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An Overview of the American Academy of Audiology Clinical Consensus Statement on Assessment of Vestibular Function in the Pediatric Population

Violette Lavender, AuD, Co-Chair
Kristen Janky, PhD, Co-Chair
Kay Bachmann, PhD
Melissa Caine, AuD
Micheal Castiglione, AuD
Guangwei Zhou, ScD

Violette Lavender, AuD

Violette Lavender, AuD has been a pediatric audiologist with Cincinnati Children's Hospital for over 20 years. She attended Purdue University, where she earned both her BS and MS in Audiology. She graduated from the University of Florida with her AuD. She specializes in both hearing and balance disorders. Violette has previously published and presented in the area of pediatric balance assessment. Violette is interested in translational research and strives to make the vestibular test battery accessible for young children.

Kristen Janky, PhD

Kristen Janky is Lead Audiologist of Vestibular Clinical Services and Director of the Vestibular and Balance Research Laboratory at Boys Town National Research Hospital. Her PhD is from the University of Nebraska. She completed a postdoctoral fellowship at Johns Hopkins University. Her research focuses on the effects of vestibular loss in children and special populations.

Katheryn Bachmann, PhD

Dr. Bachmann has been an audiologist for over 30 years. She completed her undergraduate studies at Miami University of Ohio before graduating from the University of Akron with her MS in Audiology. After her clinical fellowship at Henry Ford Hospital in Detroit, Dr. Bachmann attended Vanderbilt University, earning her PhD in 1996. She is currently a clinical audiologist at Cincinnati Children's Hospital Medical Center, specializing in the evaluation of dizziness and balance disorders in children, both clinically and through her research. Dr. Bachmann has co-authored several book chapters and many articles and has given numerous presentations across the country on hearing and balance disorders. Dr. Bachmann is also an adjunct assistant professor at the University of Cincinnati, where she advises student capstone projects and teaches the vestibular courses in the AuD program.

Melissa Caine, AuD

Melissa Caine, AuD, is a clinical specialist and audiologist at Children's Hospital of Philadelphia (CHOP). She received her B.A. in Communication Disorders and English Literature from Loyola College in Maryland in 2004 and her AuD from Salus University in 2008. Melissa currently provides diagnostic and rehabilitative services at CHOP in both the outpatient and inpatient settings. In addition to her clinical position, Melissa is the department's lead audiologist for the Balance & Vestibular Program and coordinator of professional development/continuing education. Her areas of clinical interest include pediatric vestibular assessment, electrophysiologic assessment in the NICU population, and adolescent focused rehabilitation.

Micheal Castiglione, AuD

Dr. Castiglione is a pediatric audiologist at Cincinnati Children's Hospital Medical Center. She has over 25 years of experience, most of which has been in the pediatric setting. Dr. Castiglione's specialty areas include pediatric vestibular disorders and electrophysiology. She was integral to the set up and launch of the Pediatric Balance Center at CCHMC, which opened in 2008. Dr. Castiglione has co-authored several articles on pediatric vestibular testing and has also given numerous presentations on this topic.

Guangwei Zhou, ScD

Guangwei Zhou, ScD, is the Clinical Director of the Balance and Vestibular Program in Boston Children's Hospital at Waltham and Assistant Professor in Otolaryngology, Harvard Medical School. His clinical research includes evoked potentials in patients with inner ear structural anomalies and cochlear implants. He is also investigating etiologies of balance and vestibular dysfunction in children. He has published over two dozen peer-reviewed paper in the field of Otology and Audiology and is known for his work on vestibular evoked myogenic potential (VEMP), pediatric video Head Impulse Testing(vHIT), semicircular canal dehiscence (SCD) and enlarged vestibular aqueduct (EVA), nationally and internationally. Prior to obtaining his ScD in Audiology, Dr. Zhou attained medical degree from Beijing Medical University. He also completed his residency and research fellow training in otolaryngology.

Disclosures

- **Presenter Disclosure**: Violette Lavender: Financial: Violette Lavender is employed by the Pediatric Balance Center at Cincinnati Children's Hospital. She received an honorarium for this presentation. Non-financial: Violette Lavender is the Co-author of the Standard Practice Document for Pediatric Vestibular Assessment. Kristen L. Janky Financial disclosures: Employee of Boys Town National Research Hospital; NIH Grant Recipient; Consultant: Natus; Interacoustics, Balance Function Assessment and Management Textbook, Editor. Kristen L. Janky Non-financial disclosures: Ear & Hearing, Section Editor; Pediatric Vestibular and Balance Network Board Member; VEDA Board Member. Katheryn Bachmann: Financial: Katheryn Bachmann is employed by Cincinnati Children's Hospital Medical Center. She received an honorarium for this presentation. Non-financial: Katheryn Bachmann has no relevant non-financial relationships to disclose. Melissa Caine: Financial: Melissa Caine is employed by Children's Hospital of Philadelphia (CHOP). She received an honorarium for this presentation. Non-financial: Melissa Caine has no relevant non-financial relationships to disclose. Micheal Castiglione: Financial: Micheal Castiglione is employed by Cincinnati Children's Hospital Medical Center. She received an honorarium for this presentation. Non-financial: Micheal Castiglione has no relevant non-financial relationships to disclose. Guangwei Zhou: Financial: Guangwei Zhou is employed by Boston Children's Hospital. He received an honorarium for this presentation. Non-financial: Guangwei Zhou has no relevant non-financial relationships to disclose.
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- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
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Learning Outcomes

After this course, participants will be able to:

- Identify and describe modifications to each assessment of vestibular function when completed in children.
- List the age each assessment of vestibular function can be completed.
- Summarize outcomes for each assessment of vestibular function.

Introduction

Violette Lavender, AuD

How it all began…

Drivers…

- Lack of formalized vestibular battery for children
- Normative data was changing with the equipment landscape
- Clinicians in smaller centers requesting guidance
- Centralized document with national distribution

The Team


Boston Children's Hospital
Children's Hospital of Philadelphia
BOYS TOWN
Cincinnati Children's

Resources…

- Clinical Practice
- Textbooks
- Conferences
- Peer Reviewed Articles
  - Recommendation papers (ex: Janky et al, Cushing et. al, Colleagues at Ghent University, etc.)

Document

- Practice Guideline ⟶ Clinical Consensus Document
- Not meant to be a “cookbook” approach
- Understanding of challenges with focus areas:
  - specific end organ structure
  - subjective vs. objective data
  - Functional impact
  - Age/developmental level

Overview

Table 1 Overview of Vestibular Function Tests Available by Child Age

Test	0–2 Years	3–7 Years	8+ Years
Bedside	Identification of nystagmus Head impulse test	Identification of nystagmus Dynamic visual acuity screen Romberg test Tandem gait and walk mCTSIB Single-leg stance test	Identification of nystagmus Dynamic visual acuity screen Romberg test Tandem gait and walk mCTSIB Single-leg stance test
Questionnaires	Ages and Stages: Gross Motor (birth–5 years)	Ages and Stages: Gross Motor (birth–5 years) DHI-PC (5–12 years) PVIDQ (6–17 years) PVSQ (6–17 years)	DHI-PC (5–12 years) PVIDQ (6–17 years) PVSQ (6–17 years)
Canal	Video head impulse test (remote camera system) Rotary chair test (electrodes, in-room camera, handheld goggles after 2 years)	Video head impulse test Rotary chair test	Video head impulse test Rotary chair test
Otolith	Cervical VEMP	Cervical VEMP Ocular VEMP	Cervical VEMP Ocular VEMP
VNG	High-frequency headshake Skull vibration-induced nystagmus test	High-frequency headshake Positional testing Skull vibration-induced nystagmus test Ocular motor test (after 5 years)	All components of VNG

Bedside Examination in Pediatric Balance/Vestibular Assessment

Guangwei Zhou, ScD, Balance and Vestibular Program

Boston Children's Hospital at Waltham

Historical Background of Bedside Examination

- A clinical term used in medical practice, with the evolving understanding of human anatomy & physiology/pathophysiology
  - Ancient medicine: Egypt, India, Greek and traditional Chinese medicine
  - Medieval/Renaissance/transition to clinical medicine
  - The rise of modern medicine/examination: e.g., use of stethoscope
  - 20th Century: standardized exam (inspection, palpation, percussion, and auscultation), aided by technological advancements (X-rays, ultrasound, etc.)
  - Contemporary medicine: many practice with over-reliance on technology; however, bedside examination still has a value as a diagnostic/screening tool, foster human connection in healthcare

Bedside Examination for Pediatric Balance/Vestibular Conditions

- To evaluate basic vestibular and balance function in children, aiding clinical diagnosis and management in real time.
  - Patients' bedside/inpatient hospital care
  - Emergency Room
  - Ambulatory care/outpatient clinics
  - Primary care/Pediatrician office
  - Audiology practice
  - Relying on the clinician's knowledge/skills/observation

Observation/Identification of Nystagmus

- Nystagmus is involuntary rhythmic eye movement, with fast/slow phases
  - Direction of nystagmus: named for the direction of the fast phase
  - Horizontal nystagmus (left/Right-beating)
  - Vertical nystagmus (up/down-beating)
  - Torsional nystagmus, goggles might be
  - needed
  - Nystagmus? or not
  - None-vestibular nystagmus (e.g., congenital nystagmus, etc.)

Common Types of Nystagmus

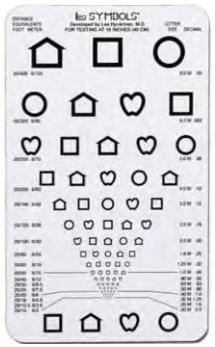
- Spontaneous Nystagmus
  - Uncompensated peripheral vestibular loss, suppressed by fixation
  - Horizontal nystagmus in most cases
  - Vertical nystagmus (e.g., down-beating) uncommon, central involvement?
- Evoked Nystagmus
  - Gaze-evoked, using of attractive toys, avoid end-gaze nystagmus
  - Sounds/pressured-evoked nystagmus
  - Post-head shake nystagmus

Assessment of Vestibulo-Ocular Reflex

- The vestibulo-ocular reflex (VOR) is present at birth and even infants have nystagmus in response to angular acceleration.
  - Function of semicircular canal, vestibular nerve, central nerve system
  - **Head Impulse/Thrust**: reliable tool for unilateral/bilateral loss
  - **Post-rotary nystagmus**: rotating a child at a constant velocity on a swivel chair for about 30 seconds with eyes closed → nystagmus when the VOR is intact. Lack of it or with short a decay is predictive of vestibular loss

Assessment of Vestibulo-Ocular Reflex

- **Dynamic Visual Acuity**
  - Impaired VOR can affect visual acuity during head movement
  - Use of pocket-size eye chart, different optotypes
  - First establish static visual acuity
  - Then get dynamic acuity: head moving horizontally (at 2 Hz)
  - A drop of two lines or more → impaired VOR or bilateral loss
  - Often used at bedside to screen for ototoxicity



Assessment of Vestibulo-Spinal Reflex

- The vestibulo-spinal reflex helps stabilize the body and maintain postural control.
  - Typically developed child: head holding (6 weeks), head turn/controlled move (16 weeks), sitting (9 months), standing (about 12 months), walking independently (no later than 15 months)
  - Romberg Test: unilateral/bilateral loss or cerebellar lesion
  - Tandem gait/stance and walk: sensitive to acute loss

Age-Specific Norms for Tandem Stance

Age	Duration in Seconds (Eyes Open/Closed)
4–5 years	>7/4
6–7 years	>13/6
8–9 years	>51/12
10–11 years	>68/17
≥12 years	>120/18

Screening Tests for Balance Function

- Assessment of balance function is important for accurate diagnosis of vestibular impairment, identification of fall risk, and treatment planning
  - Modified Clinical Test of Sensory Integration of Balance (mCTSIB): hard surface vs soft surface/foam, eyes open vs closed
  - Single-Leg Stance Test: stand on one leg and record time in seconds; raising a concern if < 10s; vestibular loss likely if < 4~5s

Age-Specific Norms for Single-Leg Stance

Age	Duration in Seconds (Eyes Open/Closed)
30–36 months	1–2
4 years	5
5 years	10/<5
7 years	15/5
9 years	30/15
11 years	30+/30

Cervicogenic Screening

- Cervicogenic dizziness/vertigo in children refers to a condition where a child experiences dizziness or a sensation of unsteadiness primarily caused by issues with the neck muscles and joints in the cervical spine.
  - Often accompanied by neck pain
  - Usually worsened by head movements or certain neck positions
  - Associated with whiplash injuries, cervical/neck pathologies, poor neck posture, etc.
  - Hold the head still while the child moving side to side or palpation of the neck → dizziness

The Value and Limitations of Balance/Vestibular Bedside Examination

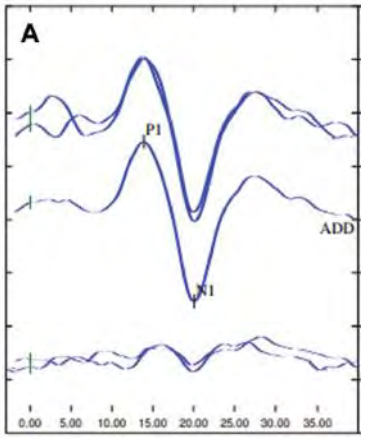
- Despite technological advances in laboratory balance and vestibular testing, bedside exams remained valuable; however limitations should be aware
  - Use for triage and screening patients, first-line evaluation, central vs peripheral
  - Rapid and readily accessible/available, cost-effective
  - Direct interaction and engagement, patient-centered care
  - Limitations: variable sensitivity/specificity, insufficient for complex or non-specific dizziness, subjective nature in observation, etc.

Vestibular Evoked Myogenic Potentials (VEMPs)

Kristen Janky, PhD

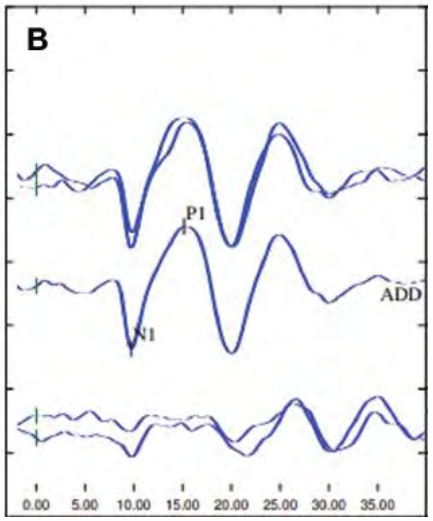
Cervical VEMP

- Related to the Vestibulo-collic reflex
- Uncrossed -Ipsilateral response
- Saccule: Inferior VN
- INHIBITORY (release from **contraction**) of SCM in response to acoustic stimuli
- Amplitude most often reported
- 1994



Ocular VEMP

- Related to the Vestibulo-ocular reflex
- Crossed – contralateral response
- EXCITATORY : contraction of the inferior oblique
- UTRICLE: Superior VN
- Amplitude most often reported (2 – 20µv)
- 2005



Effects of Age

- Cervical VEMP
  - Can be assessed in newborns; usually start at 6 months
  - Better responses in full- vs pre-term infants
  - Currently being used to screen for vestibular loss in children who fail their newborn hearing screening
  - latencies are shorter in infants and children compared with adults, which has been attributed to neck length.
- Ocular VEMP
  - Due to maturation and compliance, not assessed until 4 years
  - There is no difference in oVEMP parameters between children and adults

Normative Data

- Lack of standardization
  - no uniformity in stimuli, electrode placement, and test settings.
  - Most studies have used either 500Hz or click stimuli;
- Both cVEMP and oVEMP responses have been recorded in nearly 100% of control ears, demonstrating their feasibility.
- An overview of normative data can be found in the manuscript, Table 4

cVEMP Modifications

- To contract the SCM
  - Children 3 years and older lay in the supine position, elevated 30 degrees (often propped on their forearms), and are instructed to lift their heads and turn away from the ear receiving the air-conducted stimulus.
  - Toddlers can sit on a parent's lap and contract the SCM by turning the head
  - Infants can either lay supine and turn the head or be held in a declined position, facing the parent/caregiver, during acoustic stimulation. cVEMP
  - Use of EMG monitoring is recommended
- Reinforce with toys or a short video

oVEMP Modifications

- Children can lie down or be seated
- To maintain a constant upward gaze, fun stickers or short video recordings can be placed at 30 degrees upward gaze
- For children who cannot sustain upward gaze, oVEMP can be completed with the eyes closed; however, it should be noted that response rates are lower and oVEMP amplitudes are smaller and less reliable.

VEMP Considerations

- Tympanometry
  - Rule out middle ear disorder
  - if ear canal volumes are < 0.8 mL, 120 dB SPL (92 dB nHL) should be used to ensure safe SPL levels
- Bone Conduction
  - Preferred in young children where OME is prevalent
- Reliability
  - cVEMP and oVEMP responses are reliable in children
- cVEMP Amplitude Normalization
  - Helpful when children cannot sustain SCM contraction

VEMP Interpretation

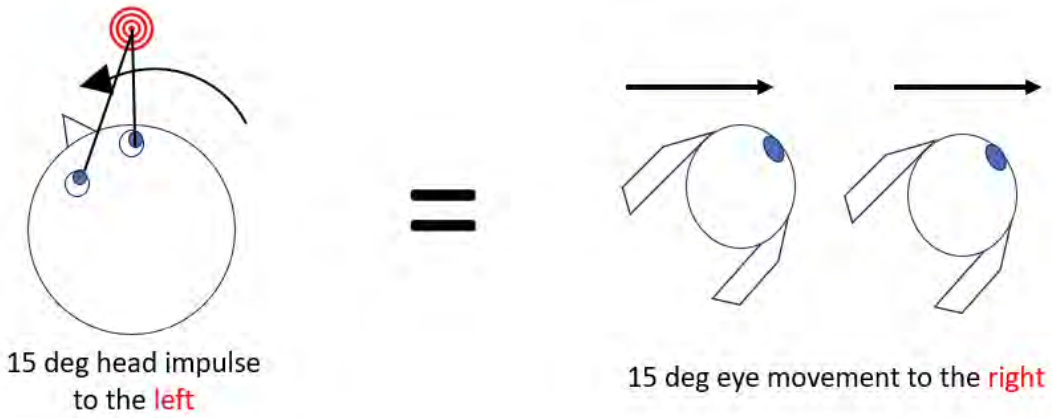
- Cochlear Implantation
  - Bone conduction stimuli are recommended for accurate pre- and post-testing
- Sensorineural hearing loss
  - cVEMP being used to screen for vestibular loss in children with hearing loss
- Conductive hearing loss
  - Bone conduction stimuli are recommended for accurate pre- and post-testing
- Large Vestibular Aqueduct Syndrome
  - Type of 3rd WVariable outcomes (increased/decreased thresholds, increased/decreased amplitudes

Video Head Impulse Test (vHIT)

Kay Bachmann, PhD

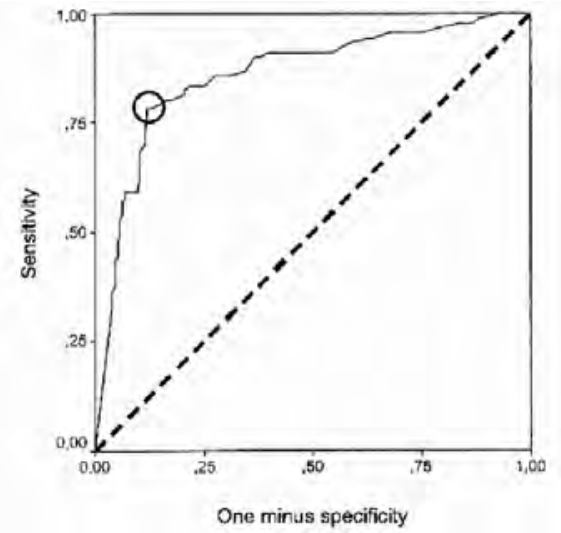
vHIT BACKGROUND

- Based on the Head Impulse Test (HIT) bedside test developed by Halmagyi and Curthoys (1988)
  - Measure of the vestibulo-ocular reflex of the semicircular canals



Sensitivity of the HIT screening

- Studies have shown that catch up saccades can be seen best by the human eye if the caloric weakness is 42.5% or greater.



Perez and Rama-Lopez 2003

Sensitivity - Correctly identifying dysfunction = 0.45
Specificity - Correctly identifying normal function = 0.91

vHIT – sensitivity and specificity of 1.0!

(MacDougall et al., 2009)

Currently two commercially available and FDA approved devices

Group 1: Klaus Bartl, Nadine Lehnen, Stefan Kohlbecher,and Eric Schneider *Annals of the New York Academy of Sciences,* 2009 May;1164:331-333

Group 2: H.G. MacDougall, K.P. Weber, L.A.McGarvie, G.M. Halmagyi, and L.S.Curthoys Neurology, 2009 Oct 6;73(14):1134-41.

Group 1:"Eye See Cam"

Group 2: ICS Impulse

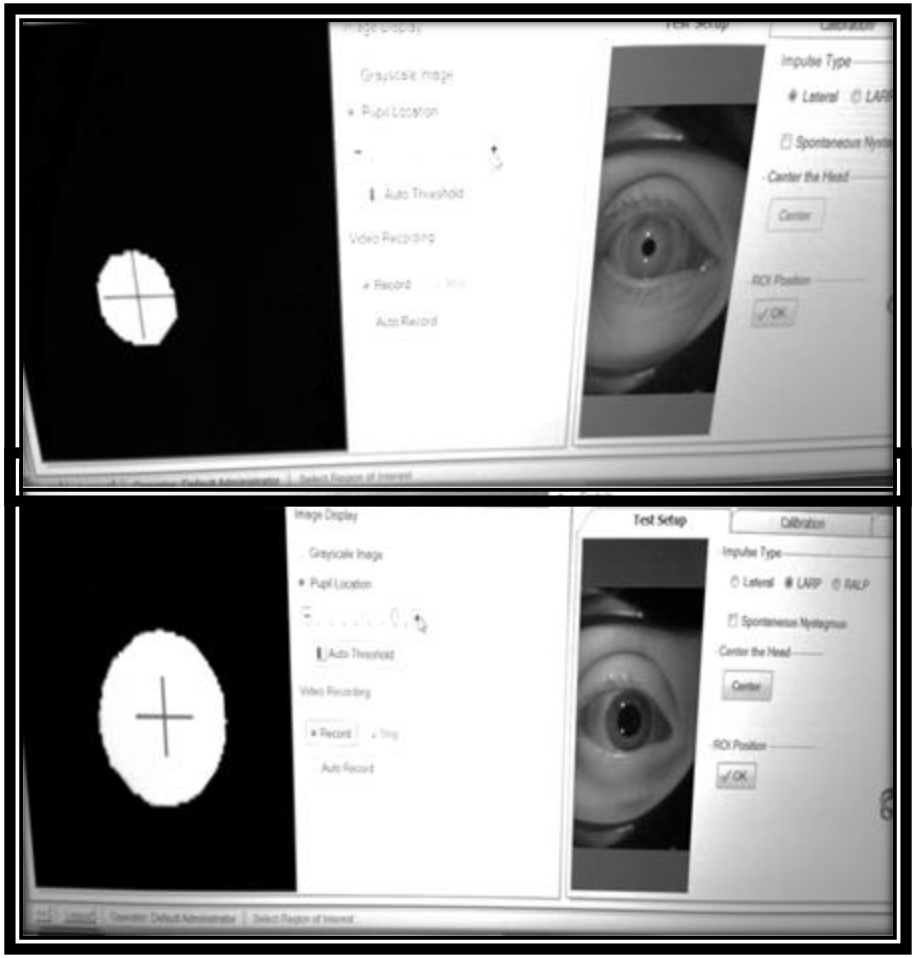
vHIT: How To…

1. Fit the goggles to the patient (must be tight so there is minimal slip)

- Eye movements are measured by tracking the pupil

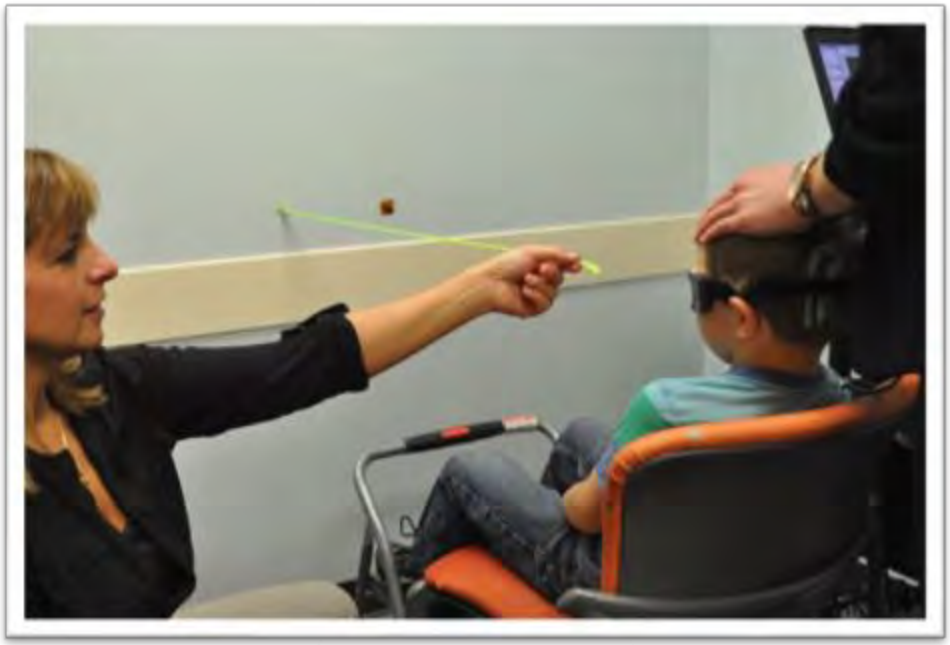
vHIT: How to:

2. Make sure the whole pupil is visible to the camera (may need to lift eyelid)



vHIT: How To…

3. Calibration (in vivo)- to measure pupil displacement, DEFAULT used for younger children



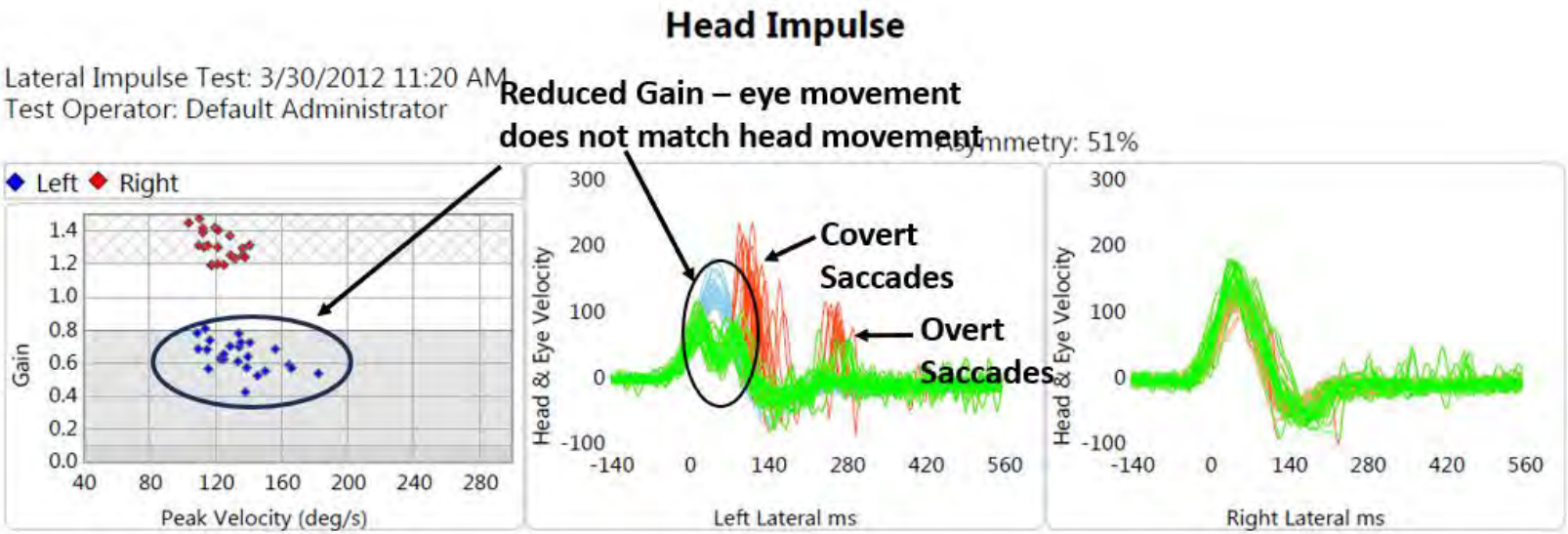
vHIT: How To…

4. Subject Position – seated at least 1 meter from a 1”x 1” focal sticker on a wall

vHIT: Lateral Impulses – 11 y.o.

vHIT Interpretation: Unilateral Loss

- **0.80–1.2 is considered the reference range for lateral canal vHIT.**
- **0.60 –1.2Gain cutoff values for left/right- anterior/posterior semicircular canal**



Videonystagmography (VNG)

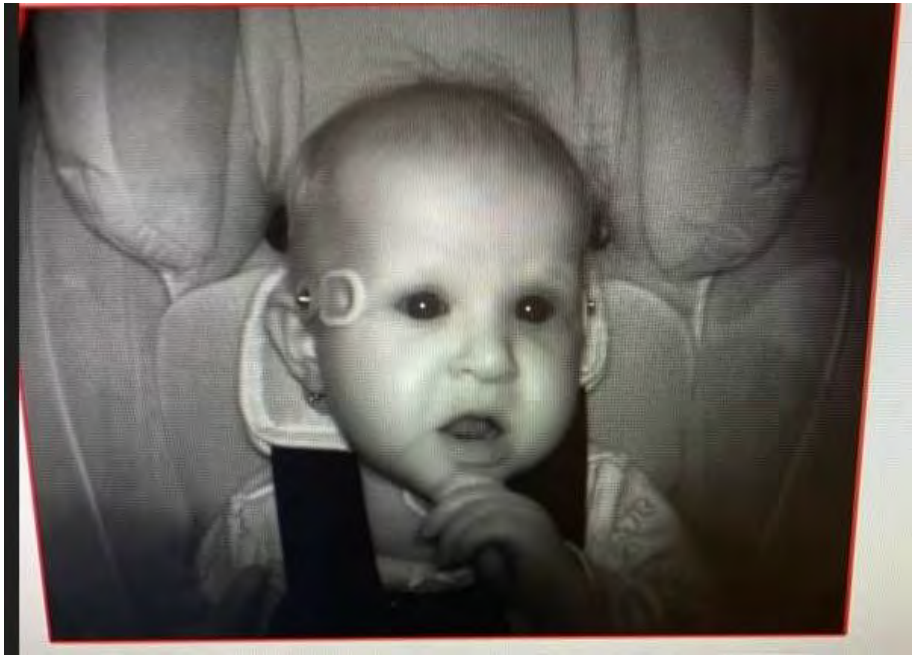
Micheal Castiglione, AuD

Videonystagmography (VNG)

- Subtests
  - High-Frequency Headshake
  - Skull Vibration-Induced Nystagmus Test
  - Positional Testing
  - Dix-Hallpike/Roll Test
  - Ocular Motor Test
  - Caloric Irrigation

Test	0-2 years	3-7 years	8 + years
VNG	High-frequency headshake Skull vibration induced nystagmus test	High-frequency headshake Skull vibration induced nystagmus test Positional testing Ocular motor test (after 5 years)	All components of VNG

Pediatric Recording Options



High Frequency Headshake

- Age 10 months and older
- Assess for asymmetrical vestibular system function
- No normative data specific for children
- 3 consecutive beats considered pathological
- Central involvement-latent onset and/or persistent
- Can be completed with in-room camera, electrodes or goggles
- Tell the child “we are going to be silly and shake our head and say No! No! No! 10 times

Skull Vibration-Induced Nystagmus Test

- Any age
- Assess asymmetrical function in the peripheral vestibular system
- Presence of nystagmus (>10 beats and > 2 deg/sec or enhancement of pre-existing nystagmus by at least 50%
- Record for 5 seconds without stimulation and at least 10 seconds with stimulation
- Show the child the vibrator and let them feel the vibration
- Tell them “This is going to tickle our ear, and we are going to sing a song. When we are done, we are going to tickle the other ear and sing

Positional Testing

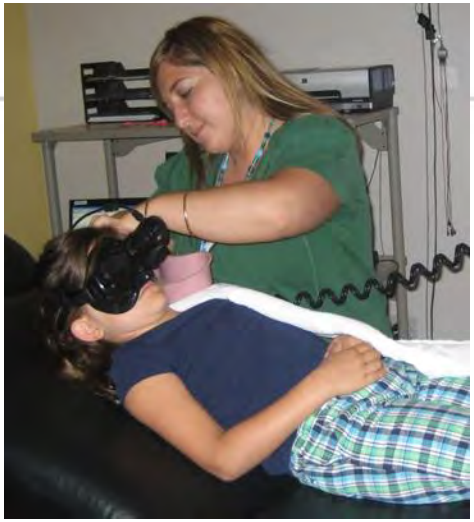
- 4 years and older
- Determine if certain positions elicit nystagmus
- Often non-localizing
- Normative data not established for children
- Most clinic consider positional nystagmus to be significant if it's persistent, >4-6 deg/sec and is in greater than 50% of positions
- Tasking for children: sing songs, play guessing games "what animal says "woof woof"
- The authors collective experience is when all other peripheral tests are normal, nystagmus without fixation can be a peripheral or central finding

Dix-Hallpike Test/Roll Test

- Assess for BPPV
- Not common in children
- Should be considered on patients who complain of positional vertigo
- Avoid on patients who have cervical or vascular issues
- Assess ability to rotate their head prior to testing

Ocular Motor Testing

- Best on ages 9 years or older
- Assess central vestibular ocular motor system
- Limited normative data in pediatrics
  - More artifact noted under age 7-attention
  - Smooth pursuit-lower gain and varied asymmetry
  - OPK-differences in asymmetry
  - Random saccade-longer saccadic latencies
- Infant and toddlers can be done as bedside exam as general observation of ocular motor function
  - Use finger puppet, light stick or sticker
  - Have patient sit on parent's lap facing out
  - Assess: Can the child move their eyes smoothly? Can they move their eyes quickly and accurately? Is nystagmus observed when they look left, right, up or down?
- 4-8 years
  - Can obtain using pediatric goggles
  - Skip if time and attention are limited
  - Use cartoon character as visual target if software allows
  - Shorten the recording time



Caloric Irrigations

- Age 8 and older, may be tolerated as young as 5
- Assess for vestibular weakness and side involvement
- Normative data-centers should establish their own norms. Responses in children tend to be more robust
- Use of monothermal screening
- Middle ear pathology or PE tubes need to be taking into consideration
- Air versus water
- May not perform if other tests confirm bilateral hypofunction or consider using ice water caloric
- Tasking for children: sing songs, play guessing games “what animal says “woof woof”

Pediatric Rotational Chair

Melissa Caine, AuD

Pediatric Rotational Chair

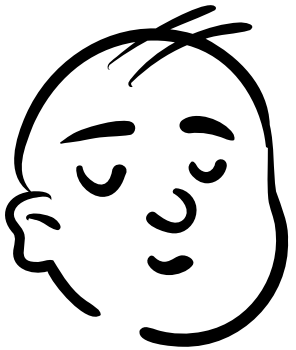
- Pediatric testing:
  - Sinusoidal harmonic acceleration (SHA)
  - Step velocity
  - VOR suppression

- Pediatric age range:
  - SHA & Step velocity: 10 months – adulthood
  - VOR Suppression: 7 years – adulthood

Sinusoidal Harmonic Acceleration

- Age range
  - 10 months – adulthood
  - VOR responses are present across all frequencies by 10 months

- Testing younger infants
  - Can be completed but any abnormalities found should be confirmed after 10 months
    - Rule out maturational factors

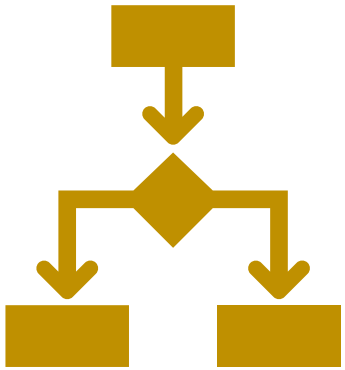


But What About Norms?

- Normative data available for ages 5 years through adulthood
- Testing centers are recommended to collect and establish normative data with their equipment and patient population
- Future multi-center study opportunities

Sinusoidal Harmonic Acceleration

- Assess at a minimum of three frequencies
  - Include a high, mid, and low frequency
- Results within control group reference range?
  - Testing complete
- Abnormal result at any frequency?
  - Repeat to ensure consistency
  - Test adjacent frequencies
- Complete tympanometry prior to testing
  - Impact of middle ear dysfunction



Sinusoidal Harmonic Acceleration

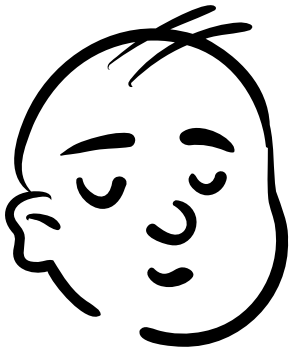
- Interpretation:
  - Gain:
    - High gain is considered an abnormal finding for children
    - Affected by fatigue, stress, anxiety, level of alertness, difficulty level of mental tasking
  - Phase:
    - Affected by head movement and goggle slippage
  - Gain symmetry:
    - Greater variability in children compared to adults
    - Still a reliable measurement

Pediatric Considerations

- Order of testing frequencies
  - Vary to increase comfort and compliance
  - Start with higher frequency to avoid provoking motion sickness
- Challenge:
  - Patients with motion intolerance, generalized anxiety disorders, or general nervousness during testing
- Modification:
  - Patience and empathy
  - Distraction
  - Mindfulness

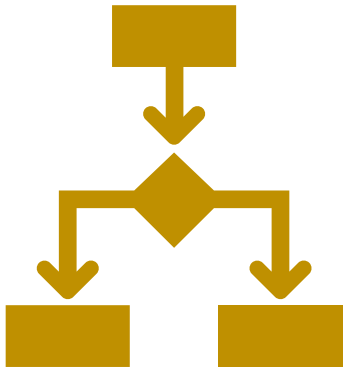
Step Velocity

- Age range
  - 10 months – adulthood
  - VOR responses are present across all frequencies by 10 months
- Testing younger infants
  - Can be completed but any abnormalities found should be confirmed after 10 months
    - Rule out maturational factors



Step Velocity

- Current research suggests that step velocity testing results in children should fall within established adult normative data
- Assessment at one rotational speed is recommended
  - 100 deg/sec is suitable for children
- Abnormal results should be repeated for consistency
- Complete tympanometry prior to testing
  - Impact of middle ear dysfunction

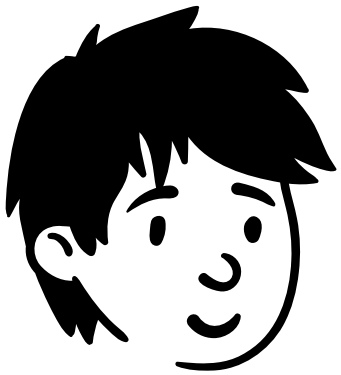


Step Velocity

- Interpretation:
  - Gain:
    - High gain is considered an abnormal finding for children
    - Affected by fatigue, stress, anxiety, level of alertness, difficulty level of mental tasking
  - Time constants:
    - Range of 11-26 seconds
  - Time constant symmetry:
    - Within 30%

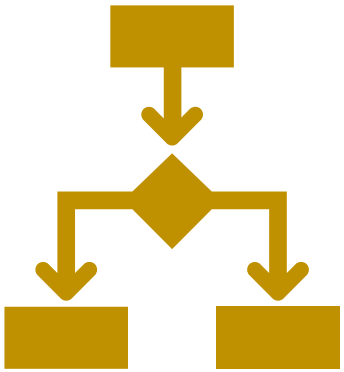
VOR Suppression

- Age range
  - 7 years through adulthood
    - Understanding of test instructions
    - Maintain visual focus on the target
- Lack of established pediatric normative data
  - In adults expected to be >70%
  - Greater variations in VOR suppression in children is possible given high VOR gain value in children



VOR Suppression

- Assessment at two frequencies is recommended
  - High frequency and low frequency
    - Select frequencies completed with SHA testing
    - Do not assess frequencies below 0.04 Hz
- Abnormal results should be repeated for consistency



Pediatric Considerations for Rotational Chair Testing

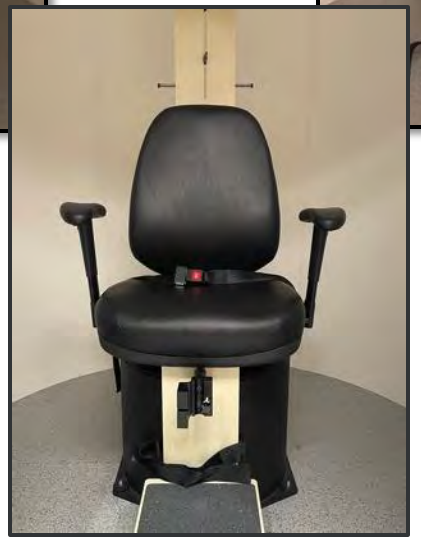
Melissa Caine, AuD

Calibration

- Complete standard calibration whenever possible
  - Ensure patient is age/developmental level to complete
  - Utilize default for infants and young children
  - Challenges with monocular goggles

Pediatric Seating

- Patients <40lbs
  - Car Seat
    - Designed for
    - chair use
  - Caregiver lap
- Patients >40lbs
  - Booster seat
  - Standard seat



Seating & Head Position

- Buckle up!
  - Must maintain secure and safe seated position
- Heads up!
  - Ensure horizontal canal is in lateral plane
  - Secured to avoid excessive movement
    - Hand-held
    - Velcro
- Eyes up (and open)!
  - Goggle placement
  - Infrared camera height

Testing Comfort

- Quiet hands!
  - Clinic
    - Balls, fidget toys, etc
    - Meet testing center's toy policy
  - Comfort items from home
    - Small hand-held toys
    - Blankets

- Lights out!
  - No light-up toys while testing
  - Remove light-up shoes
  - Smart watches
    - Caregivers, patients, and test assistants

Recording Methods

- Electronystagmography (ENG) electrodes
  - Ages:
    - Infants – young toddlers
  - Bitemporal montage
  - Challenge:
    - Electrode tolerance
  - Modification:
    - Electrode choice
    - Direction of leads
    - Distraction

Recording Methods

- Infrared camera
  - Ages:
    - Infants – young toddlers
    - Older children who cannot tolerate goggle or electrode placement
  - Limitations:
    - Subjective observation of the VOR only
      - No gain, phase, symmetry data
    - Cannot be used for VOR suppression

Recording Methods

- Monocular goggles
  - Generally fit children by 2 years of age
  - Challenge:
    - Goggle acceptance
  - Modification:
    - Consider hand-held placement
      - Likely not feasible for step velocity testing
    - Utilize caregiver for placement/retention

Recording Methods

- Binocular goggles
  - Made for adults!
  - Can be used if binocular recording is preferred
    - Ensure both eyes are centered
  - Challenge:
    - Potential gapping on patient's face
    - Compromising vision-denied state if not using an enclosed chair
  - Modification:
    - Adjust testing environment
    - Goggle padding


ARKSIDE
ANTHER

Tasking

- Distracted, aware, alert, motivated!
- Challenge:
  - Eyes open
  - Minimize eye blinking, shifting, crying
- Modifications:
  - Involve caregivers
  - Consider child's language and development level
    - Appropriate tasking speed and difficulty

Testing Environment

- Ensure light-free testing space
  - Rotational chair enclosure recommended
- Challenge:
  - Many children fear the dark
- Modification:
  - Allow visual assess as needed between testing cycles
    - Open enclosure door
    - Open monocular goggle cover
    - Light-emitting toy

Recommended Supplies

- Recording
  - Standard and pediatric goggles
  - Infrared camera
  - ENG electrodes and leads
- Seating
  - Car seat and booster seat
  - Willing caregivers
- Busy hands and moving heads
  - Quiet toys
- Communication with caregivers and/or testing assistants
  - Intercom
  - Wireless video camera

Pediatric Questionnaires

Pros: low cost, easy to administer
Cons: in children, parents have to report = BIAS

Violette Lavender, AuD

Questionnaires (standardized ages)

- **Birth -5**=Ages and Stages Gross Motor
- **Ages 5-12**= Dizziness Handicap Inventory
- **Ages 6-17** years= Pediatric Visually Induced Dizziness Questionnaire (PVID)
- **Ages 6-17** years= Pediatric Vestibular Symptoms Questionnaire (PVSQ)

Questionnaire

COMMUNICATION

	YES	SOMETIMES	NOT YET	
1. If you call to your baby when you are out of sight, does she look in the direction of your voice?	○	○	○	___
2. When a loud noise occurs, does your baby turn to see where the sound came from?	○	○	○	___
3 If you copy the sounds your baby makes, does your baby repeat the same sounds back to you?	○	○	○	___
4. Does your baby make sounds like "da," "ga," "ka," and "ba"?	○	○	○	___
5 Does your baby respond to the tone of your voice and stop his activity at least briefly when you say "no-no" to him?	○	○	○	___
6 Does your baby make two similar sounds like "ba-ba," "da-da," or "ga-ga"? *(The sounds do not need to mean anything.)*	○	○	○	___

COMMUNICATION TOTAL ___

GROSS MOTOR

	YES	SOMETIMES	NOT YET	
1. When you put your baby on the floor, does she lean on her hands while sitting? *(If she already sits up straight without leaning on her hands, mark "yes" for this item.)* 	X	○	○	___
2. Does your baby roll from his back to his tummy, getting both arms out from under him?	X	○	○	___

GROSS MOTOR *(continued)*

	YES	SOMETIMES	NOT YET	
3 Does your baby get into a crawling position by getting up on her hands and knees? 	X	X	○	___
4. If you hold both hands just to balance your baby, does he support his own weight while standing? 	○	X	○	___
5 When sitting on the floor, does your baby sit up straight for several minutes *without* using her hands for support? 	X	○	○	___*
6. When you stand your baby next to furniture or the crib rail, does he hold on without leaning his chest against the furniture for support? 	○	X	○	___

GROSS MOTOR TOTAL ___

**If Gross Motor Item 5 is marked "yes" or "sometimes," mark Gross Motor Item 1 "yes."*

FINE MOTOR

	YES	SOMETIMES	NOT YET	
1. Does your baby reach for a crumb or Cheerio and touch it with her finger or hand? *(If she already picks up a small object, mark "yes" for this item.)* 	○	○	○	___
2. Does your baby pick up a small toy, holding it in the center of his hand with his fingers around it? 	○	○	○	___
3. Does your baby *try* to pick up a crumb or Cheerio by using her thumb and all of her fingers in a raking motion, even if she isn't able to pick it up? *(If she already picks up a crumb or Cheerio, mark "yes" for this item.)* 	○	○	○	___
4. Does your baby pick up a small toy with only one hand? 	○	○	○	___

Scoring the ASQ

- Great for monitoring some milestone progress for children with CMV

1. **SCORE AND TRANSFER TOTALS TO CHART BELOW:** See *ASQ-3 User's Guide* for details, including how to adjust scores if item responses are missing. Score each item (YES = 10, SOMETIMES = 5, NOT YET = 0). Add item scores, and record each area total. In the chart below, transfer the total scores, and fill in the circles corresponding with the total scores.

Area	Cutoff	Total Score	0	5	10	15	20	25	30	35	40	45	50	55	60
Communication	33.06		●	●	●	●	●	●	●	○	○	○	○	○	○
Gross Motor	30.61		●	●	●	●	●	●	●	○	○	○	●	○	○
Fine Motor	40 15		●	●	●	●	●	●	●	●	○	○	○	○	○
Problem Solving	36.17		●	●	●	●	●	●	●	●	○	○	○	○	○
Personal-Social	35 84		●	●	●	●	●	●	●	●	○	○	○	○	○

Screening Questionnaires

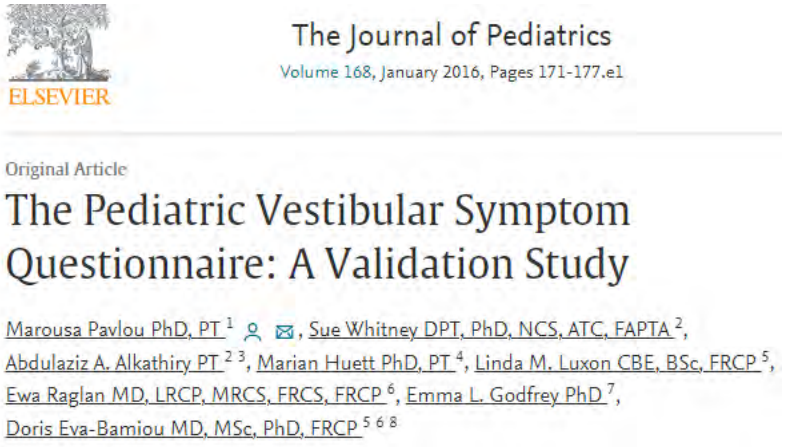
- **Vanderbilt Pediatric Dizziness Handicap Inventory (DHI-PC)**
  - 21 items
  - Yes, no or sometimes
  - Parent/ caregivers
  - Ages 5-12
  - Quantify subjective handicap of dizziness
- McCaslin DL, Jacobson GP, Lambert W, English LN, Kemph AJ (2015). "The development of the vanderbilt pediatric dizziness handicap inventory for patient caregivers (DHI-PC)." *Int J Pediatr Otorhinolaryngol.* 79 (10): p1662-1666

Answer each question as it pertains to your child's dizziness problem only.

	Yes (4)	Sometimes (2)	No (0)
1. Does your child's problem make him/her feel tired?			
2. Is your child's life ruled by his/her problem?			
3. Does your child's problem make it difficult for him/her to play?			
4. Because of his/her problem, does your child feel frustrated?			
5. Because of his/her problem, has your child been embarrassed in front of others?			
6. Because of his/her problem, is it difficult for your child to concentrate?			
7. Because of his/her problem, is your child tense?			
8. Do other people seem irritated with your child's problem?			
9. Because of his/her problem, does your child worry?			
10. Because of his/her problem, does your child feel angry?			
11. Because of his/her problem, does your child feel "down"?			
12. Because of his/her problem, does your child feel unhappy?			
13. Because of his/her problem, does your child feel different from other children?			
14. Does your child's problem significantly restrict his/her participation in social or educational activities, such as going to dinner, meeting with friends, field trips, or to parties?			

Screening Questionnaires

- **Pediatric Vestibular Symptoms Questionnaire**
  - 11 questions
  - Ages 6-17
  - Quantify subjective vestibular symptom (ie, dizziness, unsteadiness) severity in children



ELSEVIER

The Journal of Pediatrics
Volume 168, January 2016, Pages 171-177.e1

Original Article

The Pediatric Vestibular Symptom Questionnaire: A Validation Study

Marousa Pavlou PhD, PT [1], Sue Whitney DPT, PhD, NCS, ATC, FAPTA [2], Abdulaziz A. Alkathiry PT [2 3], Marian Huett PhD, PT [4], Linda M. Luxon CBE, BSc, FRCP [5], Ewa Raglan MD, LRCP, MRCS, FRCS, FRCP [6], Emma L. Godfrey PhD [7], Doris Eva-Bamiou MD, MSc, PhD, FRCP [5 6 8]

Table I. The PVSQ

The following questions ask about how often you feel dizziness and unsteadiness. Please circle the best answer for you.

How often in the past month have you felt the following?

1. A feeling that things are spinning or moving around

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

2. Unsteadiness so bad that you actually fall

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

3. Feeling sick

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

4. A light-headed or swimmy feeling in the head

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

5. Feeling of pressure in the ear(s)

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

6. Blurry vision, difficulty seeing things clearly, and/or spots before the eyes

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

7. Headache or feeling of pressure in the head

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

8. Unable to stand or walk without holding on to something or someone

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

9. Feeling unsteady, about to lose balance

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

10. A fuzzy or cotton wool feeling in the head

3	2	3	4	?
Most of the time	Sometimes	Almost never	Never	Don't know

11. Do any of these symptoms stop you doing what you want to do?

If yes, which ones? .....

Screening Questionnaires

- Pediatric Visually Induced Dizziness Questionnaire
  - 11 items
  - Ages 6-17
  - Quantify the presence and severity of visually induced dizziness

Front. Neurol., 05 December 2017
Sec. Neuro-Otology
Volume 8 - 2017 | https://doi.org/10.3389/fneur.2017.00658

Visually Induced Dizziness in Children and Validation of the Pediatric Visually Induced Dizziness Questionnaire

Marousa Pavlou[1]*, Susan L. Whitney[2], Abdulaziz A. Alkathiry[2,3], Marian Huett[4], Linda M. Luxon[5], Ewa Raglan[6], Emma L. Godfrey[7] and Doris-Eva Bamiou[5,6,8]

The following questions ask about how often you feel dizziness and unsteadiness in different places and situations. Please circle the best answer for you.

How often in the past month have you felt the following?

1. Riding in a car

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

2. Walking down a supermarket aisle or in a busy shop

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

3. Standing in the middle of a wide open space (e.g., large football field or square)

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

4. Watching T.V. or at the cinema

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

5. Riding on a bus

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

6. Looking at striped or moving surface (e.g., curtains, flowing water)

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

7. Using the computer (e.g., emails, computer games)

3	2	1	0	?
MOST OF THE TIME	SOMETIMES	ALMOST NEVER	NEVER	DON'T KNOW

8. Watching moving traffic or trains (e.g., trying to cross the street or at the station)

Conclusions

Takeaways for the Consensus Document

- Table presented may be a useful deskside companion
- Again, not required to do all tests; rather, tools for the job
- Document points to resources and provides normative data
- Tips and tricks shared for each area of testing

Notes

- Expected publication JAAA Spring 2025
- Opportunities to amend and grow the document
- Does not include vestibular rehabilitation or treatment options

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Thank You!

Questions?

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