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MAINZ

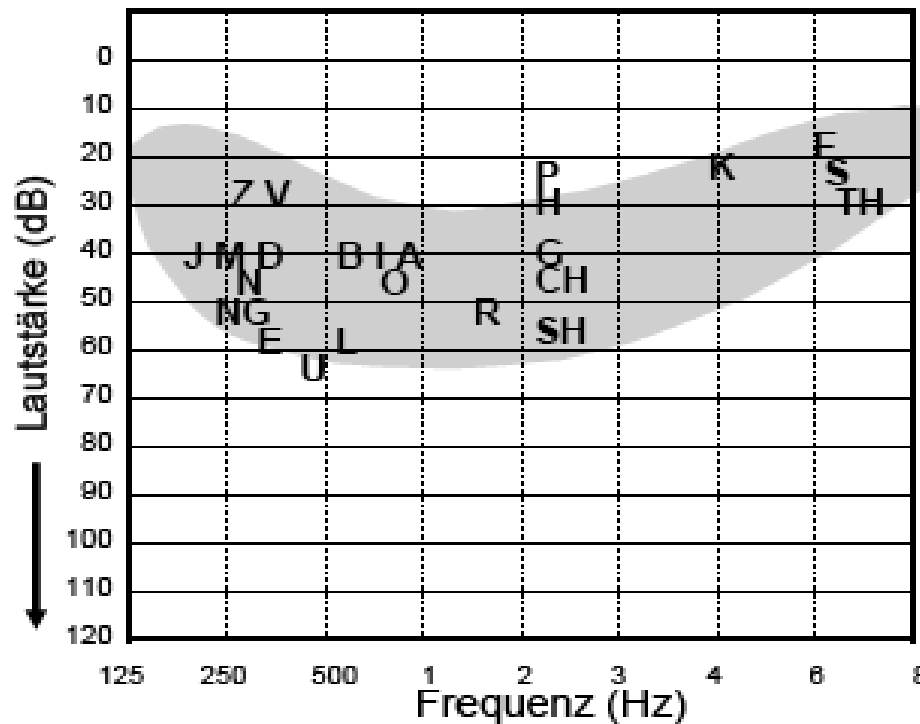
Frequency Compression Technology in Hearing Aid Fitting in Children

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Speechspectrum

Identification/Intelligibility of high frequency sounds



- Severe Hearing loss:
 - Difficulty in recognizing high frequency speech sounds like: /f/, /s/, /sh/
- Grammatical Information:
 - Plurality of pronouns
 - Possessive pronouns

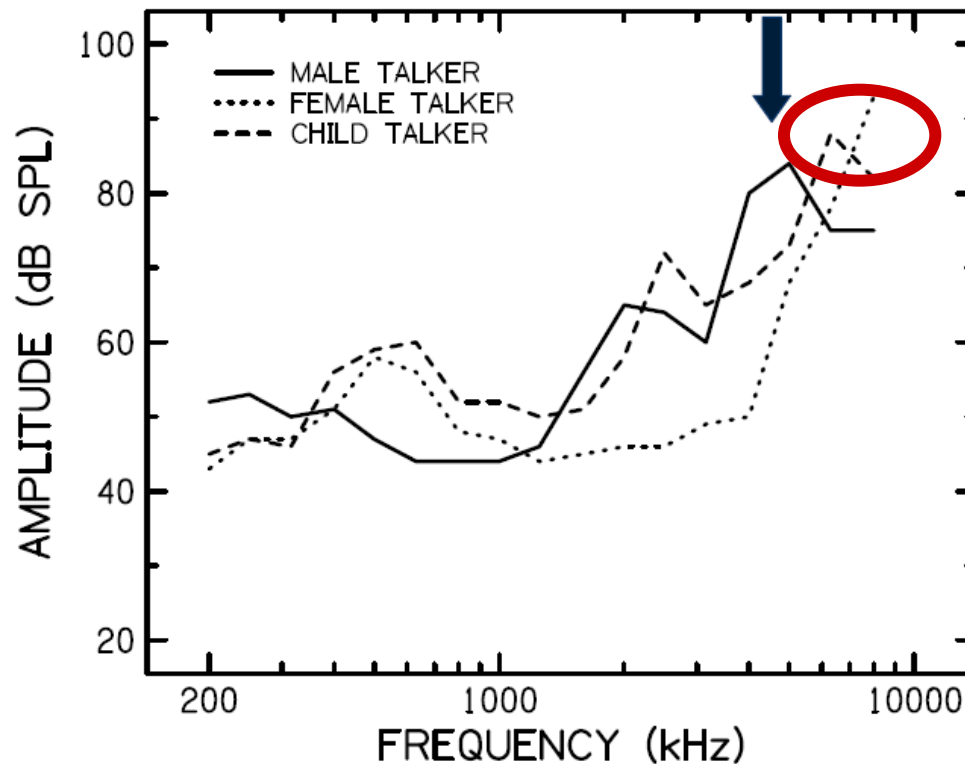
Speechspectrum

/S/ male, female, child speaker

~ 5 kHz male

~ 6-9 kHz female

~ 9 kHz child



Boothroyd et al,
1992

Stelmachowicz
et al, 2001

Hearing instruments

More gain in high frequencies?

- Increased risk of feedback
- More high frequency gain is often considered uncomfortable – too loud, too shrill, too sharp
- Dead Regions - „off frequency listening“

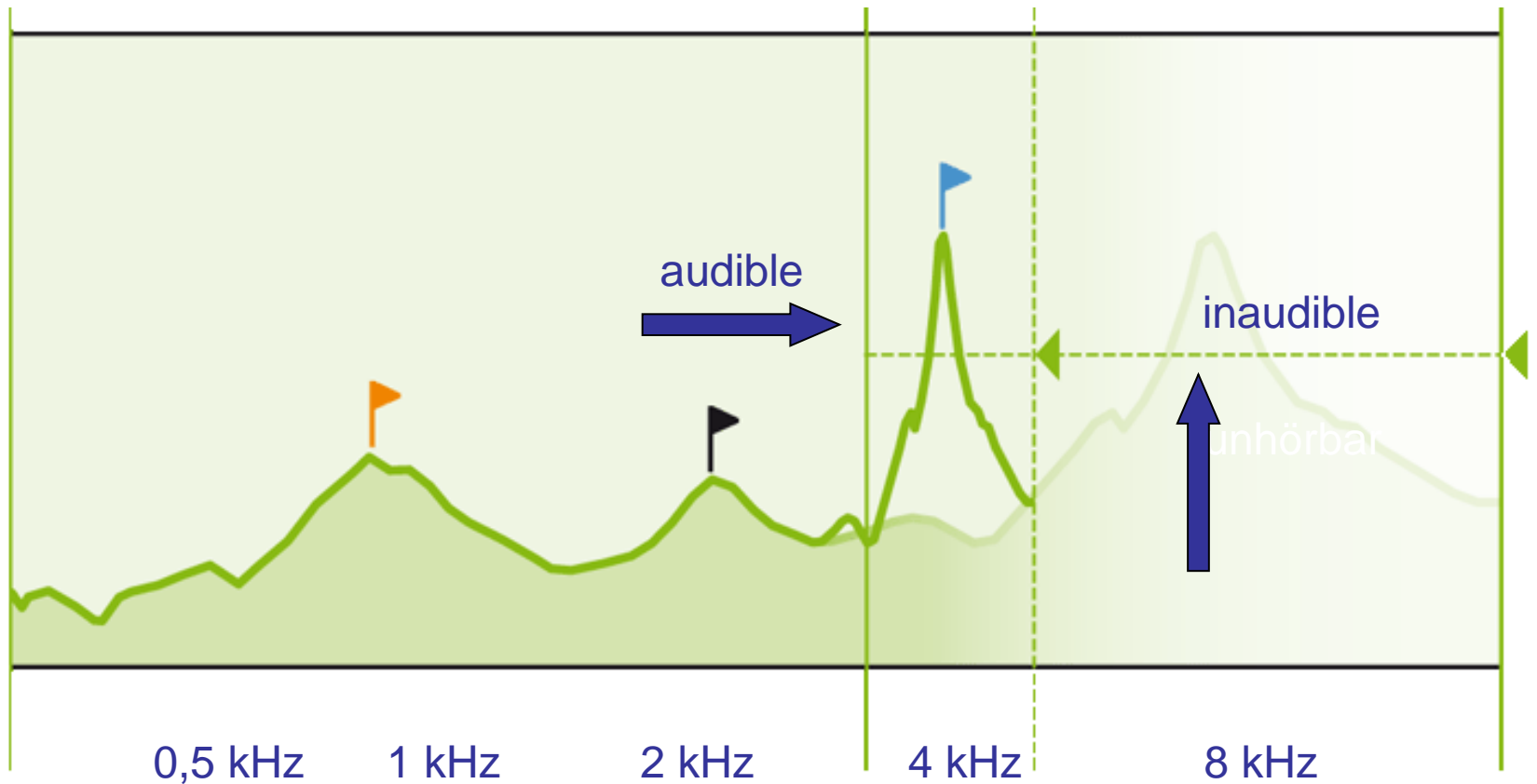
Hearing Impairment

Dead Regions

„... regions in the cochlea with no or few functioning inner haircells and /or neurons“

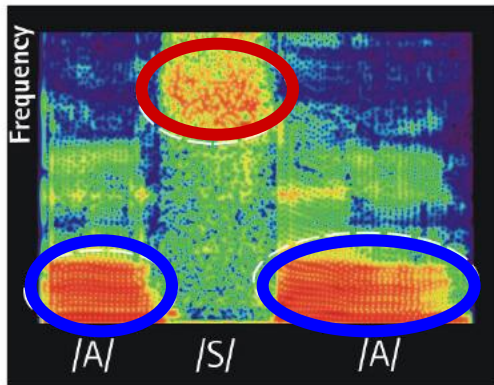
(Moore 2004)

Frequency compression (FC) = SoundRecover

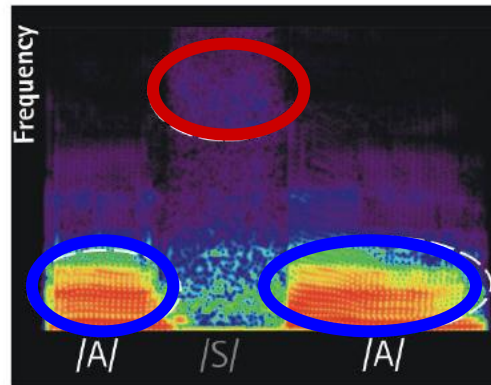


Launer, Chicago 2007

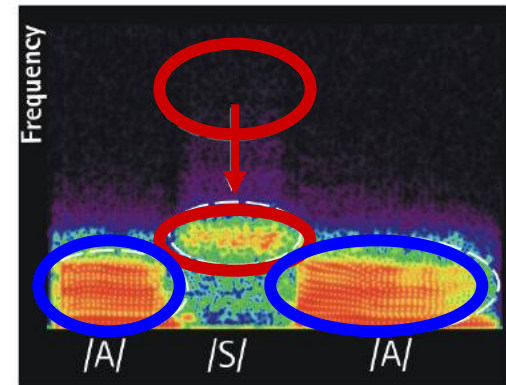
Frequency Compression (FC)



Original signal



Simulated high frequency hearing loss



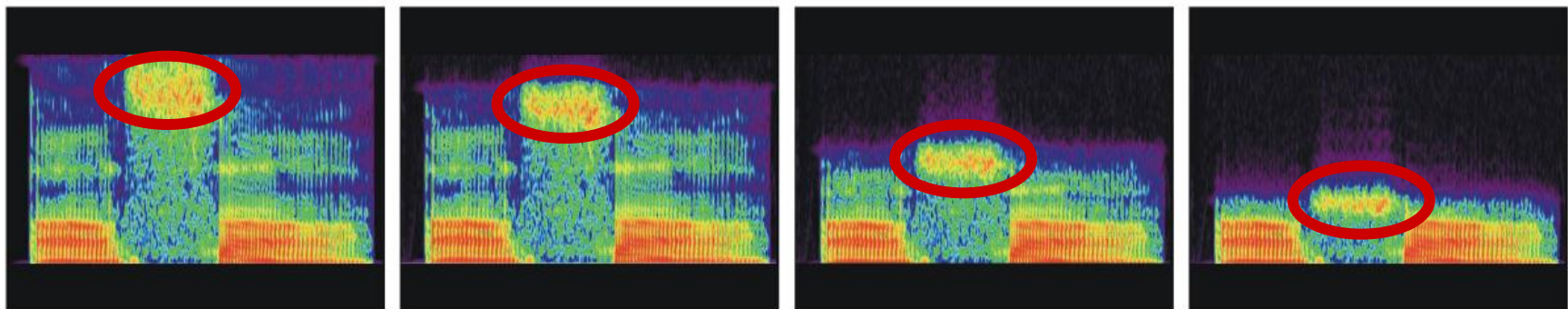
Non-linear frequency compression

Launer, Chicago 2007

Frequency Compression (FC)

- Cut-off frequency between 1.5 and 6 kHz
- Compression ratio between 1.5:1 and 4:1
- Compression is only applied to frequencies above the cut-off frequency

Launer, Chicago 2007



Original

4000
1.5:1

2000
2:1

1500
4:1

Some studies on Frequency Compression

Glista et al., 2009a, *Int J Audio1-13*, DOI: 10.1080/14992020902971349

Glista et al., 2009, *Hearing Review*, 16 (12): 20-24

- FC improves detection/recognition (group vs individual)
- Significant candidacy factors (hearing loss, age group)

Wolfe et al., 2009, *The Hearing Journal* 2009 62(9): 32- 35

Wolfe et al., 2010, *J Am Acad Audiol* 21 (10): 618-628

Wolfe et al., 2011, *Int J Audiol* 2011 50, 396-404

- FC improves audibility for sounds and speech recognition in quiet
- FC offers improvement in recognition in noise

Bohnert et al., 2010, *Eur Arch Otorhinolaryngol*, DOI 10.1007/s00405-009-1170-x

- FC improves speech recognition in quiet and in noise

Pediatric Fitting Method for FC

Protocol developed by

⇒ ⇒ Glista & Scollie

Audiology Online 2009

⇒ ⇒ Scollie, Glista, Bagatto, Moodie

Ontario Infant Hearing Program 2011

Frequency-Lowering Hearing Aids

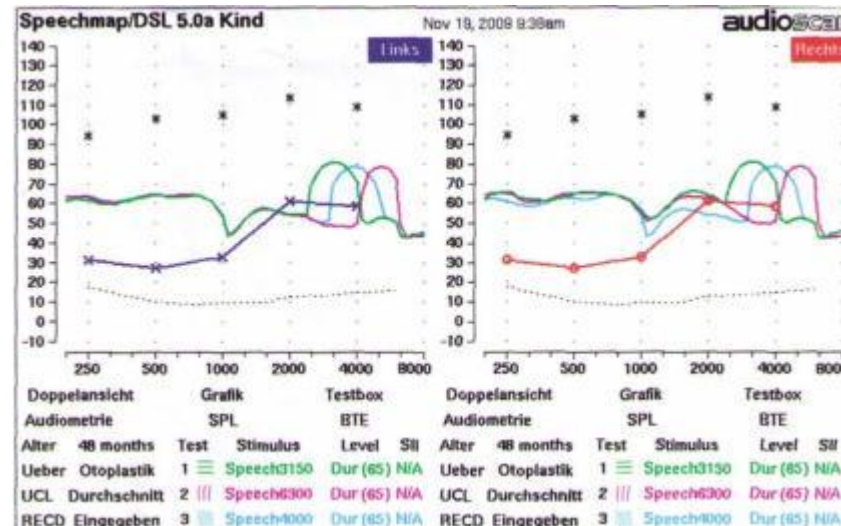
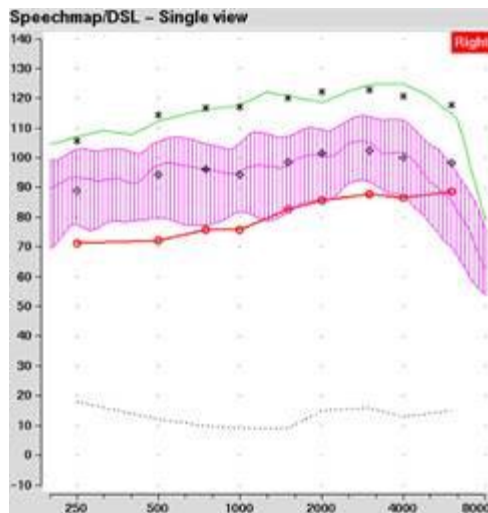
Protocol Addendum and Support Document

Fitting Method for FC (pediatric)

1. Frequency response should be based on DSL 5 *m* [i/o] child
2. Fit to target with FC disabled
Provide audibility of high frequency cues as good as possible
Measure with speech shaped signal / ISTS
3. Enable FC
4. Measure with speech shaped signal / ISTS and with filtered high frequency speechband stimuli
5. Live voice - /s/ and /sh/

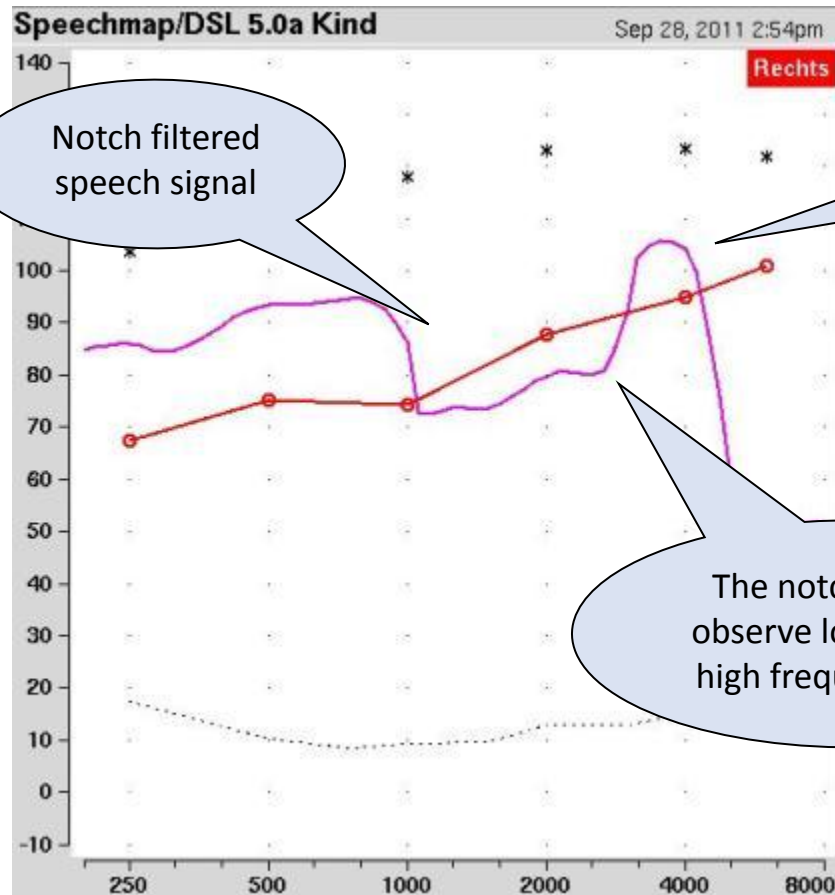
Verification

- Speech shaped signal / ISTS Signal (International Speech Test Signal)
- Filtered high frequency speech band signal



Verification

- Filtered high frequency speech band signal (Speechsignal)



Centre frequencies:

3150 Hz

4000 Hz

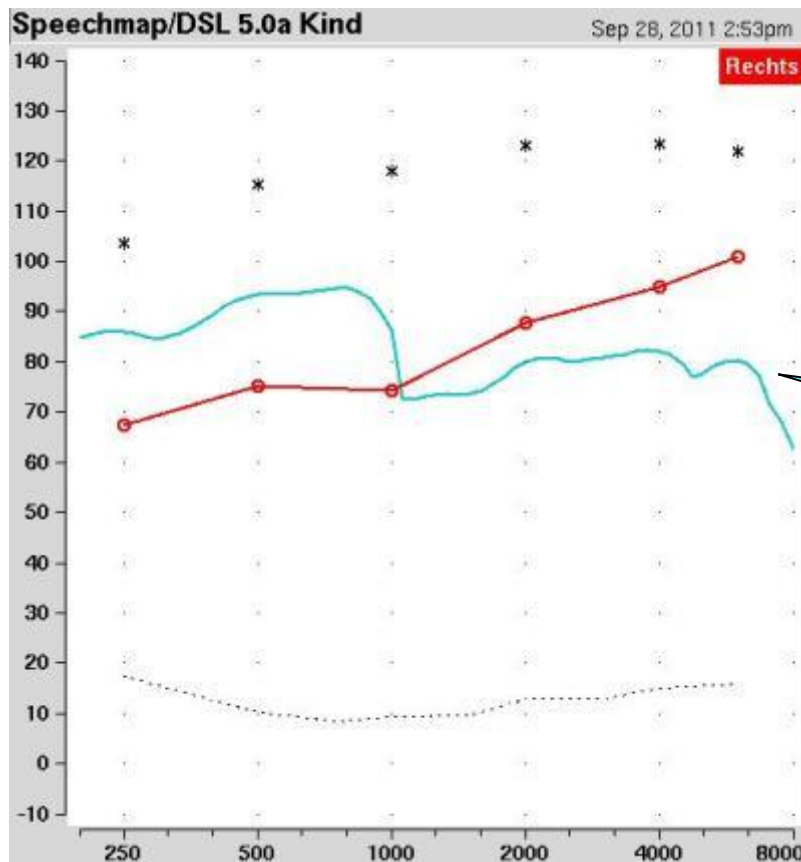
5000 Hz

6300 Hz

Screenshot from Audioscan Verifit

FC disabled / enabled

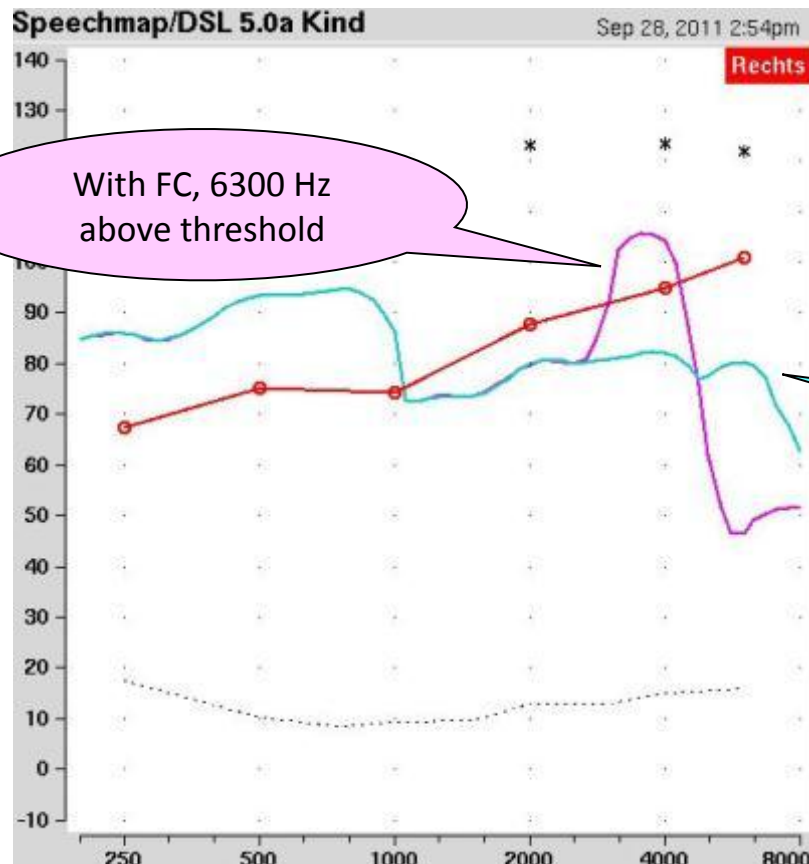
- Filtered high frequency speech band signal (Speechsignal)



Without FC, 6300 Hz
below threshold

FC disabled / enabled

- Filtered high frequency speech band signal (Speechsignal)



With FC, 6300 Hz
above threshold

/s/ is audible now!

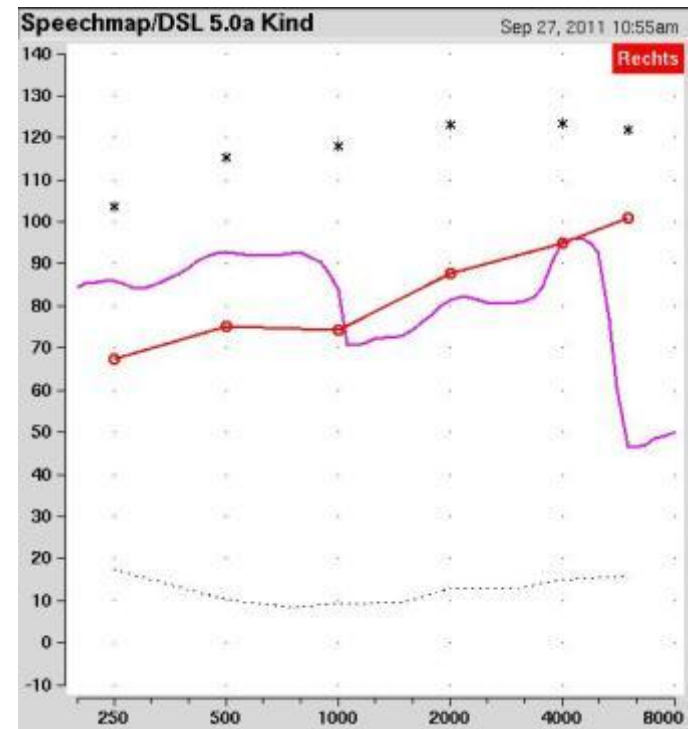
Without FC, 6300 Hz
below threshold

FC settings

- Software provides default setting for FC
- Cut off frequency / Compression ratio set to audiogram better ear
- Verificate audibility of /s/ and /sh/
- Fine-tune if necessary....!!!!!!!



Default setting

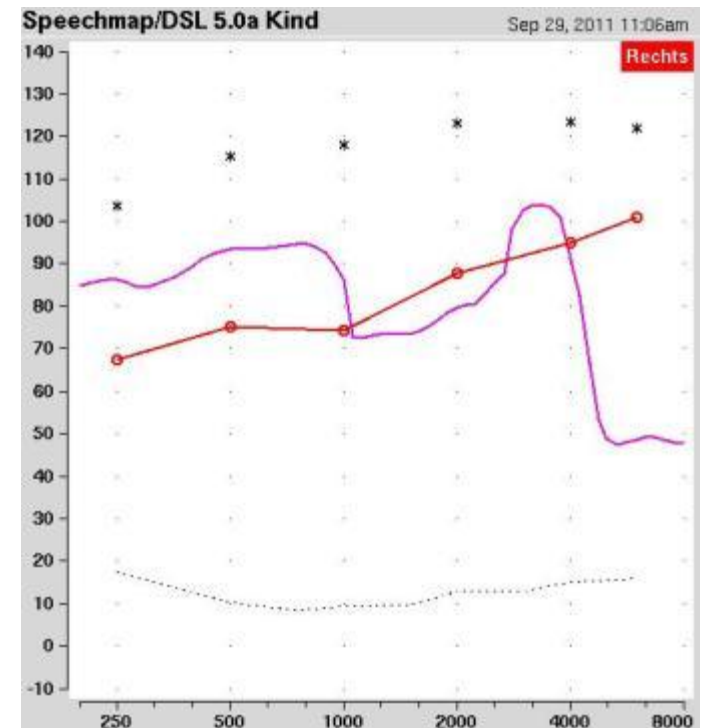


FC settings

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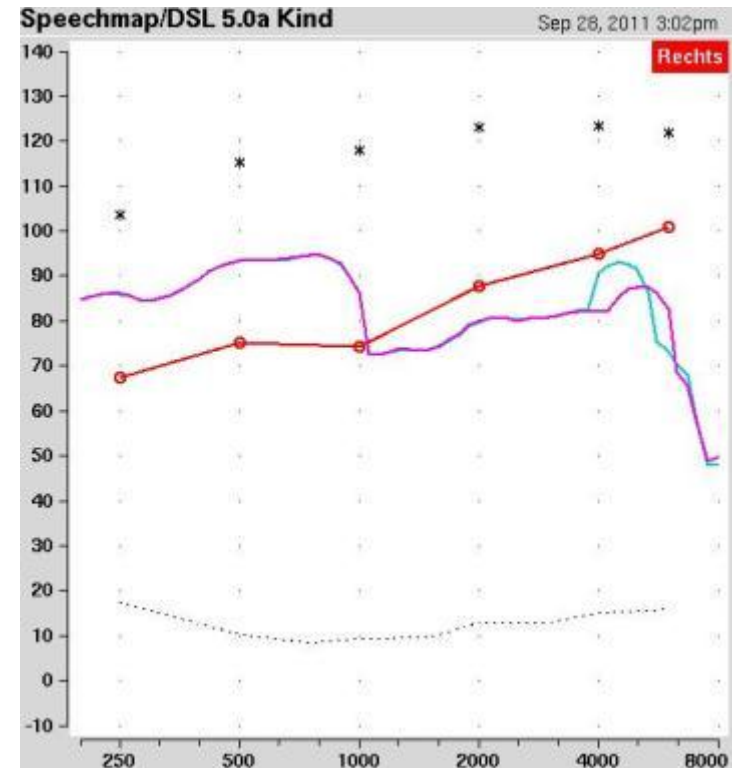
Fine-tuning



Fine tuning hints for FC setting

FC is too weak – not audible enough

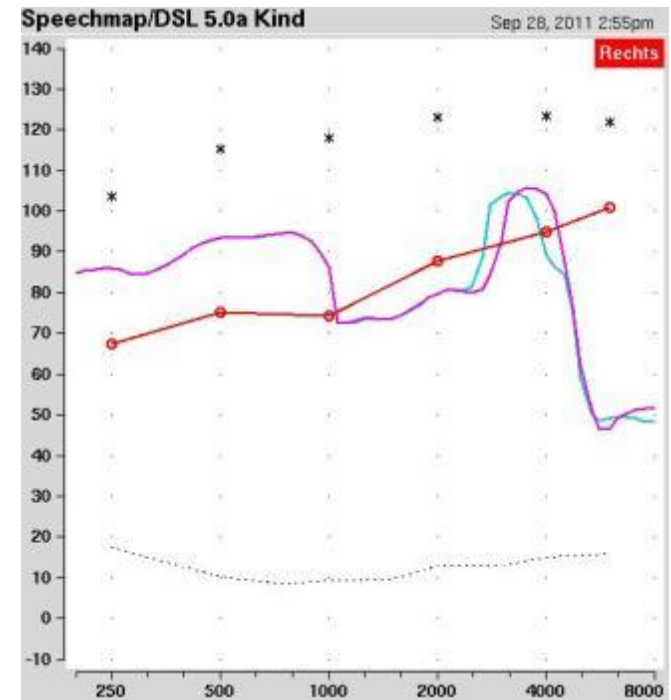
- High frequency cues are not audible
- No improvement, neither in measurements nor in verbal reports



Fine tuning hints for FC setting

FC is too strong - overlapping

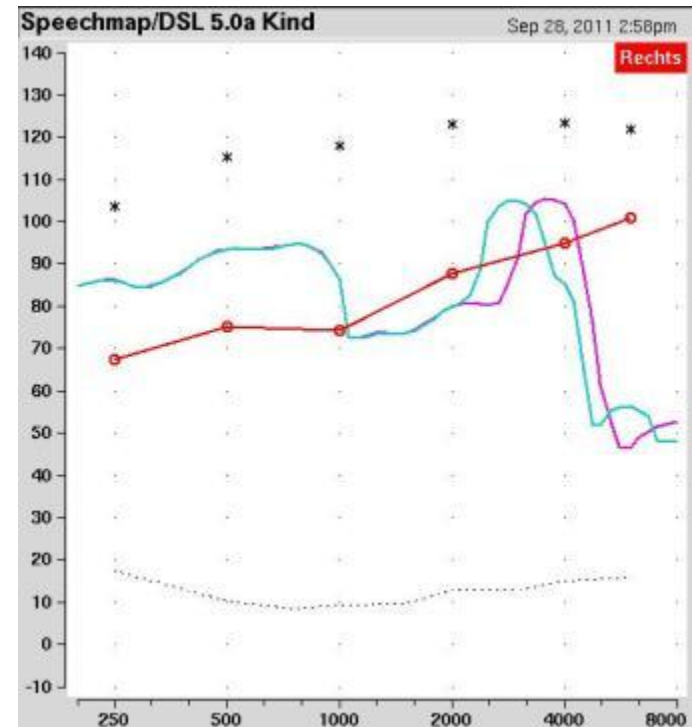
- /s/ and /sh/ cannot be distinguished
- Patient hears him/herself lisping
- Everything sounds sharp, shrill, too loud
- Issues may occur mainly with female voices (start with weaker settings and let acclimatize)



Fine tuning hints for FC setting

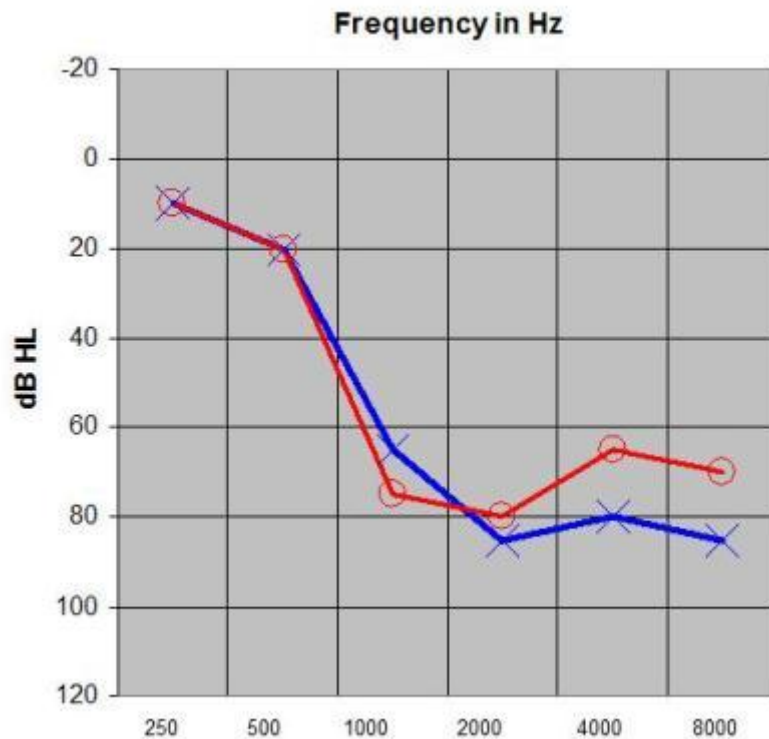
FC well adjusted:

- Difference between /s/ and /sh/ is audible
- Patient perceives everything a bit „softer“
- Speech is perceived as clearer
- Patient may hear sounds not heard before



Two examples.....

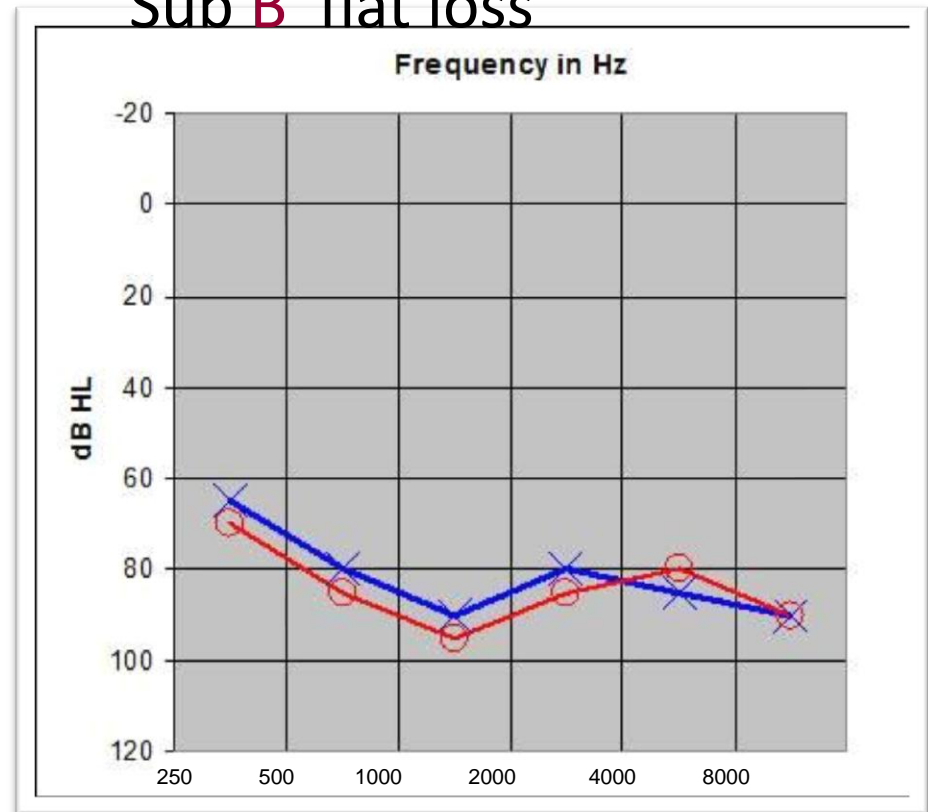
Sub A steep loss



10 y, good speech development

Traditional HI = Eleva 411

Sub B flat loss

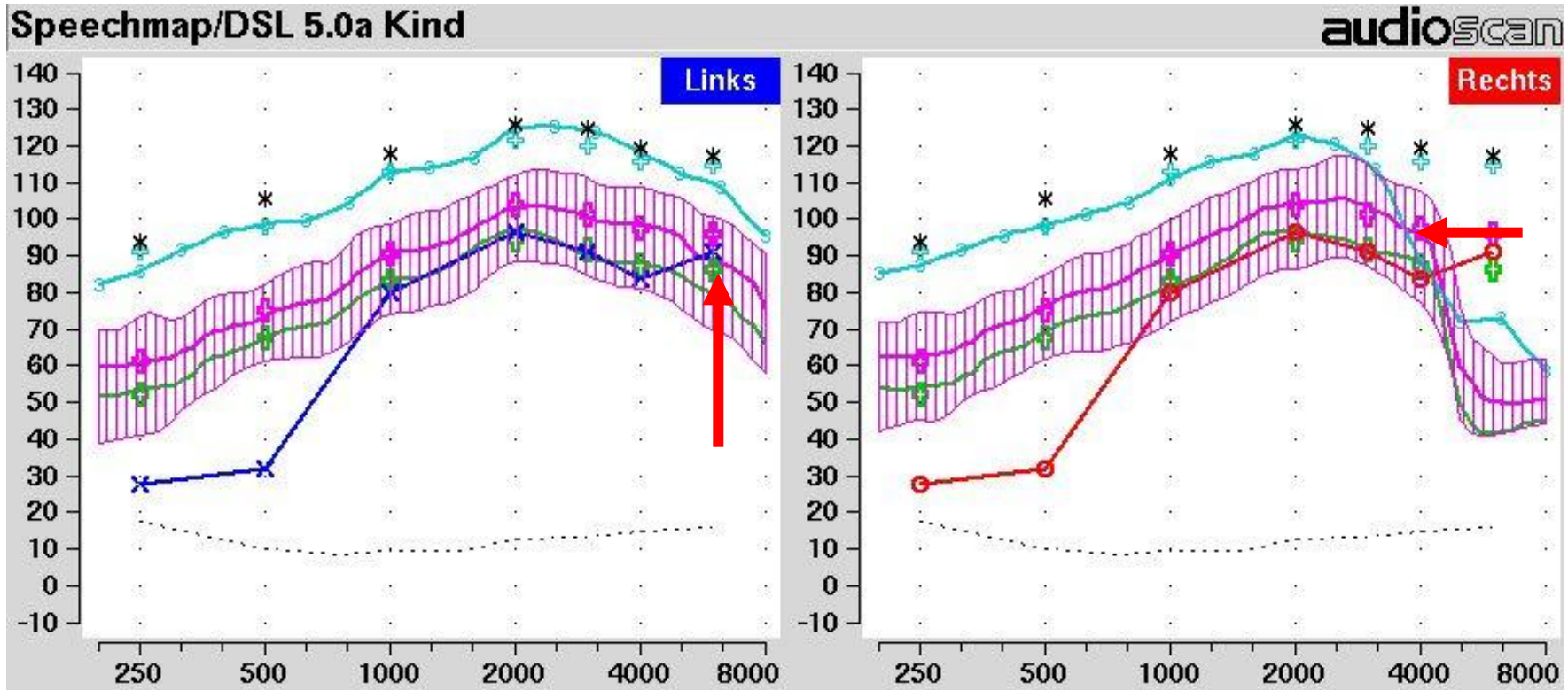


8 y, good speech development

Traditional HI = Siemens Artis P

Two examples.....

Sub A steep loss

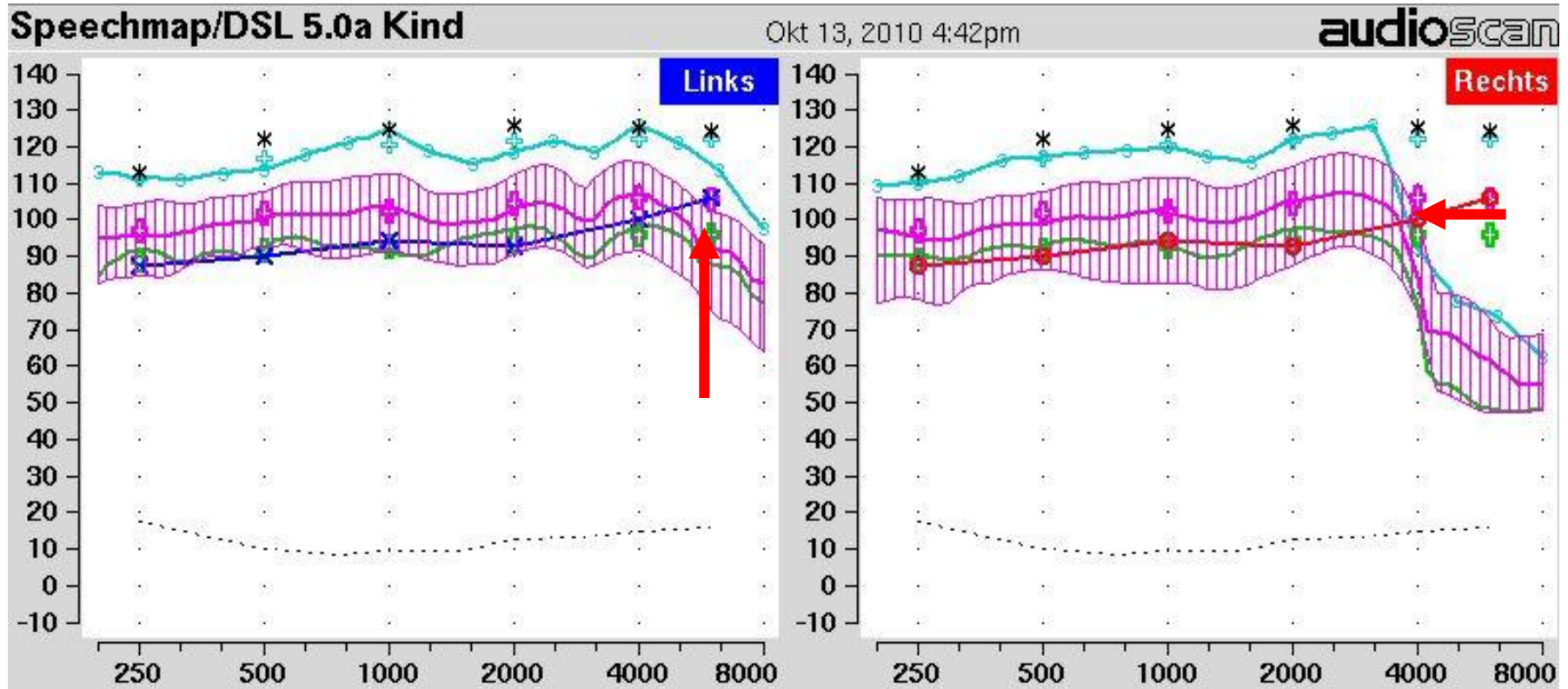


Traditional HI

NLFC HI

Two examples.....

Sub B flat loss



Traditional HI

NLFC HI

Case studies

■ Speech Scores open and closed sets

Open set words	Trad HA	Freq Comp T2	Freq Comp T5	Open set words	Trad HA	Freq Comp T2	Freq Comp T5
55 dB	30 %	50 %	60%	55 dB	0 %	0 %	40%
65 dB	60%	70 %	90%	65 dB	10 %	40%	70%
Closed set quiet 65 dB SRT	36 dB	32 dB	27 dB	Closed set quiet 65 dB SRT	56 dB	42 dB	42 dB
Closed set noise 65 dB SNR	2 dB	-5 dB	-3,5 dB	Closed set noise 65 dB SNR	9 dB	7,7 dB	3 dB

Subj A

Subj B

T2 = 1 week / T5 = 6 months

Case studies

Subject A

Hears new sounds, birds etc.

More relaxed after school

Rather relaxed facial expression

*Trivial sounds are recognized
earlier*

TV set to normal volume

*Speaks with clearer voice –
more self confident*

Subject B

Teacher can be heard with less effort

More relaxed after school

*Audio books can be heard with
normal volume*

*More open-minded – takes part in
holiday camps with 50 children*

*Does not accept everything in
conversation, but argues*

Summary

Several studies showed significant improvements in.....

- Aided sound detection
- Speech recognition in quiet and in noise
- Subjective benefit
- For mild to moderate, severe and profound HL
- Acclimatization effects for newly audible HF sounds

Summary

- ✓ Viable and robust technology for all hearing losses
- ✓ It does need to be individually and carefully fitted

***Respect the protocols for
fitting Lowering Technologies!!***



Clinical implications - future questions....?

We still need to learn more.....for example:

- Cochlear implant candidacy
- Asymmetrical hearing loss
- Auditory neuropathy disorders
- Bimodal fittings

Clinical implications - future questions....?

- ✓ Test results may be not always consistent
- ✓ Do we have the right tests to show all effects of modern technology?

We should always listen to our children.....

