A review of the benefits of SoundRecover for children

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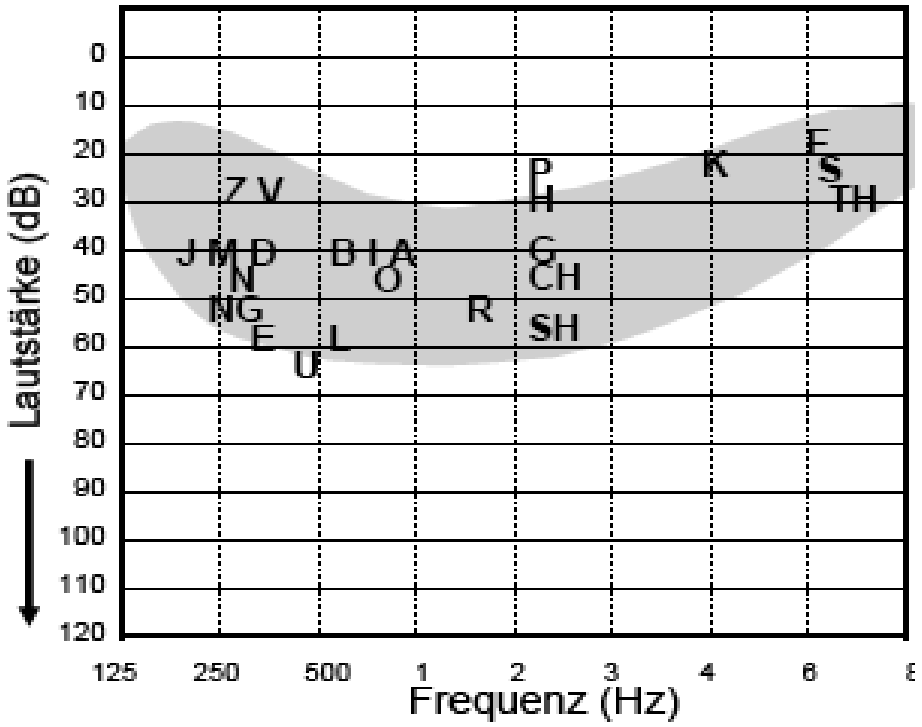
Identification of high frequency speech sounds



- Severe Hearing loss:

  Difficulty in recognizing high frequency speech sounds like: /f/, /s/, /sh/

- Grammatical Information:

  - Plurality of pronouns
  - Possessive pronouns

Pat Stelmachowicz et al., 2000 – 2004, Boys Town

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Identification of high frequency sounds

- Identification of many types of sounds….
  - Birdsongs
  - Alarms
  - Doorbells
  - Telephone ring tones etc.
- Sounds are valuable – enhance the quality of a child‘s overall expierence of hearing

Refers to children with tonal and non-tonal languages

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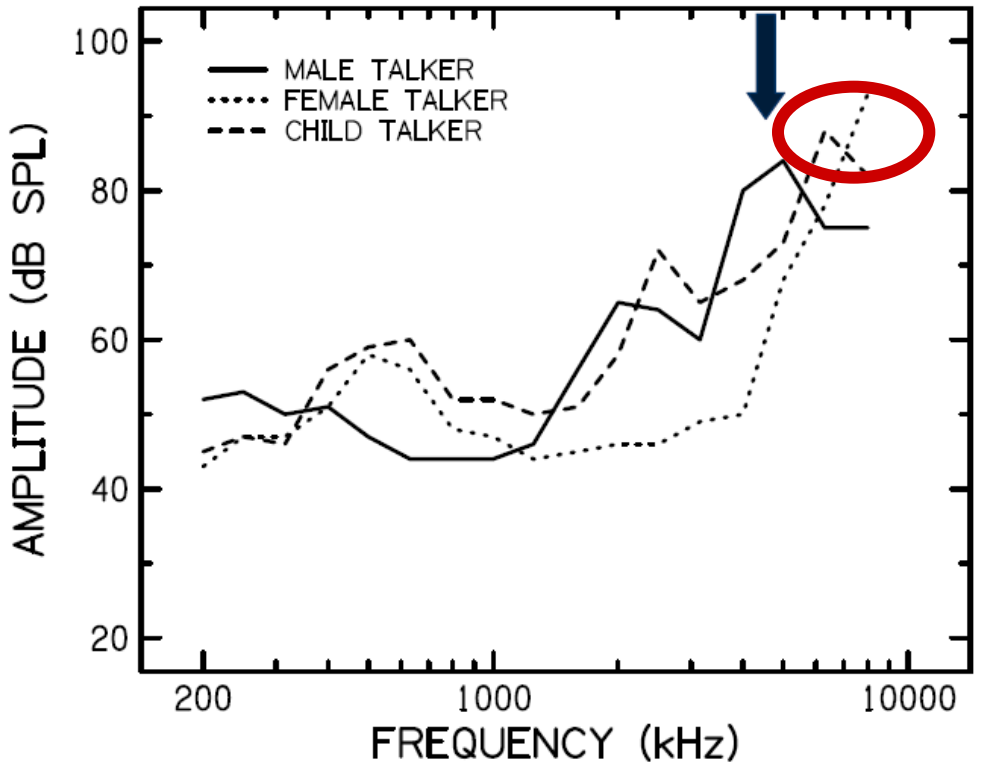
Speech spectrum

/S/ male, female, child speaker

~ 5 kHz male

~ 6-9 kHz female

~ 9 kHz child



Boothroyd et al, 1992

Stelmachowicz et al, 2001

Stelmachowicz Como 2008

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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“

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Hearing Impairment

Dead Regions

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

(Moore 2004)

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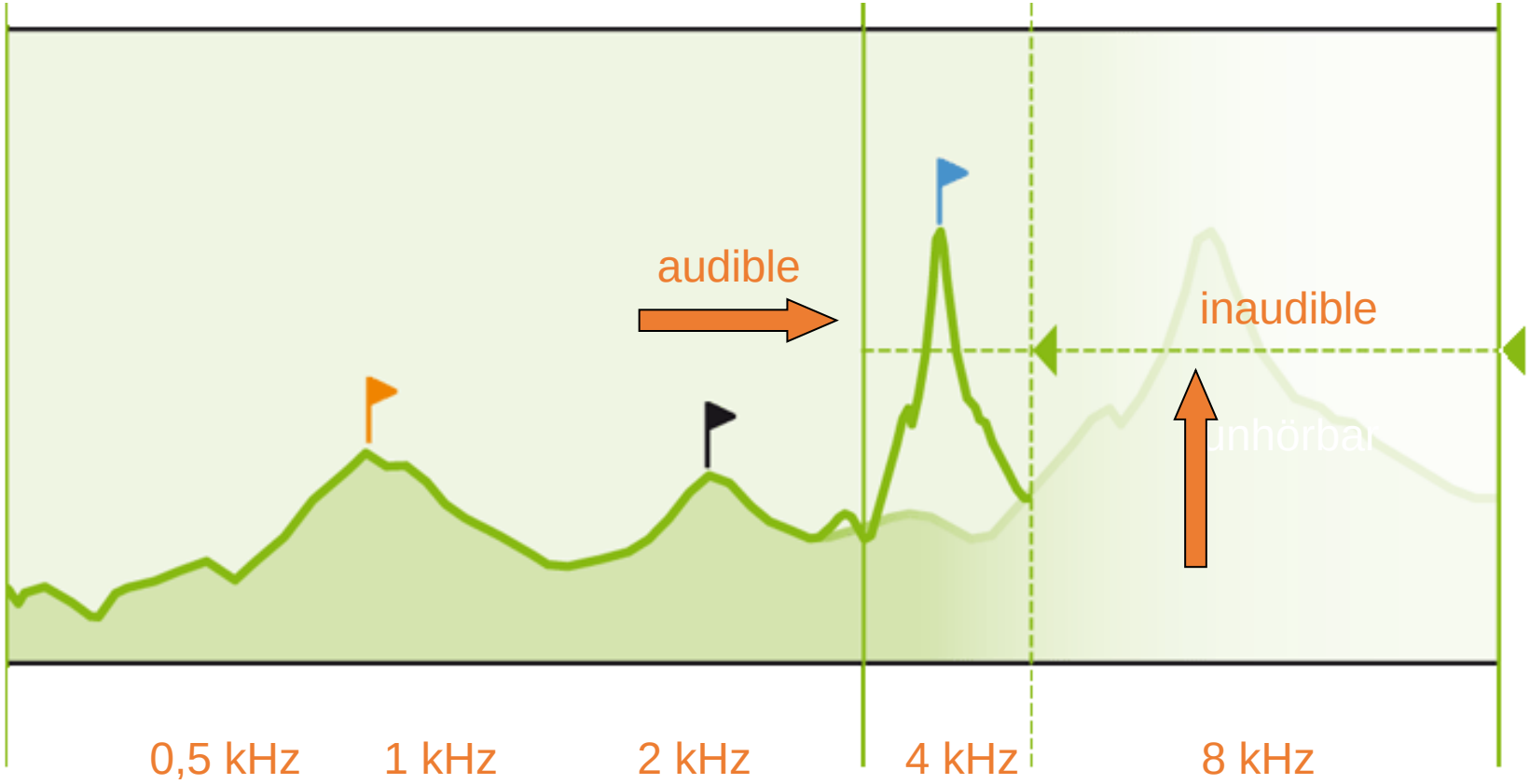
Frequency compression (FC) = SoundRecover



Launer, Chicago 2007

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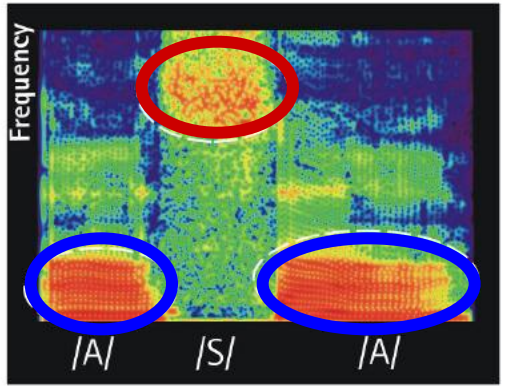
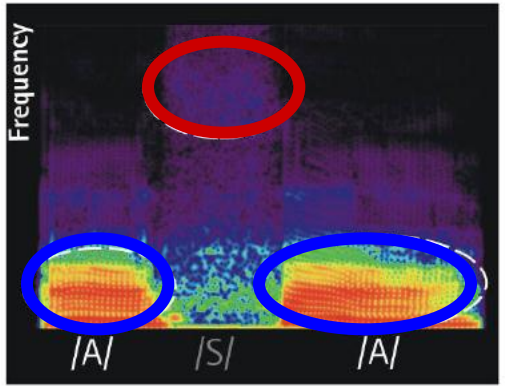
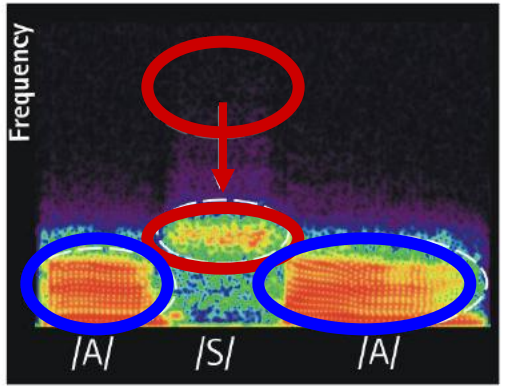
Frequency Compression (FC)



Original signal



Simulated high frequency hearing loss



Non-linear frequency compression

Launer, Chicago 2007

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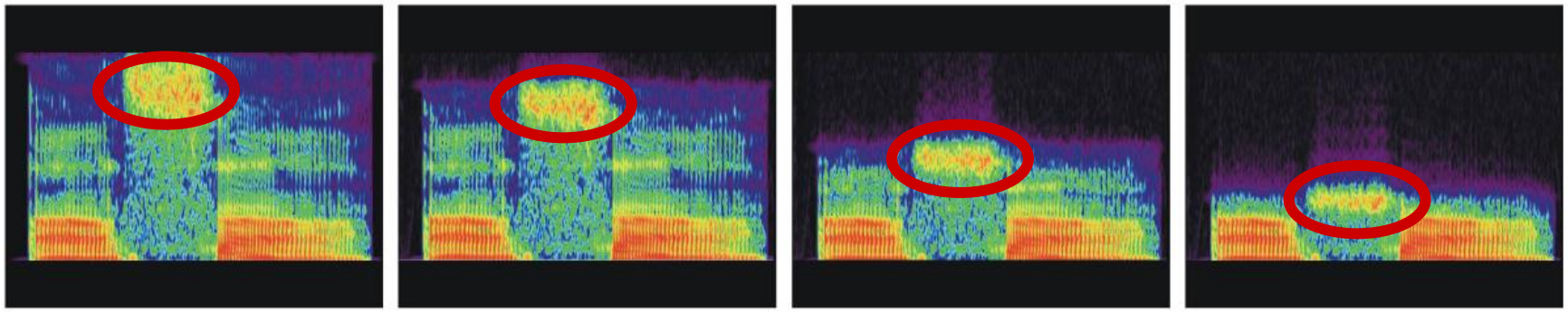
Frequency Compression (FC)

- Different FC settings
- FC is only applied to frequencies above the cut-off frequency
- FC output signals do not overlap lower frequencies
- Global relations between different speech components remain intact



Launer, Chicago 2007

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Frequency Compression (FC)

What happens if we use frequency lowering?

Who is a candidate?

Does it help?

Is there evidence …..?

A lot of studies are available from……..

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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*

Scollie et al., 2011 *ENT & Audiology News*, vol. 20, no. 5, pp. 83–87

Glista et al., 2012 *International Journal of Otolaryngology. Article ID 982894, 12 pagesdoi:10.1155/2012/982894*

Glista et al., 2012 *American Journal of Audiology,* 21: 76-81

Glista et al., 2012 *Journal of Speech, Language, and Hearing Research.* Vol. 55,1-23

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Studies on Frequency Compression

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

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

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

Wolfe et al., 2013 *The Hearing Journal, 66(9), 26-29*

Wolfe et al., 2014 *The Hearing Journal, in press*

Wolfe et al., 2014 *J Am Acad Audiol , submitted*

Wolfe et al., 2014 *J Am Acad Audiol , submitted*

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Studies on Frequency Compression

They found …..

- Significant improvements in high frequency speech sound detection and recognition
  - No decrement for vowel recognition
- Improved audibility for sounds and speech recognition in quiet
- Offers improvement in recognition in noise

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Studies on Frequency Compression

They found …..

- Significant candidacy factors

  - Greater degree of high frequency hearing loss
  - Children had more benefit and preference
  - Individual variability
  - Possible acclimatization effects
    (6 to 8 weeks, may relate to degree of HL)

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Frequency Compression – own studies

Children with a severe to profound loss:

- Can we demonstrate speech recognition benefit?
- In quiet as well as in noise conditions?
- How long will it take for children to acclimatize?

Which configurations of hearing loss will benefit….

Steep or flat losses???

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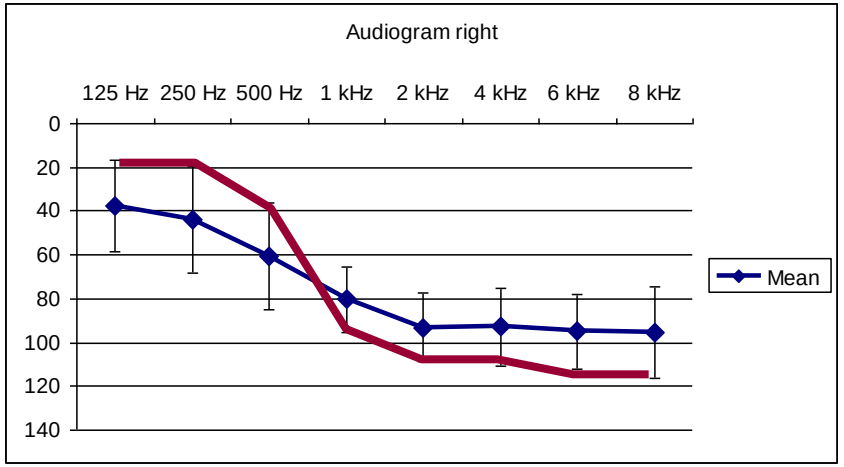
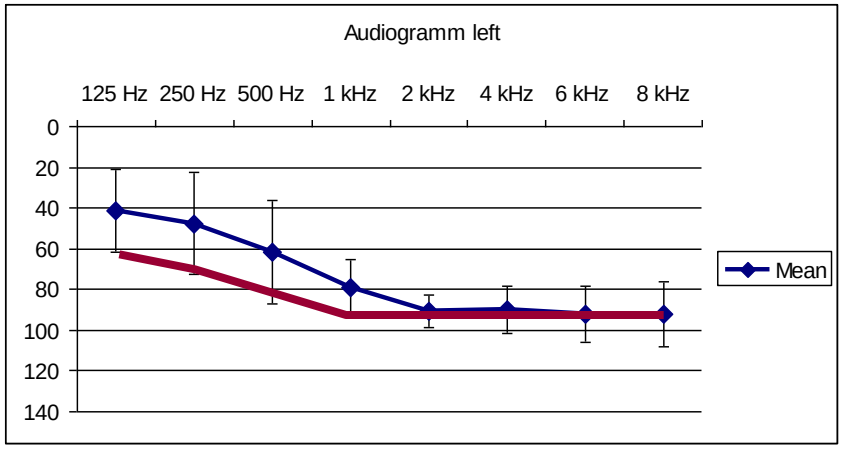
Clinical field trial

- 13 children (4 f, 9 m)
- 6-15 years of age (Mean Age: 10 years, 5 mths)
- Full-time users of digital behind-the-ear hearing aids.
- Fitted on DSL basis with high quality HA
- No previous experience with frequency lowering technology
- Oral-Aural communicators with German as primary language

Audiogram right / left





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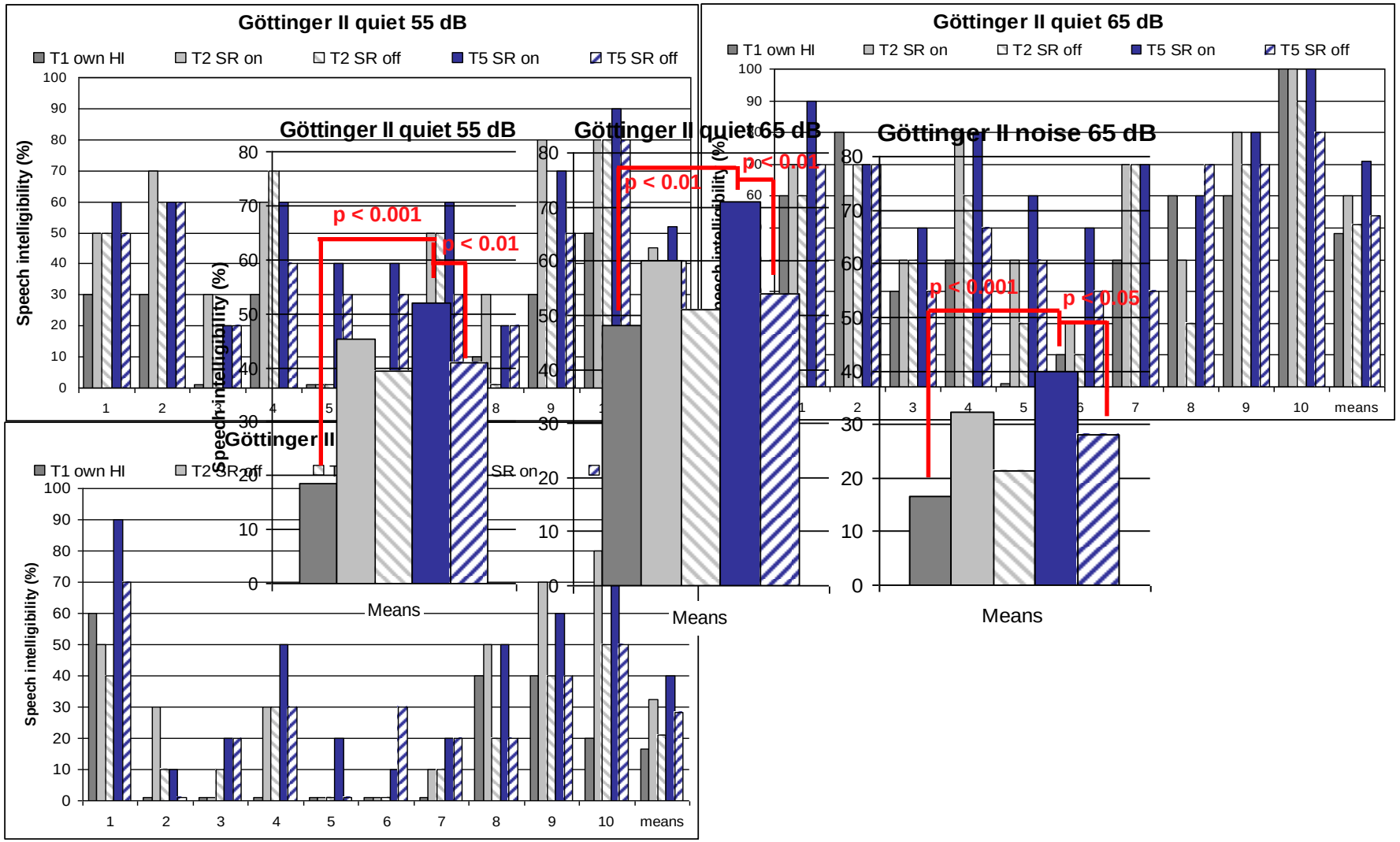
Study - Group results – GII T1 vs T5



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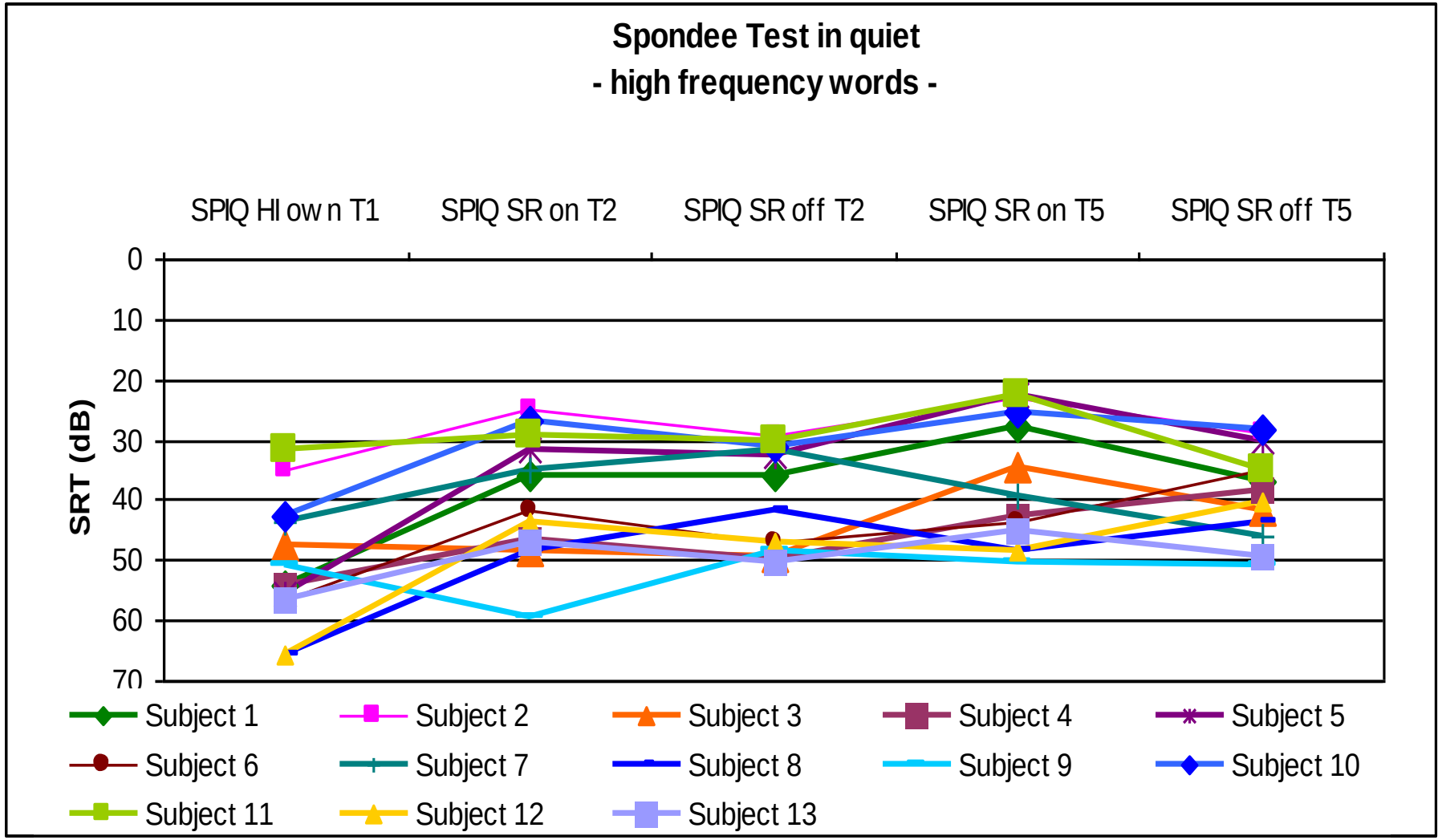
Study – Group results – HF-AAST in quiet



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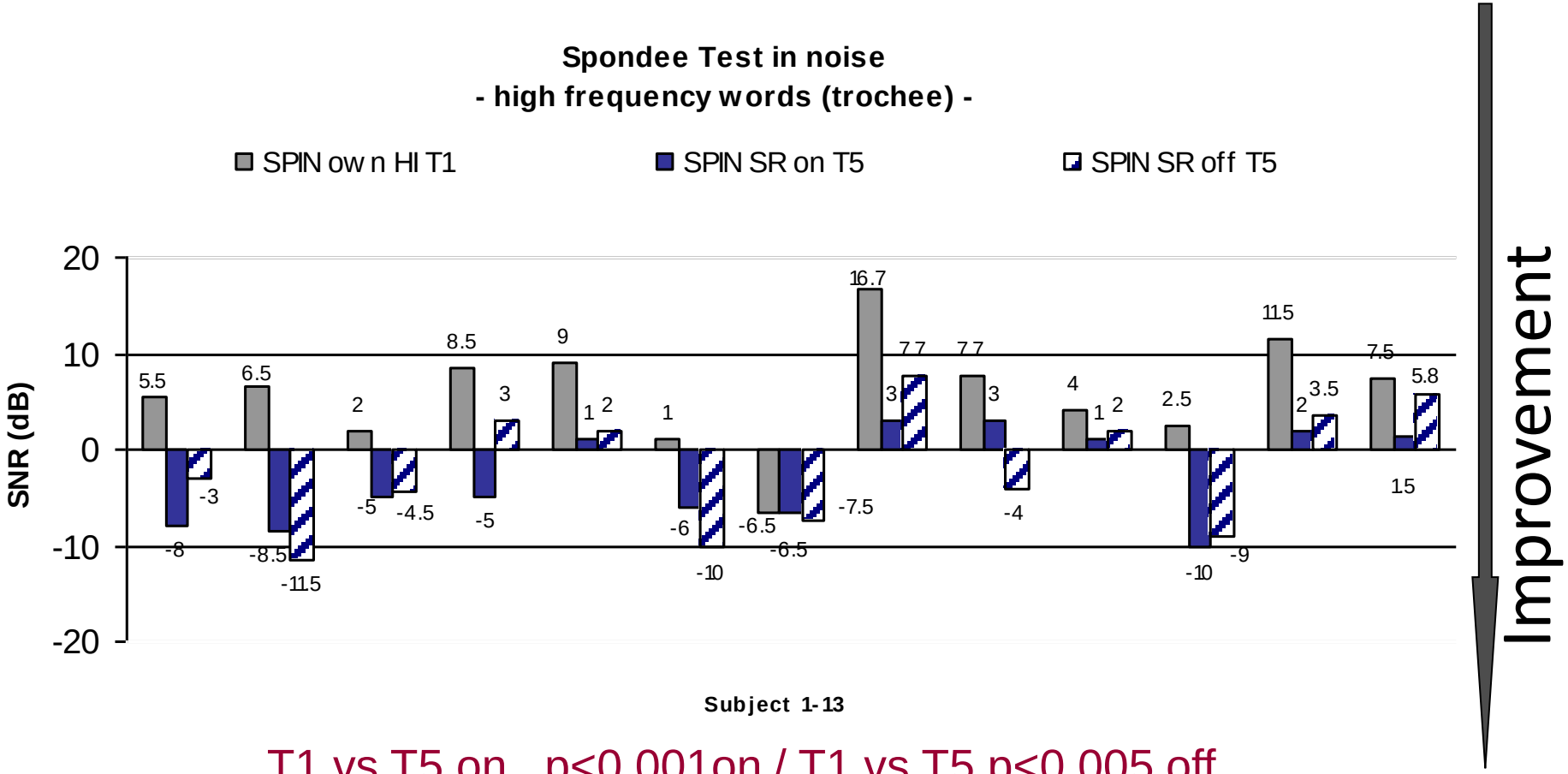
Study – Group results – HF-AAST in noise



T1 vs T5 on p<0.001on / T1 vs T5 p<0.005 off

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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

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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. Life voice - /s/ and /sh/

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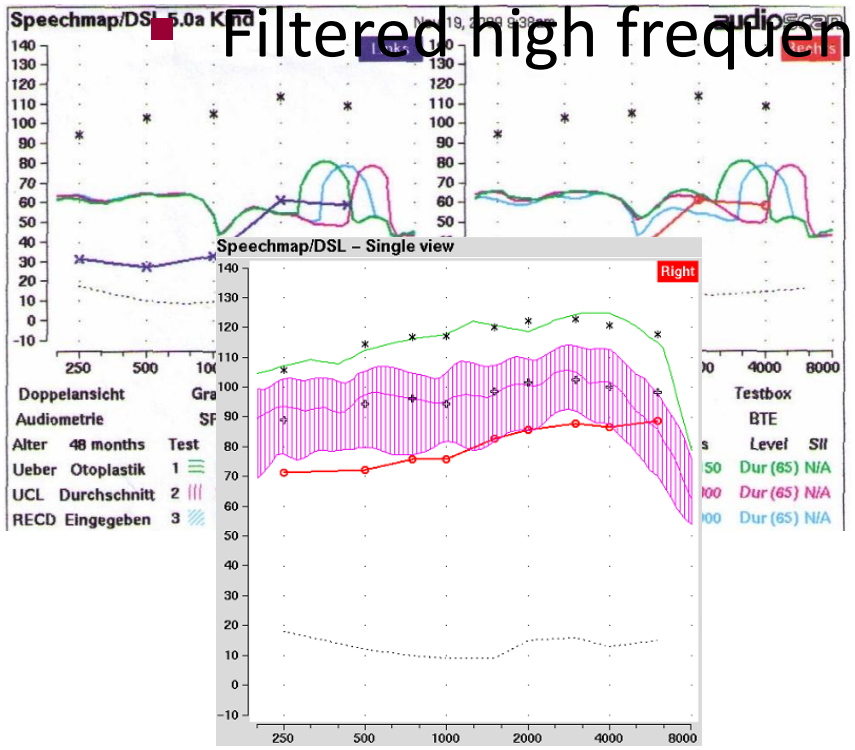
Verification

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



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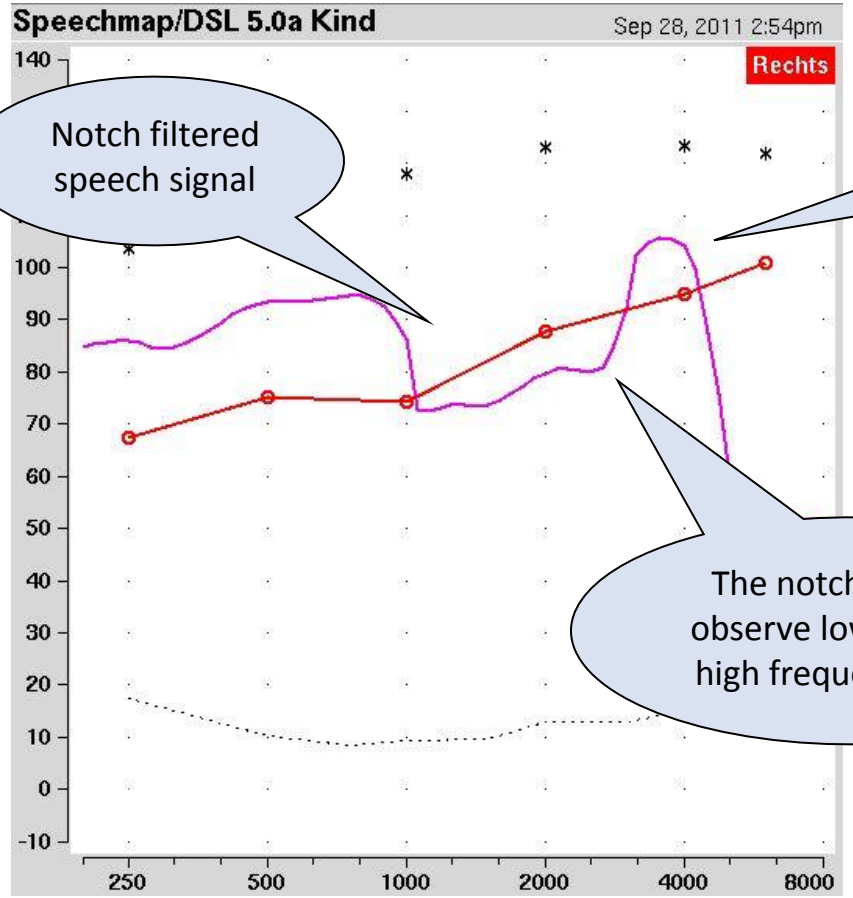
Verification

- Filtered high frequency speech band signal (Speechsignal)



Notch filtered speech signal

High frequency band is left

The notch lets you observe lowering the high frequency band

Centre frequencies:

3150 Hz

4000 Hz

5000 Hz

6300 Hz

Screenshot from Audioscan Verifit

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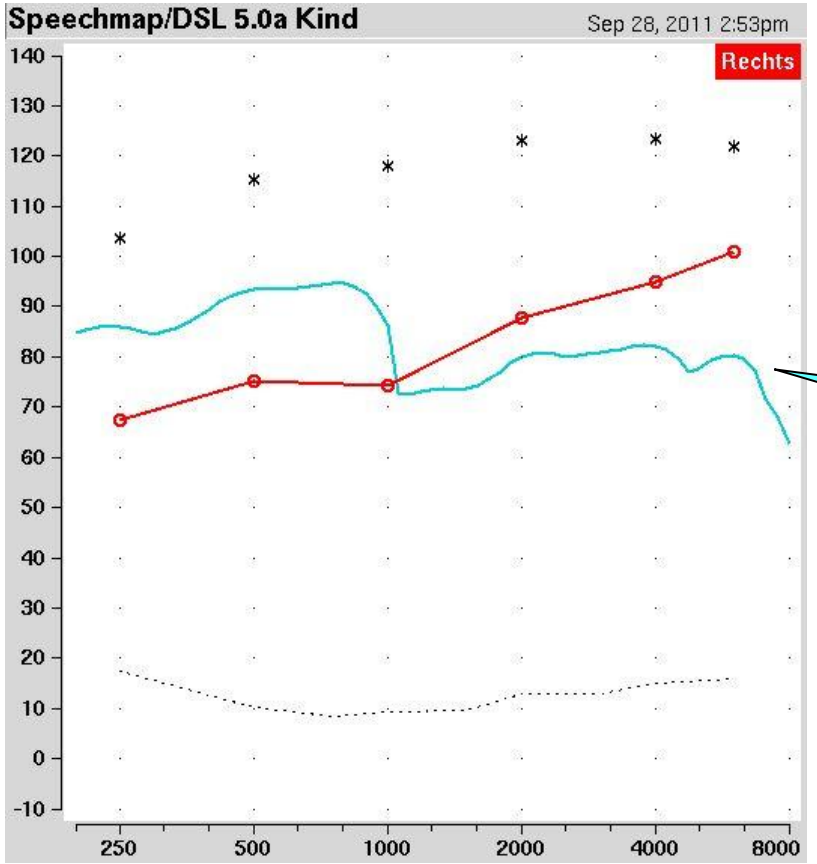
FC *disabled / enabled*

- Filtered high frequency speech band signal (Speechsignal)



Without FC, 6300 Hz below threshold

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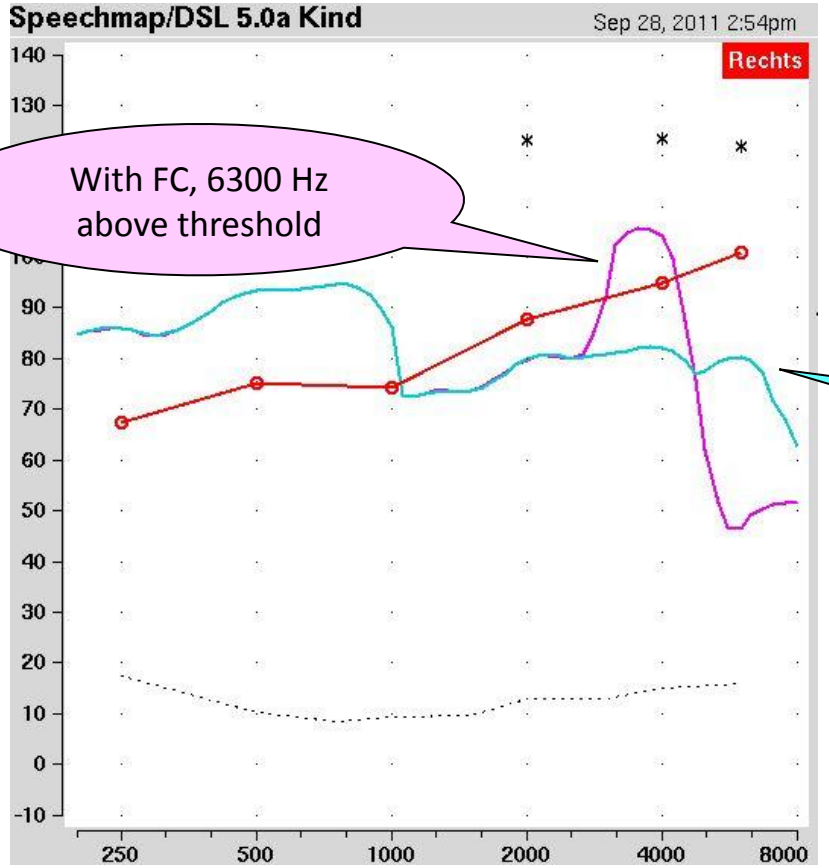
FC *disabled / enabled*

- Filtered high frequency speech band signal (Speechsignal)



/s/ is audible now!

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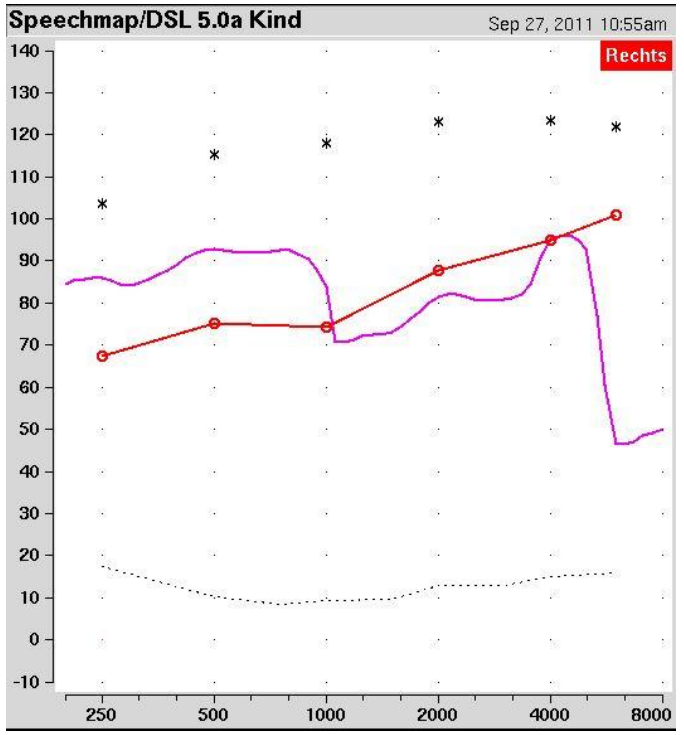
FC settings

- 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



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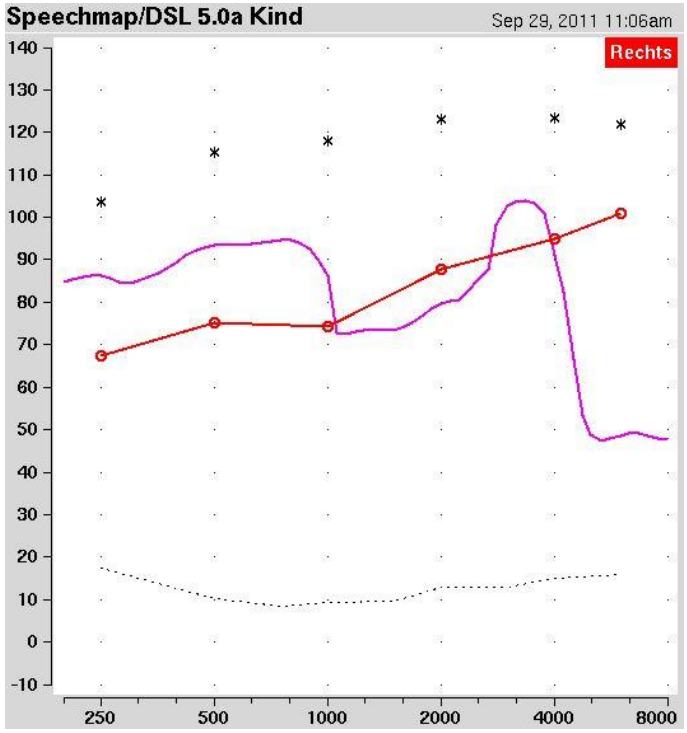
FC settings

- 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….!!!!!!!!

Fine-tuning



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Take home message for FC fitting

- ✓Fine tuning is possible!
- ✓Gain and FC interact
- ✓Less high frequency gain ⟷ use a stronger FC setting to make /s/ audible

Use always the weakest setting that has positive effects to make /s/ audible

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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

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Summary

- ✓ Viable and robust technology for adults and children
- ✓ It does need to be individually and carefully fitted

Respect the protocols for

fitting Lowering Technologies!!

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What about FC and tonal languages…?

A language difference is expected due to……..

- Lexical tone contribution
- The consonant-vowel syllable structure in Mandarin differs significantly from the complex syllable structure of English
- Mandarin sentences result in a larger proportion of sentences being identified based on vowel segments (i.e., 66% in Mandarin vs. 45% in English
  [Chen, Wong and Wong, JASA 2013; Fogerty and Kewley-Port, JASA 2009])
- The statistical probability of syllable identification in Mandarin based on vowel segment is much higher than in English

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What about FC and tonal languages…?

- HF information is important, but not to the same extent as in non-tonal languages
- Low frequency information - vowel carries about 3 times more information as e.g, in English (2:1)

  (Chen, Wong and Wong, JASA 2013)
- HF consonants do not carry lexical information

HF are important carriers of speech information

→ *eg. distinguishing different words*

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What about FC and tonal languages…?

- Most tonal information is contained in frequencies below 1500 Hz
- Therefore FC do not harm tonal languages

High pitched environmental information is important for the quality of a child's overall experience of hearing.

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Clinical implications – future questions…?

We still need to learn more……..

….about the effects of *FC and tonal languages*

Studies

Department of Otorhinolaryngology, Head and Neck Surgery
The Chinese University of Hong Kong
Team of Dr. Anna Kam
„Clinical Evaluation of Frequency Compression Technology"

Tongren Hospital, Beijing
Team of Dr. Chen
„Frequency Compression and tonal languages"

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