



Interior Health
Every person matters

SPEECH INTELLIGIBILITY INDEX (SII)

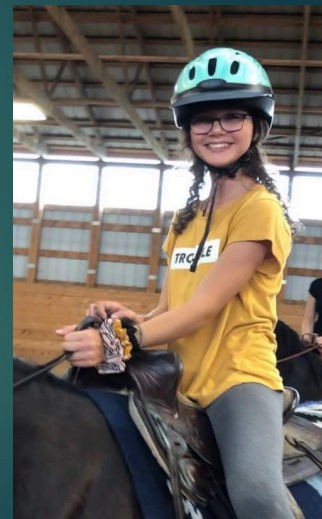
FOR TEACHERS OF THE DEAF AND HARD OF HEARING
MAY 5, 2020

Naomi Smith, MSc., RAUD/RHIP
Interior Health Audiologist and
BC Early Hearing Program
Amplification Support

1

Topics of webinar:

- ▶ SII and audibility – Definition
- ▶ Old and new methods for calculating SII
- ▶ How do we use SII?
 - ▶ Counseling re: effect of hearing loss on audibility
 - ▶ Determining hearing aid candidacy
 - ▶ Determining hearing aid benefit
- ▶ Expectations
- ▶ What about functional gain?
- ▶ Benefits and limitations of the SII
- ▶ Questions??



2

SII - Definition

- ▶ The Speech Intelligibility Index, or SII, is a measure, ranging between 0.0 and 1.0 “that is highly correlated with the intelligibility of speech.” (ANSI, S3.5, 1997, p. 1).

$$SII = \sum_{i=1}^n I_i A_i$$

- ▶ Amount of speech that is available to the listener (S. Scollie).
 - ▶ 0.0 = 0% of speech is available
 - ▶ 1.0 = 100% of speech is available
- ▶ Not a new measure – has been around since 1997. But recently getting more attention and more use.

3

Audibility

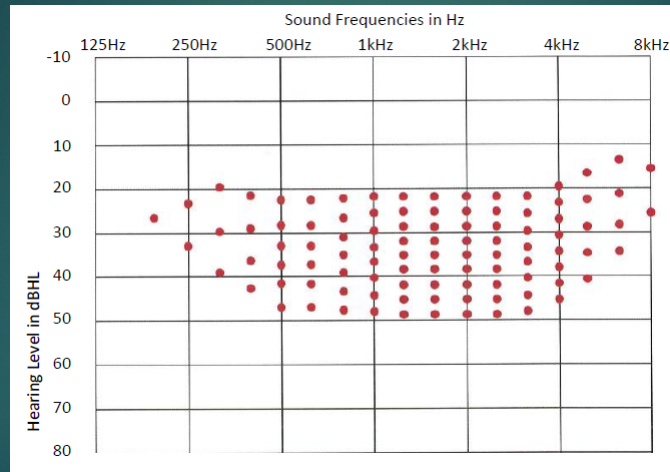
- ▶ How well we can hear a specific sound
- ▶ Children can only develop what they hear
- ▶ Determined by:
 - ▶ Hearing thresholds
 - ▶ **Level** and **location**
 - ▶ Noise
 - ▶ Device (if present)

From Dr. Ryan McCreery – Boystown National Research Hospital



4

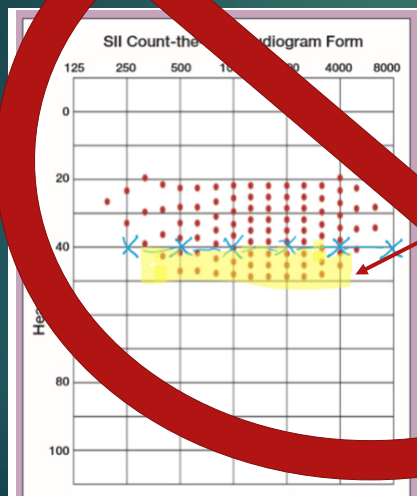
Count the Dots Audiogram



Mead Killion - 1989

5

Count the Dots Audiogram with Hearing Loss



Flat 40 dBHL Hearing Loss

From Dr. S. Scollie - Audiology Online, 2018 "Using the aided intelligibility index in hearing aid fittings".

6

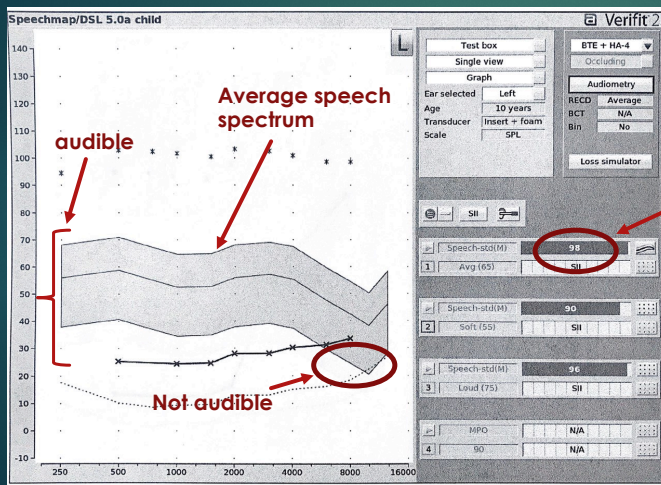
Hearing Aid Analyzer



Audioscan Verifit 2 – Image from user manual

7

Flipping the Audiogram Upside Down – SPL-o-gram



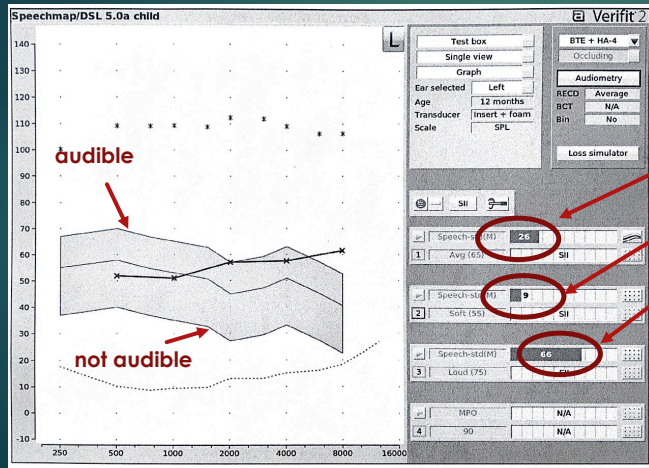
Normal Hearing
(15 dB HL)

98 SII (average)

8

Hearing Loss Examples

Flat (40 dB HL) Mild Hearing Loss

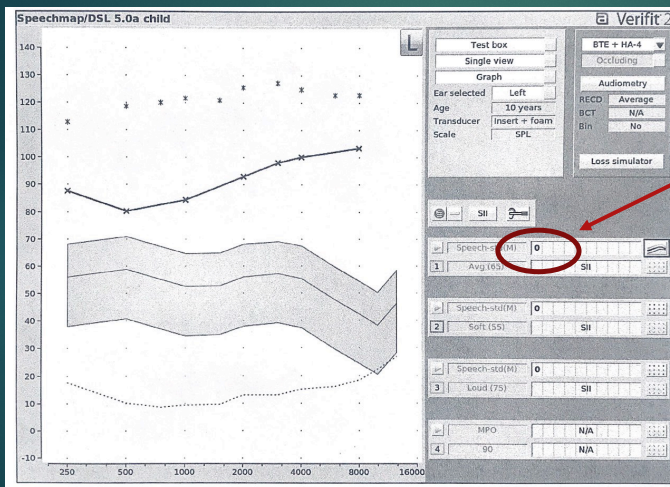


26 SII (average)
9 SII (soft)
66 SII (loud)

9

Hearing Loss Examples

Severe Hearing Loss

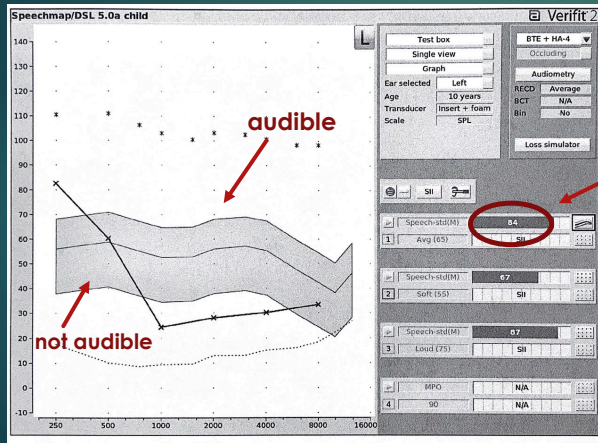


SII = 0

10

Hearing Loss Examples

Low-frequency Moderate to Severe Hearing Loss

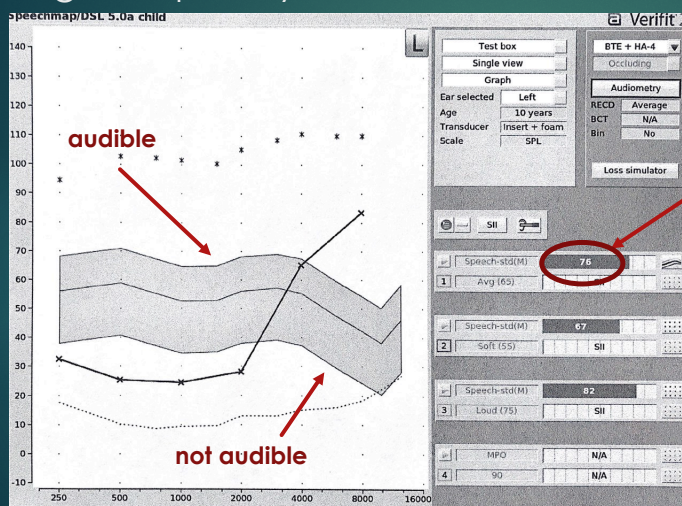


SII: 84

11

Hearing Loss Examples

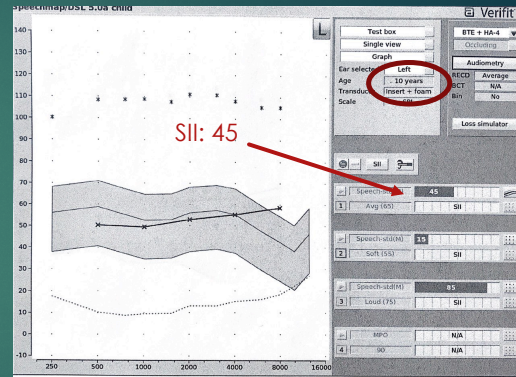
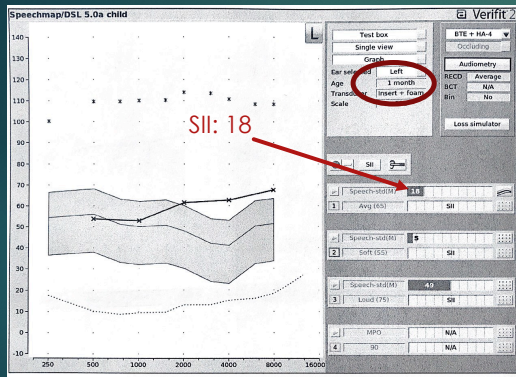
High frequency Moderate to Severe Hearing Loss



SII: 76

12

Hearing Loss Examples: How age affects SII



Same 40 dB HL flat loss
 One (1) month old baby: 18 SII (average speech)
 Ten (10) year old child: 45 SII (average speech)

13

Hearing Aid Candidacy and SII

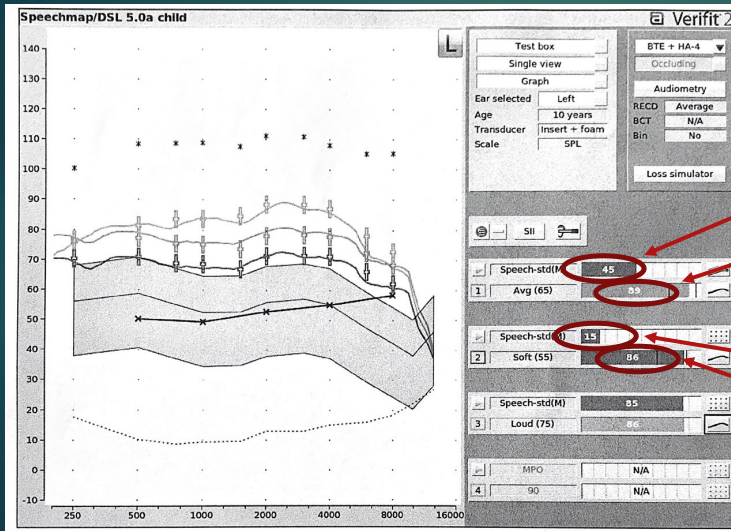
- BC Early Hearing Program criteria:
 - Children with an unaided SII of ≤ 80 should be considered for amplification
 - Unilateral: SII 5-80 (or aided SII >50).



14

Hearing Loss Examples:

Aided versus unaided SII – 40 dB HL flat hearing loss



Average speech

unaided SII: 45

aided SII: 89

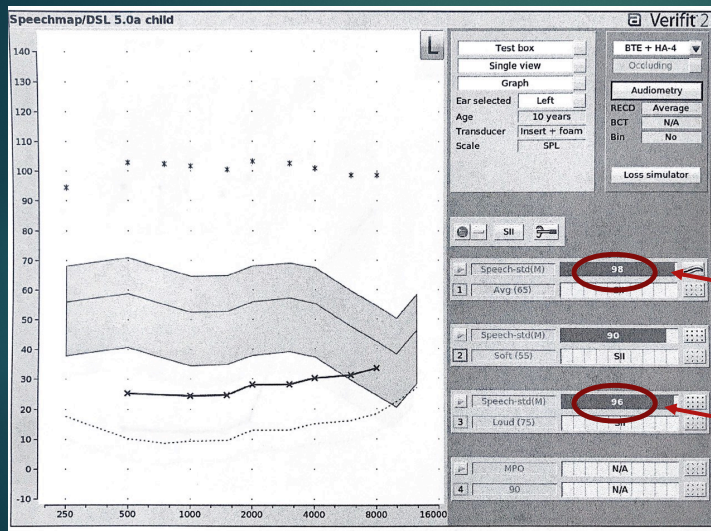
Soft speech

unaided SII: 15

aided SII: 86

15

Realistic Expectations



Normal hearing:
15 dB HL
thresholds

Average speech:
unaided SII: 98

Loud speech:
unaided SII: 96

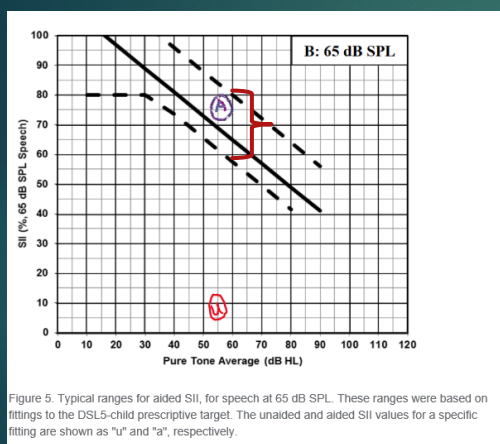
16

Realistic Expectations

- ▶ Is our goal an SII of 100 for all fittings? No!
- ▶ In general, the higher the degree of hearing loss, the lower the SII (unaided *and* aided) - but configuration of hearing loss matters!
- ▶ For moderate-severe and severe-profound hearing losses, the SIIs may look a bit lower than expected.

17

What is a “good” fit?



From Marlene Bagatto UWO
PedAMP Protocol (Bagatto et
al. 2011)



18

What about functional gain (aided thresholds in soundfield)?

- Aided thresholds are un-necessary and inaccurate.
- Non-linear processing and compression = variable gain based on input level. At low input levels, the gain of the hearing aid is close to maximum.
- Noise reduction algorithms in hearing aids can interpret the 'warbled tones' that we use in the soundfield as 'noise' and can actively suppress the noise.
- In rare cases, we do functional gain measures (i.e. bone conduction hearing aid on a softband where you can't use a hearing aid analyser), only because we have nothing better!
- We can do speech perception testing in soundfield.

19

SUMMARY

Benefits of SII

- Quick, easy 1 number that translates to percentage
- Can be used to estimate percentage of speech audible for different input levels (soft, average, loud) and for different age levels
- Can be used to compare unaided versus aided benefit
- Great counseling tool!

20

What the SII *doesn't* tell us...

- ▶ The configuration, type or degree of hearing loss
- ▶ How much speech is audible in adverse listening environments (i.e. noise, fast speech). It only reflects proportion of speech sounds audible in quiet (i.e. best case scenario).
- ▶ How a child processes the information they have access to (Just because a child can 'hear' speech sounds, it does not mean that they can interpret them).
- ▶ How a hearing aid with adaptive technology and directionality functions.

21



Questions ???



22

Functional Auditory Measures

Tamara Lister, M.Sc. RSLP
Speech-Language Pathologist
tamara@popdhh.ca

May 5, 2020



23

Overview



OBSERVATIONAL
MEASURES




ENVIRONMENTAL
MEASURES



BEHAVIOURAL
CONSIDERATIONS

24



Children's Home Inventory for Listening Difficulties

Questions for Parent to Answer
Try the following situations with your child or recall how your child has responded under these various situations. Everyone has some difficulty hearing clearly and understanding in some situations. Choose the level on the Understand-O-Meter you think describes your child's abilities most closely and place this number in the blank at the end of each question. This can be very difficult but try to estimate the child's listening abilities as best you can.

Child's Name: _____ Parent Completing CHILD: _____


Understand-O-Meter

1. Sit next to your child and look at a book together or talk about something in front of you using familiar words and a normal conversational manner. Talk in a quiet place and sit so your child is not looking at your face as you talk together. How difficult does it seem for your child to hear and understand what you say? _____
2. Gather your family together for a meal at home or in a fairly quiet restaurant. Sit across the table from your child and ask some questions about a familiar topic or event. How difficult does it seem to be for your child to hear and understand? _____

8 GREAT
Hear every word, understand everything

7 GOOD
Hear it all, miss part of an occasional word, still understand everything

6 PRETTY GOOD
Hear almost all the words



Children's Home Inventory for Listening Difficulties

Questions for the Child to Answer:
Picture yourself in the following situations. How easy is it for you to hear and understand? Use the Understand-O-Meter to pick the level that tells how easy or hard it is for you to understand and put the number in the blank after each question. Everyone has a harder time hearing in some situations. Only you know the right answer for you.

Understand-O-Meter

1. You are sitting next to your mom or dad. You are looking at a book together or talking about something in front of you. You are not looking at mom or dad's face as they talk to you. It's quiet. How difficult is it for you to hear and understand what they say? _____
2. Your family is together for a meal at home or at a restaurant. Someone across the table says something or asks you a question. How difficult is it for you to hear and understand what is said? _____
3. You are in your bedroom playing quietly. Mom or dad walk into the room without saying your name or getting your attention before they tell or ask you something. How difficult is it for you to hear and understand what is said if your parents don't get your attention before talking to you? _____

8 GREAT
Hear every word, understand everything


7 GOOD
Hear it all, miss part of an occasional word, still understand everything

6 PRETTY GOOD
Hear almost all the words

Children's Home Inventory for Listening Difficulties (CHILD) by Karen Anderson

- For caregivers and students
- Ages 7-12 years
- Identifies challenging listening situations

25








Listening Inventory for Education


Life Student Appraisal

Student: _____ Grade: _____ Date: _____ School: _____

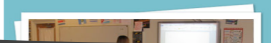
Student: Read the question. Select the circle that best represents how well you hear and understand.


1. The teacher is talking in front of the class. The kids are quiet. Everyone is watching and listening to the teacher. How well can you hear and understand the words the teacher is saying?

 Always Easy
 Mostly Easy
 Sometimes Difficult
 Mostly Difficult
 Always Difficult



2. The teacher is talking, but has his back to you as s/he writes on the board or faces another student. How well can you hear and understand the words the teacher is saying?





Listening Inventory For Education-Revised (L.I.F.E.-R.)

Teacher Appraisal of Listening Difficulty

By Karen L. Anderson, PhD, Joseph J. Smaldino, PhD, & Carrie Spangler, AuD

Name: _____ Grade: _____ School: _____

Teacher: _____ ☐ hearing Aid ☐ User Date LIFE Completed: _____

Type of Classroom Hearing Technology: _____

L.I.F.E. Classroom Listening Situations					
	No challenge or very rare	Slightly challenged	Sometimes challenged	Often/severely challenged	Almost always challenged
1. Student's ability to focus on/follow large group verbal instruction (i.e., teacher front of room):	5	4	3	2	1
2. Student's ability to focus on/follow verbal instruction when you are moving about the room:	5	4	3	2	1
3. Student's ability to focus on/understand verbal responses by other students seated across the classroom from him/her: Check one: <input type="checkbox"/> With FM mic used by student <input type="checkbox"/> Without FM mic	5	4	3	2	1
4. Ability to attend when listening to directions presented to the whole class (focus):	5	4	3	2	1
5. Ease of following directions provided to large group (hesitation before beginning work):	5	4	3	2	1
6. Ability to attend to class when not directly addressed:	5	4	3	2	1

Listening Inventory for Education-Revised (LIFE-R) by Karen Anderson

- For teachers and students
- Identifies areas of student need and teacher accommodations

26

Overview



OBSERVATIONAL
MEASURES



ENVIRONMENTAL
MEASURES



BEHAVIOURAL
CONSIDERATIONS

27

The Environment

- Echo
- Background noise
- Lighting
- Visual Access

How acoustically friendly is your classroom?
School _____ **Room** _____ **Date** _____

Respond by circling the relevant statements:

What are the basic descriptors of the room?

Open plan	Low ceiling	High ceiling	Well fitting Doors with an acoustic / fire seal	Poorly fitted door(s) / doors left open	Double / triple glazing
-----------	-------------	--------------	---	---	-------------------------

Which Acoustic Treatments have been applied to the room?

Soft furnishing in reading area	Display boards void behind and filled	Acoustic ceiling tiles painted	Drapes on display tables	No window covers
Carpets	Display boards	Hard floor	Curtains	Blinds

What noise are you aware of within the classroom?

Computer monitors and printers	Old strip lighting	Positive classroom management of pupil behaviour	Whiteboard Projector	Toilets/ Corridor noise	Pupils talking
Workshop machinery	Scraping of chairs and table legs	Clattering pens and pencils	Wall heaters	Central heating pipes	Fan(s) ventillat on

External noise

Playing field noise	Road traffic	Neighbouring classes	Noise < 40 dB room empty	Dining hall	Quiet location
---------------------	--------------	----------------------	--------------------------	-------------	----------------

Distance between teacher and pupil with a known difficulty e.g. HI, APD
 1m 2m 4m

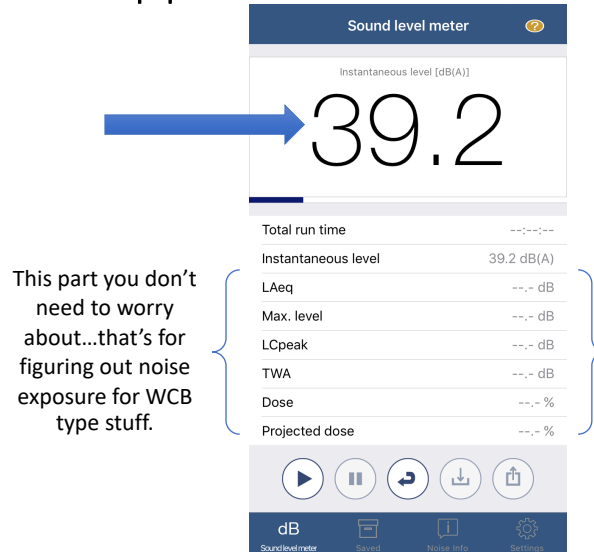
Amplification Technology

EduLink or Convector	Appropriate, well maintained hearing aid	Cochlear Implant	Effectively set up Radio aid	Direct output from TV, computer	Sound field system
----------------------	--	------------------	------------------------------	---------------------------------	--------------------

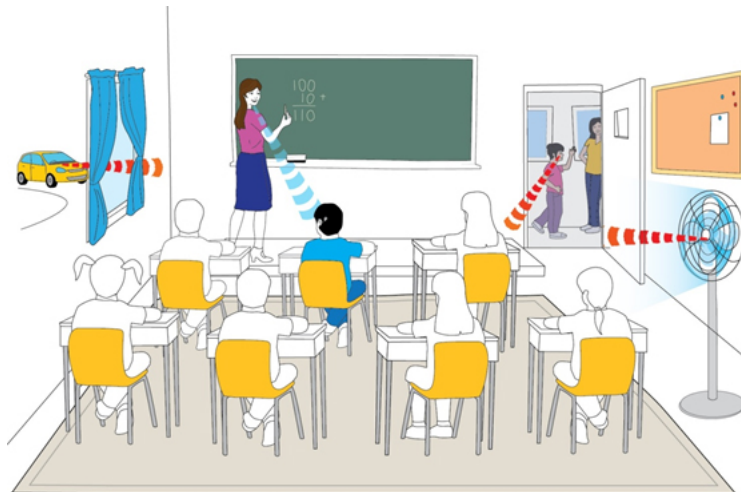
FINAL SCORE	No. of green answers _____ No. of red answers _____
	More green answers than red = acceptable acoustic environment. Minor improvements recommended
	More red answers than green = poor acoustic environment. Major improvements must be made

28

dB Meter App: NIOSH



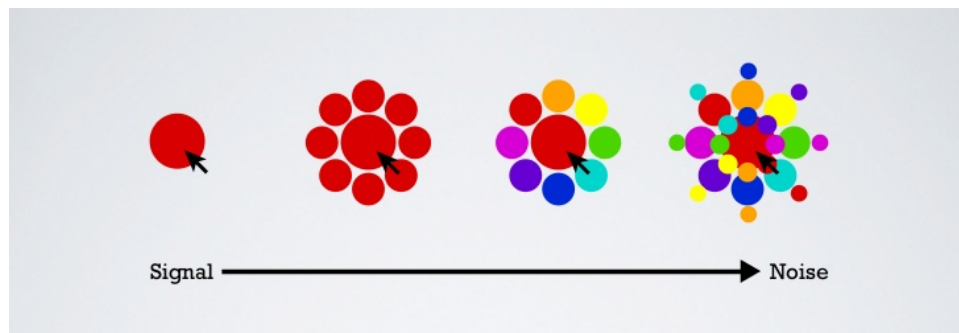
29



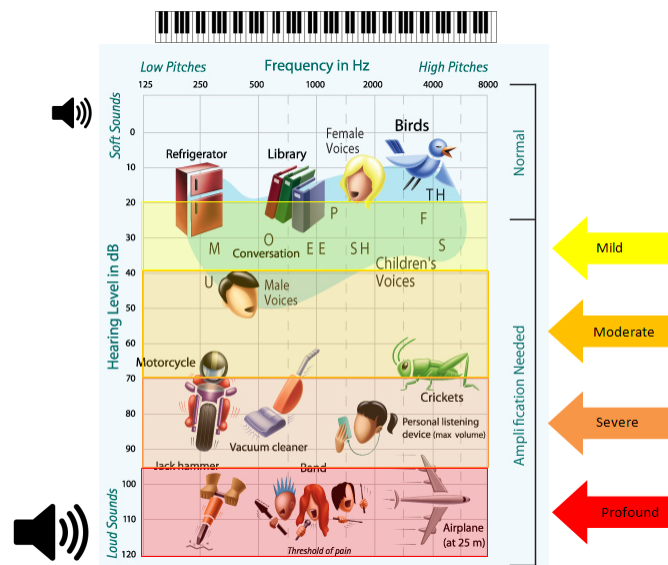
30

Signal to Noise Ratio

- Children with normal hearing require an SNR of +15-20 dB (10x louder)
- Adults need an SNR of +6 dB (2x louder than background noise)



31



32

Overview



OBSERVATIONAL
MEASURES



ENVIRONMENTAL
MEASURES



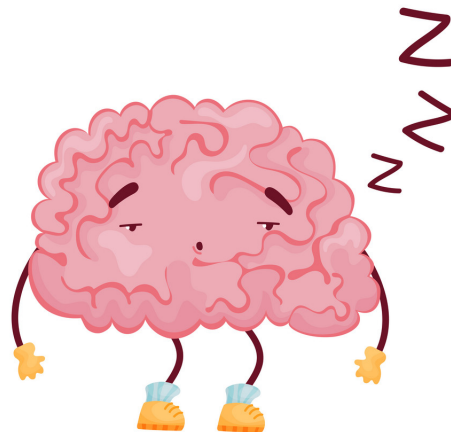
BEHAVIOURAL
CONSIDERATIONS

33

Fatigue

A study found that DHH children experience more fatigue than children with cancer, rheumatoid arthritis, diabetes and obesity.

Hornsby, Werfel, Camarata & Bess, (2014) American Journal of Audiology



34

Listener Fatigue: The Struggle is Real



35

Learning Effort-Reward Imbalance (LERI) Scale		
1. When I am in school or during class, I must often stop my learning because the actions or noises of other students disturbs me	Yes	No
2. I should be performing well in class or be a well-behaved child	Yes	No
3. I often do extra learning outside of school (more homework or tutoring than my class mates)	Yes	No
4. My family members or teachers let me know how much they appreciate my learning in school	Yes	No
5. My friends let me know regarding my learning in school	Yes	No
6. I am afraid that I will not be able to catch up with learning in school in the future	Yes	No
7. My school grades depend on my effort in learning	Yes	No
8. I have a promising future because of my effort and grades	Yes	No
9. As soon as I get up every morning, I begin to think about learning in school	Yes	No
10. I am almost always thinking about learning in school, when I am going to bed	Yes	No

Learning Effort-Reward Imbalance (LERI) Scale
adapted by Karen Anderson

- Grades 4-9
- Educational impact of fatigue

36



tamara@popdhh.ca

Thank you!