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Hearing in the Communication Society

INTEGRATED PROJECT

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D-2-4: Proposal for dissemination of the Auditory Profile via reference implementation and via Internet distribution

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Pre-Amble

This deliverable concerns the dissemination plan for the auditory profile that has been defined in deliverable D-2-1, by a multi-centre experimental approach. The protocol for this multi-centre study has been described in deliverable D-2-2 and results have been given in D-2-3. The auditory profile was designed in order to enable consistent characterization of an individual's auditory impairment across Europe. The auditory profile can be used to determine the individual hearing deficiencies in communication and can help to determine the benefit by assistive devices. The auditory profile should include all necessary measures to describe the details of, and differences between, different hearing impairments.

The auditory profile is relevant for the work in SP2 (Adverse Conditions), because its outcome values will define the auditory demands for the acoustical conditions required in case of hearing impairment. The work is relevant for SP3 (Rehabilitation) and SP4 (Assistive Technology), because the auditory profile indicates the deficits that need to be compensated, either by signal processing (SP3) or by alternative strategies (SP4). Finally, the implementation of these tests in OMA (Oldenburg Measurement Applications) will have a great impact on the dissemination of the test procedures and will stimulate a broad clinical acceptance of this innovative approach to auditory testing.

1 Executive Summary

The HEARCOM (Hearing in the Communication Society) project aims at full participation in the modern communication society by reducing the limitations in auditory communication. Two of the focus areas of HEARCOM are on the identification and characterization of auditory communication limitations and on the development of standardized testing and evaluation procedures for hearing-impaired persons. In this context, a preliminary auditory profile has been defined. This preliminary auditory profile has been validated in an international multi-centre study. The results of that study were presented in D-2-3 and the dissemination plan is described here.

The aim of the auditory profile is that it should be used as a diagnostic tool in a broad population of subjects with complaints about their performance in (auditory) communication tasks. It will be a diagnostic profile that can be assessed in a (specialized) hearing centre or clinic or in audiological research. The end user of the auditory profile is the professional interested in the characteristics of the hearing of a particular client/patient.

In a multi-centre field trial the clinical applicability has been investigated and the relevance of the test results to characterize communication ability has been assessed. Although the Auditory Profile needs some fine tuning, time has come to plan more dissemination activities in order to:

- Make the Auditory Profile more well-known among professionals
- Discuss the clinical relevance for auditory diagnosis and auditory rehabilitation
- Work towards a general acceptance of the Auditory Profile as an (international) standard in clinical audiology
- Disseminate the tests, testing procedures, and reference values to interested clinics and professionals. To this end all tests have been implemented in OMA (Oldenburg Measurement Applications) software. For applications in research, the software can be left more open in order to be flexible towards diverging applications. However, for clinical use the test procedures should be described in detail and the software should obtain a CE-approval in due course.

2 Introduction

2.1 The focus of the Auditory Profile

The Auditory Profile refers to both a set of psychoacoustic tests to characterise the hearing abilities of individuals and the outcome of the set of tests for the individual. In this deliverable, the set of tests will be termed the Auditory Profile Test and the outcome will be termed the Auditory Profile.

The purpose of the Auditory Profile Test is to enable clinical professionals, typically audiologists and in some countries hearing-aid dispensers, to derive the Auditory Profile for individuals with the aim of understanding the hearing difficulties experienced by the patient. This may be used for:

1. Audiological diagnosis
2. To guide the audiologist in counselling the patient
3. For selection of appropriate treatment (e.g. selection of hearing aids).

Currently, very few audiology centres have the capability to perform tests of the type included in the Auditory Profile Test due to lack of suitable equipment and materials and lack of standardization, including reliable and representative reference values. In those few centres that do, they would only be able to perform a minority of the tests and the implementation would be non-standard. Therefore, development of the Auditory Profile Test offers ready availability of standardised tests and materials. The Auditory Profile would be best suited to more specialised clinics that have the interest and expertise to perform the tests and interpret the results appropriately. Also, it will be an important tool to characterize participants in audiological research project in an objective and internationally accepted form.

It is envisaged that the Auditory Profile Test will be implemented on a console in a quiet room within the clinic. Sounds will be delivered to the test subject via sound-attenuating circumaural earphones, so that the acoustic requirements of the room are less stringent than audiometric rooms. Therefore, the Auditory Profile Test has its main focus on advanced audiological diagnosis and hearing aid selection, rather than on the evaluation of the results of auditory rehabilitation with hearing aids. The latter application will follow the techniques and evaluation procedures developed in WP7.

2.2 The contents of the Auditory Profile

The initial development of the Auditory Profile Test has been described in Deliverable D-2-1. It contains tests of the dynamic range of hearing in the intensity domain (threshold, loudness growth), frequency and temporal resolution, speech recognition in noise, spatial hearing ability (minimum audible angle, binaural intelligibility level difference), lexical decision-making and rating of listening effort. It also contains a questionnaire concerning self-reported hearing difficulties.

We agreed on the following tests to be included in the preliminary auditory profile (see also D-2-2):

Topic	Test	Details
Audibility	Audiogram	air conduction: .25/.5/1/2/3/4/6/8 kHz bone conduction: .25/.5/1/2/3 kHz
Loudness perception	Acalos	narrowband noises (500 Hz, 3000 Hz) broadband noise
Frequency-time resolution	FT test	500 Hz 3000 Hz
Speech recognition	SRT with Plomp-type sentences	in quiet (binaural) in stationary noise (monaural) in fluctuating noise (monaural)
Spatial hearing	MAA test	broadband noise low-pass noise high-pass noise
	ILD	SRT with matrix-type sentences
	BILD	SRT with matrix-type sentences
Cognitive abilities	Lexical Decision Making	
Subjective judgement	Gothenburg Profile	
	Listening Effort	Running speech in continuous or fluctuating noise, at SNR=-5 or SNR=+5

Table 1: List of tests included in the preliminary auditory profile.

All these tests have been implemented on a common software platform in Oldenburg (called OMA, Oldenburg Measurement Applications), see deliverable D-2-1b. All tests were conducted unaided, via headphones. For an extensive description of the protocol, see D-2-2.

2.3 The validation of the Auditory Profile

The first version of the Auditory Profile Test has been evaluated by multi-centre study, as described in deliverable D-2-3. The protocol for the validation is described in D-2-2. That validation has informed the process of streamlining the Auditory Profile Test so that redundant tests are removed, tests showing floor or ceiling effects are adjusted and the total time taken to complete the Auditory Profile is reduced to a more practical amount. The streamlining process is underway at the time of writing. The initial validation has enabled comparison to be made across four languages (Dutch, English, German and Swedish) to ensure comparability. It has also allowed intra-subject repeatability to be estimated for each test, as well as estimation of effect sizes.

Based on analysis of the initial validation, an optimised version of the Auditory Profile Test is being defined. The optimised test will be described in D-2-6. Further validation will be performed on the optimised test and reported in D-2-6.

2.4 The implementation of the Auditory Profile

The Auditory Profile Test has been implemented on a computer workstation, comprising a PC running the Windows operating system, high-quality sound card, audiometer or external amplifier and Sennheiser circumaural earphones. All of these items can be purchased commercially. The Sennheiser HDA-200 earphones are listed in the international standard ISO 60389 and hence can be calibrated according to international standards.

In order to run the Auditory Profiles Test, clinics also require software to implement the tests and to provide the test materials in the required language(s). It is this software that instantiates the Auditory Profile Test on otherwise readily available equipment. Licensing of the software is underpinned by the requirement of a USB “dongle” to run the tests in anything other than demonstrator mode. Distribution of the Auditory Profile Test entails delivery of the software, either on a fixed medium or via internet download, and physical delivery of the corresponding “dongle”.

3 Dissemination goals for 2009

In the first meetings of the HEARCOM dissemination group, we identified the main results that needed to be disseminated to the target groups (see D13-3-2). Also we defined the goals for 2009.

At the end of the HEARCOM project in 2009 the aim is that HEARCOM:

- has contributed important knowledge to the audiological world
- offers expert knowledge for assessing and improving the quality of auditory communication
- is a broadly accepted EC-standard for state-of-the art procedures in audiology and auditory communication
- has spread its knowledge to EC-countries also beyond the Project, stimulating all countries to strive for the same high-quality professional standards
- Has provided sustainable product ideas and solutions for audiology that will be further distributed and developed by the commercial partners.

4 Dissemination strategy

To reach the goals, HEARCOM needs to raise support in society and in specific fields. There are several methods to achieve this:

- Presentation of the results at congresses, in scientific publications, and at the HEARCOM website.
- Through a forum for professionals in order to build a network
- Workshops for professional groups, both national and international, both for a broad public or more focused to specific themes
- Exploitation of the Auditory Profile as a quality hallmark, associated with HEARCOM

The dissemination of the tests needed for the assessment of the auditory profile among professionals will be part of HEARCOM eServices.

For the dissemination of the results of the Auditory Profile, the main target groups are:

1. Researchers, working in audiological research and in hearing aid industry. The use of the Auditory Profile by other research groups can be arranged relatively easily.
2. Professionals working in clinical audiology like audiologists, ENT-physicians, and hearing aid acousticians. For the health professionals HEARCOM will deliver diagnostic tools and a well standardized battery of tests that constitutes the auditory profile.

Given the fact that all tests have been implemented on the same software platform (Oldenburg Measurements Applications, OMA), there is a large potential to market the complete set of HearCom tests to the target groups described above.

Application of the Auditory Profile Test in clinics needs a CE-approval of the equipment and the software packages used. This is not an easy task, and it will at least take some time before the Auditory Profile is ready to be disseminated to clinics and hearing aid dispensers.

The aim of the auditory profile is that it should be used as a diagnostic tool in a broad population of subjects with complaints about their performance in (auditory) communication tasks. However, the diagnostic scope here is not primarily on the medical impairment, but on auditory deficits that have an impact on auditory functioning in daily life. In the future, the auditory profile should serve as a standard approach in a (specialized) hearing centre or clinic.

4.1 Presentations and discussions at conferences

We presented the basic choices made for the composition of the Auditory Profile at the international conference Age-Related Hearing Impairment (ARHI) in Antwerp[1]. Here the main focus was on the applicability of the Auditory Profile for earlier diagnosis of presbyacusis (age-induced hearing loss).

At the bi-annual international conference of the European Audiological Societies (EFAS) meeting in Heidelberg, June 6-9, 2007, we presented four papers about the Auditory Profile. One presentation was related to the optimal choice for the test of frequency and time resolution[2]. Another presentation focused on the problems that occurred in standardizing speech tests across languages and the way is has been solved within the HEARCOM project[3]. A third paper was related to the optimal choice of cognitive test for the Auditory Profile[4]. Finally, the HEARCOM consortium was invited to present the main results of the Auditory Profile in one of the scientific Round Tables[5]. Also the composition and test procedures of the Auditory Profile were discussed with visitors to the HEARCOM booth.

At the bi-annual conference of the International Collegium of Rehabilitative (ICRA), we presented an overview of the Auditory Profile and its validation[6], followed by a lively discussion about the clinical applicability by the experts in this group.

At the ISAAR conference in Helsingor (DK) we presented one paper[7] and about the results of the first multi-centre study.

These international activities should be complemented with a national plan of dissemination. In the Netherlands, for example, separate presentations

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[1] Dreschler W, The Auditory Profile: diagnostics on a European level. Age-Related Hearing Impairment Congress, Antwerp, 23-25 May 2007.
[2] Van Esch T, Sol J, Dreschler WA. Auditory processing. 8th EFAS Conference, 6-9 June 2007.
[3] Wagener KC, Brand T, Kollmeier B. International cross-validation of sentence intelligibility tests. 8th EFAS Conference, 6-9 June 2007.
[4] Larsby B, Hällgren M, Lyzenga J. Cognitive aspecst of speech recognition in noise. 8th EFAS Conference, 6-9 June 2007.
[5] Dreschler WA, Kollmeier B. The !Auditory Profile": proposal from the European HEARCOM project. 8th EFAS Conference, 6-9 June 2007.
[6] Dreschler W. The "Auditory Profile": diagnostics on a European levelInternational Collegium of Rehabilitative Audiology, Leuven 17-20 June 2007.
[7] Dreschler W. Diagnosis of impaired speech perception by means of the "Auditory Profile". International Symposium on Auditory and Audiological Research, Helsingor, Denmark, 29-31 August 2007.

have been given for ENT-doctors, audiologists, and hearing-aid dispensers. In Sweden presentations have been given for Technical Audiologists, Audiologists and ENT doctors.

4.2 Publication strategy

The Auditory Profile is unlikely to gain acceptance without publication of the research on its development and validation in peer reviewed academic journals. Preliminary publication has already occurred via conference presentations and proceedings of meetings (see above). At least the following publications are envisaged to disseminate the work.

- Description and validation of the first version of the Auditory Profile Test, with recommendations for optimisation.
- A publication about the details of the Lexical Decision Test
- A publication about the relevance of FT tests for speech recognition.
- A paper on the procedures used for the normalization of speech tests across languages (in Europe)
- A paper about the description and validation of the optimised version of the Auditory Profile Test.
- A position paper about the relevance of the Auditory Profile for the selection and fitting of hearing aids.

Several further publications will address more detailed aspects of the work.

4.3 Website publication and download of demonstrator

Description of the Auditory Profile Test and its uses will be permanently available on the HearCom website. This will describe the nature of the tests, give examples of how it may be used in practice and explain how to set up the equipment and software. Potentially, a discussion board could be hosted for users of the Auditory Profile (Auditory Profile User Group).

The website will include a download page for the Auditory Profile Test software and ordering information. Potential users will be able to download a demonstration version of the software for evaluation. The performance of the demonstration version will be limited so that genuine users must purchase a licensed version.

4.4 Forum of professionals

Since the auditory profile will be defined soon and it will be evaluated in a thorough multicentre study in the UK, Sweden, Germany, and the Netherlands, there is much material that we can share with the research community in order to convince them about the added value of the HEARCOM approach.

There are several reasons to start with the research community. First of all, the research community belongs to the target groups for the auditory profile. For the exchange of information about supra-threshold processing, loudness perception, binaural cooperation, and the role of cognition in speech recognition and comprehension, there is need for standards that can be used to compare results across studies, in a similar way as the pure-tone audiogram is often used as a well developed and standardized method for auditory acuity.

Within the audiological research community, the hearing aid manufacturers play a special role. They usually have their own research labs, and also there is much co-operative work with industries and universities. For them a standardized approach to the more complex aspects of hearing is extremely important, because they operate on the bridge between basic research and applications in clinical audiology and rehabilitation.

The second reason is that most professionals in clinical audiology base their protocols on evidence that has been obtained in research. So, the Auditory Profile needs full support of the research community to become accepted by the clinicians. That in itself is not yet enough, but it is a first prerequisite.

The third reason is that the use of the Auditory Profile by other research groups can be arranged relatively easily, while an application of the Auditory Profile in the clinics needs a CE-approval of the equipment and the software package used. This is not an easy task that will at least take some time, before the Auditory Profile is ready to be disseminated to clinics and hearing aid dispensers.

4.5 Packaging of Auditory Profile Test with audiometers

As an alternative means of dissemination, partnerships will be sought with distributors of audiometers. The aim would be to provide a complete package of equipment for running the Auditory Profile Test in addition to standard audiometry. A business model would be required whereby the audiometer distributor was responsible for setting up and calibration of

the equipment, verification of its performance and training of users. A licence fee would be payable by the distributor to relevant HearCom partners for each package sold.

5 Opportunities and threats

For the health professionals current practice has shown that high-end hearing aids need better procedures for selection and fitting. Also there is lack of standardized procedures in some countries. So the results of HEARCOM will be welcomed, unless the added value is too small or unless huge investments are needed in terms of testing time and the costs of specialized equipment.

For the hearing-aid industry it is unclear whether the results of HEARCOM will add to their own lines of development that are usually focused to specific product lines with proprietary procedures. On the other hand, the hearing aid industry may be interested in EC-wide standards.

6 Summary

The Auditory Profile Test has been developed in its initial version and an optimised version is awaiting final definition and validation. The final version will be validated within the lifetime of the HEARCOM project by means of a large multicentre trial. Further work will be required beyond the project to evaluate the Auditory Profile Test in different contexts, such as for establishing discrete diagnostic categories and for use as a guide to selection of different rehabilitation approaches for people with hearing impairment.

The dissemination of the tests needed for the assessment of the auditory profile among professionals will be part of HEARCOM eServices.

For the dissemination of the results of the Auditory Profile, the main target groups are researchers working in audiological research and in hearing aid industry and professionals working in clinical audiology, like audiologists, ENT-physicians, and hearing aid acousticians.

For health professionals, HEARCOM will deliver diagnostic tools and a well standardized battery of tests that constitutes the Auditory Profile. The optimised version will be disseminated via publication in peer reviewed academic journals, via the internet and potentially via distributors of audiometers. A licence fee will be payable for use of the Auditory Profile Test, which will help to ensure its sustainability as a maintained product.

In the future, the Auditory Profile should serve as an EU-wide standard in (specialised) hearing centres or clinics.