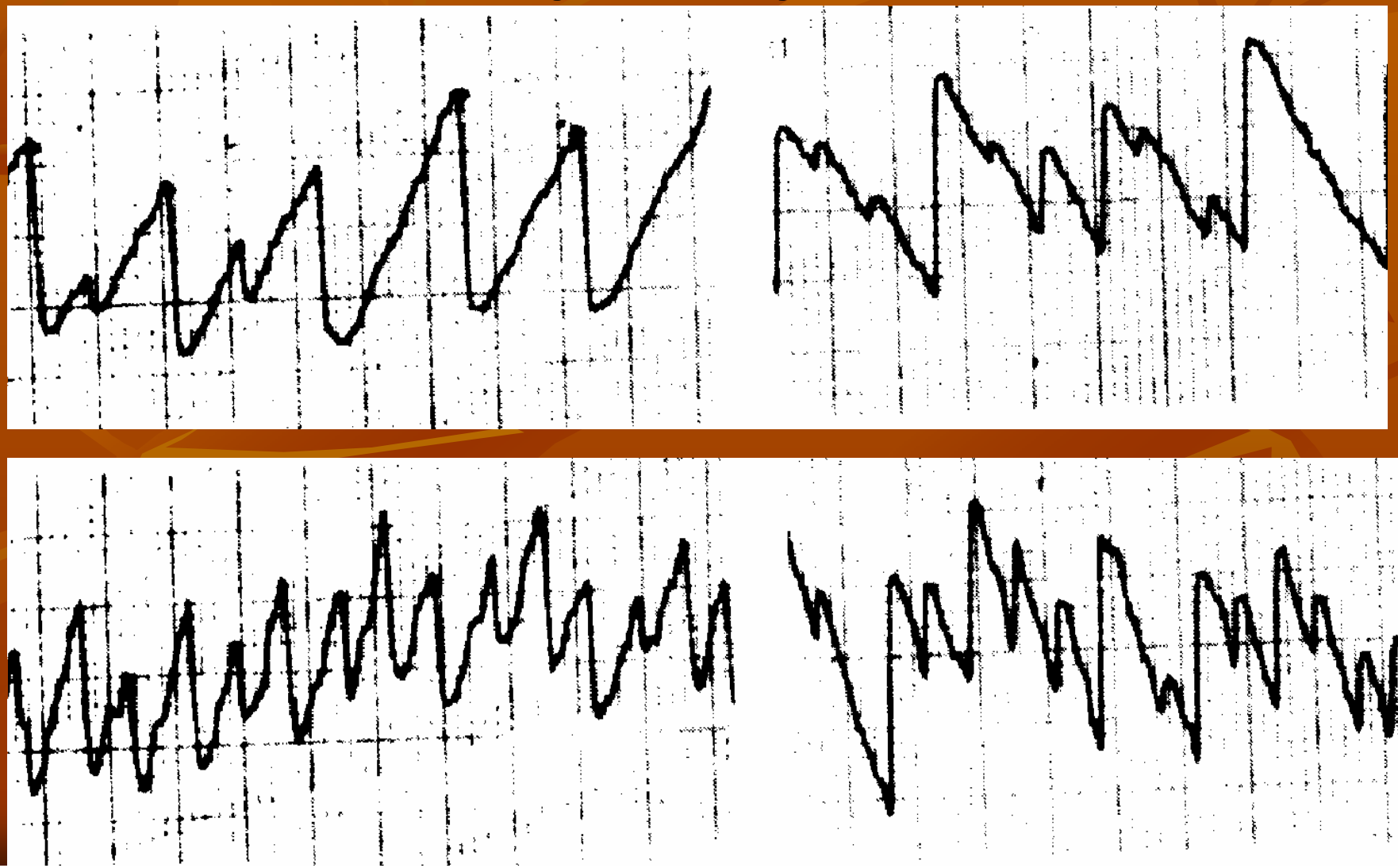


- tracks multiple stimuli.
  - stripes on a rotating drum
  - stream of lighted dots across a light bar
  - full field array of moving stars or trees.
- moved at 300, 400, or 600 per second
- asymmetrical responses →CNS pathology



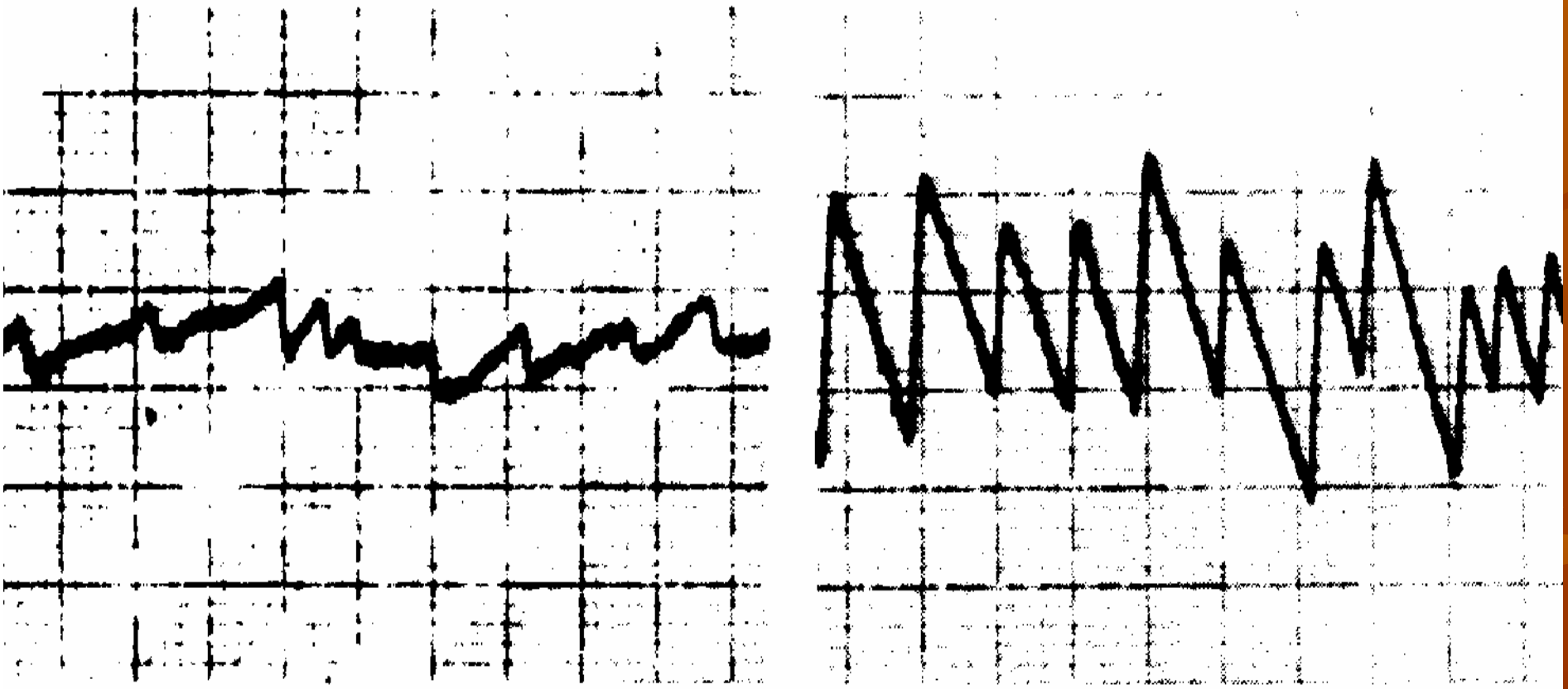
Opokinetic Test:Normal

symmetry



Opokinetic Test: Abnormal

Asymmetry

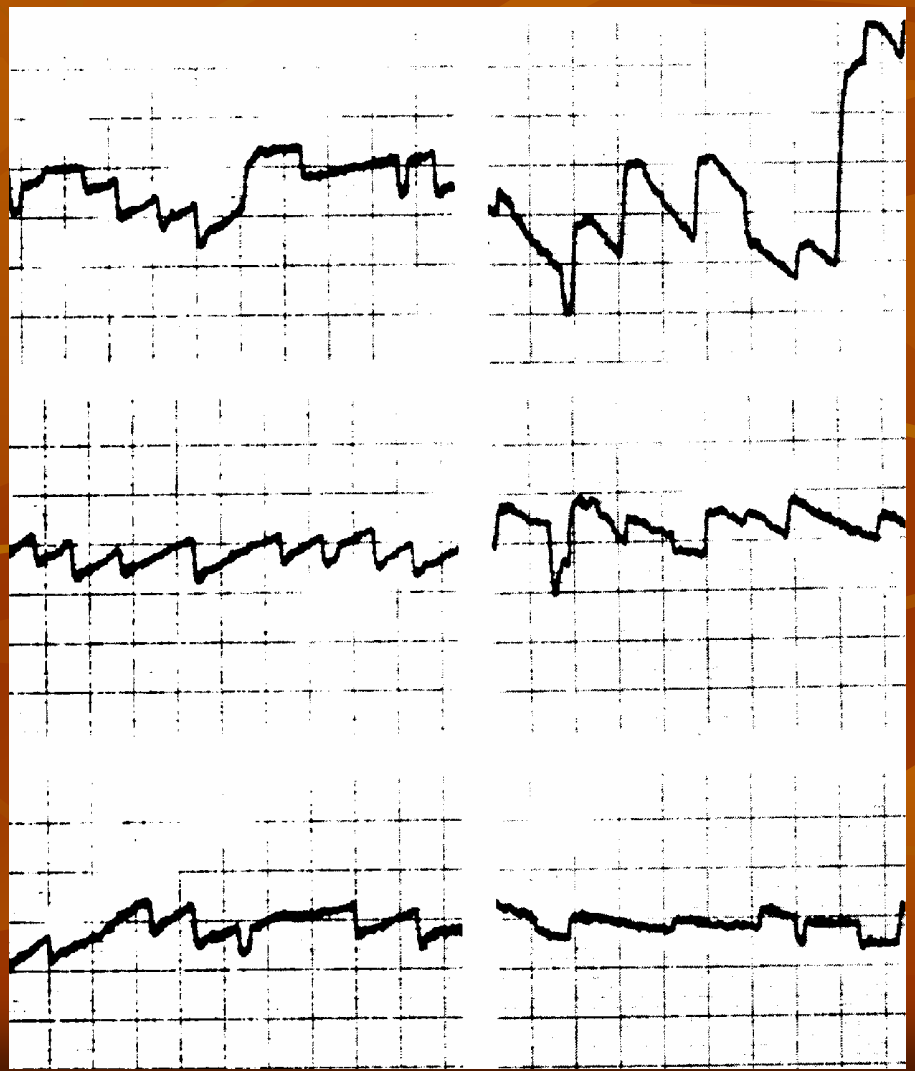


Opokinetic Test: Abnormal Declining Response Intensity

20/s

60/s

100/s



Positioning
Dix-Hallpike maneuver

- should be completed prior to any other positional testing.
- Delayed onset - observe patient for at least 20 seconds
- Transient burst of nystagmus - Lasts about 10-15 seconds
- Subjective report of vertigo
- Fatigability

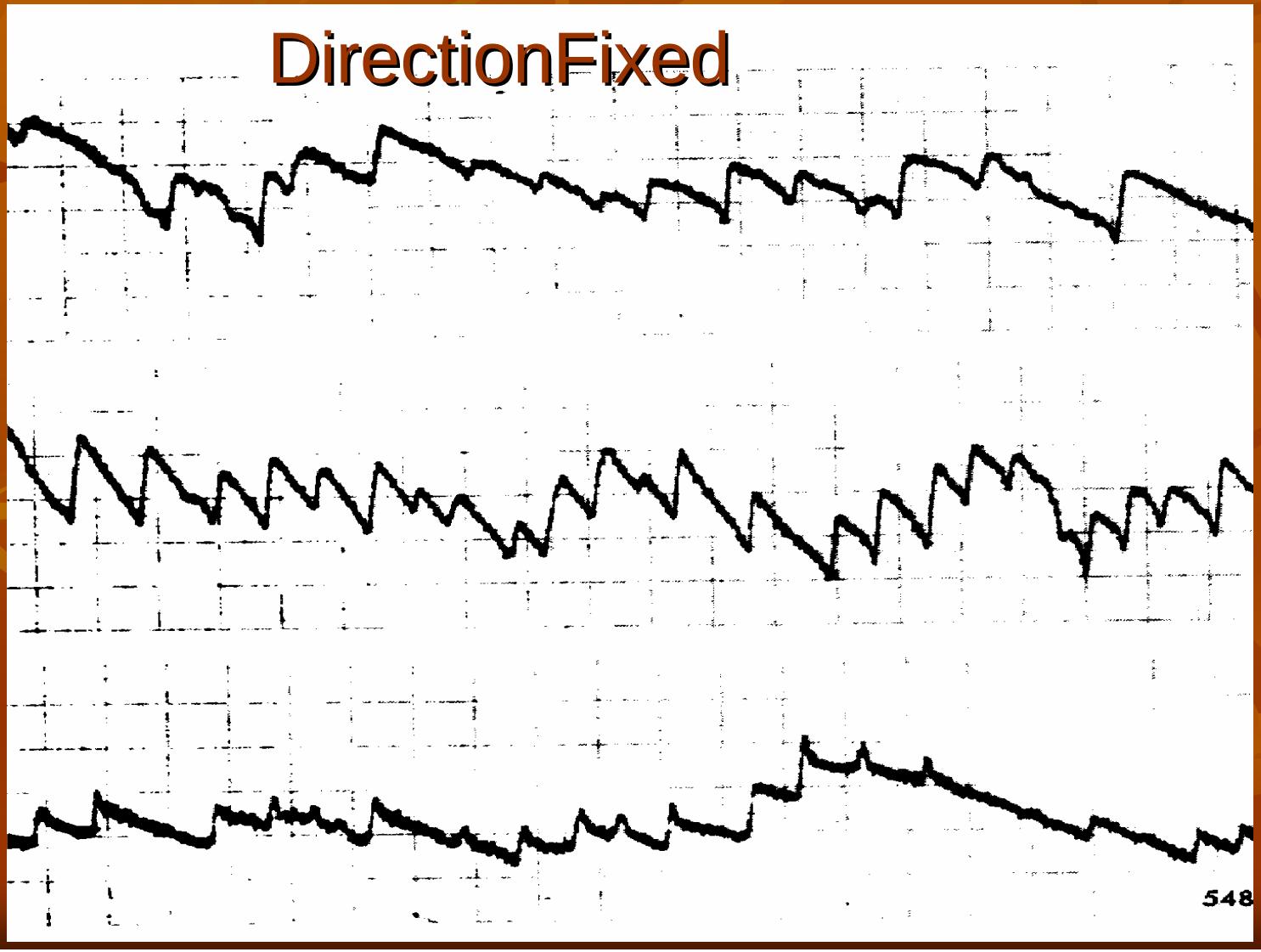
Positional tests

- minimum of 20-30 seconds
- Mental tasking infrared goggles or with the patient's eyes closed with electrodes
  - Head hanging
  - Supine
  - Supine, head right
  - Supine, head left
  - Lateral right
  - Lateral left
- considered abnormal
  - exceed 60 per second
  - change direction in any 1 position
  - persist in at least 3 different positions
  - intermittent in all positions

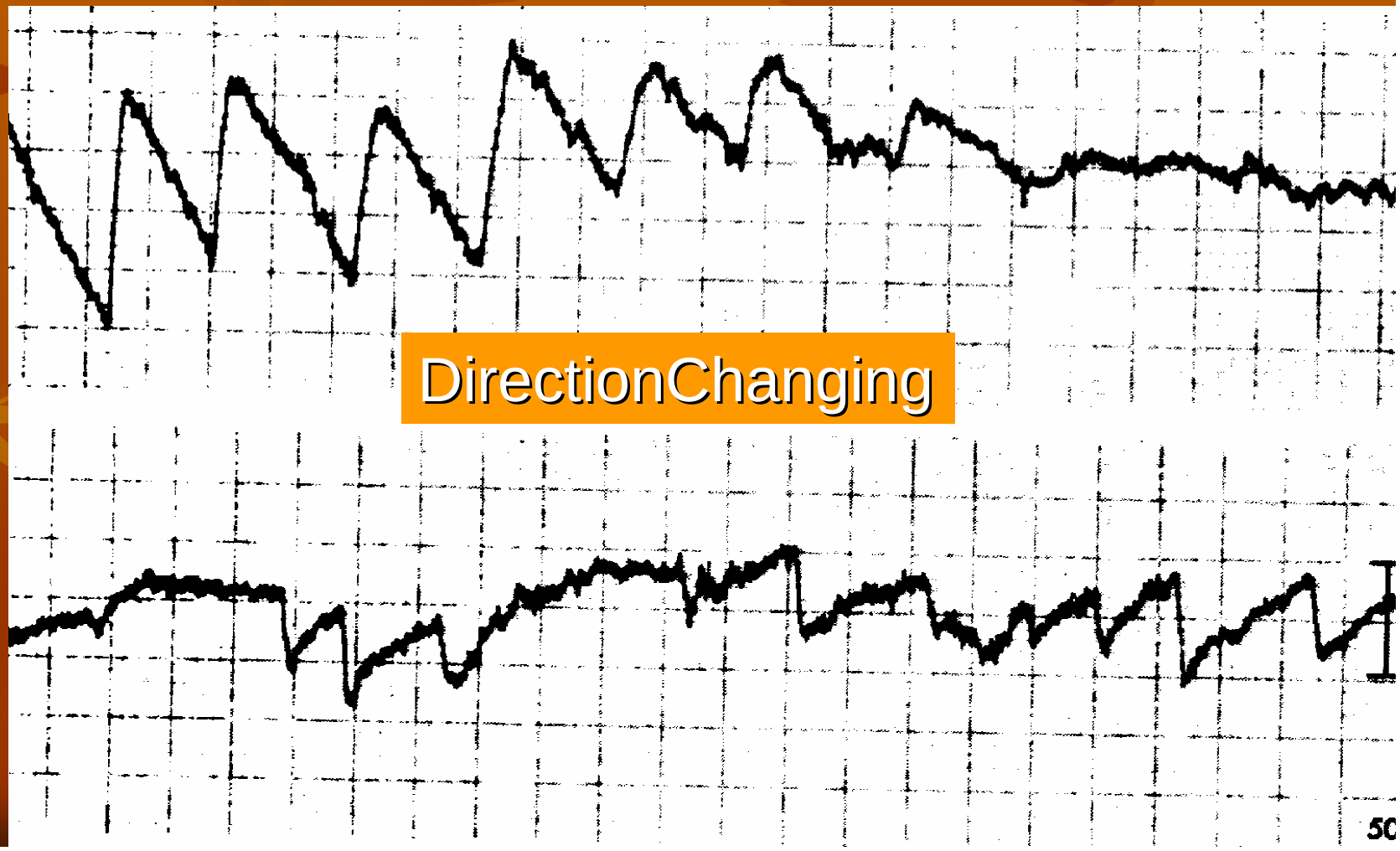
Positional tests

- Peripheral indicators include the following:
  - Direction-fixed
  - geotropic direction changing in different positions, *horizontal SCC variant of BPPV*
  - Latency of onset
  - Fatigable
- Central indicators include the following:
  - ageotropic direction changing in different positions,
  - Direction changing in a single position,
  - Immediate onset
  - Not fatigable

Positional Test: Abnormal Peripheral



Positional Test: Abnormal Most Often CNS



Caloric stimulation

- The most informative ENG subtest
- water, air, and closed-loop cuff
- Water calorics provide a strong stimulus
- air, and closed-loop cuff used with PET or perforation of TM
- cool = 30 C warm = 44 C
- Response pattern follows the form of COWS

Caloric test disadvantage

- Low frequency(0.003 Hz)* = PTA @125Hz
- Indirect (depend on heat transferring capacity of EE+ME)
- Lateral SCC
- LOC

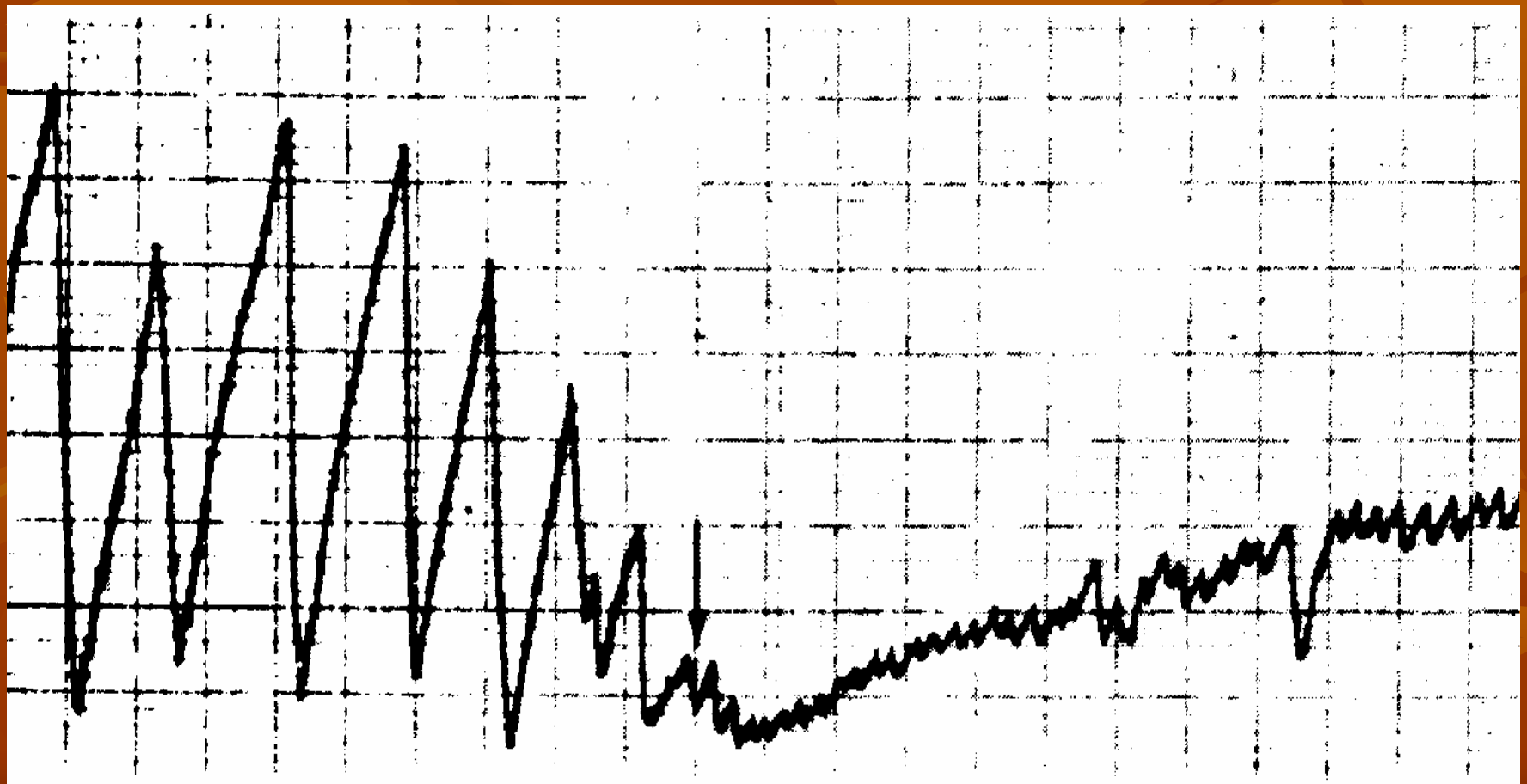
*0.01-10.0 Hz Vestibular system

Caloric stimulation

- head at an angle of 30°
- LSCC in the vertical plane
- spontaneous nystagmus is evaluated 1st
- Bilateral weakness
  - Average responses of <60/s
  - bilateral peripheral or central
  - drug effects should be excluded
- Fixation after each test
  - R/O CNS No reduce nystagmus
  - Fast recovery .
- no response→ Ice water for residual

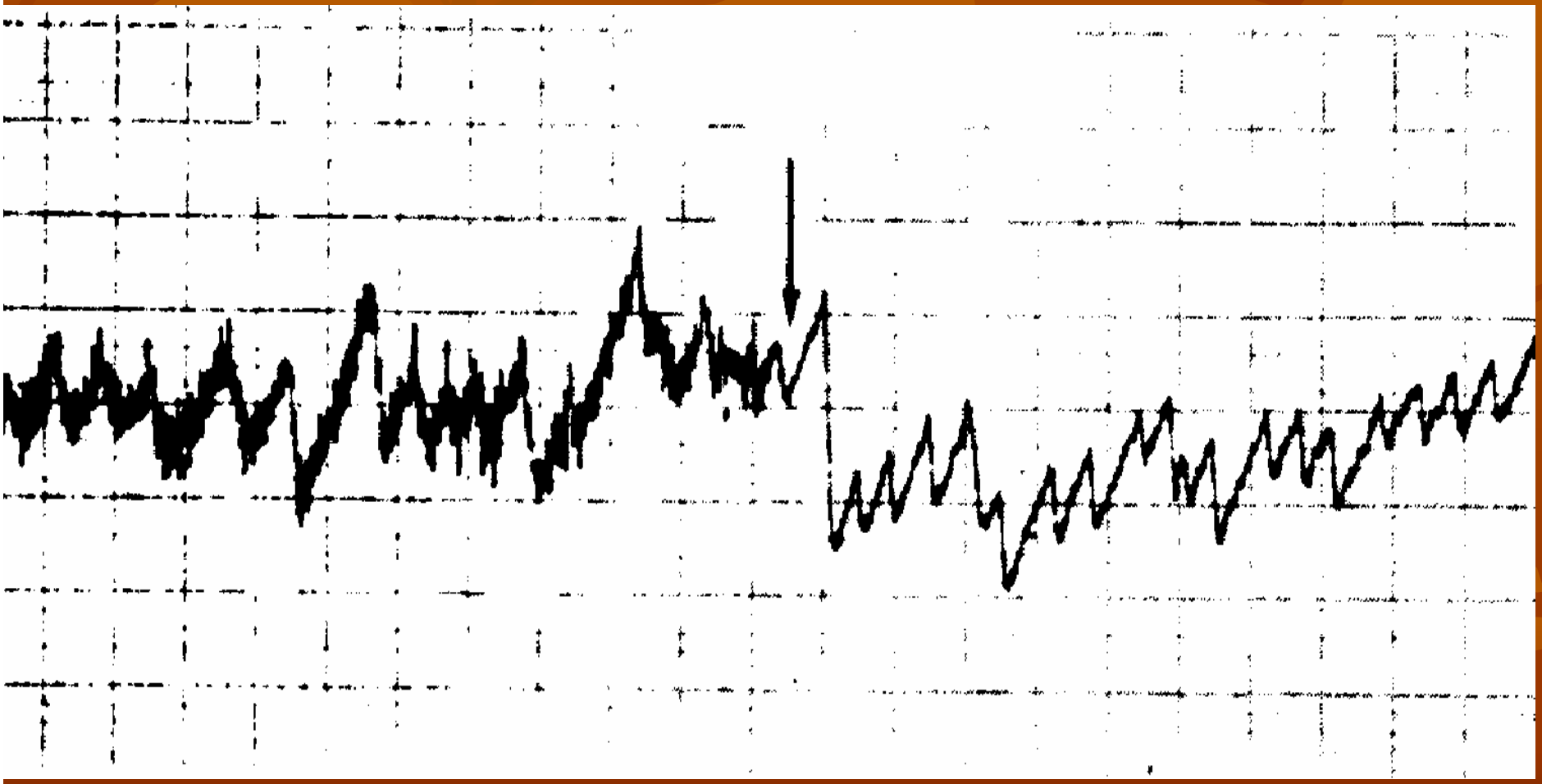
Caloric Test: Normal

Fixation Suppression



Caloric Test

Failure of Fixation Suppression

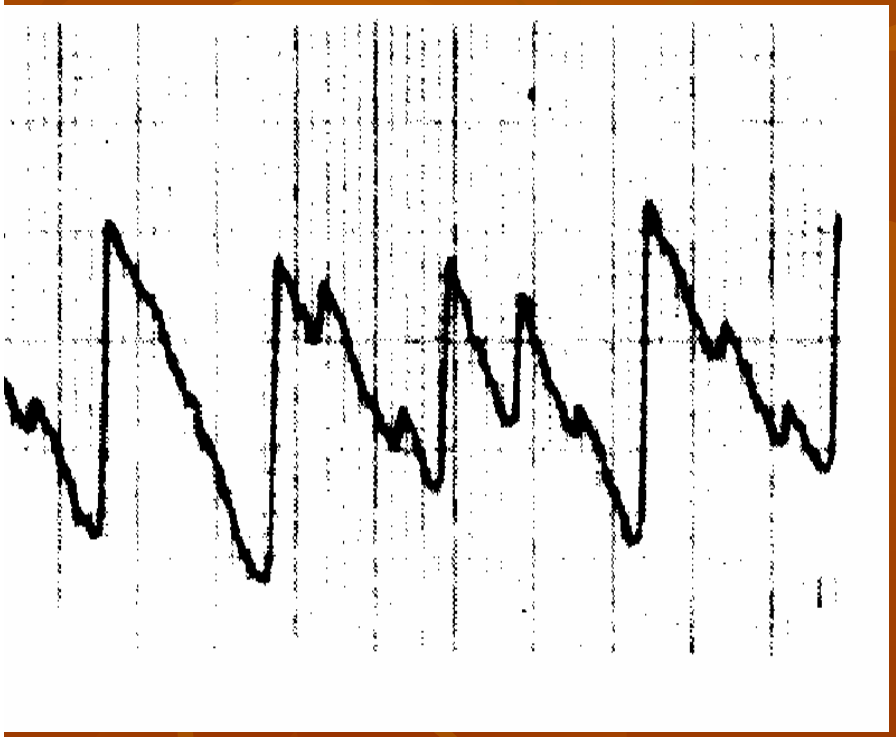


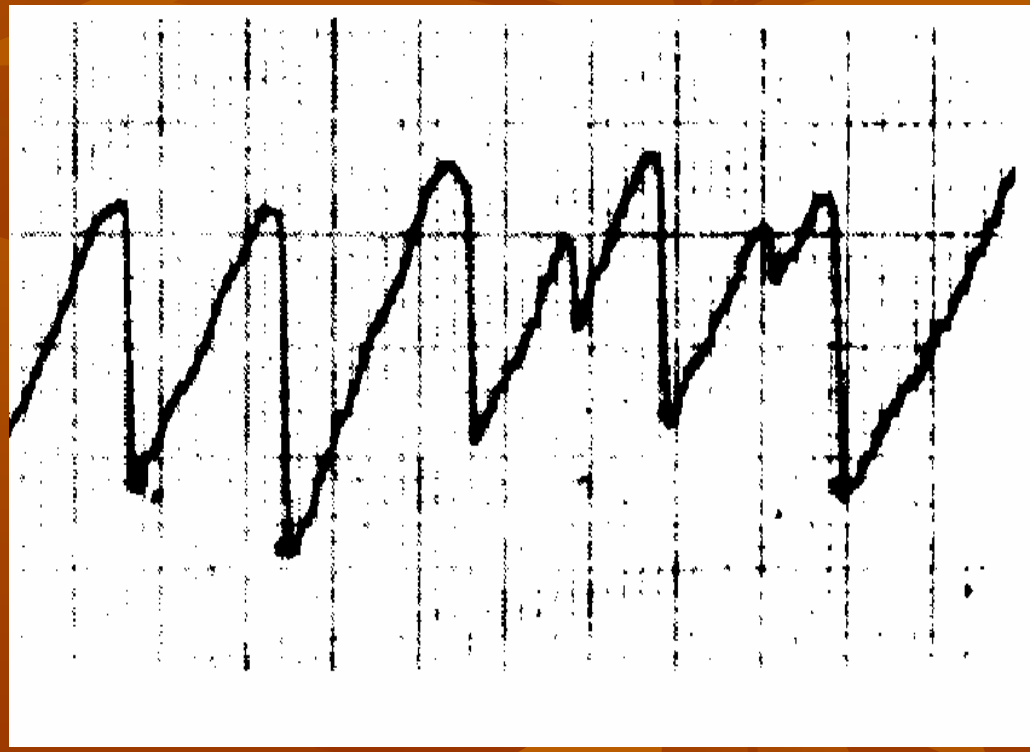
Caloric stimulation

- Unilateral weakness (UW) *Labrynthine preponderance (LP)*
  - evaluate symmetry
  - > 25% is significant.
  - = [(RC + RW - LC + LW)/(RC + RW + LC + LW)] X 100.
  - peripheral lesion (nerve or end-organ)
  - lesion in the side of the weakness.

- Directional preponderance (DP)
  - with spontaneous nystagmus
  - >20-30% is considered significant.
  - = [(LC + RW - RC + LW)/(RC + RW + LC + LW)] X 100

Which direction?





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