17th Workshop on
NEUROTOLOGY and
MEDICAL AUDIOLOGY

Kolkata : 19th to 21st Jan, 2018

THE FUNCTIONAL HEAD IMPULSE TEST (FHIT)

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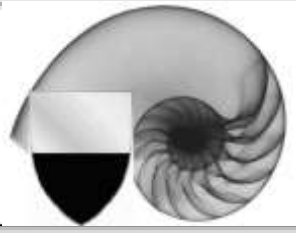
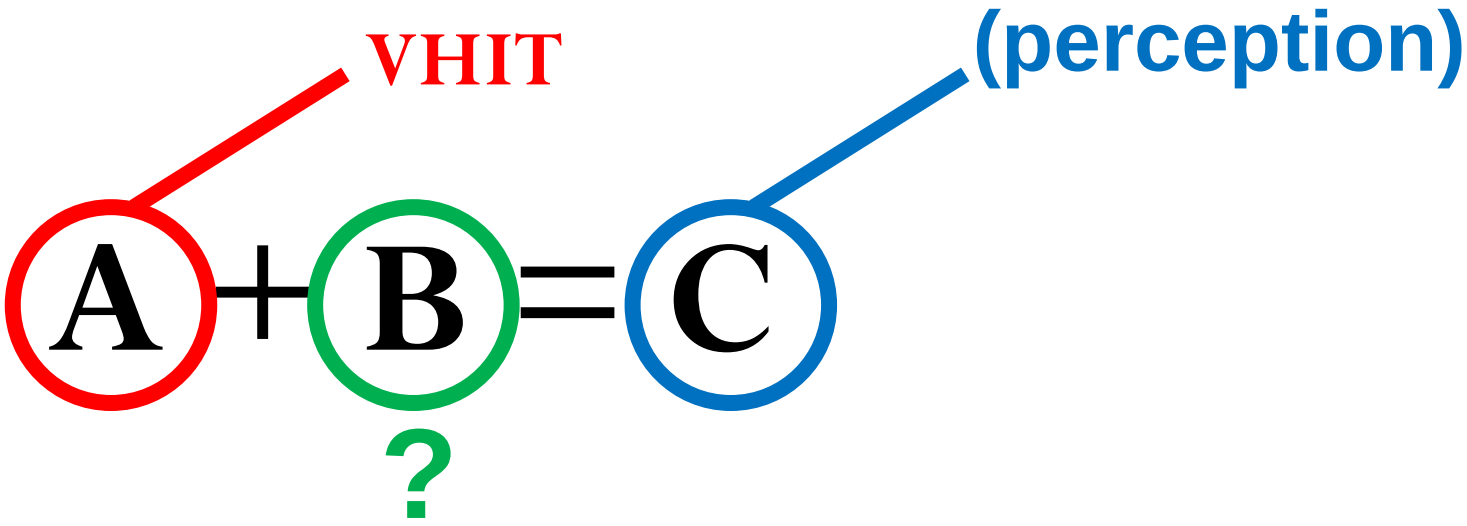


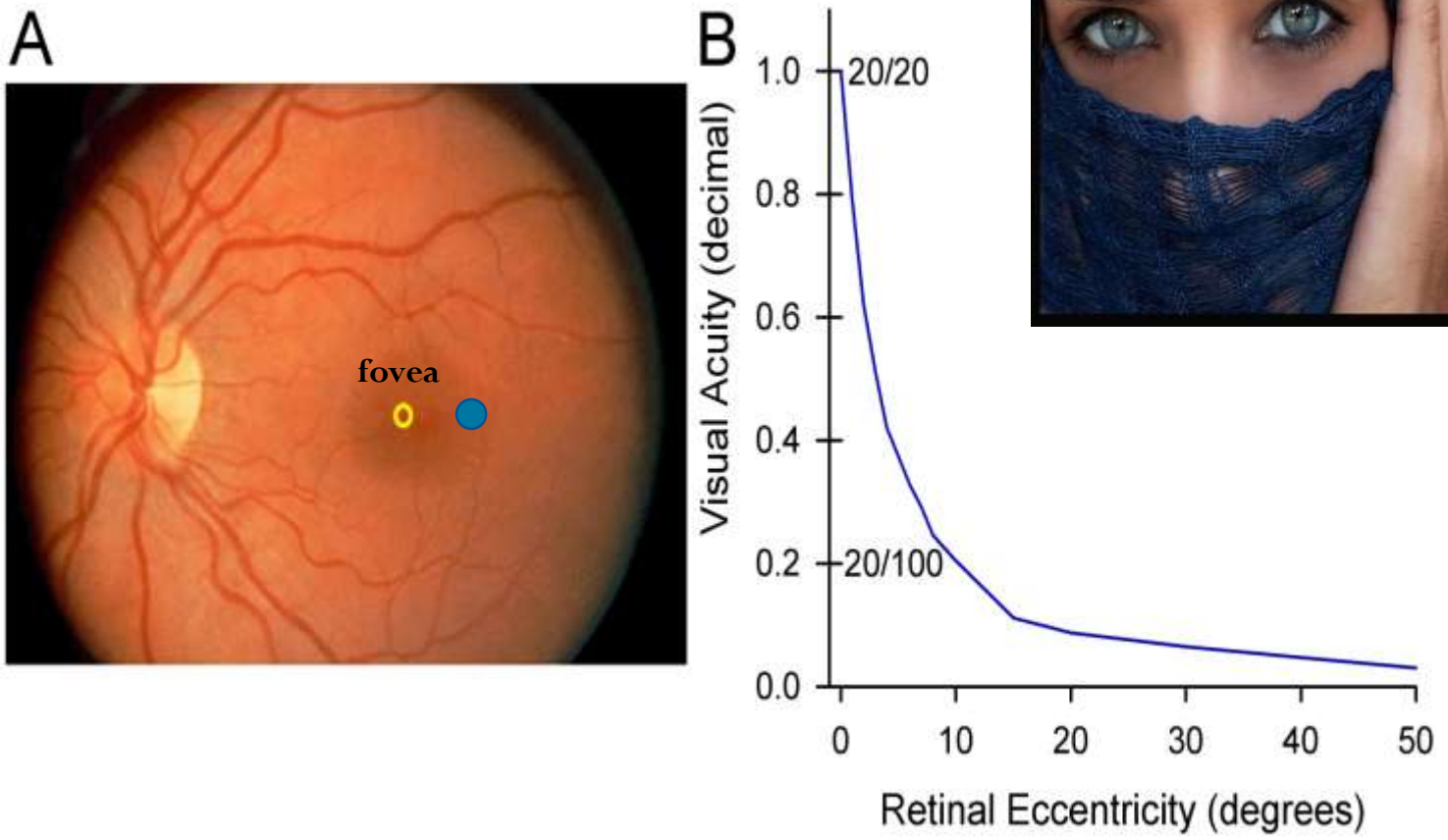
In case you were the last audiologist on an remote island would you prefer to have with you the pure tone or speech audiometry?



Vestibulo Ocular Reflex (VOR)

- VOR: enables clear vision by stabilizing gaze (eye position in space) during head movements (mediated by six SCCs)
- Locomotion: head movements with predominant high frequencies **(0,5 to 5.0 Hz)** and accelerations **(4.000 deg/s^2 and above)**
- VOR: rapidly acting reflex with short latency **(7-15 ms)** - fast enough to generate eye movements that compensate for these frequencies
- Latency of visual-mediated eye movements in humans too slow **(75 ms)**
- Function of the angular VOR: to hold images on the retina during head rotations… to allow perception!

Da Leigh & Zee



*Clear vision of an object requires that its image is held steadily within 0,5 deg from the center of the fovea (greatest photoreceptor density-***optimal visual acuity)**

2 degrees from the center of the fovea, visual acuity declines by about 50%.

VOR impairment

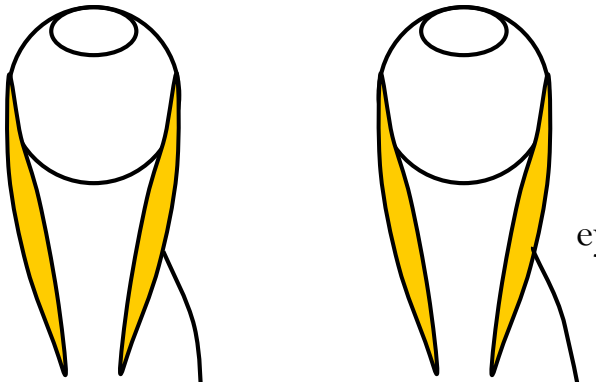
- *Poor gaze stabilization during head movements*
- *Impairment of vision when walking*
- *Dizziness / instability*

aVOR assessment: the HIT

- **A clinical sign of canal paresis.** (Halmagyi & Curthoys, Arch Neurol 1988)
- Revolution in the evaluation of vestibular disease
- Aw et al. (1996): scleral search coil HIT

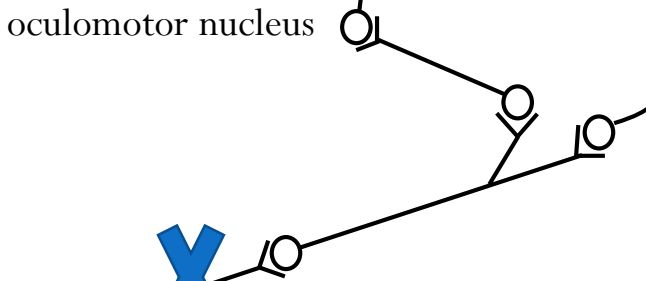
➢ MacDougall et al.(2009): The Video HIT (Lightweight high speed video system – objective measurement)

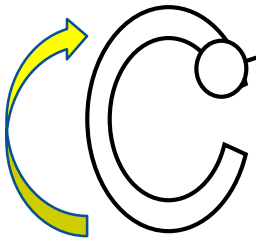
Left vestibular neuritis – Acute unilateral vestibulophathy



-**Head turn to the left is not transduced**

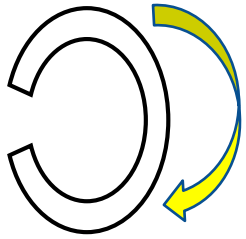
-**Absent or reduced aVOR**
- **Loss of normal compensatory eye movement**





left LC

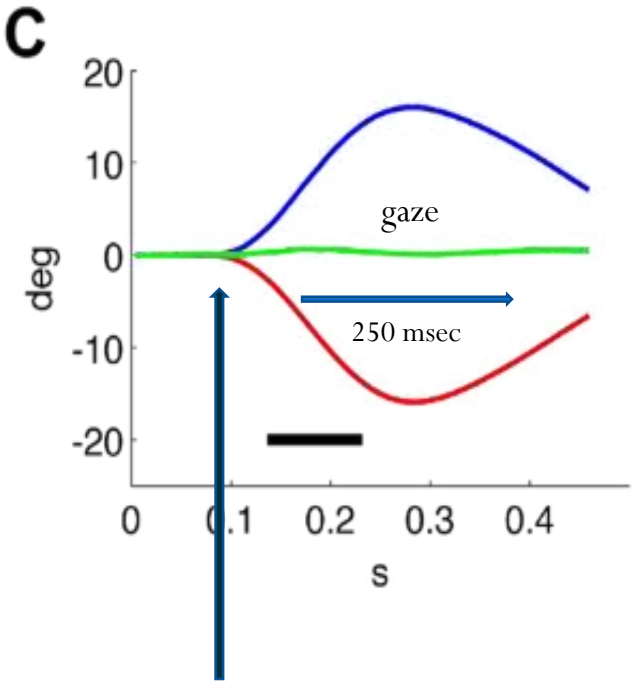
Simultaneous right ampullar nerve inhibition: reduced excitation of the antagonist muscles
Minimal contribution from the contralesional side



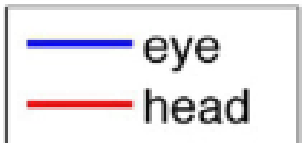
Right LC

Video HIT: ocular response (yaw axis)

normal

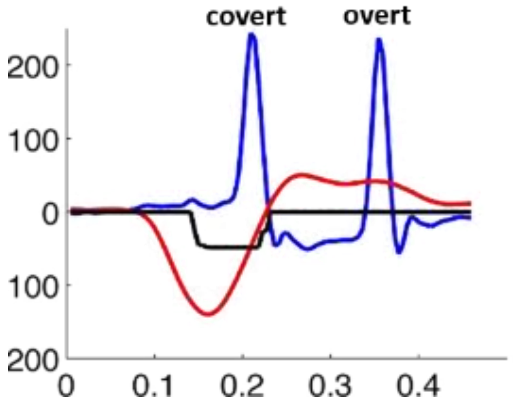


aVOR: 1



aVOR latency: 8 msec

Vestibular neuritis



Dynamic Visual Acuity Test

Normal subjects lose only 1 line of acuity with head shaking. Patients with no vestibular function lose about 5 lines with horizontal or vertical rotation but not with rotation in 'roll' (ear to shoulder) since the image is still on the fovea. Patients who lose DVA in 'roll' are malingering!

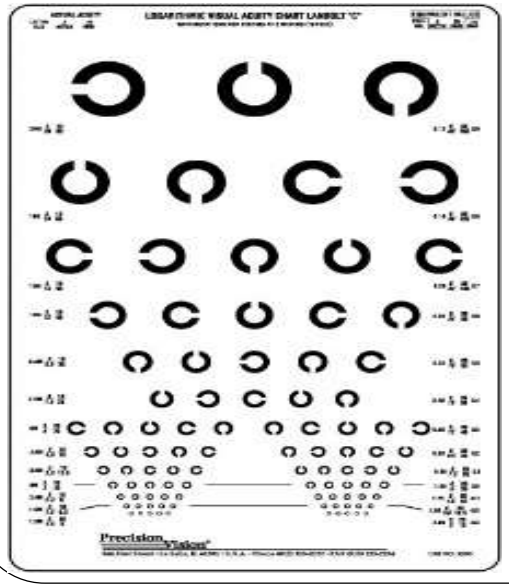
Functional HIT

- Perceptive test
- Does not measure the eye movements
- Assess the *function* of angular VOR at high acceleration/velocity
- Determines the ability to keep an image into focus when HIT is performed at different head accelerations and velocities

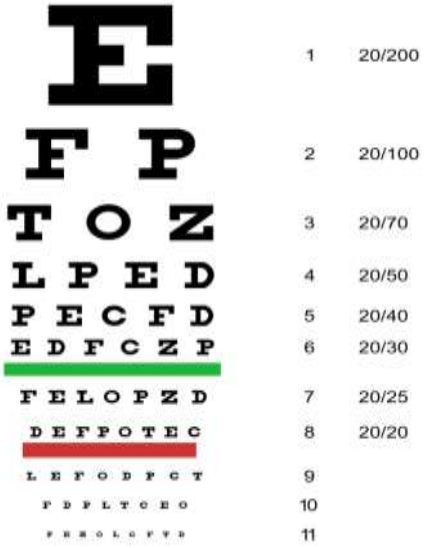
Functional HIT

- **Measure of the ability to read an optotype briefly shown on the screen during head acceleration**
- The patient must recognize the orientation of the Landolt C optotype with random orientation
- or a alphabet letter of the Snellen chart (Disney characters for children!)

Landolt C chart



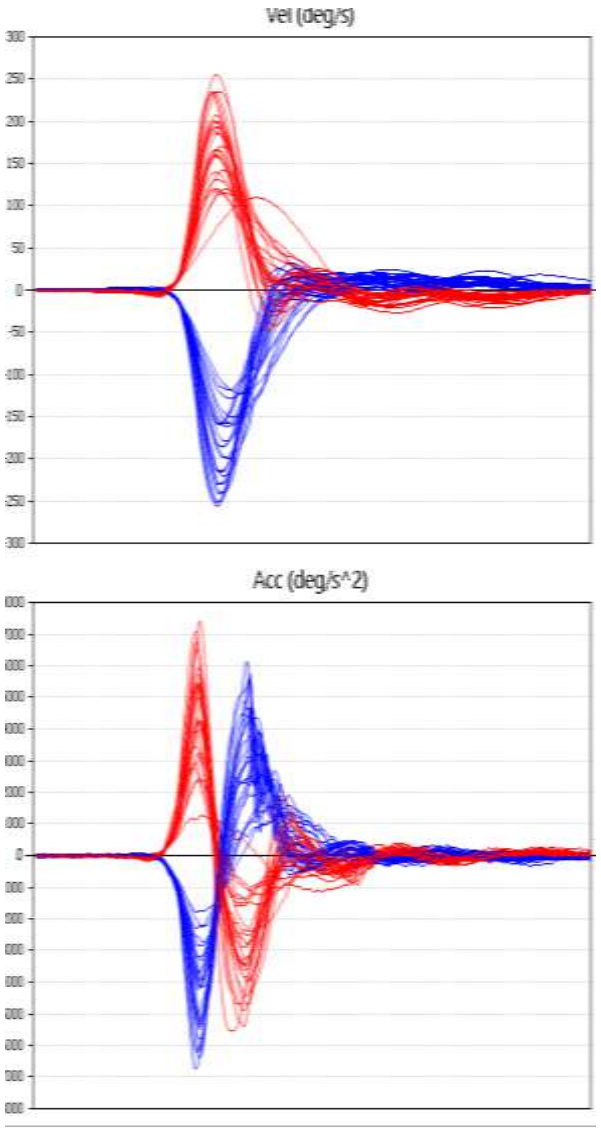
Snellen chart for visual acuity



Functional HIT

The **measure of static visual acuity** allows to normalize the size of the visual stimulus so that the letters shown were 0.6 logMAR lines larger.

The imposed head thrusts have different head accelerations, **classified in acceleration bins** (width of 1000°/s^2 with upper bounds ranging 2000–7000/s^2) based on their direction.



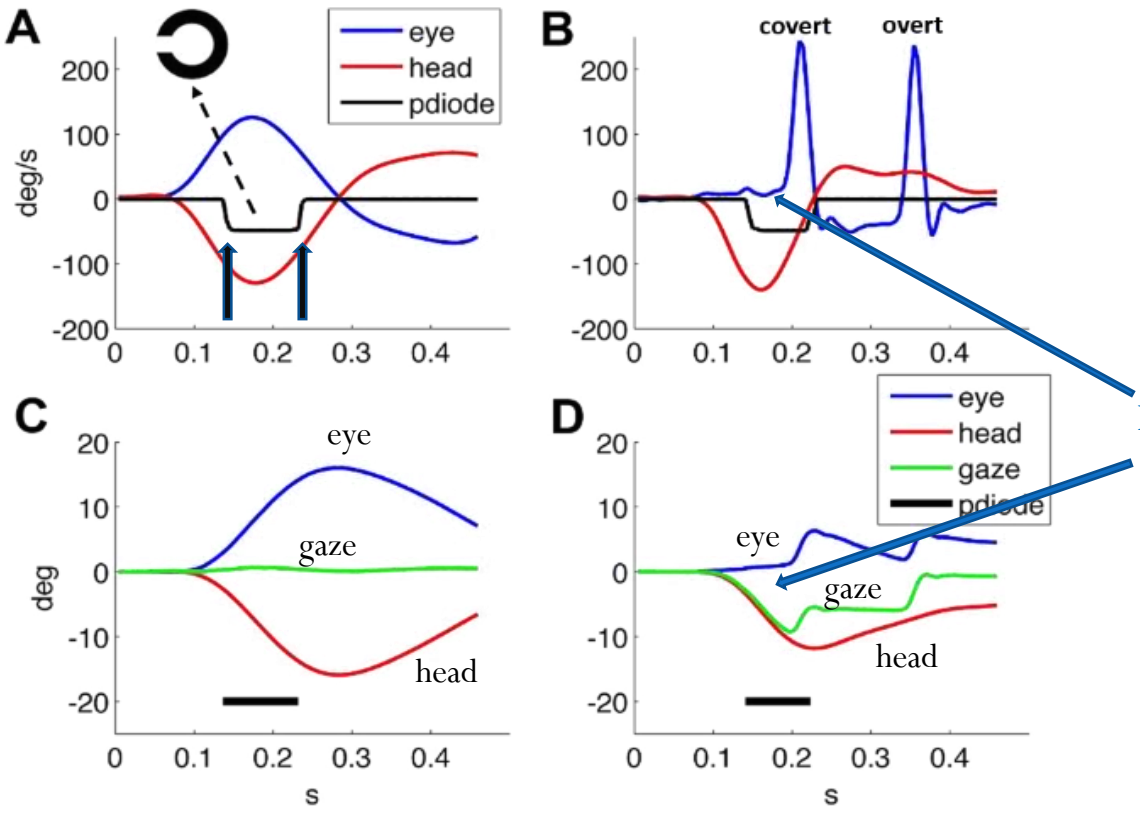
Functional Head Impulse Test (summary)

1. The **measure of static visual acuity** allows to normalize the size of the visual stimulus so that the letters shown were 0.6 logMAR lines larger.
2. An **optotype** with random orientation was shown during the head impulse based on head angular acceleration.
3. Patients were asked to recognize the shown letter.
4. Different head accelerations: the imposed head thrusts are **classified in acceleration bins** (width of 1000°/s2 with upper bounds ranging 2000–7000/s2) based on their direction.

✓ Outcome % correct answers (Y axis) vs range of head accelerations (X axis).

fHIT

Optotype presentation period: around 80 msec

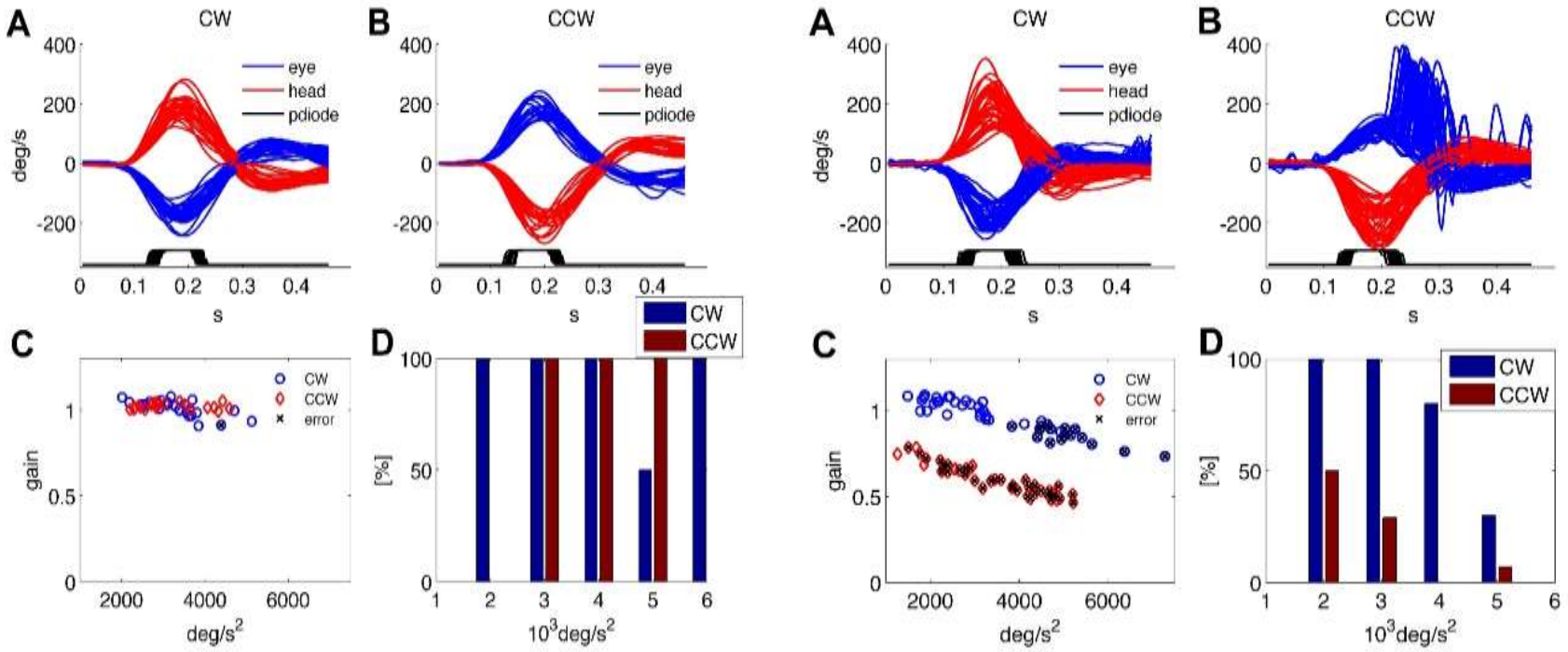


Colagiorgio et al. "A new tool for investigating the functional testing of the VOR". Front. Neurol. 4:165, 2013.

Validation with VHIT

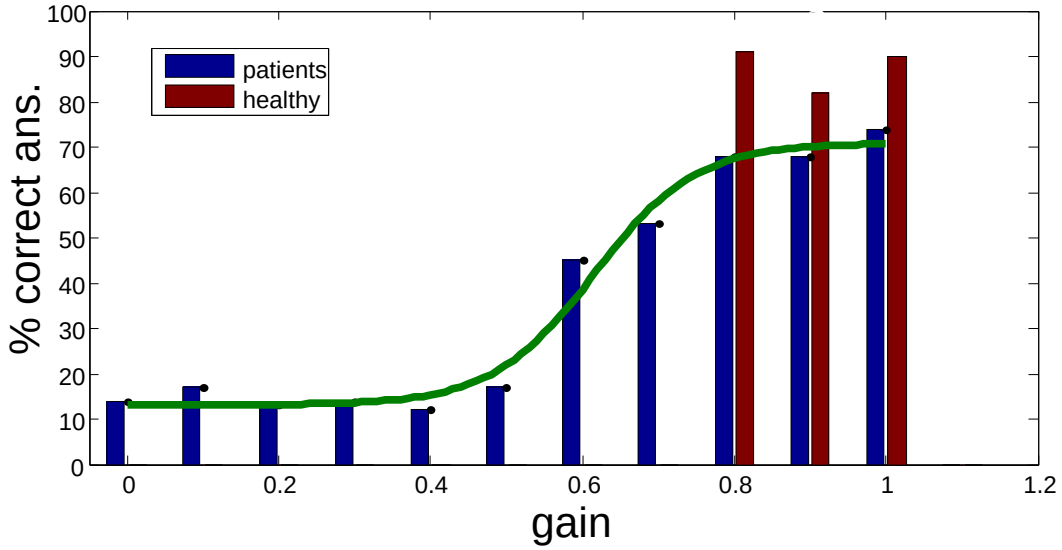
Healthy subject

Vestibular Neuritis – Acute Unilateral Vestibulophaty

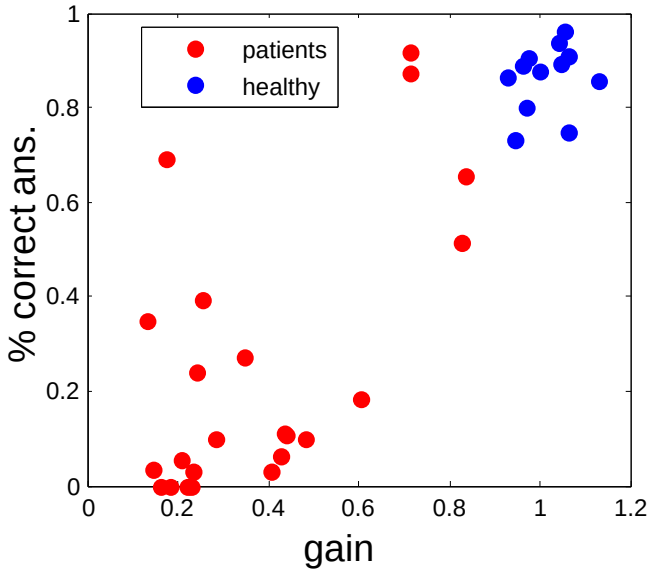


Versino M, Colagiorgio P, Sacco S, Colnaghi S, Quaglieri S, Manfrin M, Benazzo M, Moglia A, Ramat (2014) S. ***Reading while moving: The functional assessment of VOR***. Journal of Vestibular Research, 24(5).

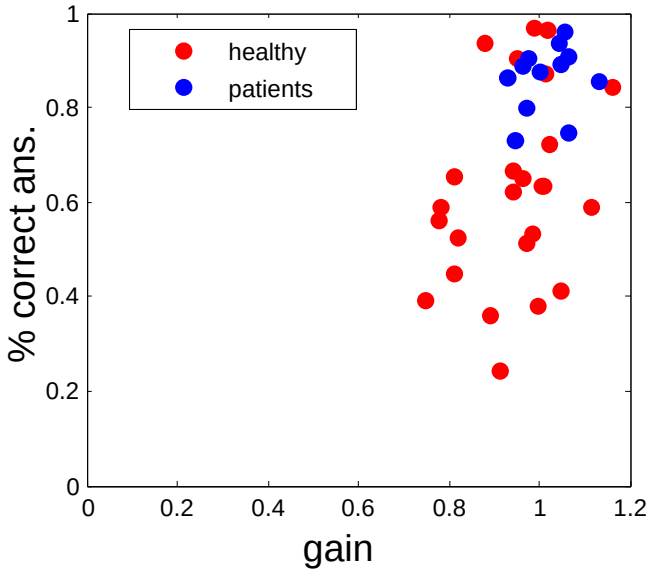
Validation with VOG



Ipsilateral



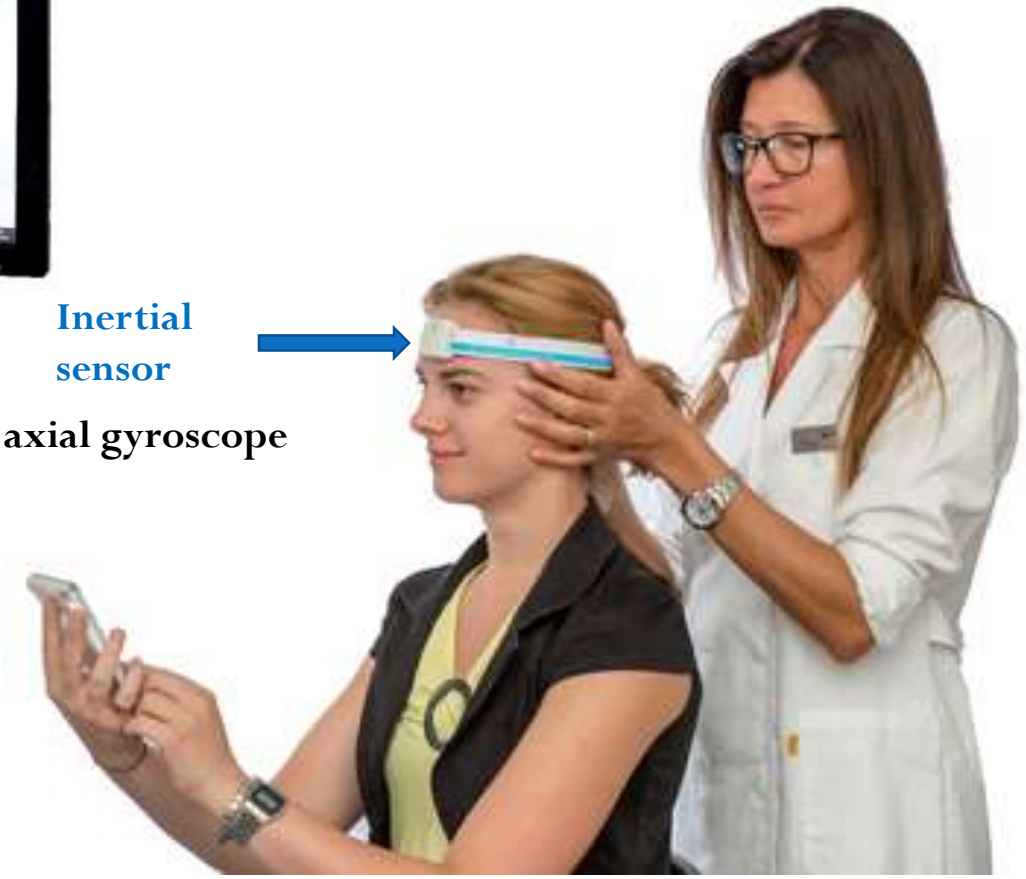
contralateral



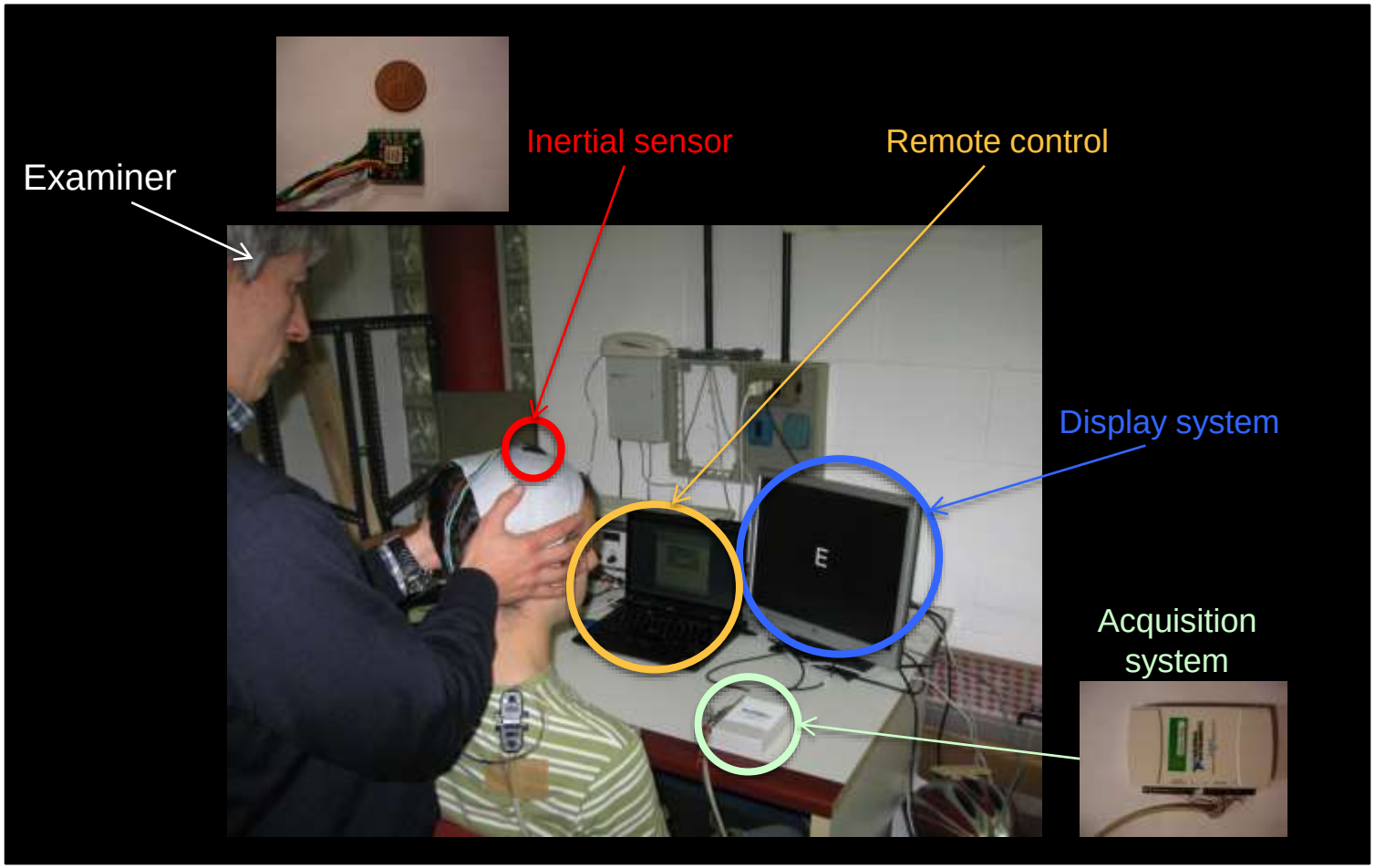
Functional Head Impulse Test

Inertial sensor

3 axial gyroscope

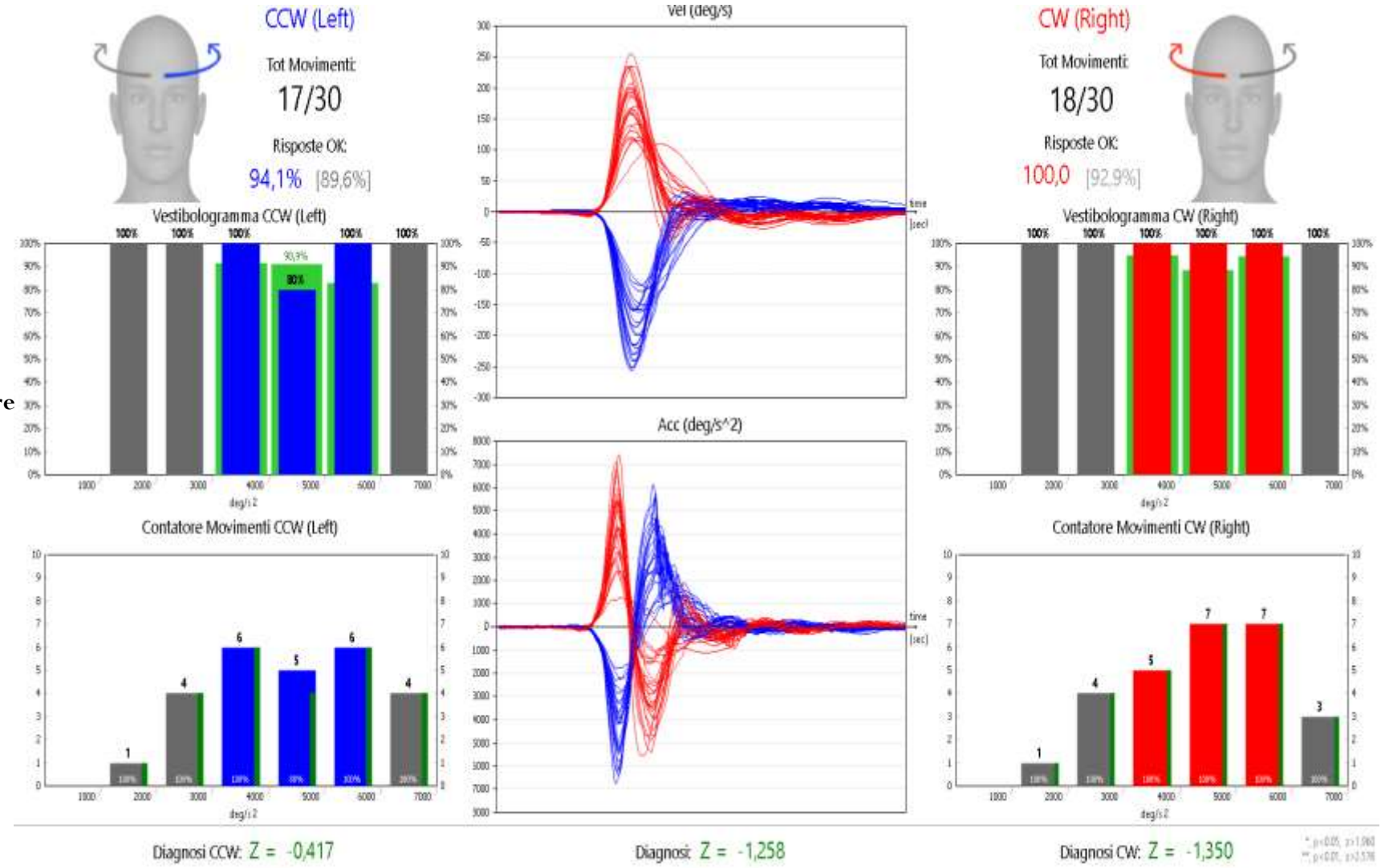


FHIT: FUNCTIONAL HEAD IMPULSE TEST
…the beginning



FHIT

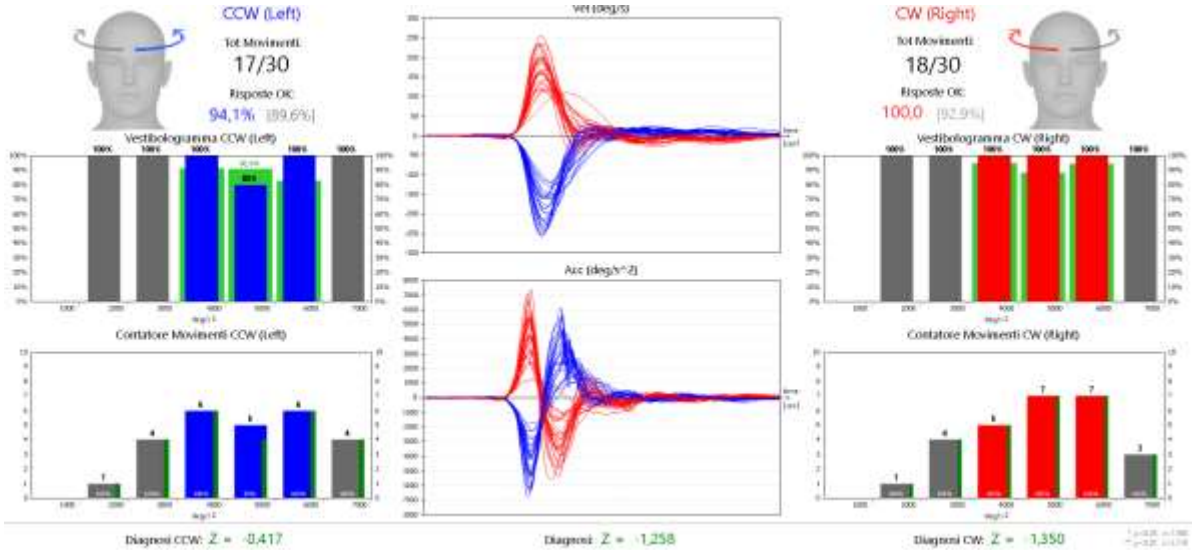
Test Outcome= % correct answers



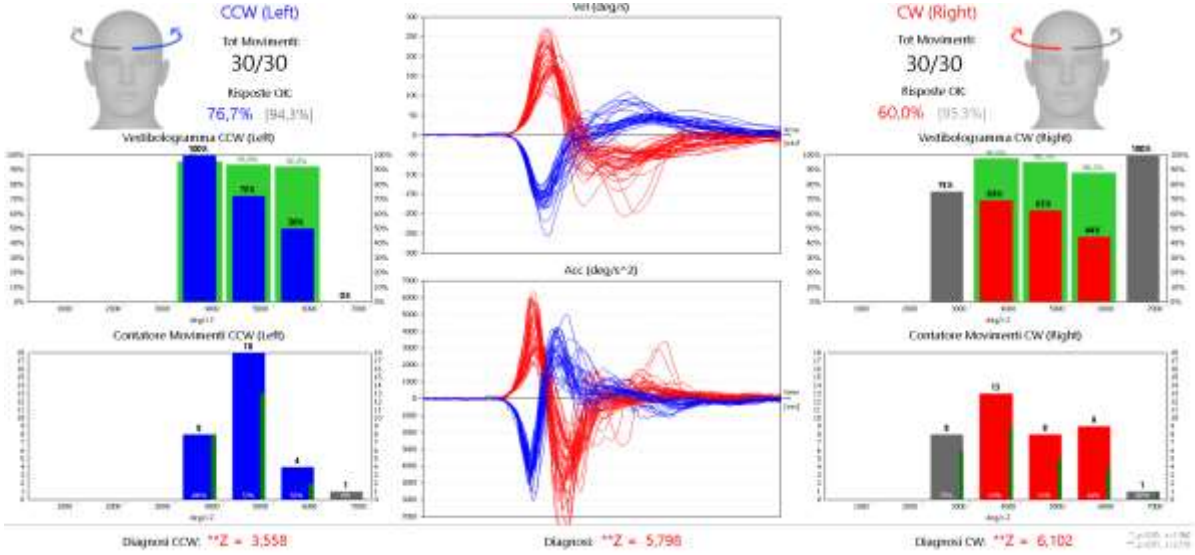
Score Percentage of correct responses

N° head impulses

Functional Head Impulse Test



Healthy subject



Patient

Conclusions

- FHIT is a complementary test to assess vestibular function (like speech audiometry and pure tone audiometry)
- Does not require eye movements analysis
- Easy and fast (10 minutes) – patient clear insight of the disorder
- Paediatric patients
- "Small eyes" people
- With glasses (?)
- Good correlation with patient perception of the disorder (bilateral VL…)
- New perspectives: vestibular neuropathy, presbiastasis, vestibular migraine…
- Rehabilitation

Functional
Head
Impulse
Test

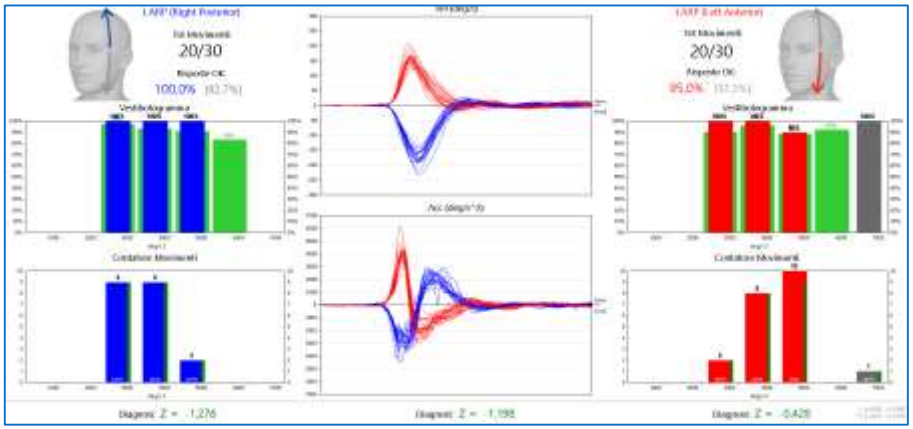
Stefano Ramat

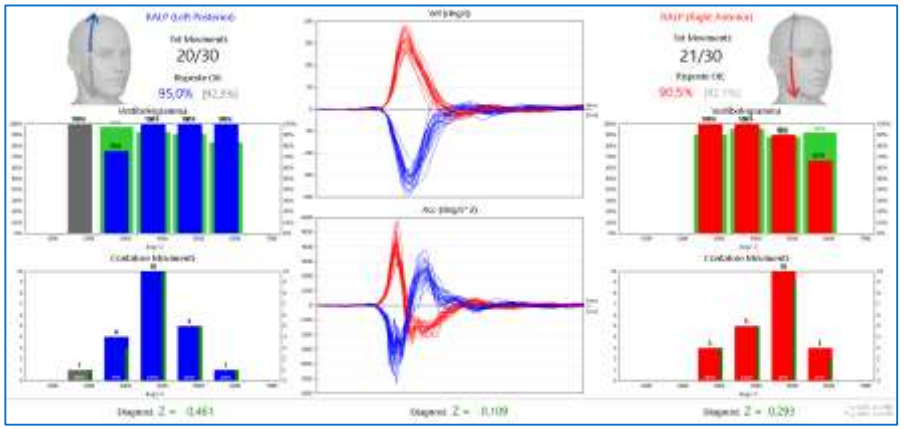
Marco
Mandalà

Maurizio
Versino

LARP

RALP





LEFT ACUTE VESTIBULAR NEURITIS

Data referto: 15/05/2017

Operatore referto: utente utente

Impulso della testa

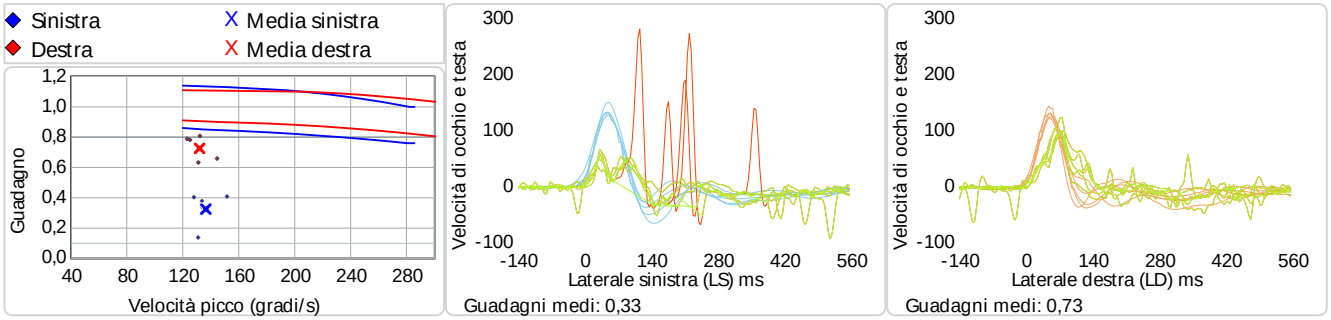
Prova impulso laterale: 05/04/2017 12:02:32

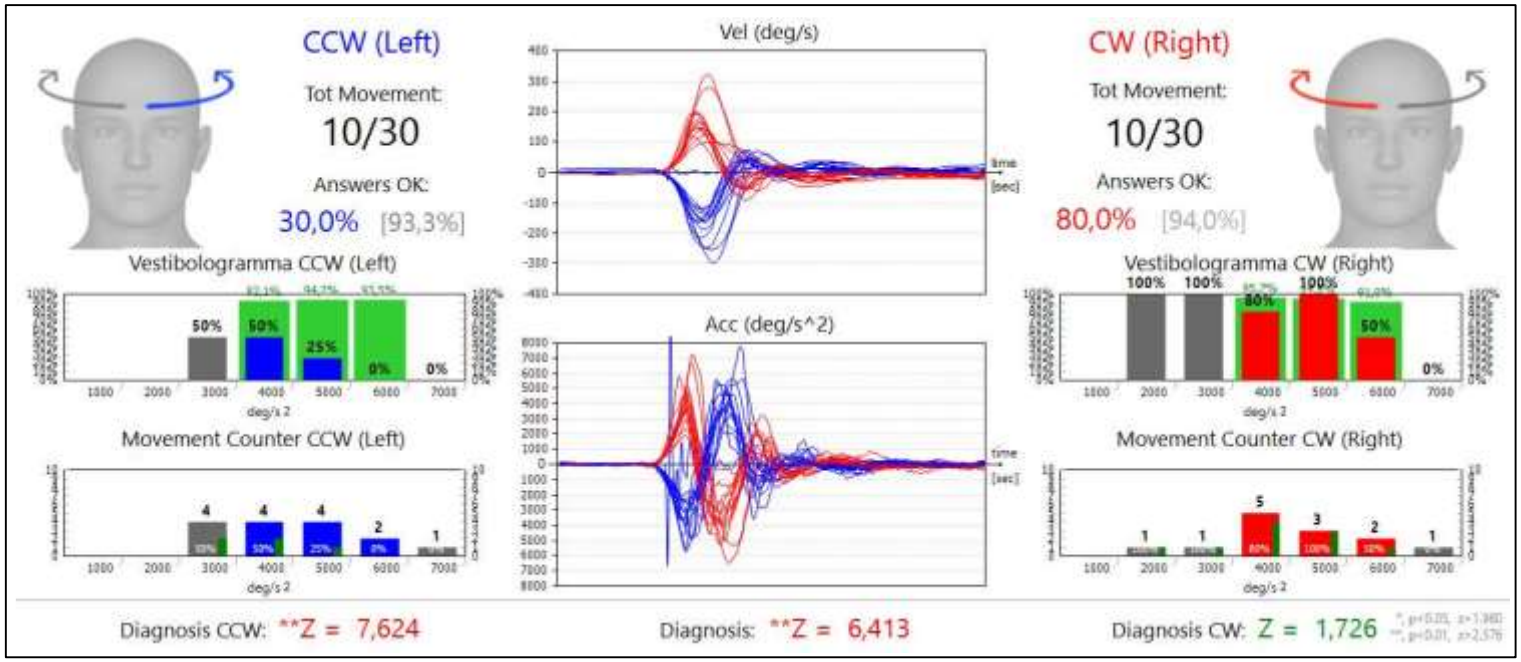
Operatore della prova: utente utente

x̄ Sinistra: 0,33, σ: 0,1

x̄ Destra: 0,73, σ: 0,07

Asimmetria relativa: 55%





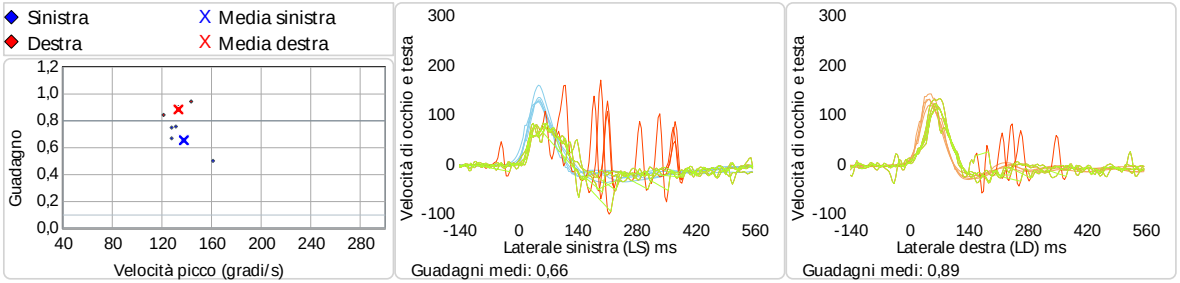
LEFT ACUTE VESTIBULOPHATY (FOLLOW-UP 3 MONTHS)

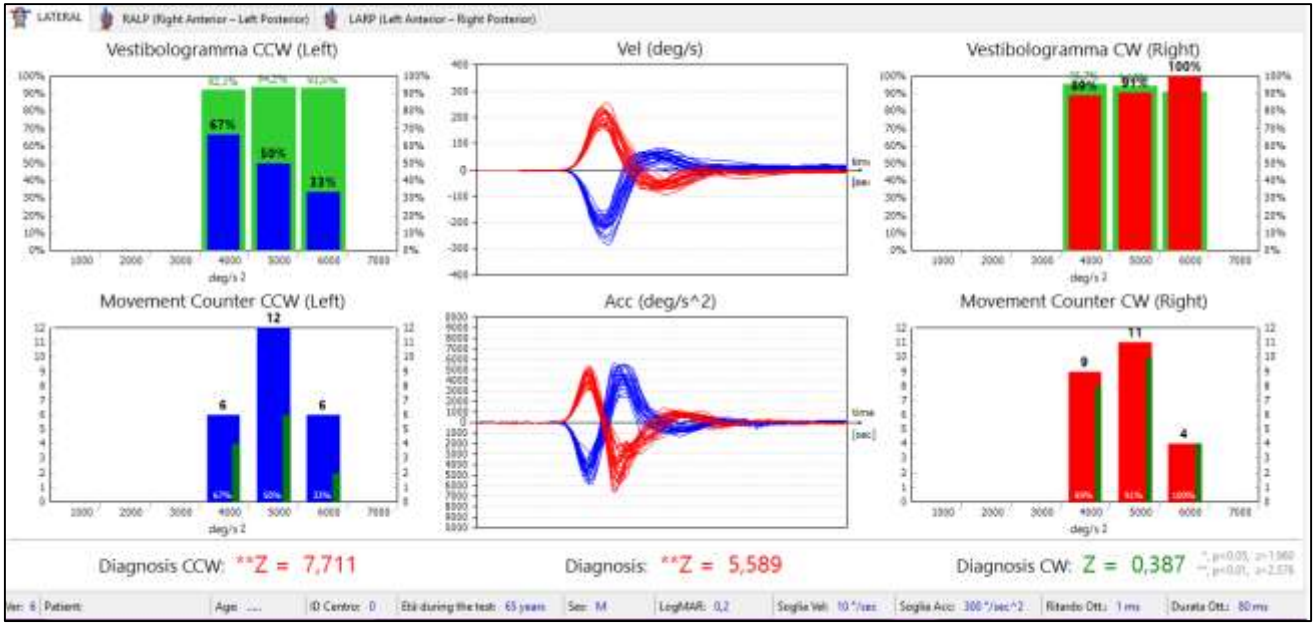
Data referto: 15/05/2017 Operatore referto: utente utente

Impulso della testa

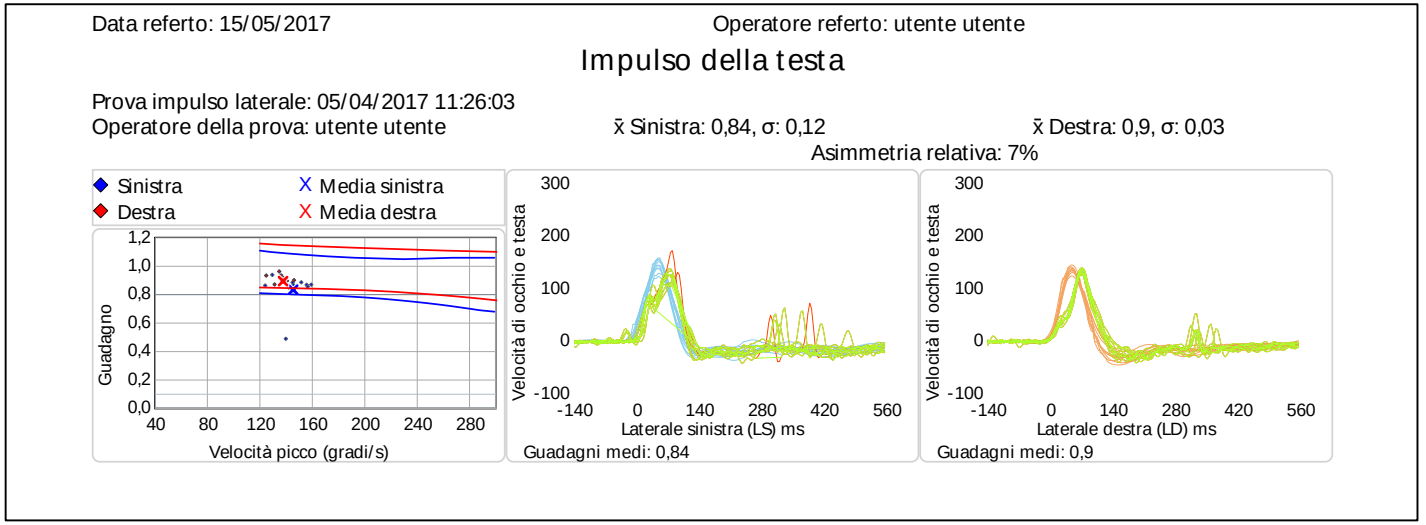
Prova impulso laterale: 26/04/2017 11:08:35
Operatore della prova: utente utente

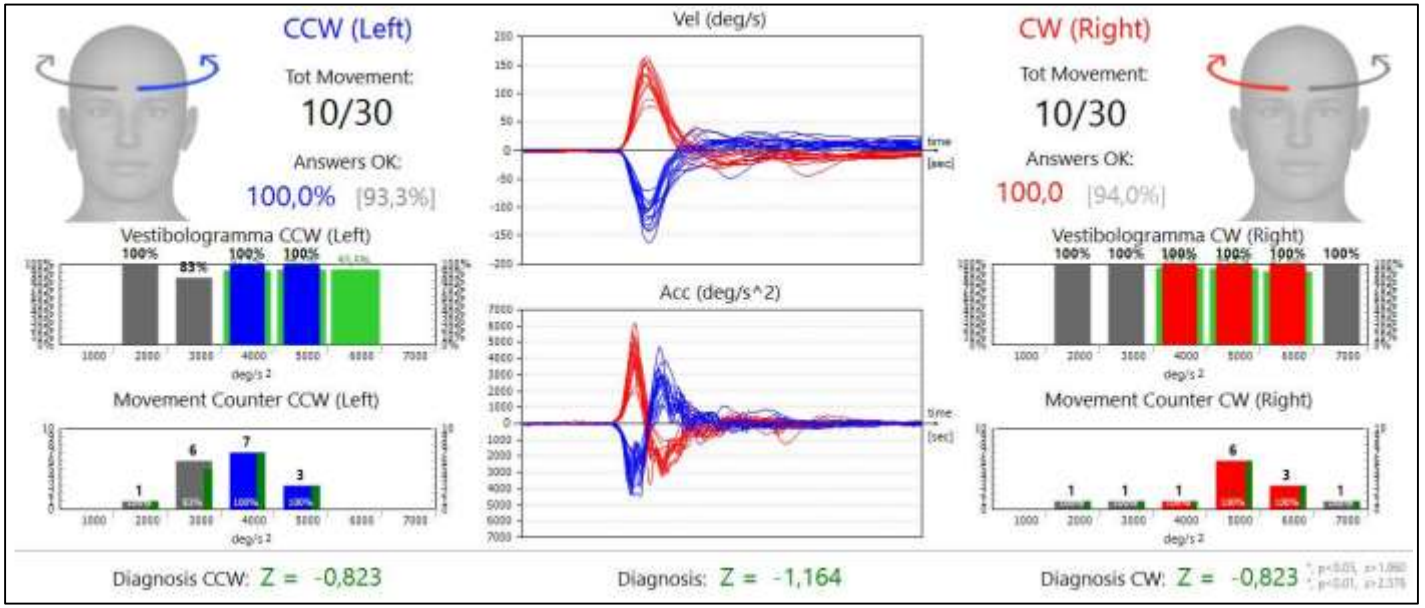
x̄ Sinistra: 0,66, σ: 0,09 x̄ Destra: 0,89, σ: 0,04
Asimmetria relativa: 26%



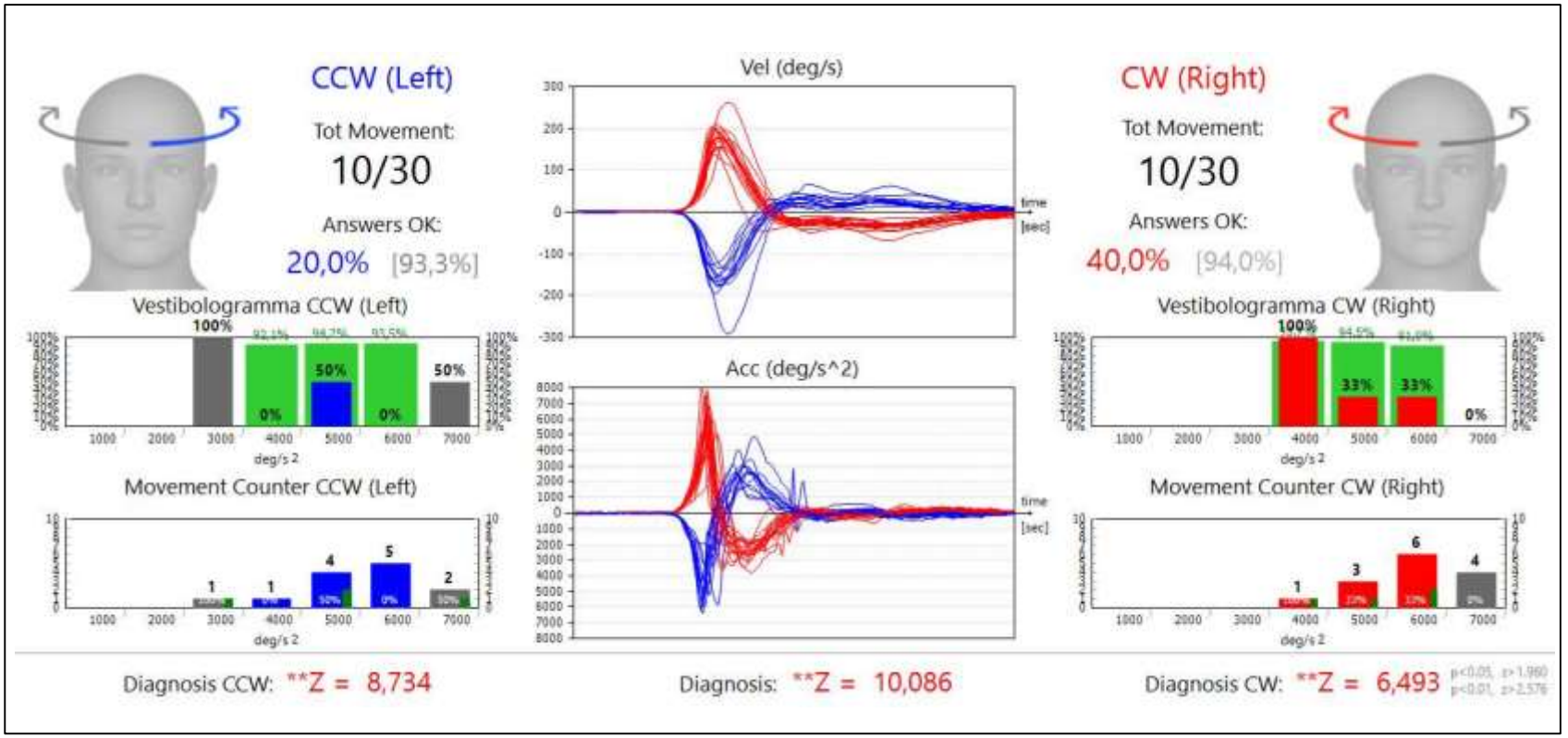


LEFT VESTIBULAR NEURITIS 6 MONTHS FOLLOW-UP (RECOVERY)





BILATERAL VESTIBULAR LOSS



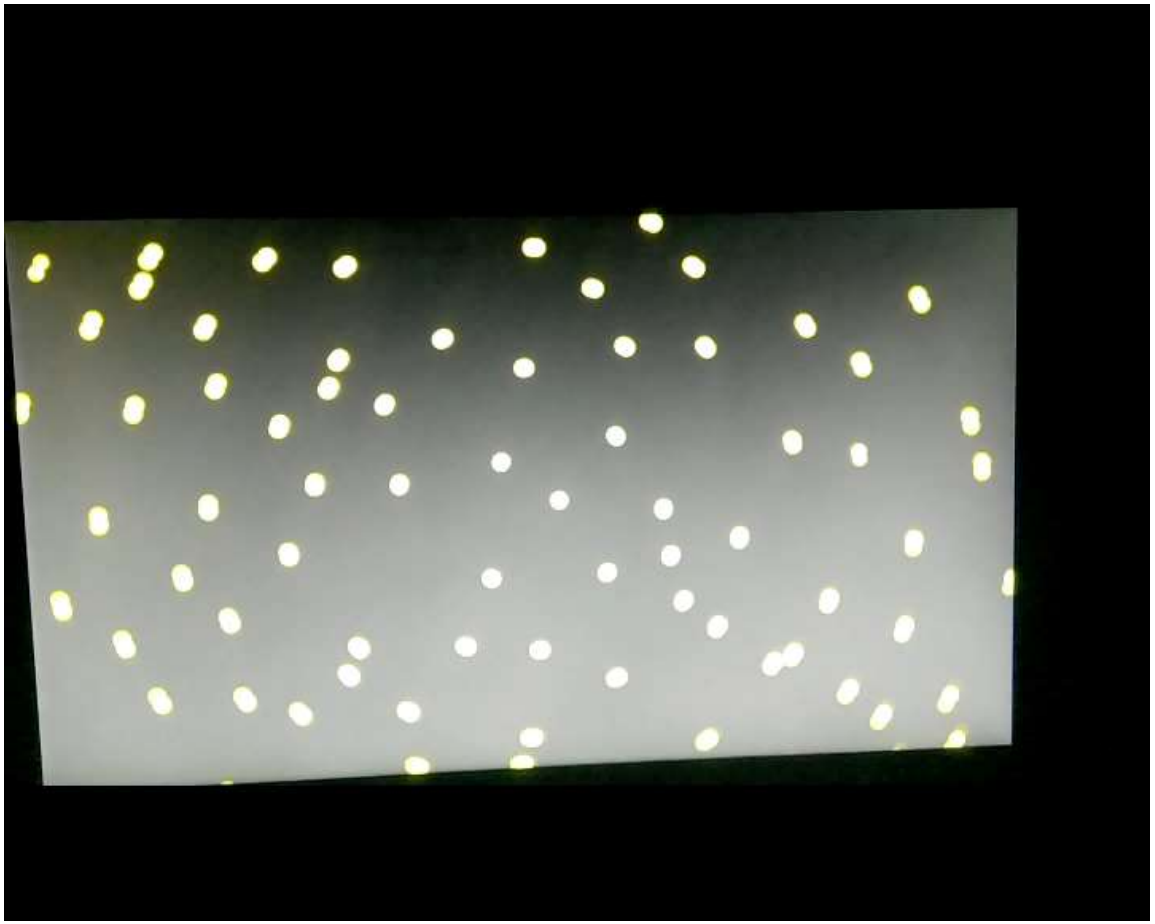
FHIT IN CHILDREN

THE ROTATING FRAME - FHIT

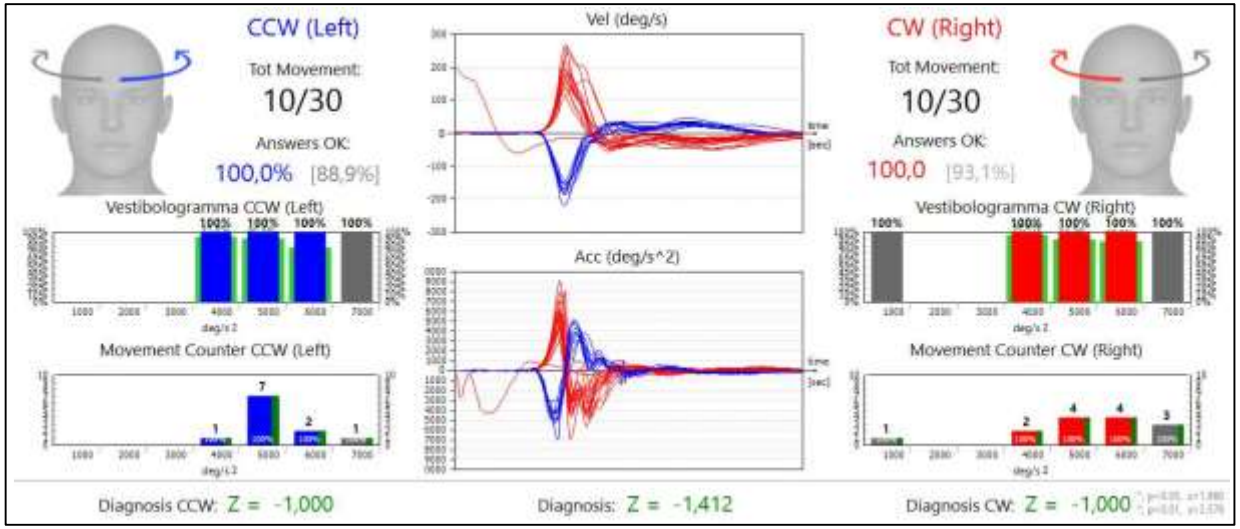
Background:

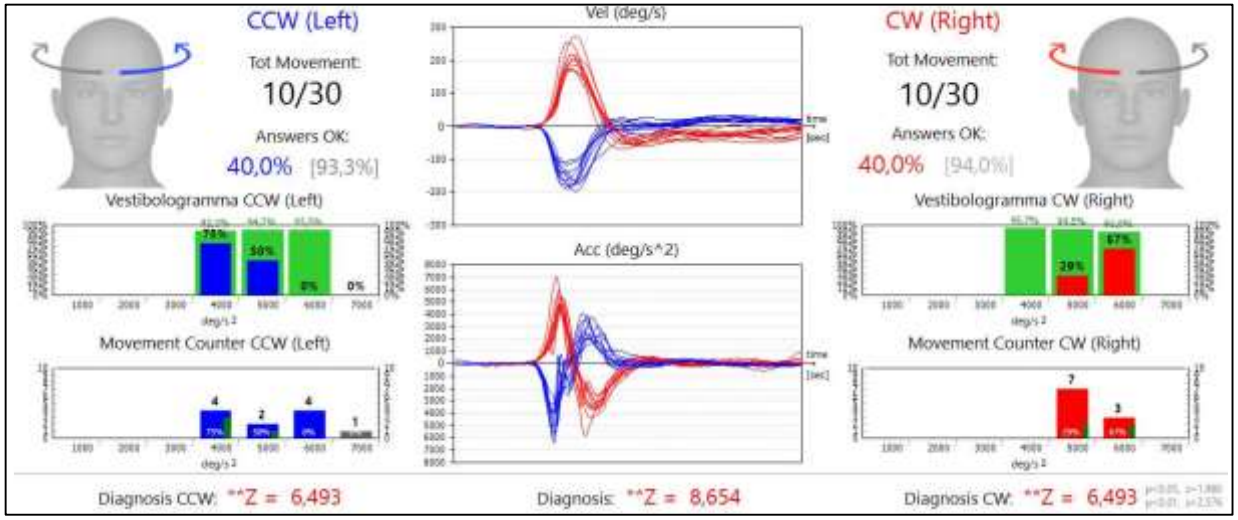
Visual Vertigo (Guerraz et al., 2001)

Postural-perceptual dizziness (Dieterich and Staab, 2016)



VISUO-VESTIBULAR NEUROPHATY in VESTIBULAR MIGRAINE



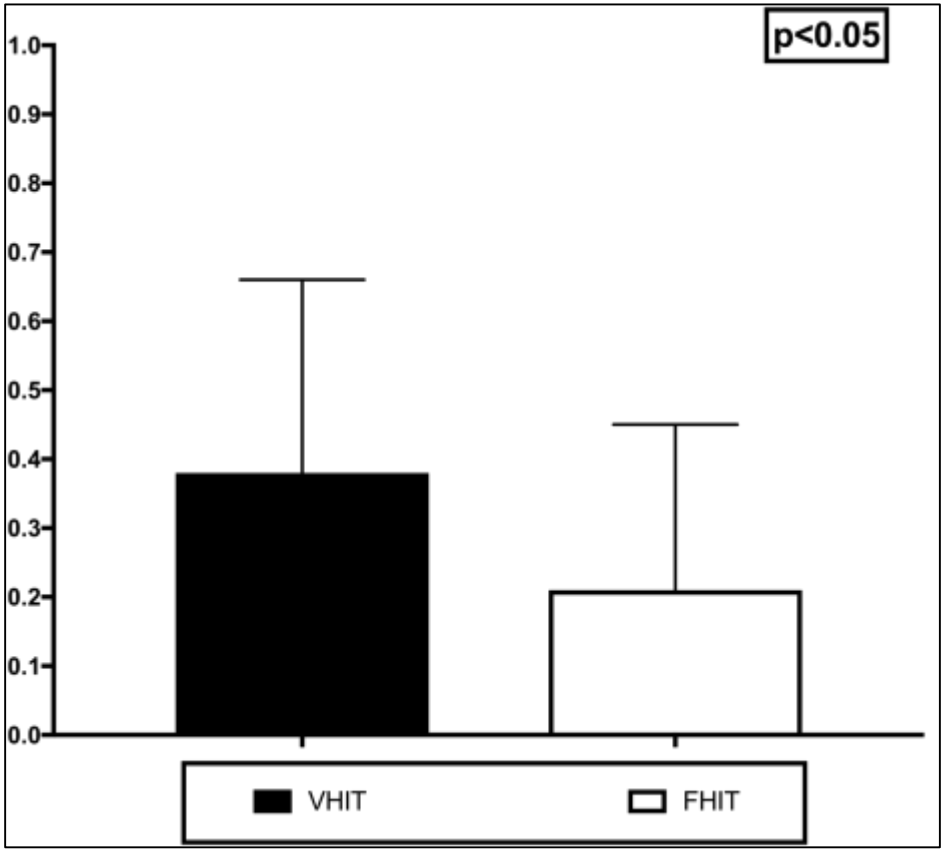


With rotating frame on

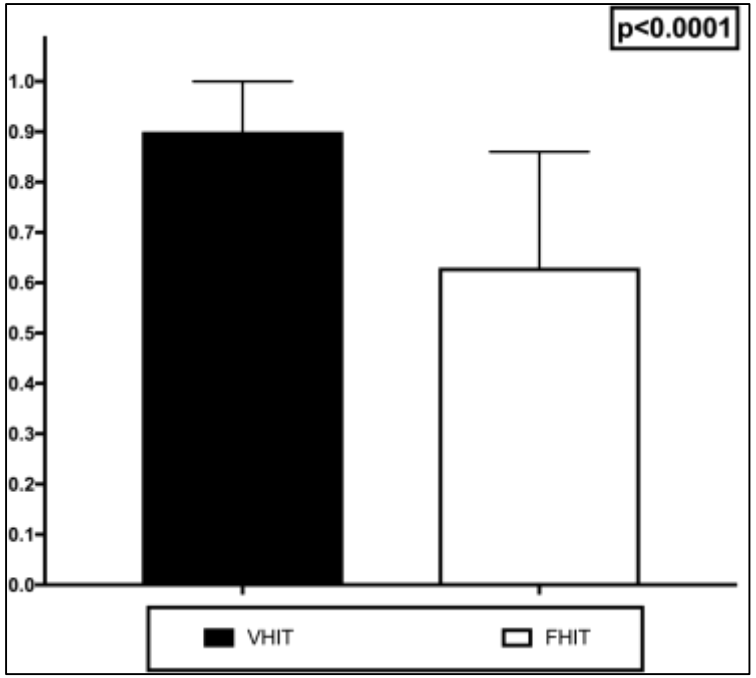
Examintion:	**Spont. ny, Calorics, HST, HIT, HHT, Vibr, VHIT, FHIT, DHI**
N° subjects:	**25**
Sex (M/F):	**13/12**
Age (years):	**55.6±12.1**
Side (R/L):	**11/14**
Follow-up:	**acute, 3 months**

ACUTE

IPSILESIONAL SIDE

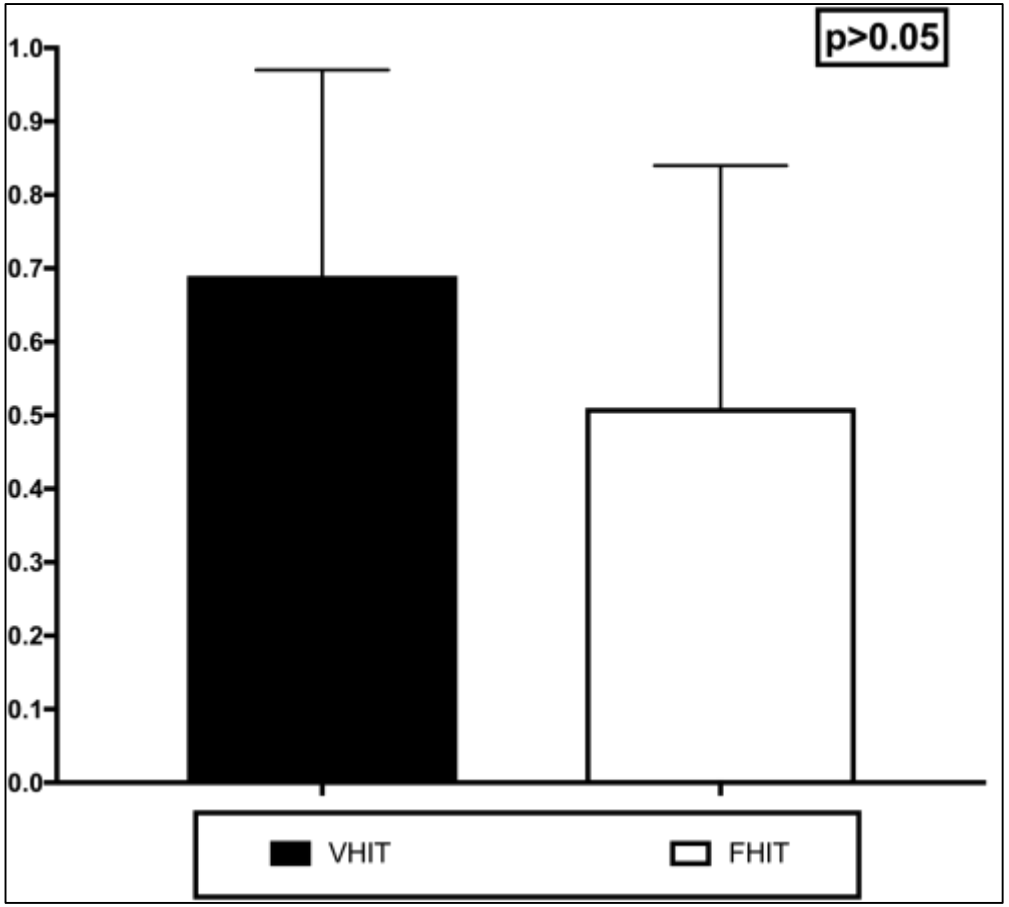


CONTRALESIONAL SIDE

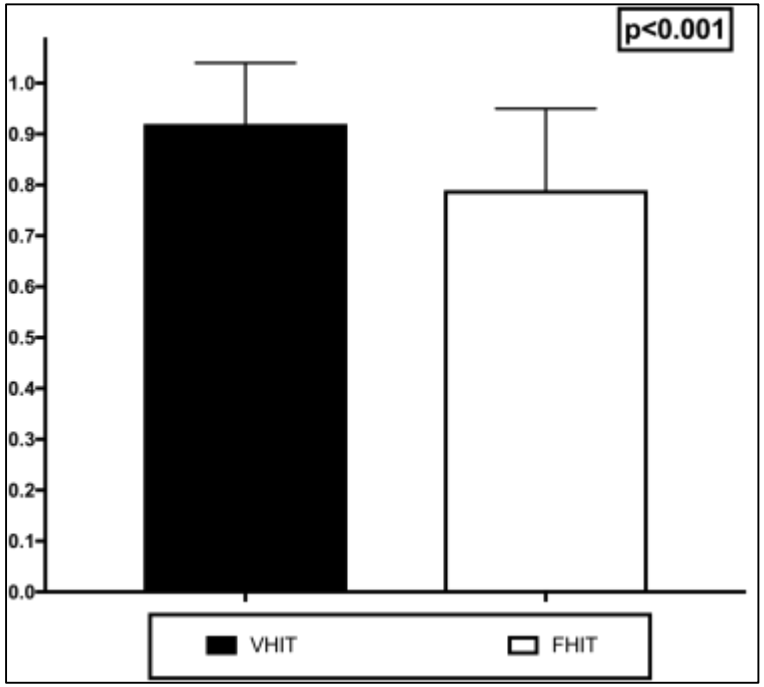


3 MONTHS FOLLOW-UP

IPSILESIONAL SIDE



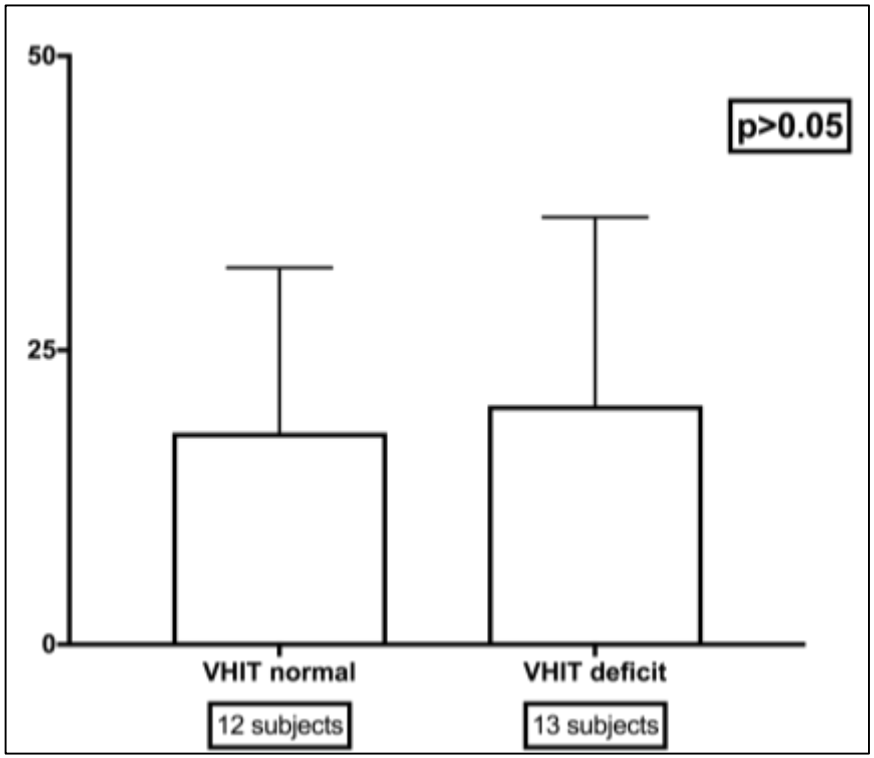
CONTRALESIONAL SIDE



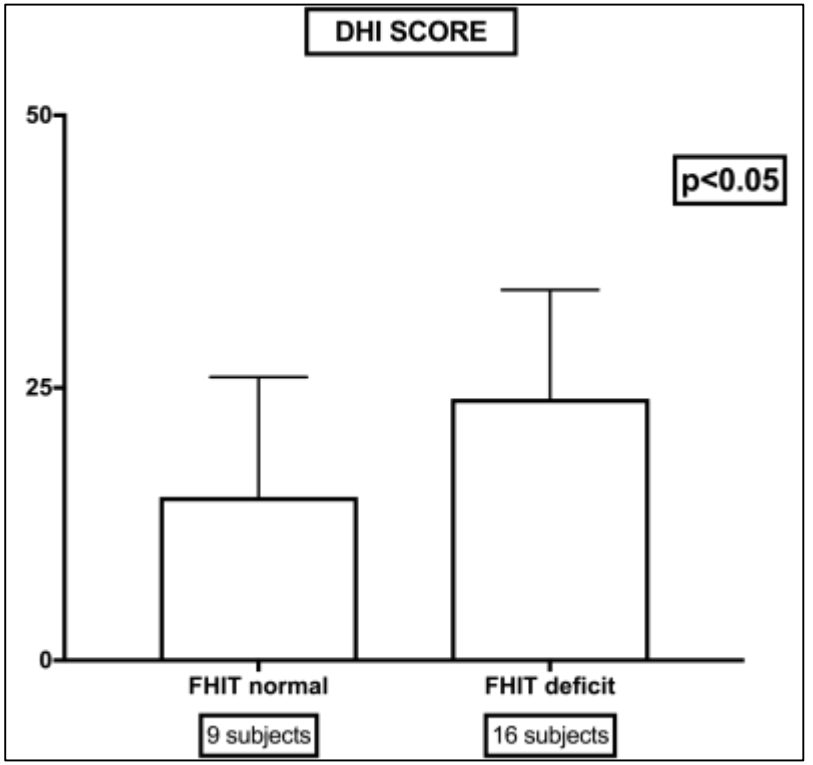
3 MONTHS FOLLOW-UP

DHI TOTAL SCORE

VHIT



FHIT



DISCUSSION

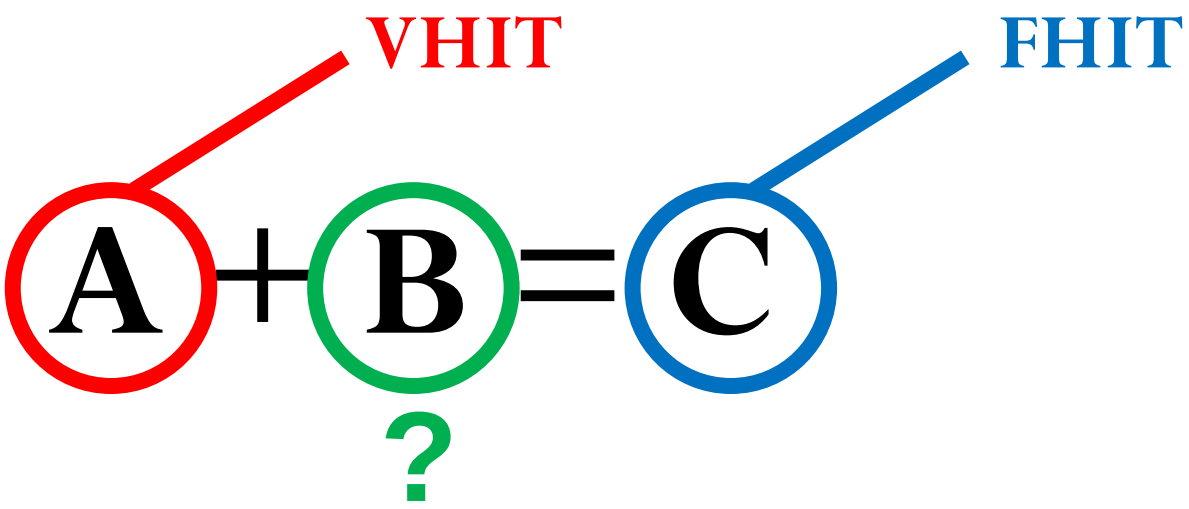
- **The VHIT and FHIT have similar results in acute and at 3 months follow-up despite contralesional side appears to be slightly more affected at FHIT**

- **5 subjects who showed covert saccades were correctly identified by the FHIT**

- **The FHIT shows a stronger correlation with DHI (perceived disability) than VHIT**(McCaslin et al. 2014; Patel et al., 2016)

- **Artifacts are not present in the FHIT while it is not an objective test**

In case you were the last audiologist on an remote island would you prefer to have with you the pure tone or speech audiometry?



THANK YOU