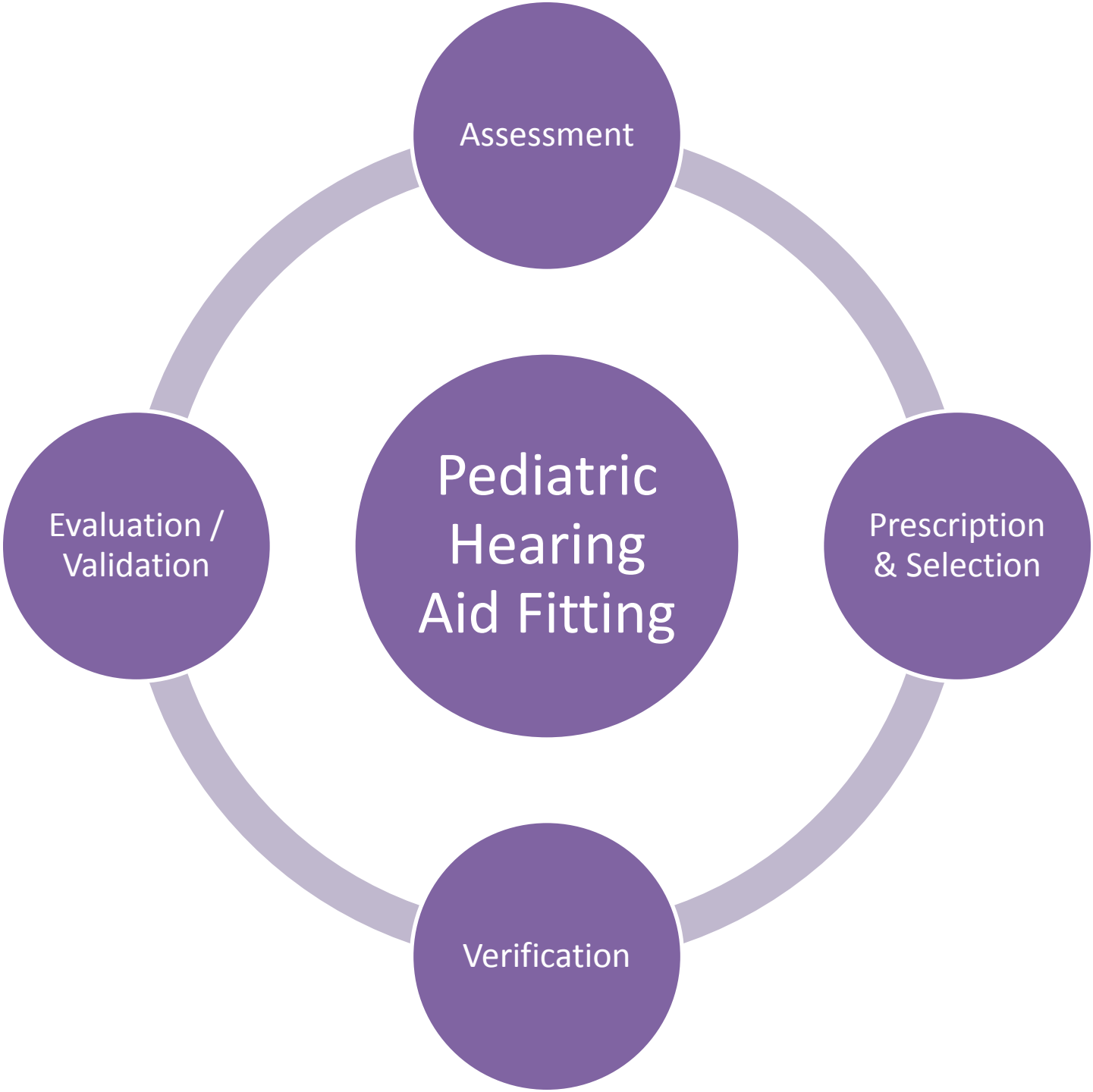


Establishing a Sound Foundation Through Electroacoustic Verification

Marlene Bagatto, Au.D., Ph.D.

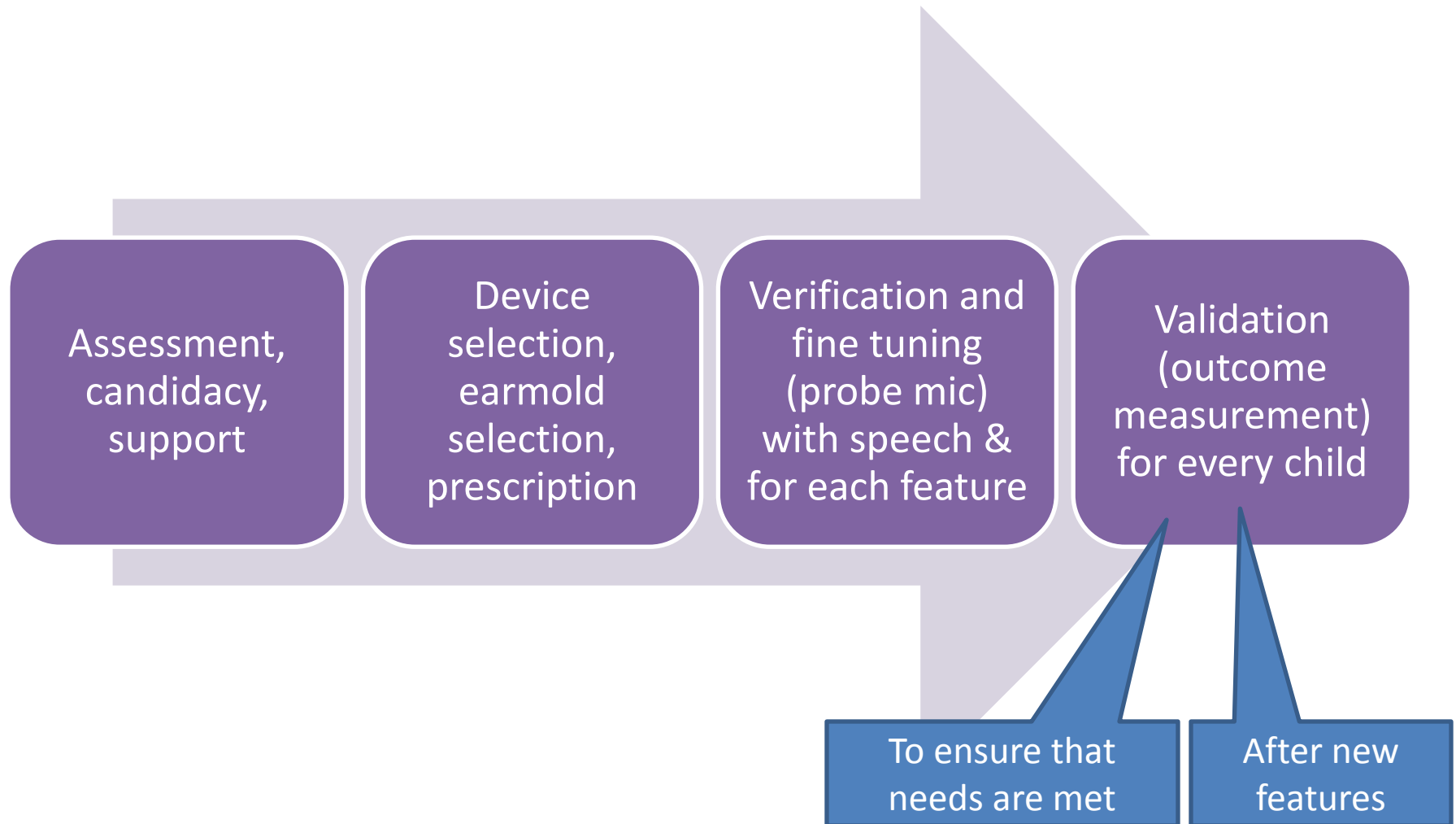
A Sound Foundation Through Early Amplification Conference
October 2-5, 2016
Atlanta, GA, USA



Provision of Hearing Aids

- Suitable technology and evidence-based hearing aid fitting guidelines and protocols support accurate and safe hearing aid fittings for the pediatric population
 - American Academy of Audiology, 2013
 - Australian Protocol; King, 2010
 - British Columbia Early Hearing Program, 2006
 - Modernizing Children's Hearing Aid Services, 2005
 - Ontario Protocol; Bagatto, Scollie, Hyde & Seewald, 2010;
Updated in 2014: www.dslio.com

AAA Pediatric Amplification Guideline (2013)



Ontario Infant Hearing Program Protocol



- Version 2014.01
- Editors: Marlene Bagatto & Susan Scollie www.dslio.com
- Contributors:
 - Susan Scollie, Marlene Bagatto, Sheila Moodie, Richard Seewald, Martyn Hyde, Stacey Weber, Vanessa Martyn
 - Danielle Glista, Anne Marie Tharpe, Jeff Crukley, Viji Easwar, Marianne Hawkins, Charla Levy, Sahar Zimmo, Andrea Dunn
 - Shane Moodie, Frances Richert, Christine Brown, Vijay Parsa

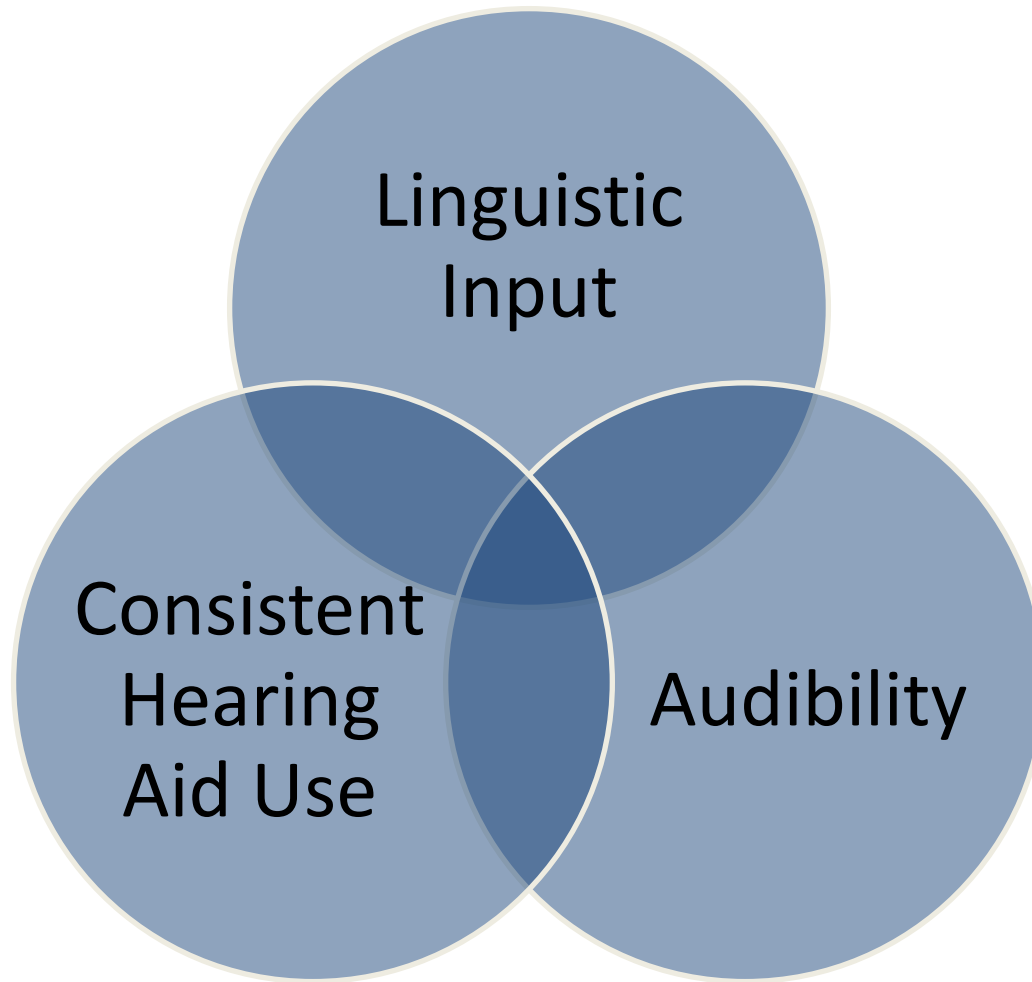
Ontario Infant Hearing Program Protocol



- Document addresses provision of Amplification to infants and pre-school children registered in the Ontario Infant Hearing Program (IHP)
- Specific context and procedures including specification of key procedures and equipment requirements
- Updates to evidence are intended to support current clinical practice within IHP (& other jurisdictions)
- Aligns with AAA Pediatric Amplification Guidelines (2013)

Factors Influencing Outcome

Outcomes of Children with Hearing Loss
Ear & Hearing, 2015



Babies are not Small Adults



Early hearing loss impacts communication development

- Maximize critical period

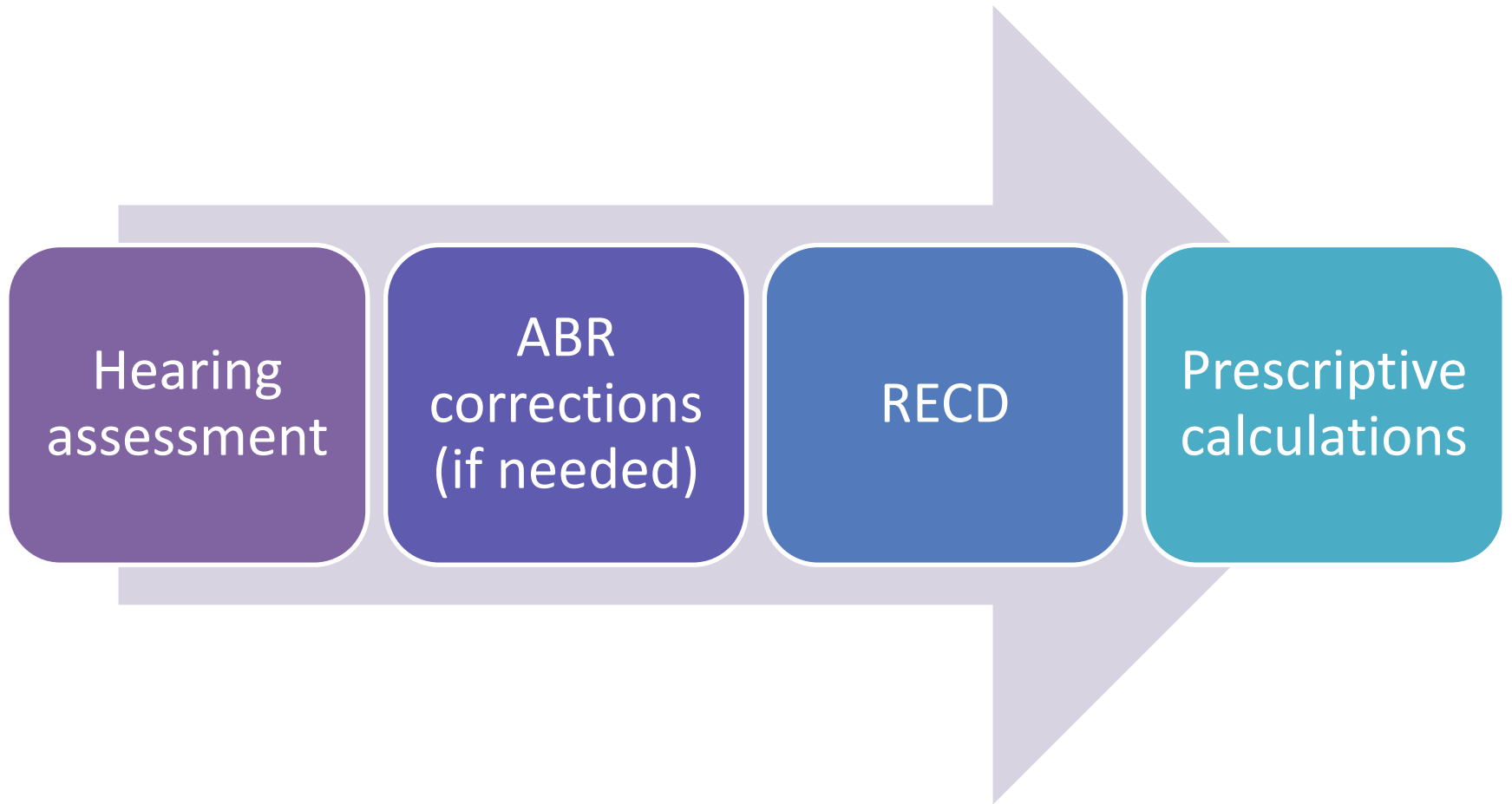
Small ears that are growing

- Account for changes in ear canal acoustics

Depend on caregivers for hearing aid use

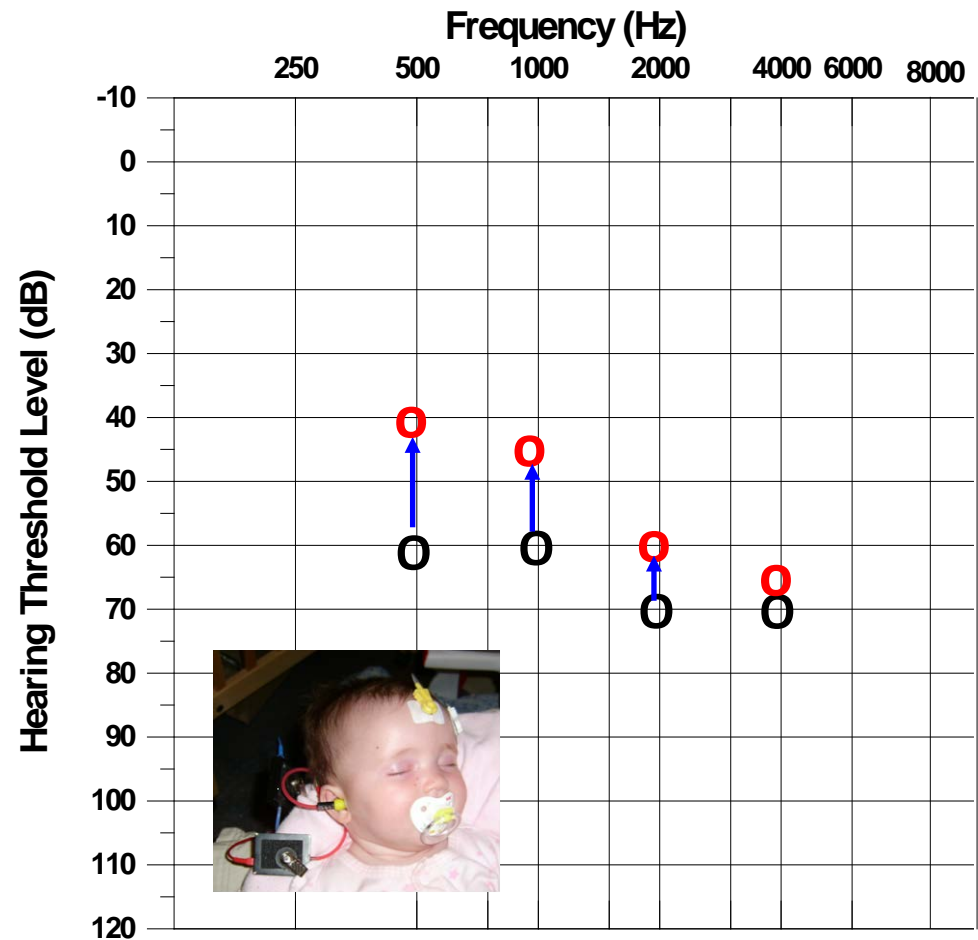
- Cannot provide verbal feedback

Assessment for Amplification



Best Practice: ABR Corrections

Ensure a smooth transition from electrophysiologic hearing assessment to early hearing aid fitting: *standardized nHL to eHL corrections, if needed.*



Assessment for Hearing Aid Fitting



- Connect inserts to personal earmolds for follow-up audiograms
 - Better retention and acceptance
 - Sets you up for a more accurate hearing aid fitting
 - Earmold Audiogram
 - Earmold RECD

Best Practice: Measure the RECD

Account for the child's unique ear canal: *measure the Real Ear to Coupler Difference (RECD) with the child's earmold, routinely.*

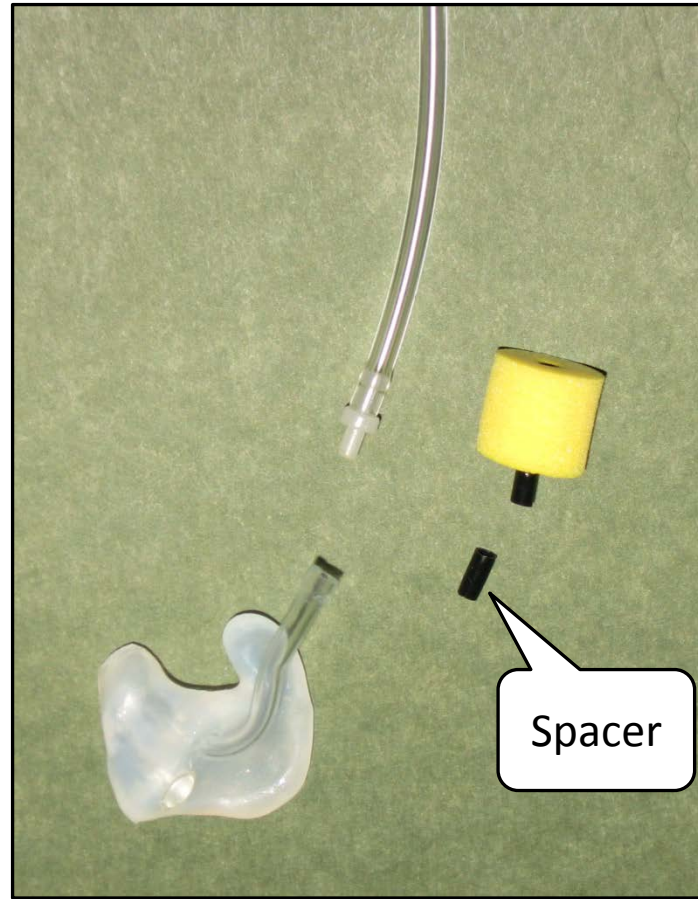


Audiometry & RECD with Earmolds

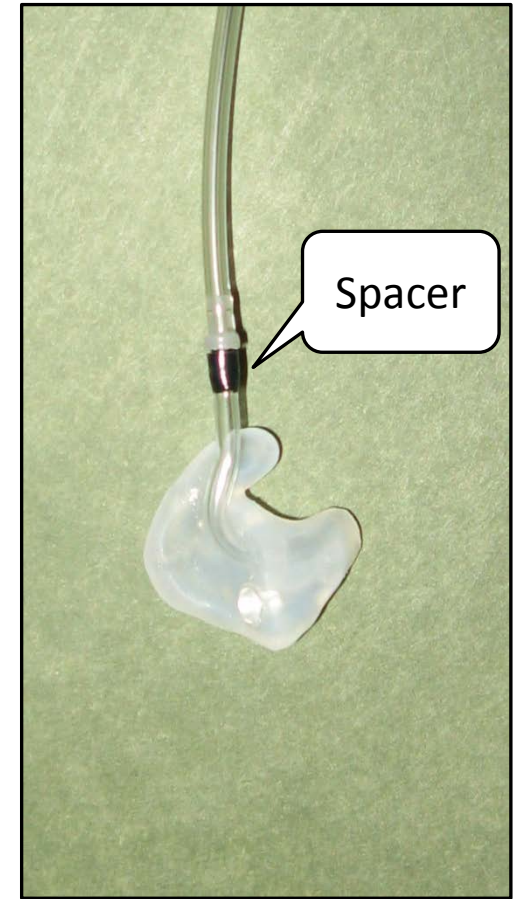
Trim Earmold Tubing



Trim Tube from Foam Tip



Connect Earmold to
Insert Earphone



What does using the *earmold* for audiometry & RECDs have to do with *verification*?



RECD is used in two places:

HL Threshold + RECD + RETSPL
= Real-ear SPL Threshold

HL to SPL
Transform

SPLogram

Coupler SPL or gain + RECD + MLE
= Predicted Real-ear SPL or gain

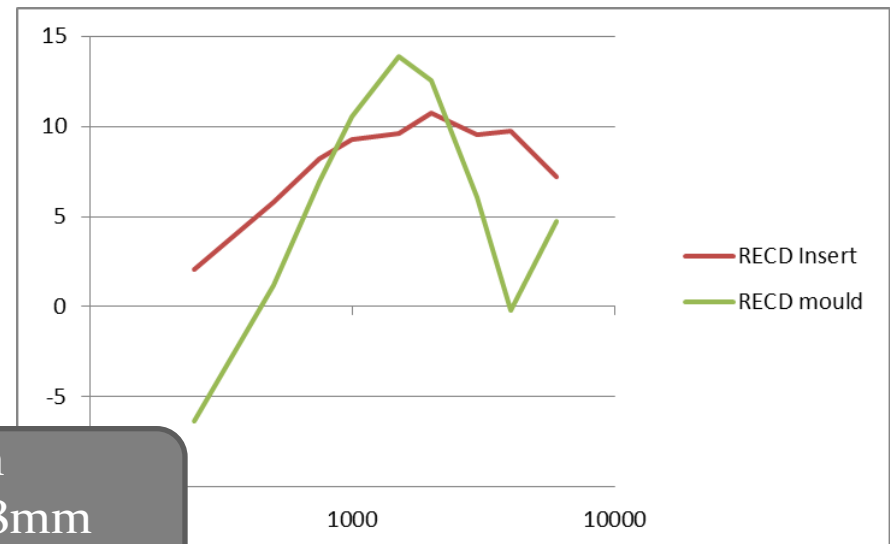
Coupler
Verification

For BTEs this
needs to
account for the
 earmold!

RECDs Measured with Foam Tips vs Earmolds are Not the Same

- Foam tip tubing is 25mm long
 - Earmold tubing is usually longer
 - High frequency roll-off results

Let's call this:
“Coupling Type”



36 children
Avg tubing = 38mm
Moodie et al, 2016

Coupling Type: Foam tip vs Earmold

- What if you need one type and only have the other type?
 - Example: foam tip audiogram, earmold RECD
 - Age trends for both types are known (Bagatto et al 2002; 2005).
- DSL v5.0 will generate a predicted RECD for either type
 - These might be used instead of measured RECD if the **Coupling Type** is not matched between *RECD type* and *RECD usage*

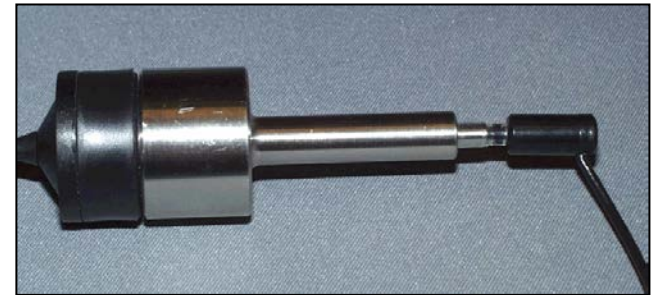
ANSI 2013 Standard Uses HA1

- Conceptually, this accounts for the acoustic properties of the ear cavity and not designed to measure anything about earmolds
 - *Means that verification would use the HA1 coupler + putty (another solution now available)*
- Conversion between HA1 and HA2 is applied
 - Simple, well-understood and easily transformed by software



In the Clinic.....

- Can use **HA2** coupler for coupler portion of RECD
- **Clinical** advantages: *No putty*
 - Fewer infection control issues
 - Faster, more reliable connection
- **Standardization** advantages:
 - HA1 RECD can be constructed & reported by software even though it wasn't measured that way
- Let's call this: “**Coupler Type**”



New software functions for the RECD are appearing

Goal: to comply with the ANSI standard, but also to support a wide range of clinical practice.

Note: Specific to Audioscan[®] systems

Text course:

<http://www.audiologyonline.com/U/26580/298f27b4d409b3a65e>

Pediatric Fitting Protocol

(historical, and relies on “matching” for accuracy)

Matching

- ✓ Audiometry with insert phones + earmolds
- ✓ Measure RECD with earmolds
- ✓ Verify BTE in HA2 coupler

Mis-Matching

- ✓ Audiometry with insert phones + foam tip
- ✓ Measure RECD with earmolds
- ✓ Verify BTE in HA2 coupler

Coupler Verification

Good for infants & young children
Likely little or no venting

New software systems allow you to label the RECD type. This supports new corrections that handle mismatches.

- Label the type of coupler-based fitting:
 - HA2 or HA1? **COUPLER TYPE**
- Label the type of RECD you are measuring:
 - With earmold or tip? **COUPLING TYPE**
- If necessary, the software will convert between foam tip & earmold RECDs using a *new correction procedure*.
- Preliminary data suggest this may be more accurate than using age-predicted averages (Moodie et al, 2016; JAAA).

2015 1:18am **audioScan**

Instrument	BTE (HA-2)
Mode	Test box
Presentation	Single view
Format	Graph
Scale (dB)	SPL

Audiometry

Age	Adult
Transducer	Insert+Mold
UCL	Average
RECD	Entered
RECD coupling	Earmold
BCT	N/A

Test box

Single view

Graph

Ear

Targets

Age

HL transducer

Threshold

Bone conduction

UCL

RECD

RECD coupling

Left

DSL child

10 months

Insert + mold

Entered

N/A

Average

Measure

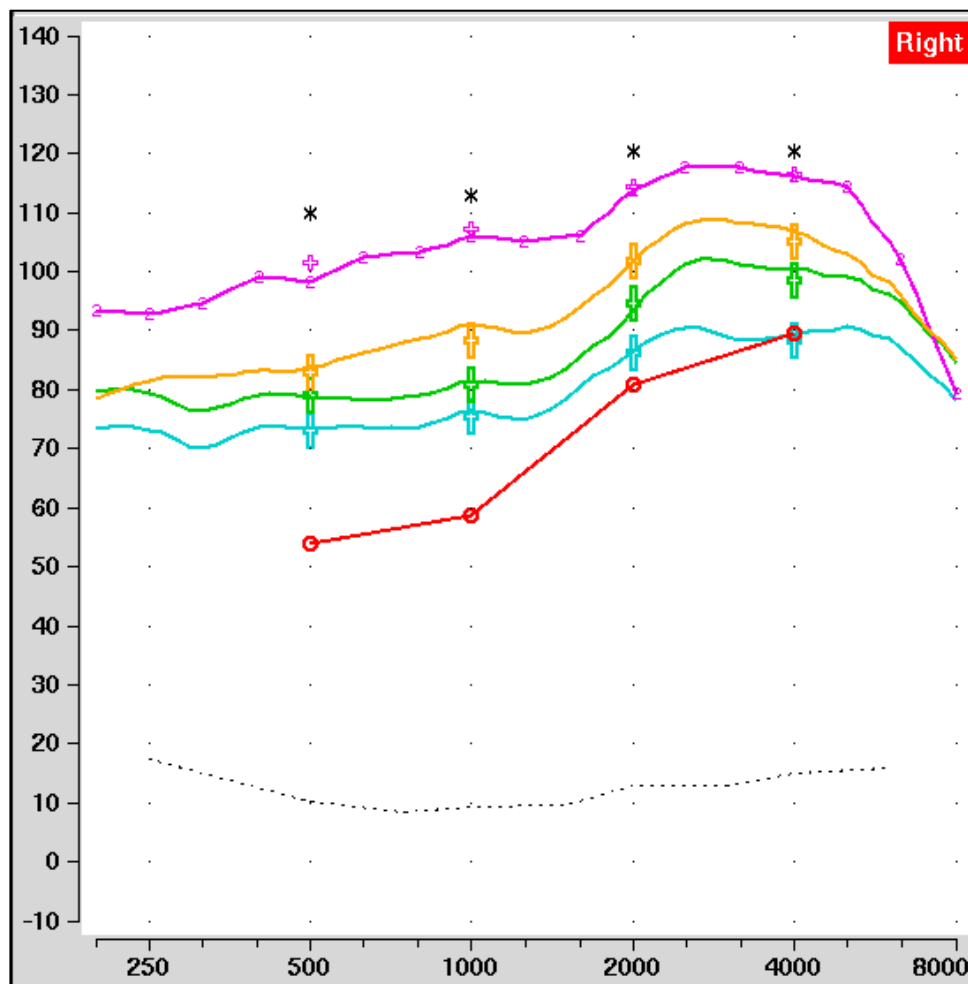
Earmold

BTE + HA-4

Audiometry

Best Practice: Real-ear Verification

Set the hearing aid for the infant **in the coupler**, focusing on the long term levels of conversational speech: *verify every hearing aid, and fine tune to target. Use speech-based equipment.*



Munro et al 2000; 2002; Moodie et al 1994; Revit 1997;
Scollie et al 2005; Seewald et al 1999

Why verify?

To provide the best possible fittings.

“The responsible audiologist wants to know as much as possible about the levels of amplified sound that hearing instruments deliver into the ears of infants and young children. To this end, the audiologist must apply comprehensive and evidence-based verification strategies that are compatible with the characteristics and capabilities of this unique population. This is because the long-term implications of the fitting decisions we make are simply too important.”

~ Richard Seewald

Goals for Verification

- ✓ Accuracy & reliability
 - Electroacoustic verification in the coupler
- ✓ Speech-like levels & MPO
- ✓ Infant-friendly procedures
 - There should be no requirement to sit up or respond behaviorally
- ✓ Meaningful displays
 - dB for dB comparison to thresholds & upper limits

Characteristics of the Aided Audiogram

No • Does it tell us how the hearing aid processes speech?

No • **Suitable for Validation**

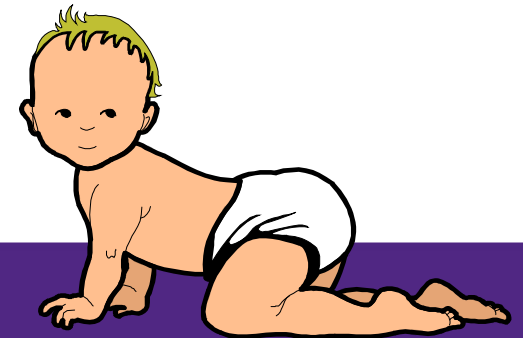
Not

Verification

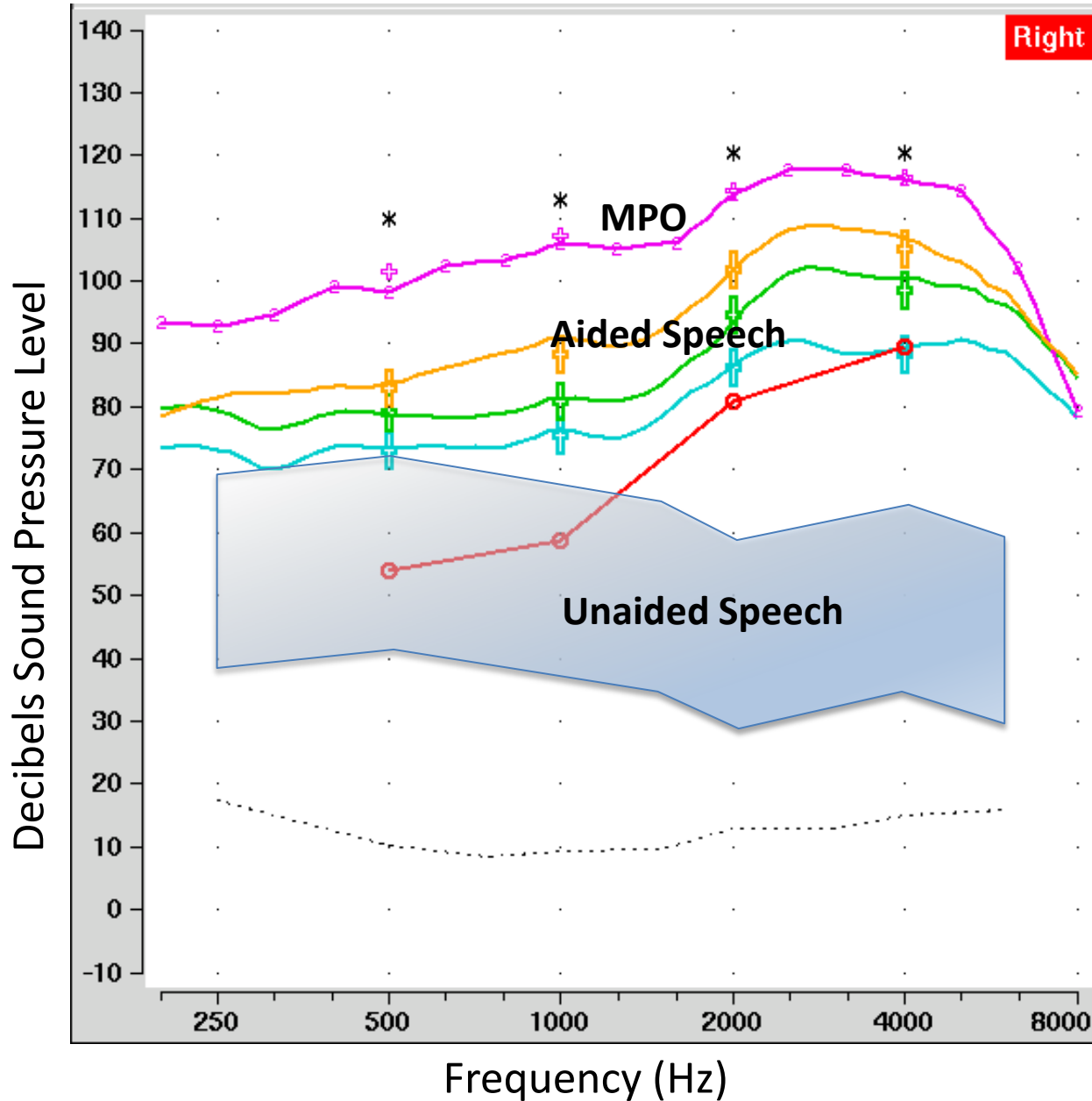
No •

No •

Yes • It is meaningful?



Electroacoustic Verification - SPLogram



Predicted from coupler measurements & the RECD

Clinical Implications

- Coupler measures & RECDs allow *accurate and reliable* prediction of real-ear hearing aid performance
 - Across ages
 - Across frequencies
- Reduces time/cooperation needed
 - Your patient must sit for ONE measurement
 - You already measured the for Assessment



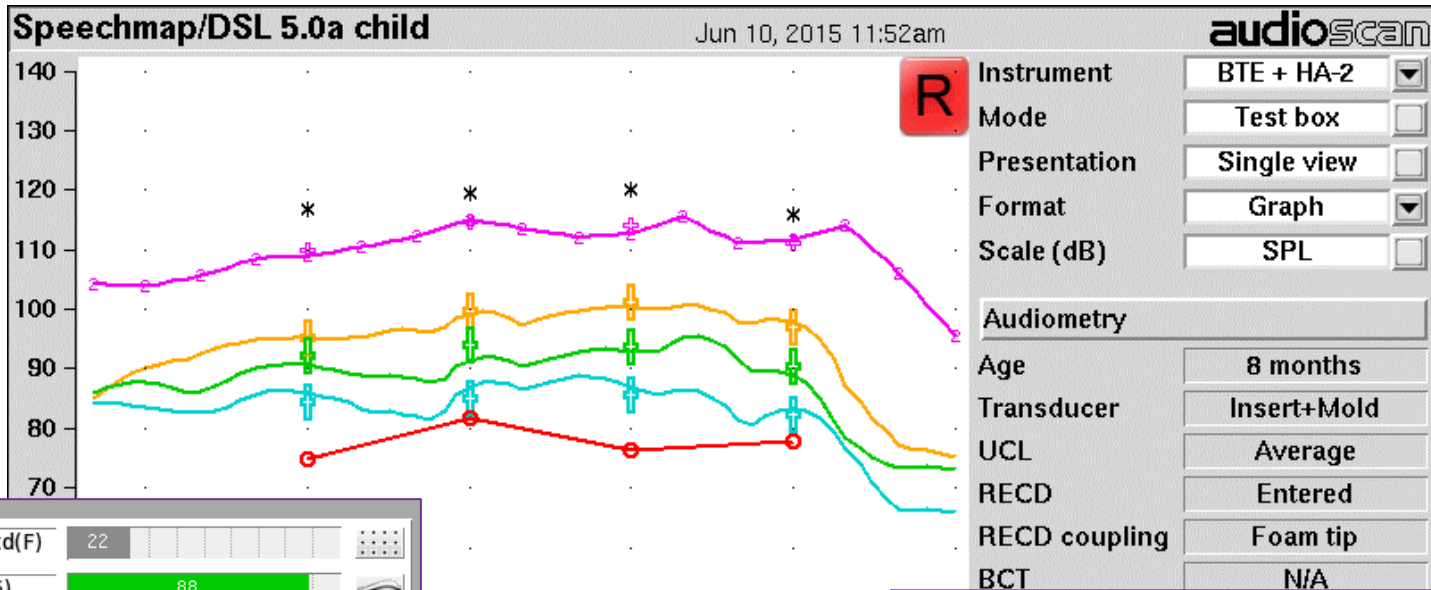
Specifics of Verification

- “Auto” or “First” fit is a starting place
 - Fine-tuning using real-ear equipment is necessary
 - View on SPLogram with measured RECD
- Speech-like signals are recommended
 - Soft (55 dB), average (65 dB), loud (75 dB)
 - MPO (narrowband; 90 or 100 dB)
- Target of choice is REAR not REIG

Other Analyses

- The Speech Intelligibility Index (SII)
 - An updated version of the Articulation Index (AI), standardized in 1997
- How to interpret:
 - 0 means no speech is audible
 - 1 means 100% is audible
 - *This doesn't mean that 100% will be heard correctly.*

Speech Intelligibility Index (SII)

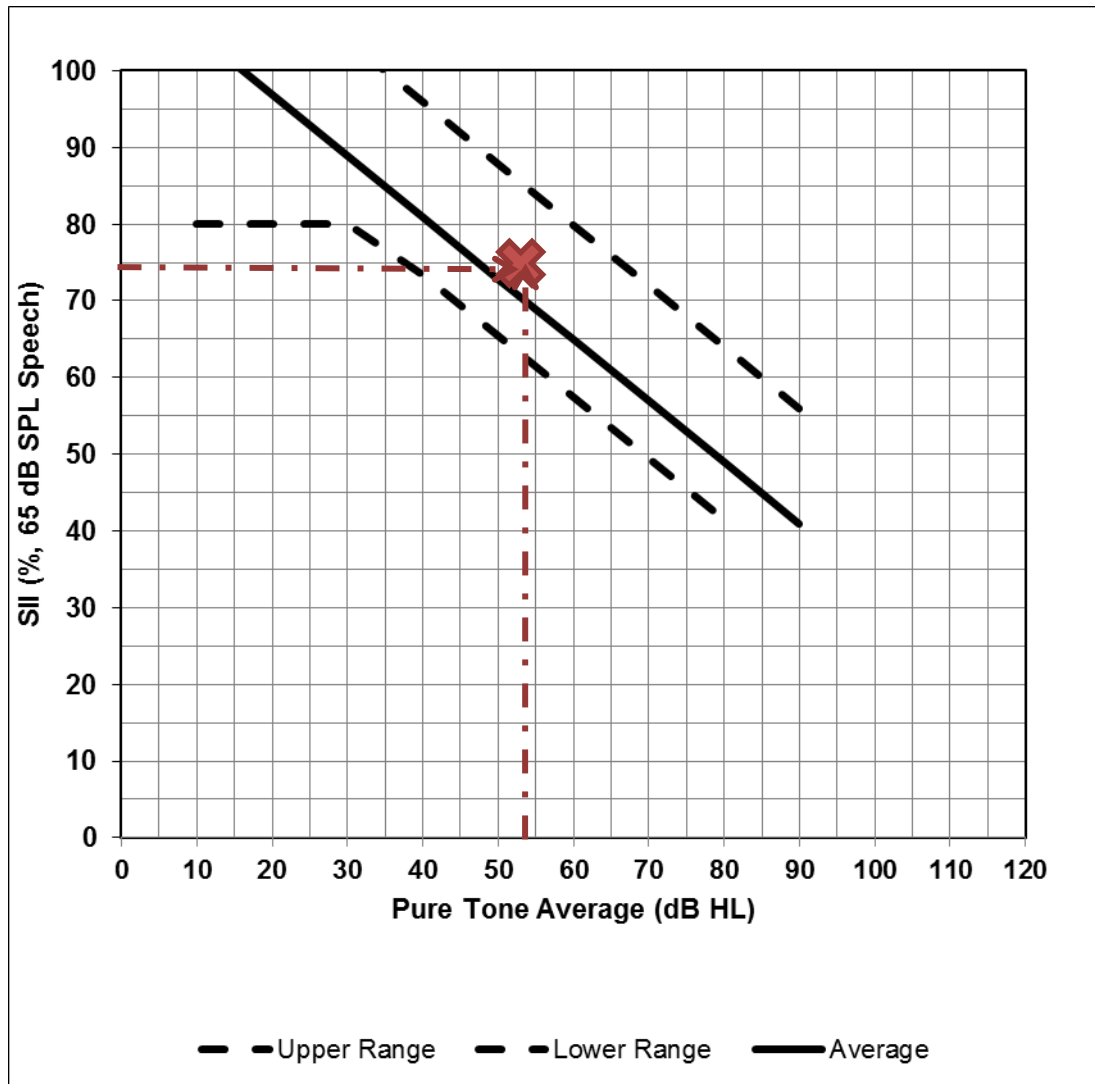


Speech-std(F) 22

1	Avg (65)	88
2	MPO	N/A
3	90	N/A
4	"S"	N/A
5	Avg (65)	N/A
6	Soft (55)	80

Test	Stimulus	Level	SII
1	Speech-std(1)	Avg (65)	62
2	MPO	90	N/A
3	Speech-std(1)	Soft (55)	49
4	Speech-std(1)	Loud (75)	73
Unaided avg (65)			0
Curve		Hide / Show	

Pediatric Norms



Verification Protocol

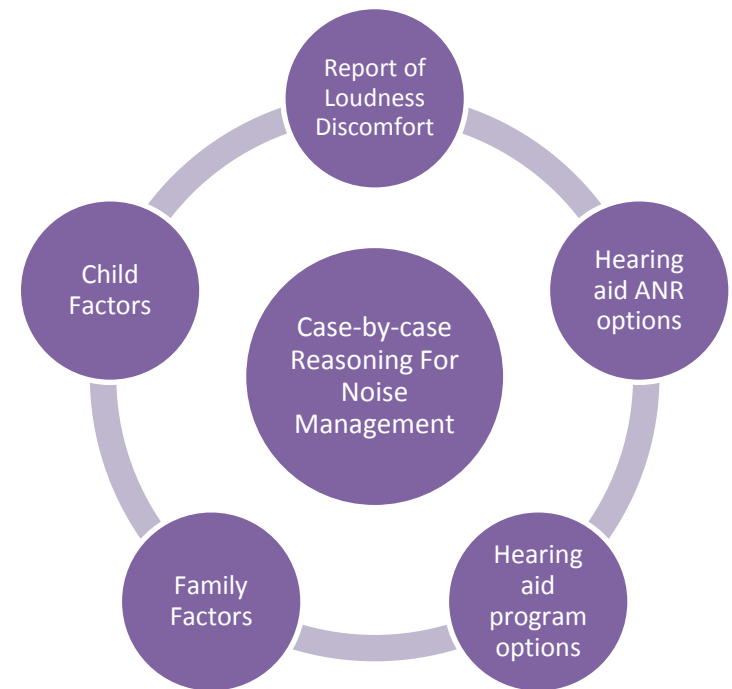
- ✓ Obtain ear-specific hearing levels
 - Correct ABR if necessary
 - Use earmolds for follow-up behavioural assessments
 - Measure the RECD with earmold
- ✓ Calculate targets & select device
 - BTE with small filtered earhook & DAI
 - Lock controls & battery door
- ✓ Verify for speech & maximum output
 - Deactivate advanced technologies
 - Coupler-based verification
- ✓ Follow up every 2-4 months
 - Outcome measures & reports from caregivers
 - Re-assess thresholds & RECDs (earmolds!) and re-adjust

ADDITIONAL HEARING AID TECHNOLOGIES FOR CHILDREN



Ontario Protocols

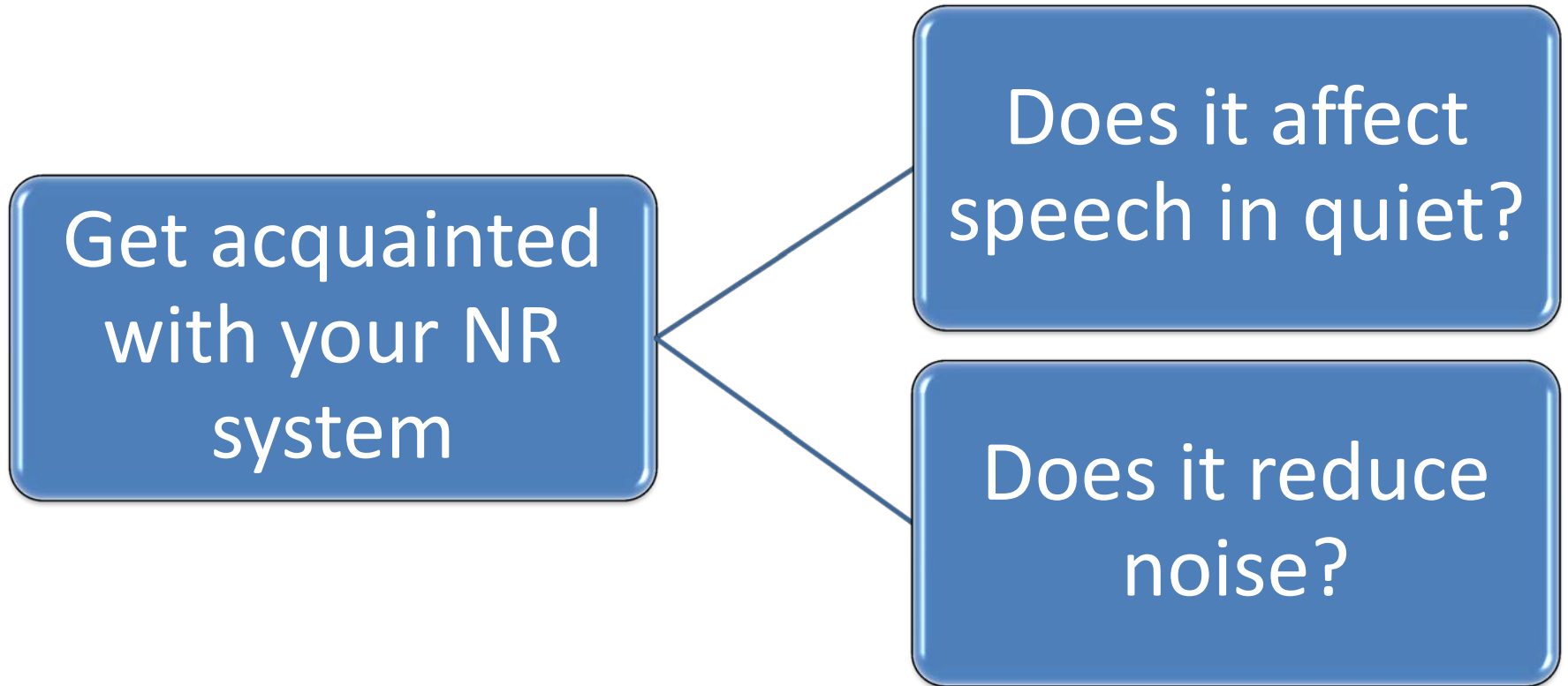
- Noise Management
 - Scollie et al, 2016, JAAA
- Frequency Lowering
 - Scollie et al, 2016, JAAA
- Candidacy themes:
 - Case-by-case
 - Factors to consider



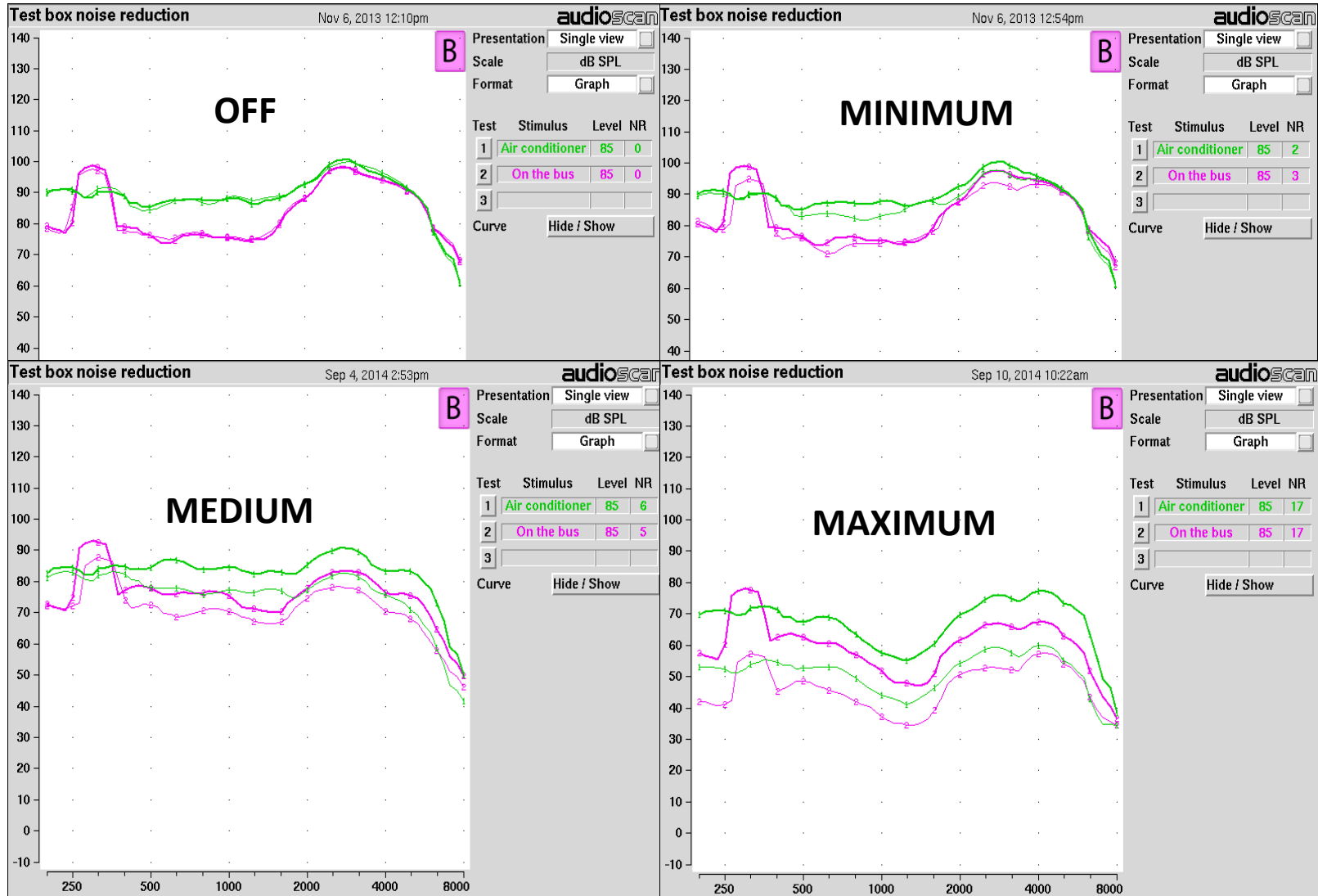
Noise Management in Pediatric Hearing Aid Fitting



Verify Noise Management System



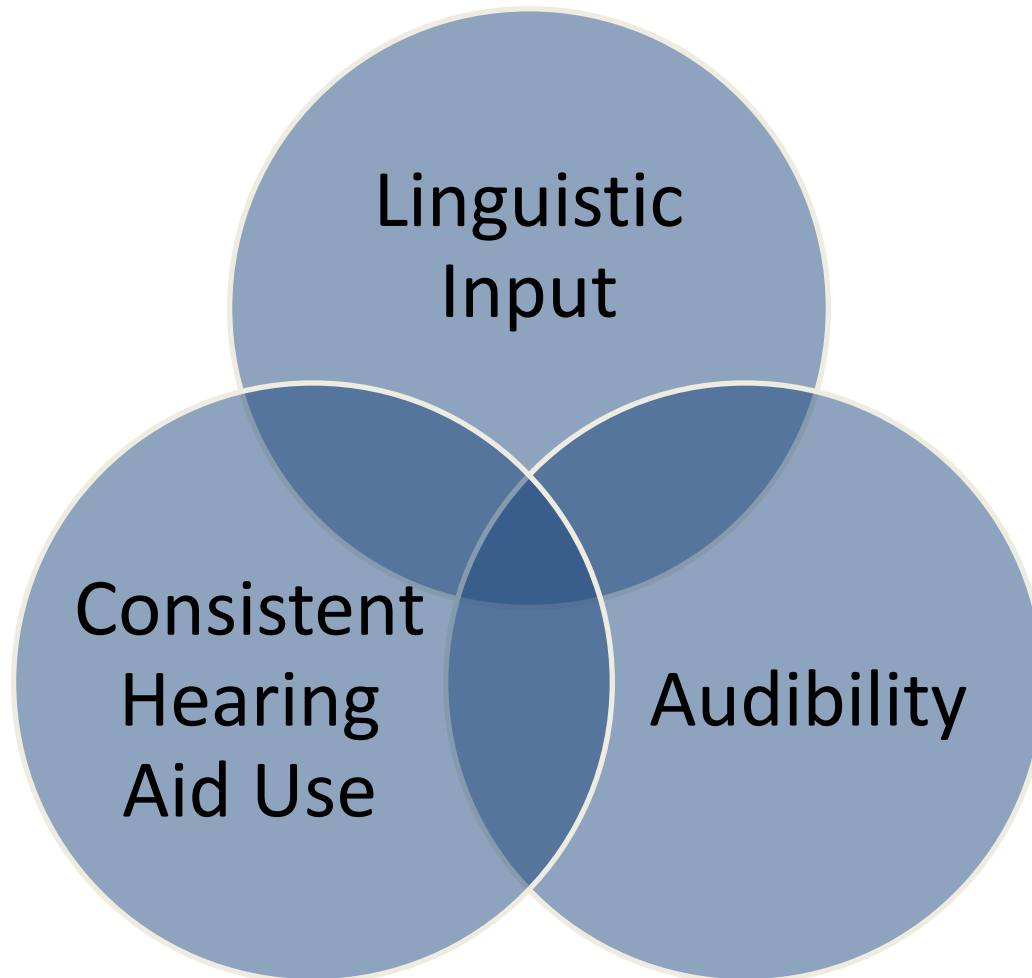
Strength of Noise Reduction Varies



Take Home Messages

- A *measured* RECD is necessary for an accurate description of your patient's ear canal which individualizes the hearing aid fitting
- RECDs are used to convert HL to SPL *and* allow for coupler-based verification
- Simulated REAR is a valid way to assess hearing aid performance for infants & children
- Consider other hearing aid technologies (noise reduction, frequency lowering) on a case-by-case basis
- If activated, verify the characteristics, impact on audibility and benefit

Good Fittings Contribute to Good Outcomes



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