Vanderbilt Bill Wilkerson Center

Hearing Aids: Pre-fitting testing, feature selection and adjustment considerations

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The Plan …

- Discuss a few more features which we believe can be individualized and describe some of our preliminary work with the long term goal of individually optimized hearing aid feature selection and adjustment.
  - “Selection” refers to either activation of a feature only available in premiere products or selecting a manufacturer/device when there are differences across manufactures/devices.
- Review some clinical tools that can help with individualization.

SERVICE, PRICE, FIT, STYLE, RELIABILITY, CONFIDENCE IN THE FITTING PROFESSIONAL AND A NUMBER OF OTHER FACTORS UNRELATED TO SIGNAL PROCESSING MATTER A LOT TO THE PATIENT!

I am not here to talk about any of those though!

Instead, lets consider specific signal processing and the individual patient's total listening experience.

Why focus on the role of the professional in individualization?

Polling Question…

- When considering an average across all environments, we expect a 30% speech recognition improvement for average patients when they purchase a “Higher” Level Hearing Aid compared to an entry level (True/False).

HOW IMPORTANT IS LEVEL OF TECHNOLOGY?

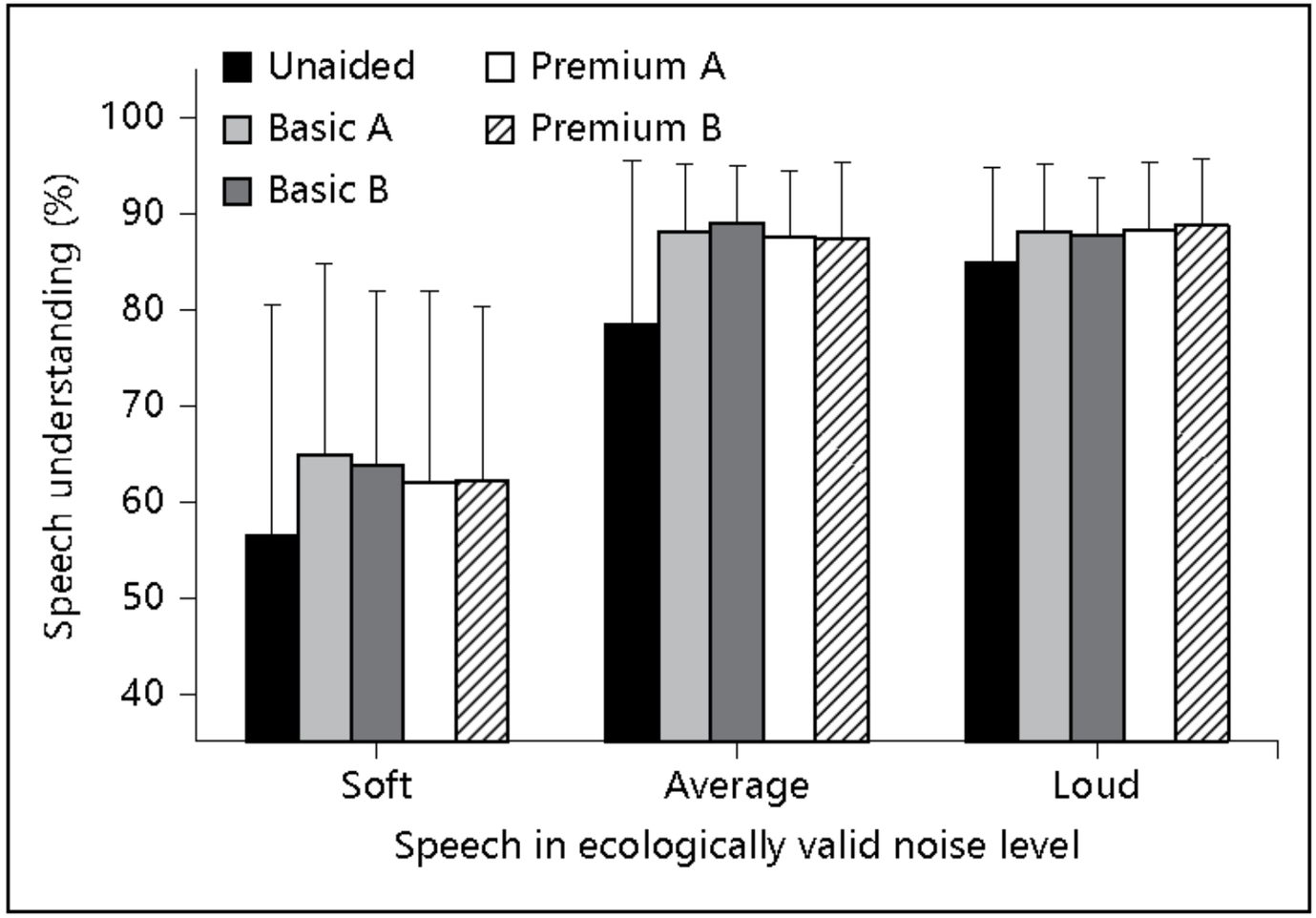
Impact of Advanced Hearing Aid Technology on Speech Understanding for Older Listeners with Mild to Moderate, Adult-Onset, Sensorineural Hearing Loss. Robyn M. Cox, Jani A. Johnson & Jingjing Xu, Gerontology (2014)

Do patients fit with “premium” and “basic” hearing aids lead to different outcomes for speech understanding and quality of life?

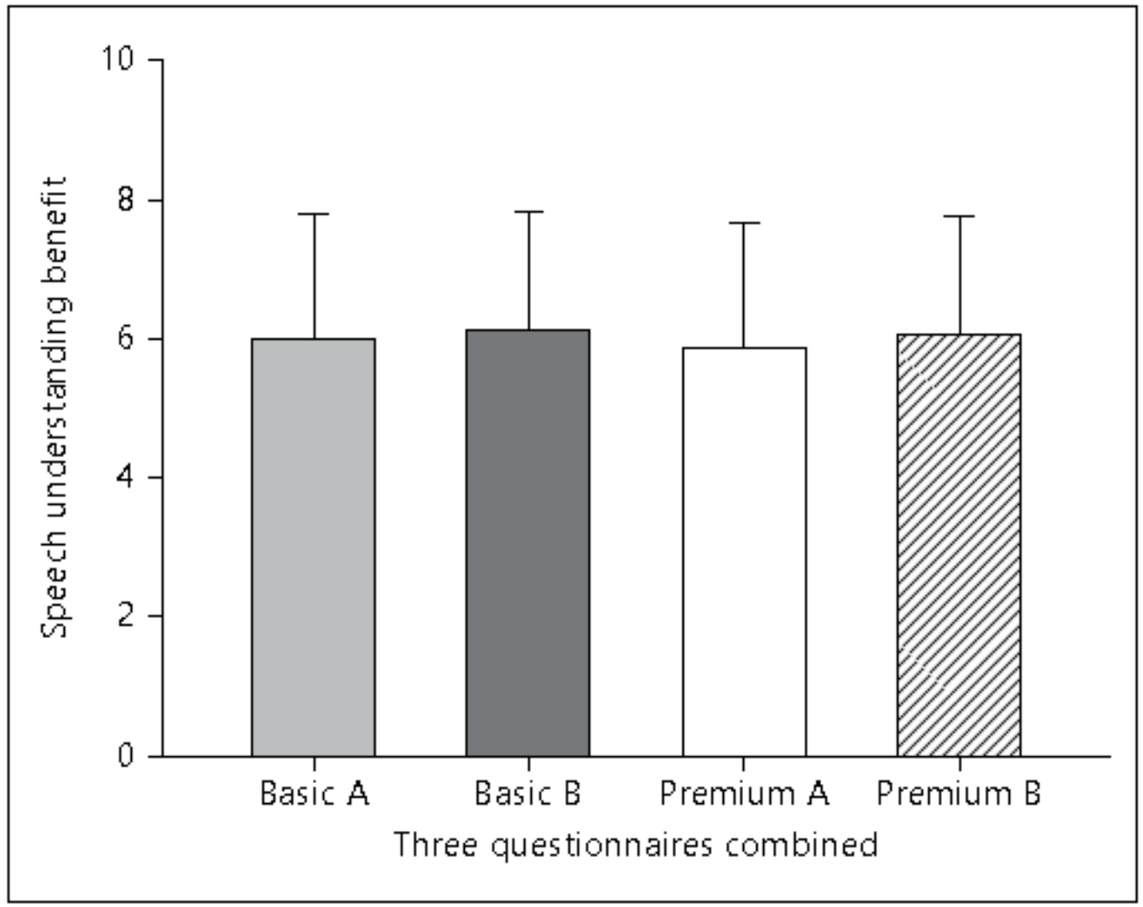
What Does “Level” Mean?

- In current modern hearing aids all levels (even the most basic) typically include many features: multichannel compression, directional microphones, digital noise reduction, and feedback suppression. In this study one basic model even included a simple form of wind noise suppression.
- Higher level hearing aids general distinguish themselves by including more complex, automatic and adaptive versions of these basic features
- They also may add a few additional features: Depending on the manufacturer - bilateral data sharing, reverse directional or other lobe steering technologies, learning VC, impulse noise reduction, reverberation suppression, remote microphone, etc.

Premium Versus Basic Levels: Laboratory speech recognition



Premium Versus Basic Levels: Overall composite of self report inventories



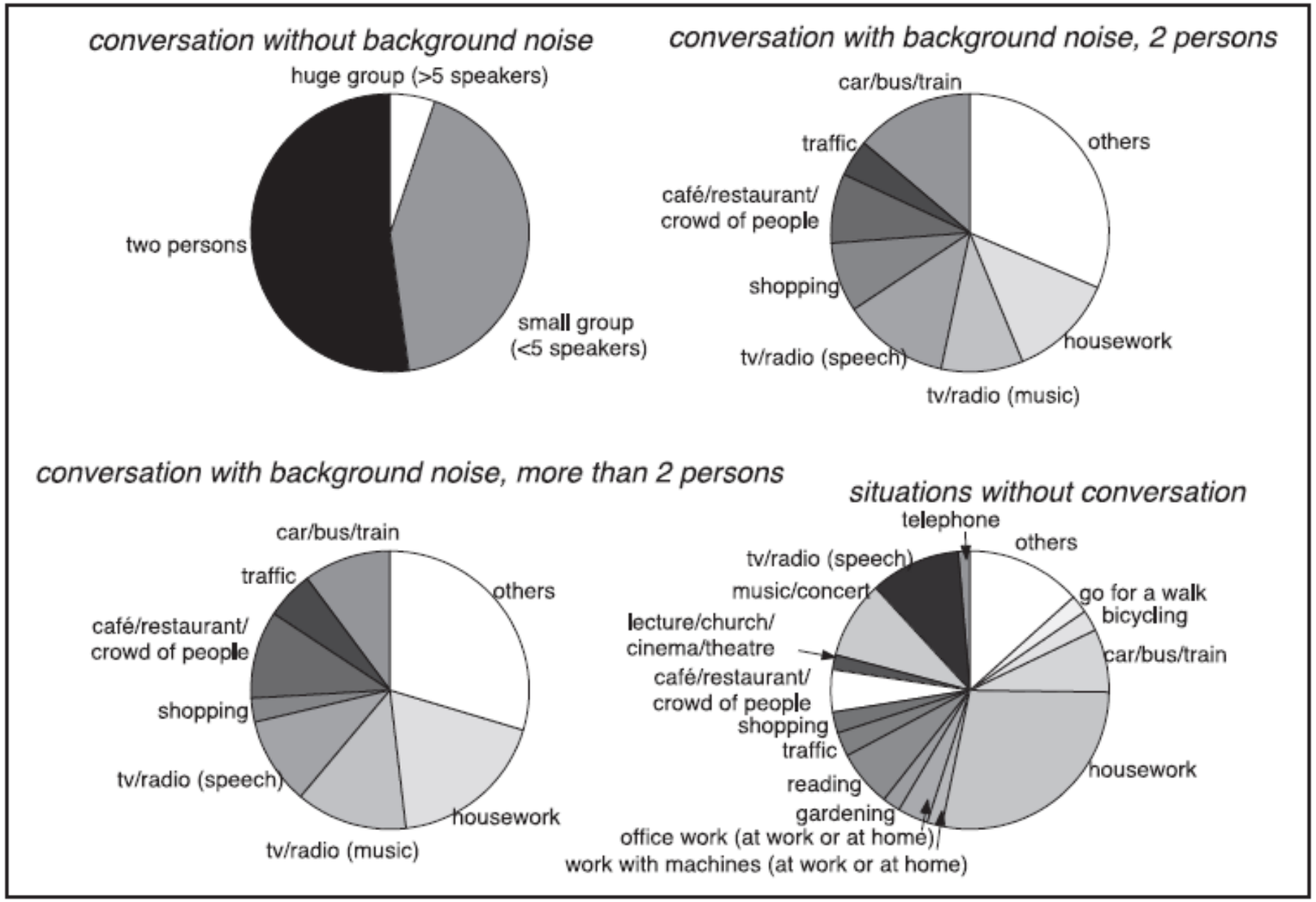
Opinion: Perhaps we should consider technology AND the importance of clinical expertise in optimizing these technologies!

- Amplification results in large and significant benefits – but we can't assume that more expensive hearing aids will be better without appropriate professional services.

- Selecting, fitting and optimizing hearing aid technology to addresses the individual needs of the patient while also providing appropriate counseling is at least as important as the technology itself!

General outcome measures and the variability in communication situations in everyday life

Wagener et al 2008, JAAA



How could we possibly capture all of the interactions between specific technologies and all of these environments in a general outcome measure?

I ADVOCATE THAT GOOD CLINICAL PRACTICE IS AT LEAST AS IMPORTANT AS TECHNOLOGY IN OPTIMIZING PATIENT OUTCOMES

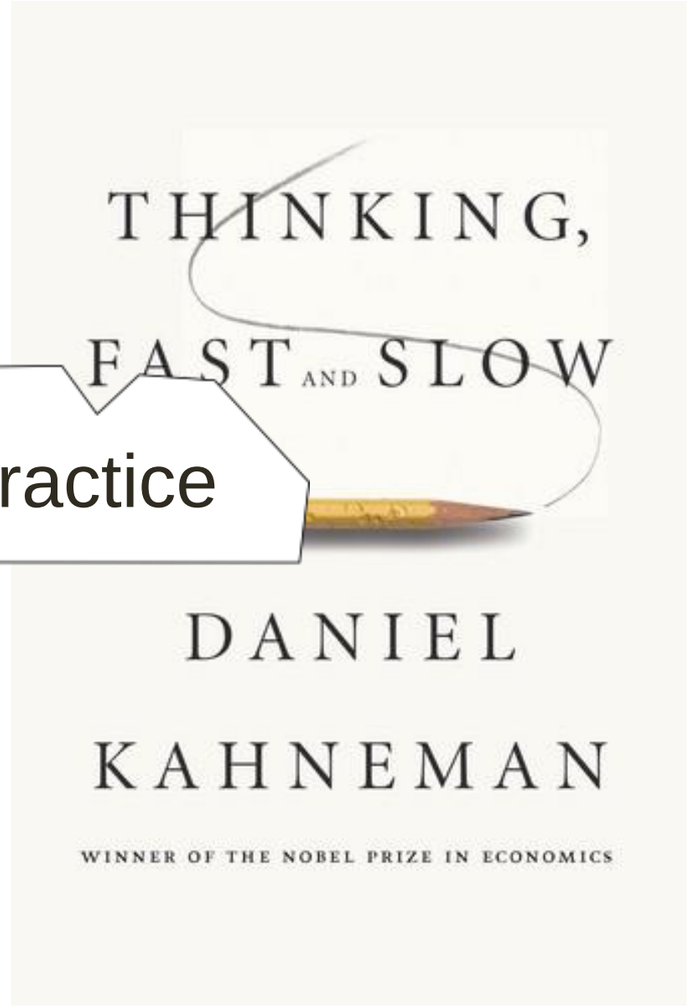
So do clinicians know best?

This argument should not be confused as advocating Clinical Intuition/Expert Opinion over Evidenced Based Practice

A Note On Individualization Based On Clinical Intuition

- Expert clinical opinion <u>on the average</u> is less accurate than a simple unbiased algorithm (Paul Meehl)
  - Examples: psychologists attempti… t jobs for soldiers, medica… be… vin… when … ure,
- Clinical … by factor… portant and fluctuating
  - Tasting immatur… ine, etc.
- Clinical opinion is important too, but use it as one factor with equal weighting
  - The more factors that are introduced in low validity environments, the greater potential for bias, error and reduced reliability.

Evidence Based Practice



WHAT IS IMPORTANT FOR PATIENTS?

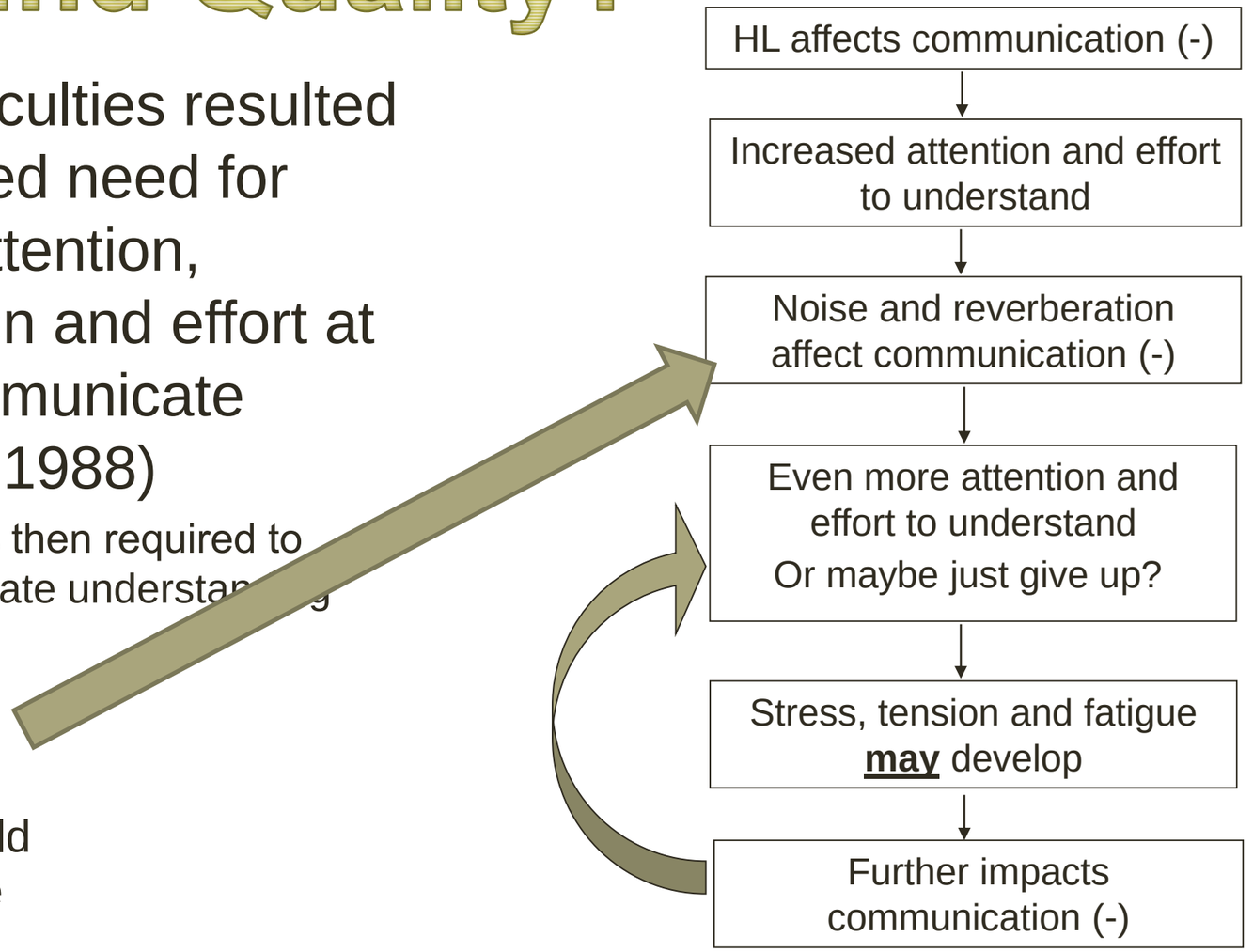
We want to maximize benefits and minimize any limitations. So what outcomes matter?

#1 for most patients? Speech recognition including speech recognition in noise

What happens with hearing loss in difficult situations?

Sound Quality?

- Hearing difficulties resulted in a perceived need for increased attention, concentration and effort at work to communicate (Hetu et al., 1988)
  - Extra “effort” is then required to achieve adequate understanding



Reduced spatial abilities in some listeners and talkers outside the field of vision (no visual cues) can make this much worse!

What information will enhance hearing aid selection/ setting of features?

- We want to know as much as possible about the benefits, limitations and interactions of specific hearing aid features.
  - Does adjustment/use directly affect patient outcomes?
- Learn as much as possible about the patient's hearing loss and communication/listening needs in as short of time as possible.
  - What information is already gathered and what more information you need?
  - Tools need to be clinically viable and clinically effective!
- Put all the pieces together in order to find out what is most important for the patient.

How important are these tests for *selecting or adjusting hearing aid gain, style output and features?*

- Ability to understand speech in quiet?
- Hearing handicap (HHI) - opinion
- Tinnitus handicap (THI) - opinion
- Patient's Threshold of Discomfort? - opinion
- Patient's cognitive abilities? - opinion
  - Interactions with technologies including processing speed, capacity, listening effort, etc.
- Ability to understand speech in noise?
- Patient's "acceptance" of background noise
- Patients goals, problems and expectations? (including specific listening needs)

Speech Recognition in quiet: Evidence to support . . .

- That these tests will help determine hearing aid candidacy?
- That the scores will help predict how a person is doing in the real world?
- That the scores will help predict hearing aid benefit and satisfaction?
- That these tests will help diagnose auditory pathology?
- That they will help determine differences between ears?

Recorded Versus Live?

- Recent surveys show that as many as 60-70% of audiologists use live voice testing.
- Some reasons given for using live voice testing:
  - “My voice sounds like the people who live around here”
  - “If they get the word wrong I can repeat it”
  - “They seem to score higher when I use my own voice”

Comparison of live voice versus recorded for right and left ears of 16 patients (From Roeser and Clark, 2008)

FIGURE 1a

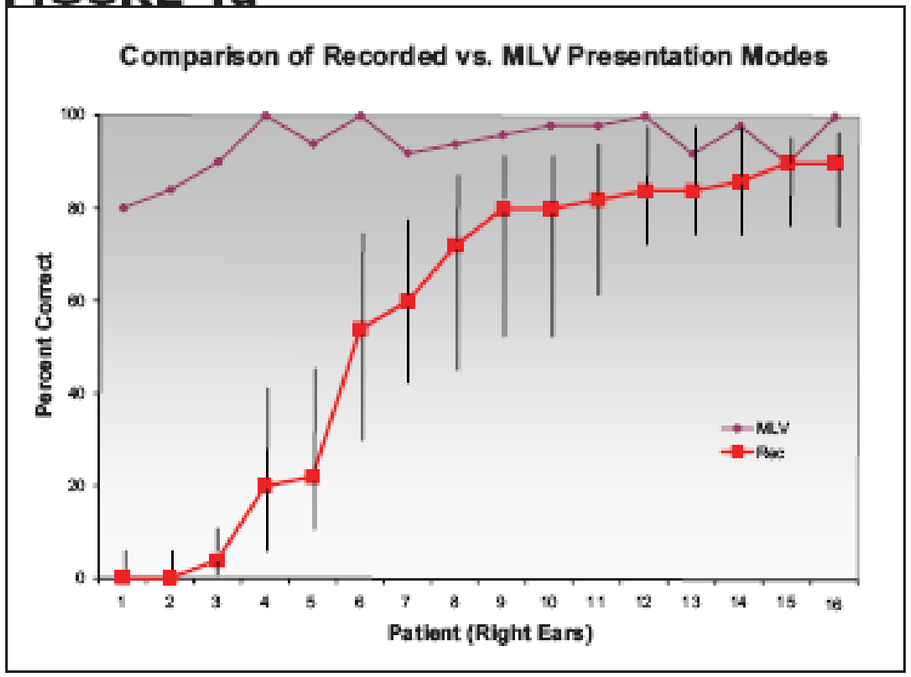


FIGURE 1b

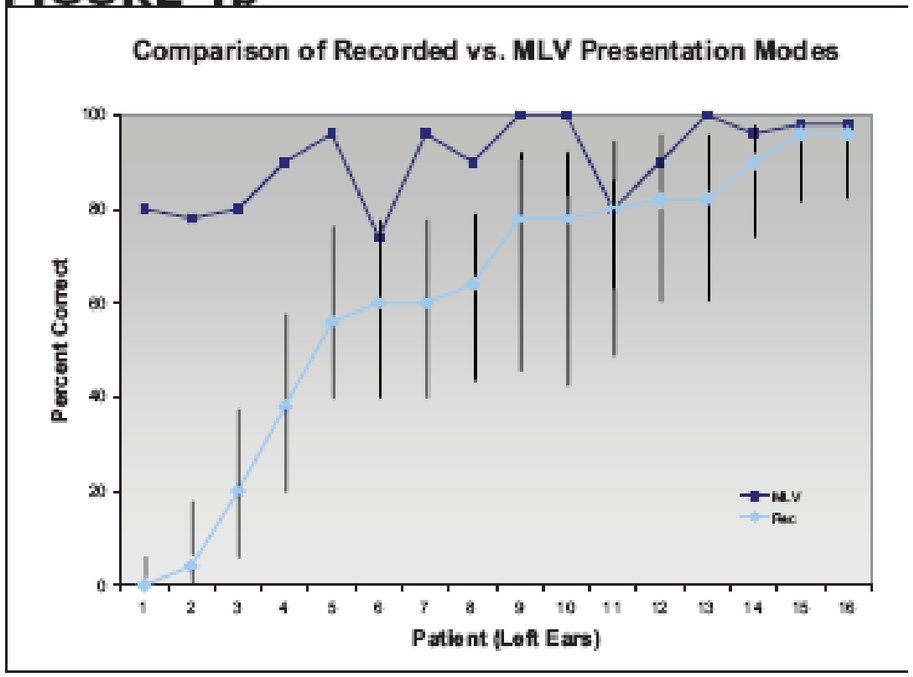


Figure 1. Comparison of word recognition scores for the *(a)* right and *(b)* left ears using monitored live voice and recorded presentation for 16 patients. The ranges shown for the recorded presentations are the 95% confidence levels predicted from the Raffin and Thorton (1980) binomial tables.

Determining if two word recognition scores (e.g., right versus left ear) are truly different:

- Important *NOT* to use differences that are not really different !
- Check out chart from Thornton-Raffin article (in 1978 *JSHR,* also in *Chapter 5*, and many, many other places).
- Or – **Carney E, Schlauch RS (2007). Critical Difference Table for Word Recognition Testing Derived Using Computer Simulation. *Journal of Speech, Language, and Hearing Research,*** 50, 1203-1209.

NOTE: General rule of thumb—differences need to be 16-18% before they are REALLY different.

The Bottom Line?

- The most useful information is PB-Max, but if you don't do the test right, there is really little reason to do it at all.
- Does Word Recognition in quiet really add anything to the selection and fitting of hearing aids?
- Still very useful benchmark and for diagnostics, but if you are trying to save some time for other tests with a hearing aid fitting goal…

TECHNOLOGY SELECTION

What can we individualize and what tools might be useful?

Considering more technologies that are likely to affect the total listening experience and might be individualized?

- Reverberation suppression: Will it reduce listening effort and fatigue? Could it improve emotional responses to sound? Improve sound quality?
  - No data today – but stay tuned!

- Sound cleaning technologies: From advanced directional microphones to bilateral beamformers to reverse directional to wireless companion microphones, and beyond?
  - Often controlled by increasingly complex logic algorithms (e.g. ambisound)
- Telephone streaming technologies?
- Wind Noise Reduction?

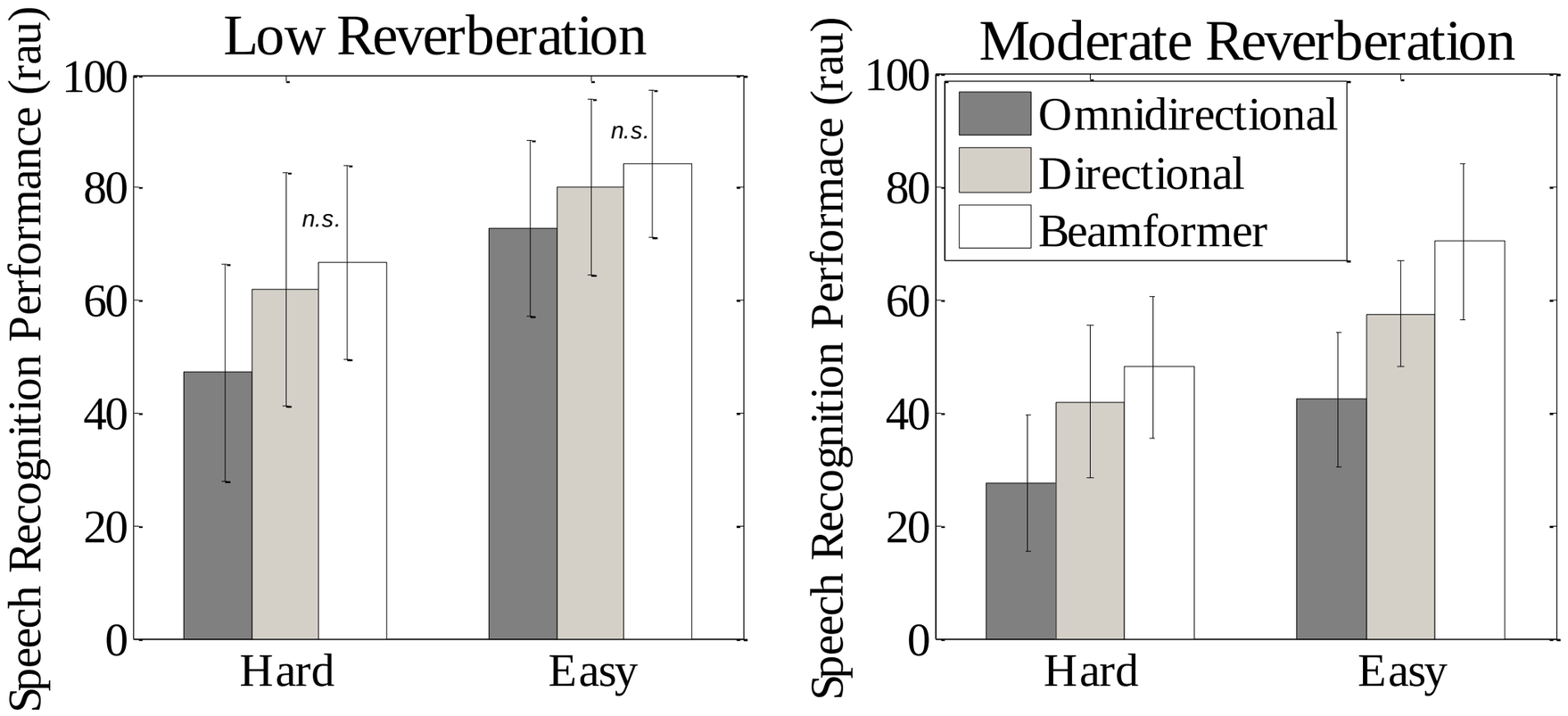
Compare Benefits and Limitations of Three Types of Directional Processing (Picou, Aspell & Ricketts, 2014; Picou, Moore & Ricketts, 2016; Ricketts & Picou, In Prep)

- Cue Preserving Bilateral Beamformer (**Strong Directional Processing**)
  - A-DI ~ 6 – 7 dB
- Bilateral Adaptive or Fixed Directional Microphone (**Moderate Directional Processing**)
  - A-DI ~ 4.5 – 5.5 dB
- **Weak Directional Processing** aimed at making up for the loss of pinna shadow (similar to omnidirectional in a custom instrument) or **Omnidirectional**
  - A-DI ~ 1.0 dB

- A-DI for Omni mini-BTE is approximately -1.5 dB (0.5 dB for CIC and open ear).

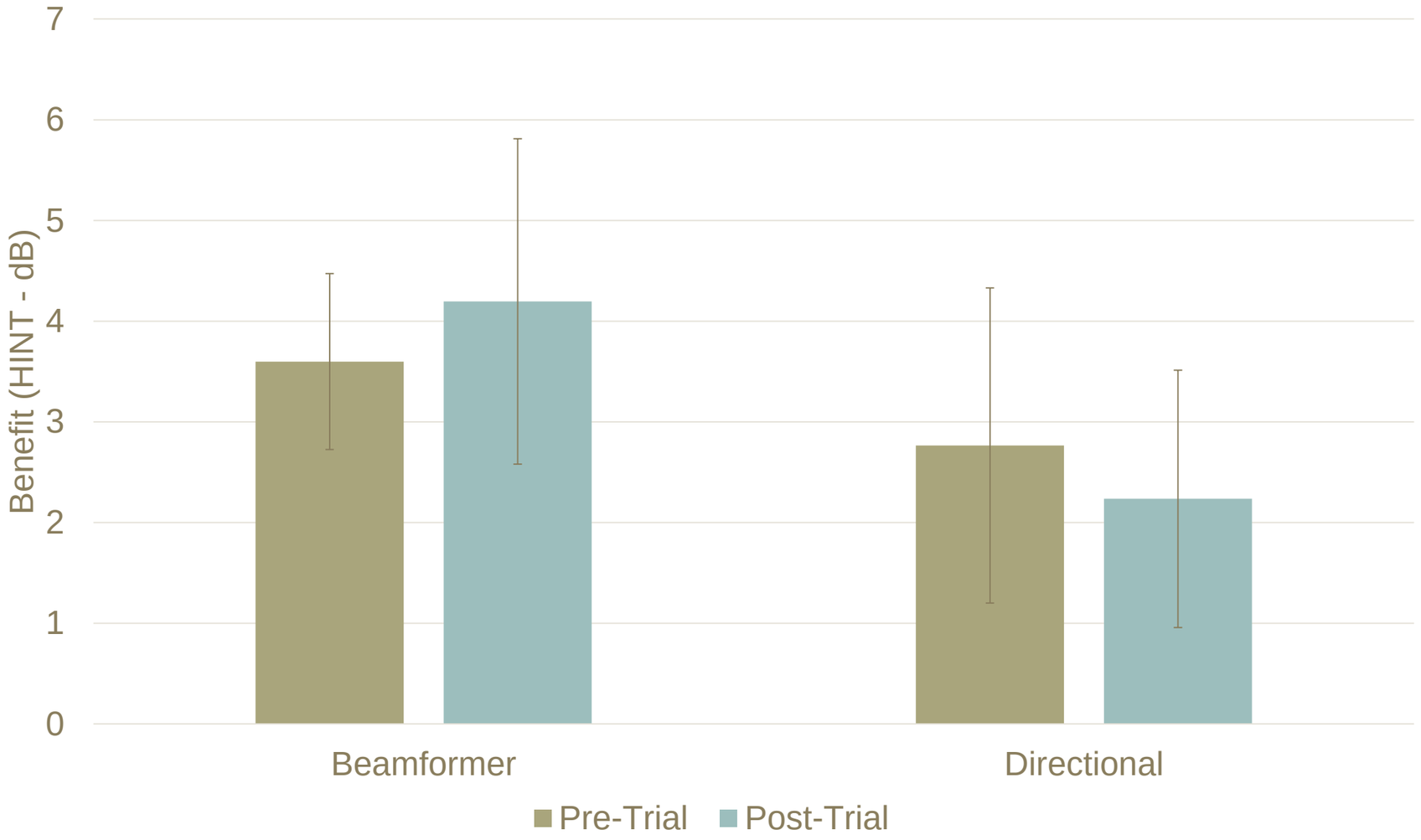
First generation speech recognition advantage (N = 18)

(+3, +6, +9, or +12 dB SNR)

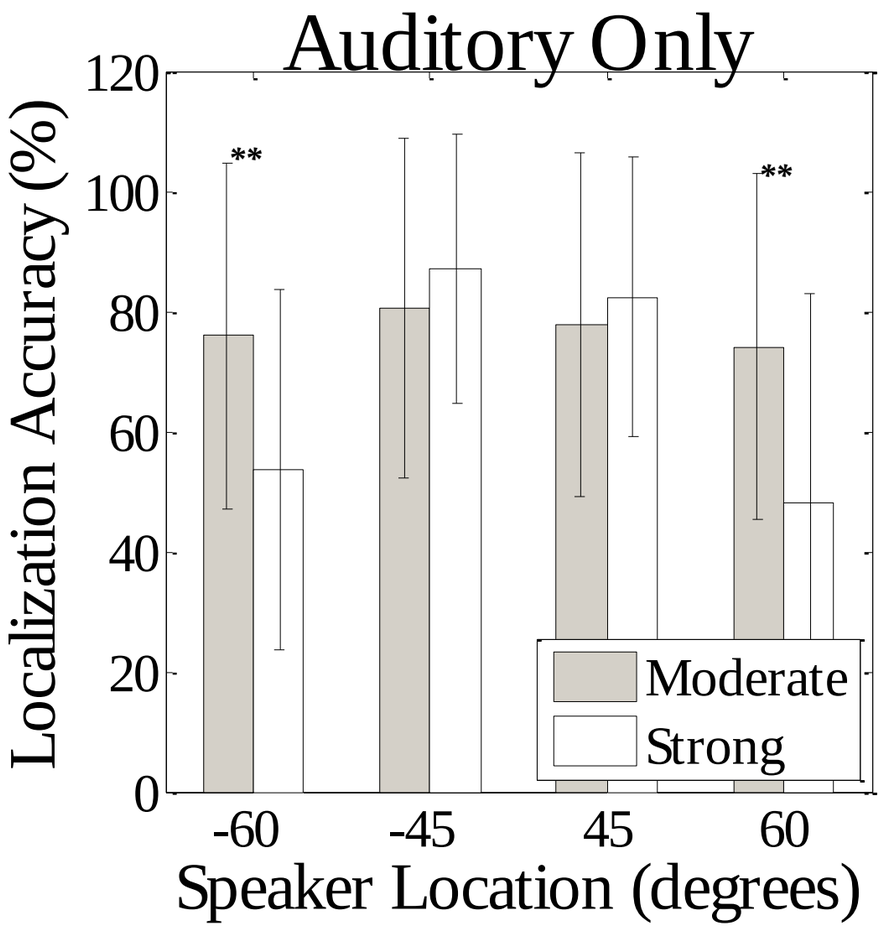


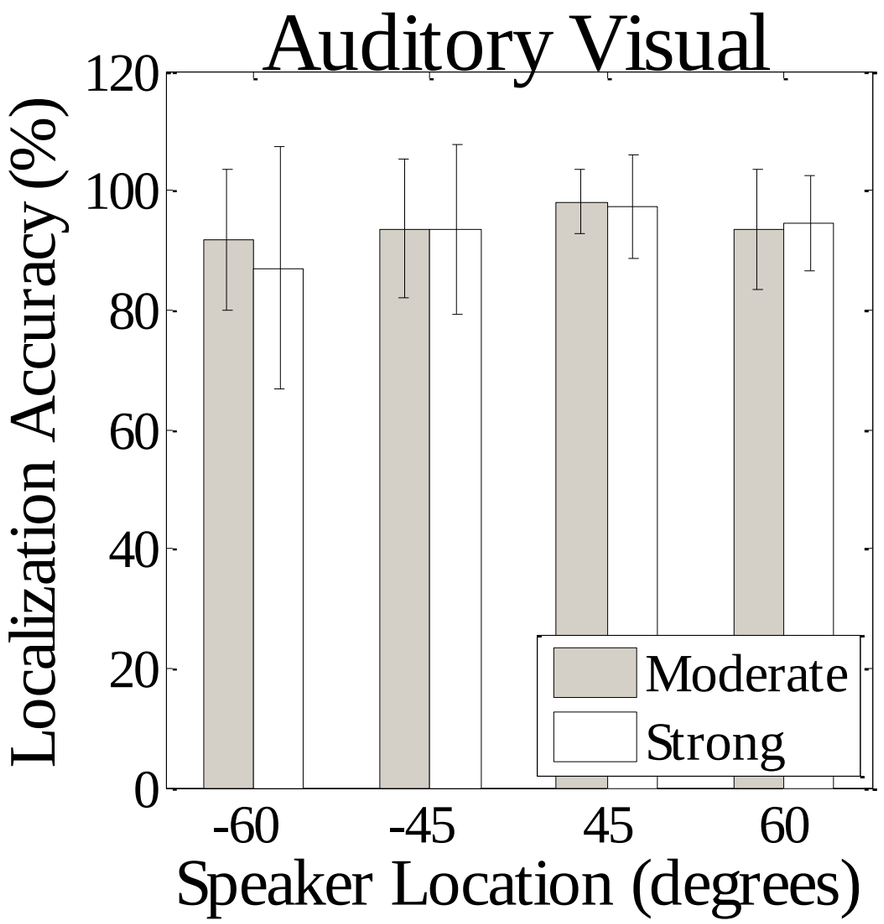
Beamformer improves speech recognition about 8-15% in reverberation (compared to directional) – Picou, Aspell & Ricketts (2014)

Second generation benefit (custom instruments): Moderate HL



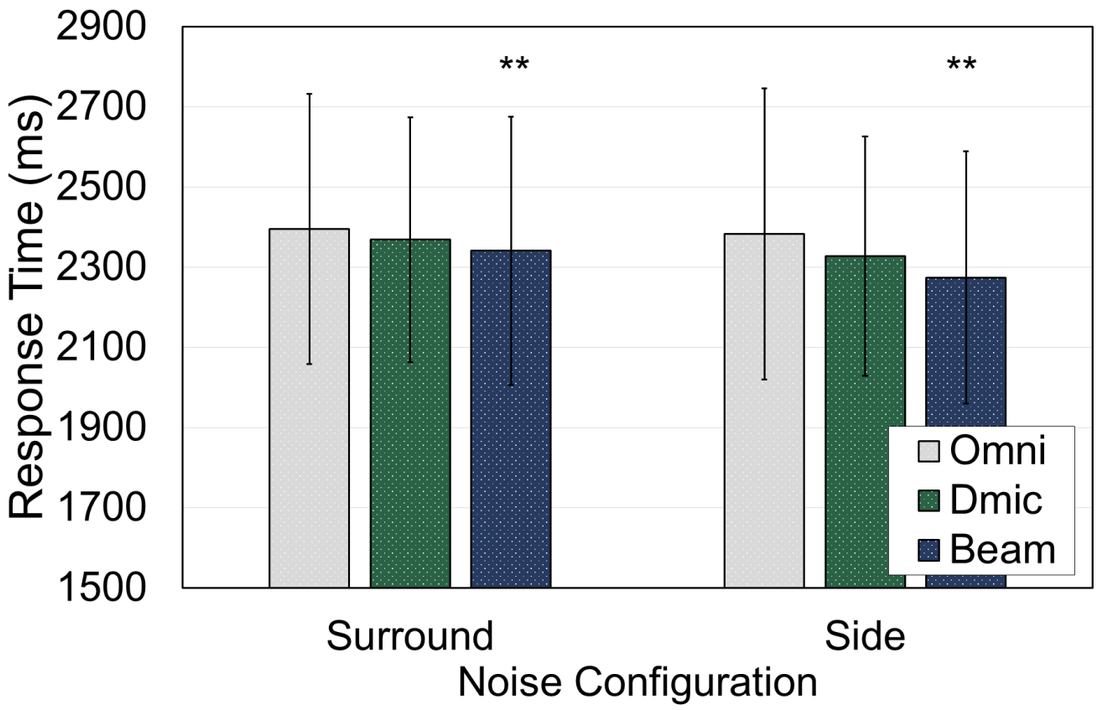
Gross Localization Results (First Generation)



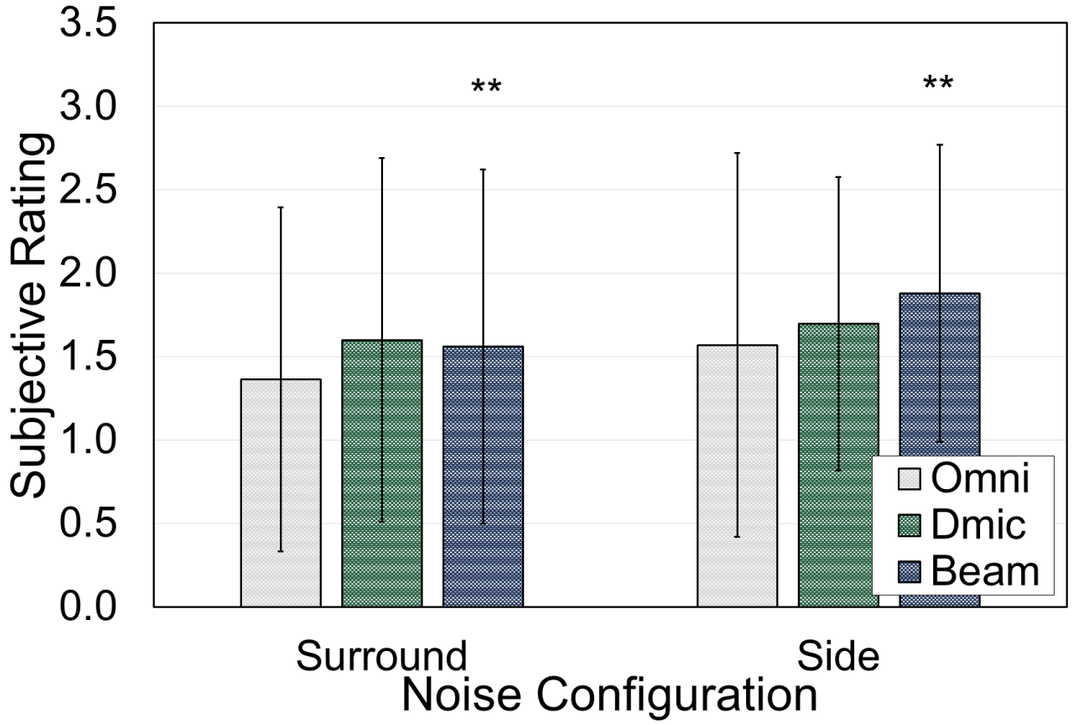


Listening Effort Outcomes with an Adaptive Beamformer (in Prep)

Behavioral Listening Effort Improvements



Subjective Effort (Control)



Polling Question…

- Directional microphone technology can reduce listening effort (True/False).

Current Conclusions – Cue-Preserving Bilateral Beamformers

- Bilateral beamformers have the potential to provide additional speech recognition benefits over adaptive directional processing when listeners are facing the signal of interest
  - Similar bilateral beamformer benefits are observed across style and degree of hearing loss
  - Some localization issues, but preference was not significantly affected
- Directional microphones and bilateral beamformers can reduce listening effort!

- Directional hearing aids and beamformers can result in poorer than omnidirectional performance when the talker is to the side or behind.

The Importance of Average Data

- The mini-BTE style has proven to have significant advantages over other styles for some adult listeners (particularly when fitted open) and is preferred by the majority who are good candidates.
- FM systems and remote microphones can improve speech recognition in noise by up to 8-15 dB.
- Directional microphones (unilateral Beamformers) can produce smaller (about 2-5 dB), but significant enhancements to speech recognition in a wide range of environments.
- These evidenced based data have informed clinical practice and enhanced hearing aid fittings.

Automatic Switching Accuracy (Ricketts et al., 2017)

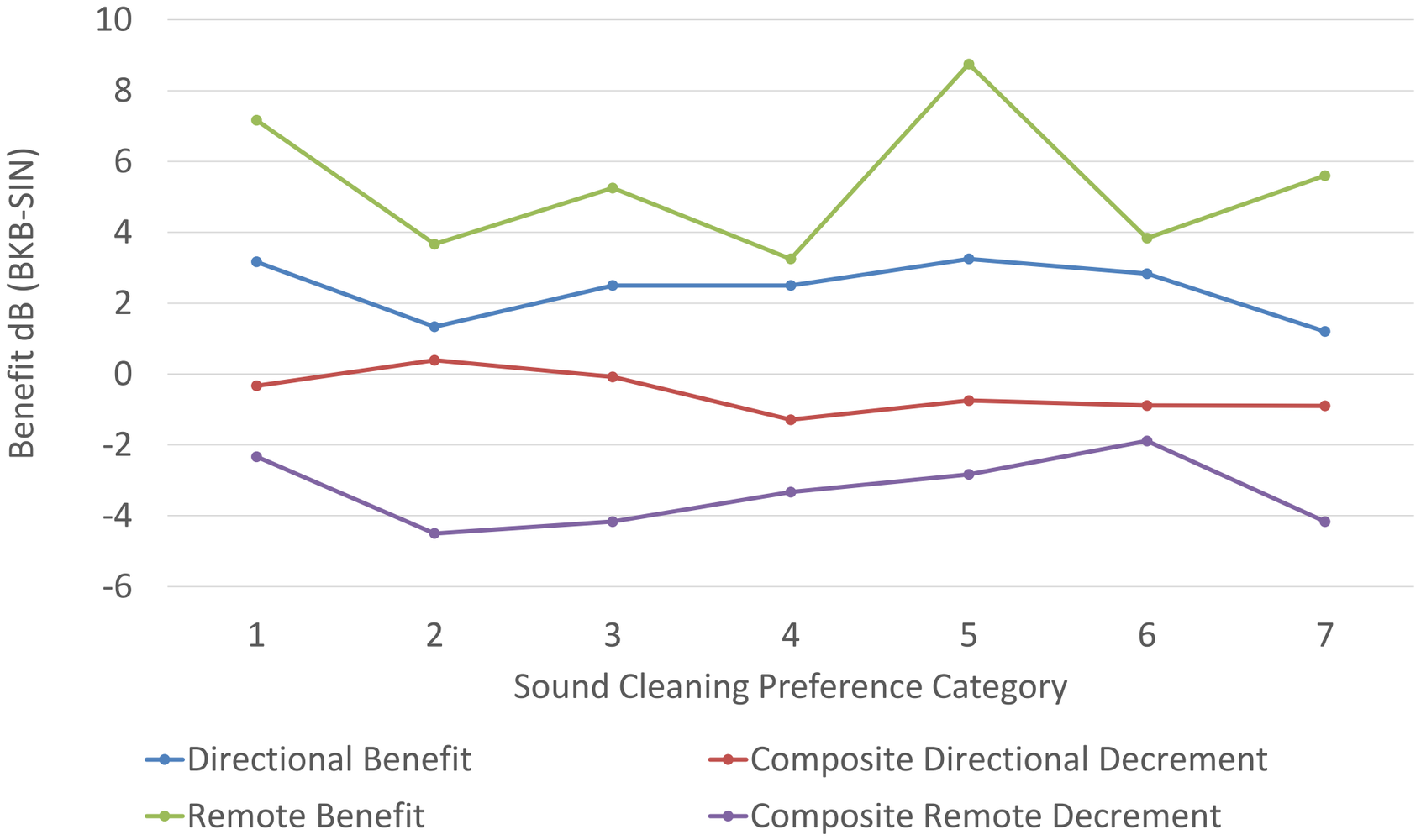
- Accuracy is moderate to good overall
  - Advanced switching including Speech Location Detection and Reverse Directional technologies would eliminate SOME of the mistakes.
  - To correct some of the mistakes the hearing aid would have to know the listeners intent
  - The listening environment matters too – many environments include noise that is too low level to trigger a switch to directional
  - Real listening situations can be very complex – overhearing can be very important for social development (Akhtar, 2005; Forrester, 1993; Rogoff,Mistry, Göncü, &Mosier, 1993) and learning (Moeller et al., 2009).
- To date we have focused on improving the instrument and the interaction between instrument and environment
- **What about behavior, benefit and preference? Can these factors improve clinical application of microphone based technologies?**

What Do 20 Patients Prefer? Judgements Made for Front/Back and Left/Right For +3 and +8 dB SNR (Speech = 62 dB SPL)

- (4) Omnidirectional
  - (3) for all situations
  - (1) Omnidirectional all but one situation
- (2) Directional for all but one situation - O
- (2) Omni 75%, directional 25%, but Remote always 2nd
- (7) Remote – High level noise; Speech front
  - (2) Omni elsewhere
  - (2) Split omni/directional elsewhere
  - (3) Directional elsewhere
- (4) Remote – Speech Front; directional elsewhere
- (1) Inconsistent preferences

Two repetitions with strength of preference (0-9) each judgement

Preference as a Function of Speech Recognition Benefit?

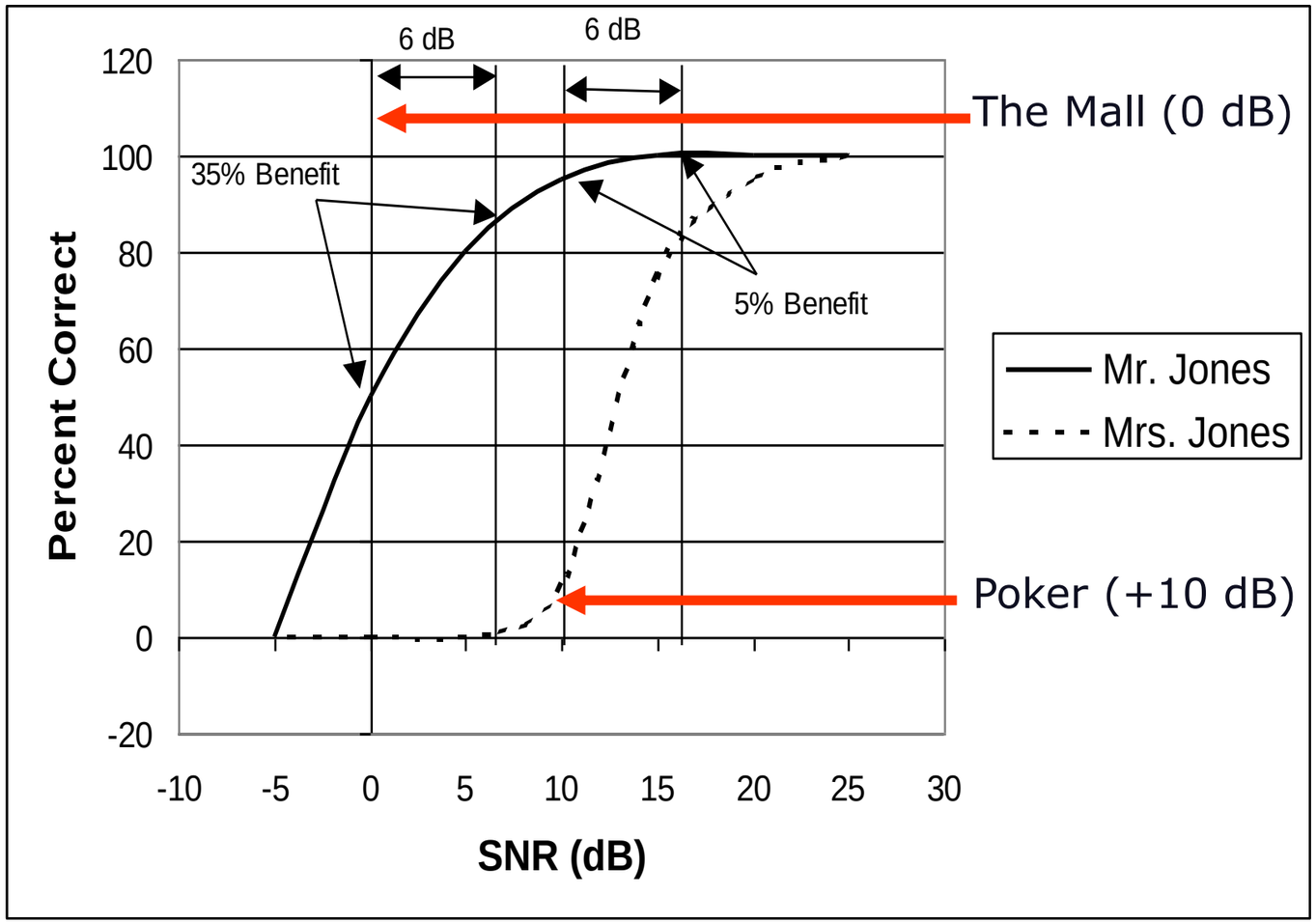


Improving Automatic Switching Accuracy?

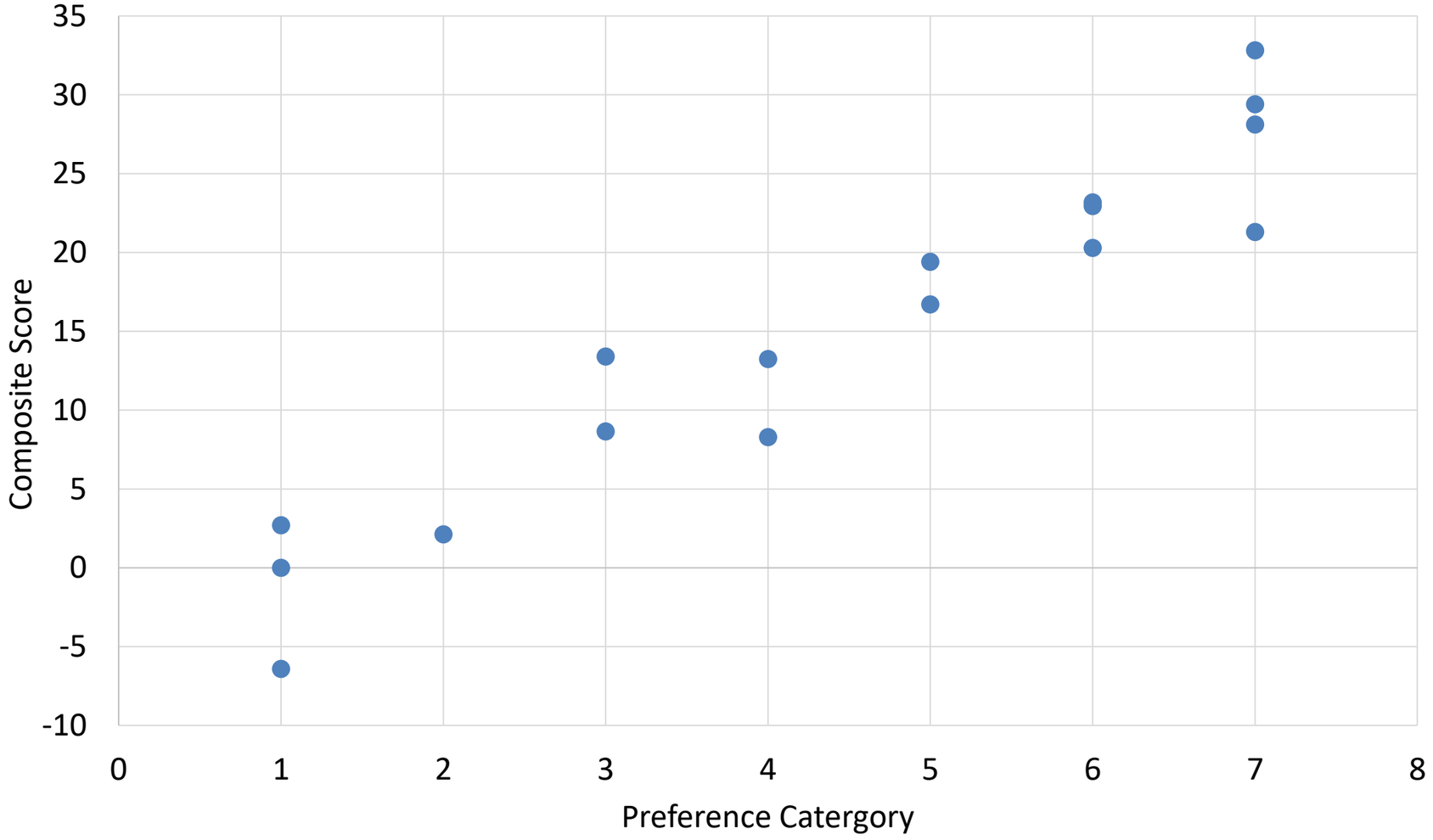
- Preference is not easily predictable on the average, factors that are important are probably different across individuals.

- **What about differences in individual listeners?**
  - Can significant further improvements be made through individualization?

Individual Patient Differences



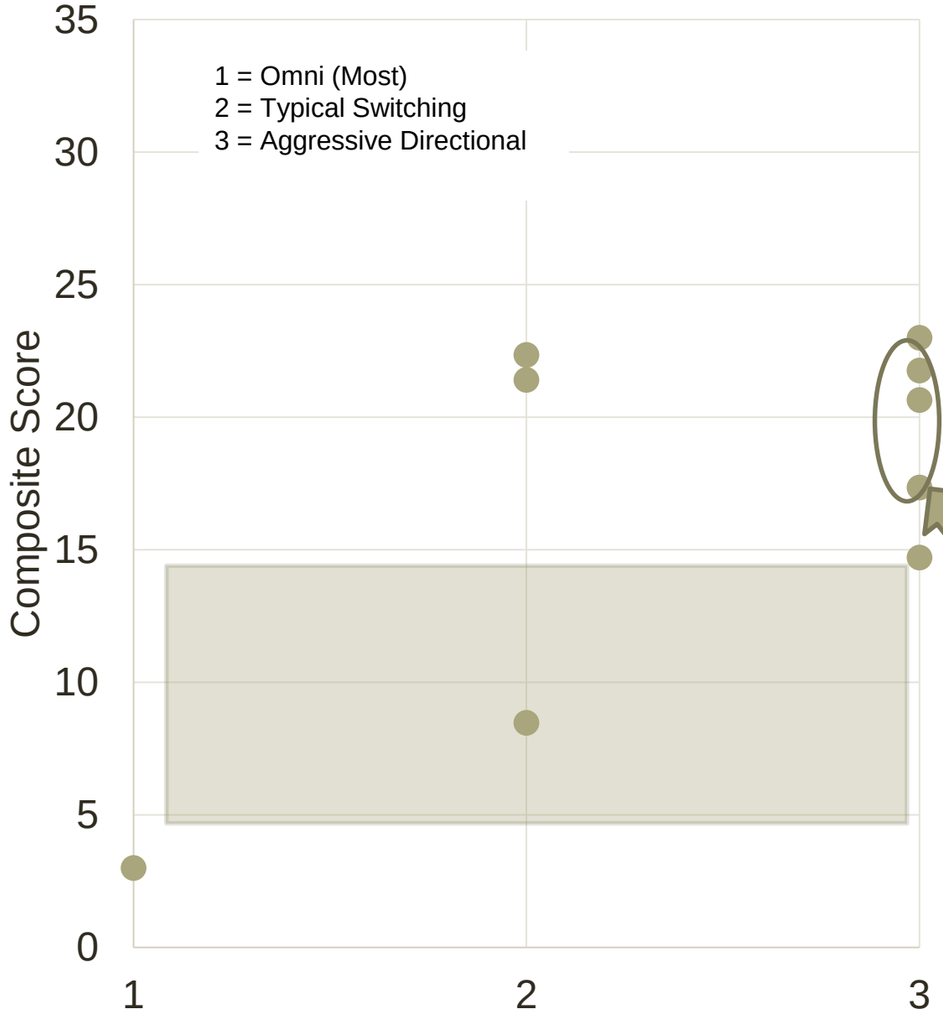
Application of a weighted algorithm: Including remote microphone



Preliminary Recommendations - Factors that matter in adults (less than 15 minutes to test)

- Unaided speech recognition in noise presented at a high level (SNR loss).
- Correction for SNR tolerance
- Correction for importance of hearing and understanding specific sounds from behind.
  - The positive affect of directional speech finders?

Experiment 2: Pilot predictive data on additional cohort



- No preference or prediction for omni yet in this group.
- Patients reported more difficulty telling settings apart than previous study.
  - No difference right/left.

Additional support that speech in noise alone is not enough – SNR-50 less than 2 dB!

Polling Question…

- Evidence supports that examining individual differences in patients that are unrelated to pure tone thresholds has the potential to improve hearing aid fittings (True/False).

A few good adaptive clinical speech in noise tests: All will give you a measure of speech in noise difficulties – other benefits?

- Quick-SIN
  - Quick, easy, inexpensive, weak reliability unless multiple lists are used.
- BKB-SIN (Etymotic)
  - Quick, easy, inexpensive
- Hearing in Noise Test (HINT) – developed at house ear institute (Soli)
  - Available in many languages, currently difficult to get in the US
- Matrix Test (Oldenburg)
  - Available in many languages, no learning effects, multiple choice results in performance that is much better than many other tests (real world?)

Example Test Materials: HINT (HINT-C Kids down to 5 yo)

- Hearing in Noise Test (HINT) developed for testing in Noise (Nilsson, Soli, & Sullivan, 1994).
- Noise level fixed, amplitude of sentences adaptively varied in 4 (first 5 sentences) then 2 dB steps to determine SNR for 50% performance threshold.
- Can use 10 (about 3 minutes) or 20 (6-7 minutes) sentences.
- Sentences are scored as right or wrong.
- Average SNR over the last 6 sentences of 10 (+1) determines the performance threshold.

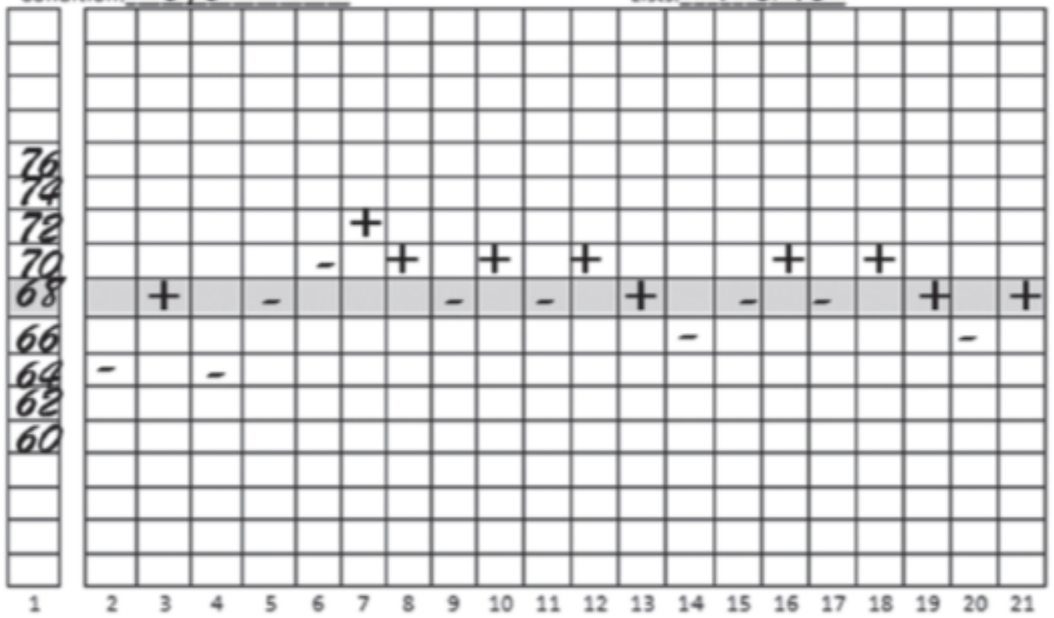
Best Additional Reasons to Use?

- Normed for spatial release from masking – evaluation of binaural hearing.
- Using the HINT for evaluation of job critical hearing skills (police and firefighters).
- Pediatric (norms down to age 5), offered in many languages, autoscoring, spatial under headphones…

HINT Score Sheet

Name:_____ Date:_____

Condition: 0|0 Lists: 9 & 10



5	
6	
7	
8	
9	
10	
11	
total / 7 =	

5	68
6	70
7	72
8	70
9	68
10	70
11	68
12	70
13	68
14	66
15	68
16	70
17	68
18	70
19	68
20	66
21	68
total / 17 =	68.5

68.5 (average) minus 60 (noise reference) = 8.5 dB RTS

HINT Normative Data Adults With Normal Hearing

Listening Condition	Mean Threshold	Standard Deviation (dB)
Noise Front	-2.6 dB SNR	1.0 dB
Noise Right	-10.1 dB SNR	1.3 dB
Noise Left	-10.1 dB SNR	1.3 dB
Noise Composite	-6.35 dB SNR	0.9 dB

Percentile	Quiet (dB[A])	Noise Front (dB SNR)	Noise Right (dB SNR)	Noise Left (dB SNR)	Noise Composite (dB SNR)
95	10.50	-4.24	-12.24	-12.24	-7.83
75	13.51	-3.27	-10.98	-10.98	-6.96
50	15.60	-2.60	-10.10	-10.10	-6.35
25	17.69	-1.93	-9.22	-9.22	-5.74
5	20.70	-0.96	-7.96	-7.96	-4.87

Obtaining the HINT

- Disk version and online version owned by two different groups.
- The standalone HINT$$$
- Online HINT - Pay per test?
- Will negotiate – particularly with larger clinics, academia

The QuickSIN: Another reasonable choice for clinicians

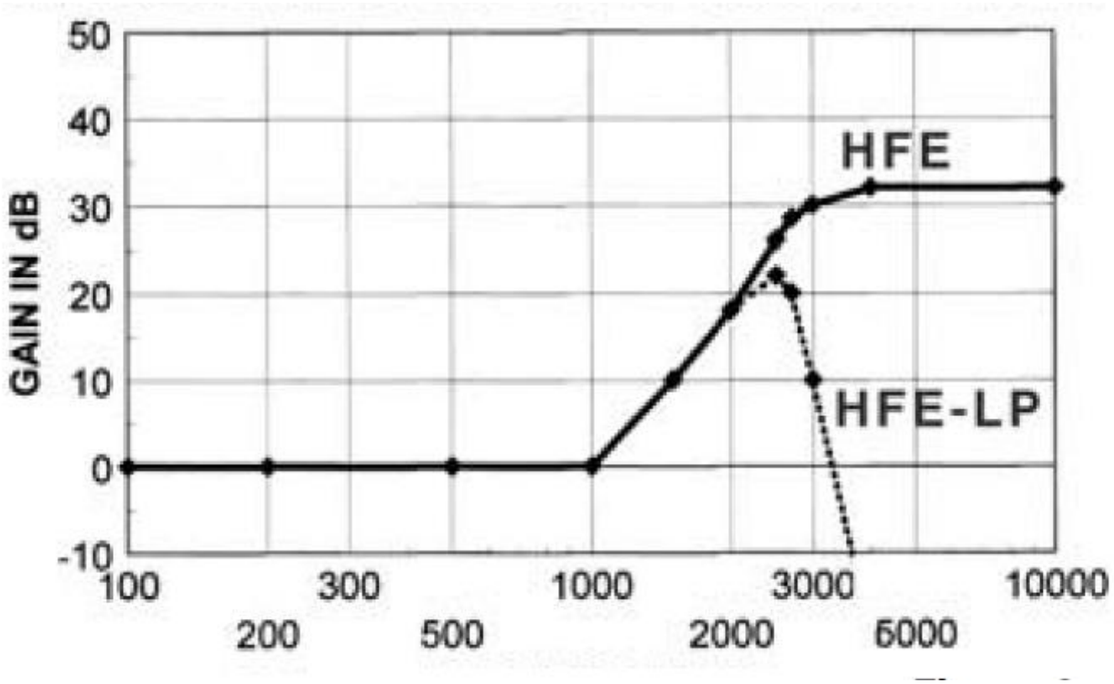
- Recorded with 6 different S/N ratios
- Six sentences/list; only one sentence at each level
  - Yes it is quick! About 1 minute per list
- Female talker with four competing talkers (yes there is informational masking)
- Very easy to administer
- Fairly easy to score

Quick-SIN Lists

- 12 equivalent list.
  - Note: Research by McArdle and Wilson (2006) revealed that Lists 4, 5,13 and 16 were not within critical range for people with hearing loss
- Four Different Types of Sentence Lists.
  - Mixed Signal and Noise – Measure SNR loss.
  - Separate signal and noise – Best for testing directional benefit.
  - 30 dB High Frequency Emphasis.
  - 3 KHz low pass with HFE.

Use in tandem to decided if it is worth chasing the highs

Q-SIN HFE Lists Applied Gain



The QuickSIN: Critical difference values are available

Lists per Condition	1	2	3	4	5	6	7	8	9
95% C.D. ±, in dB	3.9	2.7	2.2	1.9	1.7	1.6	1.5	1.4	1.3
90% C.D. ±, in dB	3.2	2.2	1.8	1.6	1.4	1.3	1.2	1.1	1.1
80% C.D. ±, in dB	2.5	1.8	1.5	1.3	1.1	1.0	1.0	0.9	0.8

Note: Research by McArdle and Wilson (2006) revealed that Lists 4, 5,13 and 16 were not within critical range for people with hearing loss

Best Additional Reasons to Use?

- Relatively Inexpensive
- Fast – About 1 minute per condition after instructions.
  - But - use 2 or more list per condition for reasonable reliability.
- Good if you need a difficult test
- HFE/HFE – LP lists for high frequency utility.
- Recordings with reverberation and other room effects (see Brungart et al)
  - But not for kids…

Standard and Non-Standard Uses?

- Normed for headphones at 70 dB HL (83 dB SPL). Use mixed S/N list to evaluate…
  - SNR loss (from counselling to selection and beyond)
  - Unilateral/bilateral considerations
  - Chasing the highs (HFE/HFE-LP)?

- Outcome Measure? Counselling related utility?
- Calibrate in the sound field with split list from front and back speakers at 65 dB SPL to demonstrate…
  - Directional benefit
  - FM/Remote/Spouse mic Benefit (place mic about 7 inches from the from speaker).
- Calibrate in the sound field with mixed S/N list from a single front speakers at 50 dB SPL to demonstrate…
  - Hearing aids work

BKB – SIN (an easier, better normed Q-SIN +Kids)

- The BKB-SIN contains 18 List Pairs (equated for difficulty). Each List Pair takes approximately three minutes.
- List Pairs 1-8 have ten sentences in each list, with one sentence at each SNR of: +21, +18, +15, +12, +9, +6, +3, 0, -3 and -6 dB. These List Pairs can be used with all listeners.
- List Pairs 9-18 have eight sentences in each list, with one sentence at each SNR of: +21, +18, +15, +12, +9, +6, +3 and 0 dB. These provide ten additional equivalent List Pairs aimed at CI Users and those with significant SNR loss. Too easy for general population.
- Standard, split track, split track fixed SNR

BKB-SIN

List 9A	Key Words	# Correct	SNR
1. The football player lost a shoe.	4	_____	+ 21 dB
2. The painter used a brush.	3	_____	+ 18 dB
3. The lady sat on her chair.	3	_____	+ 15 dB
4. The milkman brought the cream.	3	_____	+ 12 dB
5. The dog chased the cat.	3	_____	+ 9 dB
6. Mother shut the window.	3	_____	+ 6 dB
7. The apple pie was good.	3	_____	+ 3 dB
8. Rain falls from the clouds.	3	_____	0 dB
	Total Key Words Correct	_____	
	SNR - 50 = (23.5) – (# Correct)	_____	

BKB – SIN (Norms)

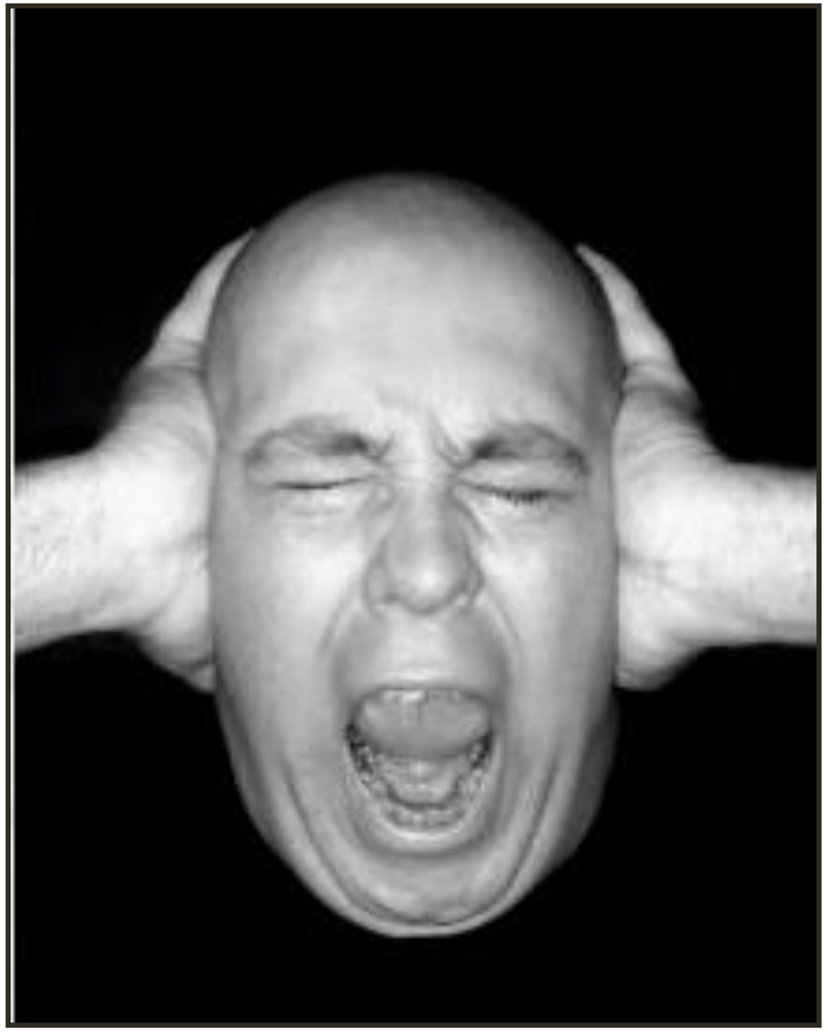
Table 5 **Critical Difference for Comparisons**

	Number of Lists =	1	2	3	4	5	6	7	8	9	
Adults	95%C.D. Test +/-	2.2	1.6	1.3	1.1	1.0	0.9	0.8	0.8	0.7	dB
	80%C.D. Test +/-	1.8	1.3	1.0	0.9	0.8	0.7	0.7	0.6	0.6	dB
Adult CI Users	95%C.D. Test +/-	4.4	3.1	2.6	2.2	2.0	1.8	1.7	1.6	1.5	dB
	80%C.D. Test +/-	3.6	2.6	2.1	1.8	1.6	1.5	1.4	1.3	1.2	dB
Children by Age											
5-6	95%C.D. Test +/-	5.4	3.9	3.1	2.7	2.4	2.2	2.1	1.9	1.8	dB
	80%C.D. Test +/-	4.4	3.1	2.6	2.2	2.0	1.8	1.7	1.6	1.5	dB
7-10	95%C.D. Test +/-	3.5	2.5	2.0	1.8	1.6	1.4	1.3	1.2	1.2	dB
	80%C.D. Test +/-	2.9	2.0	1.7	1.4	1.3	1.2	1.1	1.0	1.0	dB
11-14	95%C.D. Test +/-	3.2	2.3	1.9	1.6	1.5	1.3	1.2	1.1	1.1	dB
	80%C.D. Test +/-	2.6	1.9	1.5	1.3	1.2	1.1	1.0	0.9	0.9	dB

Polling Question…

- Speech recognition in noise testing is of little utility clinically because any patient differences are easily predicable from speech recognition in quiet (True/False).

Noise: Annoyance and Acceptance



- Do different people have different levels of “acceptance of background noise?
- Does the level of acceptance relate to hearing aid use? Benefit? Satisfaction?
- Is this something that we need to know about our patients?

The Acceptable Noise Level (ANL) Test

Note: Most any speech or noise signal can be used, but standard version is available from Frye Electronics (uses R-SPIN babble as noise)

- What is it and how is the ANL measured?
  - **MCL** – find the patients preferred listening level to on-going conversation
  - **BNL** (Background Noise Level) – find the patient's "acceptable" listening level to background noise when it is present simultaneously with conversational speech presented at their MCL
  - **ANL** = then, the BNL is subtracted from the MCL and you have the ANL

The Acceptable Noise Level (ANL) Test: What we know

- It is about 8-10 dB for both normal and hearing-impaired individuals
- No gender effect
- Although similar to an SNR, it is *not* correlated to SNR intelligibility measures
  - Varies from near 0 dB to more than +15 dB!
- When standard hearing aid technology is used, the ANL is about the same aided versus unaided
  - Improves for directional microphones
- Provides information about sound tolerance when considering sound cleaning technologies.

Complaints I Sometimes Hear About Subjective Hearing Aid Outcome Measures

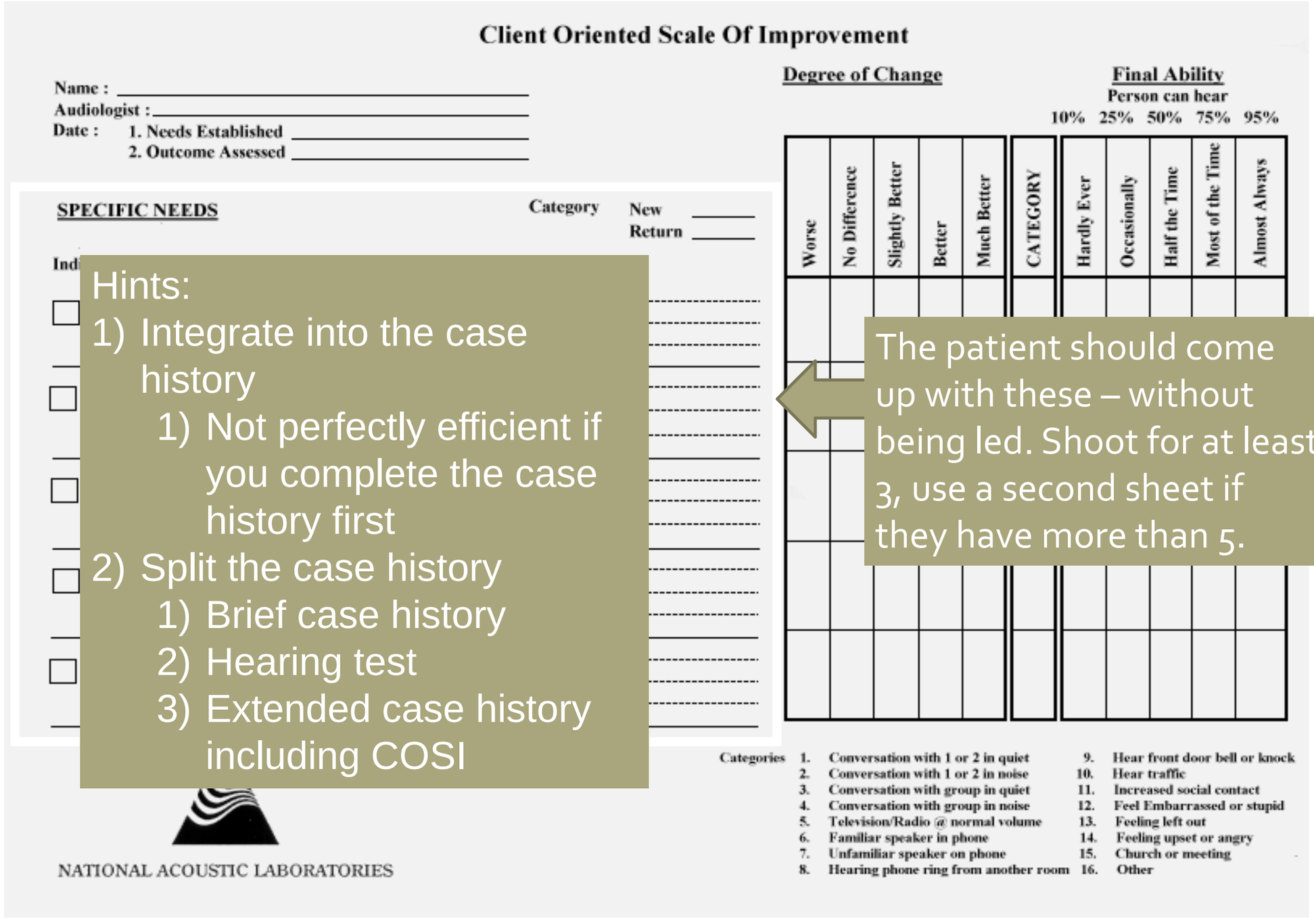
- Time consuming if I give them, but unreliable if I mail it to them or have them do it in the waiting room.
- Time consuming to score or I have to pay my assistant time to score them
- Even more time consuming if they have a pre-fitting component which I really never use for anything.

Consider Some Possibilities?

- Integrate the pre-fitting questionnaire into what you are already doing as part of case history and counselling.
  - Can seamlessly do this with the COSI and GHABP with some practice.
- Consider that the information may actually be useful for selection, feature adjustment and counselling.
- Evidence suggests simply using pre-selection and outcome measures improves patient satisfaction.

One Useful Tool – The Client Oriented Scale of Improvement

- Developed by Harvey Dillon and colleagues at NAL
- Can be used to establish goals, to measure expectations and as an outcome measure of benefit and satisfaction.
- Does not suffer from having items that the patient doesn't experience.
- Weakness? Since it is patient defined there are no normative data for comparison.


Client Oriented Scale Of Improvement
Name :
Audiologist :
Date : 1. Needs Established
2. Outcome Assessed
SPECIFIC NEEDS
Category
New
Return
Degree of Change
Worse
No Difference
Slightly Better
Better
Much Better
CATEGORY
Final Ability
Person can hear
10% 25% 50% 75% 95%
Hardly Ever
Occasionally
Half the Time
Most of the Time
Almost Always
Hints:
1) Integrate into the case history
1) Not perfectly efficient if you complete the case history first
2) Split the case history
1) Brief case history
2) Hearing test
3) Extended case history including COSI
The patient should come up with these – without being led. Shoot for at least 3, use a second sheet if they have more than 5.
Categories
1. Conversation with 1 or 2 in quiet
2. Conversation with 1 or 2 in noise
3. Conversation with group in quiet
4. Conversation with group in noise
5. Television/Radio @ normal volume
6. Familiar speaker in phone
7. Unfamiliar speaker on phone
8. Hearing phone ring from another room
9. Hear front door bell or knock
10. Hear traffic
11. Increased social contact
12. Feel Embarrassed or stupid
13. Feeling left out
14. Feeling upset or angry
15. Church or meeting
16. Other
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Once there are general ideas help the patient form them into specific goals

Consider each relative to features and other pre-fitting results

SPECIFIC NEEDS

Category New _____
Return _____

Indicate Order of Significance

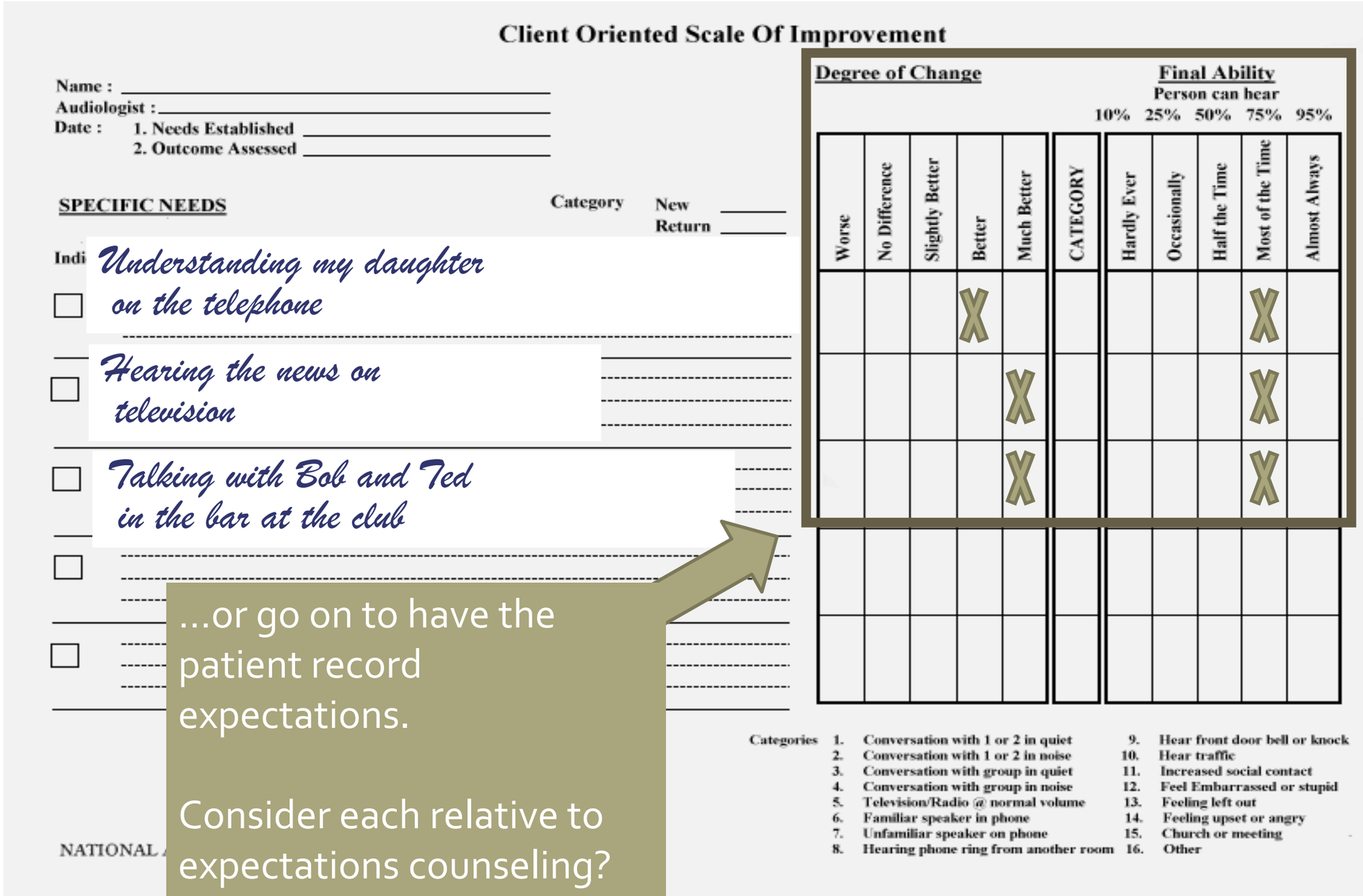
☐ *Understanding my daughter on the telephone*

☐ *Hearing the news on television*

☐ *Talking with Bob and Ted in the bar at the club*

☐

Can Stop at this Point



Client Oriented Scale Of Improvement

Name : _____
Audiologist : _____
Date : 1. Needs Established _____
2. Outcome Assessed _____

SPECIFIC NEEDS

Category New _____
Return _____

Indi

Understanding my daughter on the telephone

Hearing the news on television

Talking with Bob and Ted in the bar at the club

Degree of Change						Final Ability — Person can hear				
						10%	25%	50%	75%	95%
Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY	Hardly Ever	Occasionally	Half the Time	Most of the Time	Almost Always
			X						X	
				X					X	
				X					X	

Categories
1. Conversation with 1 or 2 in quiet
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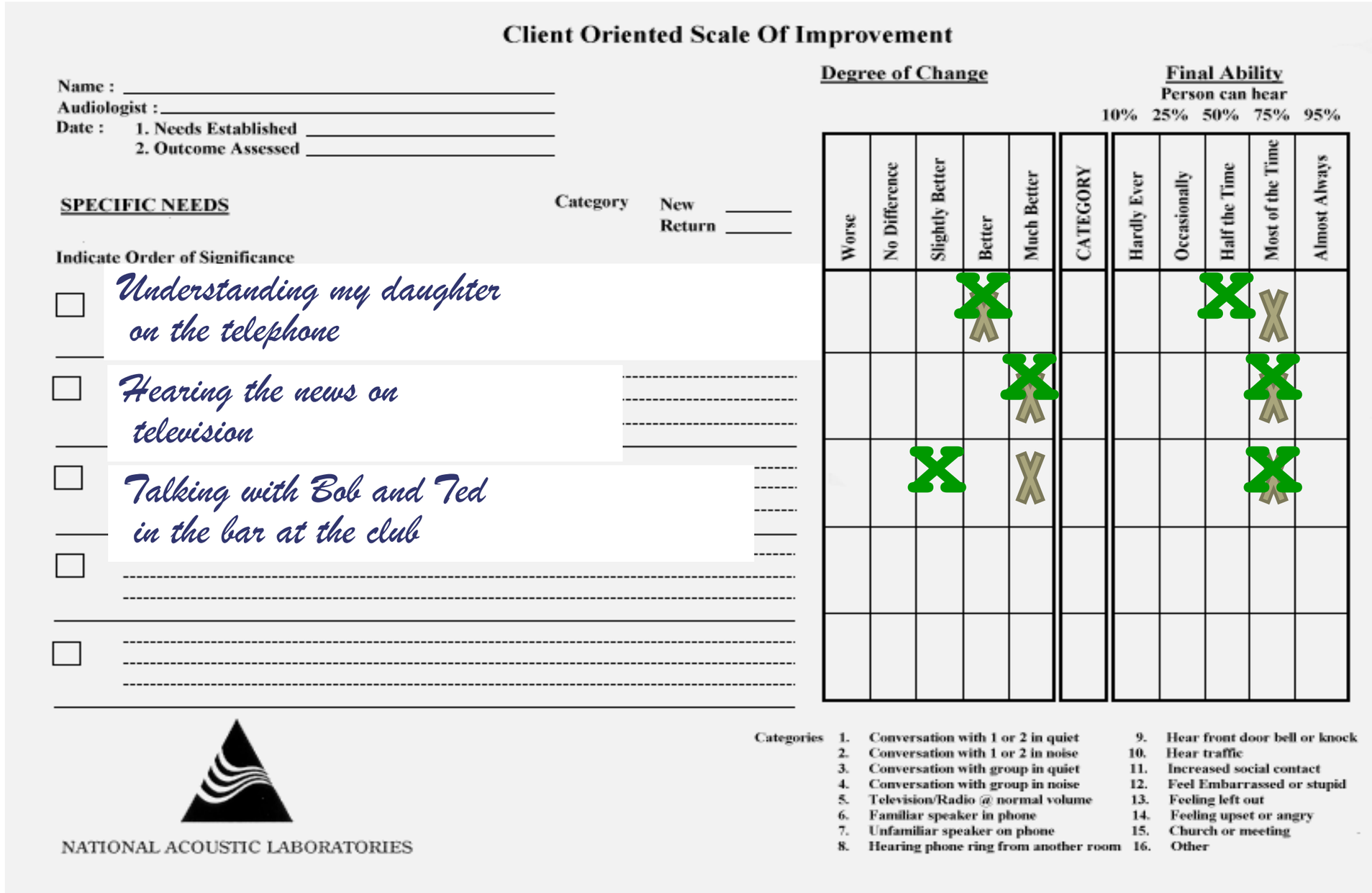
NATIONAL

…or go on to have the patient record expectations.

Consider each relative to expectations counseling?

Use as an Outcome Measure



Client Oriented Scale Of Improvement

Name : _____
Audiologist : _____
Date : 1. Needs Established _____
2. Outcome Assessed _____

SPECIFIC NEEDS

Category New _____
Return _____

Indicate Order of Significance

☐ *Understanding my daughter on the telephone*

☐ *Hearing the news on television*

☐ *Talking with Bob and Ted in the bar at the club*

☐

☐

Degree of Change

Worse	No Difference	Slightly Better	Better	Much Better
			X	
				X
		X		

CATEGORY

Final Ability
Person can hear

10%	25%	50%	75%	95%
Hardly Ever	Occasionally	Half the Time	Most of the Time	Almost Always
		X	X	
			X	
			X	

Categories
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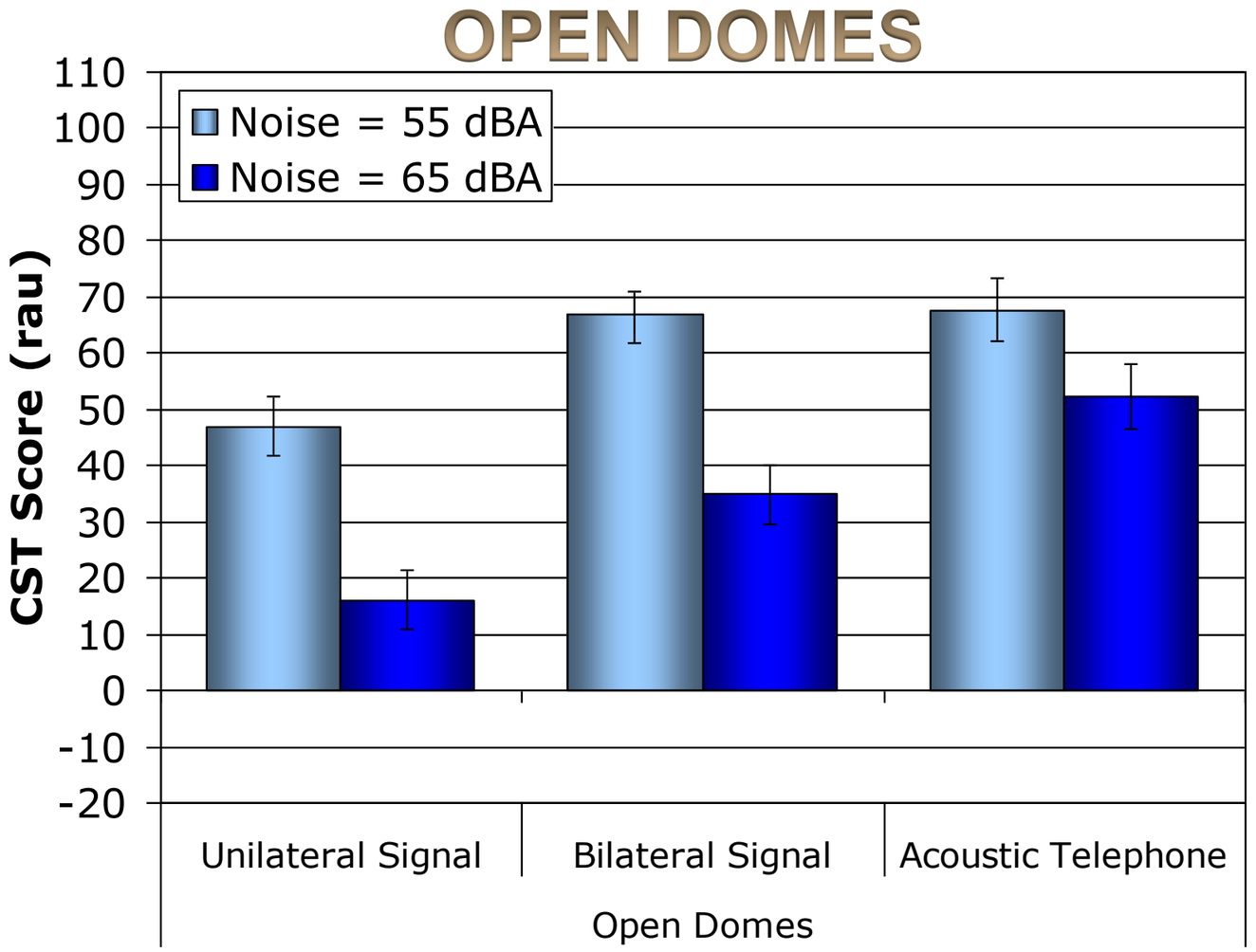
A few technology specific additions

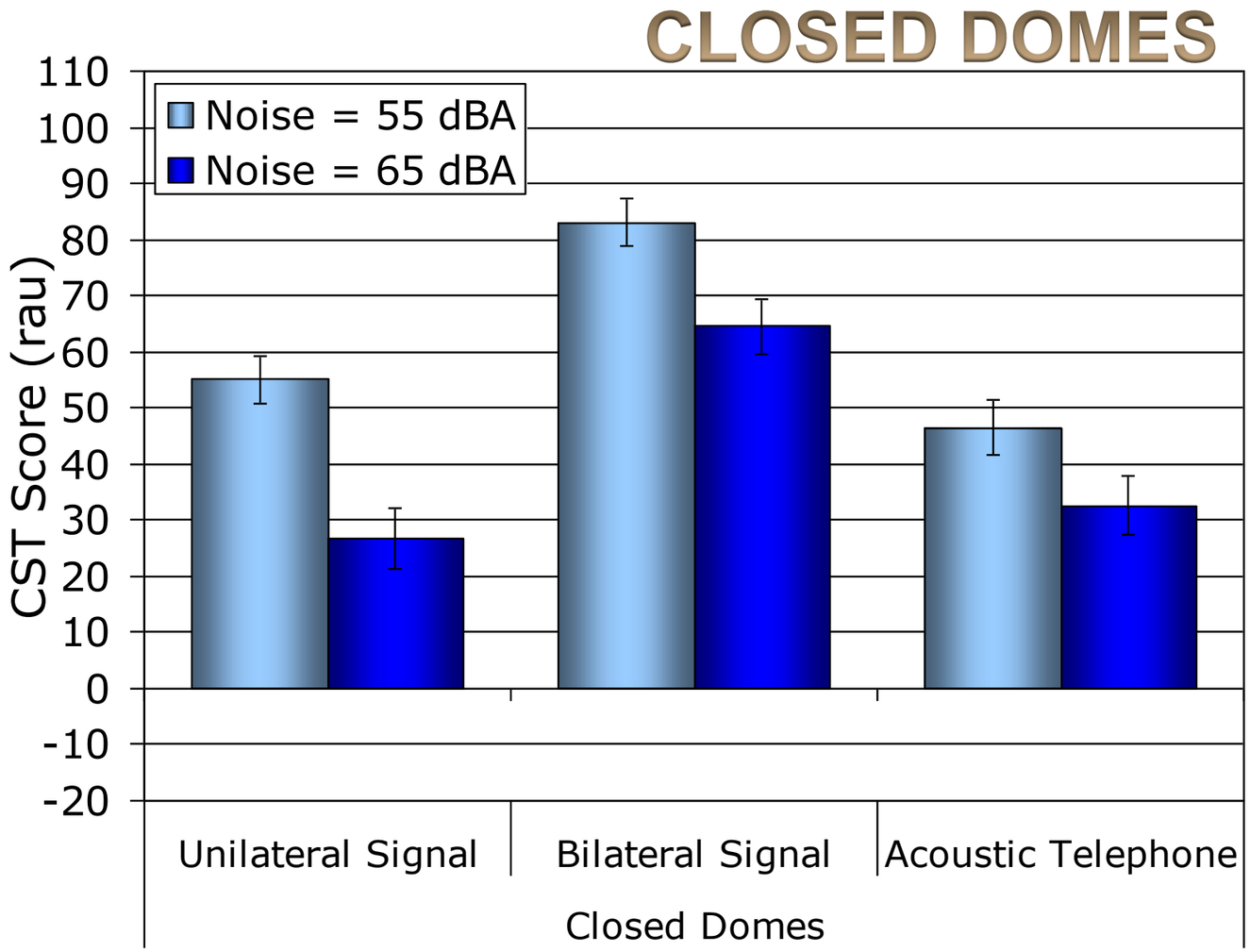
- Considering Remote Mic, versus adaptive directional (Unilateral Beamformer), versus Bilateral Beamformer (Note: Without Speech Location Finder Technology):
  - A child is speaking behind you, can you understand him or her?
  - How important is it for you to be able to find sounds you cannot see? Can you do that now if they are loud enough?
  - If the patient can understand children and find sounds they are not looking at (and this is important to them), they are more likely to prefer less sound cleaning – especially when noise tolerance and SNR-50 is good.

- Additional questions for lobe steering technologies (including reverse directional):
  - Do you have trouble listening in the car? If so, where is the person you speak with?
  - Are there any other situations which you need to listen to someone you are not facing?
  - Are you in situations where there are loud talkers who you don’t want to hear?

Individualization and Telephone Solutions: Considering “Twin Phone” Streaming Technologies



Individualization and Telephone Solutions: Considering “Twin Phone” Streaming Technologies



Needs for individualization for telephone solutions is clear! Telephone streaming to one or two ears?

- Is the listener often on the telephone in noise? If so, how poorly does the listener perform on the telephone in noise?
  - If very poor may require bilateral streaming!
- How important is monitoring outside sounds?
  - If very important, may leave hearing aid microphones active OR only stream to one ear and monitor with the other.
- What is the vent configuration?
  - If open, streaming only for convenience - may decrease performance and sound quality.

- Clear sound quality problems in open fittings and with larger vents – may be a deal breaker!

Wind Noise Reduction – Benefits and Limitations Affect Counselling!

- Wind crossing the hearing aid microphone port openings creates turbulence.
- These vibrate the diaphragm generating relatively high noise levels.
- MarkeTrak (2010) less hearing aid wearers were satisfied with their hearing aids performance in wind noise than any other type of noise listed!
- Not only very annoying, but wind noise can reduce speech intelligibility at 3 m/s, and totally mask speech at 6 m/s (Zakis and Hawkins, 2015).
- Doubling wind speed increases the wind noise realized by more than 12 dB (Kates, 2008; Morgan and Raspet, 1992).
- Physical modifications help (~18 dB) – but still many complaints
- Data have also shown that wind noise levels can vary significantly across mini-BTE device designs, revealing that small differences in microphone location, shell design, and/ or wind shielding can result in large differences in wind noise levels.

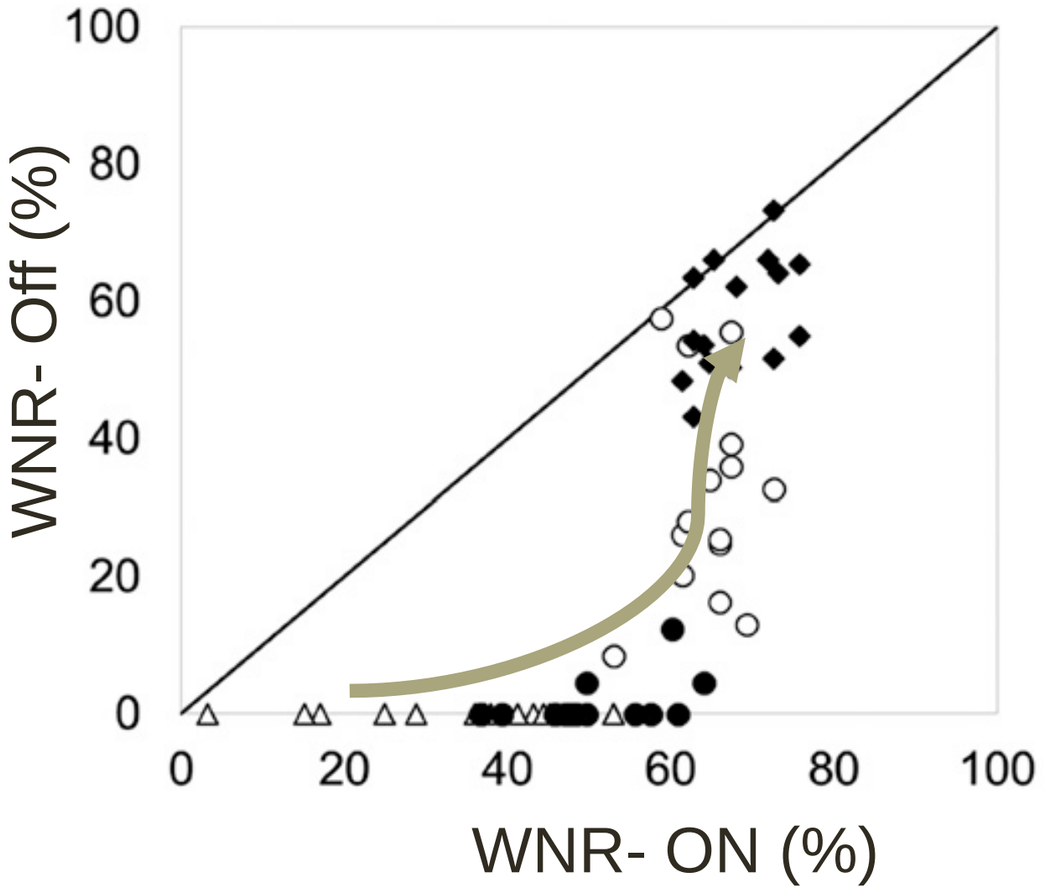
Reducing Wind Noise Through Processing: Basics

- Because it is turbulence, not noise, it is highly uncorrelated over time and at different sample places, therefore traditional spectral subtraction techniques are largely ineffective.
- Lack of correlation at the two microphone openings in a dual mic hearing aid makes it possible to identify since nearly all other signals are highly correlated at the two mics (both noise and speech).
- Directional Microphones? Wind noise creates a spherical noise front – boost in the lows.
  - Omnidirectional processing particularly in the lows

LMS Wind Noise Reduction

- Least Mean Square (LMS) filters are designed to identify the filter coefficients that minimize the squared error between the desired and the actual signal (occurs when the desired and actual signal correlate) – therefore they can reduce uncorrelated noise.
- LMS wind noise reduction has been shown to reduce wind noise by up to 15 dB (Korhonen et al., 2017).
- Most effective at reducing wind level when wind arrived from directly in front of the listener. Reduced, subjective annoyance by approximately 14% for this angle for wind speeds of 4 to 7 m/s.
- Also reported a large and significant phoneme recognition in wind noise benefit but only included wind from 0º and speech from 270º. The magnitude, or even presence of speech recognition benefits in other realistic environments are as yet unknown.
- Speculate benefits are like when wind is generally from the front and speech is from the side; with diminishing benefits when wind and speech approach the same plane of arrival (either both from the same direction or from opposite directions).

What they found (NST - adapted). . .

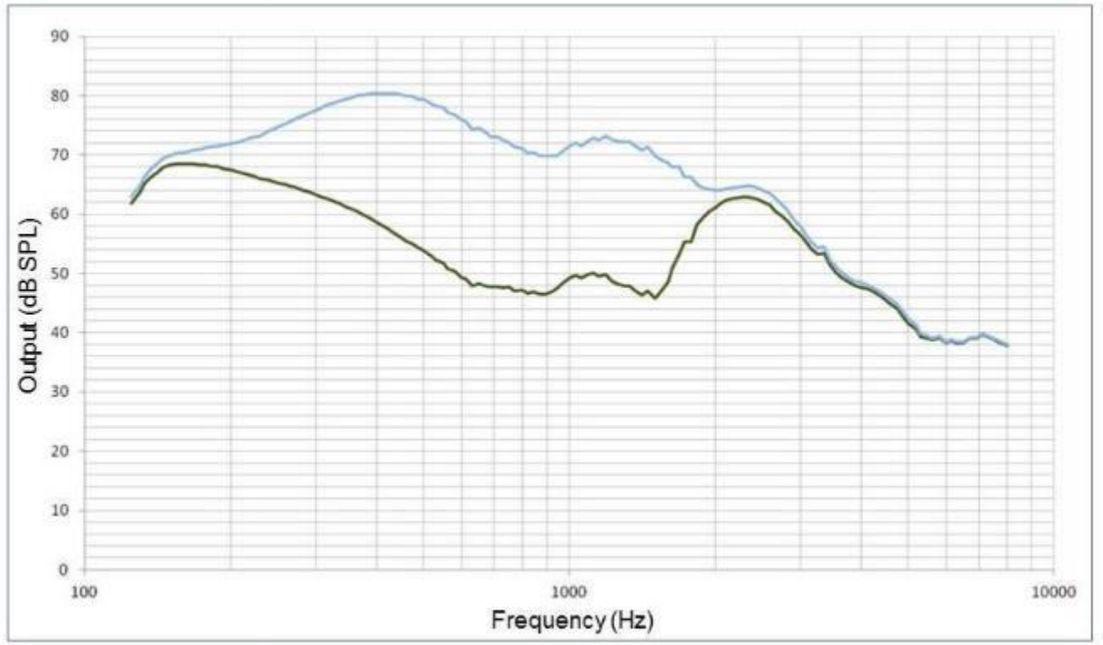


- Speech presented from 270 degrees, wind 0 degrees only.
- 4 speech presentation levels.
- Large average benefits up to nearly 50%

Adapted from Korhonen et al (2017)

Wind Noise reduction through sound sharing: Counselling changes!

- Differences in wind noise level for bilateral hearing aids, wind presented from one side.
- Sound sharing in this condition can improve speech recognition up to 27%.
- Not effective when wind is from the front.



THANK YOU!