How Speech Perception Measures Inform Amplification

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Validation of amplification: means speech-based testing from HA fitting

Systematic and Methodical Observation:

- Functional responses to speech via habilitation team and family
- Types of speech material appropriate to dev level
- Different classes of speech sounds eg Ling
  - To fine-tune hearing aid fitting
  - To identify progress from previous assessment
  - To identify targets for listening work

Aims of presentation:

To demonstrate that testing is possible and necessary

Show crucial use of speech testing in individual cases

Speech Perception study: Rationale based on case-study

Speech perception study in 2 – 8 years

Rationale: comparison of HA fittings at different stages of speech acquisition

HA Prescription rationales

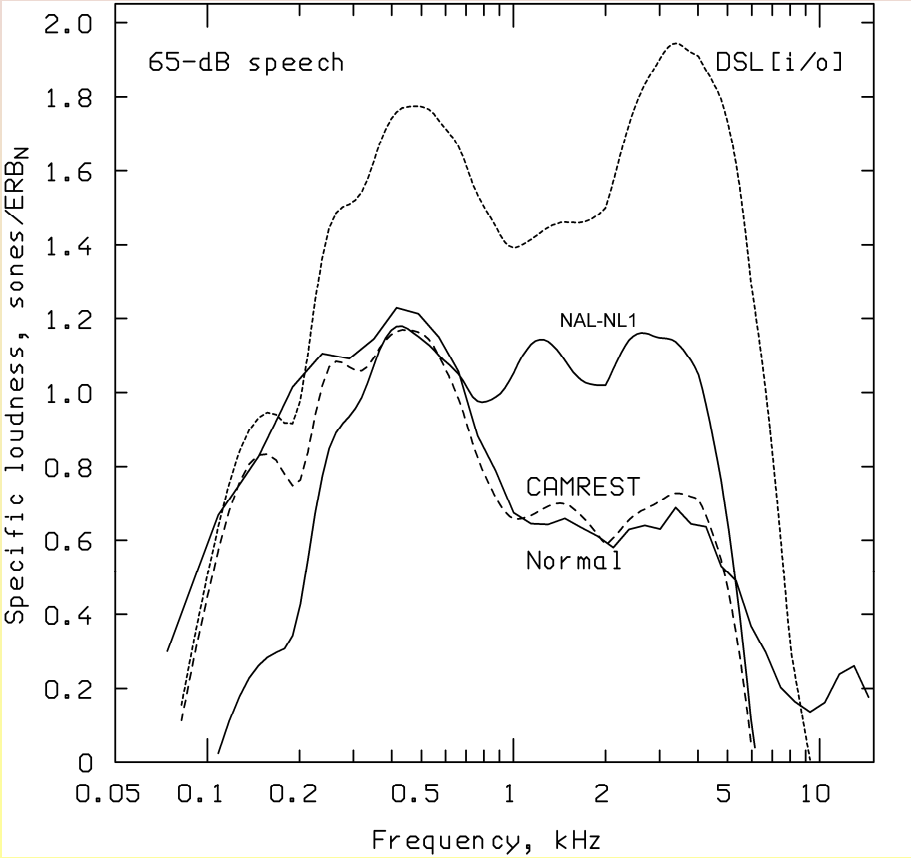
- eg Desired Sensation Level (DSLi/o, or version V)
- NAL-NL1
- CAMEQ

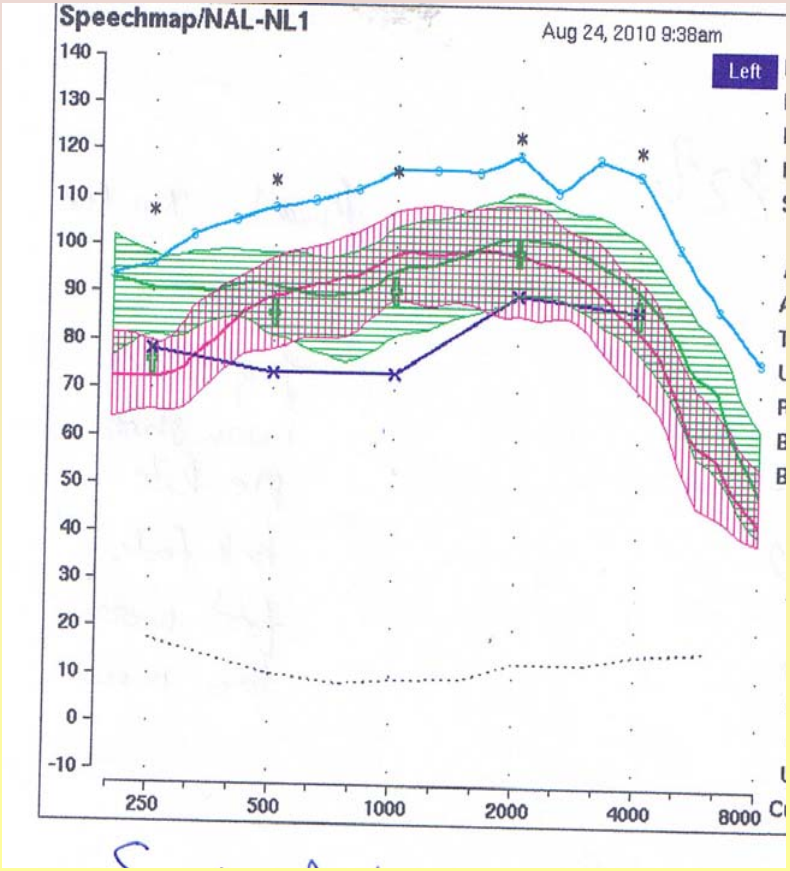
Ethics requires use of published prescriptions

Therefore study uses DSL and NAL to characterise different acoustic characteristics for hearing aid amplification

Need children with hearing loss from 2 to 8 years, peri-lingual to post-lingual stages of speech acquisition

How do NAL and DSL differ?





Considerations for new speech tests

New outcome measures: A range of new speech tests was developed.

(1) Three closed-set monosyllabic speech tests with pictures for different developmental levels. Pictures are presented on a touch sensitive screen or laptop with mouse.
(2) Ten open-set word lists for use in quiet and/or noise.
(3) Ling 5 pre-recorded stimuli (phonemes /u, a, i, sh s/.

<u>Norms for Speech Perception tests</u>
Thirty-six normally hearing (NH) children (2-8 years) norms.
Minimum level for closed set in NH: 30 dB
Vocabulary screen (Renfrew) specifies speech test to use

What do we want to check?

Validation from first fitting using speech-based material

Necessary to know functional effect of HA fitting

- Detection of high frequency speech sounds
- Discrimination of vowels
- Discrimination between consonants
- Recognition of words
- Understand running speech
- Informal observation
- Opinion of child, including perception of noise floor

ALL CLASSES OF SPEECH SOUND ARE IMPORTANT

Age for formal speech testing?

- Clinician needs to have high expectations
- Trust in child to self-motivate if interesting feasible task
- Allow child autonomy to do the testing however they wish

- Maintain child's self esteem

Detection of phonemes (3-8 years)

- Closed set detection task:

eye, ice, lice, slice (/s/)

pay, pace, space, face

eye, wine, why, wise (/z/)

- Ling 5 (Ling 6 had /u/ /m/ confusions for NH)

Repetition task: oo ar ee sh ss (pre-recorded)

Consonant discrimination

Closed set testing with four item picture task

- Age 2 – 4 years (40 items)

Eg horse, fork, ball, door

hen, peg, egg, bed

- 4 - 7 years (40 items or 60 items)

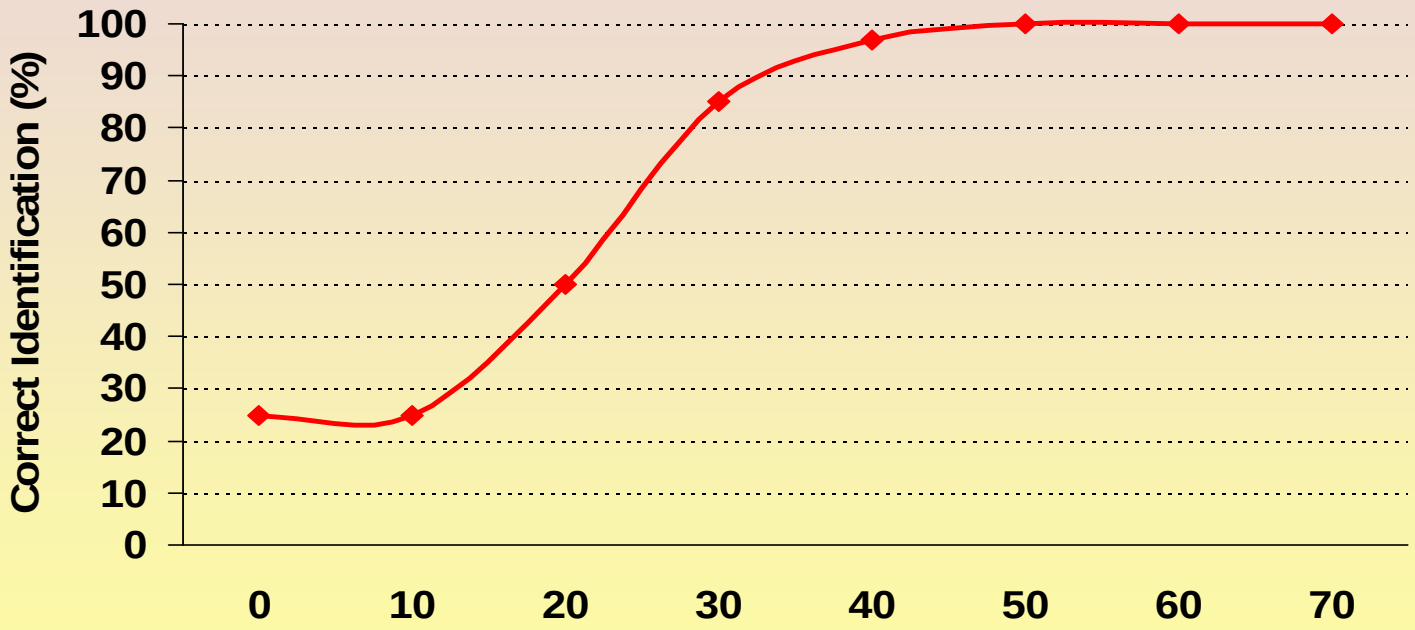
Eg fat, cat, bat, mat (word-initial)

cheese, cheat, cheap, cheek (word-final)

Derive confusion matrix of the errors

Significant difference if > 7.6% (10%) change in score, (s.d.=2.3)

Systematic use of speech tests



Presentation levels:

Level = 3 frequency PTA in better ear x 0.4 + 30 dB

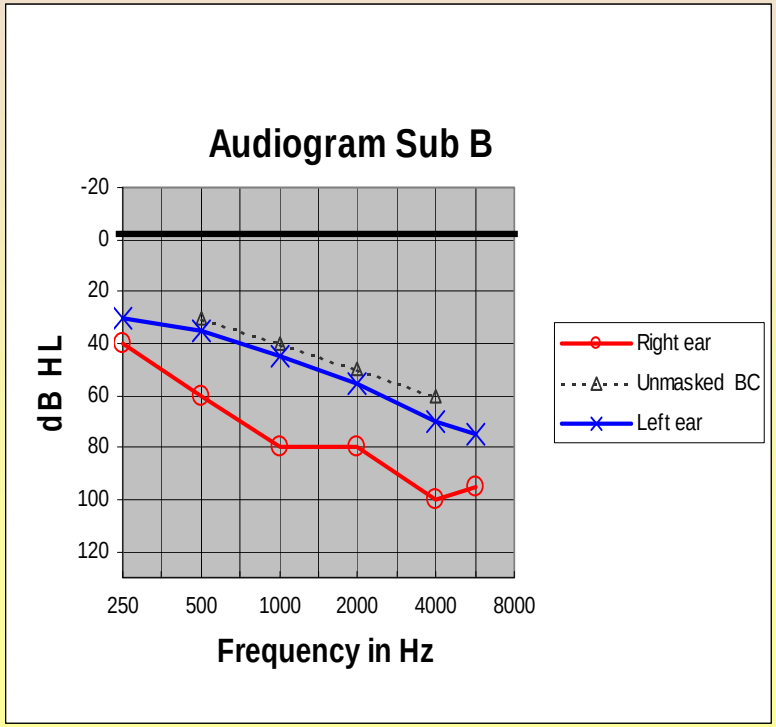
Subject: female 4 years old

<u>Closed set test</u>

Take best ear 3 freq average:57 dB x 0.4 = 22 dB

Add to NH level for test =30 dB

Present at 52 dB



Subjects and test conditions

N=54 moderate and severe HI children

☹10 subjects dropped out from study

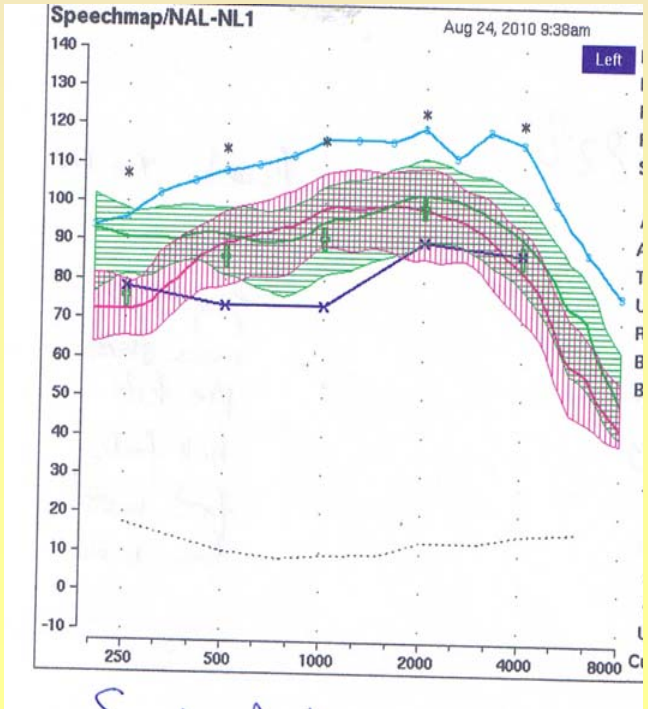
- Three age groups
  - Group 1 (2-3yrs) n=8
  - Group 2 (4-5yrs) n=14
  - Group 3 (6-9 yrs) n= 22
- Study Hearing Aids: (Phonak Savia Art, Oticon Safran or Phonak Naida + 2 own aids)
- Fitted to match gain targets for NAL, DSL I/o and DSL v
- Verified with real-ear-to-coupler difference measures using real speech input with the Verifit REM system.
- Each of the 3 prescriptions was pre-programmed and stored under a blind code.
- Tester was blind to condition under test.

Results:

Ling phoneme detection level (dB) for:

	DSL V	DSL [i/o]	NAL-NL1	
/u/	**47.4**	**48.1**	**50.0**	**p = 0.018**
/i/	**46.7**	**47.4**	**49.0**	**p = 0.019**
/s/	**51.1**	**51.3**	**56.2**	**p < 0.001**

No differences were found
for /a/ and /sh/ detection levels.



Closed set computerised testing CAPT (2 – 8 years)

Closed set discrimination (%): p <0.001 (cat, fat, mat, bat)

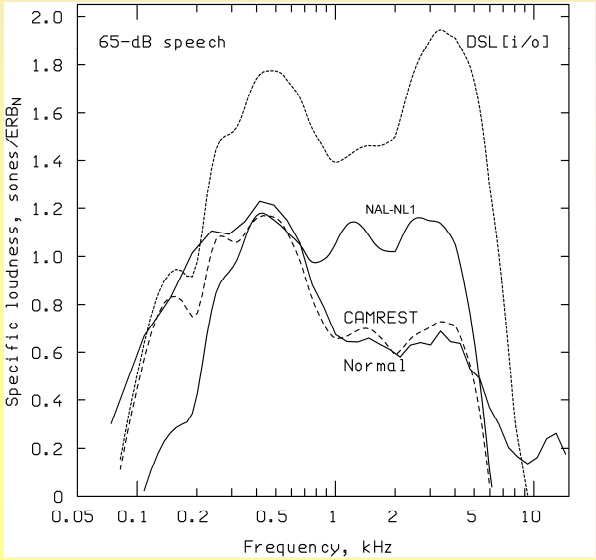
	DSL V	DSL [i/o]	NAL-NL1
mean	80.1	81.8	74.1

Closed set phoneme detection (%): p<0.001 (eye, ice, lice, slice)

	DSL V	DSL [i/o]	NAL-NL1
mean	84.2	95.6	77.9

Closed set vowel in noise (%): p = 0.32 (NS)

	DSL V	DSL [i/o]	NAL-NL1
mean	84.0	86.5	81.2



Open set words: list of 10 words, tested at 65 and 50 dB (4 – 8 years)

Open set word recognition with 65 dB presentation
No significant difference between prescriptions

Open set word recognition (50 dB) p <0.001

	DSL V	DSL [i/o]	NAL-NL1
mean	**22.4**	**23.1**	**19.7 /30**

Phrase testing (CPT) (dB) (adaptive pres) p=0.001

	DSL V	DSL [i/o]	NAL-NL1
mean	**39.4**	**38.8**	**41.5**

CAWL words in noise p = 0.055

	DSL V	DSL [i/o]	NAL-NL1
mean	**24.5**	**24.5**	**21.8 /30**

Important points for speech testing:

- **No significant difference in performance across different age** groups (p=0.12), though small number of subjects in the younger groups.
- **No significant order effects** were found, although there was a trend for performance to improve with test familiarity.
- **Only one child dropped out because couldn't do testing (ASD)**

Every decibel of the hearing aid fitting matters in optimising speech perception.

Must have systematic method for speech discrimination that identifies progress and next target for habilitation.

Case-study 1: Male 13yr

Aetiology:Meningitis at 9 months with some recovery

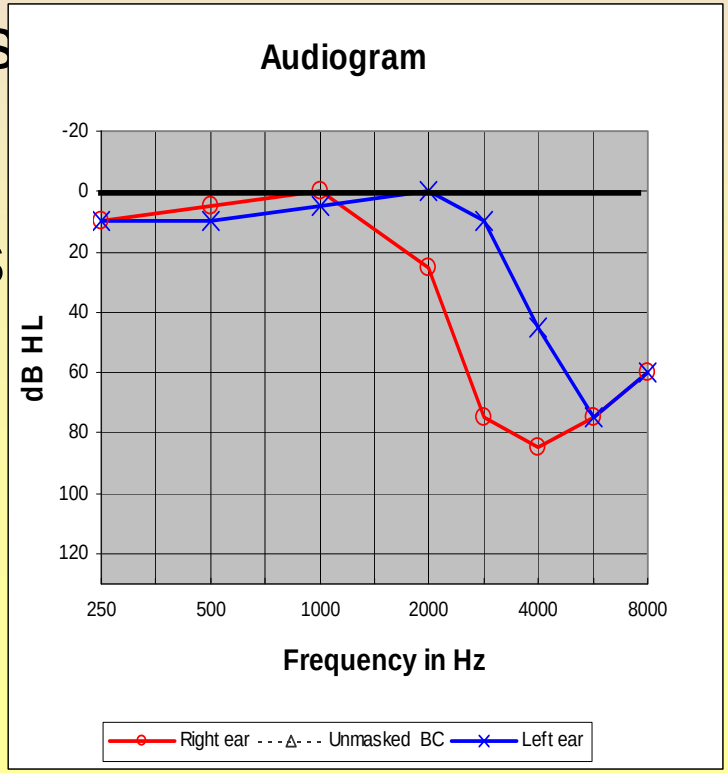
HA with open mould on right school only

Sometime doesn't feel HA helps

Good speech

Reasonable academic progress

Cups ear to hear fast speech



45 dB presentation, all fittings matched to DSL V targets

Unaided listening using both ears:

76% correct

Errors were:

Init: p/t, f/k, k/p, f/b

Final: g/z, d/z, n/nothing

Despite able to use left ear

Hearing aid right:

Masking noise to left

71% correct

Errors were:

Init: sh/s, b/f/m, dr/j sh/f, k/t, f/t, f/ch

Final: ch/t, g/z, s/n

FCHearing aid right:

Masking noise to left

82% correct

Errors were:

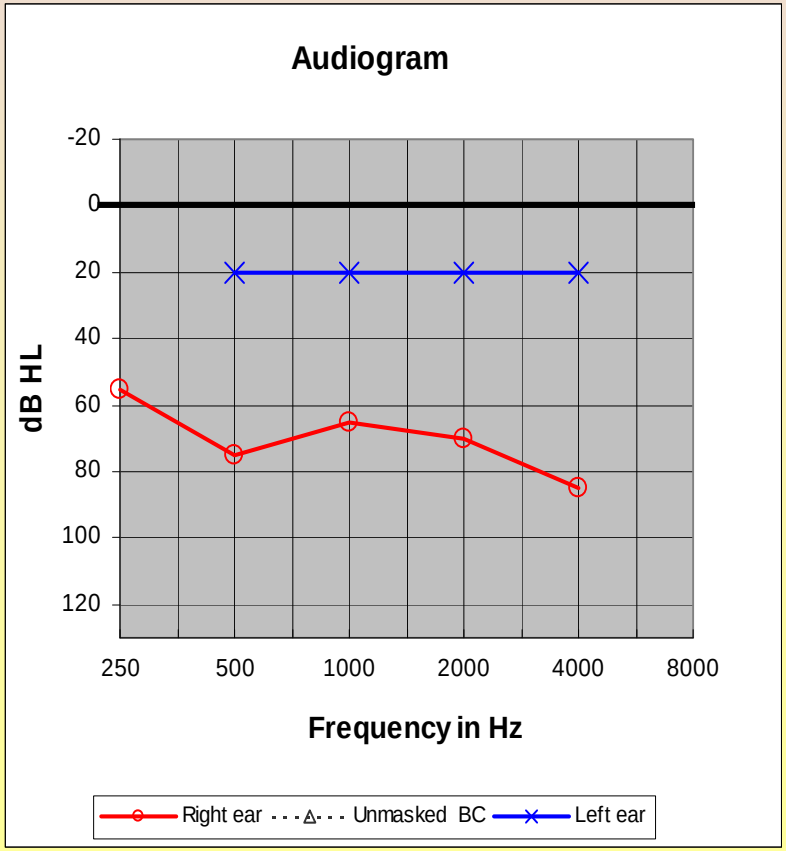
Init: b/f, k/t, ch/t, t/f

Final: n/nothin, n/z, t/k

Case study 2: 8 months female Known Unilateral Left HL via NHSP

- Aetiology investigations show widened vestibular aqueducts (WVAS) R and L
- Pendreds Syndrome screen negative
- ABR shows severe hearing loss right, responses at 20dB (click stim) on left.
- VRA with masking for audio

WVAS: hearing may deteriorate in <u>both</u> ears, need to maintain auditory function for future amplification



Child B: Management options

Parents considered the information and requested Left hearing aid fitting:

- HA is worn majority of waking hours,
- From 1 yr child takes out HA when battery dead
- Recently asked for HA after infection

BUT continues to startle to sudden onset sounds both with and without amplification

Objective Outcome Measures for HA benefit

What objective outcome measures of HA benefit can we use?

- Localisation
- Aided Ling sounds from aided side
- Aided speech discrimination at 2 years

In quiet 55 dB: 3 conditions: Unaided= 82%

Left Aided: Savia Art 311 = 82%

Left Aided: Audeo smart + freq comp = 90%

How to optimise benefit from speech test results?

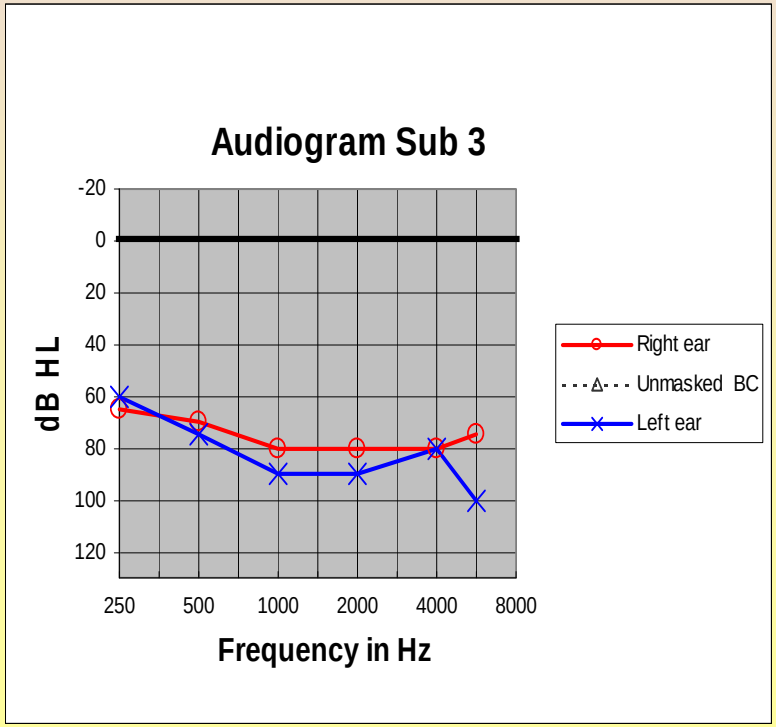
Case study 3: female 6 years old

<u>Closed set test</u>

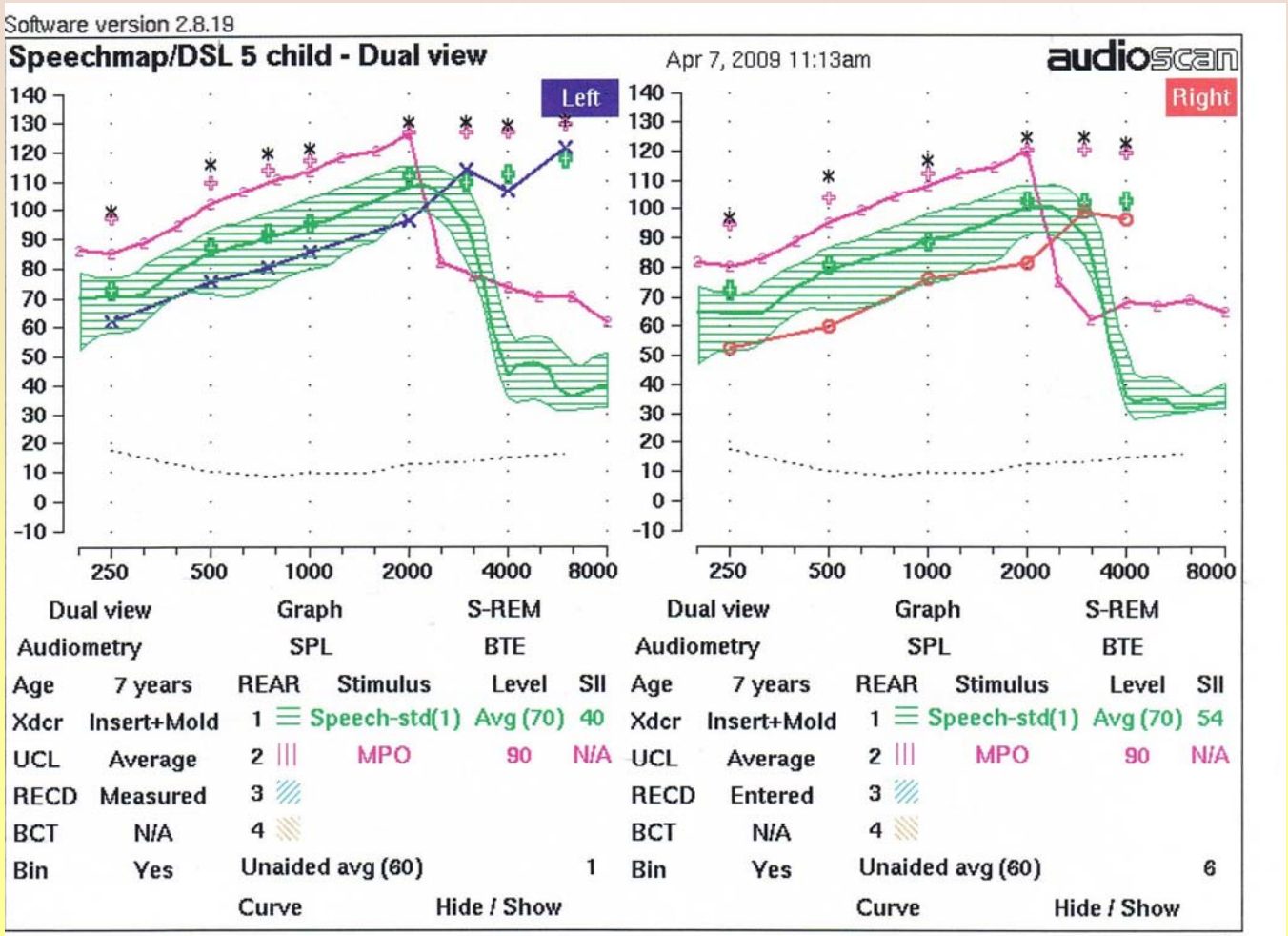
Take best ear 3 freq average:80dB x 0.4 = 32 dB

Add to NH level for test =30 dB

Present at 62 dB



Check real ear measure prescription, especially compression threshold (CT)



Case study 3:
Scores (no acclim, in one 2 hour appt)

Open set wds	Trad HA	Freq Comp
60 dB	88%	97%
50 dB	76%	91%
Ling 5 /u i a/	45 dB	45 dB
/sh s/	55 dB	45 dB
Closed set		
Detect 62 dB	71%	100%
Discrm 62 dB	75%	97%
vowel in noise	91%	100%

Case-study 3: phoneme analysis

Errors on closed set: Trad HA

Disc: kick/tick, bug/buzz, stork/chalk, fat/cat, white/right

Vowel: cat/cut, tar/tie, bark/buck

Det: bee/bees, shoe/sue, bean/bee

Errors on closed set: FC HA

None, except Disc: pick/thick

The confusions show benefit is NOT JUST FOR high frequency fricative detection but for discrimination of ALL speech sounds

Speech-based testing is crucial for:

- Validating functional benefit of Hearing aid fitting
- Fine-tuning amplification on an informed basis
- Information on expectations (and limitations) of hearing aid use and benefit
- Monitoring current progress and setting targets for habilitation

Thanks for listening