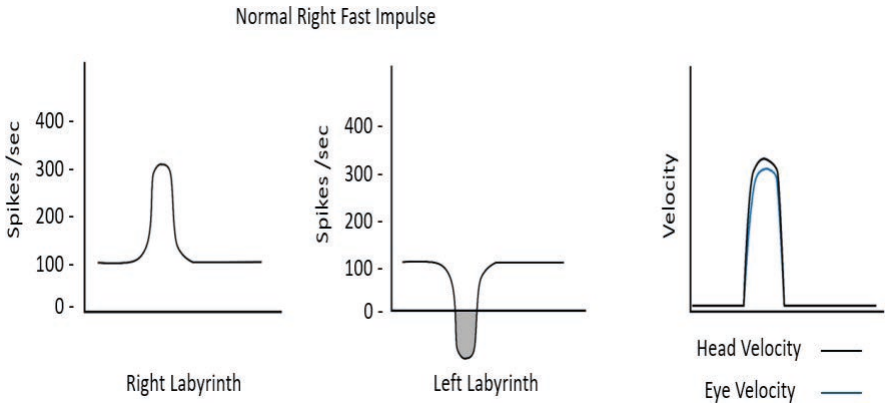
Authors
Audiology Clinical Trainer: Robert McLeod
Director of Neuro-Vestibular Product Management: Stacy Morrow

Physiology of the vHIT

The vHIT test is based on the principle that the vestibulo-ocular reflex (VOR) allows us to maintain fixation during head movement. This VOR response requires input from the semicircular canals (SSC), and the input from the SSC needs to be equal and opposite within each pair of SSCs. This input allows the head and eyes to move in opposite directions at precisely the same velocity (e.g. resulting in a gain nearly equal to 1.0). The inability to maintain fixation during head movement is an indication of pathology resulting in a reduced gain and "catch up eye movements." (Saccades) (2)



Eye velocity closely matches head velocity and gain is nearly equal to 1.0

The normal vHIT response relies on the stimulation of a co-planar pair of semicircular canals (SSC). With one canal responsible for a greater, excitatory response in each direction. (1)

In this example of a rightward head impulse, the right lateral canal is responsible for the excitation and the left lateral canal is responsible for inhibition.

vHIT vs Caloric

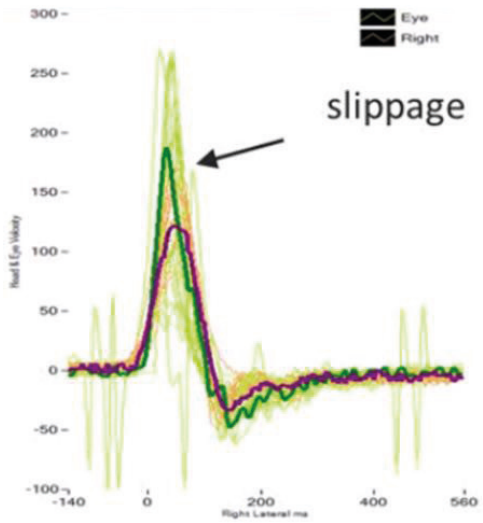
Clinicians are reminded that the vHIT test is not a direct replacement of the caloric test. The clinical value of both tests should be considered on a patient-specific basis. (3)

Listed in Table 1 are some relevant comparisons of the vHIT and Caloric tests.

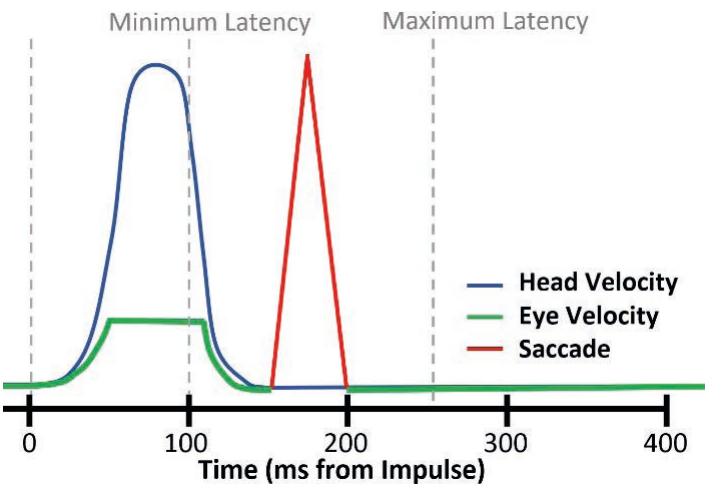
Table 1

vHIT	Caloric
Site of lesion specific	Ear specific
All six SSCs	Lateral SSC
Stimuli replicates everyday situations (~4.0hz)	Tests low frequencies (~0.025 Hz)
Physiological response (motion)	Non-physiological response (heat)
Middle ear disorders not contraindicated	Middle ear disorders may prohibit test
Ability to test patient who would not tolerate caloric testing	Some patients will not tolerate a caloric test

natus®

Good Data Capture Checklist	Notes
Well-fitted Goggles Slippage is created when the goggles do not move in synchrony with the head. This is visible on the trace as the VOR (green in this example) achieves higher peak velocity than the head velocity (purple in this example). This can create erroneous gain values >1.0	
Good average speed of impulse	Small in distance (15°) but fast peak velocity (≥ 150°/s). (2)
Abrupt and unpredictable impulses	To reduce "overshoot," not only should the patient not be able to anticipate the direction of the impulse, but the impulse should also come to an immediate stop. The abrupt stop ensures that we are isolating an ipsilateral response.
Good range of data	A spread of lateral (vertical) impulses with peak velocities occurring between the minimum of 120 °/s (100°/s) up to a maximum of 250 °/s, leads to easier visual analysis of 2D and 3D traces.
Good management of analyzed data	Traces should be removed from analysis if they exhibit artifacts or are inconsistent with vHIT trace morphology.

Analysis of Results

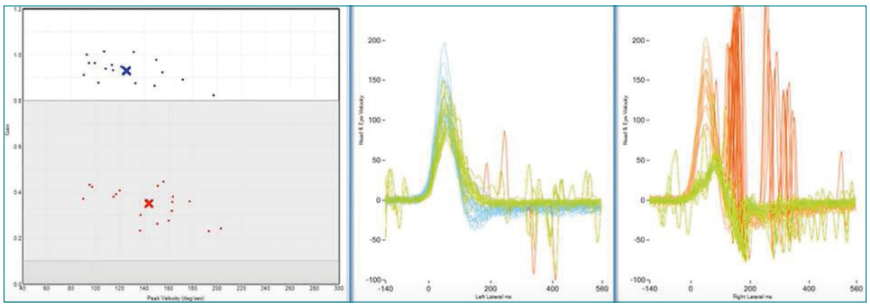


Results that indicate a pathology exhibit reduced gain and compensatory catch-up saccades.

A saccade analysis tool will highlight to the clinician saccades that have met amplitude and consistency criteria to assist in the process of identifying genuine saccades. Clinicians should ensure that saccades have a minimum latency of 70ms+ (from the onset of the head impulse). Saccades should also appear visually consistent across traces.

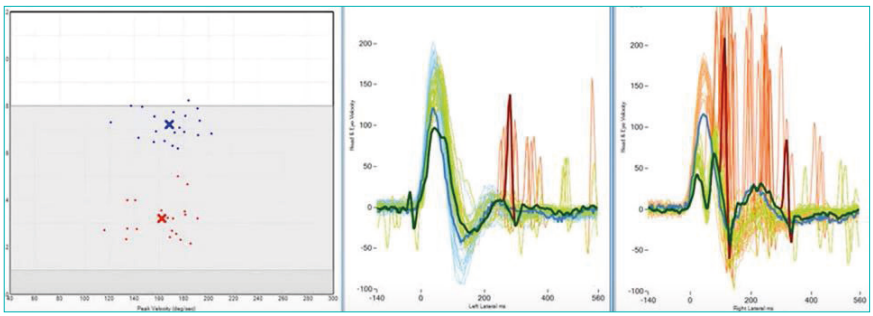
Low gain but no saccades? – The first action should be to review the data capture technique; poor technique often results in artifactual data. Low gain but no saccades may be explained by the presence of micro saccades or as a normal reduction in gain due to age, however this is an uncommon finding. (4)

Examples Results



Normal left/abnormal right:
Normal gain values fall inside the white region of the normative values on the left. The right-side results display reduced gain values as well as consistent overt and covert saccades, suggesting peripheral vestibular abnormality.

Unilateral abnormality/crossover:
It is not unusual, in cases of severe unilateral abnormalities, to observe reduced gain in the contralateral co-planar canal. As seen in this example, the left side does not display consistent saccades, nor any visually significant head/eye trace mismatch and can be considered normal. The crossover neural input form the abnormal canal is effectively reducing the normal canal gain.

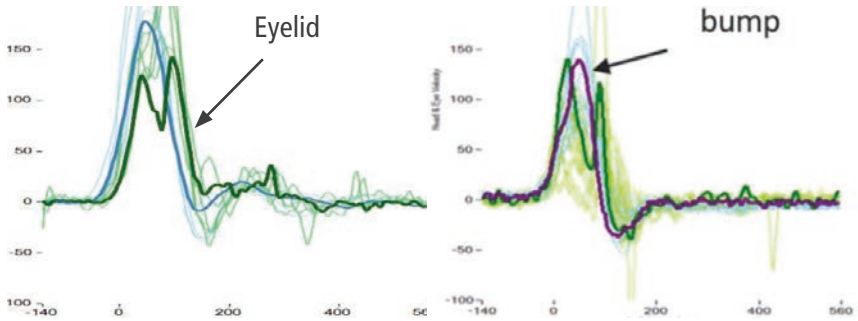


Eyelid Artifact
This "M" shape in the VOR trace can be indicative of the eyelid obscuring the pupil image and causing the crosshair to displace.

Ensure the pupil image is clear in the region of interest to resolve this artifact.

Bump Artifact – Identifying bump artifact visually appears as the eye preceding the head with an additional separation of the head/eye trace. To reduce this, ensure that the goggle rotation is the same as the head rotation.

Do not touch the strap during testing and ensure goggle strap is secure.



1: *Adapted From: Halmagyi G.M., Curthoys I.S. 1988, "A clinical sign of paresis" Arch Neurol 45:7, pp 737 - 739.*
2: *Halmagyi G. M., Chen L., MacDougall H. G., Weber K. P., McGarvie L. A., Curthoys I. S., 2017 "The Video Head Impulse Test", Frontiers in Neurology 8, pp 258, DOI: 10.3389/fneur.2017.00258.*
3: *Rambold H.A., 2015 "Economic management of vertigo/dizziness disease in a county hospital: video-head-impulse test vs. caloric irrigation. Eur Arch Otorhinolaryngol 272:10, pp 2621-8.*
4: *Anson E.R., Bigelow R.T., Carey J.P., Xue Q-L, Studenski S., Schubert M.C., et al. 2016 "VOR gain is related to compensatory saccades in healthy older adults." Front Aging Neurosci 8:150.*

Healthcare solutions with one thing in mind. You.

natus®
Natus Medical Incorporated
natus.com