Communicating in Noisy Social Situations:
Putting Divergent Signal Processing Strategies to Work in Your Practice

DISCLOSURES

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Stop me if you've heard this before …..

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A man walks into a bar…….

What does he want to do there….

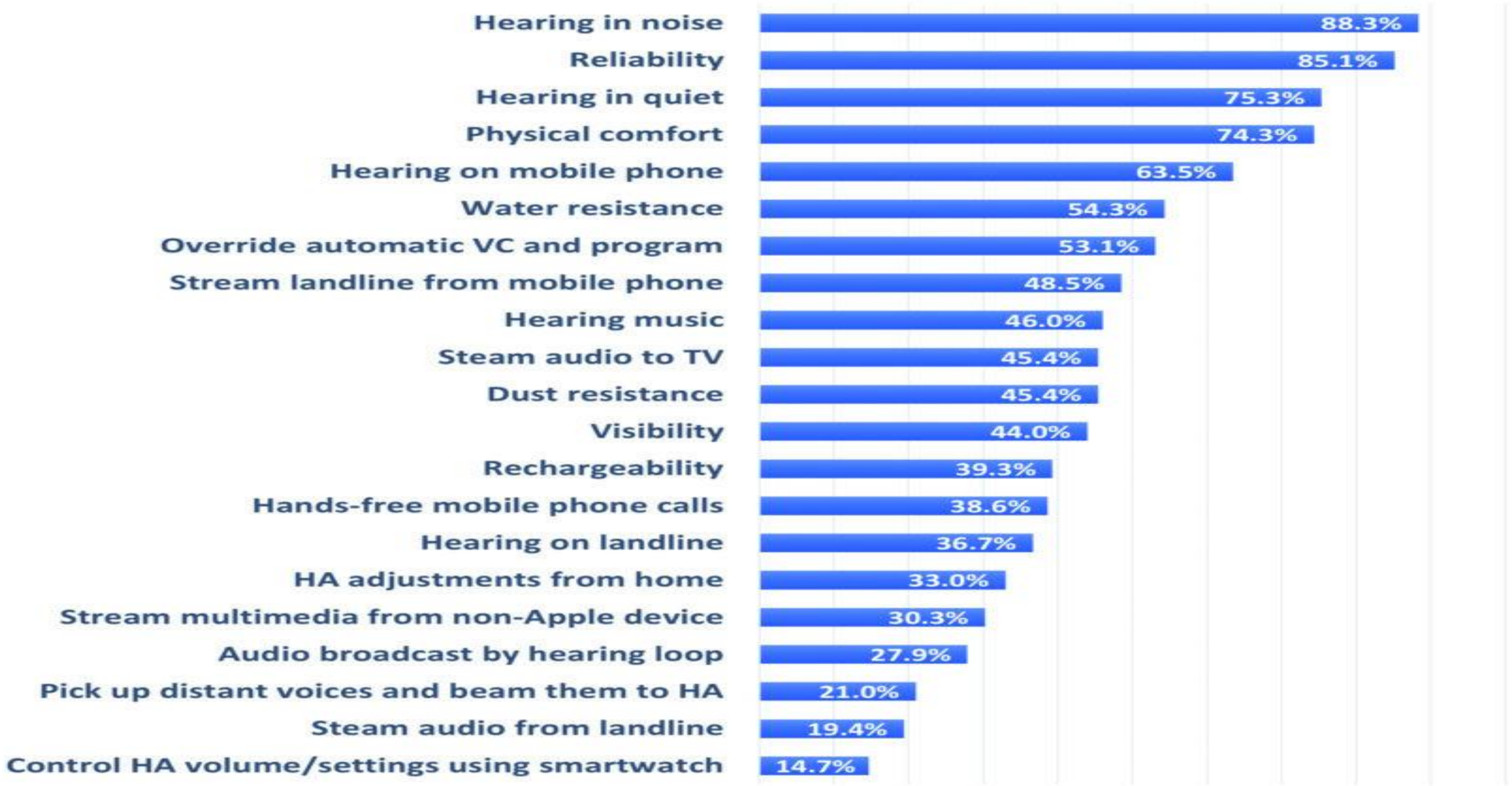
- Talk to the bartender?
- Talk to his friends across the room?
- Watch the game on TV?
- Sit quietly and think about his day?
- Listen to the live band?
- Mingle with other people?
- Maybe all the above?

How do wearers judge success?

Audiology

One of many surveys …..

Manchaiah V, Picou EM, Bailey A, Rodrigo H (2021)



Key Elements of Performance in Noise

Sound Quality

Speech Intelligibility

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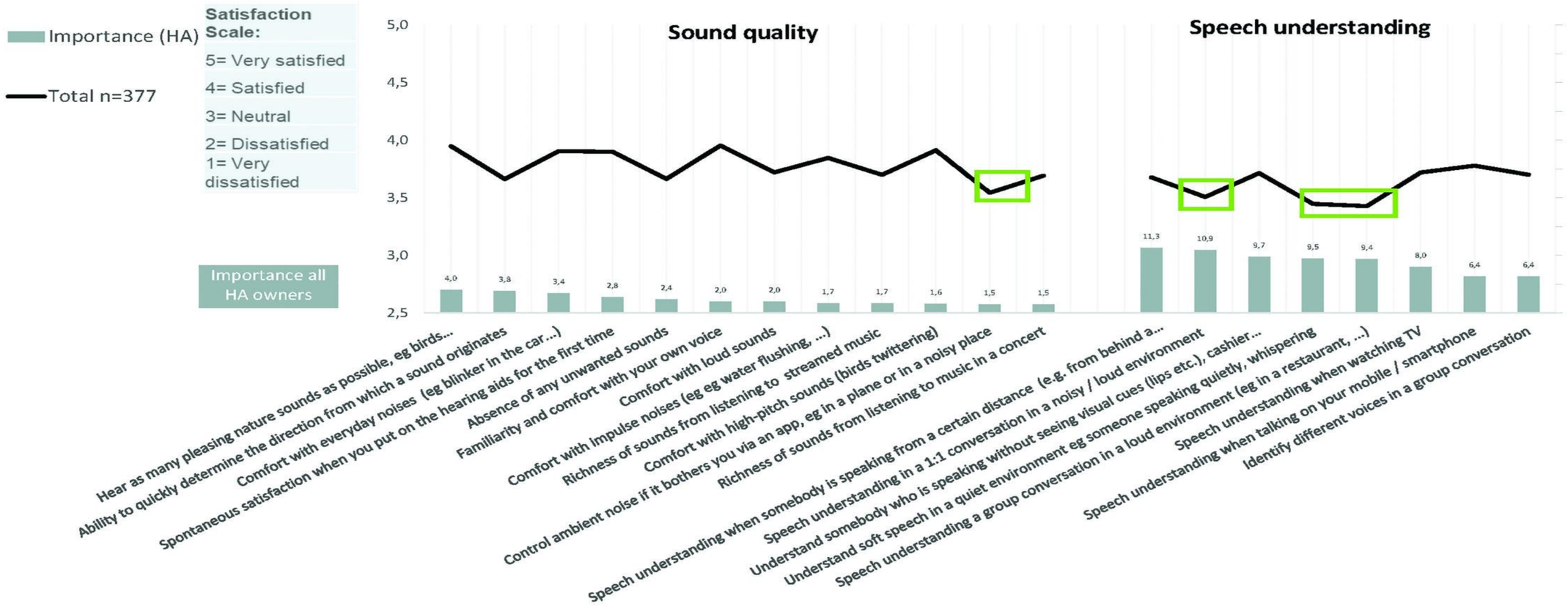
Recent study says…….

Appleton-Huber (2022)



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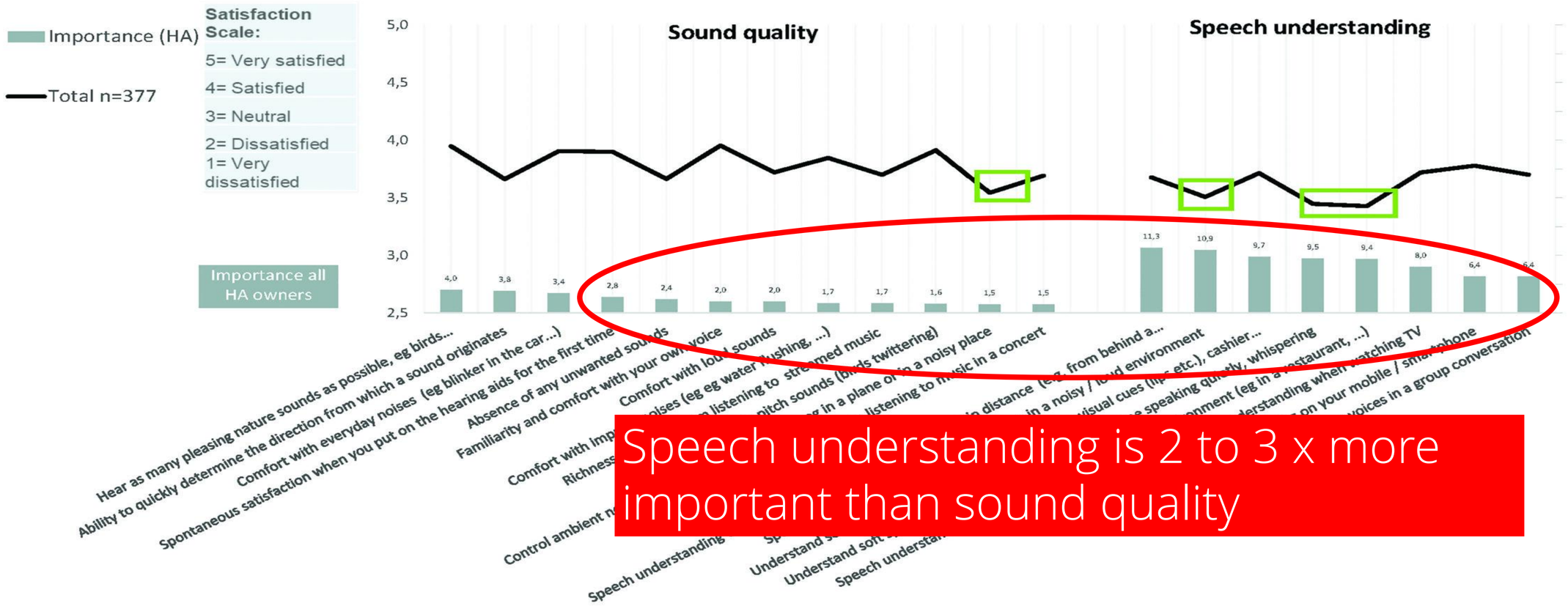

Speech understanding is 2 to 3 x more important than sound quality

Key Findings

1. Speech understanding is more important than sound quality
2. This becomes even more the case with age
3. Most important speech understanding factors are:
   A. 1:1 conversations in noise
   B. Group conversations in noise
   C. Hearing soft speech in noise

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Complex Listening Situations

- Any place rich with sound
- Coming from multiple sources and/or directions
- Where noise is often other people talking
- Sound of interest varies from moment to moment
- Talker of interest might be an unfamiliar voice
- Context of conversation is unfamiliar

Informational Masking

Energetic Masking

Questions Addressed Today

- Why do some people struggle in noise more than others?
- How do hearing aid manufacturers' approaches to this problem differ?
- How to apply those differences in the clinic when making hearing aid selection decisions?

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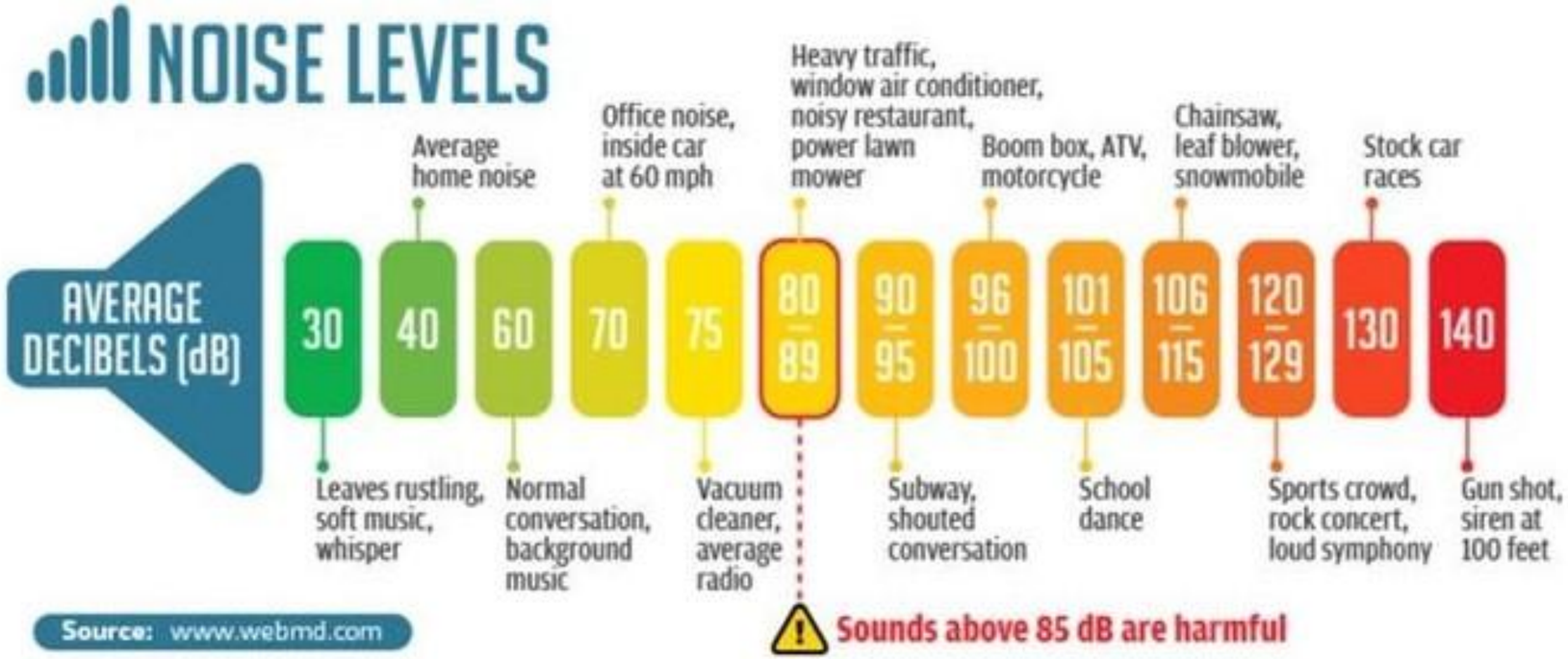
Understanding the 3 “P’s”

A closer look at that first “P” - place



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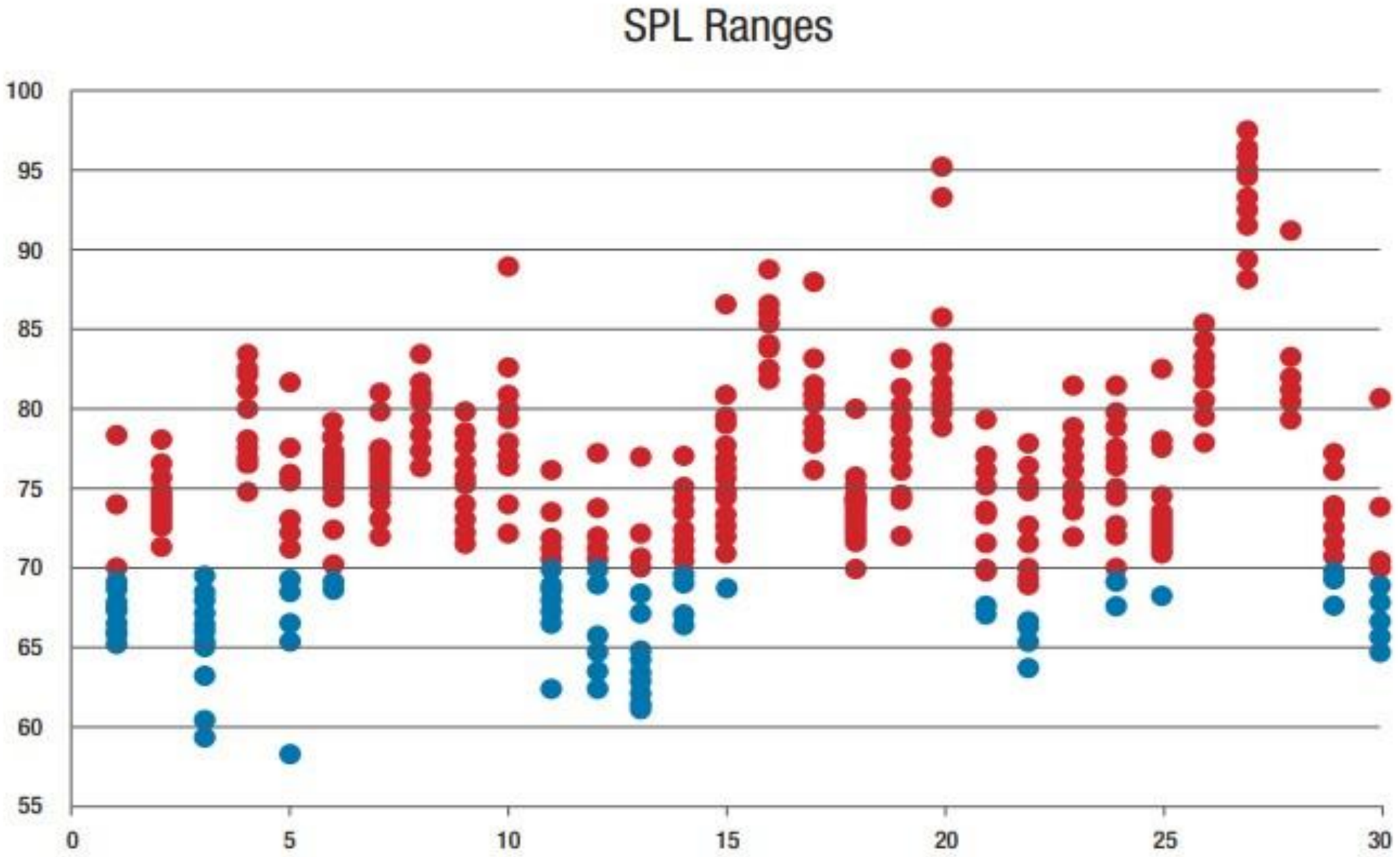
Orlando, FL


SPL Ranges
100
95
90
85
80
75
70
65
60
55
0
5
10
15
20
25
30

SPL Ranges

10-18-22
87 dB SPL

X

100
95
90
85
80
75
70
65
60
55

0 5 10 15 20 25 30

It’s all about the SNR of the place

If the noise is ….	From across the table, speech is likely to be..	The SNR is…	Percent of time per Orlando data…
45 dBA	55 dBA	+10	0%

Karl Pearsons (1977) “Speech Levels in Various Noise Environments” EPA Report

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What is the Expected SNR in Busy Dining Situations?

If the noise is …..	From across the table, speech is likely to be..	The SNR is…	Percent of time per Orlando data…
45 dBA	55 dBA	+10	0%
55 dBA	61 dBA	+6	0%

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45 dBA	55 dBA	+10	0%
55 dBA	61 dBA	+6	0%
65 dBA	67dBA	+2	10%
75 dBA	73 dBA	-2	Much more than 50%!

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Summary of Complex Listening Places

- It’s all about the SNR!
- The SNR is often unfavorable in social situations

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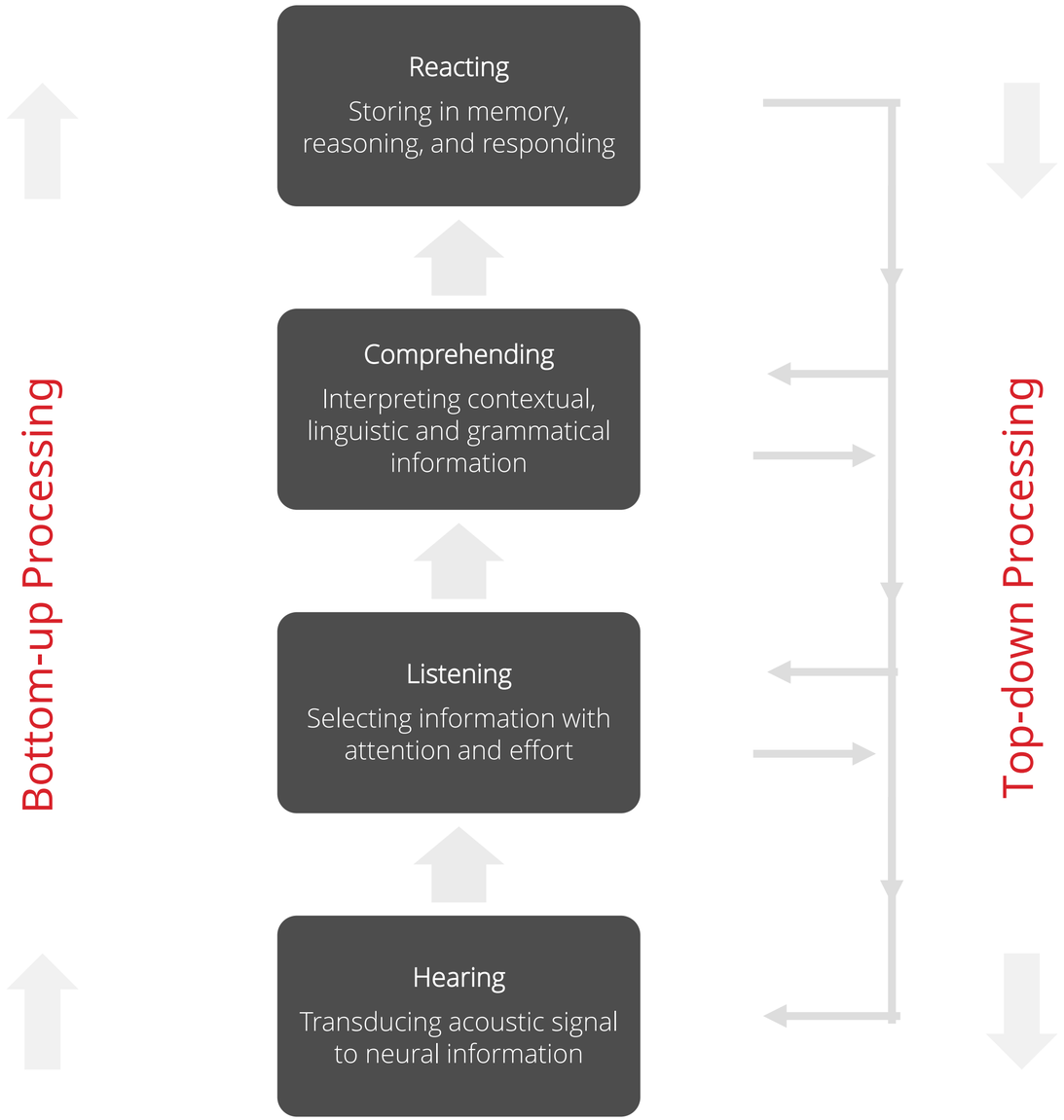
The 2nd “P” is the person

What accounts for individual differences in performance in noise?



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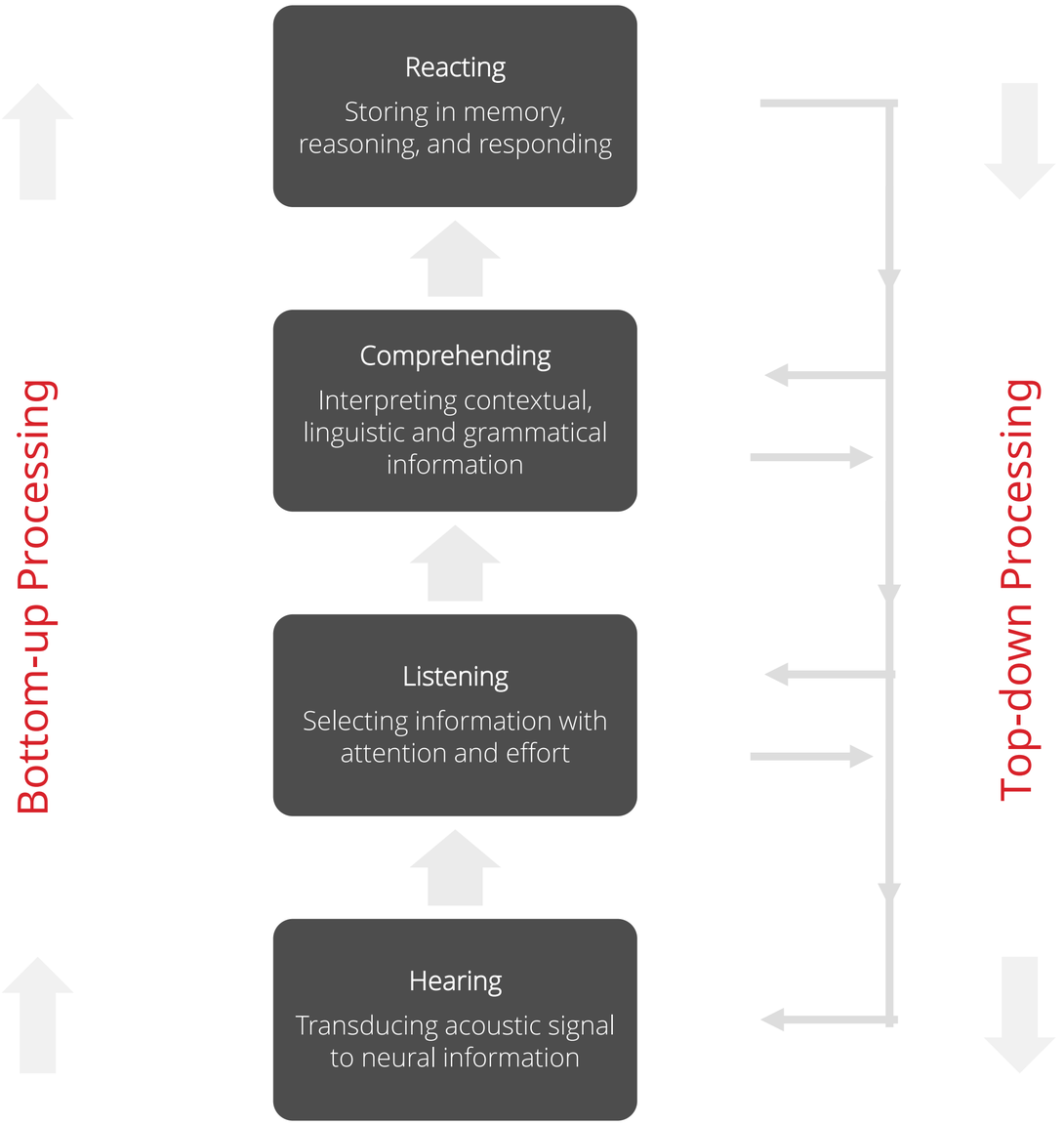
Aging



Hearing Loss

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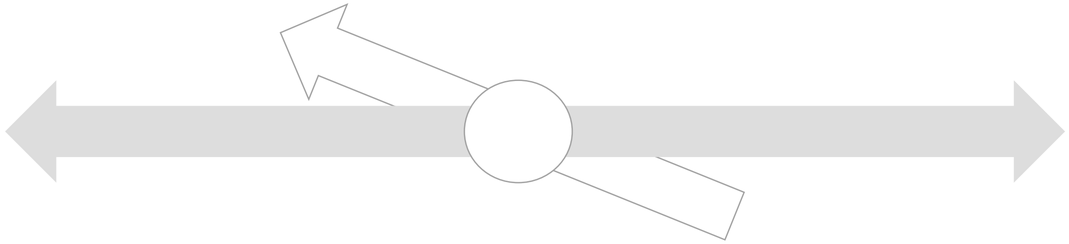
Continually Shifting Equilibrium

“I can follow the conversation”



“I missed what was said”

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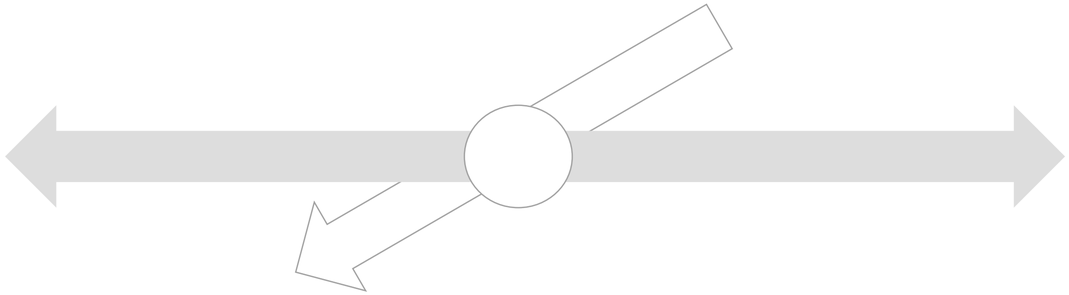
Success or Failure is Determined By 5 Factors

“I can follow the conversation”



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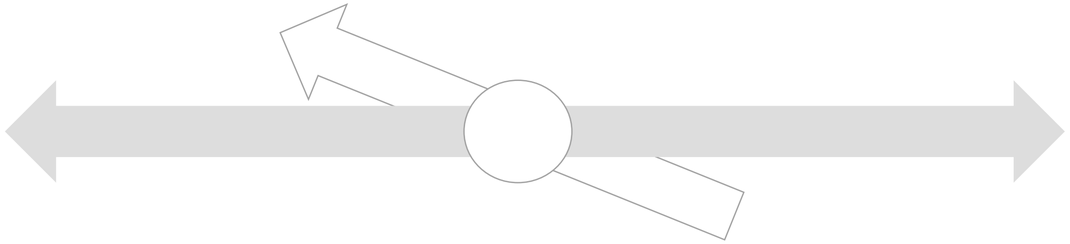

Age

Young ⟺ Old

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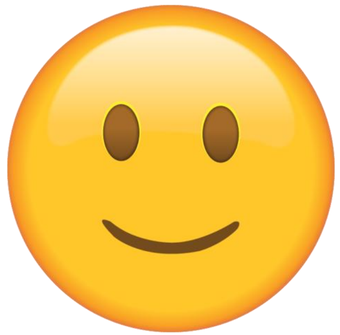
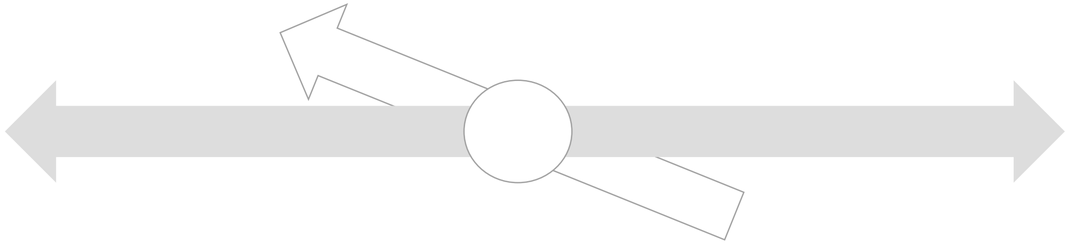
Success or Failure Is Determined By 5 Factors





Context

High ⟺ Low

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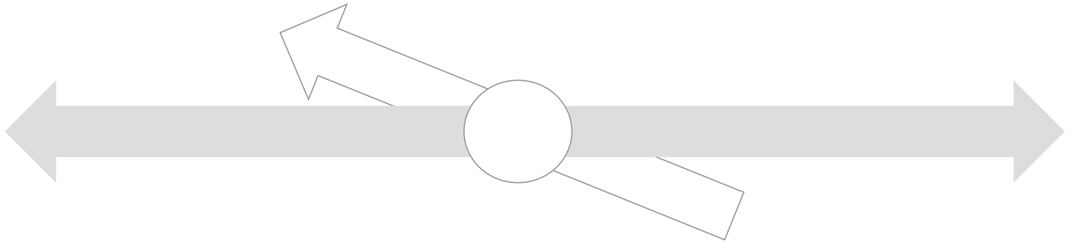
Context is important

“Dad threw the dog her _____”

“Dad threw the dog her …..”

Success or Failure Is Determined By 5 Factors



Linguistic Complexity

Low ⟺ High

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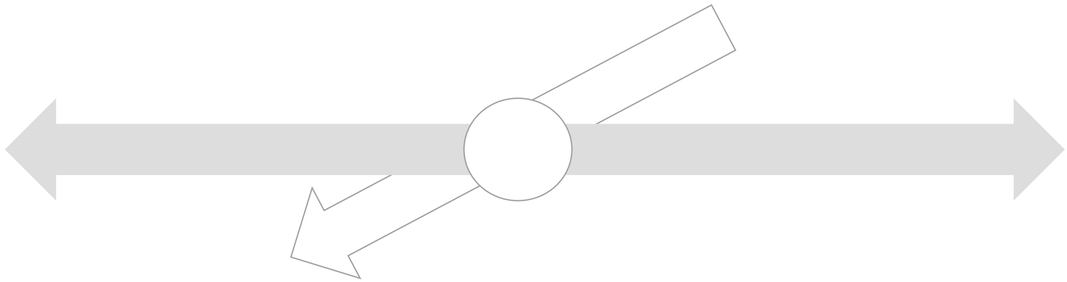
Success or Failure Is Determined By 5 Factors



Hearing Loss

Normal/
Corrected ⟺ Uncorrected

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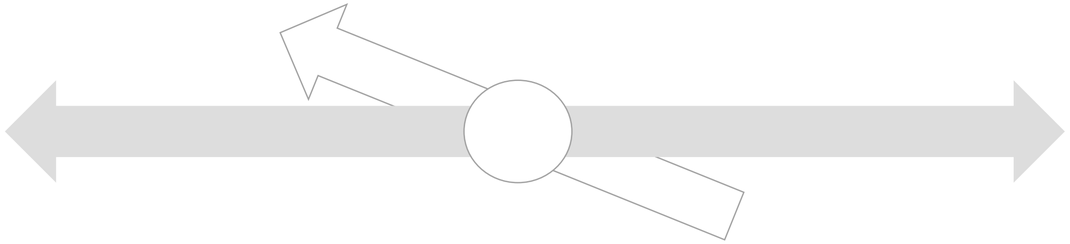
Success or Failure Is Determined By 5 Factors



SNR

Low ⟺ High

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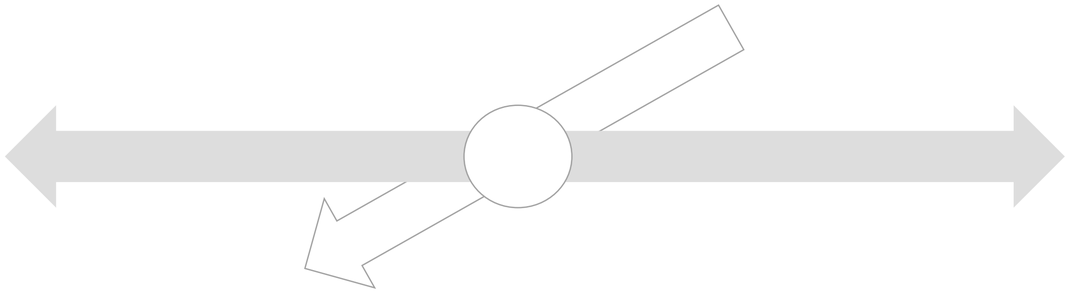
Success or Failure Is Determined By 5 Factors



Age

Young ⟺ Old

Hearing Loss

Normal/ Corrected ⟺ Uncorrected

SNR

Low ⟺ High

Linguistic Complexity

Low ⟺ High

Context

High ⟺ Low

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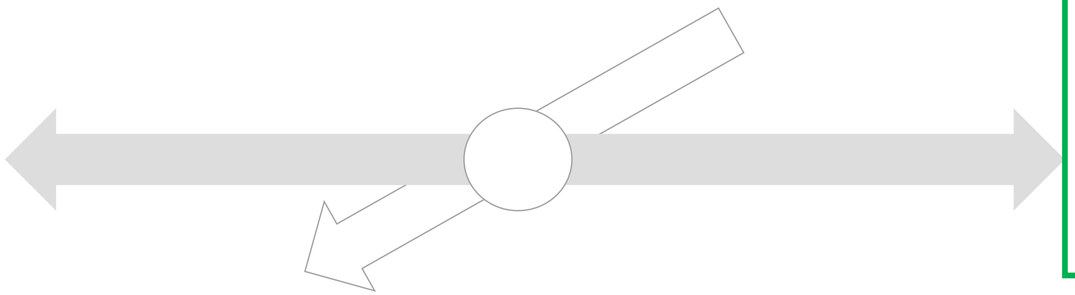
What can you measure in the clinic?



Age

Young ⟺ Old

Hearing Loss

Normal/ Corrected ⟺ Uncorrected

SNR

Low ⟺ High

Linguistic Complexity

Low ⟺ High

Context

High ⟺ Low

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How can we account for these individual differences in the clinic?

Quick SIN

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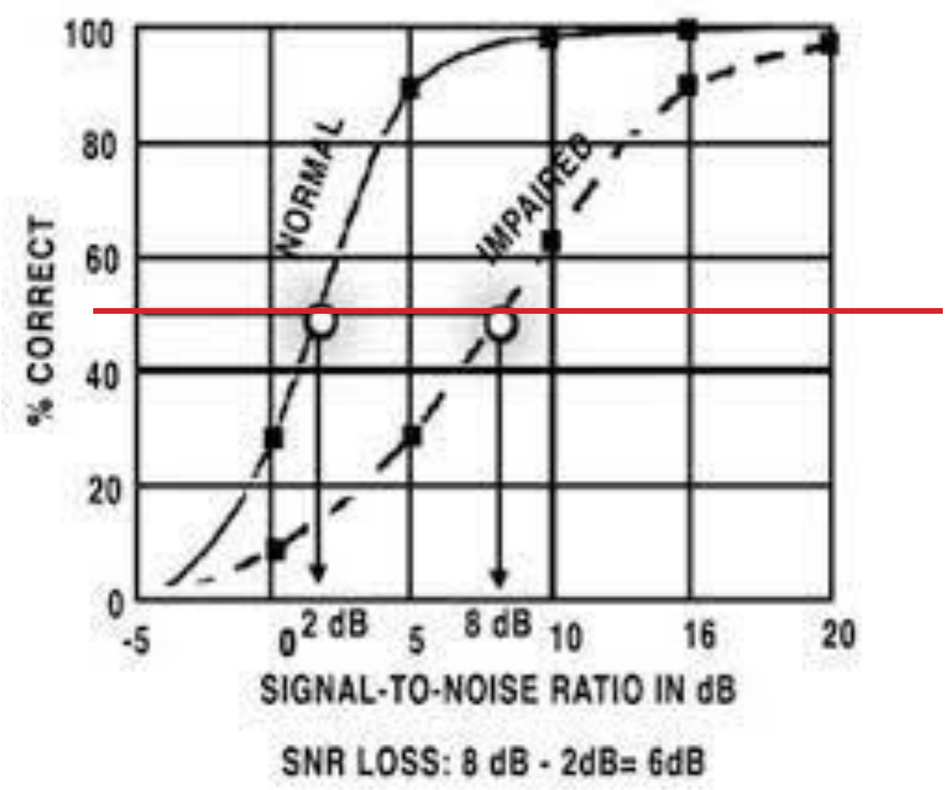
Quick Speech in Noise

- “85% of GS audiometers in the field have built-in Quick SIN capability ”
- - Brent Nissly, President, Grayson-Stadler

What the Quick SIN measures?

Performance-Intensity Function



- SNR loss
- When speech is made audible (70 dB HL or higher) at what SNR does the person understand 50% of the message?

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Things to know

- Simulates noisy listening situations, often the most important to the patient
- Female talker with four competing talkers (yes, there is informational masking)
- Easy to administer (use two lists per ear)
- Easy to score
- Takes less than 5 minutes in most cases

How to conduct the test

- During hearing assessment while patient is wearing earphones
- Find “loud, but ok” MCL
- Instruct the patient and provide some practice sentences
- Test each ear separately

Example

List 1		**Score**
1. A white silk jacket goes with any shoes.	S/N 25	5
2. The child crawled into the dense grass.	S/N 20	5
3. Footprints showed the path he took up the beach.	S/N 15	4
4. A vent near the edge brought in fresh air.	S/N 10	3
5. It is a band of steel three inches wide.	S/N 5	2
6. The weight of the package was seen on the high scale.	S/N 0	0
25.5 - TOTAL = 6.5 SNR Loss	**TOTAL**	19

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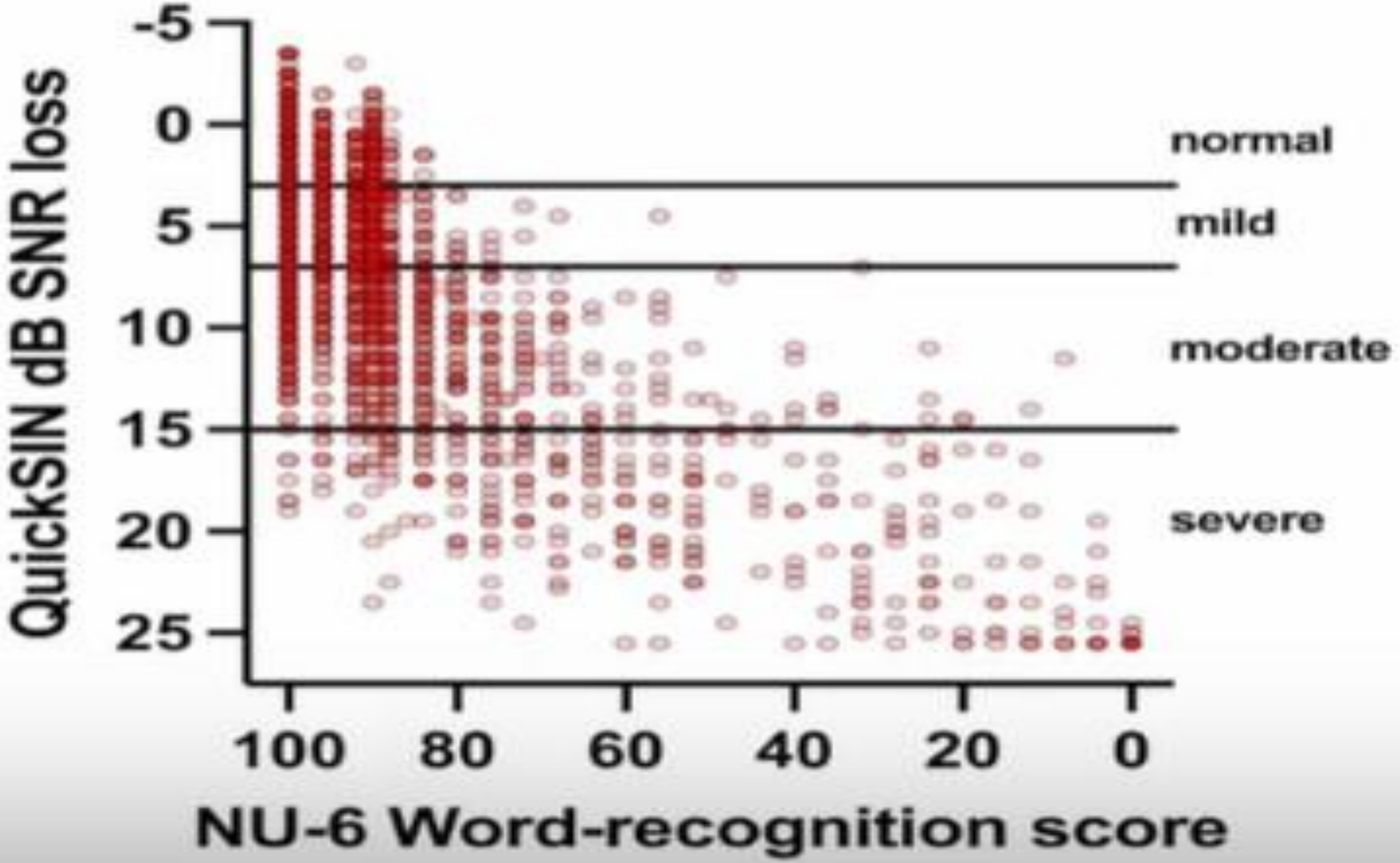
The clinical value of QSIN

Matthew Fitzgerald, PhD

Significant deficits with speech in noise despite normal word-recognition in quiet



Fitzgerald, AAS, 2022

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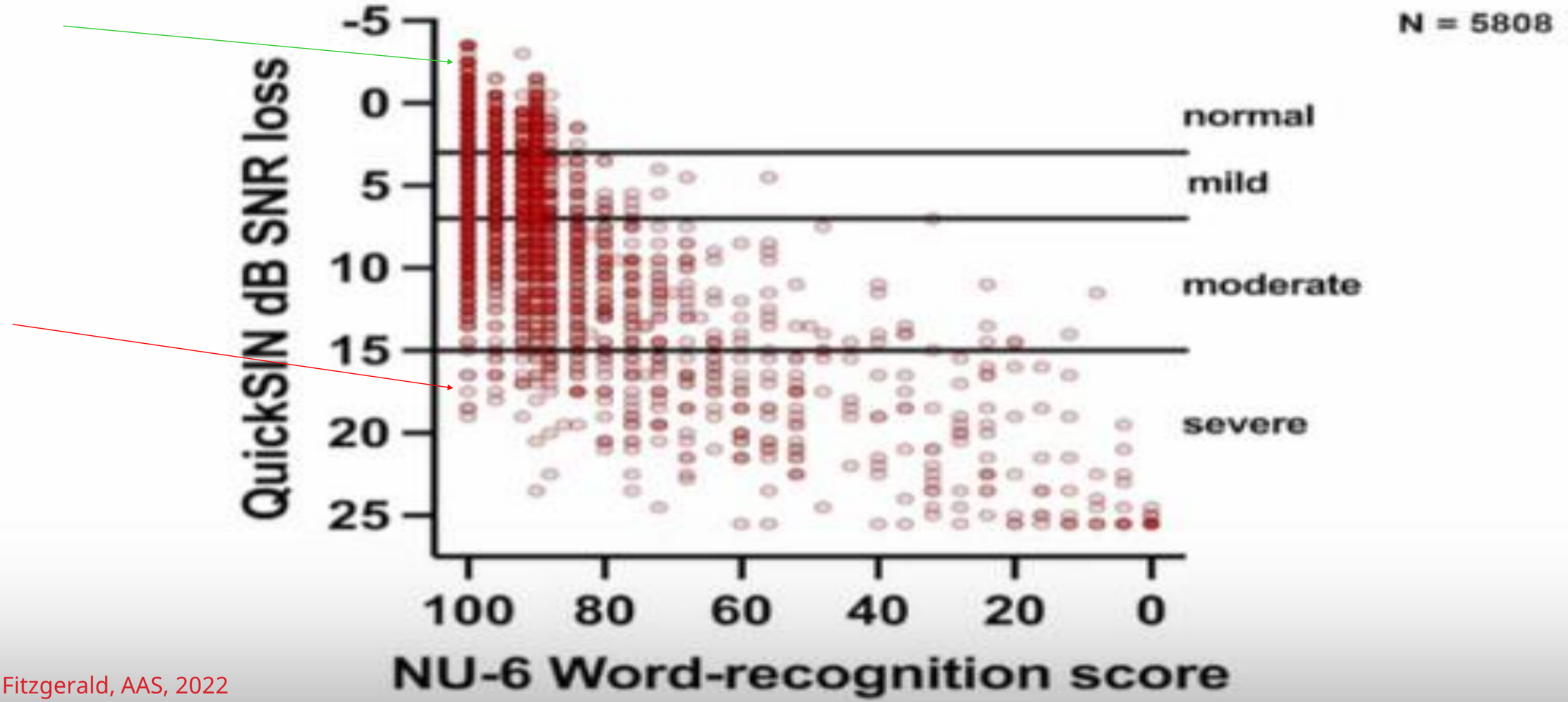

Fitzgerald, AAS, 2022

Quick SIN Results

Unaided Score	What it means?	Prevalence* (Older Adults)
0-2 dB	Normal ability to hear in noise when speech is audible	10%

* 2003 clinical data in Elk Grove Village, IL n = 100

Quick SIN Results

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13 or greater	Severe problem, Even moderate boost is not enough.	12%

* 2003 clinical data in Elk Grove Village, IL n = 100

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Limitations of Quick SIN

1. May not reflect person’s perception of how they communicate in noisy places
2. Other factors could be important:
    - Sound quality
    - Concentration ability
    - Participating in the conversation
    - Location of sound
    - Ease of communication

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Gathering Subjective Information

- Validated self-reports
- Quantifiable scale: **1**_____**10**
- Compare patients in your practice

- Examples:
  - COSI
  - IOI-HA
  - HHIE-S

Perception of the Person

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Speech, Spatial, Quality Questionnaire (SSQ-12)

1. Validated
2. Easy to administer
3. Easy to score
4. Easy to talk about results with patient

Reference:

Noble, W., Jensen, N. S., Naylor, G., Bhullar, N., & Akeroyd, M. A. (2013). A short form of the Speech, Spatial and Qualities of Hearing scale suitable for clinical use: the SSQ12. International journal of audiology, 52(6), 409–412.

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12. Do you have to concentrate very much when listening to someone or something?

Not applicable ☐

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SSQ-12 Question	Aspect of Performance in Acoustically Challenging Situations	Mean Score for older adu with normal hearing (Ba Singh and Picora-Fuller,
1. You are talking with one other person and there is a TV on in the same room. Without turning the TV down, can you follow what the person you're talking to says?	Speech in presence of noise	7.8
2. You are listening to someone talking to you, while at the same time trying to follow the news on TV. Can you follow what both people are saying?	Listening to multiple speech streams	6.7

SSQ-12 Question	Aspect of Performance in Acoustically Challenging Situations	Mean Score for older adu with normal hearing (Ba Singh and Picora-Fuller,
3. You are in conversation with one person in a room where there are many other people talking. Can you follow what the person you are talking to is saying?	Speech in presence of speech	5.5
4. You are in a group of about five people in a busy restaurant. You can see everyone else in the group. Can you follow the conversation?	Speech in the presence of noise	7.1

SSQ-12 Question	Aspect of Performance in Acoustically Challenging Situations	Mean Score for older adu with normal hearing (Ba Singh and Picora-Fuller,
5.You are with a group and the conversation switches from one person to another. Can you easily follow the conversation without missing the start of what each new speaker is saying?	Listening to multiple speech streams	7.1
6. You are outside. A dog barks loudly. Can you tell immediately where it is, without having to look?	Localization	7.6

SSQ-12 Question	Aspect of Performance in Acoustically Challenging Situations	Mean Score for older adu with normal hearing (Ba Singh and Picora-Fuller,
7. Can you tell how far away a bus or a truck is, from the sound	Distance and movement	6.9
8. Can you tell from the sound whether a bus or truck is coming towards you or going away?	Distance and movement	7.3

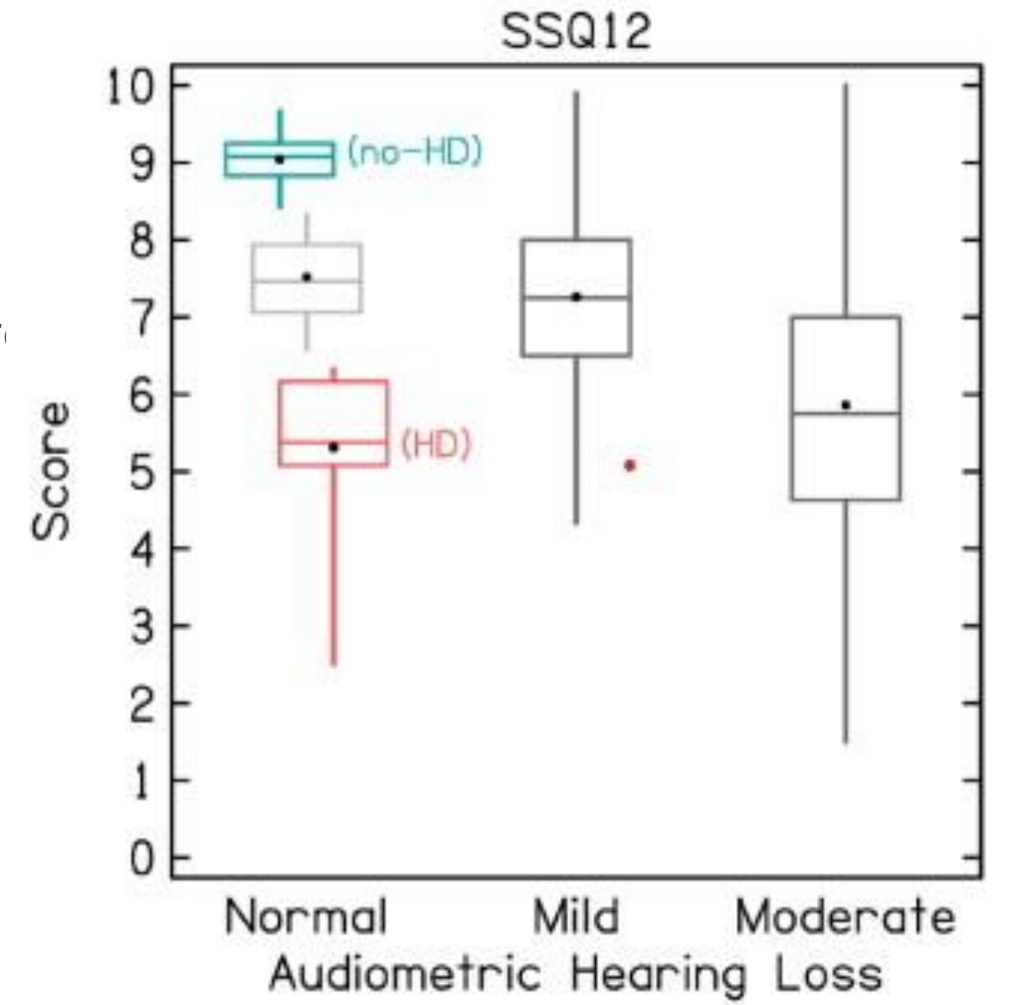
SSQ-12 Question	Aspect of Performance in Acoustically Challenging Situations	Mean Score for older adu with normal hearing (Ba Singh and Picora-Fuller,
9. When you hear more than one sound at a time, do you have the impression that it seems like a single jumbled sound?	Segregation of sounds in listening environment	7.3
10. When you listen to music, can you make out which instruments are playing?	Identification of sounds	8.0

SSQ-12 Question	Aspect of Performance in Acoustically Challenging Situations	Mean Score for older adu with normal hearing (Ba Singh and Picora-Fuller,
11. Do every day sounds that you can hear easily seem clear to you (not blurred)?	Sound quality and naturalness	9.0
12. Do you have to concentrate very much when listening to someone or something?	Listening effort	7.3

Self-reported hearing difficulty on SSQ-12

Kamerer, et al 2022

- Boystown Research Hospital, Omaha, NE
- N = 111 adults, aged 19 to 74 with normal audiograms
- History of impulse noise exposure was a predictor of self-r
- Blue, n = 29
- Gray, n = 53
- Red, n = 30 **(27%)**



Add to your clinical protocol

- Quick SIN – objective real world performance information
- SSQ-12 – subjective quality of life information

The 3rd “P” is the Product

How to squeeze the most benefit in noise from hearing aids

Two considerations

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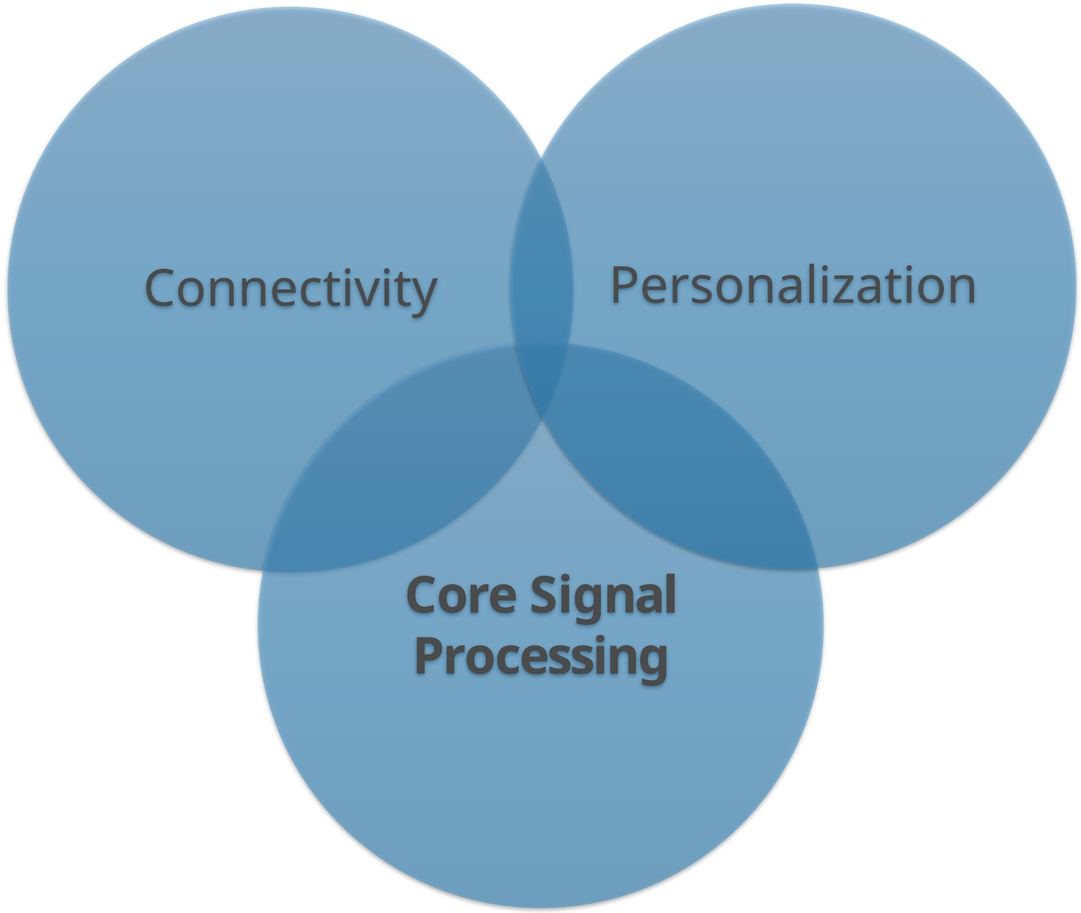
1. Engineers, data scientists, audiologists, marketing experts must prioritize what goes on the chip

”On the new platform, do we…”

- Make an existing feature better?
- Introduce something new?

Improvement Along Three Fronts

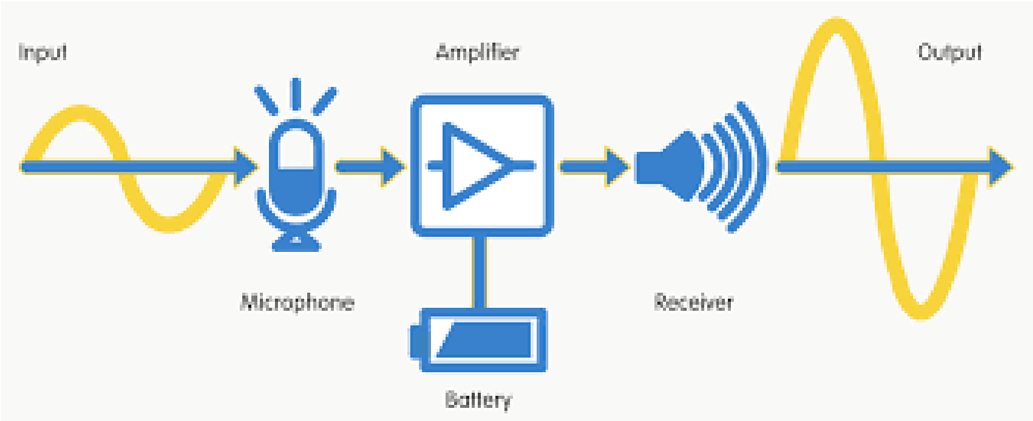


Core Signal Processing

- Analyzes and shapes all incoming sounds, Audiologist customizes to the wearer
- “Always on” Automatic program switching driven by signal classifier

2. Each manufacturers' approach to speech intelligibility improvements varies --- this variability is reflected in its' signal processing strategies – much of it is baked into their system

- Same parts
- Different philosophies to solving the problem



Slide courtesy of Chris Slugocki, ORCA

Different Philosophies

Preserve all sounds and
let the brain sort them out

Control the SNR

Different Philosophies

Preserve all sounds and
let the brain sort them out

Speech intelligibility by optimizing audibility

Control the SNR

Speech intelligibility by reducing noise

Different Philosophies

Preserve all sounds and
let the brain sort them out

Low Compression Knee-points,
No Delay, Omni-directional

Control the SNR

Bilateral Beamforming
Multiple types of NR

What philosophy is best?

Some considerations

1. Unaided Quick SIN scores
2. Listener’s demands
3. Age/cognitive ability

Some considerations

1. Unaided Quick SIN scores

7 or better dB SNR loss

7 or worse dB SNR loss

Some considerations

2. Listener’s demands

Spends most of time at home in quiet

Spends significant time in high noise levels

Some considerations

3. Age/cognitive ability

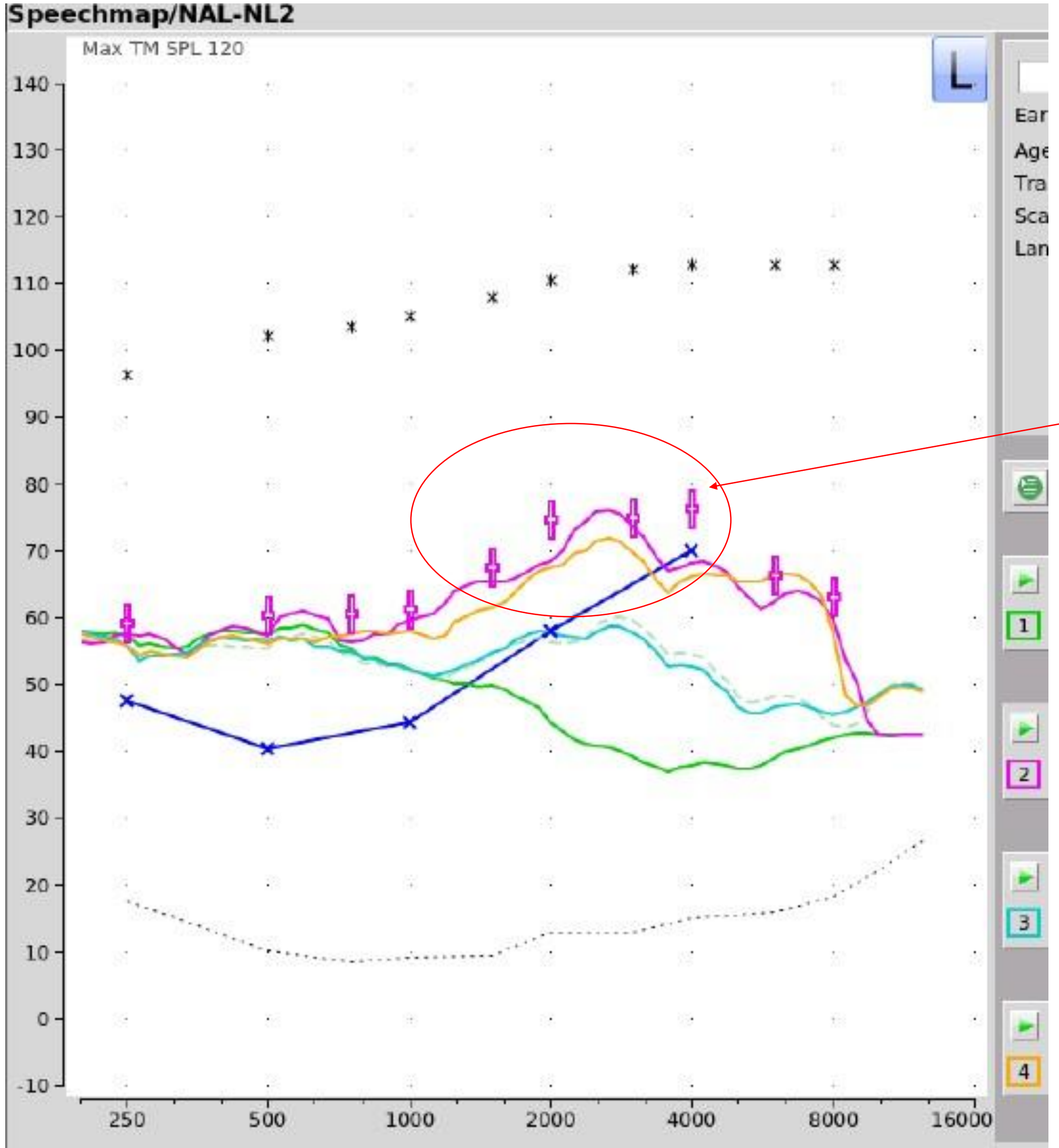
Normal cognitive function

Cognitive decline

Take-Home Tips

4 ways to get the most from today’s hearing aids for best performance in complex listening situations

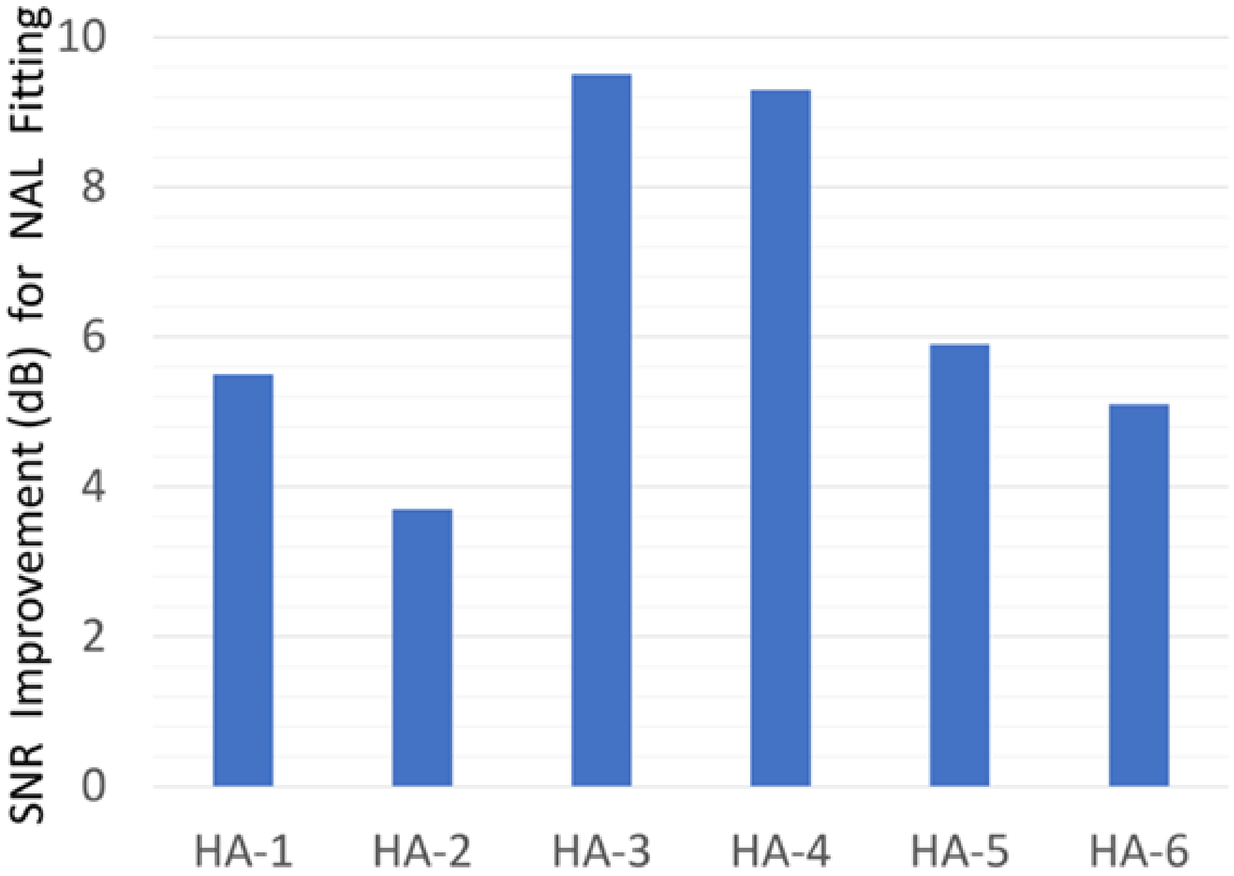
1. Optimize audibility by matching the NAL-NL2 targets as a starting point and allow patient ample time for brain to “re-wire”



Target at 2-4 KHz is often missed by more than 10 dB

Many features don’t work as well when you can’t hear soft and average speech

The minimal gain provided by proprietary fittings has an even greater effect on speech understanding in background noise



- Mean SNR improvement when participants were fitted to the NAL vs. proprietary fitting.
- Hearing aids were the premier model of the Big 6.
- Data from Ron Leavitt

2. Pay attention to the plumbing

Fit custom molds whenever possible:
RIC molds, sleeve molds

Today, instant fit domes and tips are popular: some instant-fit choices . . .

Open

Tulip

Vented

Closed

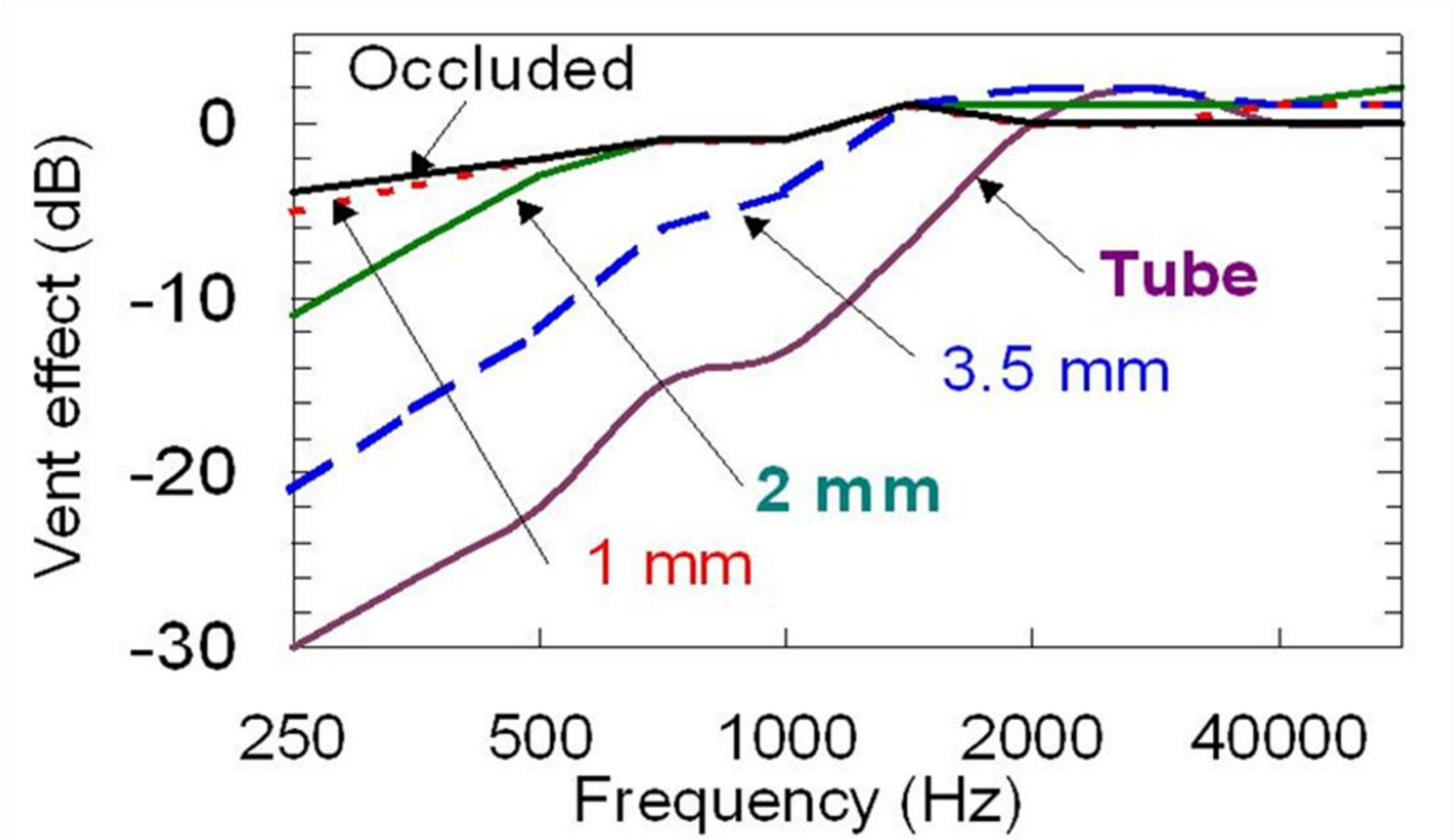
Power

The venting that we often don’t think about, common with all “closed” instant fit tips and domes . . .

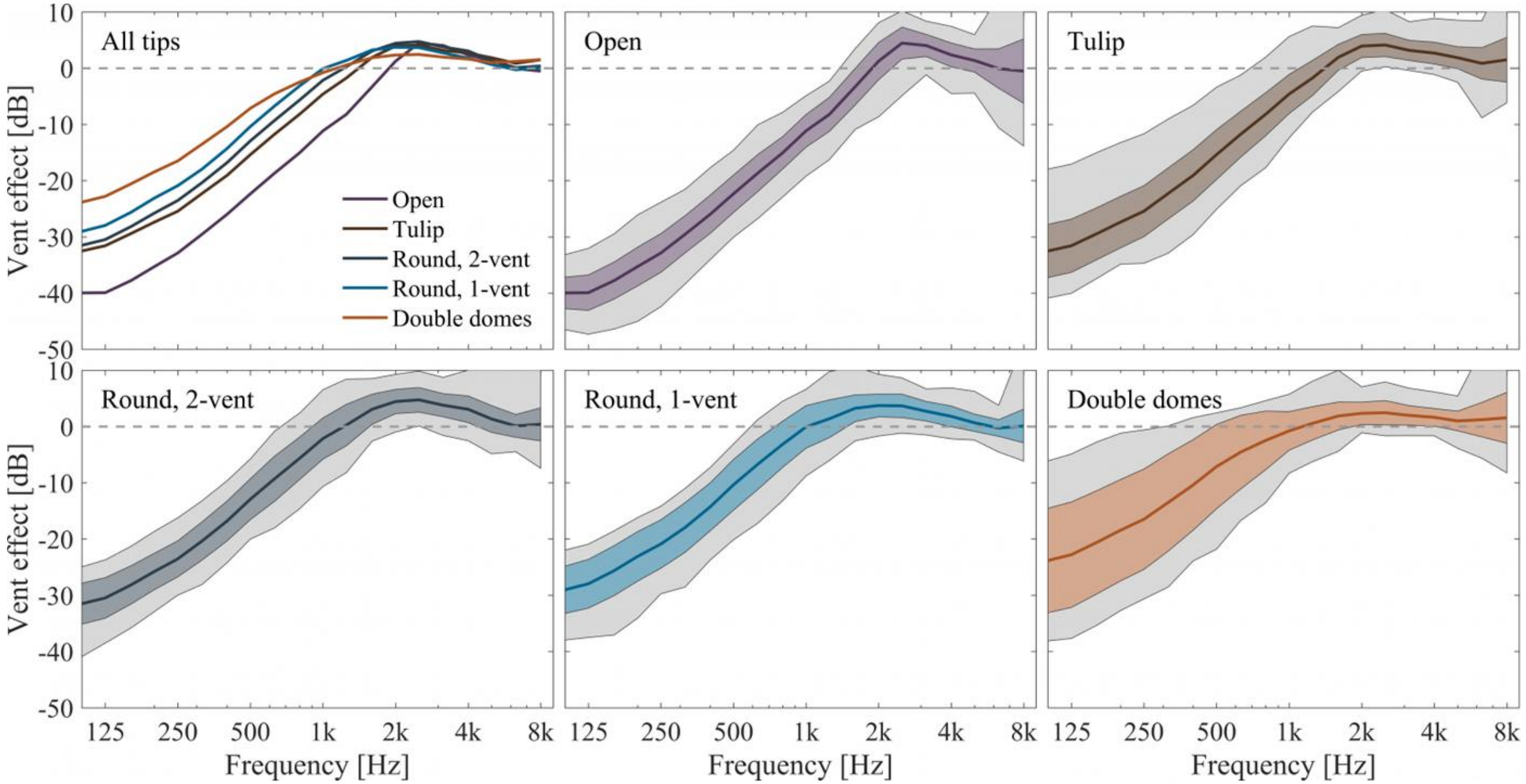
“Slit leak venting”

- Sounds that leak around the circumference of the dome—where the dome meets the ear canal.
- The shorter the distance of contact (medial to lateral) the greater the effect.

Venting data that you'll find in most textbooks, and what most of us recall

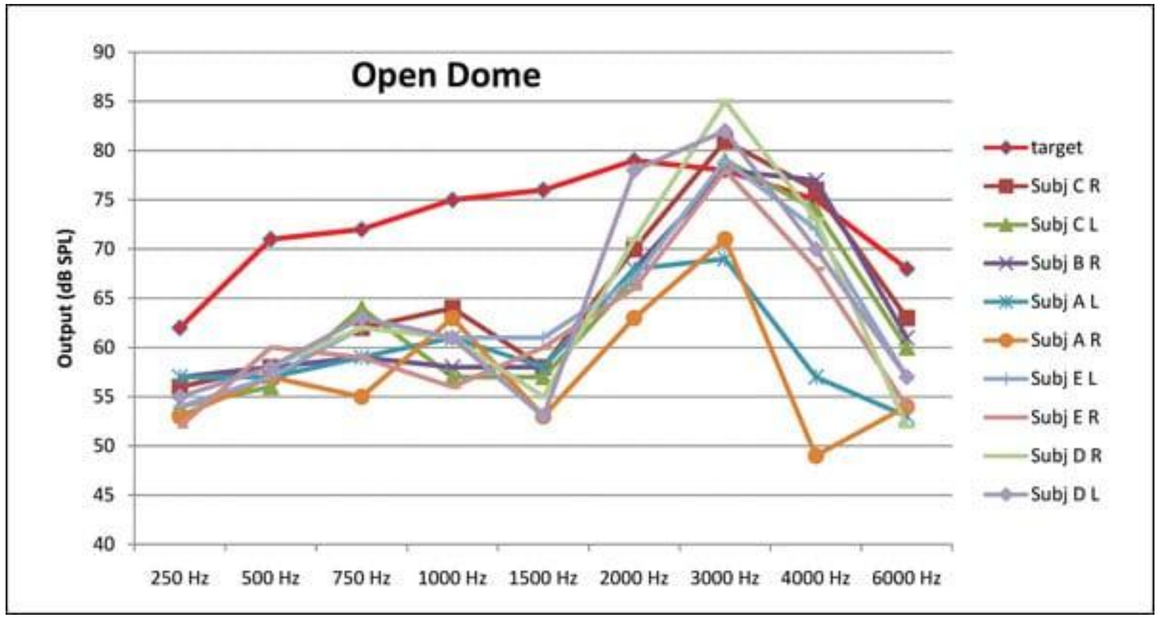


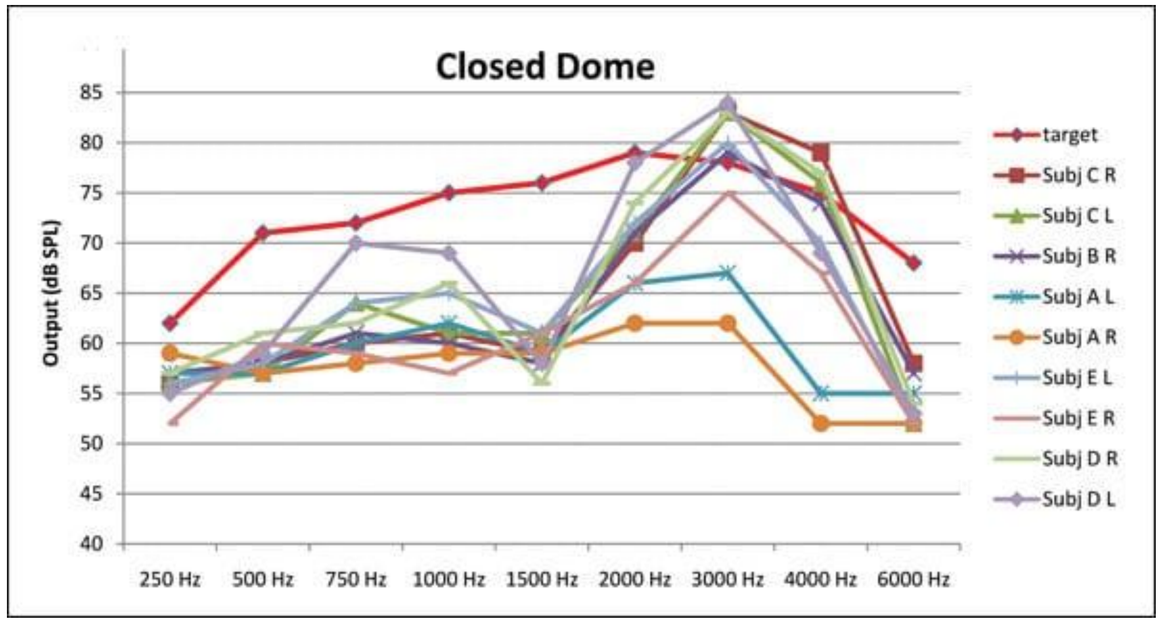
What we see from instant-fit tips is quite different



(From Balling, Jensen, Caporali, Cubick & Switalski, 2019)

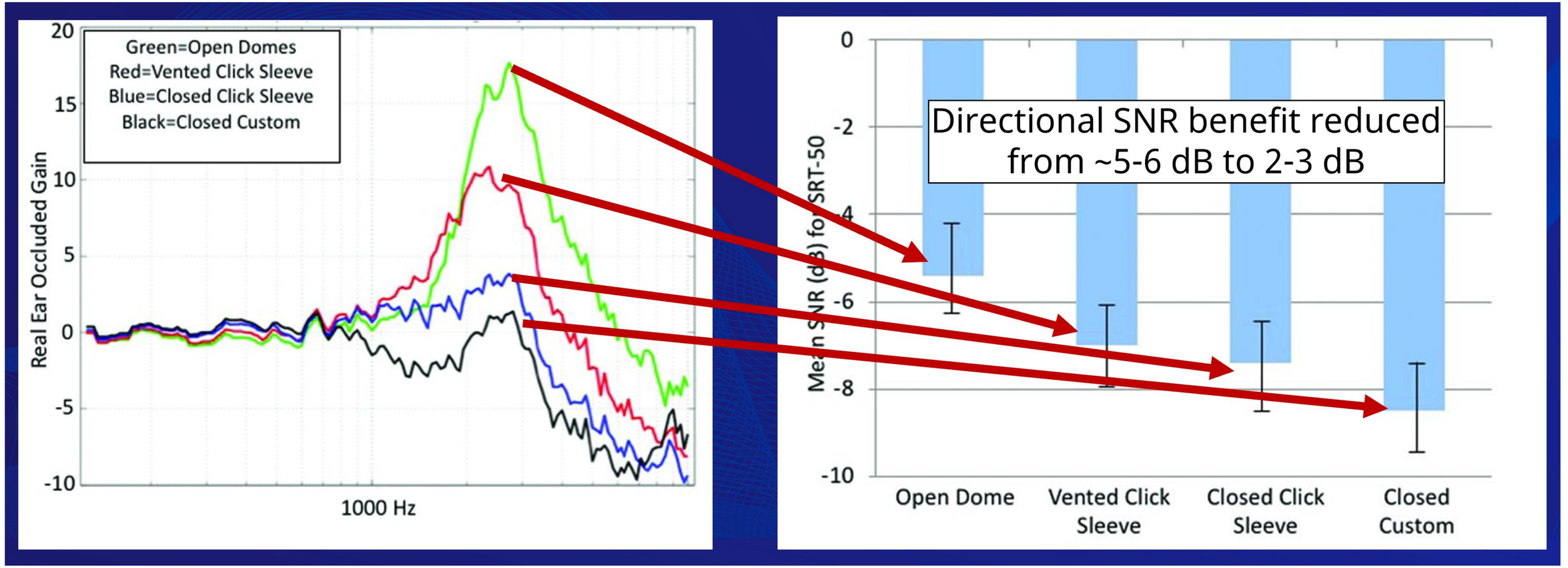
Instant fitting tips: The “openness of closed” should not be a secret—here are data from 2009!



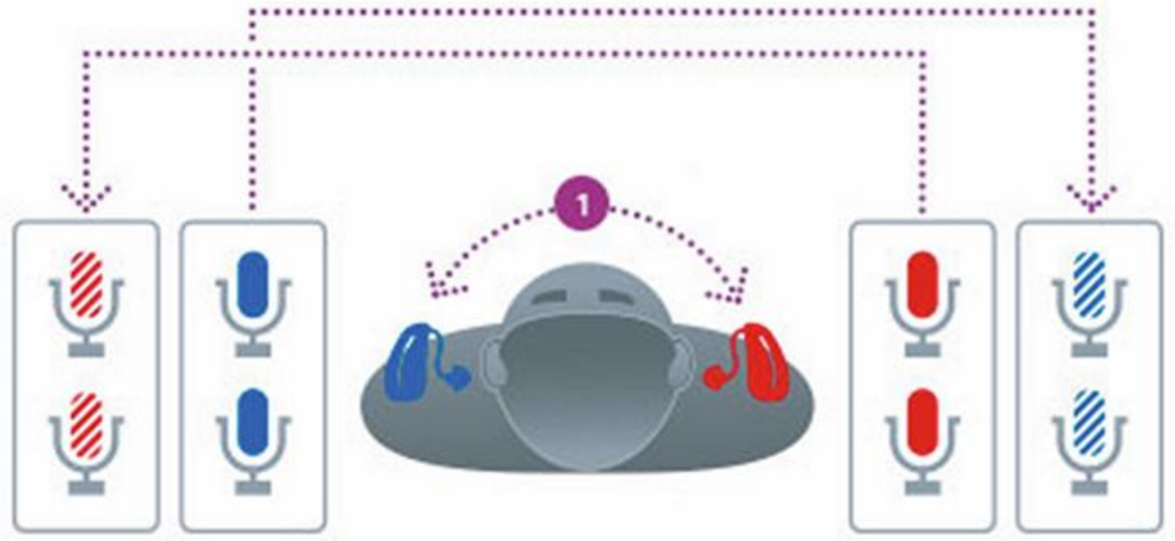


Real-ear output for hearing aids programmed to manufacturer- default NAL-NL2 using both an open and a closed instant fitting tip (From Teie [2009] *Hearing Review*)

Closed vs. Open: can also have a huge impact on directional processing



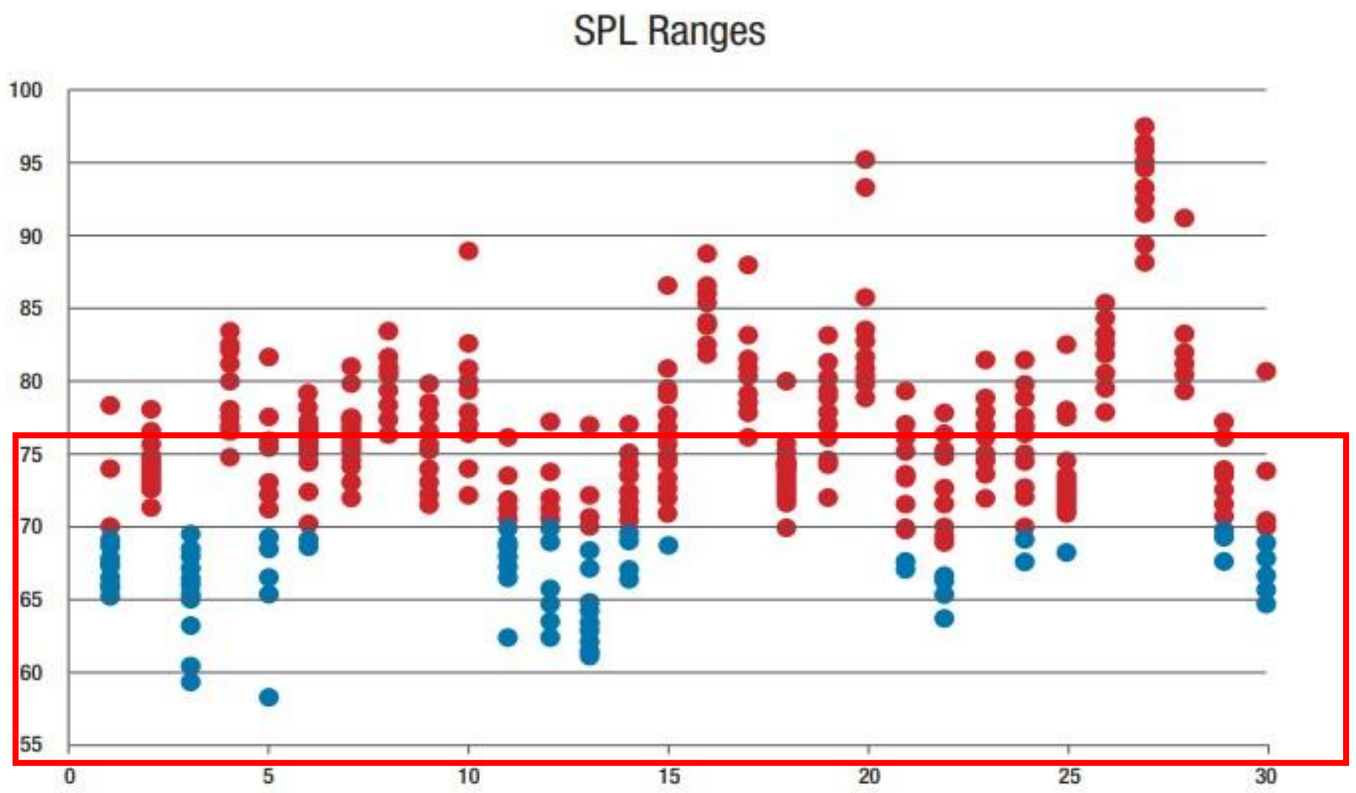
3. Leave default noise reduction features alone, but know when they will be activated



- Directional microphone system:
  - At what intensity level does it switch?
  - How long at that intensity before switching?
  - How quickly does it switch?

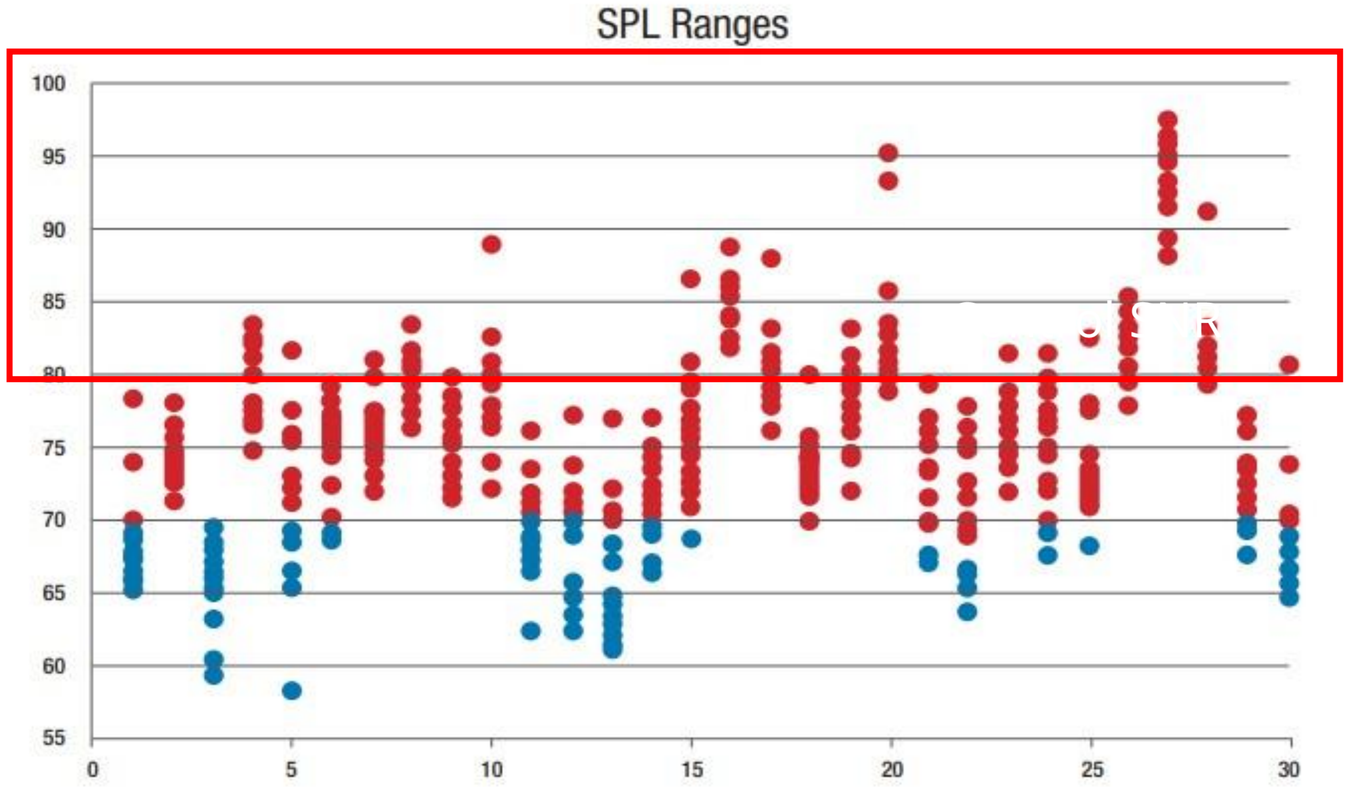
- This is reflected in their signal classification system

Back to Orlando



Control SNR

Aggressive Noise Reduction

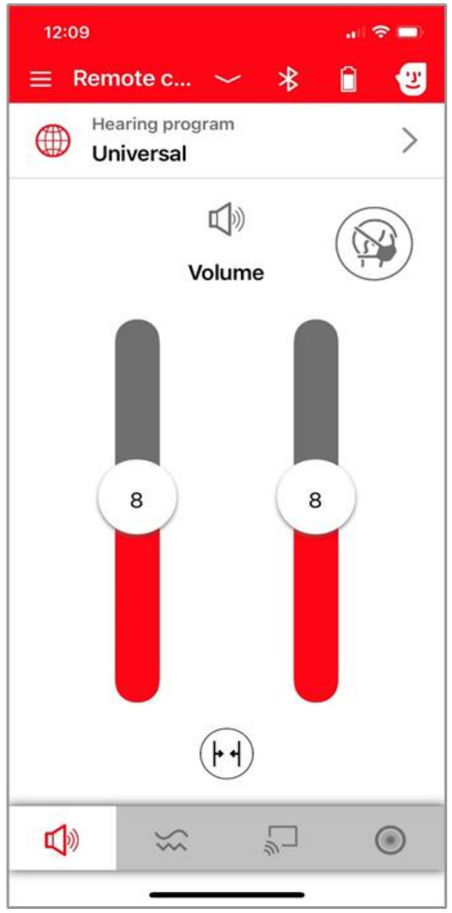


Only switch into their most aggressive noise reduction program

Optimize Audibility

signia Audiology

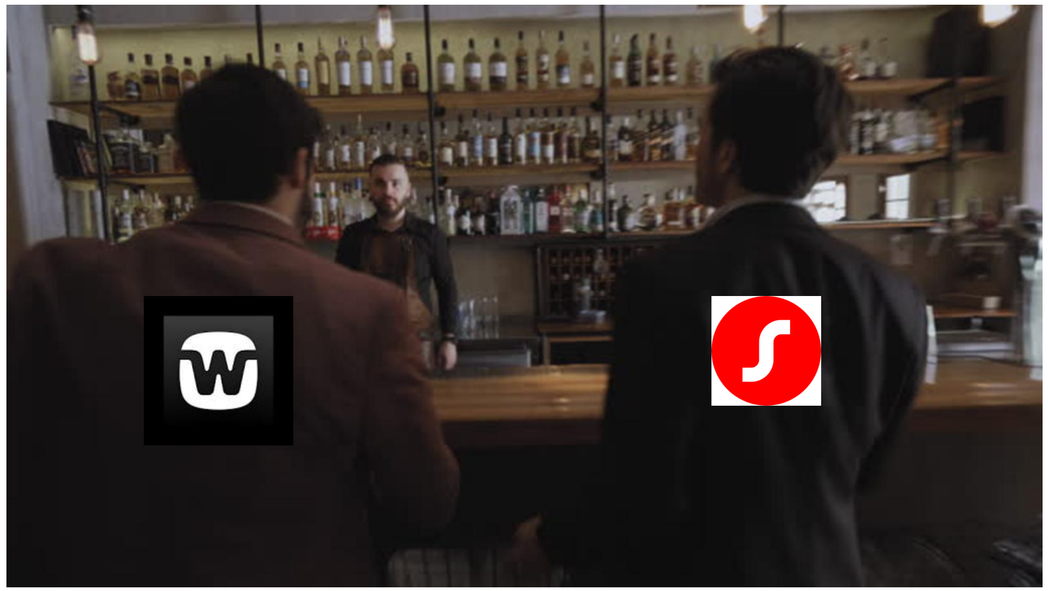
4. Give wearers a manual override



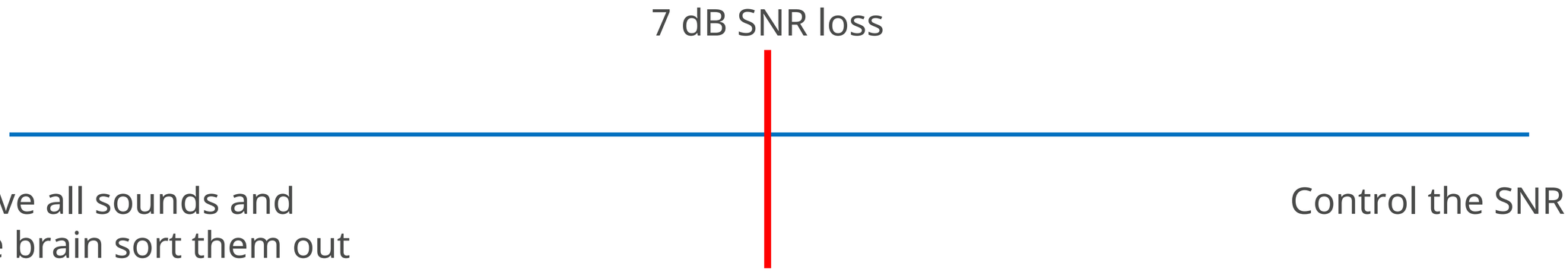
- Even the smartest classifier doesn’t know the wearers intent
  - Button or switch of hearing aid
  - App
  - Remote control

Conclusions

- A Signia rep, a Widex rep and an ADA member walk into a bar…….



Optimizing performance in complex listening places is no joke – What is your philosophy?



Thanks

Questions, comments – brian.taylor@wsa.com

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