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CONTINUED SEMINARS IN Hearing

Cochlear Implants and Children with Vestibular Impairments

SickKids COCHLEAR IMPLANT PROGRAM

Sharon L. Cushing

CONTINUED SEMINARS IN Hearing

Sharon Cushing
MD FRCSC

Dr. Sharon Cushing is a full time pediatric otolaryngologist at The Hospital for Sick Children in Toronto, Canada, and an Associate Professor and Clinician Investigator in the Department of Otolaryngology Head and Neck Surgery at the University of Toronto. She is the Director of the Cochlear Implant Program at the Hospital for Sick Children.

Dr. Cushing has a clinical and surgical interest in disorders of the external, middle and inner ear, including hearing loss and vestibular dysfunction. Her research interest include vestibular and balance function and dysfunction in children, and its association with hearing loss and cochlear implantation.

CONTINUED SEMINARS IN Hearing

Disclosures

- **Presenter Disclosure**: Financial: Sharon Cushing is employed by the Hospital for Sick Children in Toronto, Canada, and is an Associate Professor and Clinician Investigator in the Department of Otolaryngology-Head and Neck Surgery at the University of Toronto. She has a sponsored research agreement for Cochlear Corporation and is on their speaker's bureau. She is on Interacoustics' speaker's bureau. She receives royalties from Plural Publishing for the Manual of Pediatric Balance Disorder. She received an honorarium for this presentation. Non-financial: Sharon Cushing has received Patent #: 7041-0: Systems And Methods For Balance Stabilization.
- **Content Disclosure**: This learning event does not focus exclusively on any specific product or service.
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- SickKids Foundation

CIHR IRSC

SickKids FOUNDATION

Ontario

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- Valerie Simard
- Rebecca Malcomson
- Joelene Huber
- Gillian Lieberman

CONTINUED SEMINARS IN Hearing

Learning Outcomes

- After this course, participants will be able to
  1. Describe the reciprocal impact of cochlear implants on vestibular function and vice versa.
  2. Discuss which etiologies of SNHL are most likely to have associated vestibular impairment.
  3. Describe the signs and symptoms as well as diagnostics tests that can facilitate a diagnosis of vestibular impairment.

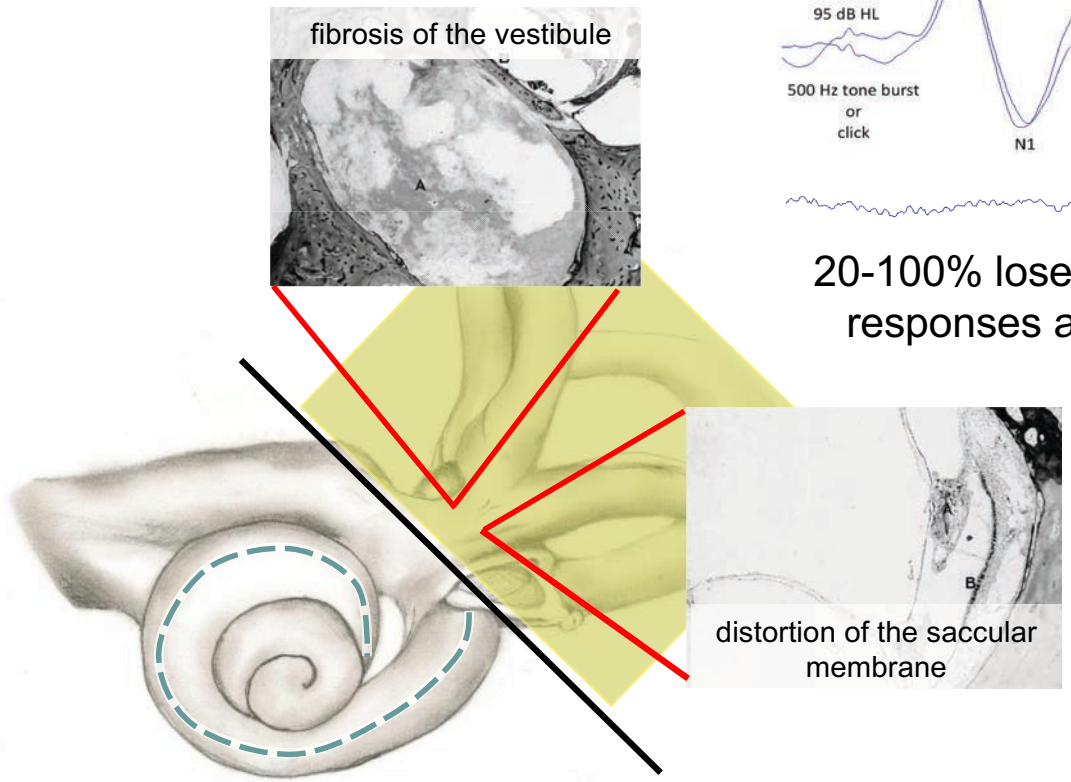
CONTINUED SEMINARS IN Hearing

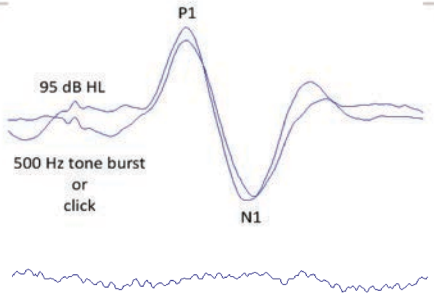
Outline

- vestibular & balance dysfunction
  - common in SNHL
- impact of dysfunction
- screening for vestibular dysfunction

CONTINUED Seminars in Hearing

Vestibular Effects of Cochlear Implantation (*negative*)



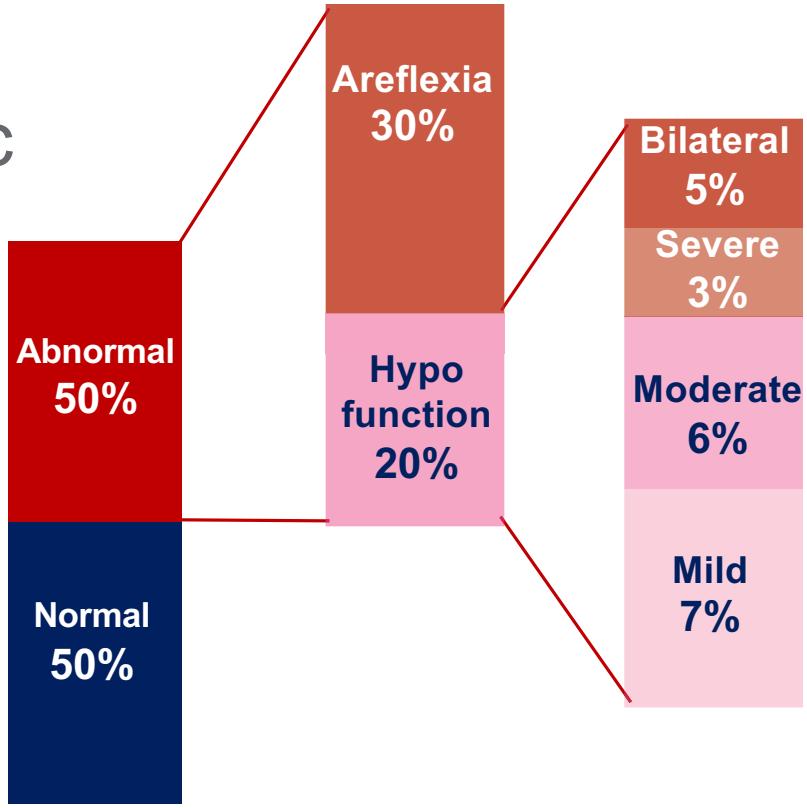


20-100% lose cVEMP responses after CI

Tien et al, 2002

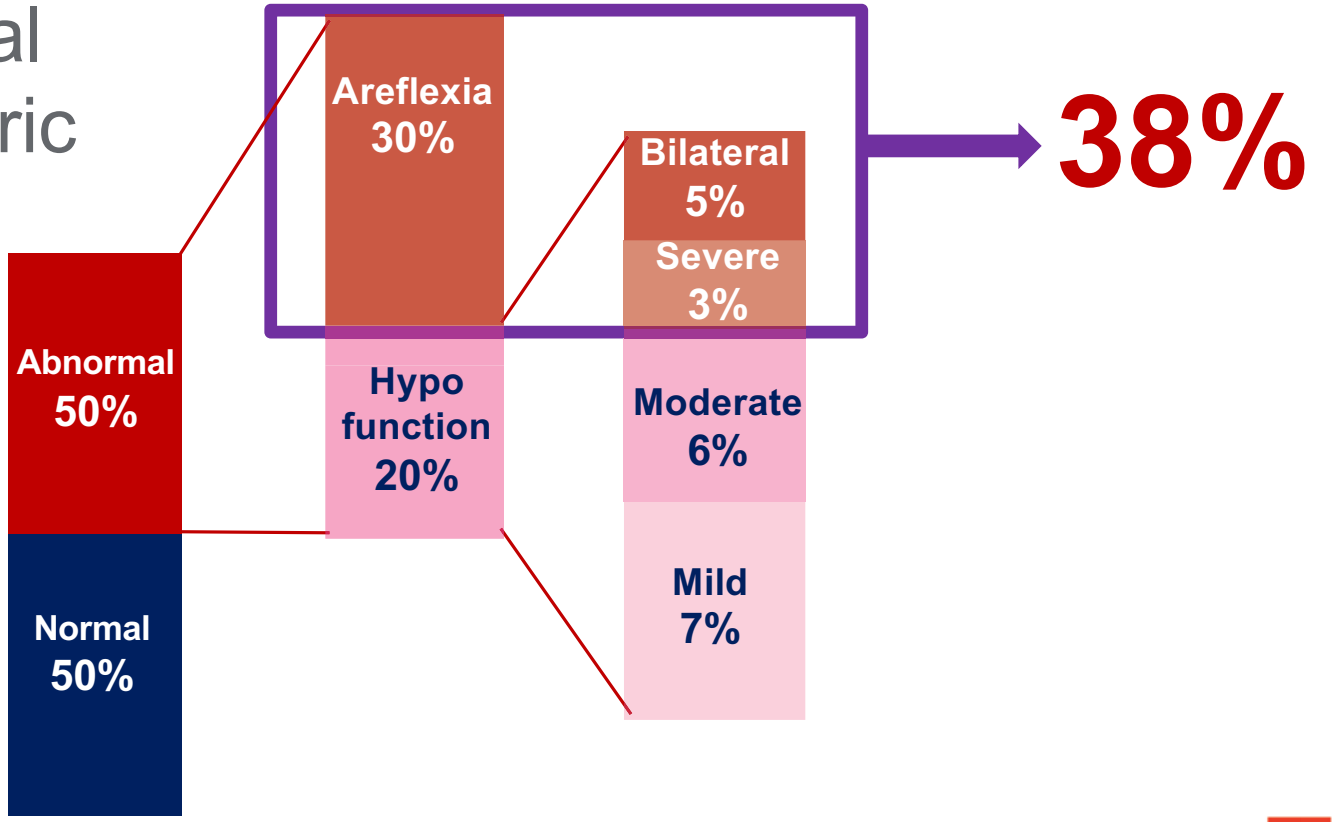
Q7

Horizontal Canal Function - Caloric



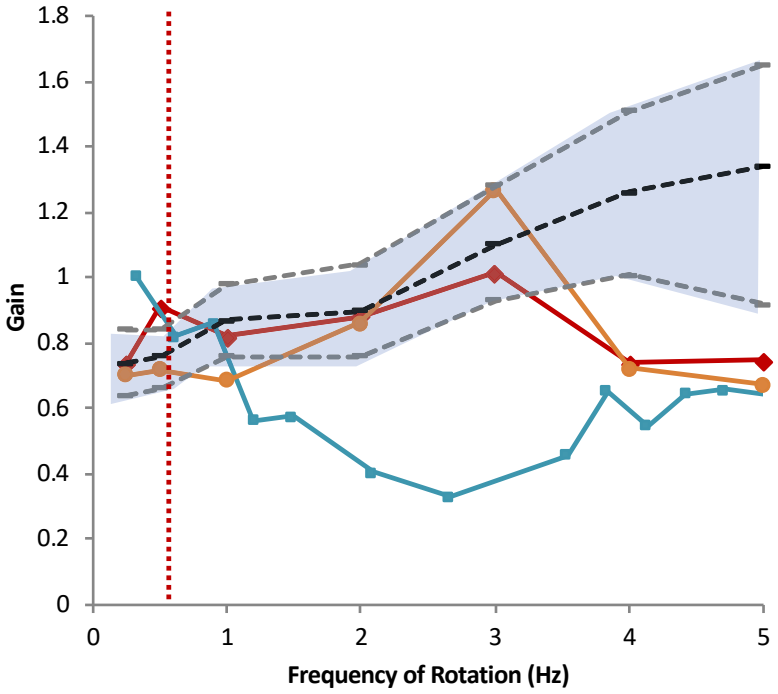
Otol Neurotol. 2013

Horizontal Canal Function - Caloric



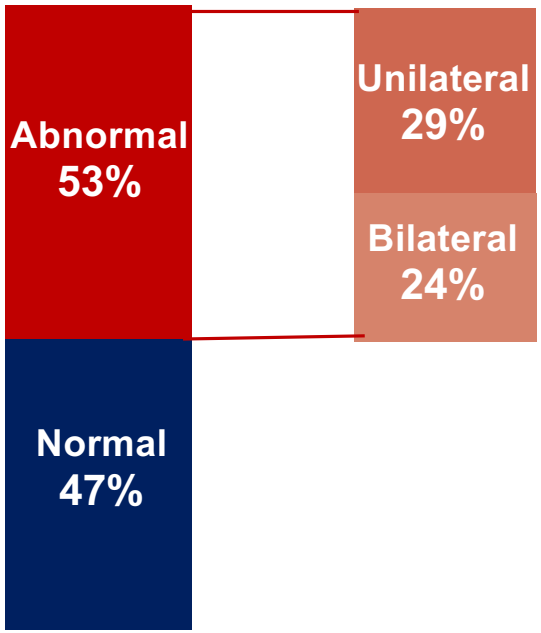
Otol Neurotol. 2013

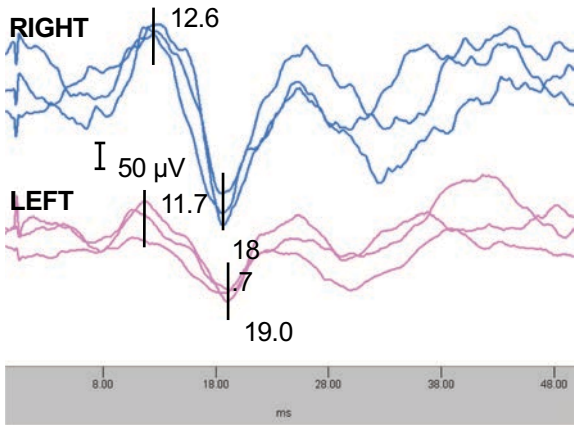
Horizontal Canal Function - Rotation



Otol Neurotol. 2013

Saccular Function - cVEMP



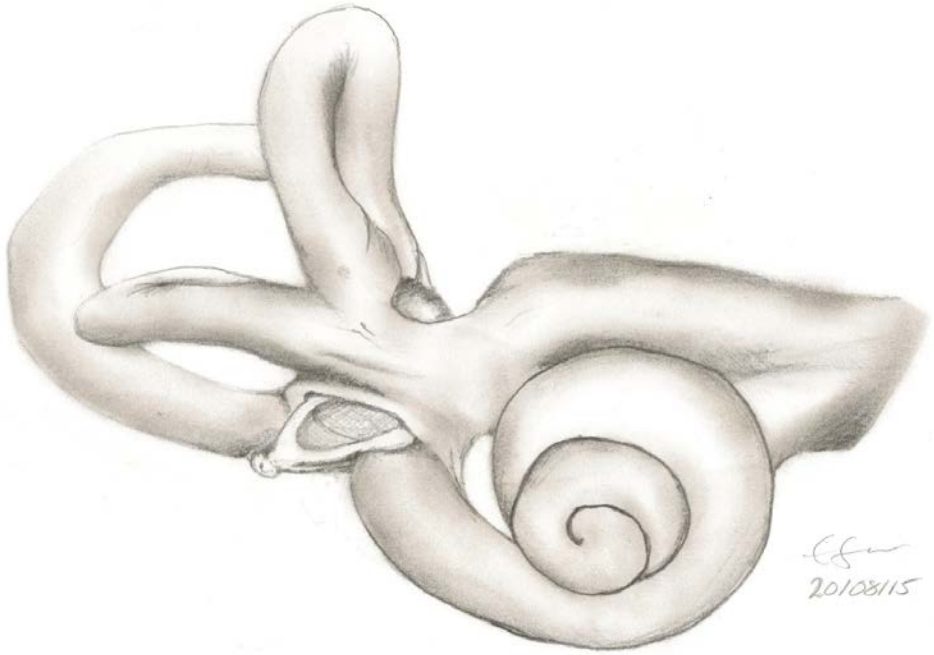


Otol Neurotol. 2013

Vestibular Dysfunction is Common in Children with SNHL

70% dysfunction

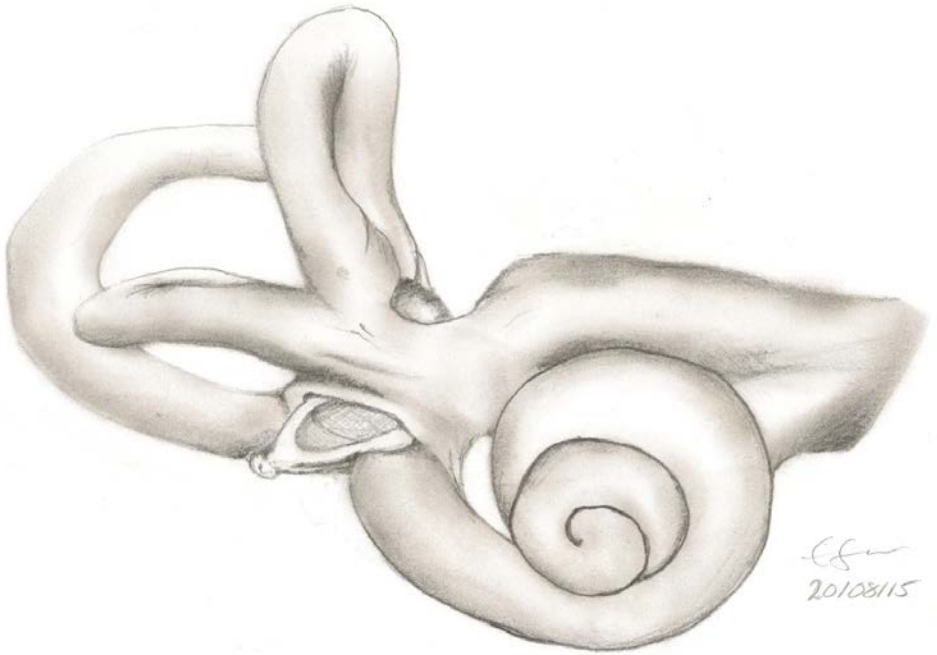
35-40% complete areflexia



Otol Neurotol. 2013

CONTINUED SEMINARS IN Hearing

Vestibular Dysfunction is Common in Children with SNHL



70% dysfunction

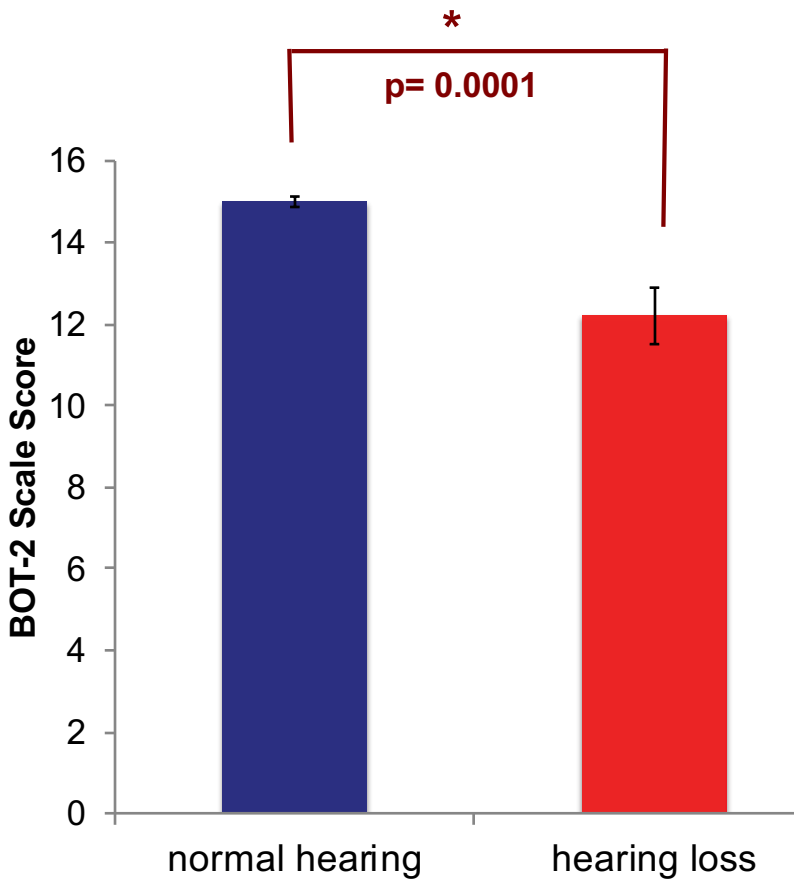
35-40% complete areflexia

vestibular impairment is the single most common associated feature of SNHL

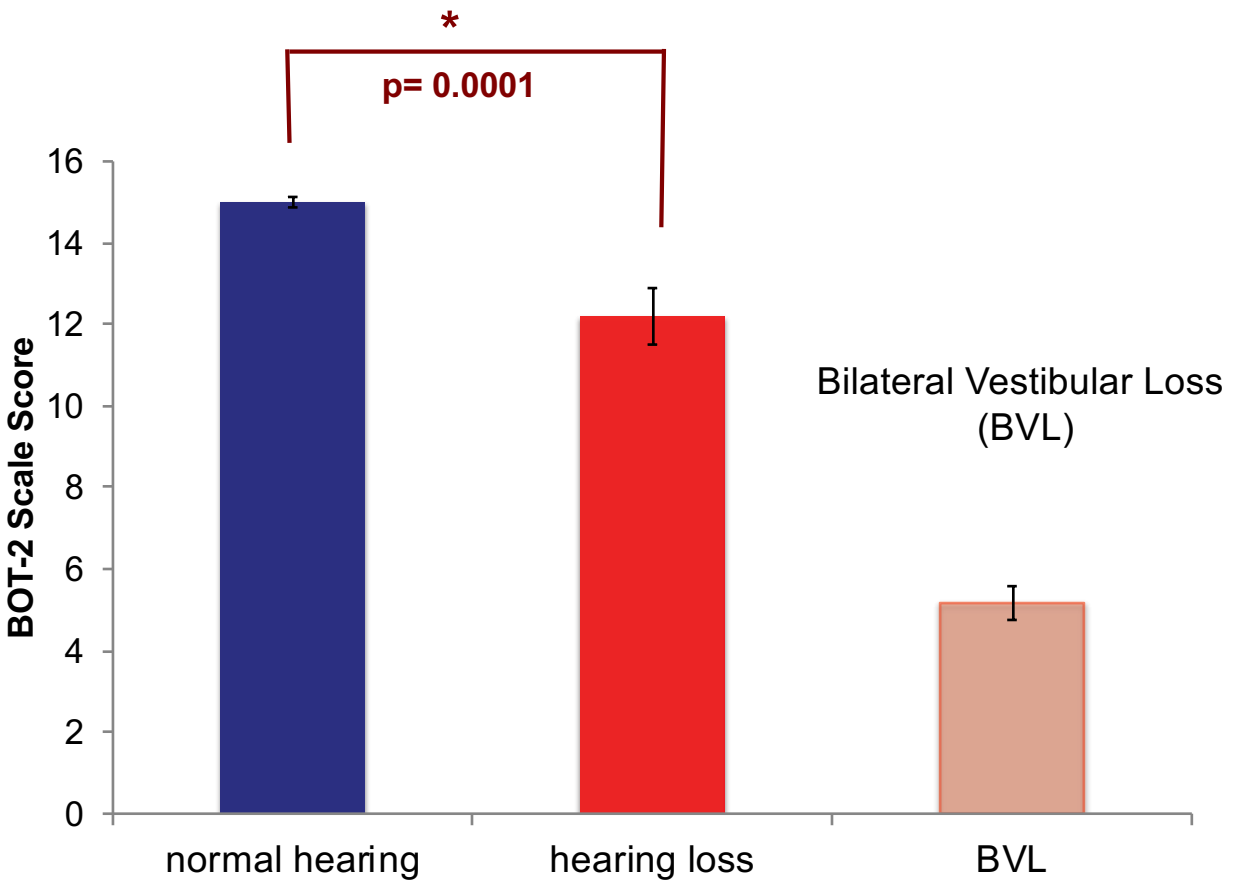
Otol Neurotol. 2013

Q8

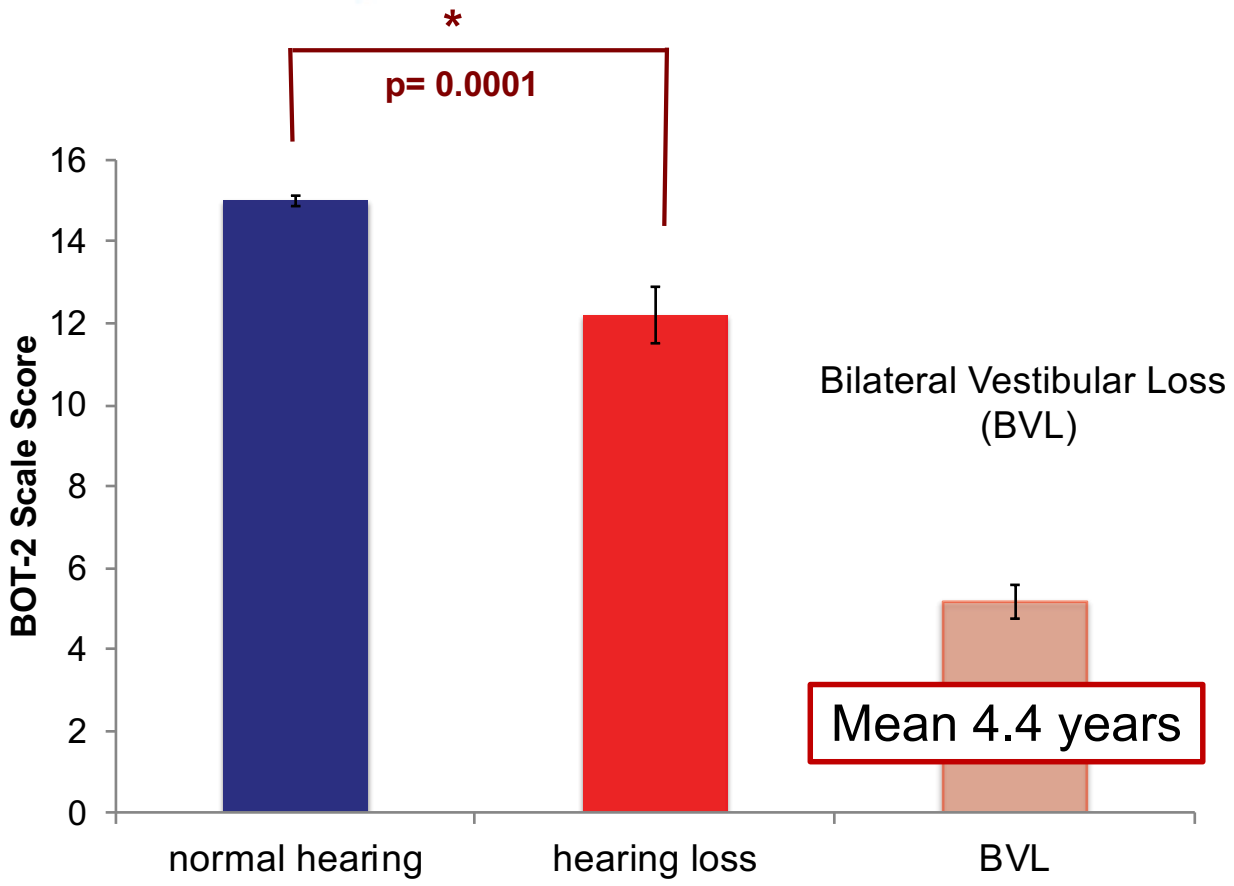
Vestibular Loss Impacts Balance



Vestibular Loss Impacts Balance



Vestibular Loss Impacts Balance



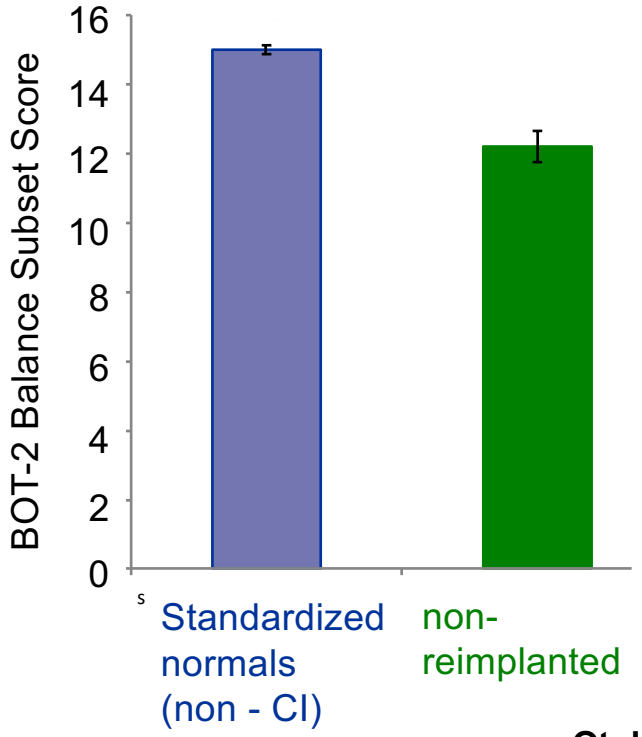
Q2

Vestibular Loss Impacts Balance

balance deficits are not always apparent

When Balance is Poor – Implants Fail

- static and dynamic balance – BOT-2

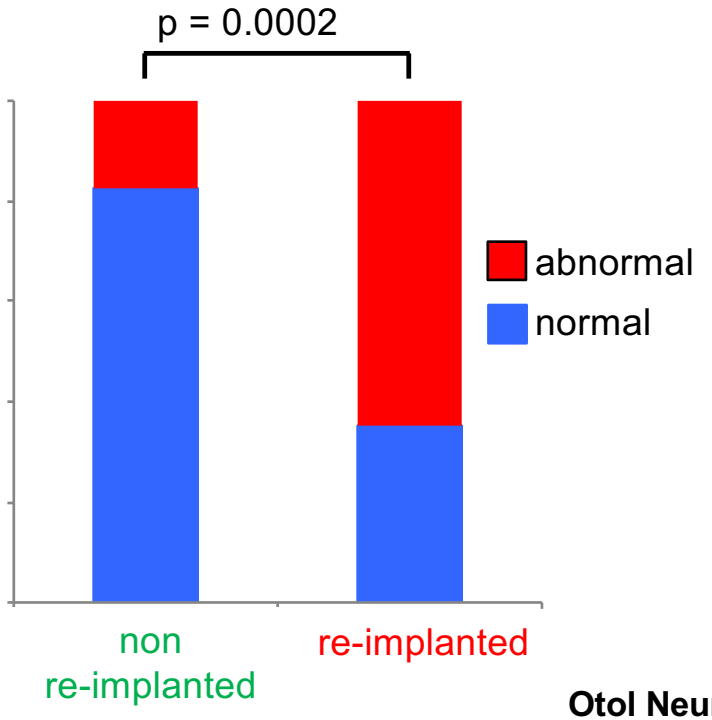


Otol Neurotol. 2015

Q6

When Vestibular Function is Poor – Implants Fail

bilateral areflexia



Otol Neurotol. 2015

Q6

CONTINUED SEMINARS IN Hearing

When Vestibular Function is Poor – Implants Fail

vestibular & balance dysfunction α risk of CI failure

Bilateral Areflexia

Odds ratio: 8.6

Implant failure

Otol Neurotol. 2015

Q6

CONTINUED SEMINARS IN Hearing

Vestibular and Balance Dysfunction Risk by Etiology

- Cochleovestibular anomalies
  - Phelps
  - Waardenburg
  - Klippel Feil
  - Pendred
- Ototoxicity
- Usher Syndrome
- Meningitis

- CMV
- ANSD

- Connexin
- Mitochondrial?
- Autoimmune?

Q1

CONTINUED SEMINARS IN Hearing

Vestibular and Balance Dysfunction Risk by Etiology

- Cochleovestibular anomalies
  - Phelps
  - Waardenburg
  - Klippel Feil
  - Pendred
- Ototoxicity
- Usher Syndrome
- Meningitis

- CMV
- ANSD

- Connexin
- Mitochondrial?
- Autoimmune?

Q1

Ototoxicity in Cancer

cochleotoxicity ≈ vestibulotoxicity

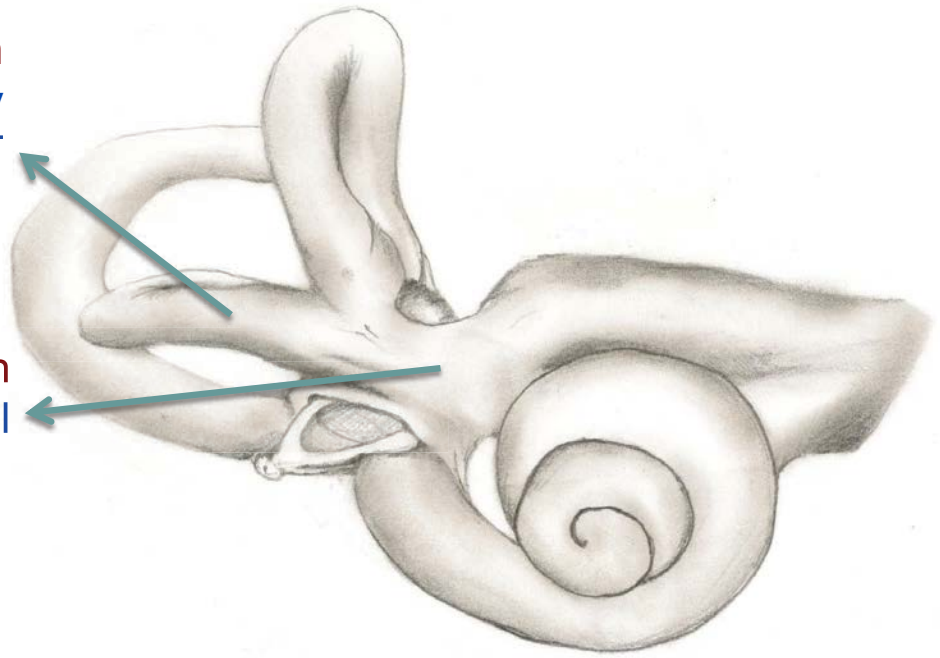
25-90% ?

platinum based therapy
aminoglycosides
cranial radiation
surgical therapy

Vestibular Impairment from Ototoxicity

Horizontal Canal Dysfunction
44% Dynamic Visual Acuity
51% VOR loss vHIT

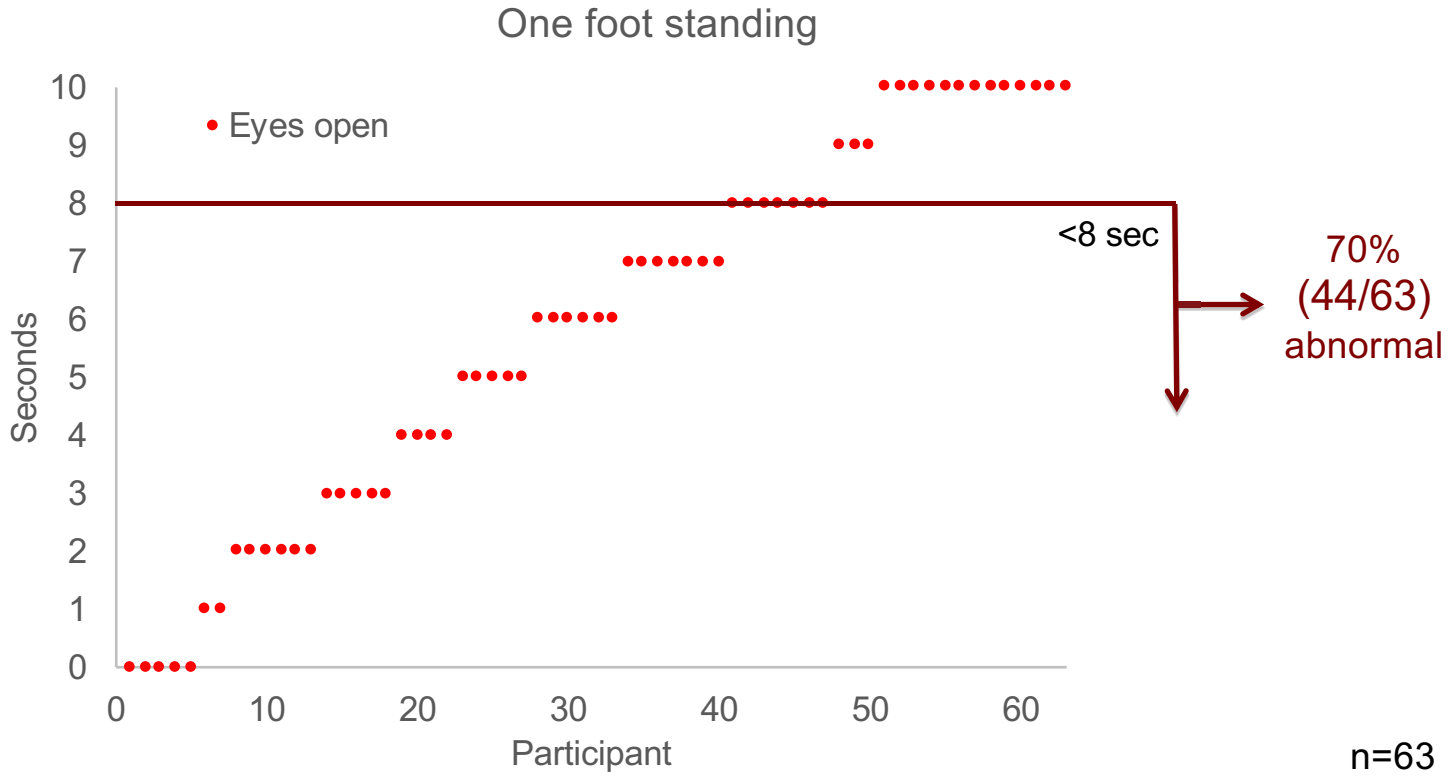
59% Utricular Dysfunction
Subjective Visual Vertical



N = 63

Q7

Ototoxicity Related Balance Impairment



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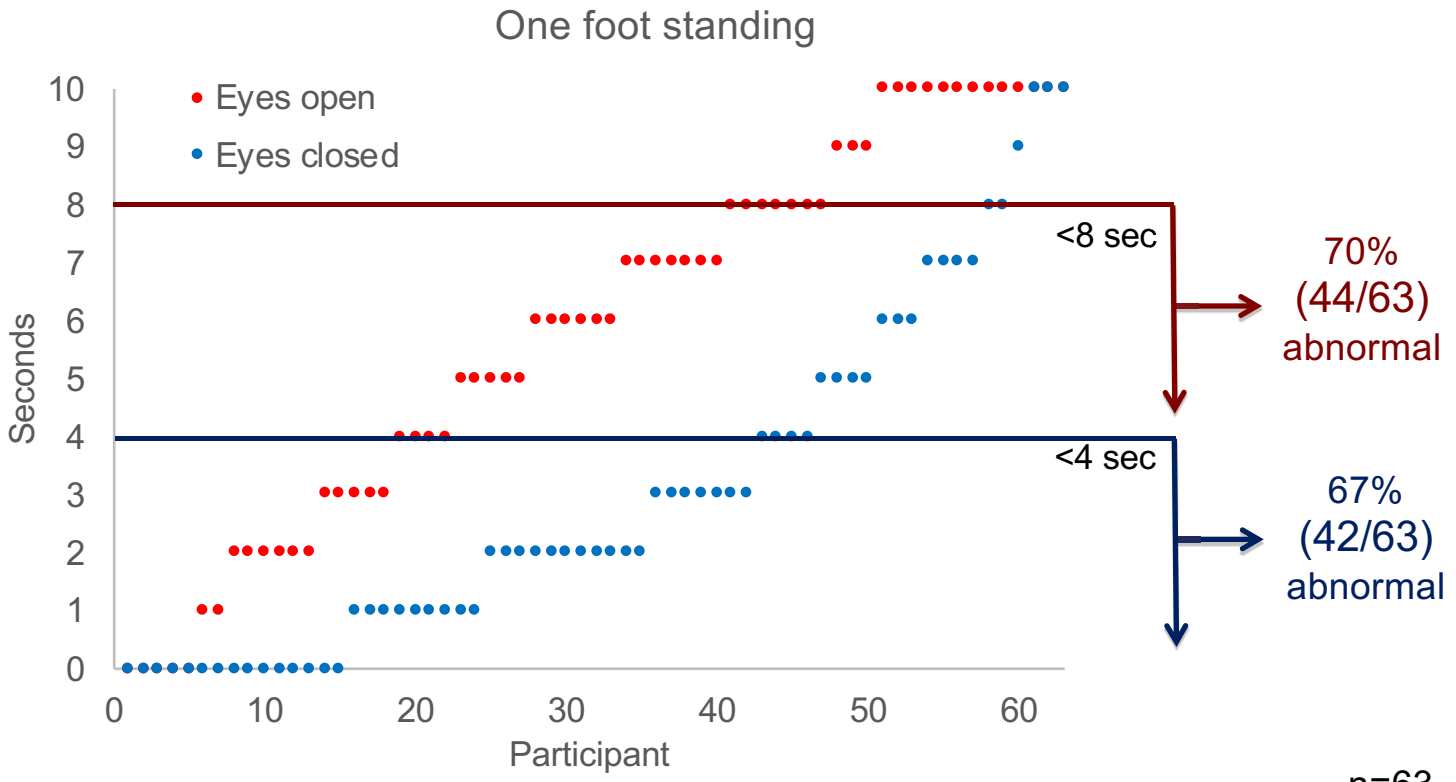
Q9

Ototoxicity Related Balance Impairment



n=63

Q9

CONTINUED SEMINARS IN Hearing

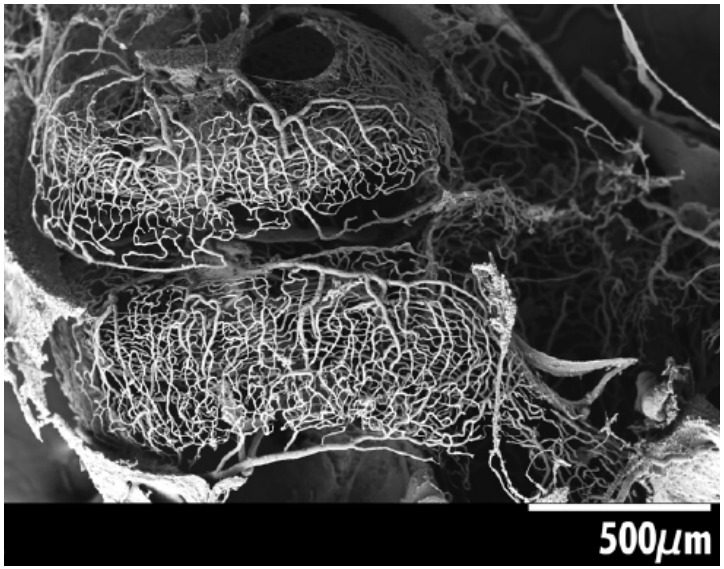
Ototoxicity in Cancer

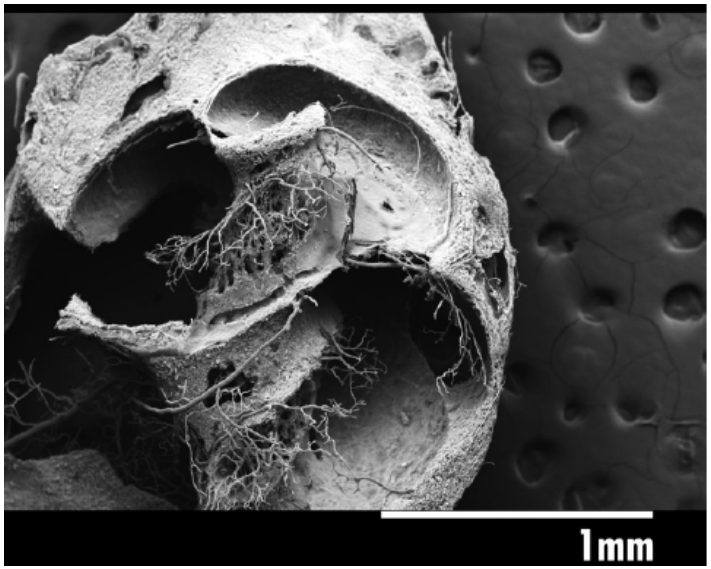
cochleotoxicity ≈ vestibulotoxicity ≈ balance impairment

25-90% | 50% | 70%

platinum based therapy
aminoglycosides
cranial radiation
surgical therapy

Congenital Cytomegalovirus

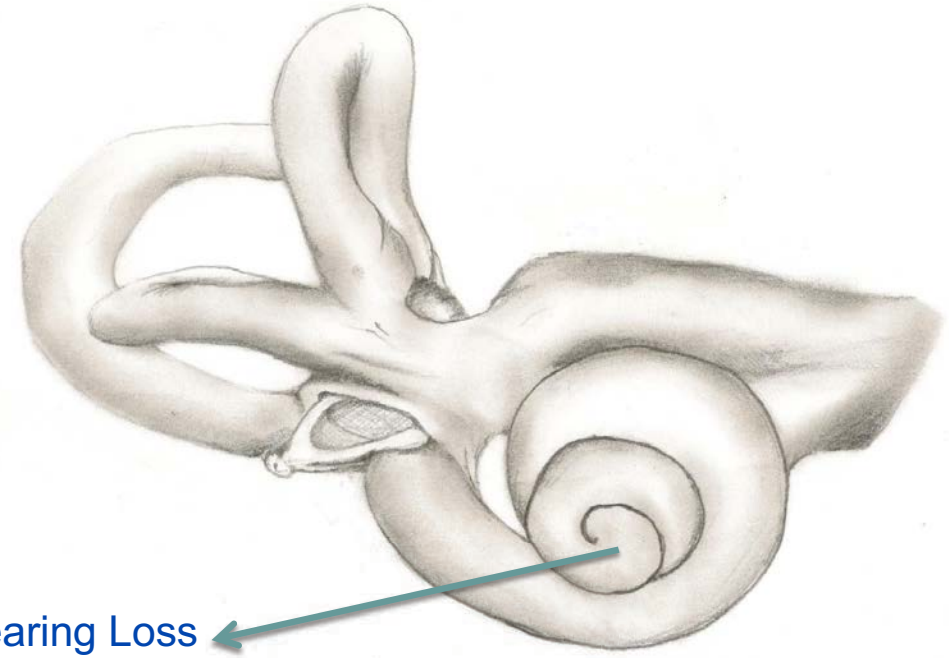




photos courtesy of Dr. Robert Harrison

CONTINUED SEMINARS IN Hearing

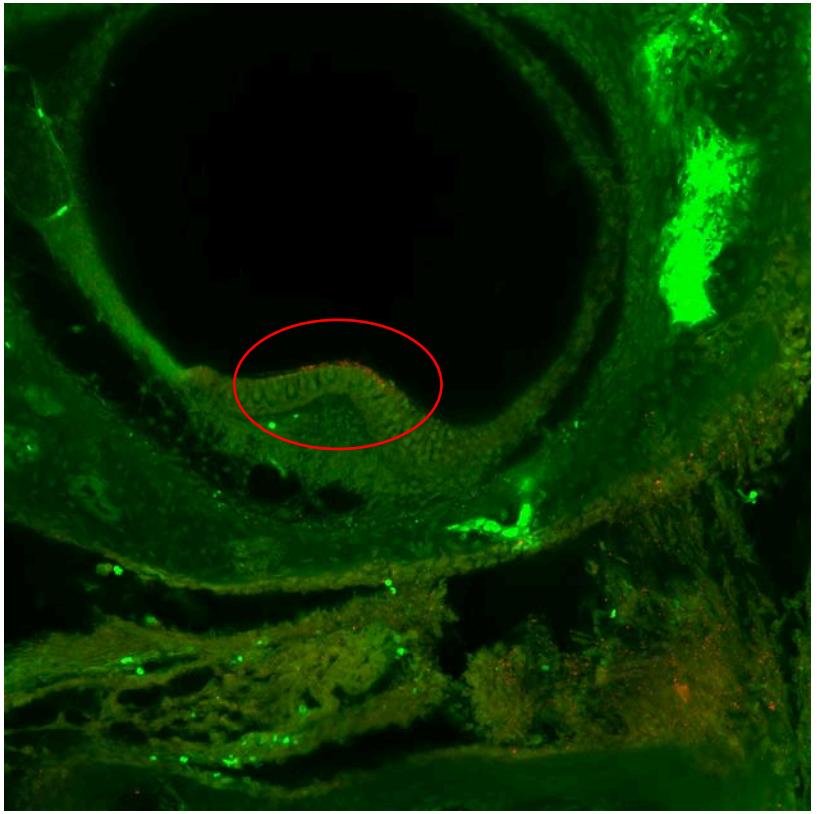
Congenital Cytomegalovirus



20-50% Sensorineural Hearing Loss

Q7

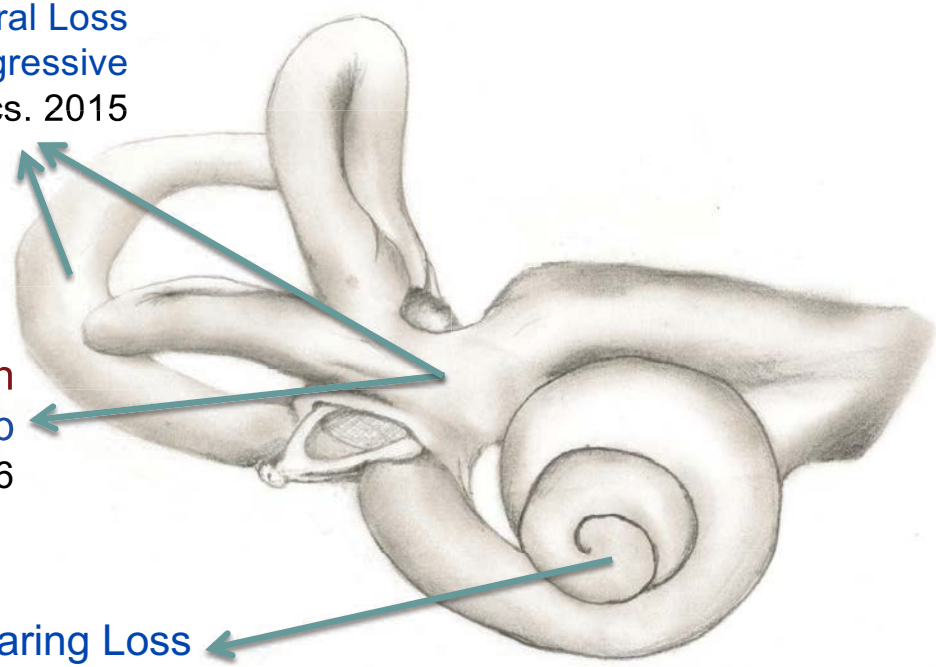
Congenital Cytomegalovirus



photos courtesy of Dr. Robert Harrison

Congenital Cytomegalovirus

92% Vestibular end-organ Dysfunction
33% Complete Bilateral Loss
50% Progressive
Bernard et al. Pediatrics. 2015

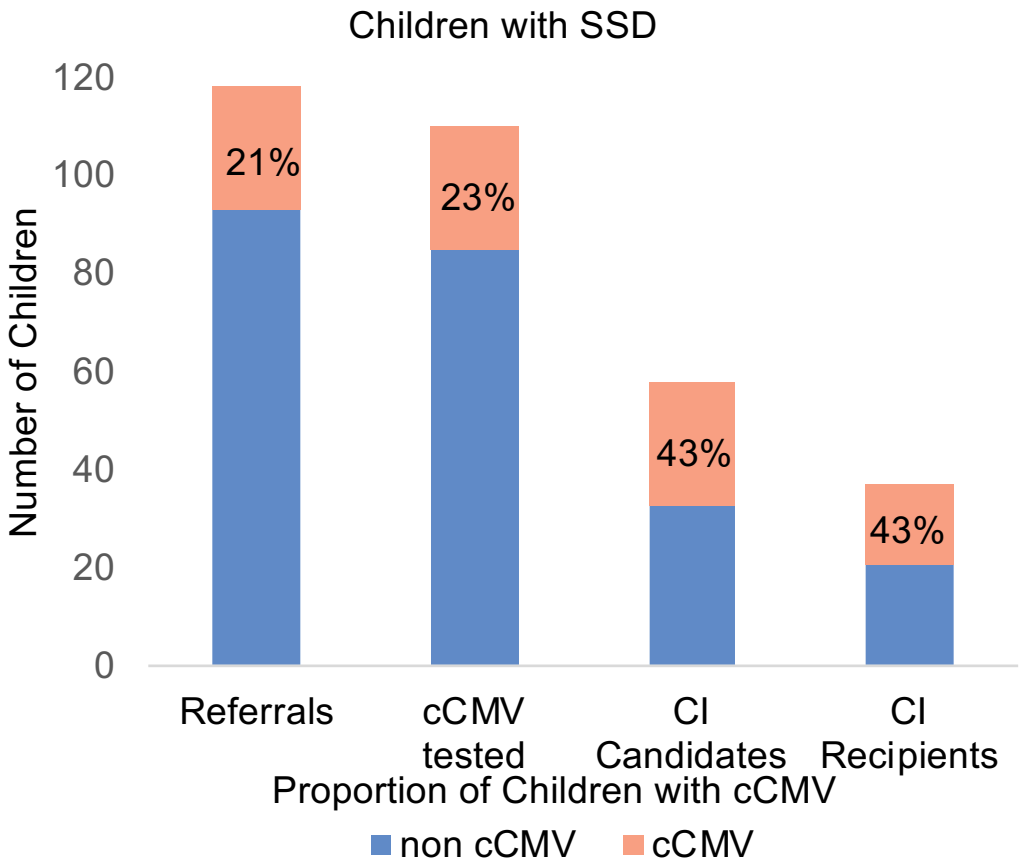


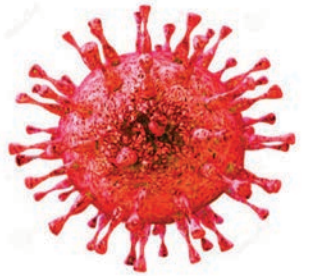
50% Otolithic Dysfunction
cVemp
Maes, Ear & Hearing. 2016

20-50% Sensorineural Hearing Loss

Q7

cCMV is Common in SSD

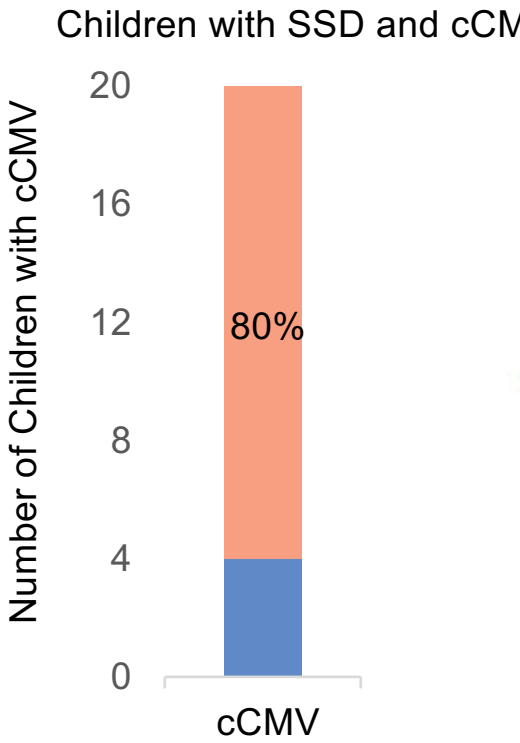


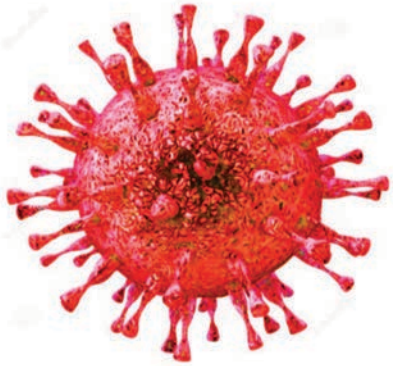


HNO. 2019

CONTINUED SEMINARS IN Hearing

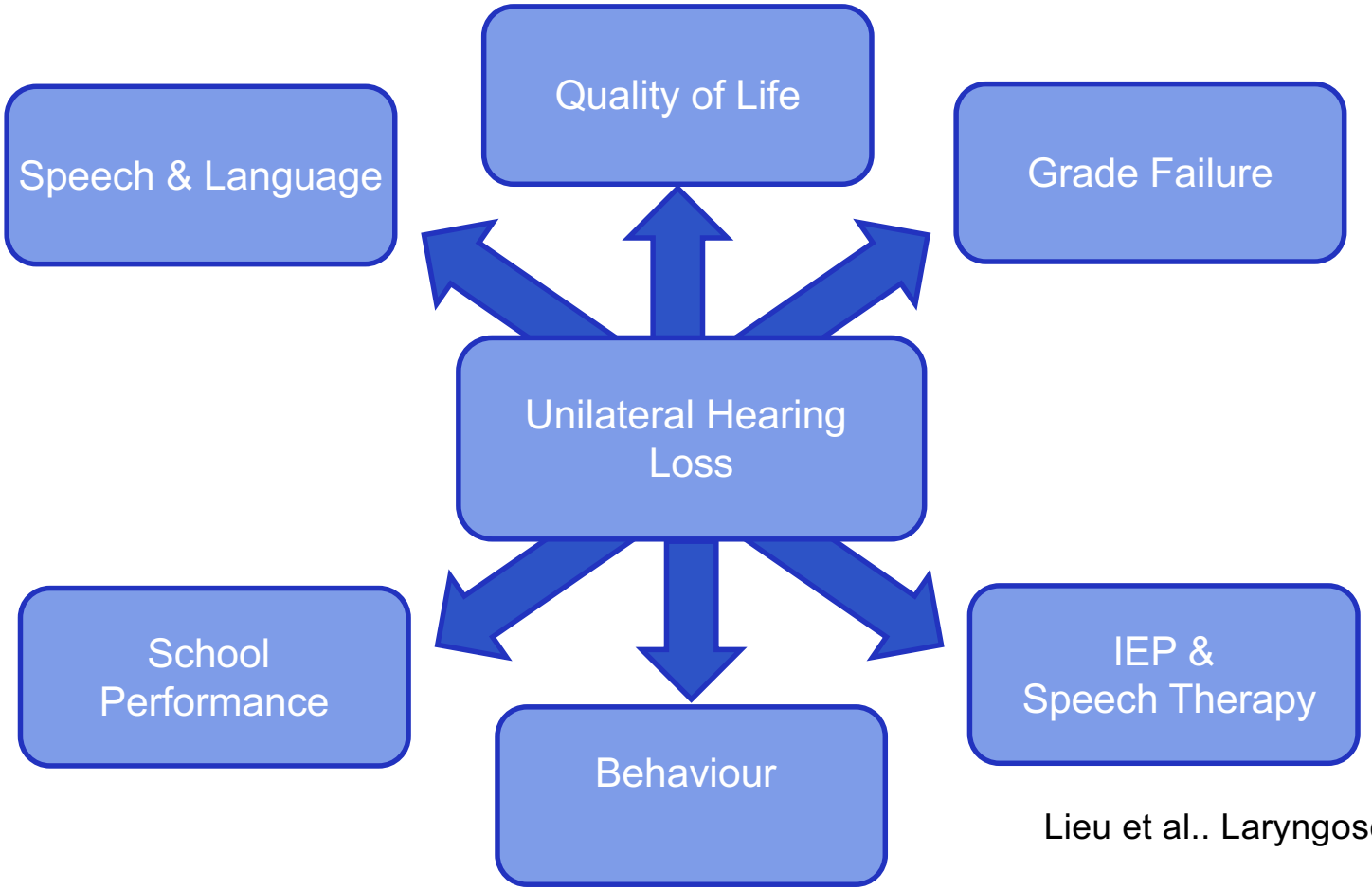
Children with cCMV Proceed to Implant





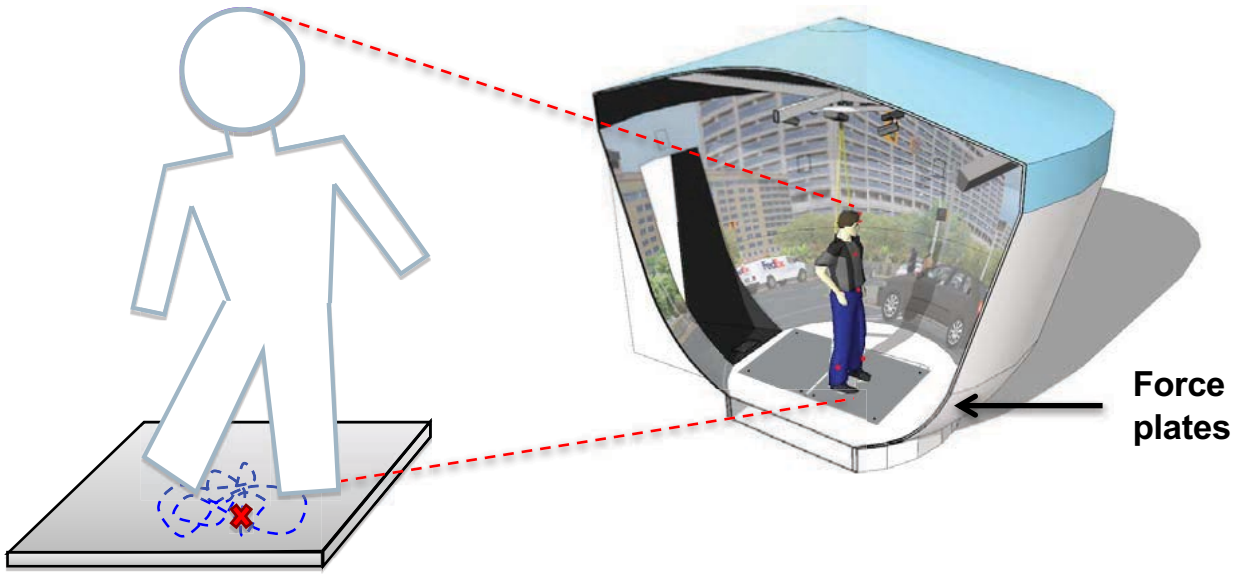
HNO. 2019

Consequences of SSD in Children

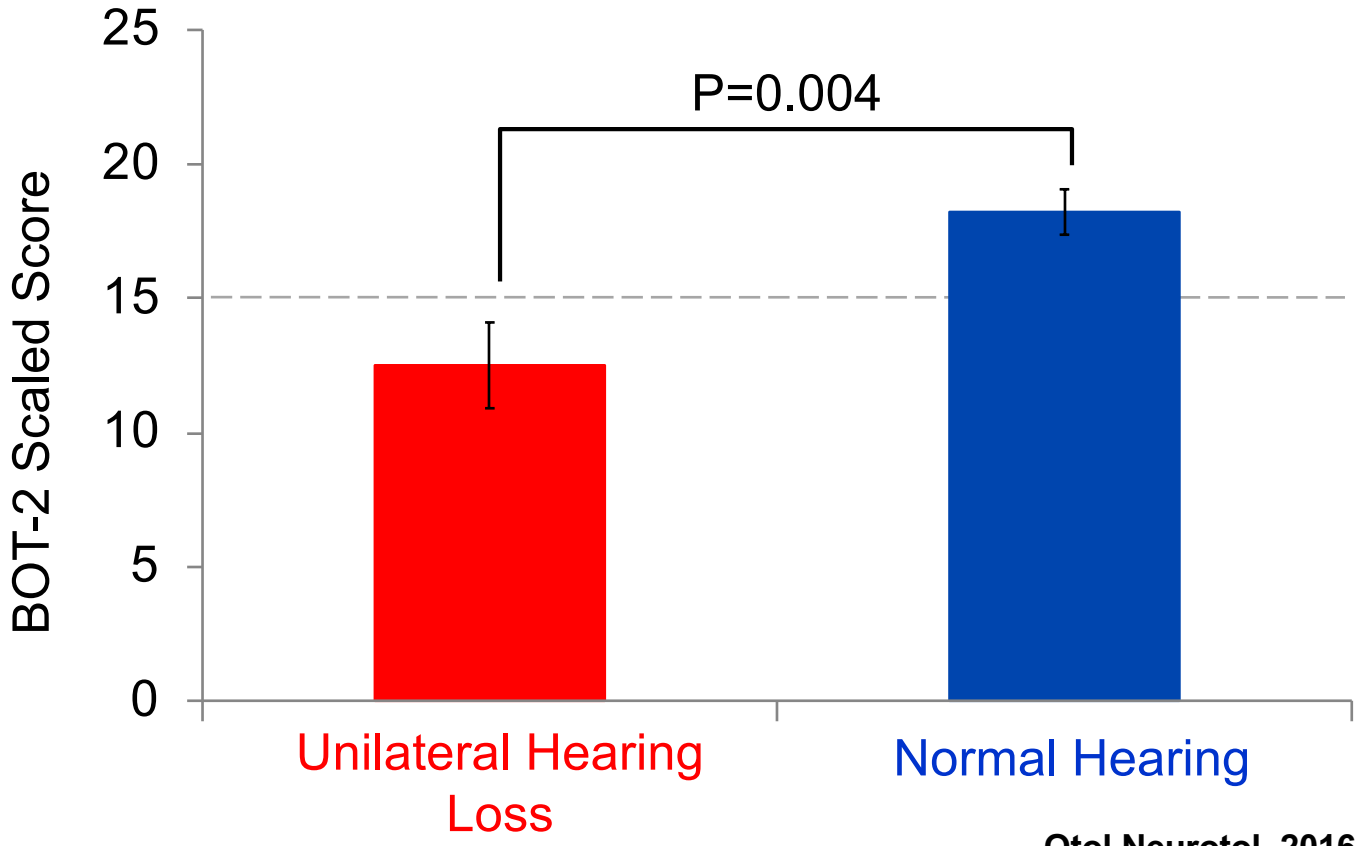


Lieu et al.. Laryngoscope. 2012

Measuring Balance Impairment



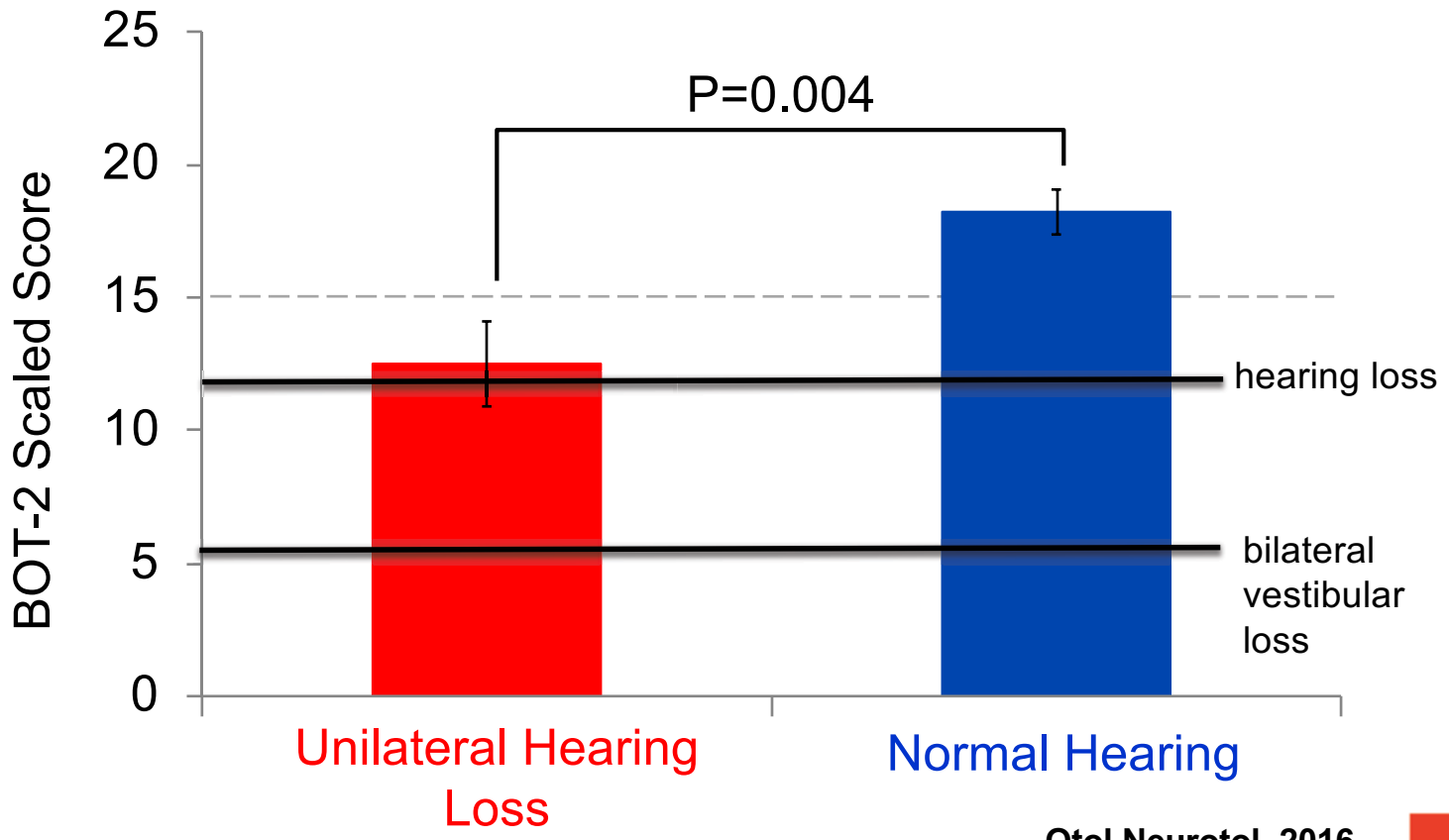
Balance is Impaired in SSD



Otol Neurotol. 2016

CONTINUED SEMINARS IN Hearing

Balance is Impaired in SSD



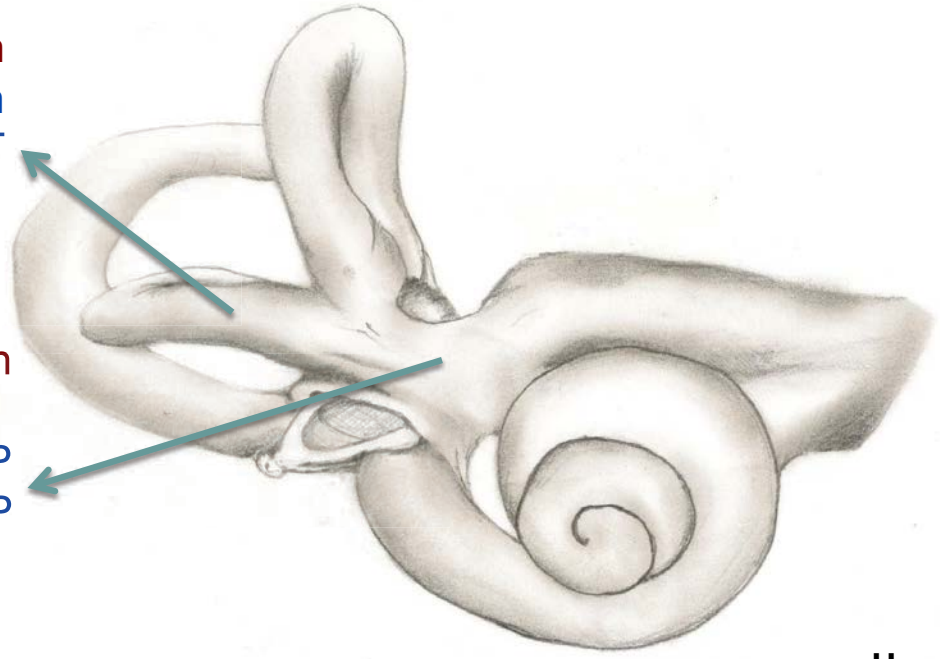
Otol Neurotol. 2016

CONTINUED SEMINARS IN Hearing

Vestibular Dysfunction in SSD

Horizontal Canal Dysfunction
48% Caloric Reduction
50% VOR loss vHIT

Otolithic Dysfunction
62.5%
Utricular 42% oVEMP
Saccular 25% cVEMP



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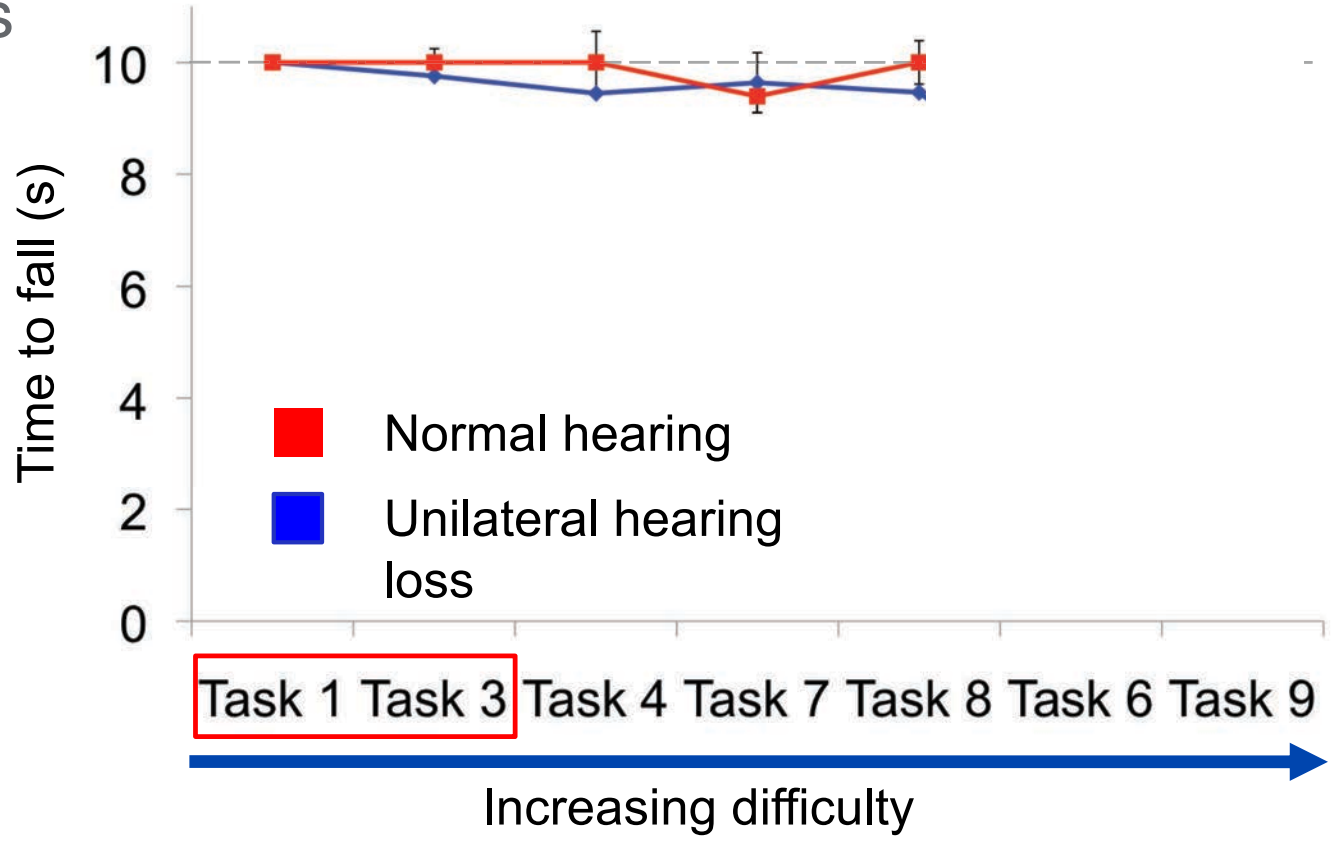
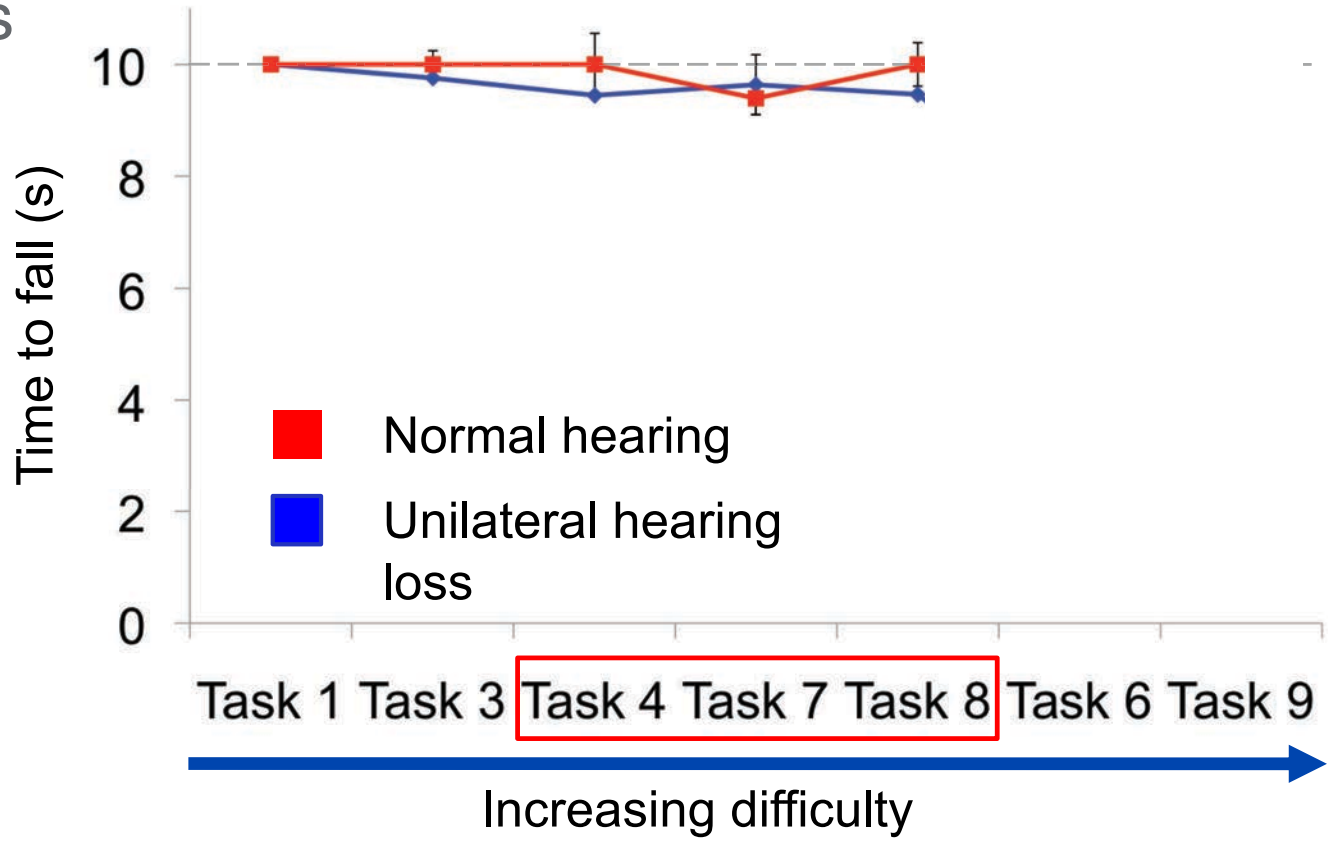
Hear Res. 2018

Balance Abilities Deteriorate as Task Difficulty Increases

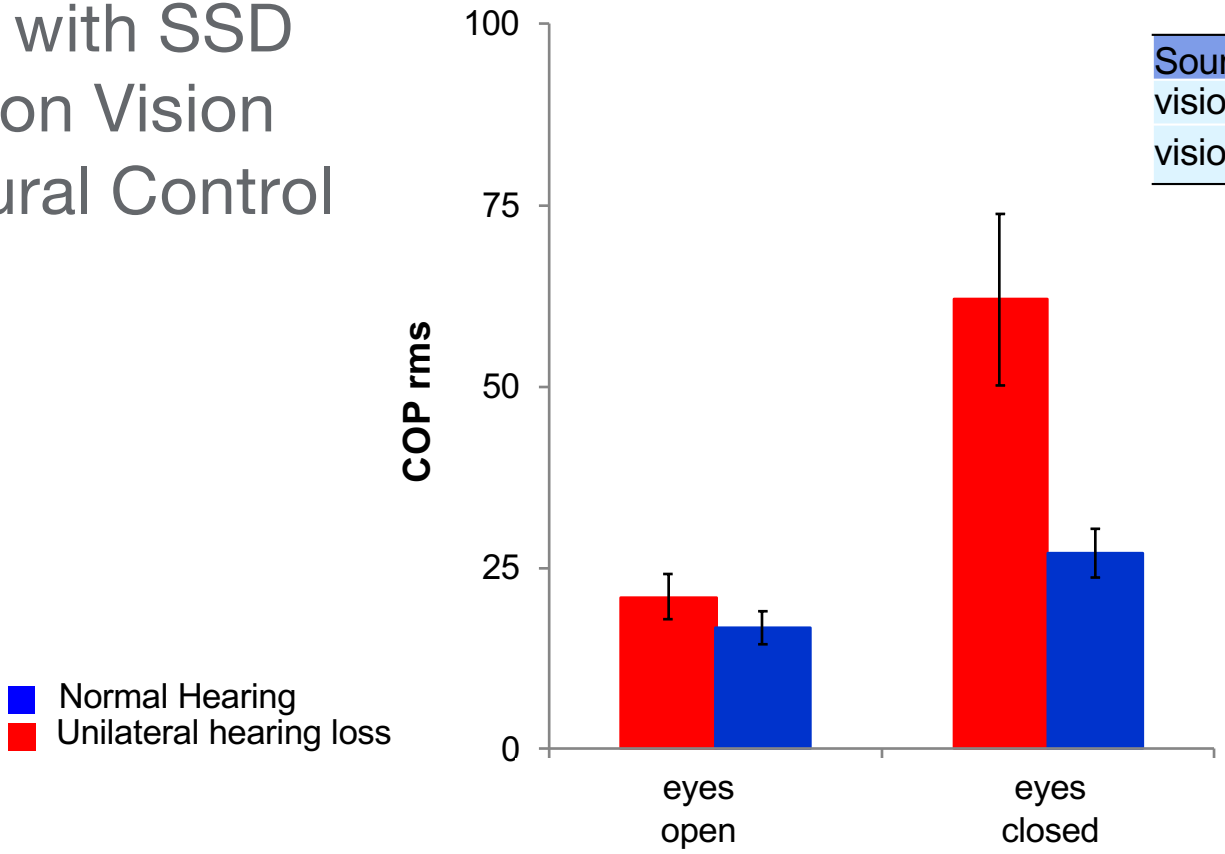


Balance Abilities Deteriorate as Task Difficulty Increases



Children with SSD Depend on Vision for Postural Control

Source	*p*
vision	0.001
vision * group	0.020



CONTINUED SEMINARS IN Hearing

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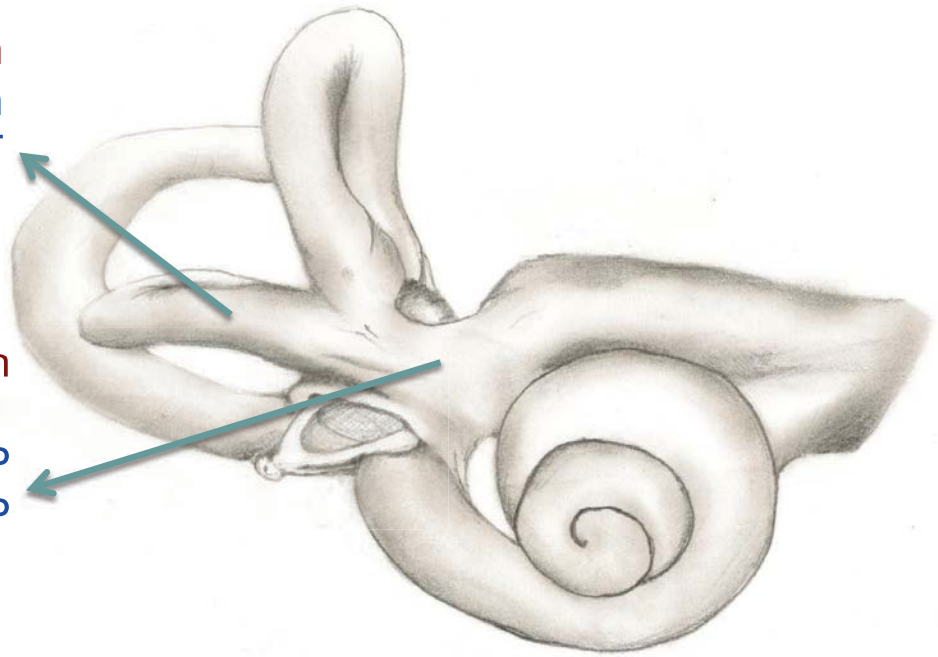

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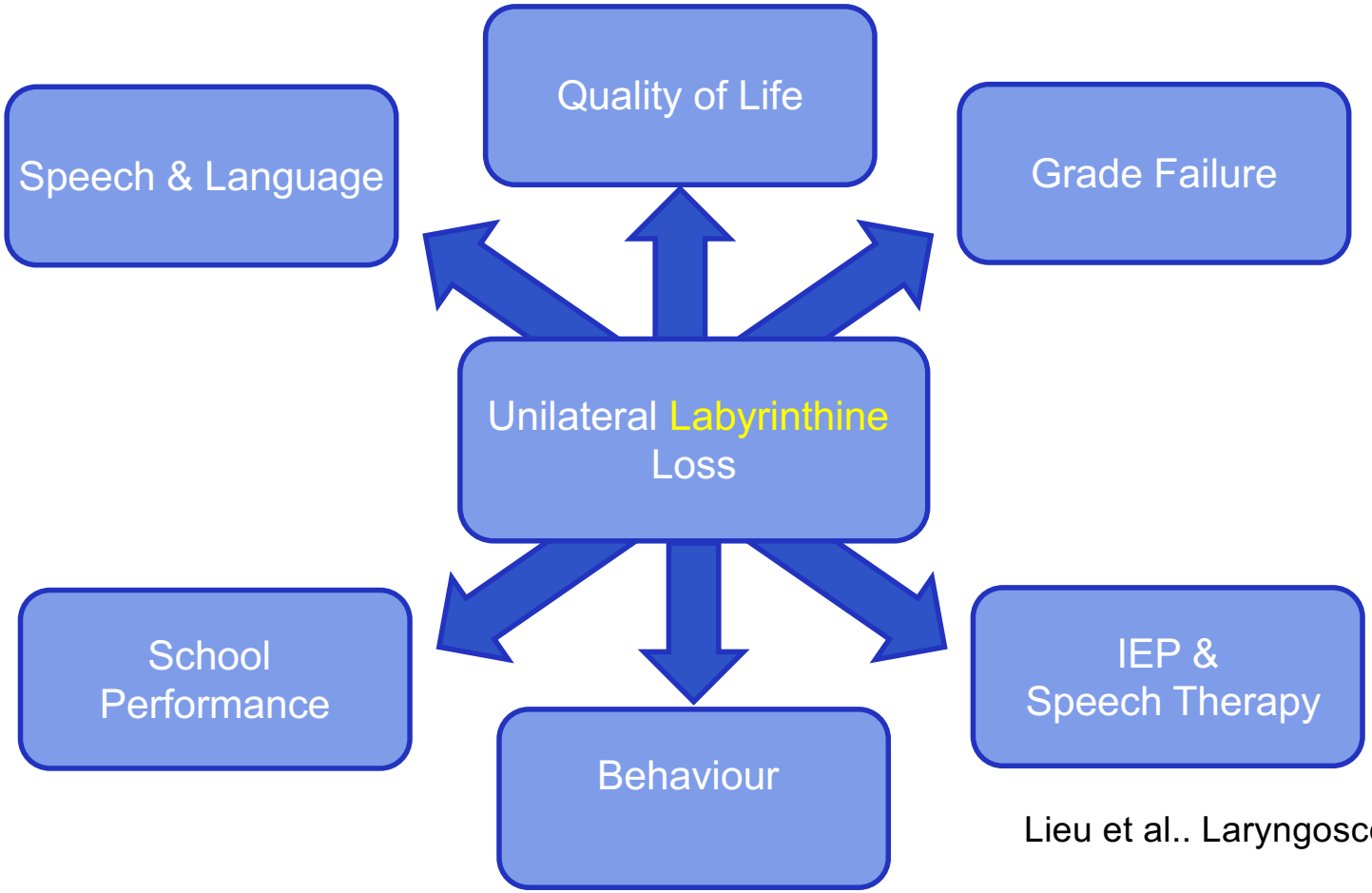
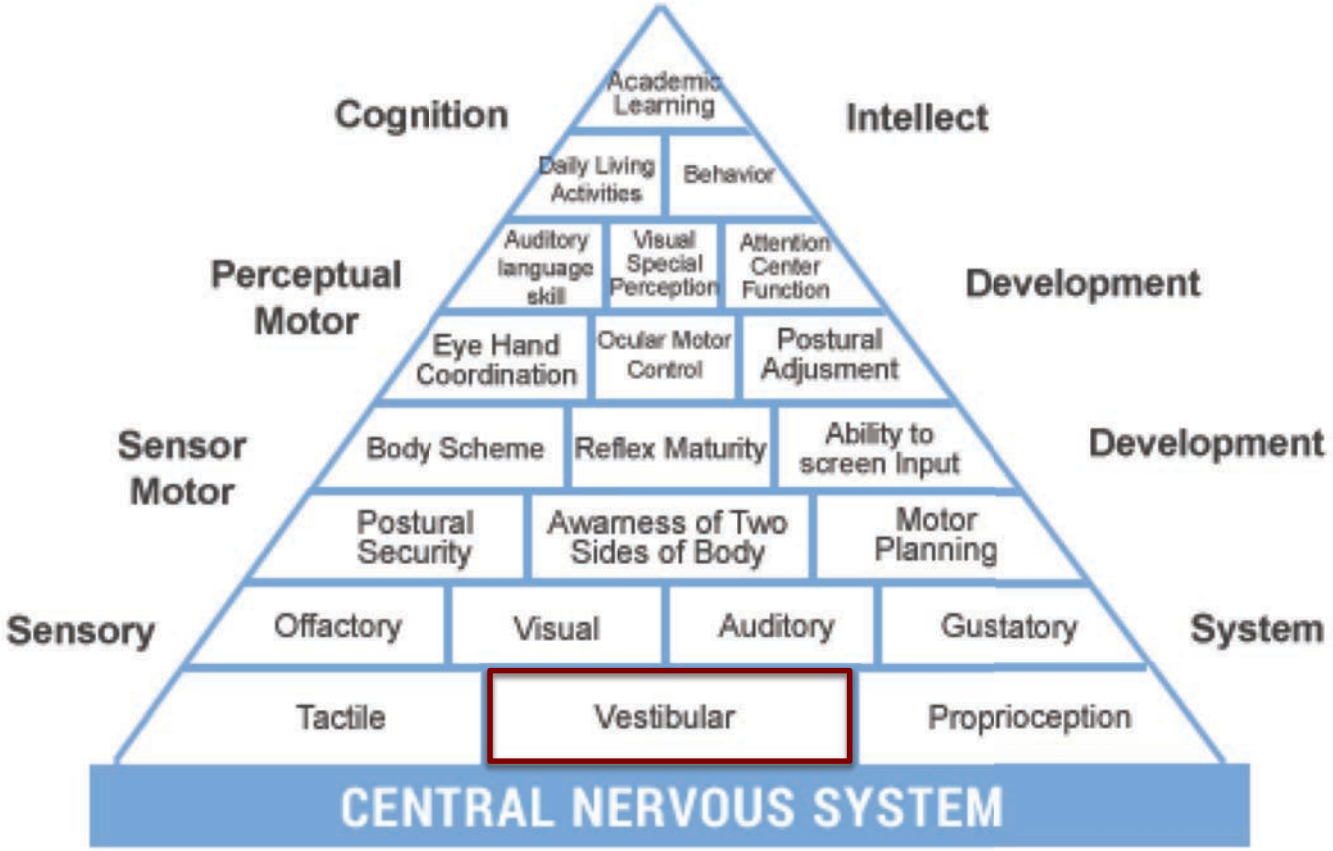
Consequences of SSD in Children



Lieu et al.. Laryngoscope. 2012

CONTINUED SEMINARS IN Hearing



Pyramid of Learning. (Williams & Shellenbeger,1-4)

CONTINUED SEMINARS IN Hearing

Screening Vestibular & Balance Function
3 Easy Steps

1. motor milestones
2. motor function
3. horizontal canal

CONTINUED SEMINARS IN Hearing

Motor Milestones – Upper Limits

- head control
  - 4 months
- sitting
  - 9 months
- walking
  - 18 months

CONTINUED SEMINARS IN Hearing

Screening Vestibular & Balance Function
3 Easy Steps

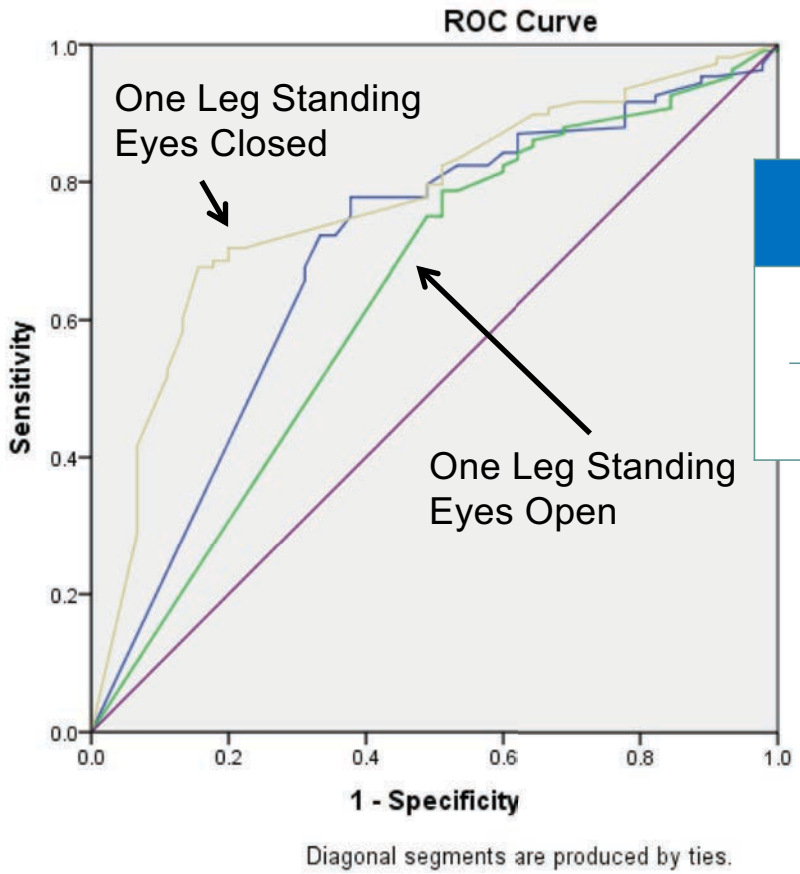
1. motor milestones
2. motor function
3. horizontal canal

One Leg Standing

Age	Duration (sec) 1 foot standing
30 months	1 (briefly)
36 months	2
4 years	5
5 years	10

Q4

One Leg Standing



Children age 5 and older

One Leg Standing	*Sensitivity*	*Specificity*
Eyes Open < 8 seconds	100%	49%
Eyes Closed < 4 seconds	90%	84%

Otol Neurotol. 2016

Q4

CONTINUED SEMINARS IN Hearing

Screening Vestibular & Balance Function
3 Easy Steps

1. motor milestones
2. motor function
3. horizontal canal

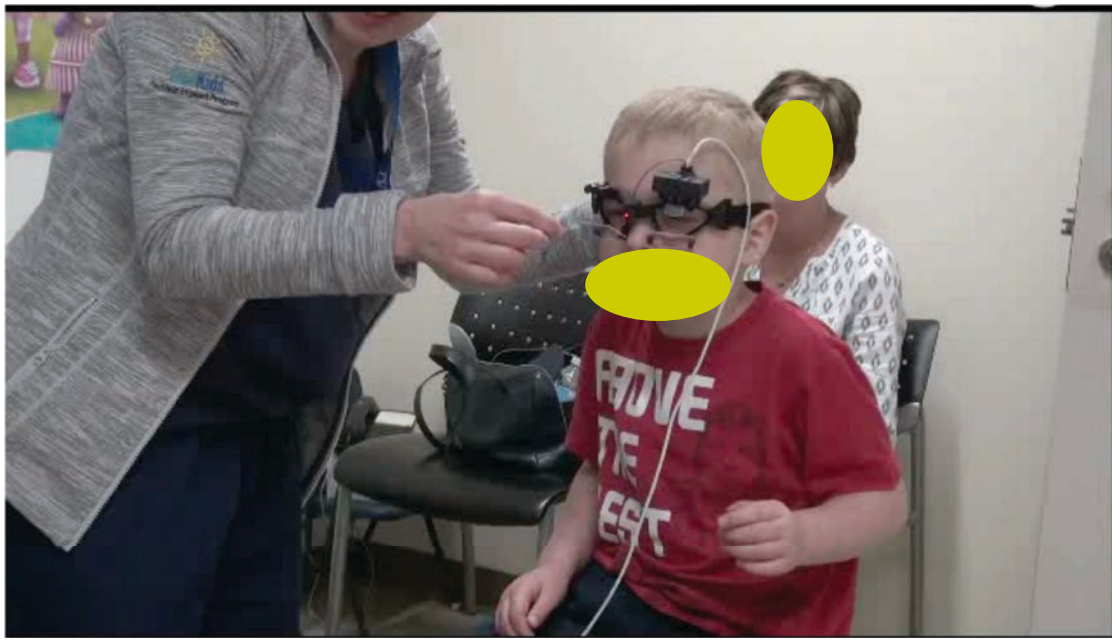
Q10, Q3

CONTINUED SEMINARS IN Hearing

Assess Horizontal Canal Function

Q10, Q3

video Head Impulse Testing (vHIT) (EyeSeeCam, Interacoustics)



Q10, Q3

video Head Impulse Testing (vHIT) Synapsys

Q10, Q3

CONTINUED SEMINARS IN Hearing

Infants < 6 months cannot visually suppress the VOR

Q10, Q3

CONTINUED SEMINARS IN Hearing

Screening Vestibular & Balance Function
3 Easy Steps

1. motor milestones
2. motor function
3. horizontal canal

CONTINUED SEMINARS IN Hearing

Summary

- vestibular & balance dysfunction
  - common in SNHL
- vestibular & balance dysfunction matters
- screening for dysfunction is feasible

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Course: #35340 Level: Intermediate 1 Hour

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American Auditory Society Cochlear Implants

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Wed, Oct 28, 2020 at 12:00 pm EDT
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Under Review: AAA/0.1 Intermediate

Presented By

Sharon Cushing, MD, FRCSC

Dr. Sharon Cushing is a full time paediatric otolaryngologist at The Hospital for Sick Children in Toronto, Canada, and an Associate Professor and Clinician Investigator in the Department of Otolaryngology Head and Neck Surgery at

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