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A Positive Spin on Things:

Understanding Rotary Chair

Kaitlin Ryan, AuD, CCC-A

Kaitlin Ryan, AuD, CCC-A

Kaitlin Ryan graduated with her Doctorate of Audiology from Northeastern University in 2019 and had a quick launch into vestibular audiology through the Department of Veterans Affairs in Palo Alto, CA serving veterans across hundreds of miles. This developed into sitting on fall prevention committees, working as an Audiology liaison for a geriatric interdisciplinary clinic and on teams of providers working to rehabilitate active-duty special forces service people after they sustained brain trauma. Currently, Kaitlin is working in a large hospital on a team of 4 vestibular audiologists in conjunction with ENT physicians to serve a significant portion of Massachusetts, helping to better characterize and understand their dizziness. Prior to this, she had the opportunity to study how hearing and balance changes during spaceflight as an intern at NASA, solidifying her passion for bettering the lives of others through audiology.

Disclosures

- **Presenter Disclosure**: Financial: Kaitlin Ryan received an honorarium for this course. Non-financial: Kaitlin Ryan has no relevant non-financial relationships to disclose.
- **Content Disclosure**: This learning event does not focus exclusively on any specific product or service.
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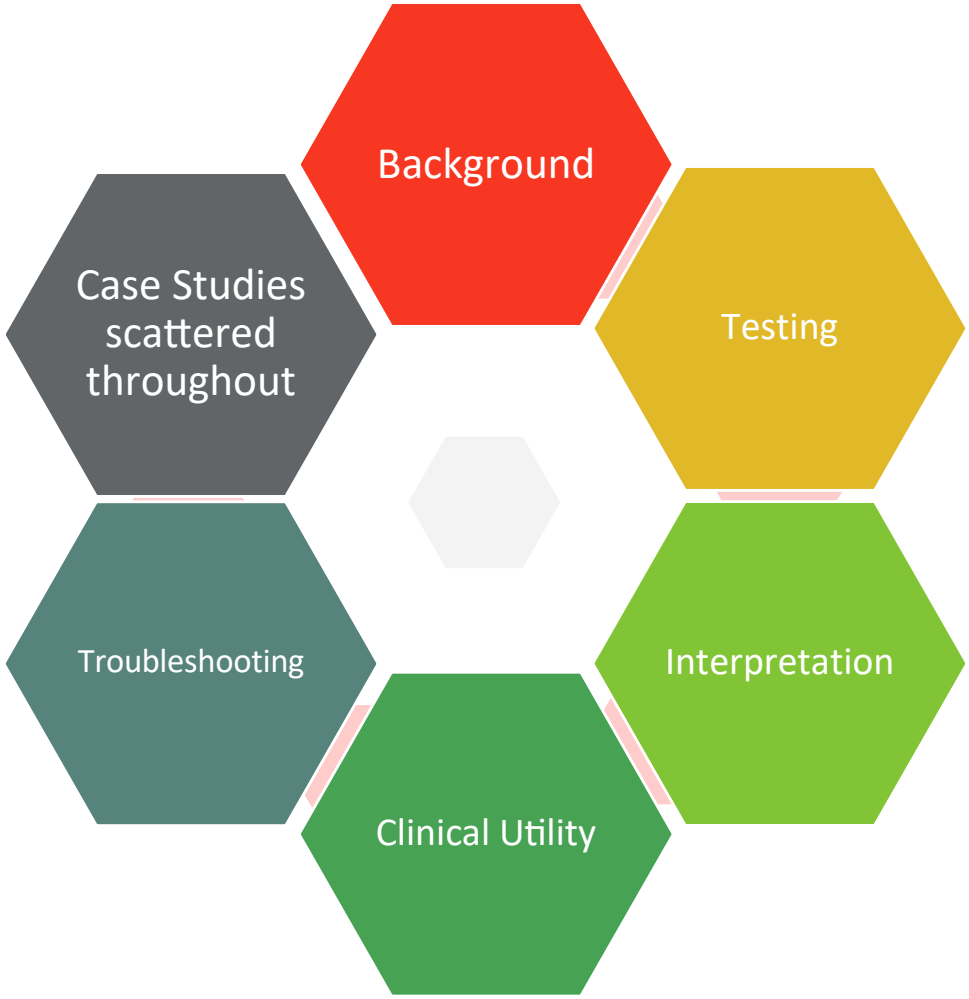
- Healthcare providers should apply cultural competence and sensitivity to ensure effective and respectful care based on their patients' diverse needs.
- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.

Learning Outcomes

After this course, participants will be able to:

- Identify clinical use of rotary chair testing and when testing may be clinically relevant.
- Explain how to interpret results of sinusoidal harmonic acceleration, step velocity testing and VOR suppression.
- Discuss how to troubleshoot rotary chair results if validity is in question.

Agenda - For Each Test



History

- Use of rotary chair in the medical field dates back to the 19th century
- Robert Barany first described his version of rotational testing in 1907
- Engineering feats in the early 1970's allowed rotational testing to be revolutionized

Sinusoidal Harmonic Acceleration (SHA)

SHA

- Cramer (1963)
  - Studied VOR in cats using single frequency sinusoidal rotation
- Precision torque motors in the 1970's allowed for individuals of different sizes be evaluated at different speeds
- 1972 study by Mathog reported first normative values for SHA

SHA

- Assess VOR and horizontal semicircular canals and afferent pathways
- Patient is rotated in clockwise and counter clockwise directions at different cycle speeds to elicit compensatory eye movements
- Measuring VOR gain, phase and symmetry

SHA - Conducting Test

- Instruct patient first
- Make sure patient is secure in the chair (seat belt and head straps)
- Make sure eyes are covered and lights are off
- Have tasking at the ready!
- Pause in between each condition
  - Check in on patient, allow nystagmus to stop completely, check validity

SHA - Protocol

- Typical frequencies tested:
  - 0.01Hz, 0.02Hz, 0.04Hz, 0.08Hz, 0.16Hz, 0.32Hz, 0.64Hz
- Anecdotally, 0.01Hz is most nauseating
  - Suggested protocol in research: 0.08Hz, 0.04Hz, 0.01Hz, 0.16Hz, 0.32Hz, 0.64Hz
    - Shortened approach: 0.08Hz, 0.04Hz and 0.01Hz
  - What I do: 0.08Hz, 0.02Hz, 0.32Hz then fill in the gaps *
- Suggestion that shorter approach may be effective too (more later)
  - 0.02Hz, 0.04Hz, 0.08Hz only

SHA - Measurement Parameters

- Gain- measure of the velocity of the head movement relative to the velocity of the slow phase eye movement when in motion
- Phase- the degree to which the eye movements produced lead/lag from the head movement
- Symmetry- analogous to directional preponderance
- Spectral Purity- quality of data

SHA Basic Interpretation

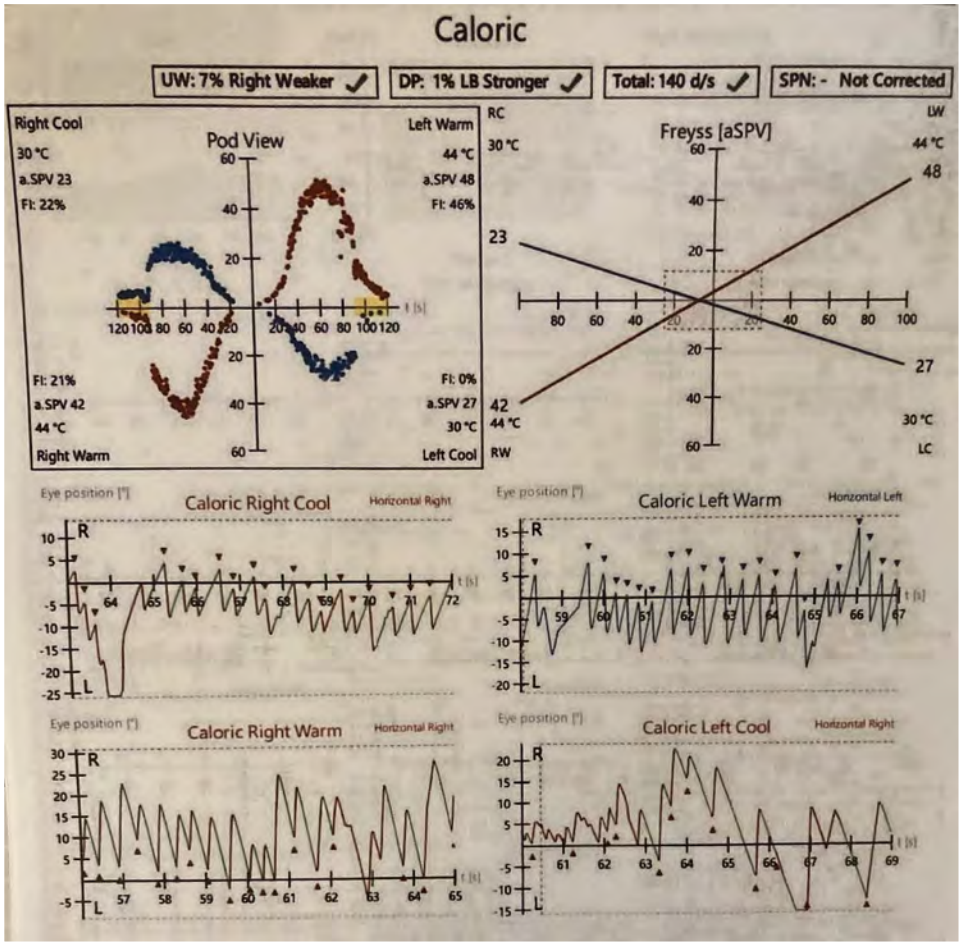
- Phase:
  - Leads: primarily unilateral peripheral indicator, can be central (brainstem)
- Gain:
  - Reduced: bilateral peripheral indicator, acute unilateral insult
  - Elevated: central indicator (cerebellar)
- Symmetry:
  - Compensation status, directional preponderance

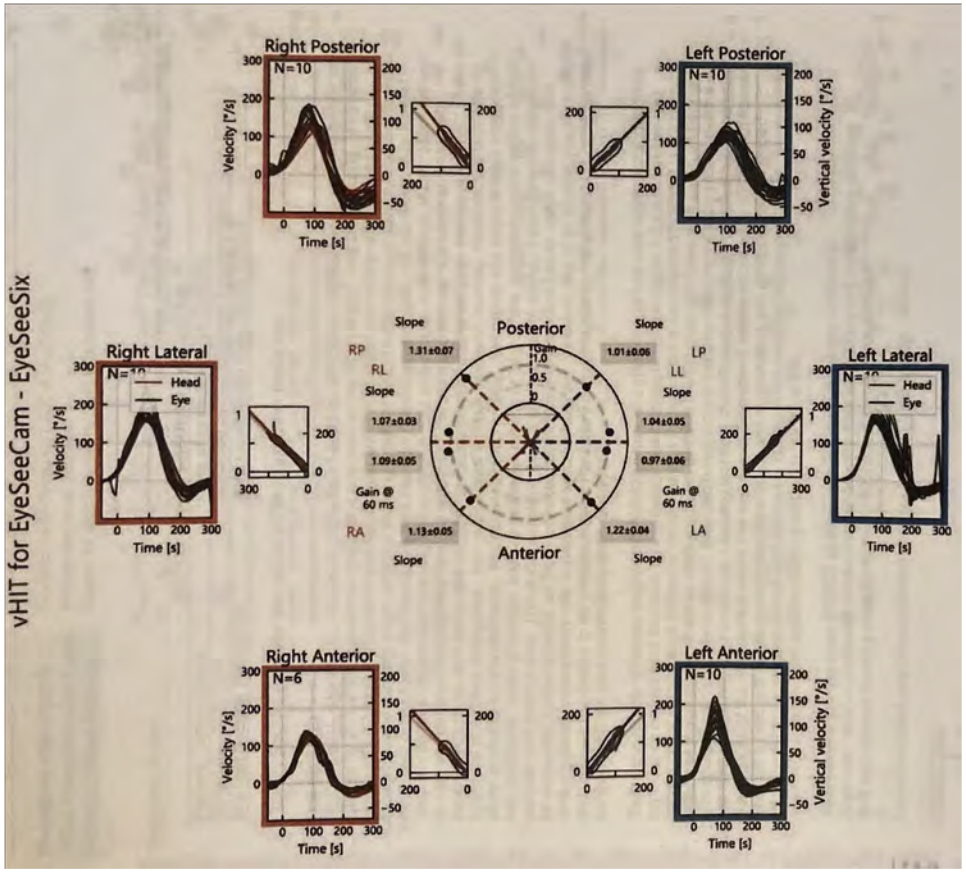
- You will see other supporting evidence of one pathology versus another
- Make sure spectral purity makes sense with the finding
- Tasking will affect the results (more on that later)

SHA Interpretation

	Unilateral Peripheral Vestibulopathy	Bilateral Peripheral Vestibulopathy	Central Vestibulopathy	Inattention/ vision not denied
Phase	Decreasingly abnormal phase lead with increasing frequency. May return to normal between 0.08-0.32Hz. Magnitude depends on extent of lesion. *0.01Hz is most sensitive to peripheral lesion*	Sometimes not calculated, may see decreasing phase leads with increasing frequency *0.01Hz is most sensitive to peripheral lesion*	Uniform phase leads up to 0.16Hz (brainstem); Abnormally decreased phase in lower frequencies may also be seen. Must have other central signs	Sporadically abnormal. If phase lead in high frequencies, suggests slippage of head/chair
Gain	Can be normal, may be reduced if insult is acute (days), severe or not well compensated. *0.01Hz most sensitive to peripheral lesion* Patients with unilaterallesions may get "stuck" in compensation process, making results look more bilateral with significant symmetry	Low. The lower the more severe *0.01Hz most sensitive to peripheral lesion* NOTE: spectral purity should be poor	High- vestibulocerebellum Must have other central signs	Low- if low in only high frequencies, slippage of head/chair. Low with normal phase/symmetry = symptomatic
Symmetry	If uncompensated, will be significant. Normal if lesion is compensated.	Sometimes not calculated, may be abnormal if there is a dominant side	May be abnormal and supported on other studies	Inconsistent with results

Case 1 - Control

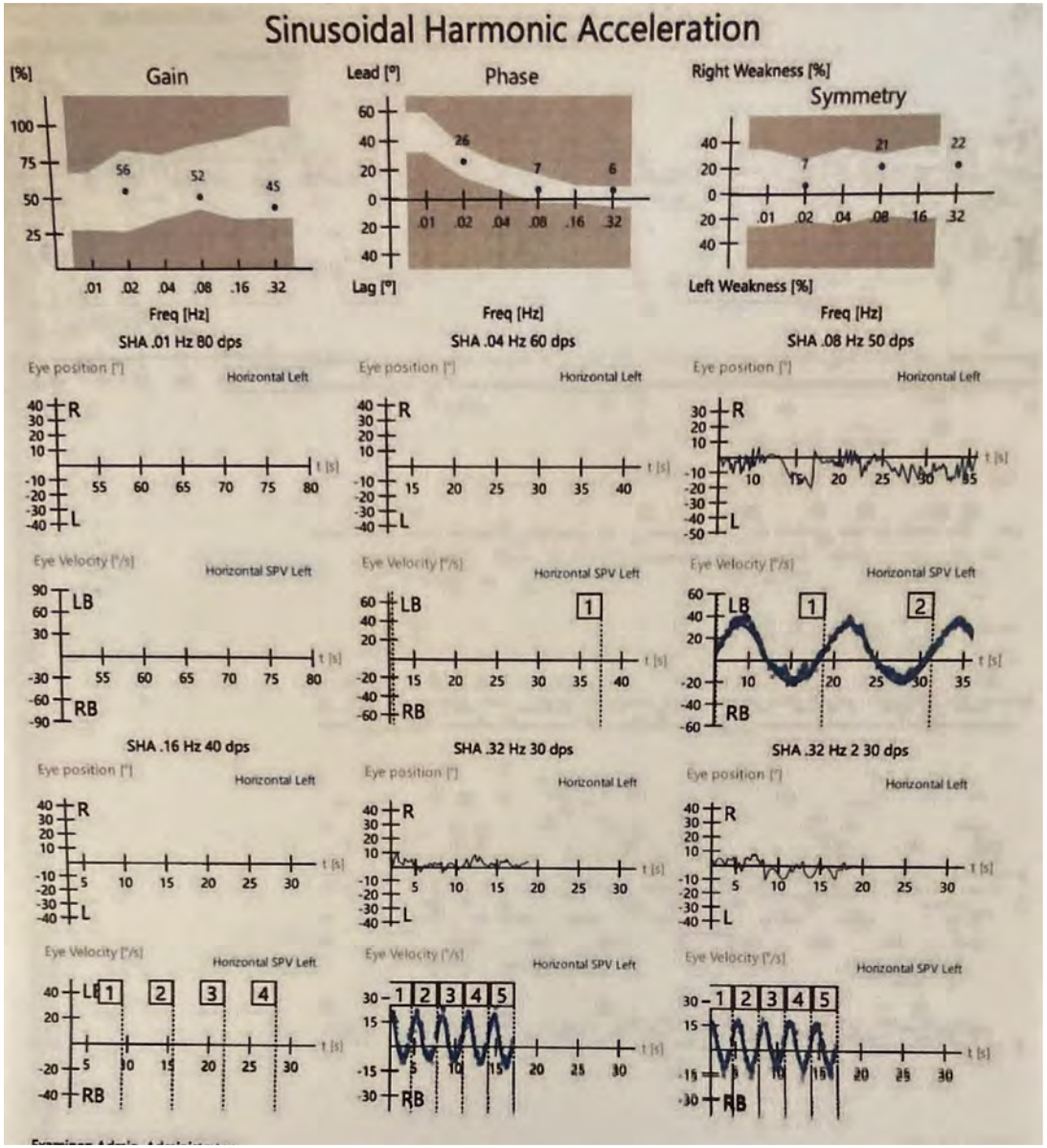


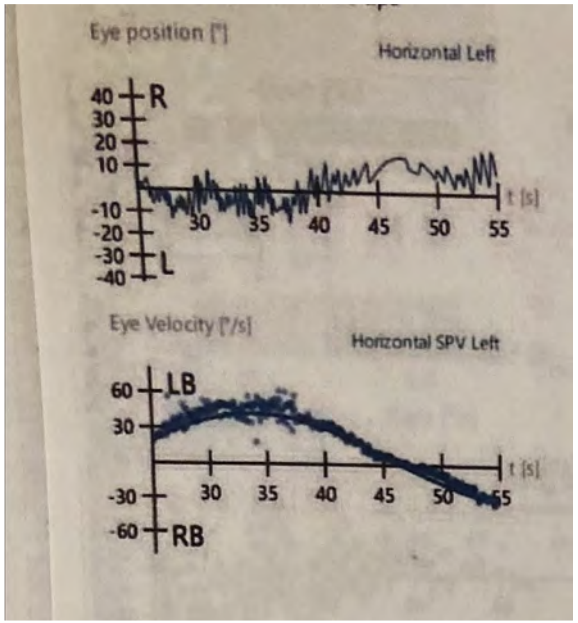


Case 1 - Control

Test	Result
Spontaneous Nystagmus	Absent
Gaze Evoked Nystagmus	Absent
Smooth Pursuit	Normal tracking gain both directions
Random Saccades (combined)	Normal Latency, Accuracy and Velocity
Optokinetic Tracking	Normal, symmetric nystagmus at 20dps
High Frequency Head Shake	No post head shake nystagmus
Positional Assessment	No clinically significant nystagmus with elicitation of vertiginous symptoms

Case 1 - Control

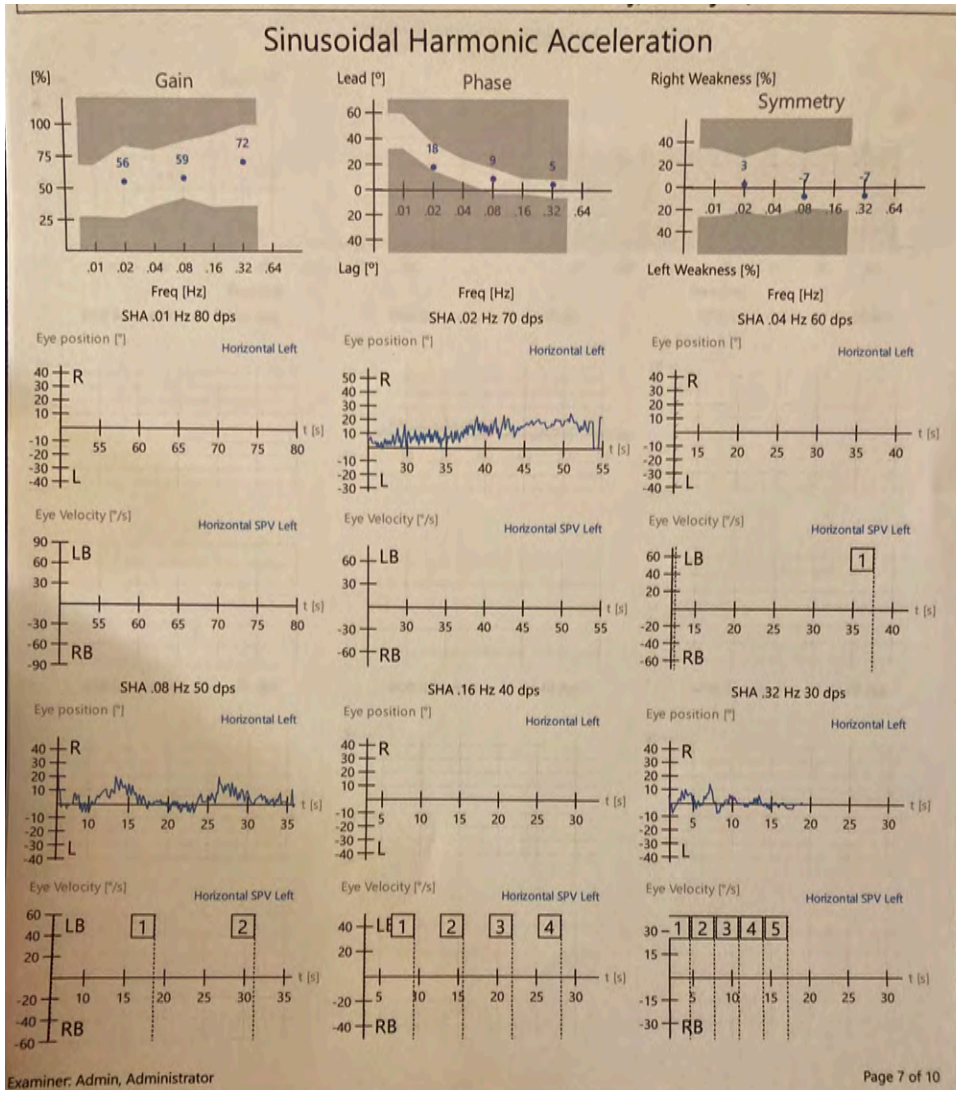


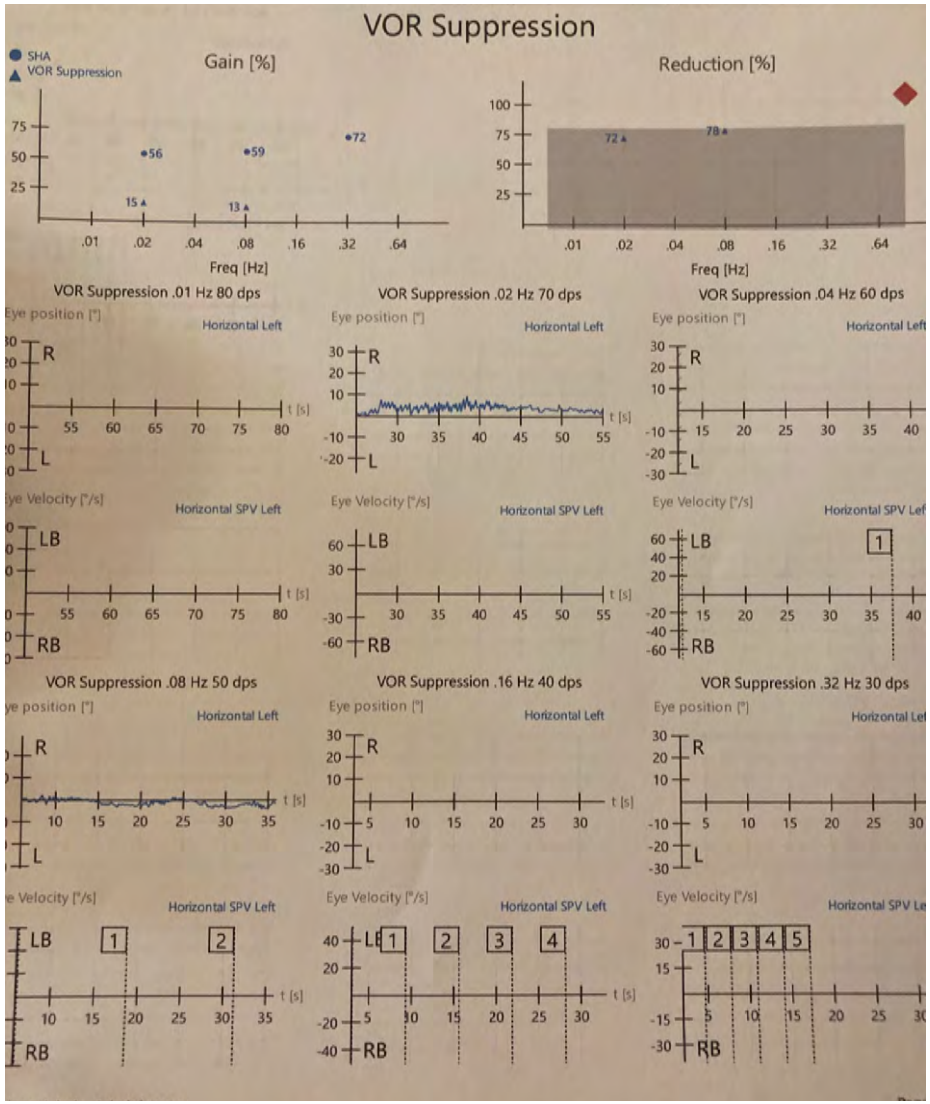


VOR Suppression

VOR Suppression

- Test of cerebellar mechanism
  - Analgous to the fixation index of caloric irrigation
- SHA rotations with fixation light provided that moves with patient
- Reduction of 80% or greater is considered normal
  - Less than 80% reduction is suggestive of cerebellar involvement
  - Highly correlated to smooth pursuit (saccadic intrusions)


Sinusoidal Harmonic Acceleration
Gain
Phase
Symmetry
Freq [Hz]
SHA .01 Hz 80 dps
SHA .02 Hz 70 dps
SHA .04 Hz 60 dps
SHA .08 Hz 50 dps
SHA .16 Hz 40 dps
SHA .32 Hz 30 dps
Eye position [°]
Horizontal Left
Eye Velocity [°/s]
Horizontal SPV Left
Examiner: Admin, Administrator
Page 7 of 10


VOR Suppression
SHA
VOR Suppression
Gain [%]
Reduction [%]
Freq [Hz]
VOR Suppression .01 Hz 80 dps
VOR Suppression .02 Hz 70 dps
VOR Suppression .04 Hz 60 dps
VOR Suppression .08 Hz 50 dps
VOR Suppression .16 Hz 40 dps
VOR Suppression .32 Hz 30 dps
Eye position [°]
Horizontal Left
Eye Velocity [°/s]
Horizontal SPV Left

Velocity Step Test (VST)

VST

- Predates SHA
- Post-rotary nystagmus first noted in literature in the 1820's
- Repeatability and reliability was very poor at first due to operator error
- 1979 Raphan, Matsuo and Cohen first discovered the central storage mechanism

VST

- Quick burst of acceleration with constant motion and then quick deceleration
- Measuring per and post rotary phases of cupular deflection and velocity storage influence over eye movement
- Advantages: measuring velocity storage of one ear with little interruption from the other ear
- Disadvantages: reliability may be questionable based on patient tolerance
- Measuring: gain, time constant and symmetry

VST - Conducting Test

- Instruct patient first
- Make sure patient is secure in the chair (seat belt and head straps)
- Make sure eyes are covered and lights are off
- Have tasking at the ready!
- Pause in between directions/ speeds 2-3 minutes
  - Check in on patient, allow nystagmus to stop completely, check validity

VST – How does this test work?

- Patient is rotated at a constant speed for 60 seconds and eye movements are recorded (per rotary phase).
- Once the velocity storage integrator has reached peak capacity, nystagmus significantly reduces/stops despite chair continuously turning
- Chair is quickly decelerated to a stop and velocity storage is released (post rotary)
- Nystagmus switches direction and slow phase is measured.

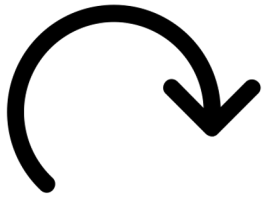
Interpretation

VST - How do I interpret this information?

- Slow phase velocity is used similar to SHA and calorics.
- If the chair is turning **rightward**, the **per rotary** nystagmus is slow phase **right beating**
  - When the chair stops the **post rotary** phase measures nystagmus that is **left beating**
- **Right peripheral measurements**: per rotary clockwise (right); post rotary counterclockwise (left)
- **Left peripheral measurements:** per rotary counterclockwise (left); post rotary clockwise (right)

Interpretation

50dps turning clockwise (right)



Per rotary

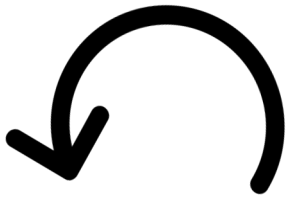
Eyes are being pulled rightward (slow phase) and snapping back to the left thanks to the VOR, producing a nystagmus with a **right beating slow phase**

This is measuring the right peripheral vestibular system

Post rotary

Velocity storage mechanism is released and nystagmus rapidly switches direction with the slow phase **now left beating**

This is measuring the left peripheral vestibular system



50dps turning counterclockwise (left)

Per rotary

Eyes are being pulled leftward (slow phase) and snapping back to the right thanks to the VOR, producing a nystagmus with a **left beating slow phase**

This is measuring the left peripheral vestibular system

Post rotary

Velocity storage mechanism is released and nystagmus rapidly switches direction with the slow phase now **right beating**

This is measuring the right peripheral vestibular system

VST – Measurement Parameters

Gain

- Peak slow phase velocity of eye movement compared to head movement (chair rotation)
- Averaged data between right and left, not single sided

Time Constant

- The length of time it takes to go from peak slow phase velocity eye movement to 37% reduction
- Cupular deflection takes about 6sec to complete, so canal-ocular reflex and velocity storage kick in after and peak about 10-15sec

Symmetry

- Average slow phase velocity of right ear stimulation versus left ear. Similar to caloric directional preponderance

VST - Basic Interpretation

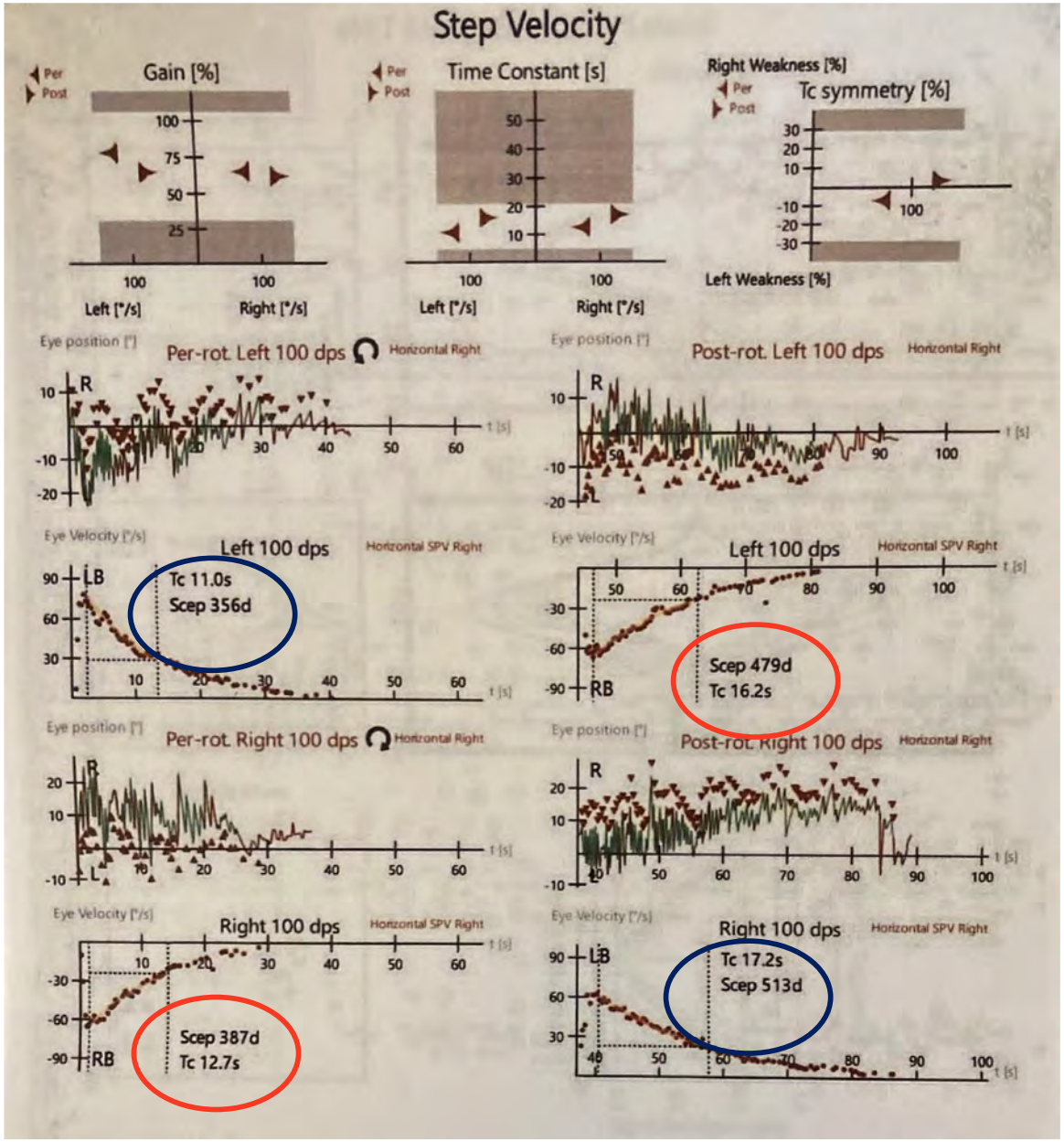
- Gain:
  - 0.4 is used in most studies, some studies use 0.27 as normative
  - Not strong to be used on its own unless gain is high
  - Low gain with asymmetry: uncompensated peripheral lesion, can be unilateral or bilateral
  - High gain: hyperactivity or cerebellar involvement
- Time Constant:
  - >10sec, <30sec across most studies is considered normal
  - <10 seconds likely just cupular activity rather than velocity storage integrator, considered reduced function
    - Considered similar to phase lead of SHA- may be peripheral or central (brainstem)
  - > 30 sec likely cerebellar involvement or hyperactivity
- Symmetry:
  - <30% considered normal
  - Used similarly to directional preponderance for calorics
  - Gain + asymmetry can suggest uncompensated lesion

Velocity Step Testing Interpretation

	Unilateral Peripheral Vestibulopathy (per rotary R and post rotary L = right side; per rotary L and post rotary R= left)	**Bilateral Peripheral Vestibulopathy**	**Central Vestibulopathy**	**Normal**
Gain	<0.4 on side of lesion If gain is normal but time constant is reduced, still may be peripheral if compensation has occurred (high and low speed)	all 4 conditions are <0.4	>1.0- hyperactive and suggest cerebellar involvement. Will see hyperactive calorics/SHA or other central signs	>0.4 on both sides- may establish clinic norms
Time Constant	<5-7sec on side of suspected lesion	<5-7sec on both sides	<5-7 sec if other central signs are present (brainstem); >30sec cerebellar involvement, other signs present	Time to reduce nystagmus to 37% = 7-15 sec
Asymmetry	>30% weaker to side of lesion. If the lesion is uncompensated will see asymmetry and it will be similar to SHA high frequency is great for identifying asymmetry (pushes system to identify asymmetry if present)	<30%= normal unless there is predominance for one side, than it would be >30%	<30%= normal	<30%= normal

Case Study

Case 1 - Control



Overall Interpretation

Interpretation

Q1, Q2, Q4, Q5

	SHA	VOR suppression	Velocity Step Testing	Other tests
Unilateral Peripheral Vestibulopathy	Phase: Phase leads-uniformly abnormal or decreasing lead with increasing frequency. *0.01Hz most sensitive to peripheral lesion* Gain: can be normal, may be reduced if insult is acute (days), severe or not well compensated. *0.01Hz most sensitive to peripheral lesion* Symmetry: if normal, compensated, if abnormal not compensated (think directional preponderance)	Normal - reduction in nystagmus by 80%, may not be necessary if central is WNL	Time Constant: 5-7sec for side of suspected lesion. Will remain with stable lesion. May be reduced in higher frequencies which is expected. Gain: <0.4 on side of lesion. May return to normal if well compensated. Symmetry: Will be similar to SHA. Normal if compensated. High frequency can help reveal asymmetry	Caloric weakness/asymmetry, asymmetric vHIT, asymmetric VEMP. Look to spontaneous nystagmus and directional preponderance for compensation clues
Bilateral Peripheral Vestibulopathy	Phase: normal, decreasing lead with increasing frequency or not calculable *0.01Hz most sensitive to peripheral lesion* Gain: Low. The lower the more severe *0.01Hz most sensitive to peripheral lesion* Symmetry: normal or not calculable	Normal- reduction in nystagmus by 80%, may not be necessary if central is WNL	Time Constant: <5-7sec Gain: <0.4 on both sides Symmetry: likely normal if no predominance or asymmetry found elsewhere	Reduced calorics, reduced vHIT, reduced/absent VEMP
Central Vestibulopathy	Phase: Uniformly abnormal phase lead (brainstem) Gain: May be high (cerebellar) Symmetry: normal	<80% reduction in nystagmus	Cerebellar: TC >30sec, gain >1.0 Brainstem: <10sec, gain normal	Must see other central signs, particularly oculomotor, failure to fixate, hyperactivity

If time constant is <5-7sec and there is a significant phase lead at 0.01Hz, that is a pretty significant indicator of a peripheral lesion in one or both ears (depending on the side(s) with the time constant)

Why should I use rotary chair?

SHA - Clinical Utility

- Considered to be the gold standard for bilateral vestibular hypofunction
  - Monitoring ototoxicity
- Used in diagnosis of unilateral vestibular hypofunction
  - In combination with other tests
- Monitor compensation of peripheral lesions with time
  - Phase leads and symmetry

VORs - Clinical Utility

- Confirming cerebellar involvement
- Confirming poor fixation index on calorics

VST - Clinical Utility

- Great to aid in the confirmation/diagnosis of unilateral peripheral hypofunction
  - Bilateral too
- Can confirm other findings and be used to support and uphold suspected diagnoses

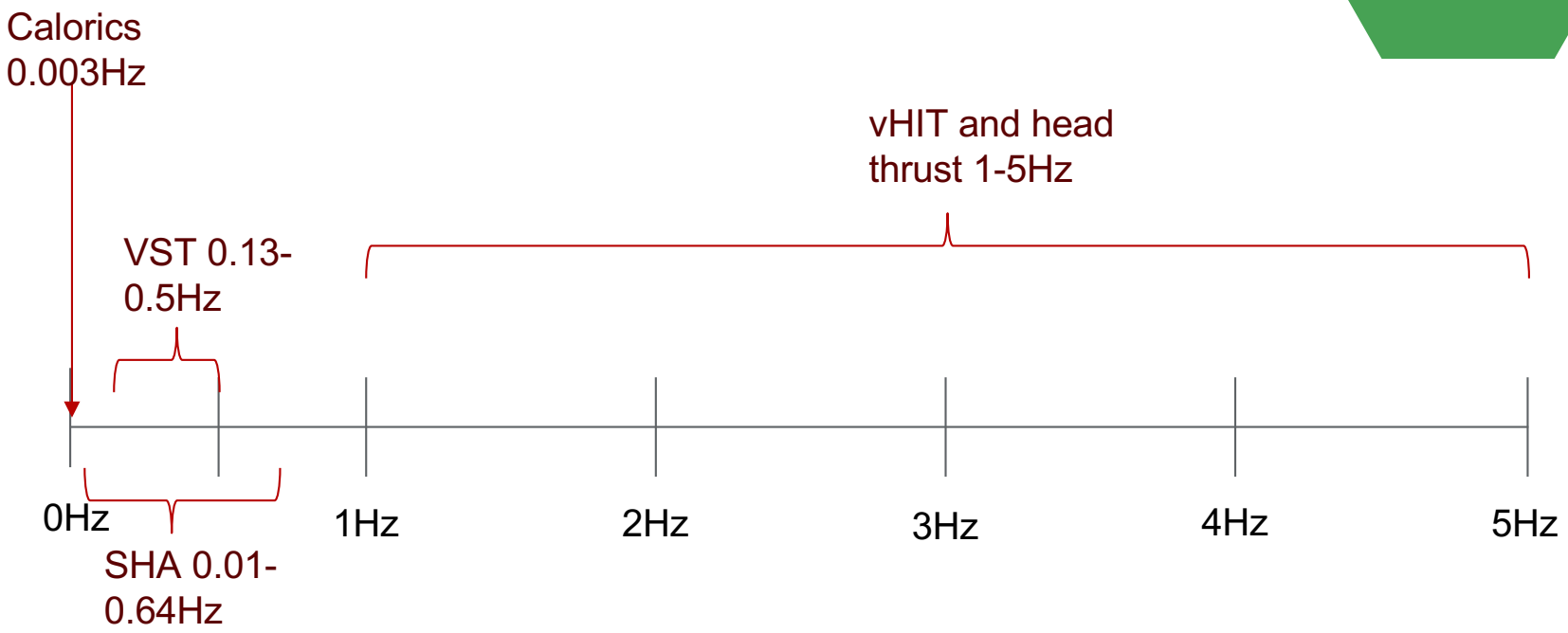
Clinical Utility

VST – Two Speed Protocol (High/ Low)

- Wait 2-3 minutes between directions to ensure nystagmus has entirely resolved
- Advantages:
  - Gain and symmetry may produce normal results at a slower speed in a peripheral lesion if it is well compensated
  - Higher speed may produce normal gain with an asymmetry if there is a compensated lesion
    - Speed will drive the velocity storage integrator to a max stimulation to highlight any differences between the right and left
- Disadvantages:
  - Human factor and motion tolerance
  - Slow speed is great for a view of the overall system at work, with increased speeds time constants become less useful and decrease by default (where clinic norms become important)

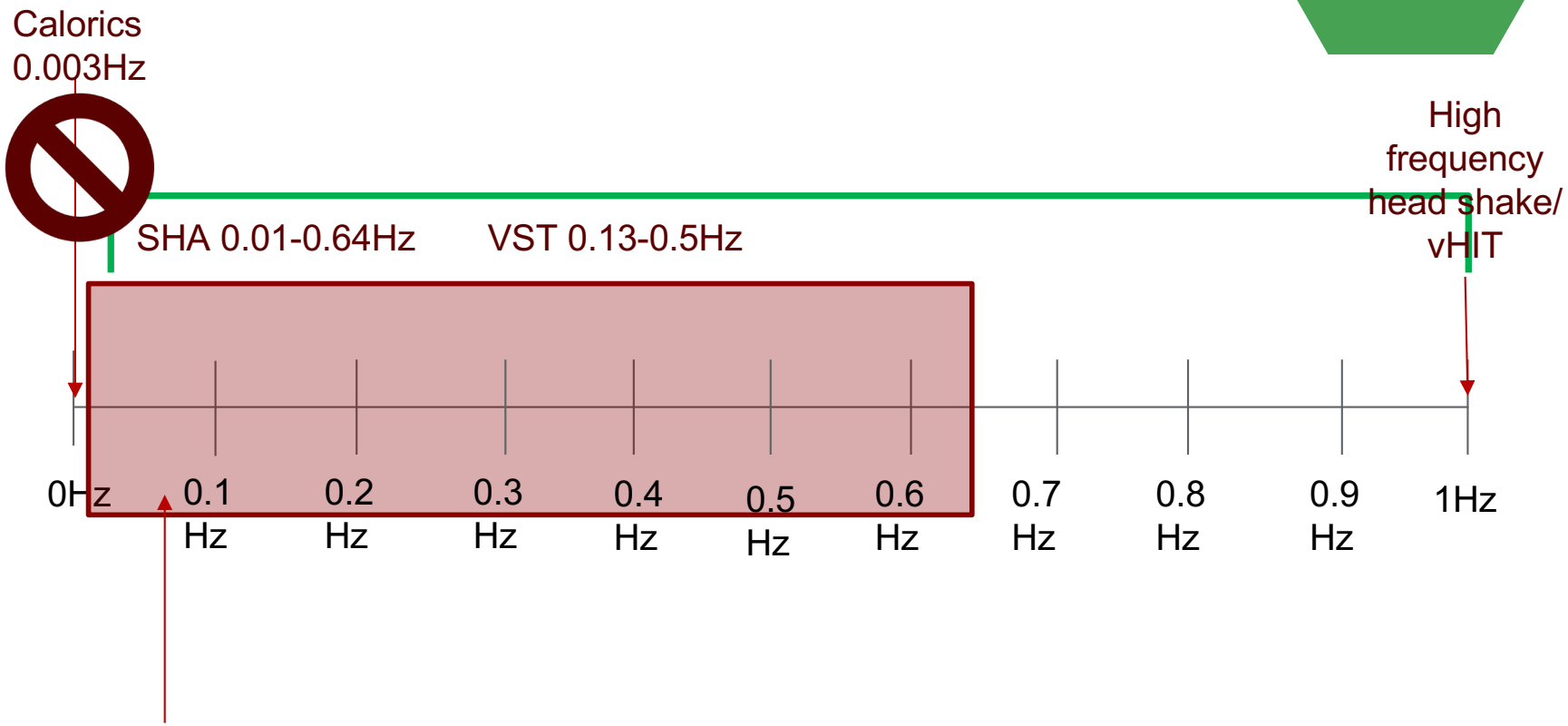
Clinical Utility

Q3



Clinical Utility

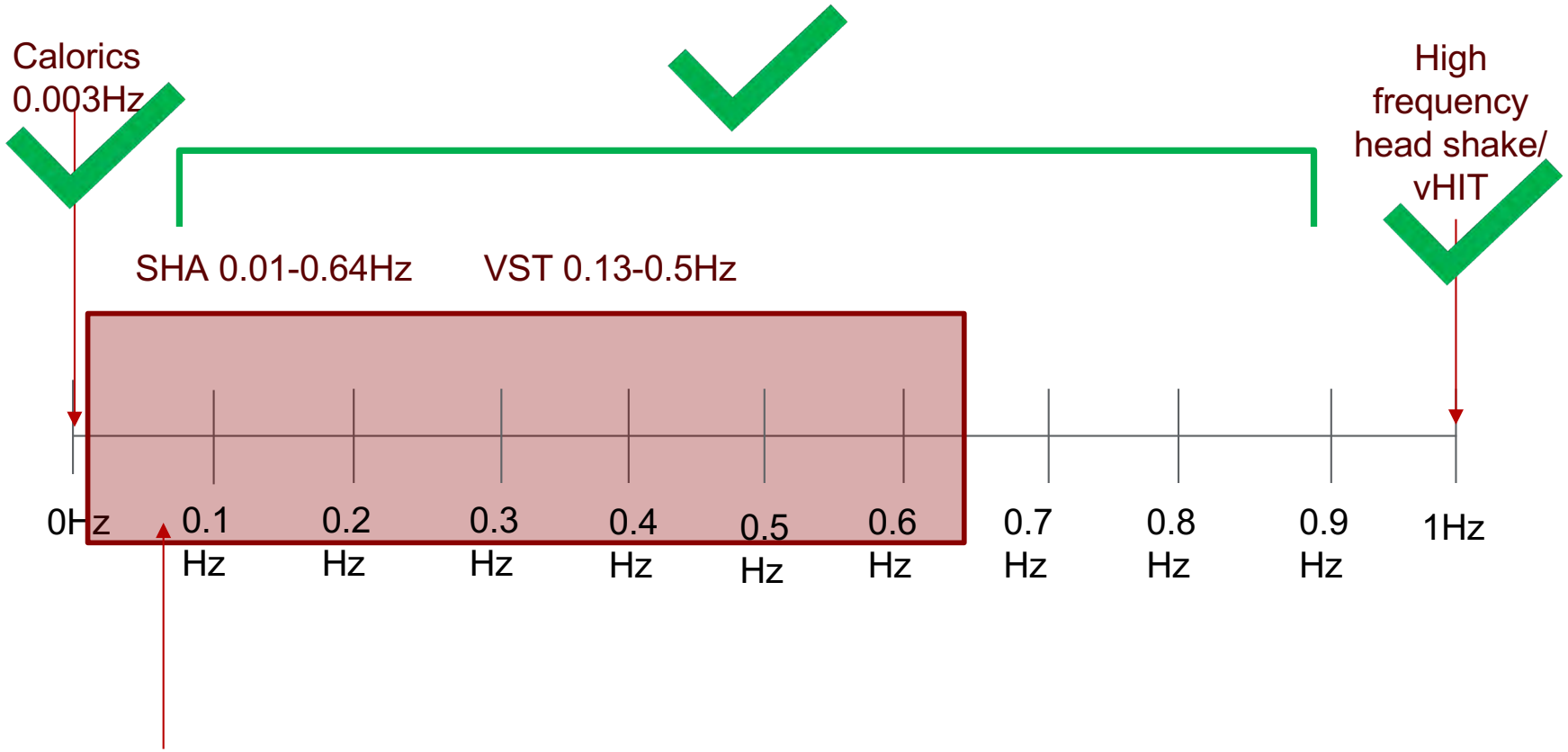
Q3



What if Calorics is contraindicated?

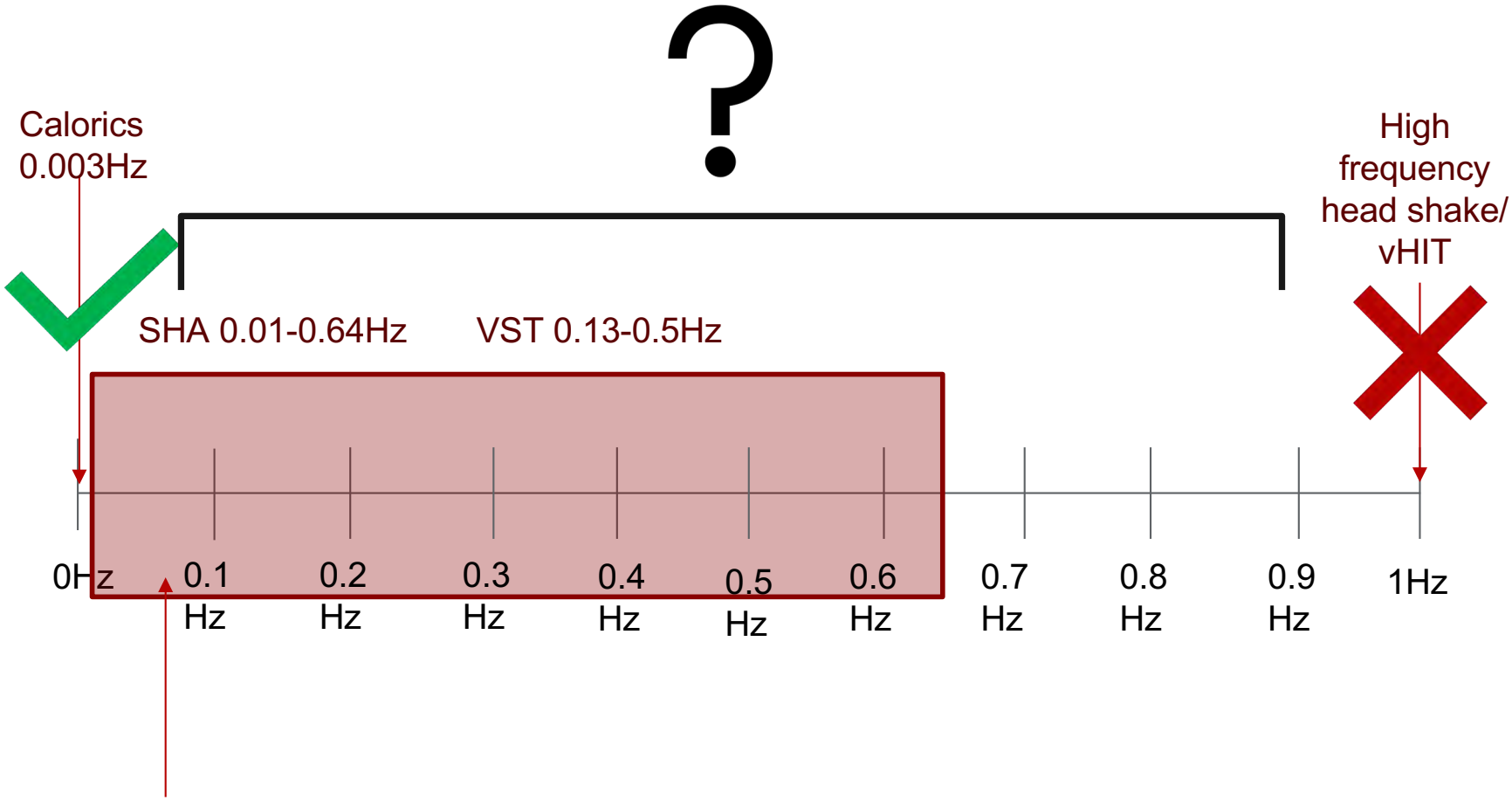
Let's think about peripheral vestibular outcomes on testing…

Q3



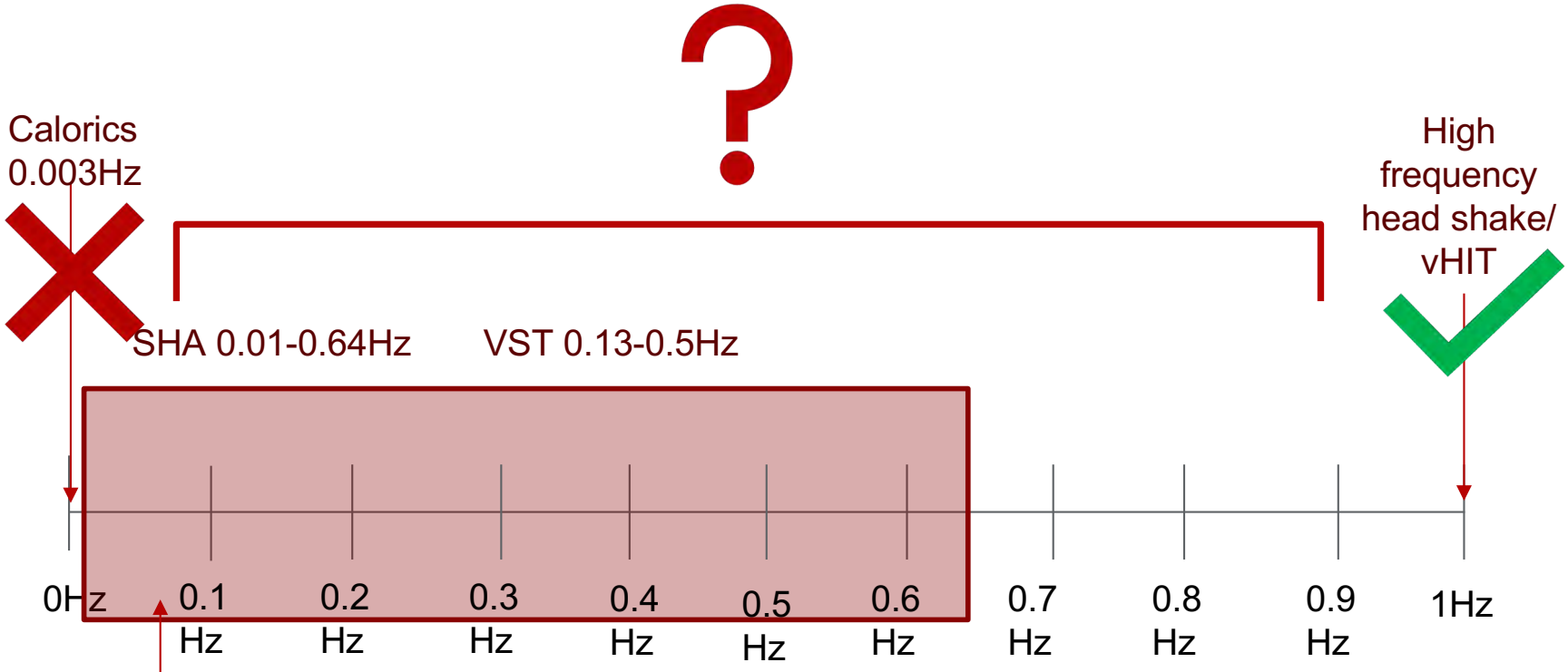
Real life starts here: 0.08Hz = turning head to look

If both calorics and vHIT are normal, you can be relatively certain that rotary chair will produce normal results.



If Calorics is normal but vHIT is abnormal…

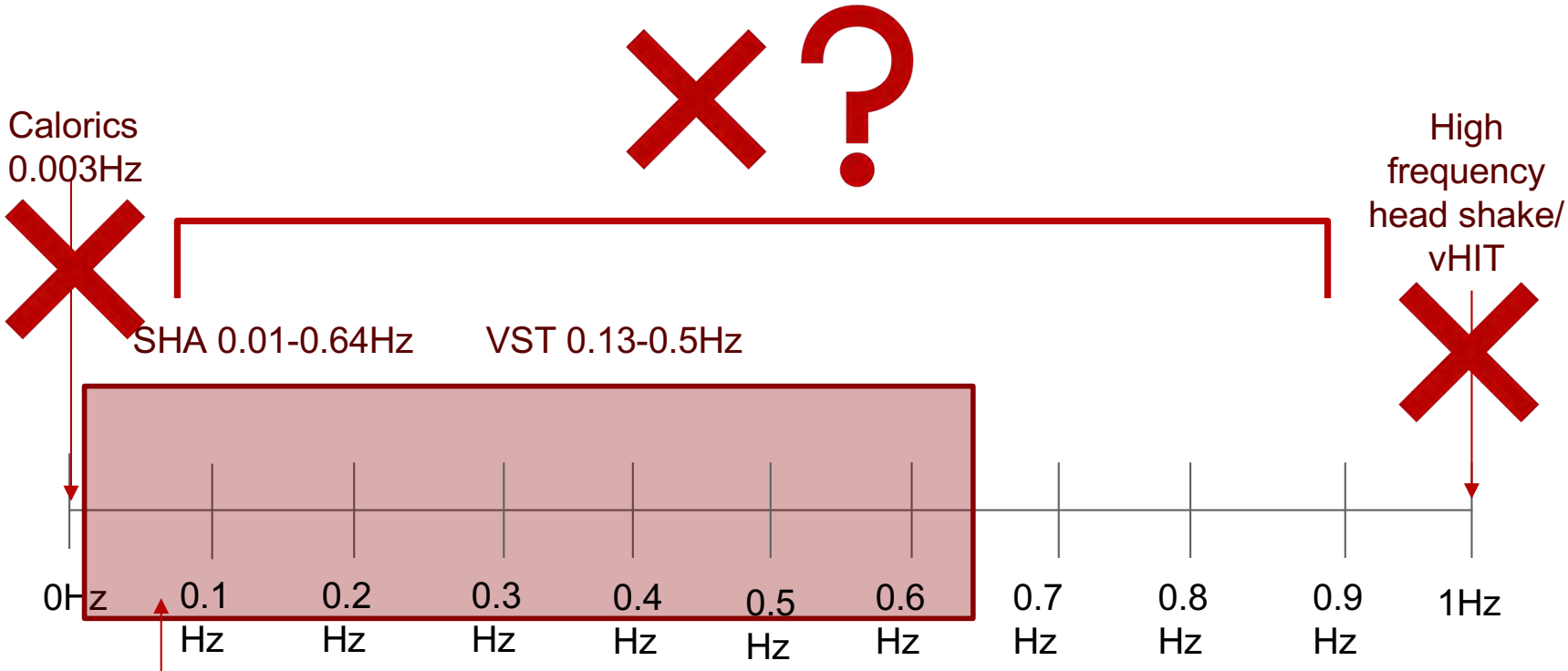
Is vHIT a false positive?
Is there added value in rotary chair?
Is there a central issue?



Real life starts here: 0.08Hz = turning head to look

If calorics is abnormal but vHIT is normal, you might start to wonder if there is a low frequency vestibular loss (Meniere's?)

Start asking questions about compensation status or the extent of the lesion where vHIT is normal



Real life starts here: 0.08Hz = turning head to look

If calorics is abnormal AND vHIT is abnormal, you can be pretty sure you're onto a peripheral lesion.
BUT
What about compensation status?
How is the neural activity beyond the cupular deflection, if there is any?

Clinical Utility

Q1, Q4

For central lesions

- Normal oculomotor function with poor fixation index
  - Is it a legitimate finding or is there something else?
- Abnormal oculomotor function
  - Gaze evoked nystagmus, poor smooth pursuit/OPK, VEMPs are suspicious and don't fit into a peripheral mold, there are concerns for central lesions per referring provider

How can I incorporate Rotary Chair reasonably?

Caloric Test Versus Rotational Sinusoidal Harmonic Acceleration and Step Velocity Test in Patients With and Without Suspected Peripheral Vestibulopathy

Ahmed, M. F., Goebel, J. A.; Sinks, B. C. (2009). Caloric test versus rotational sinusoidal harmonic acceleration and step-velocity tests in patients with and without suspected peripheral vestibulopathy. Otology & Neurotology, 30(6), 800–805. https://doi.org/10.1097/mao.0b013e3181b0d02d

Calorics

- Stimulates one ear at a time
- Low frequency stimulation- artificial
  - 0.002-0.004Hz

Rotary Chair

- Stimulates both ears at the same time
- "Medium" frequency stimulation- physical
  - 0.01-1.00Hz
- This study specifically focuses on 0.025-0.5Hz

Goal: to look at testing combinations to determine the most predictive combination of tests

Materials and Methods

- Retrospective chart review of 200 patients
  - Excluded: BPPV, SSCD, perilymph fistula, possible MD, incomplete testing
- Clinical diagnosis was made separate from rotary chair and calorics
  - Case history, physical exam, bedside neuro-otologic testing, hearing test, and radiologic studies
- 200 patients divided into with peripheral vestibulopathy and without
  - 138 patients with, 68 patients without

Clinical Utility

Testing and Analysis

- Calorics metrics:
  - Total eye speed (TES): all 4 irrigations combined
  - Caloric weakness (CW)
- Rotary Chair:
  - SHA- gain, phase and symmetry for 0.025, 0.05, 0.25 and 0.5Hz
  - Step Velocity- 100-degree/s clockwise and counterclockwise, measuring per rotary and post rotary nystagmus
    - Tc- time for nystagmus to reduce to 37% of peak value

Clinical Utility

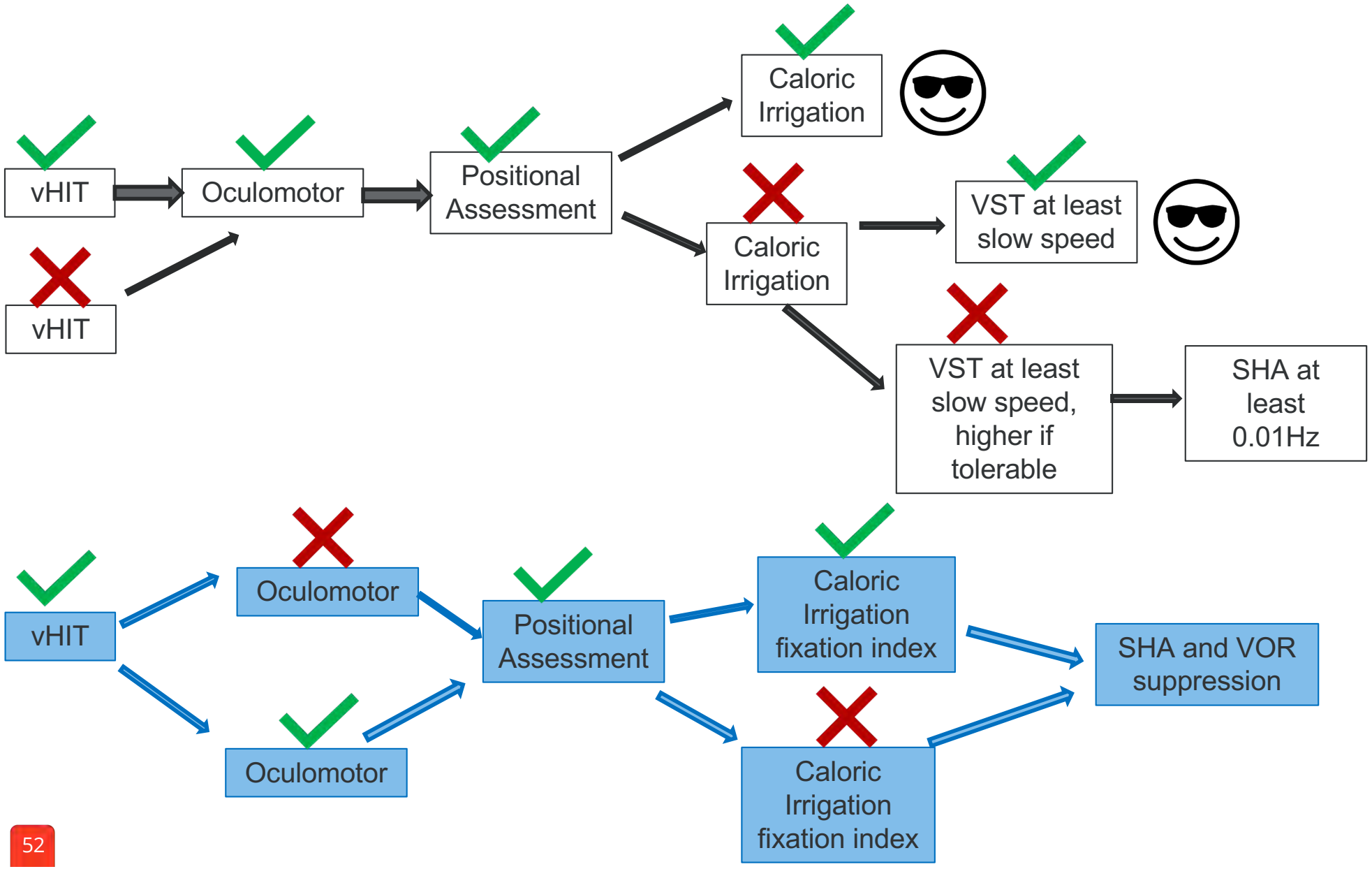
Q4, Q5

Results

- Most predictive factors (95% CI)from a single test:
  - Calorics: caloric weakness (optimally 29.5% +)
  - Rotary chair: SHA gain and phase at 0.025Hz, 100dps VST Tc
- Optimal test battery to identify peripheral versus non peripheral vertigo is calorics
- Rotary chair was not significant on its own

Calorics + SHA gain and phase 0.025Hz + 0.5Hz + 100dps VST Tc = highest predictive value Calorics and Rotary Chair are

Evidence-Based Suggested Protocol



Clinical Utility

SHA, VST and Compensation

- Signs of compensation status:
  - Spontaneous nystagmus
  - Positional nystagmus
  - Directional preponderance on caloric irrigation
- SHA:
  - Symmetry- should return to normal once compensation is complete
- VST:
  - Two- speed paradigm
  - Slow speed offers time constant for diagnostic purpose,
  - High speed will drive the peripheral vestibular system to an asymmetry that may be hidden in lower frequencies, showing lack of complete compensation

Rotary Chair – What went wrong?

SHA

- Decreased gain/increased phase lead with higher frequency
  - Goggle slippage
- Very low gain with normal phase and symmetry
  - Poor tasking, inattention, nausea
- Very poor gain with no phase/symmetry
  - May have forgotten to cover eyes

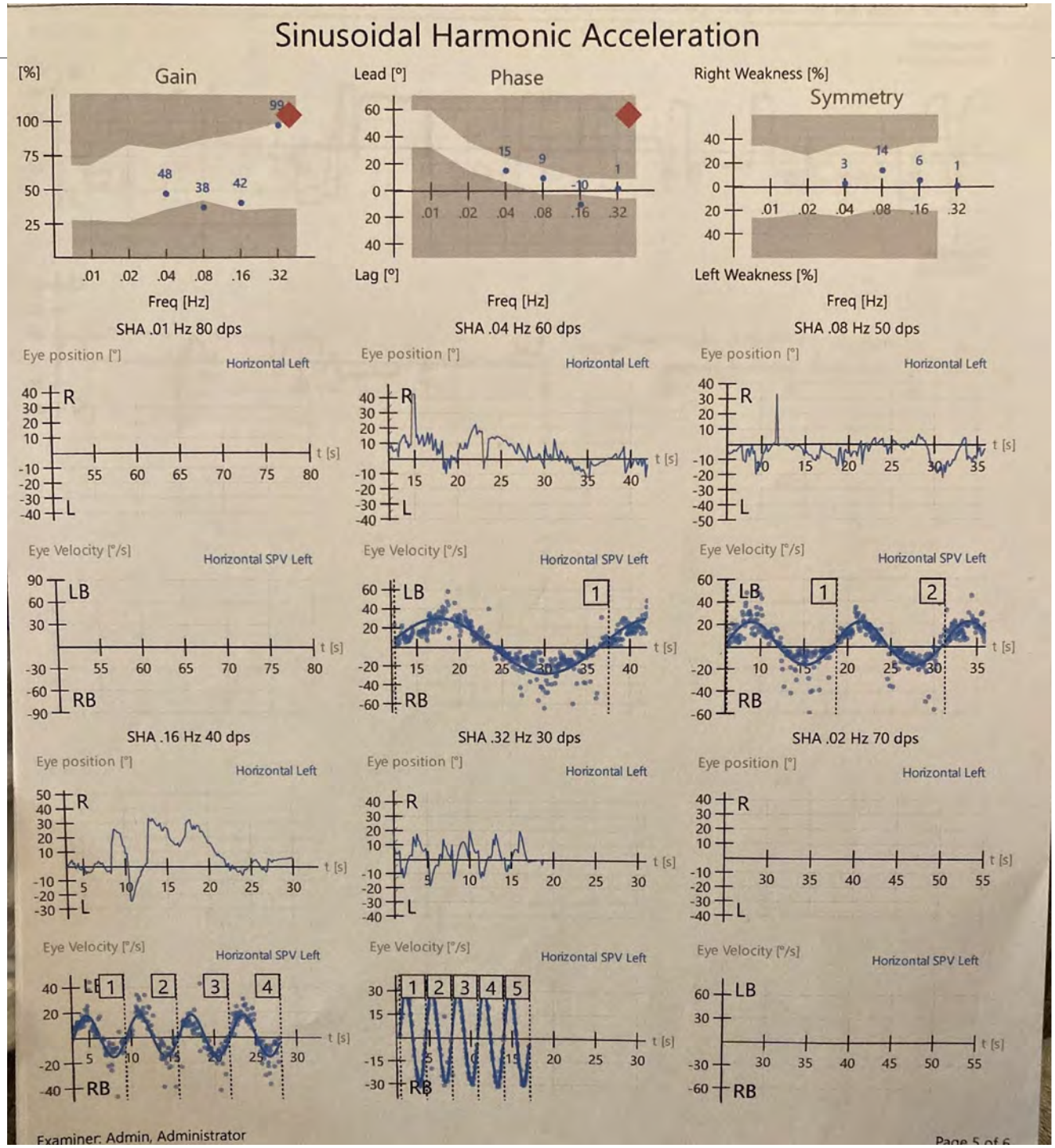
VORs

- Signifcant nystagmus
- Fixation light may not be visible
- Blinks
- Slippage

VST

- Very low gain with very low time constant and no asymmetry
  - Forgot to cover eyes
- Very low gain with whacky time constants
  - Poor tasking, inattention, nausea

My Experiment



Mental Tasting and Rotary Chair-Induced Vestibular Nystagmus Utilizing Video-Oculography

Doettl, S. M., Easterday, M. K., Plyler, P. N., Behn, L. L., & Poget, A. S. (2019). Mental tasking and rotary chair-induced vestibular nystagmus utilizing video-oculography. International Journal of Audiology, 59(5), 360–366. https://doi.org/10.1080/14992027.2019.1706768

- Should we be using mental tasking?
- Variable data suggesting what may be the best course
- 17 participants age 22-25 without vestibular disease, serving as their own control group
- SHA- 0.01-0.16Hz protocol
  - Two runs- one with tasking and one without
  - Comparing gain, phase and symmetry

Results

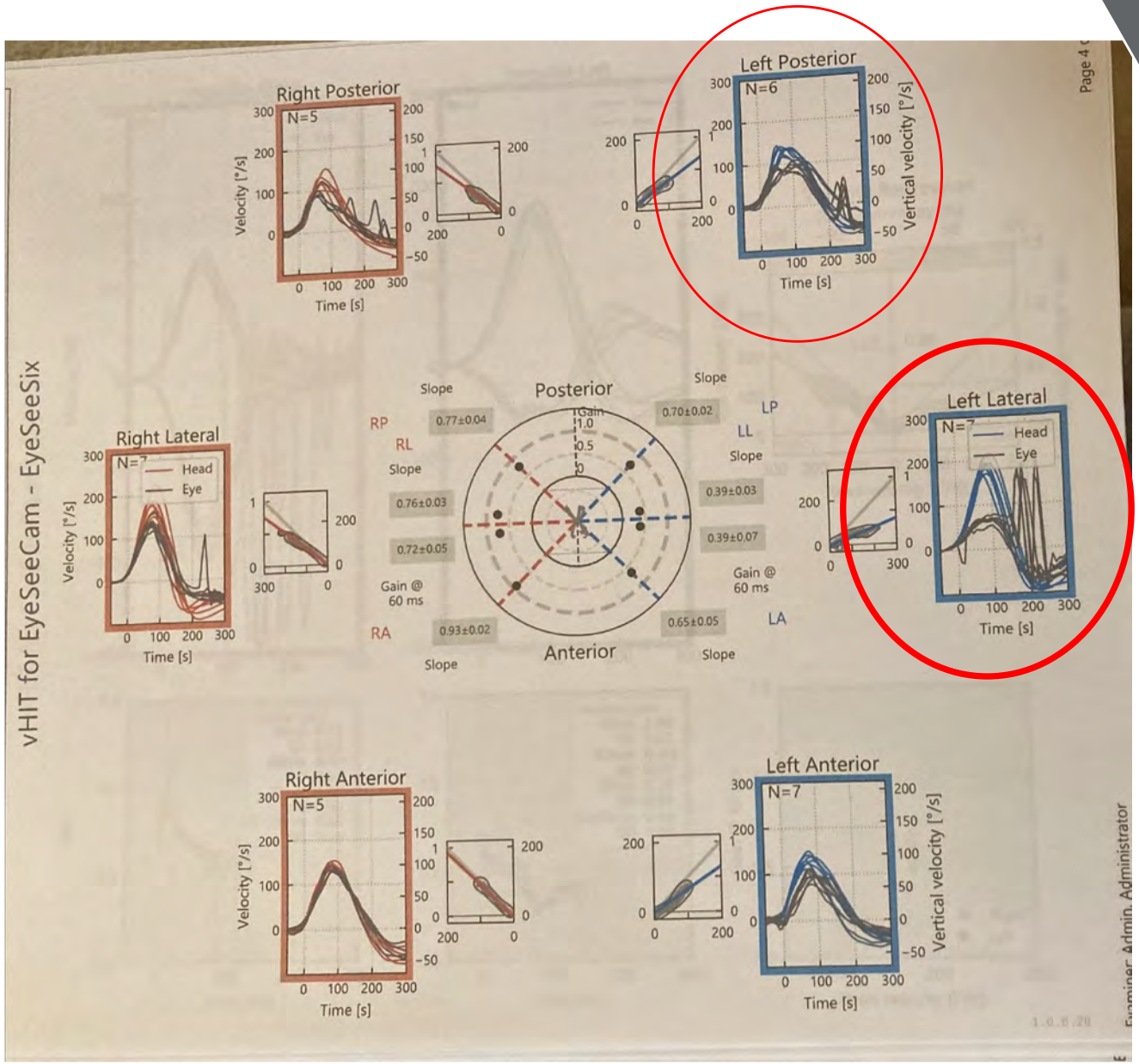
- No abnormalities noted
- Group data showed no difference
- Individual data:
  - Significant difference in tasking versus no tasking
  - Increase in gain (2), decrease in gain (2), significant change to symmetry (7), significant change to artifact (9)
- Results may not translate to other populations

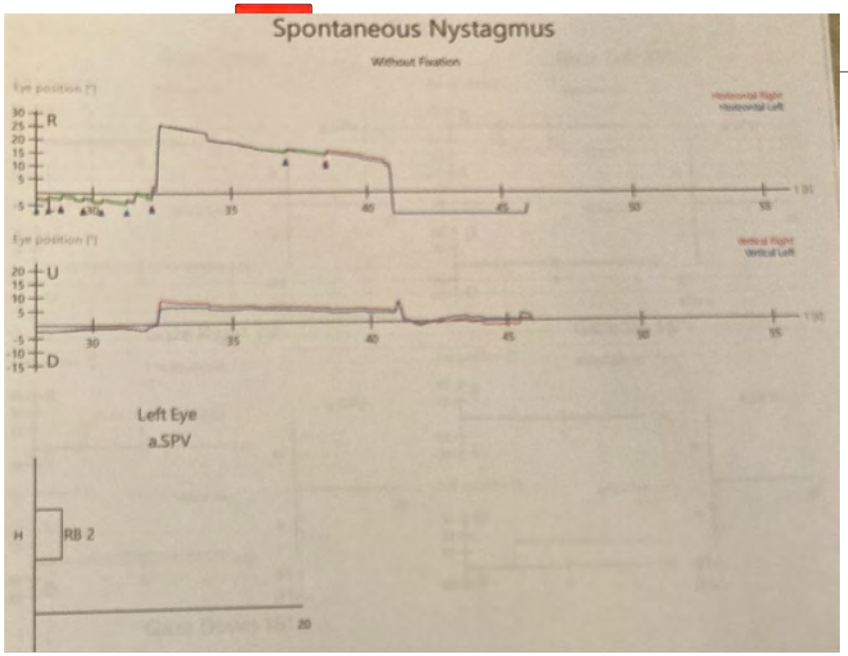
My 2 cents…

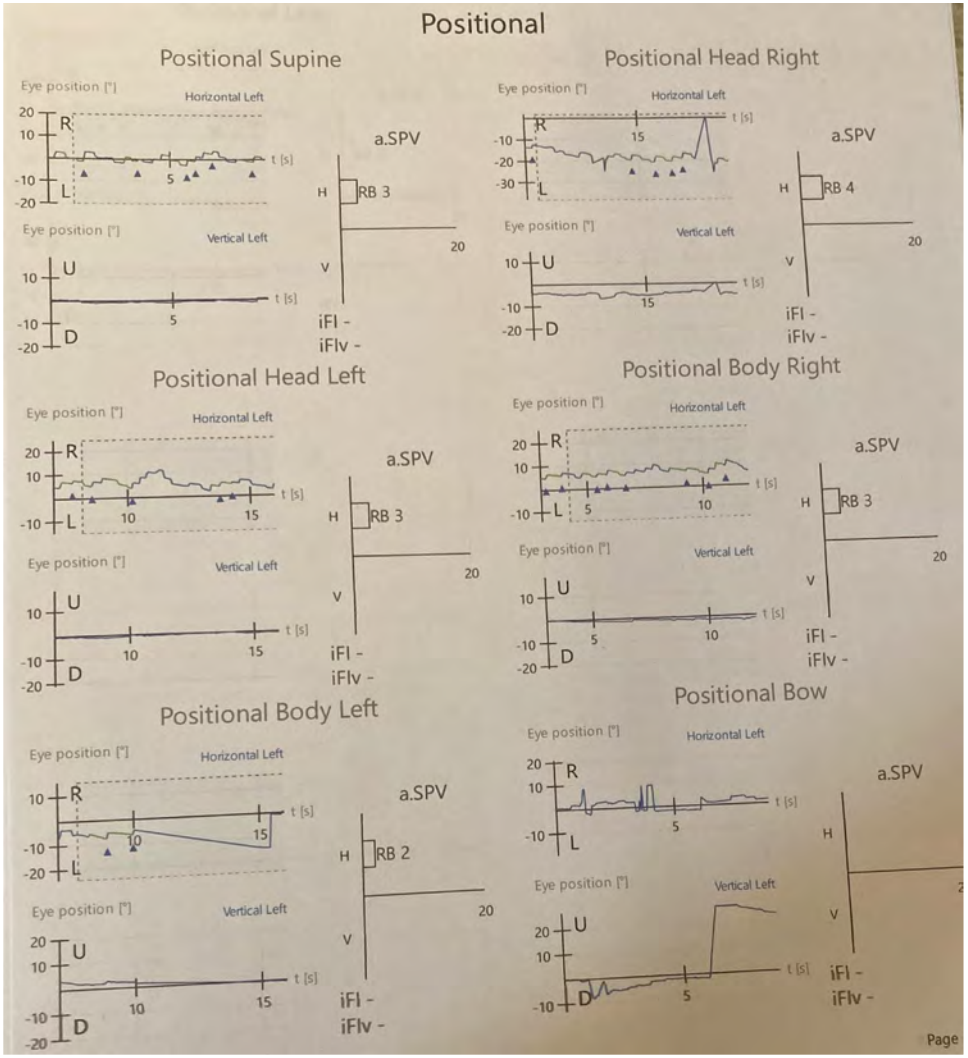
- If we consider the dual task paradigm and how it affects vestibular rehabilitation for the better, mental tasking during any vestibular tests should provide cleaner results, right?
- What about other populations, how do you think this study might change how testing sessions go?

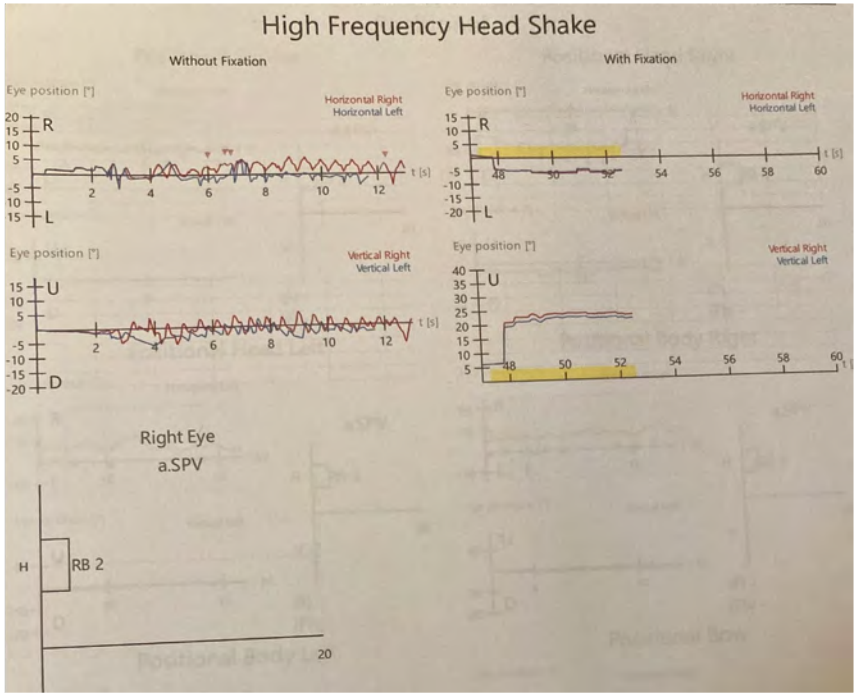
Case Study

- 80 year old man with history of BPPV 3y ago
- Notes several months ago a sudden onset of severe imbalance
- Ambulates poorly with reduced vision or if proprioception is compromised
- Asymmetry sensorineural hearing loss (SNHL), worse in the right ear
  - Right ear: moderately severe to severe SNHL
  - Left ear: mild to moderately severe SNHL

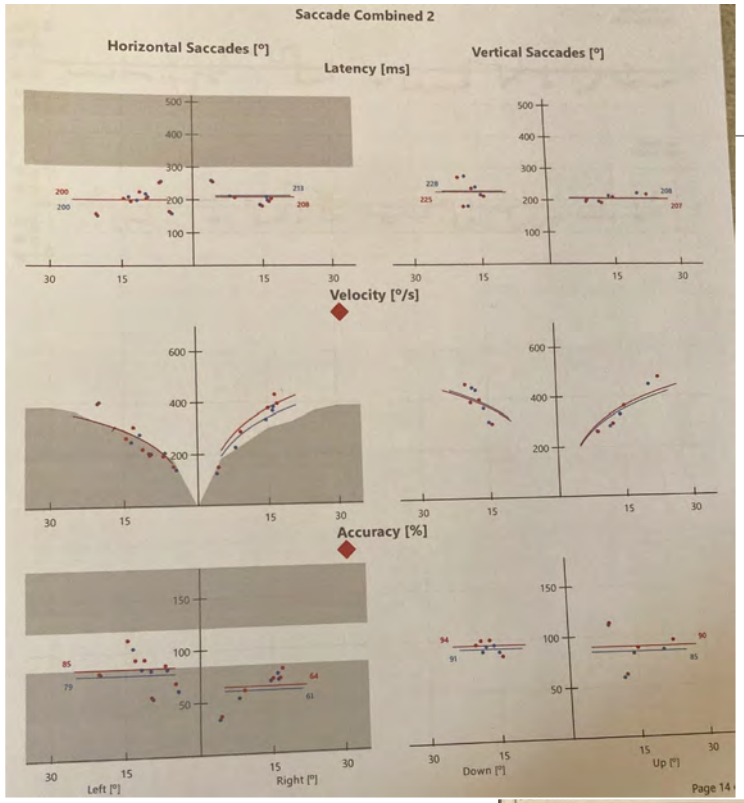

vHIT for EyeSeeCam - EyeSeeSix
Right Posterior
N=5
Left Posterior
N=6
Right Lateral
N=7
Head
Eye
Left Lateral
N=7
Head
Eye
Posterior
Anterior
Slope
RP
0.77±0.04
RL
0.76±0.03
RA
0.93±0.02
LP
0.70±0.02
LL
0.39±0.03
LA
0.65±0.05
0.39±0.07
0.72±0.05
Gain @ 60 ms
Right Anterior
N=5
Left Anterior
N=7
Velocity [°/s]
Vertical velocity [°/s]
Time [s]

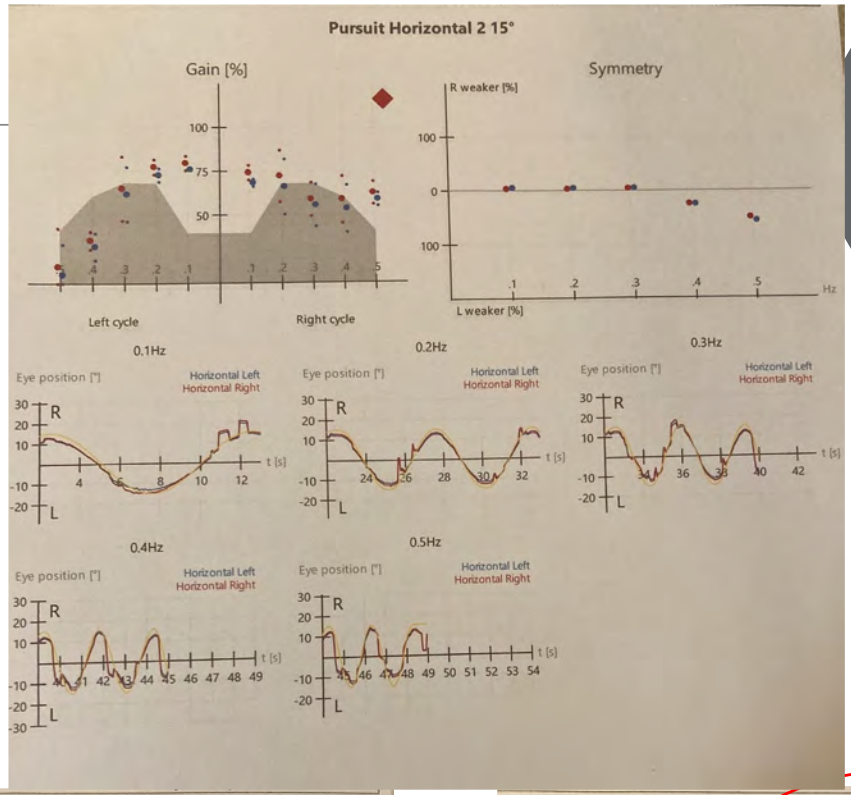

Spontaneous Nystagmus
Without Fixation
Eye position [°]
Horizontal Right
Horizontal Left
R
Vertical Right
Vertical Left
U
D
Left Eye
a.SPV
H
RB 2
20

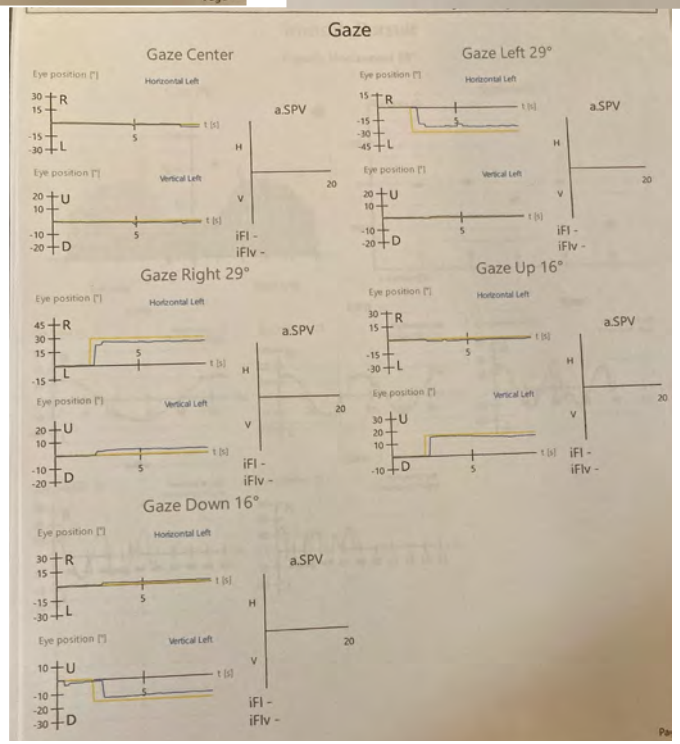

Positional
Positional Supine
Positional Head Right
Positional Head Left
Positional Body Right
Positional Body Left
Positional Bow
Eye position [°]
Horizontal Left
Vertical Left
a.SPV
RB 3
RB 4
RB 2
iFl -
iFlv -
Page

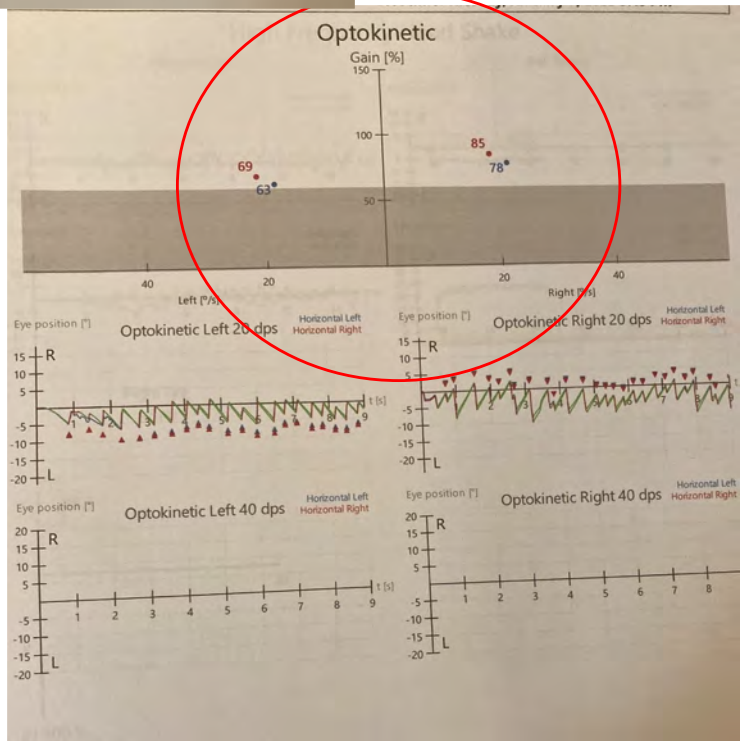

High Frequency Head Shake
Without Fixation
With Fixation
Eye position [°]
Horizontal Right
Horizontal Left
Vertical Right
Vertical Left
Right Eye
a.SPV
RB 2
20

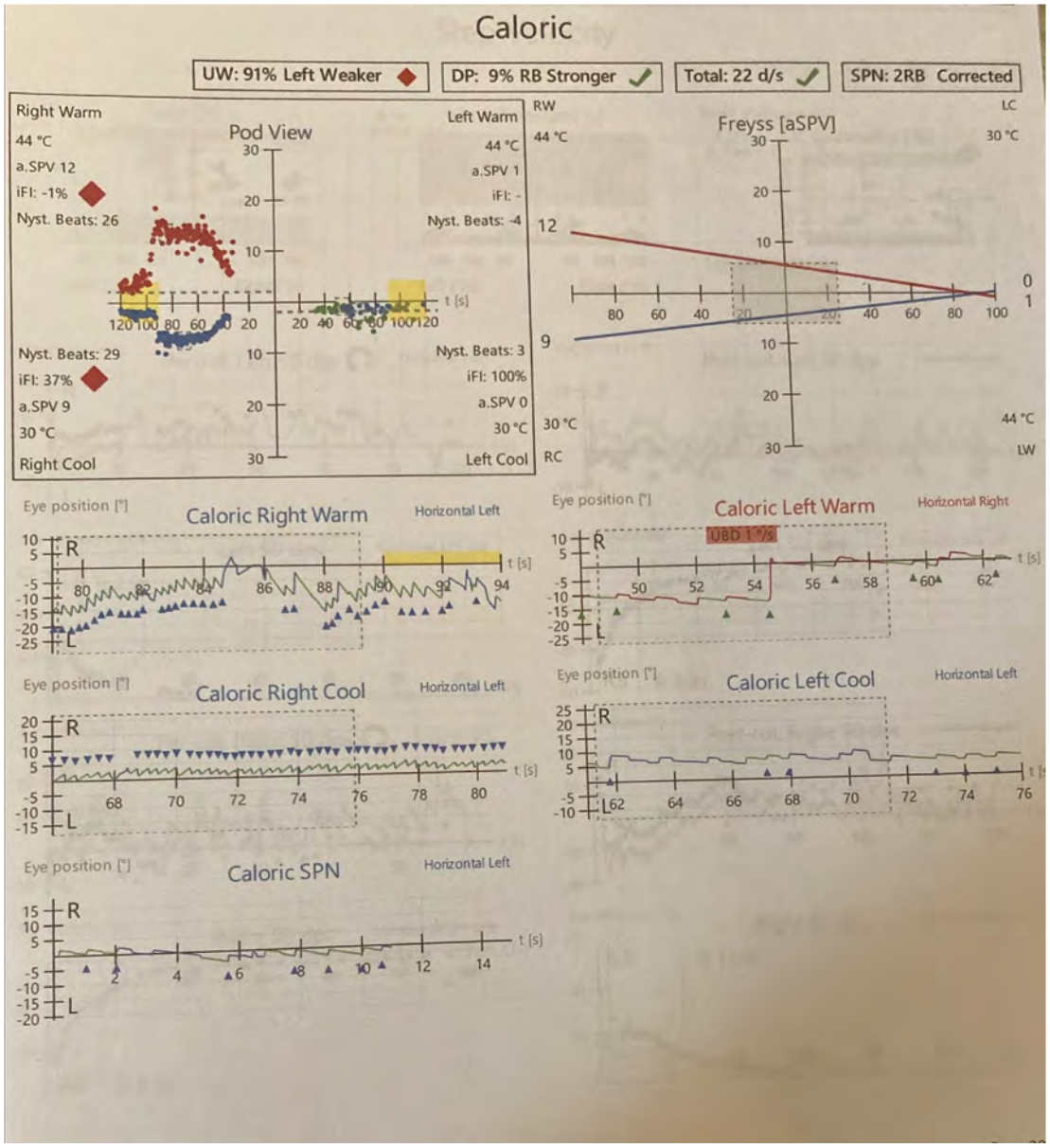
Case Study

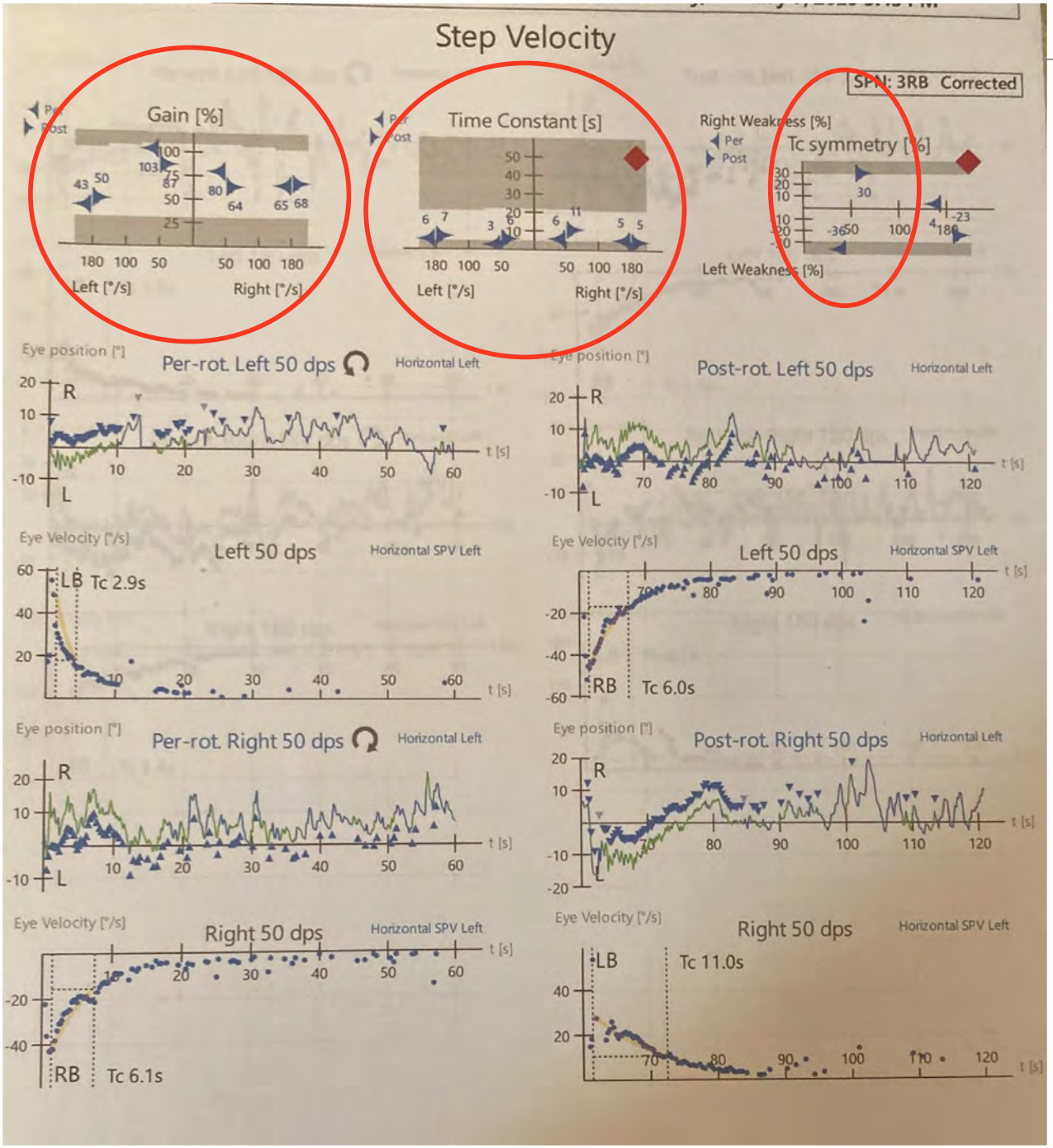

Saccade Combined 2
Horizontal Saccades [°]
Vertical Saccades [°]
Latency [ms]
Velocity [°/s]
Accuracy [%]
Left [°]
Right [°]
Down [°]
Up [°]
Page 14


Pursuit Horizontal 2 15°
Gain [%]
Symmetry
R weaker [%]
L weaker [%]
Left cycle
Right cycle
0.1Hz
0.2Hz
0.3Hz
0.4Hz
0.5Hz
Eye position [°]
Horizontal Left
Horizontal Right


Gaze
Gaze Center
Gaze Left 29°
Gaze Right 29°
Gaze Up 16°
Gaze Down 16°
a.SPV
iFl -
iFlv -


Optokinetic
Gain [%]
Left [°/s]
Right [°/s]
Optokinetic Left 20 dps
Optokinetic Right 20 dps
Optokinetic Left 40 dps
Optokinetic Right 40 dps
Eye position [°]
Horizontal Left
Horizontal Right


Caloric
UW: 91% Left Weaker
DP: 9% RB Stronger
Total: 22 d/s
SPN: 2RB Corrected
Pod View
Right Warm
44 °C
a.SPV 12
iFI: -1%
Nyst. Beats: 26
Left Warm
44 °C
a.SPV 1
iFI: -
Nyst. Beats: -4
Nyst. Beats: 29
iFI: 37%
a.SPV 9
30 °C
Right Cool
Nyst. Beats: 3
iFI: 100%
a.SPV 0
30 °C
Left Cool
t [s]
Freyss [aSPV]
RW
LC
LW
RC
Caloric Right Warm
Caloric Left Warm
Caloric Right Cool
Caloric Left Cool
Caloric SPN
Eye position [°]
Horizontal Left
Horizontal Right
R
L



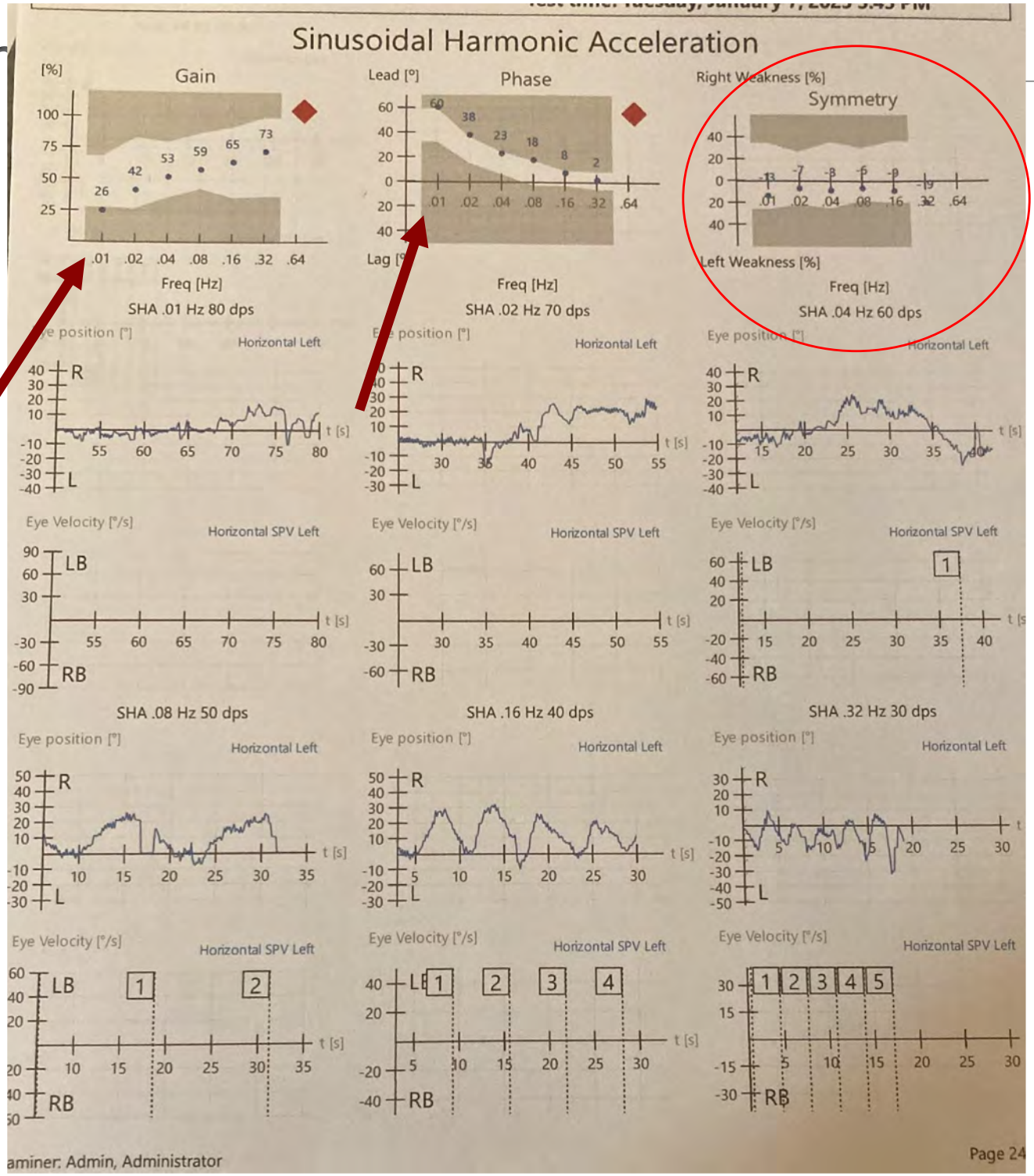
Case Study

Right measurements:
Per rotary right: 50dps- normal gain, reduced time constant; 180dps- normal gain, reduced time constant
Post rotary left: 50dps- normal gain, reduced time constant; 180dps- borderline reduced time constant

Left measurements:
Per rotary left: 50 dps- normal gain, reduced time constant; 180dps- normal gain, reduced time constant
Post rotary right: 50dps- normal gain, normal time constant; 180dps- normal gain, reduced time constant

Symmetry:
50dps: Per rotary left weakness (left); post rotary right weakness (left)
180dps: no significant asymmetry, compensation underway

Case Study


Sinusoidal Harmonic Acceleration
Gain
Phase
Symmetry
Right Weakness [%]
Left Weakness [%]
Freq [Hz]
SHA .01 Hz 80 dps
SHA .02 Hz 70 dps
SHA .04 Hz 60 dps
Horizontal Left
Horizontal SPV Left
SHA .08 Hz 50 dps
SHA .16 Hz 40 dps
SHA .32 Hz 30 dps
Eye position [°]
Eye Velocity [°/s]
t [s]
R
L
LB
RB
Page 24

Results interpretation:

Left ear:
vHIT: reduced gain with overt saccades on lateral canal
Calorics: total spv 0
VST: reduced time constants and normal gain, significant low frequency asymmetry
SHA: suggestion of bilateral weakness at 0.01Hz, decreasing phase leads with increasing frequency

Right ear:
vHIT: normal
Calorics: total spv 21, excellent fixation
VST: reduced time constants and normal gain
SHA: suggestion of bilateral weakness at 0.01Hz

Compensation:
- spontaneous nystagmus
-no directional preponderance
- significant VST asymmetry to the left at 50dps, not maintained in higher frequencies
- no SHA asymmetry

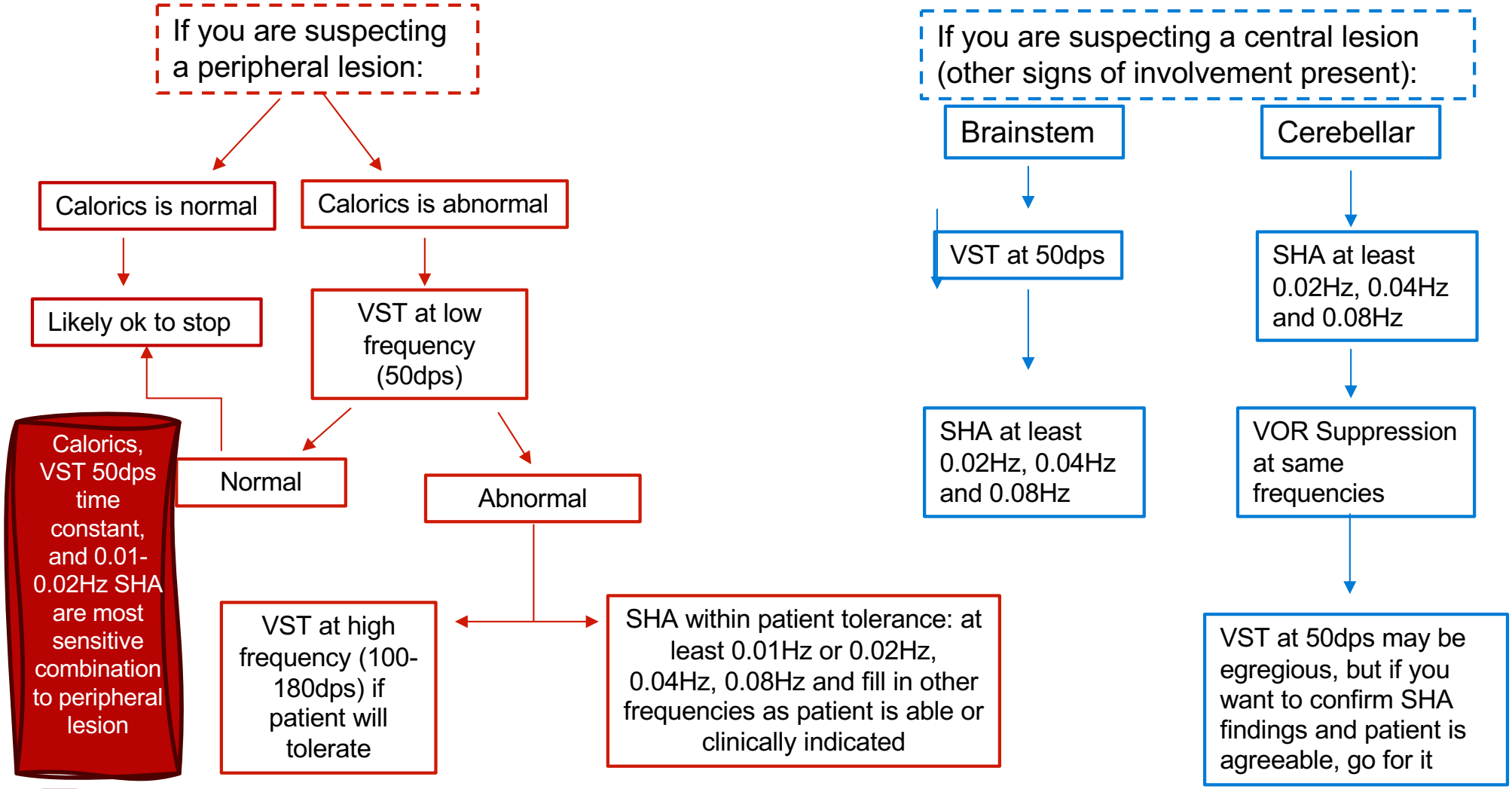
Overall interpretation:
Bilateral peripheral vestibular weakness with significant loss of function in the left ear
Compensation is established but due to lingering spontaneous nystagmus, unlikely complete

Note: did not do VOR suppression given good fixation index and low suspicion for central involvement despite poor smooth pursuit

Wrap up…

- Rotary chair may be a good alternative for individuals in which caloric irrigation is contraindicated
- It can bolster the results and provide more comprehensive information if caloric irrigation and vHIT are included
- It can provide information regarding central vestibular function that may not be seen elsewhere

Quick Reference Protocol Guide



Quick Reference Interpretation Guide:

	SHA	VOR suppression	Velocity Step Testing	Other tests
Unilateral Peripheral Vestibulopathy	Phase: Phase leads-uniformly abnormal or decreasing lead with increasing frequency, 0.01-0.02Hz most sensitive Gain: normal, unless insult is acute (days) or not well compensated	Normal - reduction in nystagmus by 80%	Time Constant: 5-6sec suggests stable lesion Gain: <0.4 on side of lesion (paretic), contralesional if irritative	Caloric weakness/asymmetry, asymmetric vHIT, asymmetric VEMP
Bilateral Peripheral Vestibulopathy	Phase: may not be calculable. If phase is calculated, may also have decreasing phase leads with increased frequency. 0.01Hz and 0.02Hz most sensitive Gain: LOW The lower the more severe	Normal-reduction in nystagmus by 80%	Time Constant: <5sec Gain: <0.4 on both sides	Reduced calorics, reduced vHIT, reduced/absent VEMP
Central Vestibulopathy	Phase: Uniformly abnormal lead (brainstem), decreasing phase lead with increased frequency Gain: May be high (cerebellar) Symmetry: normal	Abnormal reduction in nystagmus	Cerebellar: TC >30sec, gain >1.0 Brainstem: <10sec, gain normal	Must see other central signs, particularly oculomotor, failure to fixate, hyperactivity; rule out peripheral too
Compensation Status	Phase and gain are unlikely to return to normal. If lesion is suspected to be compensated, symmetry will be normal. Uncompensated: significant asymmetry	n/a	If high frequency condition produces no significant asymmetry, the lesion is suspected to be compensated Uncompensated: asymmetry at high frequency	Directional preponderance Spontaneous nystagmus

Peripheral lesion hint for SHA and VST combined:
If time constant is <5-7sec and there is a significant phase lead at 0.01Hz, that is a pretty significant indicator of a peripheral lesion in one or both ears (depending on the side(s) with the time constant)

Thank You

Kaitlin Ryan, AuD, CCC-A

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