Classification of hearing impairments using the Auditory Profile

The relevance for technical rehabilitation

Workshop Hearing Screening and Technology, Brussels 28 January 2009

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Acknowledgements

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MMOM









More than audibility ...

In diagnostics:

- Other important aspects (e.g. spectral and temporal resolution, recruitment)
- Shown and measured in many research settings
- BUT:
 - No standardized methods
 - No applications in clinical field
 - \rightarrow No data from large populations

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More than audibility ...

In technical rehabilitation:

- Prescription rules are mainly based on the audiogram [But the pure-tone audiogram is basically designed for medical diagnosis and not for rehabilitative audiometry]
- Advanced signal processing is usually based on average processing capability









So we need...

- Battery of tests in different domains
- Relevant for communication
- Clinically applicable
- Well-standardized across languages

<u>Goal:</u> Identify individual hearing capabilities → Selection of specific signal processing for individuals

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Therefore

- The Auditory Profile (AP) should become:
 - "Fingerprint of the ear"
- Characterize individual auditory deficits:
 - Detailed diagnosis in a standardized way
 - Hearing aid selection and fitting
 - Future: targets for aided performance













	Component				
	1	2	3	4	
F3000	.803				
slope audio	.787				
Т3000	.679				
MCL3000		.913			
MCL500		.841			
PTAh		.676		.593	
T500			.794		
F500			.766		
SL500				.713	
SL3000				.763	
SRTfluct			.515	.488	

Total explained variance: 73 %











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Factor 1: Highfrequency processing

Total explained variance: 73 %













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Factor 1: Highfrequency processing Factor 2: Audibility

Total explained variance: 73 %











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SL3000				.763
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Factor 1: Highfrequency processing Factor 2: Audibility Factor 3: Lowfrequency processing

Total explained variance: 73 %

Det.(corr.matrix): 0.009 KMO (sampling adequacy): 0.587

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	Component 🥿			
	1	2	3	4
F3000	.803			
slope audio	.787			
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PTAh		.676		.593
T500			.794	
F500			.766	
SL500				.713
SL3000				.763
SRTfluct			.515	.488

Factor 1: Highfrequency processing Factor 2: Audibility Factor 3: Lowfrequency processing Factor 4: Recruitment

Total explained variance: 73 %











	Component				
	1	2	3	4	Factor 1: High-
F3000	.803				frequency processing
slope audio	.787				Fostor 2. Audibility
Т3000	.679				Factor 2: AudiDinty
MCL3000		.913			Factor 3: Low-
MCL500		.841			frequency processing
PTAh		.676		.593	Factor 4. Docruitmon
T500			.794		racio 4. Reciulinen
F500			.766		
SL500				.713	SRT: related to
SL3000				763	recruitment and low
SRTfluct		(.515	.488	
Total explained variance: 73 %					





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Future Auditory Profile

Goal: broad clinical application

- → Detailed knowledge about the individual problems in hearing
- → Population data about different aspects of auditory deficits

Important issue:

Can the AP be used for a classification of HI that is relevant for auditory rehabilitation?











How to use the AP for the classification of HI?

- Main stream HI
 - Audibility is main problem
 - Problems increase with increasing hearing loss
- Complex cases with extra problems
 - Due to supra-threshold deficits
 - Reduced DR
 - Reduced F-resolution
 - Reduced T-resolution
 - Due to reduced binaural integration
 - Due to reduced cognitive functions











Hierarchical strategy in three levels

1. Assess the complexity

- Pure-tone audiogram
- SRT in quiet
- SRT in fluctuating noise
- GP speech and localization

2. Analysis phase

Test scenarios, e.g. for:

- Problems with recognition
- Speech perception in noise is poorer than expected
- Problems with localization

3. Detailed diagnosis

Test batteries on:

- Central tests / binaural cooperation
- Battery of cognition tests
- Testing for dead regions











Potential applications of the AP in technical rehabilitation

- Selection of hearing aids
 - Choice of relevant hearing aid features based on a categorization of the complexity of the HI
- Fitting of hearing aids
 - Settings and fine-tuning of SP-parameters
- Evaluation of hearing aids
 - Clinically applicable test procedures
 - Derived from the AP
 - To be compared with AP results











Imagine ... that we had more knowledge

- ... about the *prevalence* of the different types of auditory impairments *in a population*
- → This would largely stimulate the development of signal processing techniques to compensate for these impairments
- ... about the *different types* of auditory deficits in an individual
- → This would largely stimulate the selection of specific signal processing for this individual, and may support individual fitting and rehabilitation techniques to compensate for the deficits



WP2-T4

bridge between WP2 (AP) and WP7 (SP)

Perceptual evaluation of

- Single-channel noise suppression: SE-KTH, DE-RUB
- Blind source separation: DE-UEN
- Adaptive beamforming: BE-LEU
- Dereverberation: DE-UOL
- Extra measurements of the AP in two centers: AMC and HZO: n=55 subjects
 - SRT in noise
 - Listening Effort Scaling @ SNR 0 / +5 / +10 dB
 - Preference ratings











Results of 5 HEARCOM strategies for Noise Reduction











Relationship SRT-results with AP parameters

- Overall performance is related to most AP parameters.
- Benefits from the different NR-algorithms show characteristic dependencies
 - The benefits in SRT are significantly related to a number of AP parameters
 - The benefit in Listening Effort from "Beam" is related to different AP-parameters
 - Relative preferences for SP-algorithms show characteristic dependencies











Where did the AP arrived at?

- Unique set of standardized and validated tests
 - Tests that go beyond the traditional audiogram:
 - f/t resolution / loudness perception / binaural cooperation / cognition
 - Equivalent speech tests across languages
- All tests are implemented in one platform (OMA)
- Appealing for the *advanced audiology professional*
 - Advanced diagnosis of the problems in individual persons
- Appealing for the <u>EU hearing-aid industry</u>
 - Characterizing specific subgroups with special needs
- Appealing for the *EU research community*

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- Attractive tests for cooperation \rightarrow an increasing reference database
- Excellent tool for large-scale (international) population studies







Dissemination

- Expansion of the number of countries where HEARCOM procedures can be introduced
- Publication of the results
 - In papers and at the website
- Active contribution to conferences
 - ICRA / EFAS / ISAAR / ASA / Euronoise / IHCON
- Network of professionals as a HEARCOM community (AP as best practice)
 - Through EFAS or more directly
 - Organize own workshops for interested parties
- Package the AP tests with advanced audiometer equipment (OMA / other manufacturers)

→ Acceptance of the AP in the clinical field
→ Broadly used instrument in research studies

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Thanks for your attention









