Technology Options for Fitting Children

Stefan Launer
Research
Phonak AG

PHONAK life is on

Nearly 90 % of pediatric audiologist use DSL today!

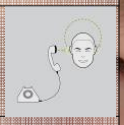
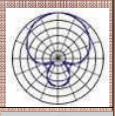
Content

- Sound Processing
  - High frequency amplification
  - Speech intelligibility in complex listening environments
  - Feedback
- Usage and handling
  - Robustness
- Wireless Connectivity
  - Conventional FM
  - Body area network

Modern Hearing Instrument Features

Feature	What is this feature?	Benefit
SoundRecover	▪ Non linear frequency compression ▪ Gently compresses and shifts high frequencies into an adjacent area of audible hearing	
SoundFlow	▪ Blend of sound cleaning tools ▪ Changes made automatically ▪ Continuously, effectively and seamlessly ▪ Spatial localization	
WhisteBlock	▪ Situation specific feedback path estimation for optimal added stable gain ▪ Good sound quality	

Modern Hearing Instrument Features

Feature	What is this feature?	Benefit
DuoPhone	▪ Real-time audio streaming ▪ Caller's voice is heard in both ears	
StereoZoom	▪ Real-time audio streaming ▪ Binaural beamforming	
ZoomControl	▪ Real-time audio streaming ▪ Focus in all directions	

Intelligibility and Identification of High Frequency Sounds

Severe to profound hearing loss causes

- Difficulty in recognizing certain speech sounds: fricative consonants /f/, /s/, and /sh/.
- Difficulty in identifying high-pitched environmental sounds
- Difficulty for young children in learning to produce high frequency speech sounds
- Difficulty for adults in maintaining speech quality.

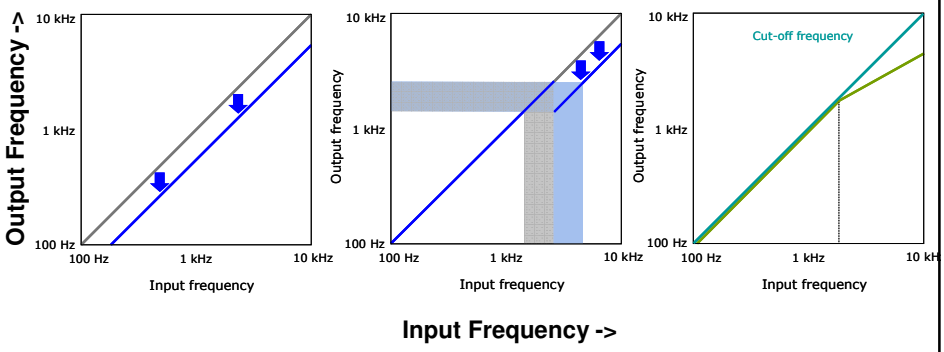
High Frequency Amplification

- Mixed results in the literature regarding effectiveness of high frequency amplification
  (Ching, Dillion and Byrne,1998; Hogan and Turner, 1998; Vickers et al, 2001; Baer et al, 2002; Mackersie et al, 2004, Hornsby & Ricketts, 2003, Ricketts, 2008, Hamacher 2006)
  - Speech intelligibility
  - Sound quality
    - Issues of speech in quiet versus noise
    - Issues of flat versus shaped responses and/or losses
    - Issues of matched versus unmatched samples
    - Issues of congenital versus acquired hearing losses
    - Individual proficiency in using audible cues
    - Individual willingness in using audible cues
    - Technical limitations of high frequency amplification

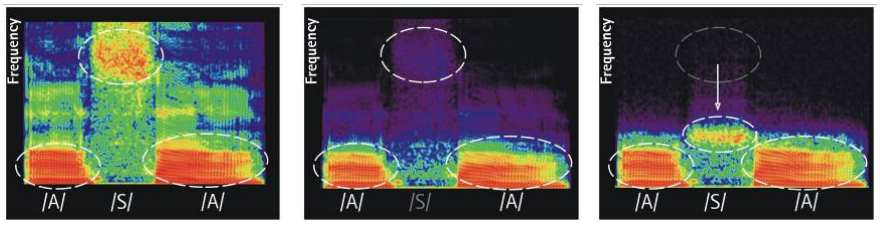
Technology Options for High Frequency Amplification

- High frequency amplification: extend frequency range of hearing instruments
  - Feedback problem
  - Acoustic coupling
  - Hair cell loss: Dead regions?!

Frequency Shifting



Non-linear Frequency Compression Spectrograms

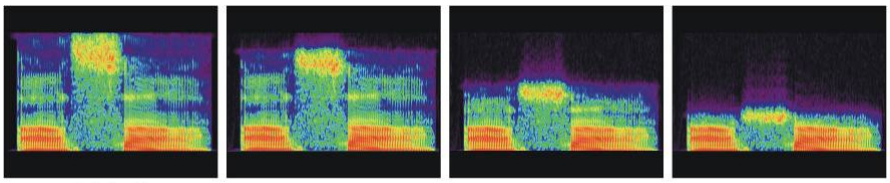


Original Signal

Simulated High frequency HL

Simulated non-linear frequency compression

Non-linear Frequency Compression
Different frequency compression settings



Original | 4000 1.5:1 | 2000 2:1 | 1500 4:1

Frequency Compression– Research Verified Benefits

- Research at University of Melbourne: H. McDermott, A. Hersbach, A. Simpson
- University of London (Ontario, CN): S. Scollie, M. Bagatto, D. Glista
- Hörzentrum Oldenburg, B. Gabriel, K. Wegener
- University of Mainz, ENT Clinic, Andrea Bohnert
- Hearts for Hearing, Oklahoma, Jace Wolfe

Frequency Compression – Clinical Evidence

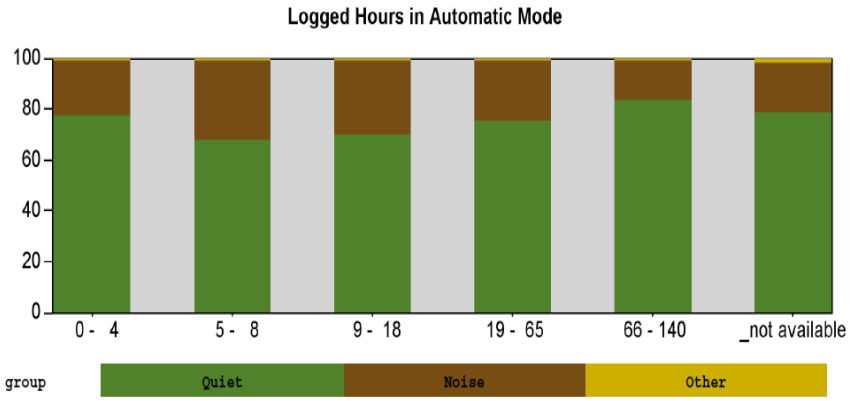
- **Different hearing loss classes: mild / moderate …. profound**
  - **Mild hearing losses: acclimatization, make subjects aware**
- **Adults and children**
- **Improved intelligibility of high frequency speech elements**
  - **In different languages**
- **Improved recognition and perception of environmental sounds**
- **Significant improvement of voice production, especially for subjects with profound hearing losses**
- **Benefit not due to increased high frequency amplification**
- **Short acclimatization period**
  - **Little fine tuning / optimization required**

Speech Intelligibility in Noise

- Directional microphones improve speech intelligibility in noise significantly
  - Adults and children
- Application in adults is widly accepted
  - Automatically / manually controlled
- Controversy about application in kids
  - Depends on age

Usage time per environment / listening program

- 40 Million hours have been logged in total…



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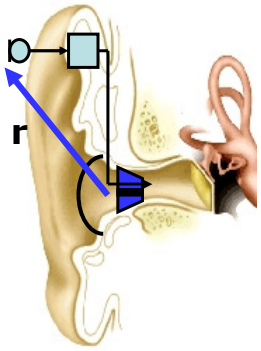
Speech Intelligibility in Complex Listening – Use of Directional Microphone Technology

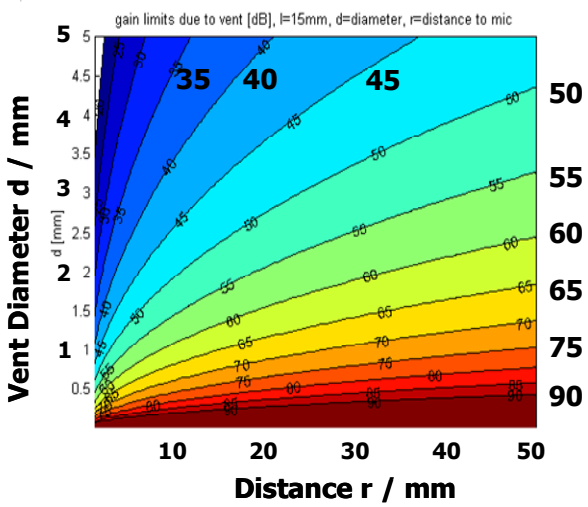
- **School aged kids benefit significantly from directional microphone technology in school environments (Ricketts 2010)**
  - **Problem: very dynamic listening environment of kids with target speech direction varying a lot**
    ⇔ Overhearing
    ⇔ look direction, target direction
  - **Automatically or manually controlled?**
  - **Counselling!!**
- **Babies: in general no directional microphone is recommended, however, in very specific listening conditios even babies might benefit from directional microphone technology**
  - **Use of directional microphones should be manually controlled by parents, automatic control is not recommended in babies**
  - **Counselling**

Feedback – Complex dynamic problem!

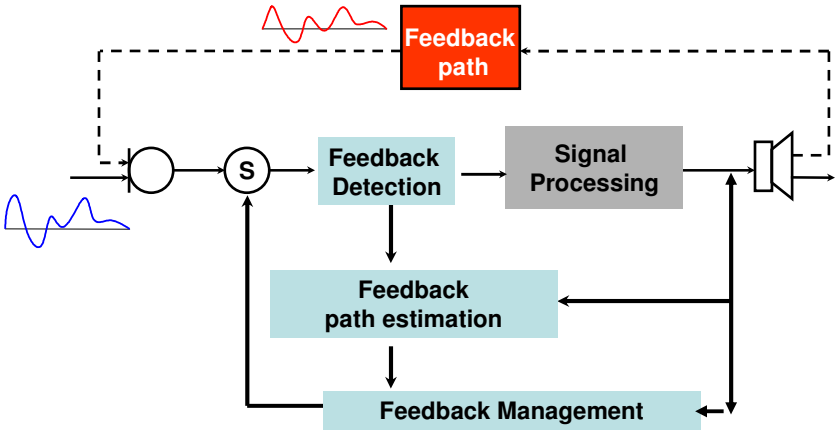
- No static but highly dynamic problem!
  - fast and slow temporal variations
  - large level changes (>10 – 20 dB!)
  - no single tone but occurs at multiple frequencies
  - frequency variation
- Inter-individual differences in ear canal geometry and dynamics
- Growing ear canal size in kids, variable sealing / feedback stability over time



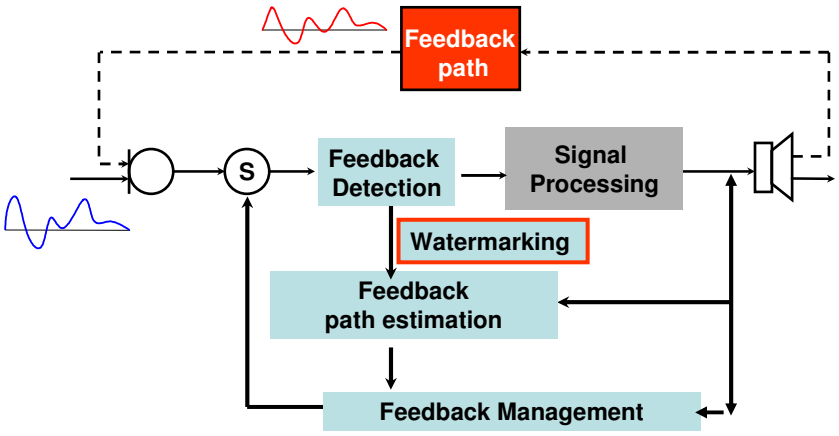
Maximum attainable (static) gain before feedback



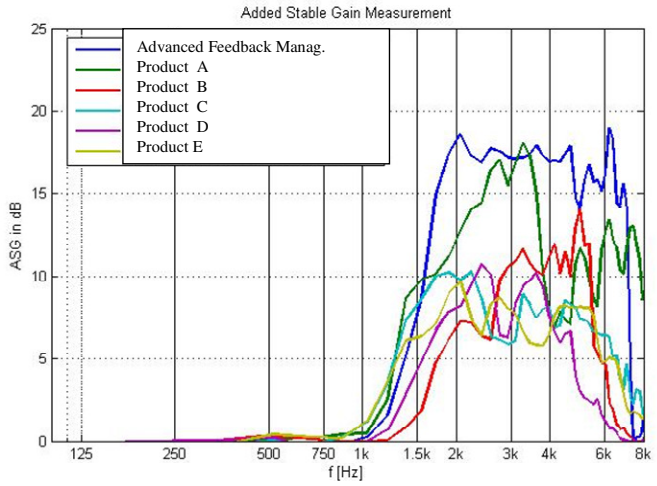
Feedback Management
Elements



New Element: Tagging / Watermarking



Added Stable Gain



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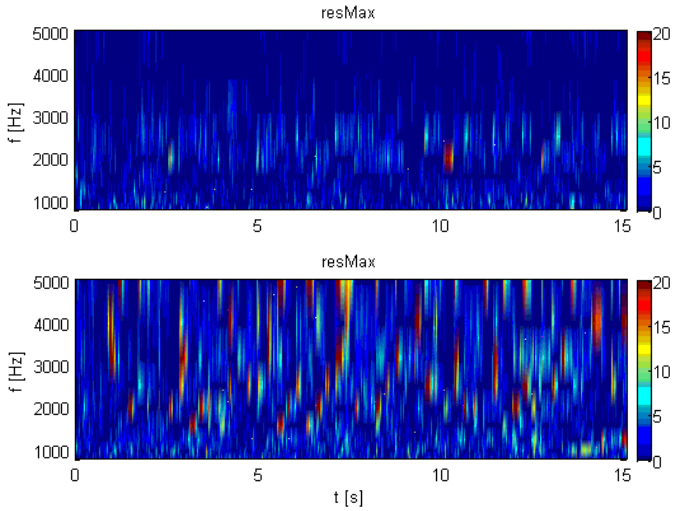
Feedback Artifact – Improve Sound Quality



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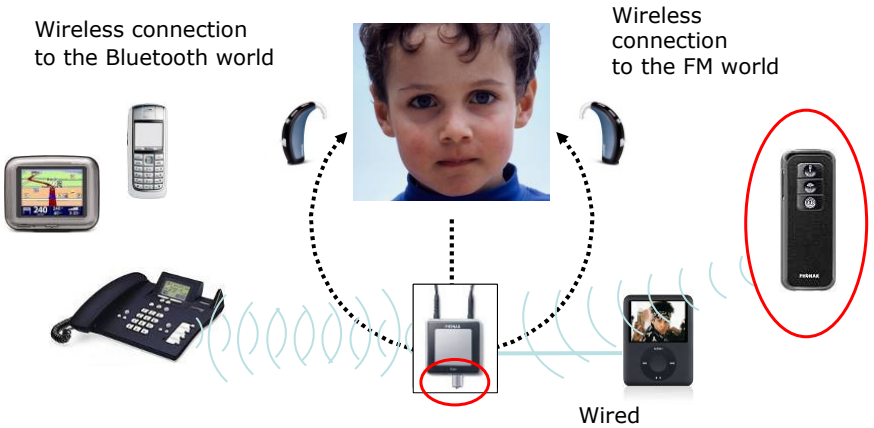
Feedback Management

- Added stable gain
  - Not just turn off gain in feedback conditions!!!
- Good sound quality and acoustic stability
  - Fast reaction time
- Avoid entrainment, ie identify feedback signal properly
  - Speech, music…

Freedom of Connectivity

- Traditional: FM systems
- New wireless short-range networks

Body Area Network



Earlevel FM

Modern FM Technology

- **Dynamic Speech Extraction**
  - **Automatic FM advantage: Adjusts the FM gain depending on the environmental noise level**
  - **Surrounding Noise Compensation**
  - **Voice Activity Detector**
- **Multi-talker networks: New team teaching concept using up to 10 transmitters**
- **Datalogging FM: saves FM transmitter usage data for analysis**
- **Channel Finder: providing interference free channels**

Usage, Ergonomic Aspects

- Active!
- Robust and reliable

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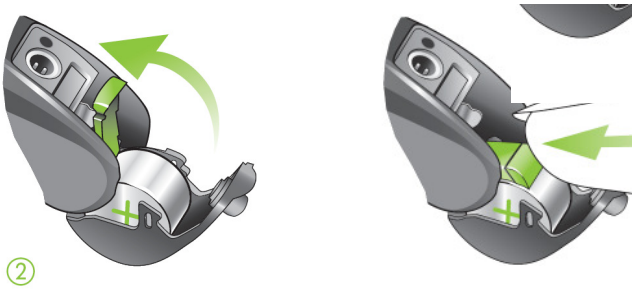
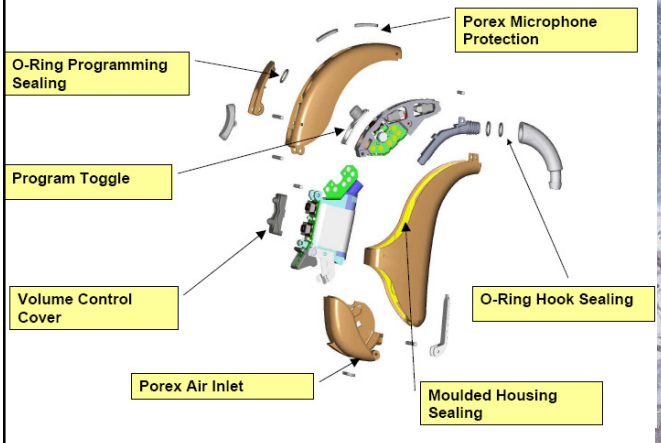
Active! -> retention

Tamper proof battery solution

- The microBTE shares the same tamper-proof battery option as the Naída models
- Locks the battery within the door but not the door itself



Moisture and water ***resistant***



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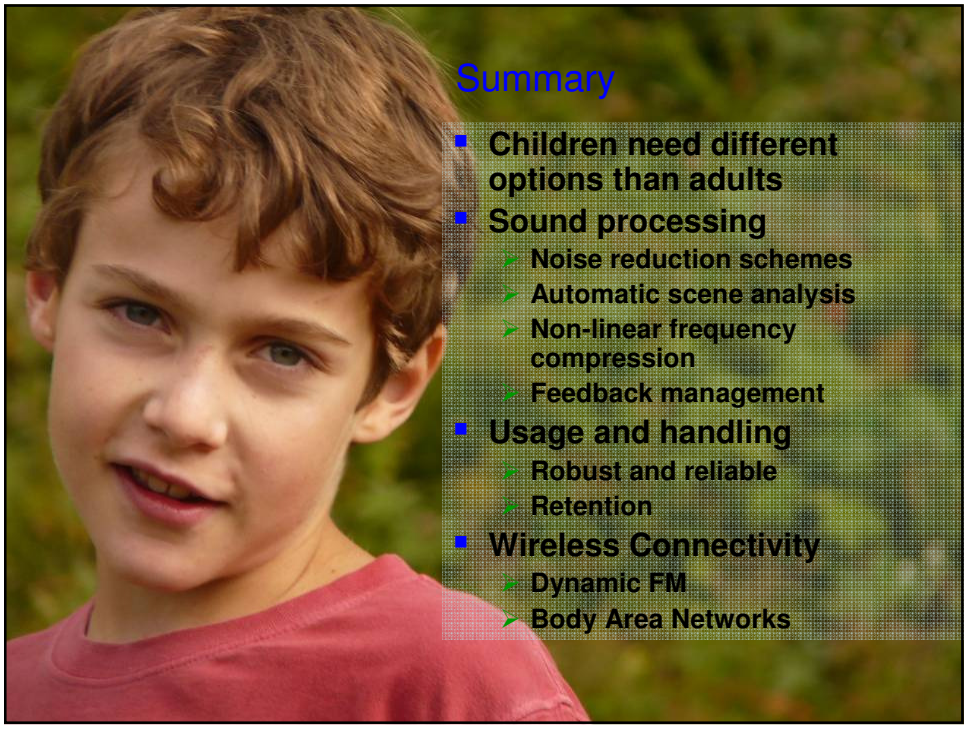
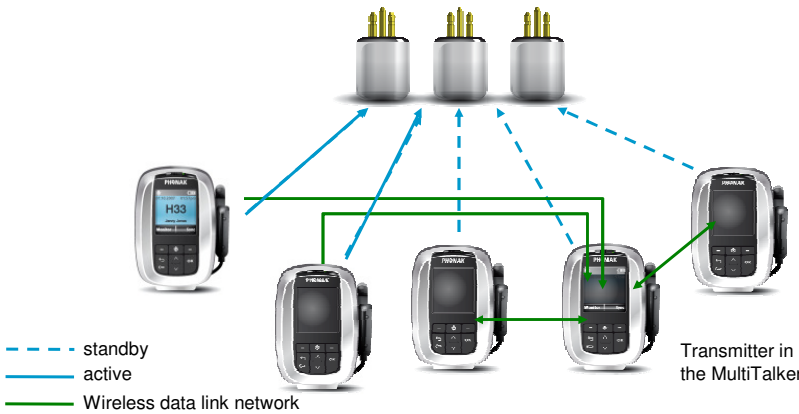
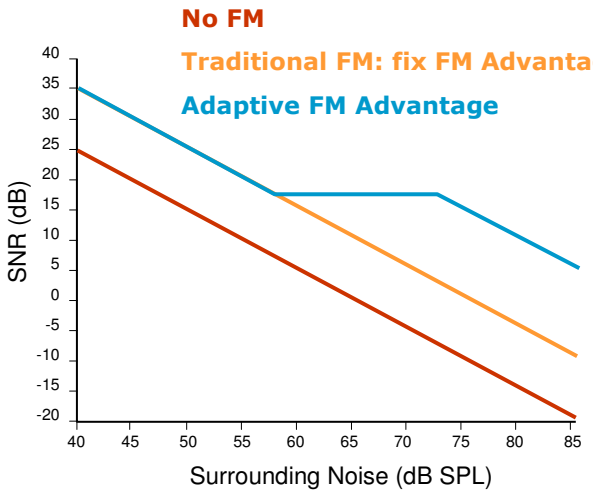

Summary
Children need different options than adults
Sound processing
Noise reduction schemes
Automatic scene analysis
Non-linear frequency compression
Feedback management
Usage and handling
Robust and reliable
Retention
Wireless Connectivity
Dynamic FM
Body Area Networks


THANK YOU!!!!

MultiTalker Network



SNR at ear level for different technologies



10 dB FM advantage:
- Good environmental awareness
- Audibility of the own voice
- Compromise at high noise levels

- Ricketts et al 2010 analysed the listening environment of school kids by following 24 kids all day long noting their listening environment and simultaneously recording the hearing instrument settings
  - How precise is scene identification in hearing instruments for scholl kids?
  - Do school kids benefit from directional microphones in school days?
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