Precision outcomes for children with hearing loss

Ryan McCreery, Ph.D.
Director of Research
Boys Town National Research Hospital
Ryan.McCreery@boystown.org

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1

Acknowledgements

- NIH/ NIDCD
  - R01 DC013591
- Contributors
  - Elizabeth Walker
  - Marc Brennan
  - Meredith Spratford



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2

hip with

Ryan McCreery

- Boys Town National Research Hospital
  - Director of the Audibility, Perception, and Cognition Laboratory
  - Director of Research
- Research interests
  - Speech perception in children who wear hearing aids

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Learner Outcomes

After this course learners will be able to…

- Implement evidence-based outcome measures that are specific to the child's needs.
- Interpret differences in outcomes to assist with device candidacy decisions.
- Explain how to monitor progress and development over time for children who have hearing loss.

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Impact of cumulative auditory experience: Case studies

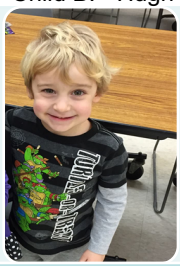
Child A: "Hayden"

Passed NHS

Parents suspected hearing loss at 27 months

Severe hearing loss by age 3

Child B: "Hugh"



Failed twice on NHS

Family did not initially pursue follow-up

Severe hearing loss by age 3

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Comparison at Age 7

Speech Production and Communication Measures						Below average / Average
Goldman-Fristoe Test of Articulation				<1	%ile	
Language Measures						
Peabody Picture Vocabulary Test - 4 (From B)	48	SS		<0.1	%ile	
WASI Vocabulary	20	T				
CELF-4						
Word Structure	1	Sc		0.1	%ile	

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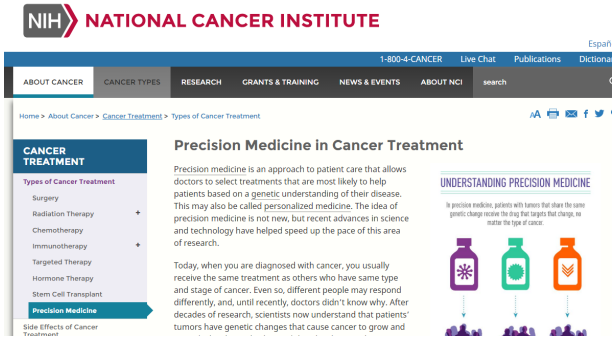
Precision audiology?

Precision Medicine



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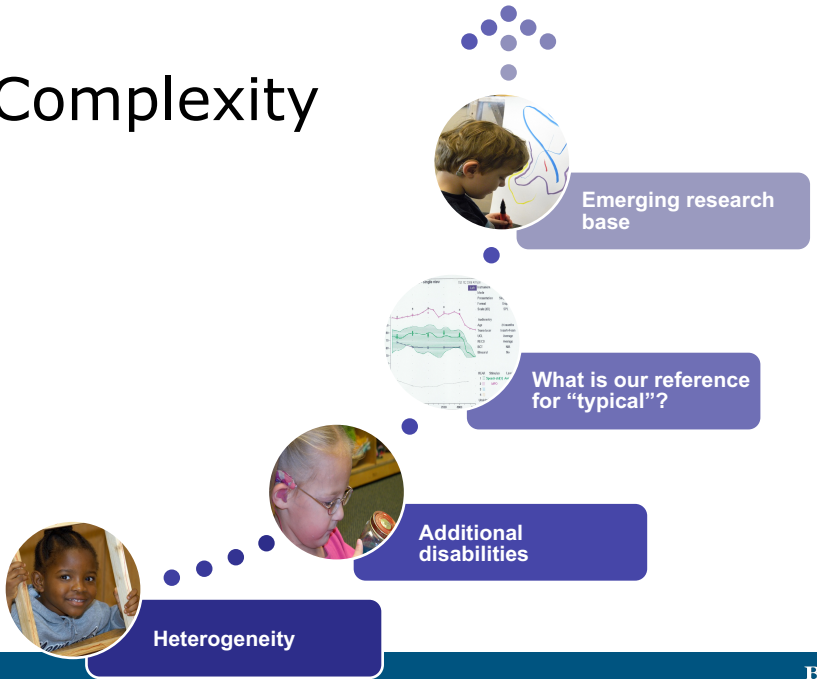
Complexity



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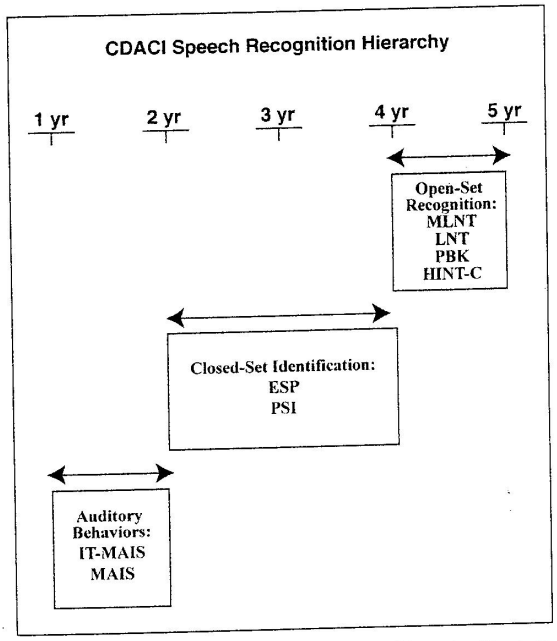

Figure 1. The CDaCI speech recognition test hierarchy. The tests

(Eisenberg et al, 2010)

Pediatric Minimum Speech Test Battery

- Described by Uhler et al. 2017
- Developed with input from a large number of pediatric audiologists, mostly in North America
- English-based
- Goal of standardizing pediatric speech recognition assessment

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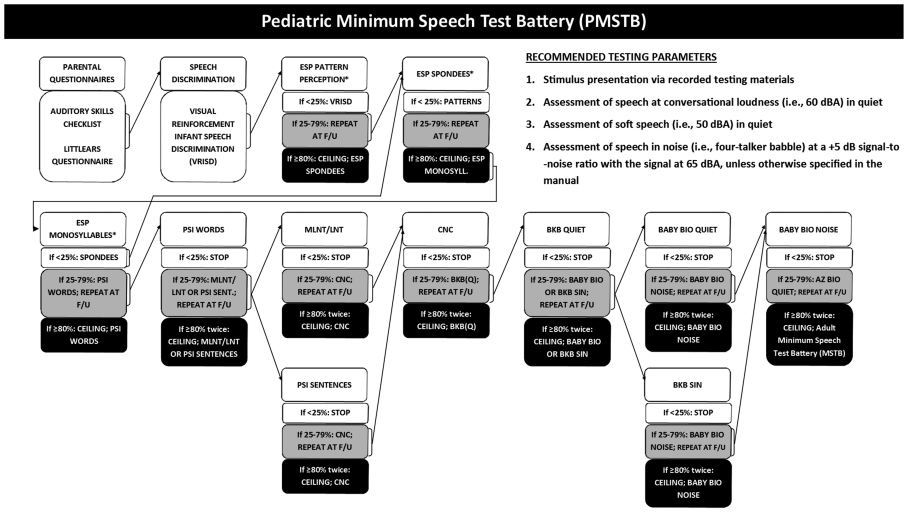

Uhler et al. 2017

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Pediatric MSTB

RECOMMENDED TESTING PARAMETERS

1. **Stimulus presentation via recorded testing materials**
2. **Assessment of speech at conversational loudness (i.e., 60 dBA) in quiet**
3. **Assessment of soft speech (i.e., 50 dBA) in quiet**
4. **Assessment of speech in noise (i.e., four-talker babble) at a +5 dB signal-to -noise ratio with the signal at 65 dBA, unless otherwise specified in the manual**

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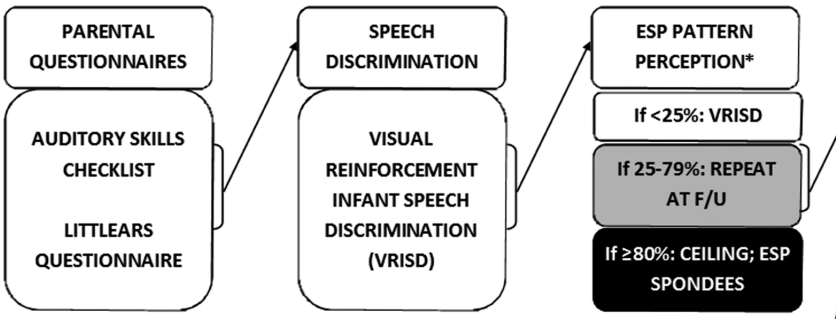
Pediatric MSTB



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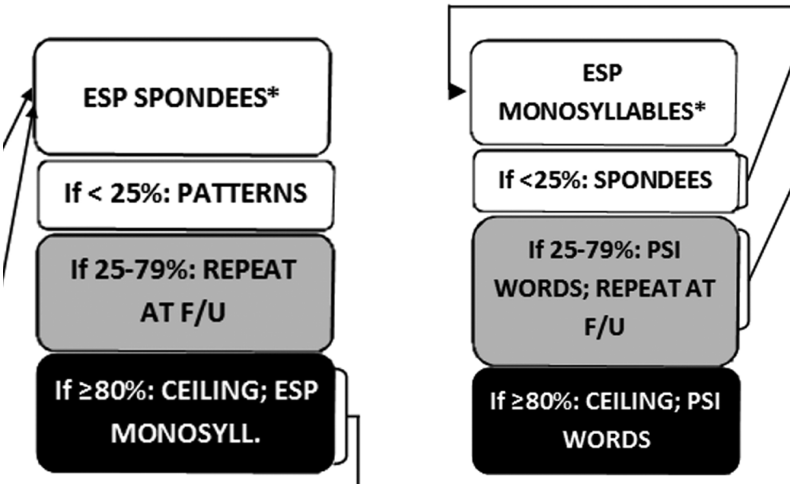
Pediatric MSTB



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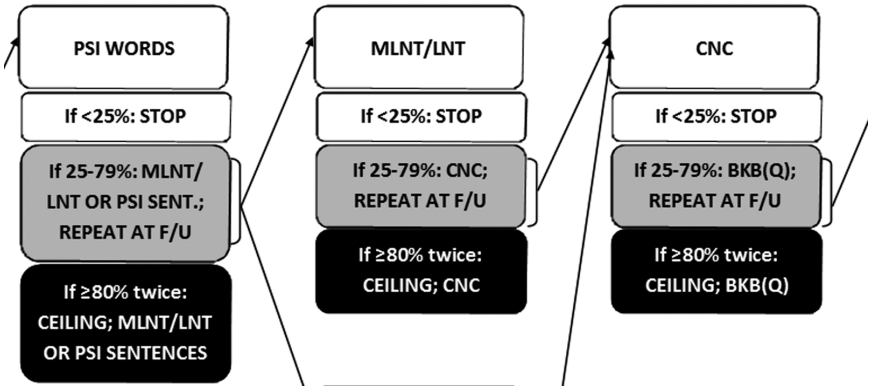
hip with

Pediatric MSTB



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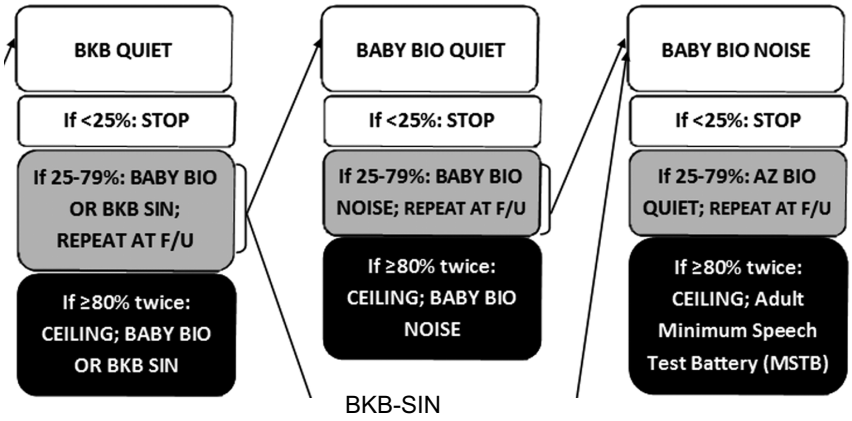
Pediatric MSTB



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Pediatric MSTB

- Advantages
  - Standardized protocol
  - Prescriptive approach to presentation level
  - Could allow development of database due to standardization

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Pediatric MSTB

- Disadvantages
  - Only English materials
  - Single presentation level and SNR recommendation unlikely to work for all children with hearing loss.
  - Lots of similar materials presented as different steps.

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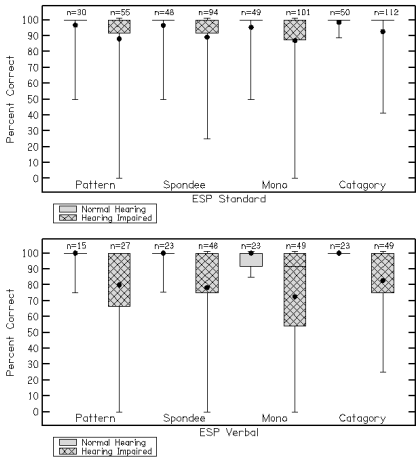
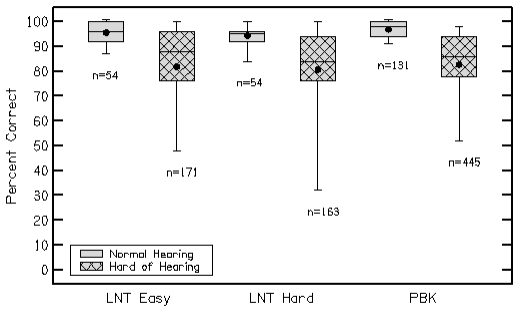
Pediatric MSTB



Performance on monosyllabic words in quiet



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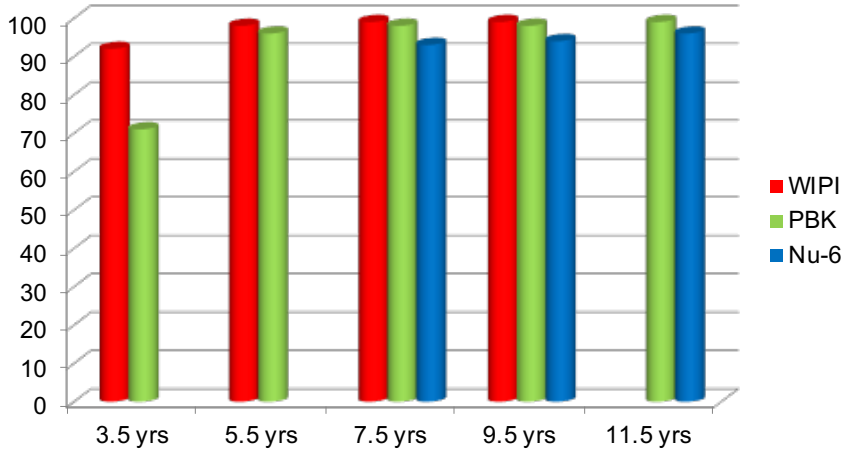
Comparing Speech Perception Tests



(Sanderson-Leepa & Rintelmann, 1976)

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Aided Speech Recognition Battery

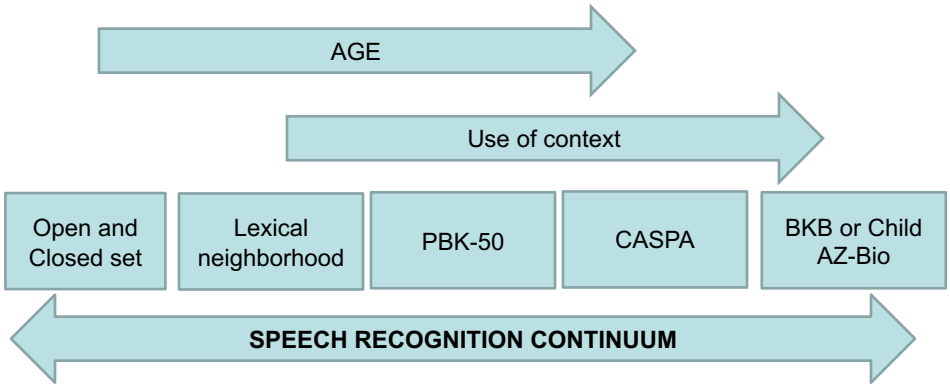

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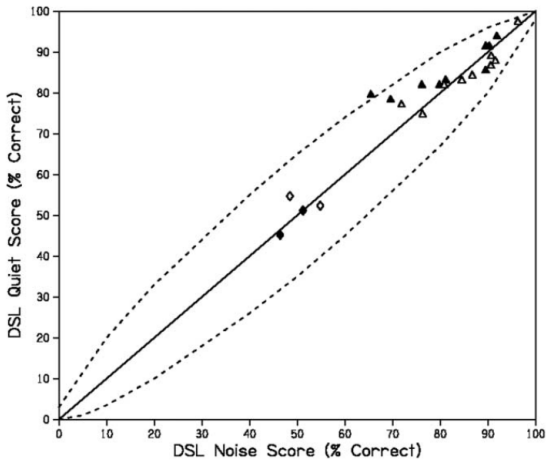
Figure 4. Individual scores on the consonant recognition in quiet task (in percent correct) across level and prescriptions. Filled symbols represent scores at an input level of 50 dB SPL and open symbols represent scores at an input level of 70 dB SPL. Diamond symbols represent scores for subjects with Sound Recover enabled. Dashed lines indicate the 95% confidence interval for significant change in individual score.



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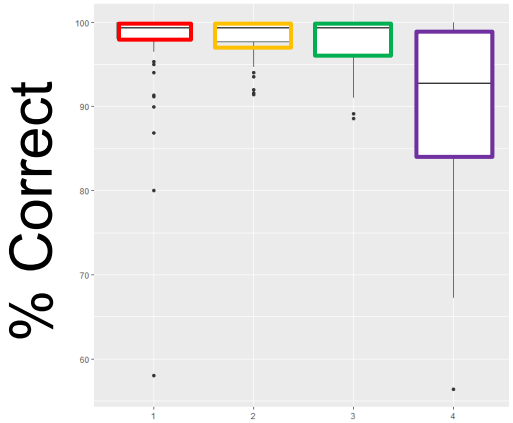

Pediatric
AZBio in Quiet

1 = Normal
2 = Mild
3 = Moderate
4 = Severe

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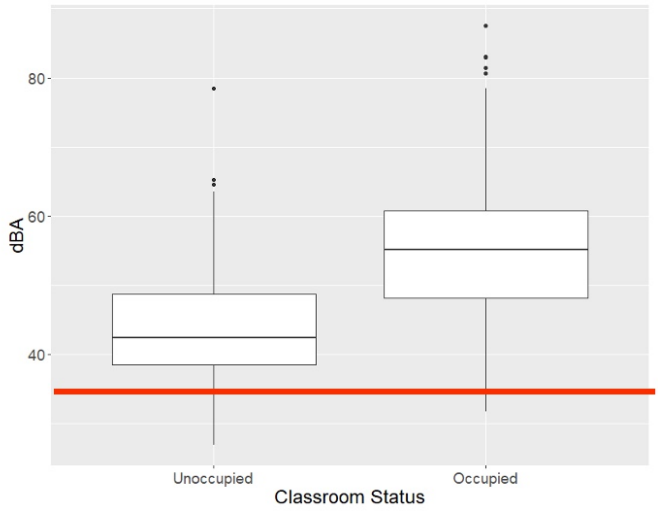
24

hip with

Classroom acoustics



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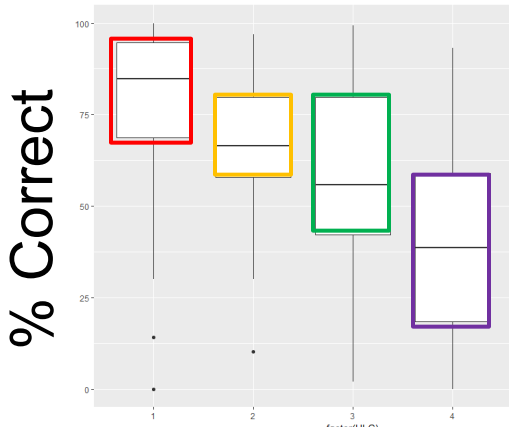

Pediatric
AZBio + 6 dB SNR

1 = Normal
2 = Mild
3 = Moderate
4 = Severe

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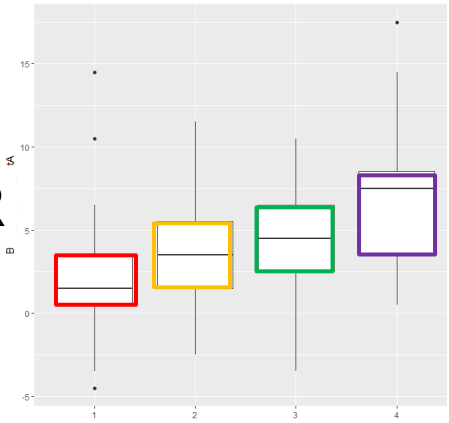
hip with

SNR



HL Group

BKB-SIN SNR
50% Correct

1 = Normal
2 = Mild
3 = Moderate
4 = Severe

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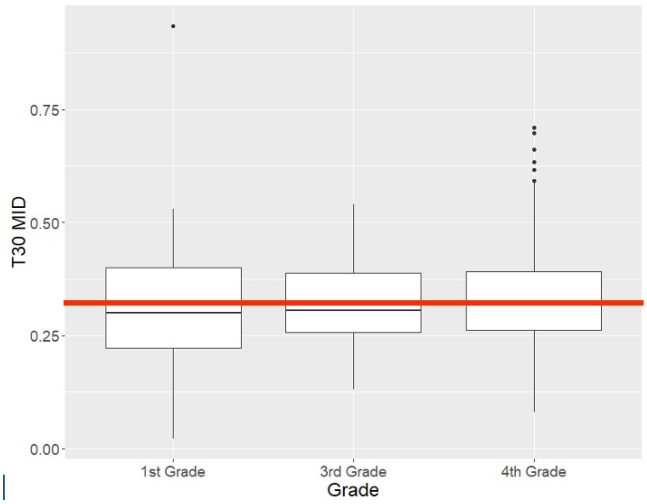
Classroom acoustics



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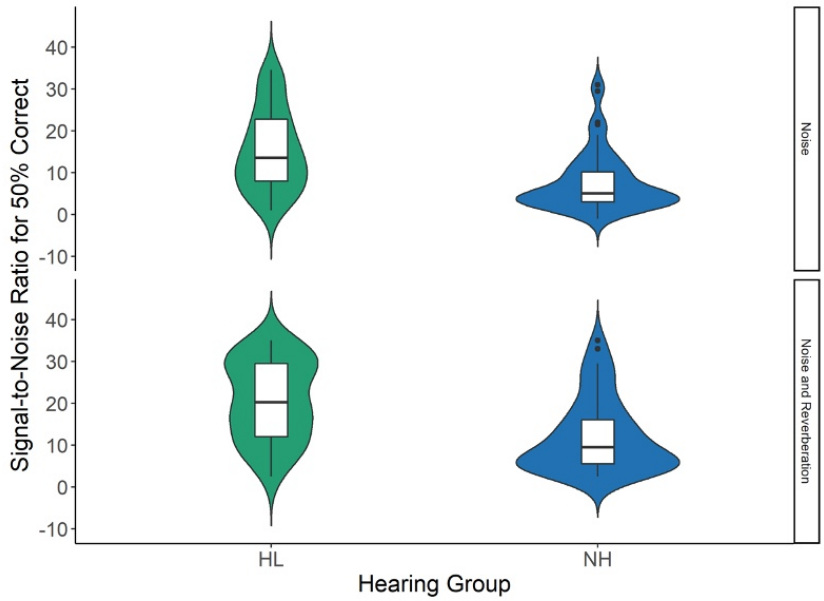
hip with



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Aided speech recognition

- Compare to outcomes from studies of children who wear hearing aids
- Check aided audibility across input levels

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Unilateral hearing loss

- Loss of binaural hearing
- Binaural means two ears
- We use binaural hearing for specific listening skills

31

UHL - Loss of Binaural Hearing

- Binaural summation
- Head shadow effect
- Sound localization
- Binaural release from masking

32

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UHL – Binaural Summation

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UHL – Binaural Summation

- We hear better when sounds reach both ears.
- Children without binaural summation may miss certain soft sounds in their environment

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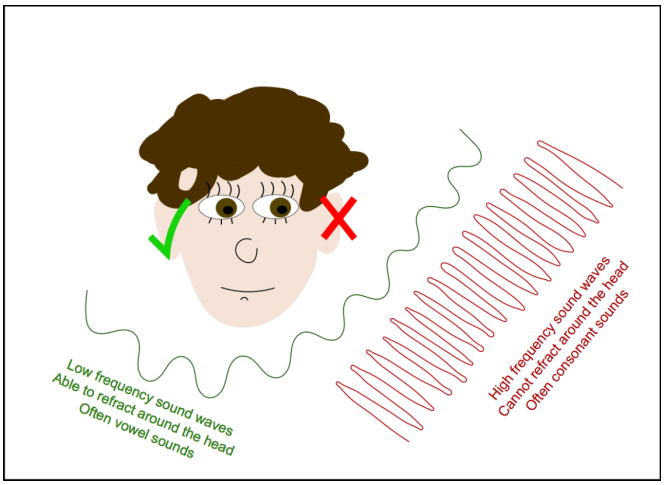
hip with

Head shadow



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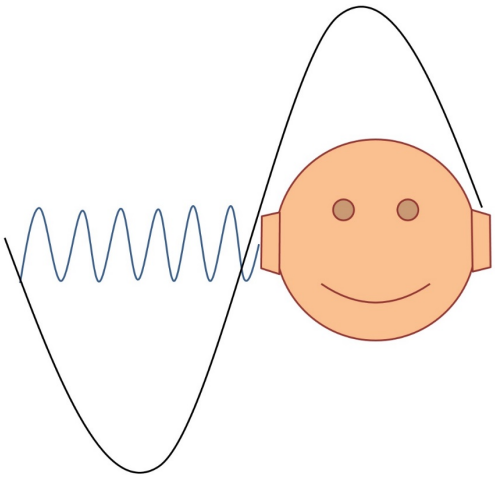
Head shadow



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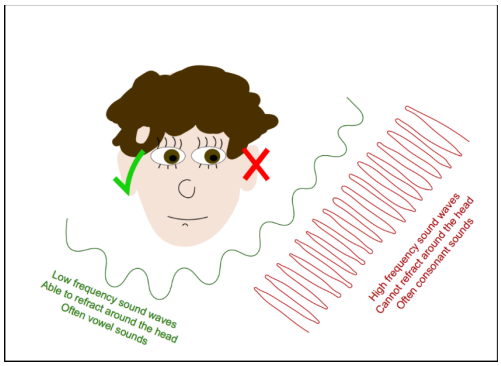
hip with

Head shadow



- Our head blocks sounds at higher frequencies that come from the side.
- We use differences created by the head shadow to determine the location of sounds in the environment.

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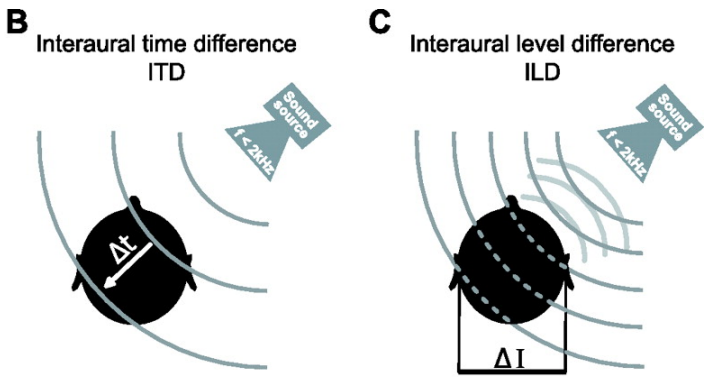
Binaural localization cues



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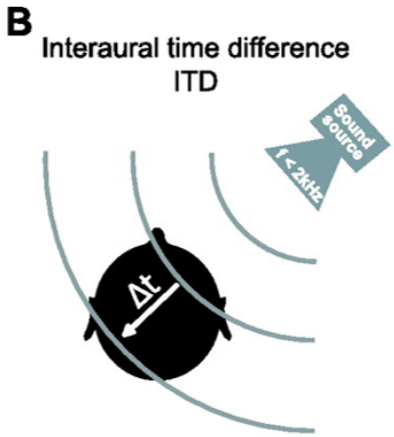
Interaural time differences (ITD)



Lower frequency sounds from the side of the head arrive at the ear closest to the sound first.

We use differences in the time of arrival between ears at low frequencies to locate sounds.

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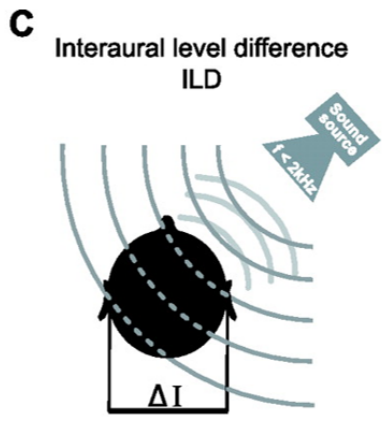
Interaural level differences (ILD)



Higher frequency sounds from the side of the head do not arrive at the opposite ear.

If a sound is louder to one side, we use the level information to determine location

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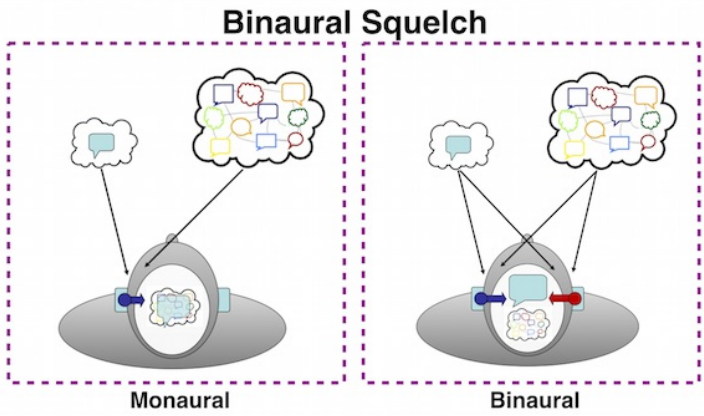
hip with

Binaural release from masking

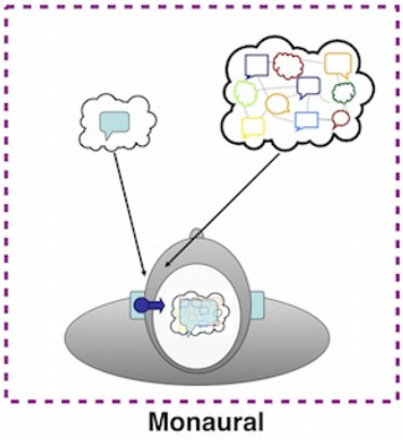


41

What is release from masking?

- Masking = noise
- One ear = monaural
- The ear receives a mix

of speech and noise



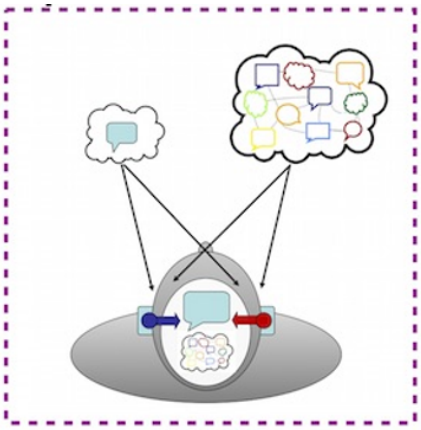
42

hip with

Binaural masking release

For sounds that are separated in space, we can better separate speech from noise.

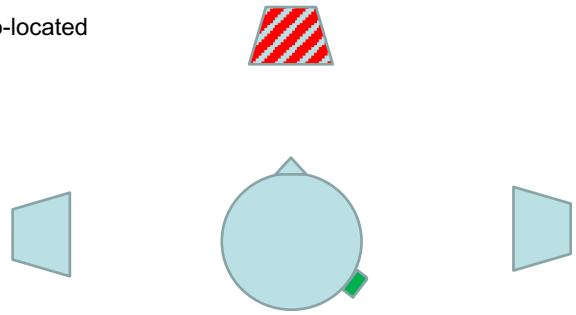
Children with UHL will have problems listening and learning in background noise



43

Spatial Release from Masking

Speech and Noise Co-located

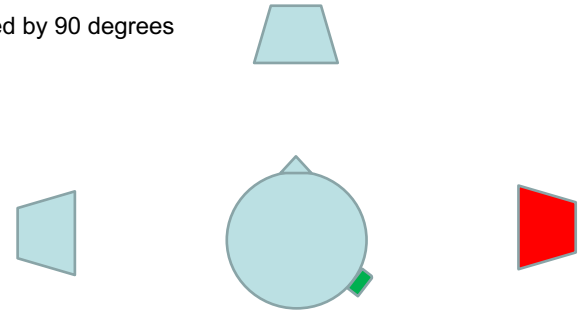


44

hip with

Spatial Release from Masking

Speech and separated by 90 degrees
Device Side



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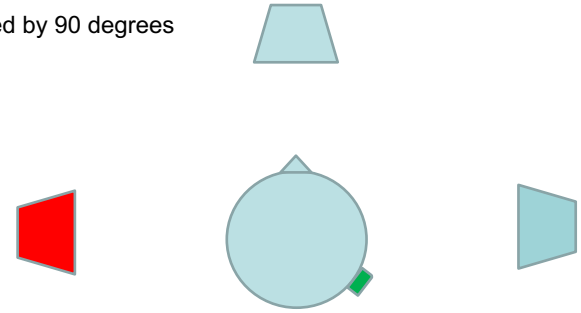
Spatial Release from Masking

Speech and separated by 90 degrees
Contra device



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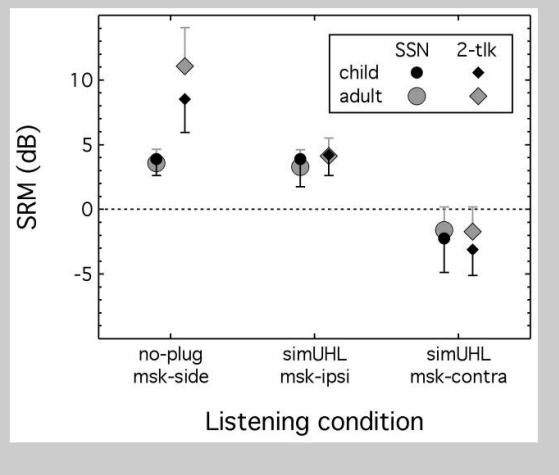
46

hip with

Spatial Release from Masking



UHL– Aidable (Unaided SII 0-80)

- Provide hearing aid to improve binaural hearing
- Factors to consider
  - Age of amplification?
  - Speech understanding (if measurable)
- If unaided SII = 0, aided SII > 50 for simulated fitting

hip with

UHL – Severe/Profound (Unaided SII = 0/ Aided SII < 50)

- Limited potential binaural hearing
- Binaural interference?
- CROS not supported in BCEHP
  - Overcome head-shadow effect
  - Limited evidence in population of the program

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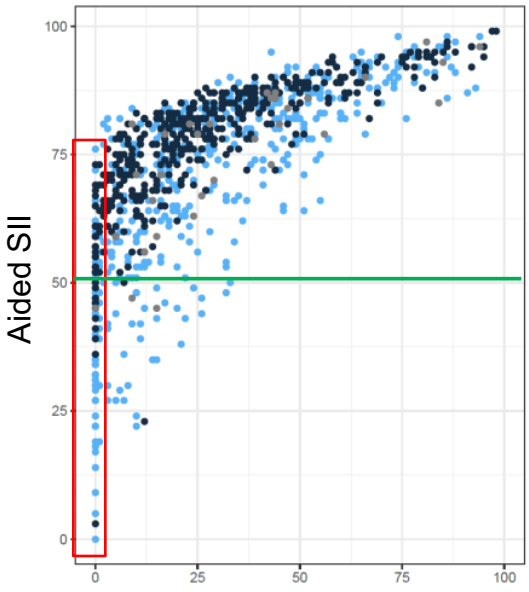
Black dots = Well-fitted kids

Blue dots = poorly fitted kids



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Bone conduction device - CROS

- Limited evidence in the age range of the BCEHP for using a bone conduction device with severe/profound unilateral hearing loss.
- Could improve head shadow
  - Bandwidth?

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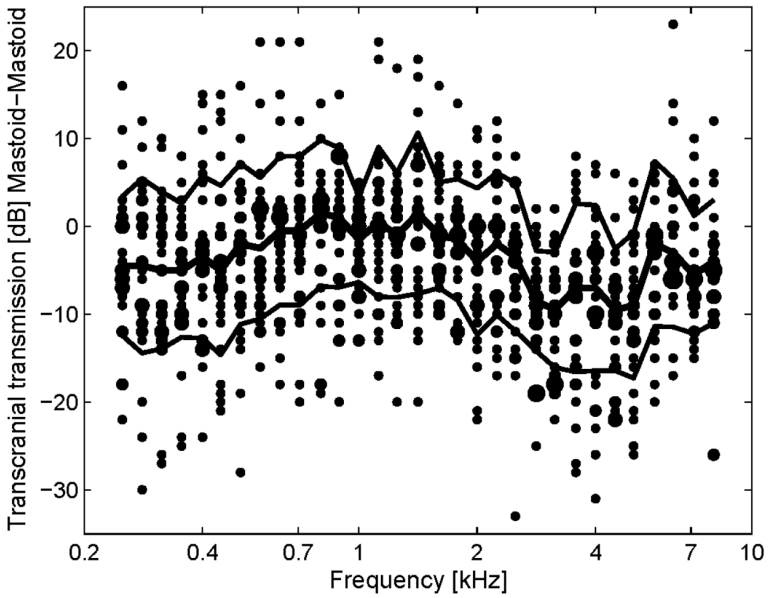

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Auditory Development Questionnaires

- LittlEars – 12 months – 2 years
- PEACH – 12 months – 2 years – once 28 on LittlEars
- SSQ – 4, 6, 8 year-olds

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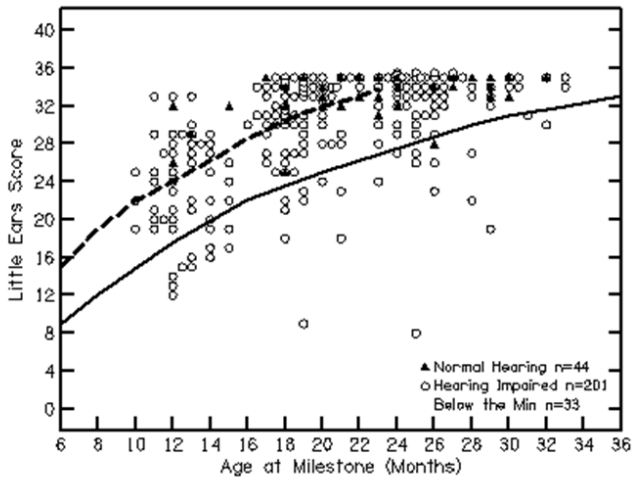
LittlEARS



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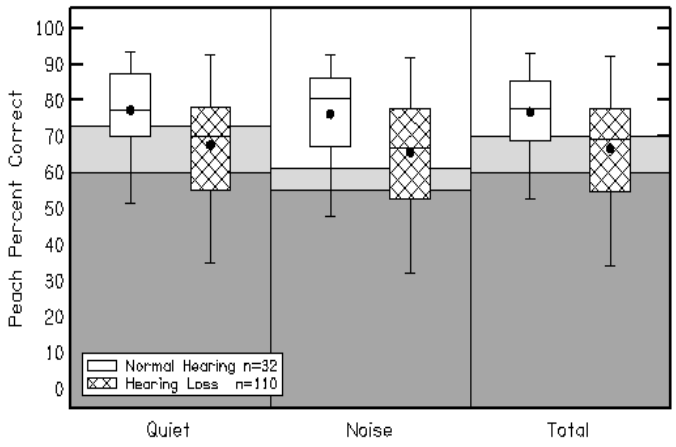
PEACH



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PEACH vs. previous studies

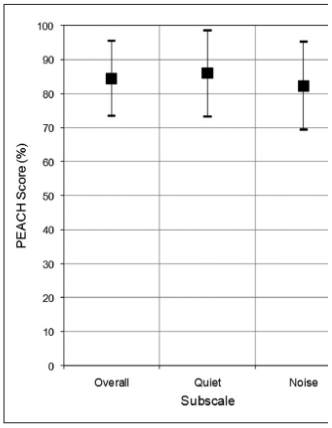
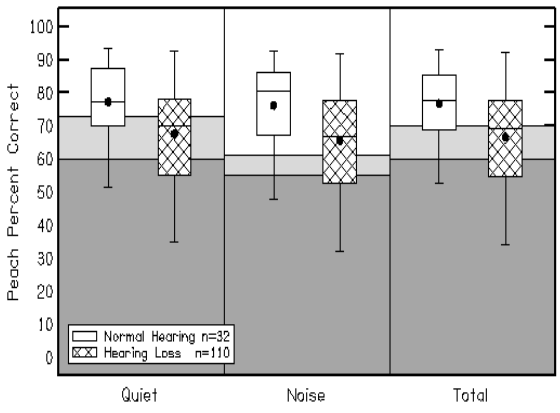


Figure 8. PEACH scores from typically developing, full-term children with hearing aids



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Auditory Development Questionnaires

- Reflect auditory variables
- Also reflect language abilities

- LittlEars – performance may be high
- PEACH – consider age of child

57

When to move to cochlear implantation or another device?

- Reduced or stagnant outcomes despite:
  - Good audibility
  - Consistent hearing aid use
- Shift in candidacy
  - Current: Audiogram
  - Future: Audibility, hearing aid use, and outcomes

58

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Thank you!

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