systems. This made that Experiment 2 was, as far as we know, the first in which noise reduction systems from different hearing aids were directly compared to each other. We conclude from the results that it depends on the type of noise reduction as well as the SNR whether normal hearing subjects prefer noise reduction over no noise reduction or over other types of noise reduction. These findings support the interpretation of previous studies on noise reduction. Furthermore, the results imply that it might be useful to give hearing-aid users the possibility to compare different noise-reduction systems in the process of selecting the most appropriate hearing aid and of fine-tuning for the optimal setting.

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Psychosocial factors affecting hearing aid adjustment

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This presentation outlines the answers from a questionnaire sent out to more than 800 users with hearing aids dispensed from public clinics in Denmark in the autumn of 2010. Answers indicate a generally high satisfaction and usage time with the dispensed hearing aids, and that this satisfaction, as expected, correlates with factors related to especially expectation, motivation, personal skills of the fitter, and user friendliness of the hearing instrument. All in all the answers from this quite large population offers a quantitative insight into the non technical factors that also affects hearing aid fitting.

BACKGROUND

Hearing aid satisfaction depends not only on the fitting and performance of the hearing aid itself, but on a lot of different factors, many of which are of a psychosocial character. A dissertation by S. Bisgaard has recently explored these factors in Denmark and qualitatively documented their relevance (Bisgaard 2010). Thus it was natural to take up the task of trying to quantify these findings; How many Danes are satisfied with their hearing aids and for which reasons? This poster is based upon the master thesis work of Technical Audiologists Derya Ceylan and Wiebke Hudemann, University of Southern Denmark (Ceylan and Hudemann 2011).

Traditional questionnaires in the field do not focus specifically on the psychosocial aspects of hearing, so an important part of the project was to create a new questionnaire with focus on the following 5 factors:

1. Expectation of the improvement when wearing hearing aids
2. Motivation, personal or from others, for the use of hearing aids
3. The wearers social activity before and after acquiring hearing aids
4. Acclimatization to the sound from a hearing aid, and to the idea of having to use these "machines" to aid the hearing.
5. Instruction and consultancy, the things professionals can do to help getting to know the hearing aid, but also to come to terms with the situation in general.

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While designing the questionnaire, opinions from various interested parties were taken into account in an attempt to optimize the questionnaire in terms of understandability and length, the ability to raise the right issues with the questions, and the registration of data for the subsequent statistical analysis. To ease the data registration most of the questions of the questionnaire were designed to be answered using a 5 point scale. Words used to span the scale were assigned on the extremes and sometimes in the midst of the scales. The words which serve as a kind of anchor points were changed to fit the possible answers of the different questions. Unfortunately some questions still seem to be misunderstood, and some scales are reversed, challenging the interpretation of the data.

The questionnaire was sent by mail to 857 HA-users primarily from 3 public Danish clinics in Copenhagen, Odense and Aarhus. 375 questionnaires, equivalent to 42 % were returned. It is in the lower end of what could be expected for this type of investigation, but given the nature of the questionnaire, fairly satisfactory. The only selection criterion for the responders was that they had to have at least 3 months of experience using hearing aids.

PRIMARY RESULTS

In the following pages the questions are translated to English and the distribution of the answers for each question is displayed in percent. Unfortunately, in many of the questionnaires the answer to one or more questions was omitted. Where the number of "no Answers" influences the distribution, it is given as a part of the result. The results are grouped in the same five parameters as the questionnaire: Expectation, motivation, social life, acclimatization and instruction.

Demographic data

Q1: Gender: 45% Female, 55% Male
Q2: Zip code (not registered for all- but the questionnaire was delivered from 3 major public clinics on Denmark)
Q3: Age: Average 67,3years, youngest respondee 10 years, oldest108 years.
Q4*:* Civil status: 62%: Married/in a relationship, 33% single 5% no answer.
Q5: Highest education:
Elementary School: 24%, College: 4%, Skilled professional: 17%,
Specialized professional: 13%, Bachelor deg.: 25%, Masters deg. or more: 13%
Q6: Is it your first time using hearing aids? 40% yes, 60% no
Q7: How old are your hearing aids? On average 14,5 months (5% did not answer)
Q8: Have you hearing aids for one or both ears? 20% one ear, 80% both ears
Q9*:* How many hours a day do you use your current hearing aid(s)?

6%	Less than one hour
1%	1-4 hours
16%	5 hours
6%	6-10 hours
67%	More than 10 hours

Expectations to hearing aids

Q10: To which degree can your current HA compensate for your hearing problems?
1(Not at all): 1% **2:** 8% **3:** 20% **4:** 31 % **5(To a very high degree):** 35%
No answer: 5%
Q11: Does your HA live up to your expectations?
1(Not at all): 4% **2:** 9% **3:** 17% **4:** 30 % **5(To a very high degree):** 37%
No answer: 4%
Q12: Have you told your friends and family that you have HA?
Yes: 91% No: 5% No answer: 3%.
Q13: To which degree do you think your peer's expectation to your HA has been fulfilled?
1(Not at all): 0% **2:** 10% **3:** 20% **4:** 30 % **5(To a very high degree):** 20%.
No answer: 10%
Q14: To which degree does your friends and family expectations to your HA inflict your satisfaction?
1(Not at all): 10% **2:** 10% **3:** 20% **4:** 20 % **5(To a very high degree):** 10%.
No answer: 10%
Q15: Are your expectations to your HA affected by commercials in TV, newspapers etc.?
1(Not at all): 80% **2:** 10% **3:** 0% **4:** 0% **5(To a very high degree):** 0%
No answer: 10%

Motivation for use of hearing aids

Q16: Have you looked forward to begin using your new hearing aids?
1(Yes): 50% **2:** 10% **3:** 10% **4:** 10% **5(No):** 20%
Q17: Who made you start using HA?
1(Own initiative): 40% **2:** 0% **3:** 10% **4:** 10% **5(Others initiative):** 30%.
No answer: 10%
Q18: Has the use of your hearing aid been difficult due to any of the following situations?

0% : "No, no problems"	30% : "Software fitting problem"
26% : "Problem with fitting mould"	21% : "HA functionality problems"
51% : "Problem w. Sound Quality"	10% : "More to annoyance than benefit"
23% : "Instrument has been broken"	20% : "Other: Feedback, mould and fitting"

Q18a: Have you searched for help in order to solve the above mentioned problems?
Yes: 73% No: 31% No Answer: 11%.
Q19: Do you feel that it is hard work to use your HA in everyday life?
1(Yes): 0% **2:** 10% **3:** 10% **4:** 10% **5(No):** 60%
No Answer: 10%

Social Life

Q20: Are you more encouraged to communicate while wearing your new HA?
1(Yes, more encouraged): 17% **2:** 17% **3:** 55% **4:** 2%, **5(No, less encouraged):** 4%. No Answer: 6 %

Q21: Does your family and friends show consideration to your hearing problems in one or more of the following ways?

20%: Eye contact- Lipreading
30%: Speaking clear and loud
12%: One speaker at a time
10%: Audibility
10%: Reduction of background noise
60%: No, no caution is taken

Q22: Do you feel that you are more or less social active after starting using your HA?

1(More active): 10% **2:** 10% **3(The same as before):** 70% **4:** 0% **5(Less active):** 0%

Q23:Do you regularly participate in the following activities?

70%: Small gatherings
50%: Meetings & lectures
30%: Active sport participant
40%: Social leisure activities
20%: Job related activities
10%: No, I do not regularly participate in any of these

Q23a: If you do not regularly attend activities - is it because your HA cannot solve your hearing problem?

Yes: 10% No: 30% I don't Know: 10 % No answer: 50%

Q24: Do you actively seek contact with other HA users (like membership of a users' association)?

Yes: 10%, No: 80% No answer: 10%

Acclimatization and instruction

Q25: If you cannot access controls on your HA mark here: 20%

Q25a: If you can - How often do you use these controls?

1(To a very high degree): 19% **2:** 7% **3:** 10% **4:** 10% **5(Not at all):** 11%
No answer: 15%

Q26: To which degree do you find your HA easy to use?

1(To a very high degree): 30% **2:** 20% **3:** 20% **4:** 10% **5(Not at all):** 10%
No answer: 10%

Q27: Did you receive adequate information about the use of your HA?

Yes: 83% No: 11% No answer: 6%

Q28: Have your HA been adjusted since they were dispensed?

Never: 45% 1-2times: 34% 3-5times: 12% 6-10time: 2 %
More than 10 times: 1% No answer: 6%

Q29: Have you been offered guidance/education for your life as a hearing aid user?

Yes, and taken: 20% Yes, but not taken: 18% No, not offered: 56%,
No answer: 6%

Q30: Have your family and friends been offered guidance/education?

Yes, and taken: 4% Yes, but not taken: 4% No, not offered: 86%,
No answer: 6%

Q31: Last time that you were seeking guidance for your hearing problems, did the professional you contacted understand your wishes and problems?

1(Not at all): 2% **2:** 5% **3:** 14% **4:** 22% **5(To a very high degree):** 41%
No answer: 16%

Q32: All in all how satisfied are you with your HA?

1(Not at all): 0% **2:** 10% **3:** 20% **4:** 30% **5(To a very high degree):** 40%

PRINCIPIAL COMPONENT ANALYSIS

A statistical tool called Principal Component Analysis was applied to analyze second order relations between variables. The shown result span two dimensions and show the dependency between questions as vectors in the coordinate system spanned by the two dimensions. The more parallel two vectors are, the more correlated the two answers are (provided the scales are in the same direction). The coverage of each dimension in percent, shows the validity of the analysis. (The higher a percentage the two dimension covers the more relevant the correlation are).

In Figure 1 five plots has been made where question 32 (Q32- in the plot named X32) about overall satisfaction are well represented on the first dimension while the second dimension are related to the questions of the five factors of the questionnaire. For the 5 plots described here dimension 1 covers from 24-36% of the variety, and dimension 2 from 14-22%. As it cannot be assumed that the dimensions are the same in all 5 plots, it cannot be concluded that if one question correlate with Q32, it also correlates with other questions that correlates with Q32 but in another plot. In the following, for all five psychosocial factors, correlations between the overall satisfaction will be described in text, and a graphical example will be given.

Correlations with primary focus on expectation

Q32 Overall satisfaction correlates with Q10 "To which degree can your current HA compensate for your hearing problem", and with Q11 that the hearing lives up to the users expectations. Also usage pr. day correlates somewhat with satisfaction. The scale for Q20 the interest in communicating while wearing hearing aid, is reversed, which means that also the desire to communicate correlates with overall satisfaction. The overall satisfaction does not correlate with Q16 The users expectations to use HA, which means that it does not seem to influence the satisfaction whether you are looking forward to use the hearing aid or not.

Correlations with primary focus on motivation

Overall satisfaction correlates with Q13 family and friends expectation and to some degree with the statement that using hearing aids is hard work (Q19) and usage pr. day(Q9). It is also interesting to note that it does not seem to have influence on overall satisfaction if the decision to use hearing aids has been taken by oneself or by another(Q17), the same applies to whether there was a positive bias towards using hearing aids before they were obtained(Q16). In general very few have indicated that they actively seek contact with other HA users,(Q24) and no correlation with overall satisfaction can be found.

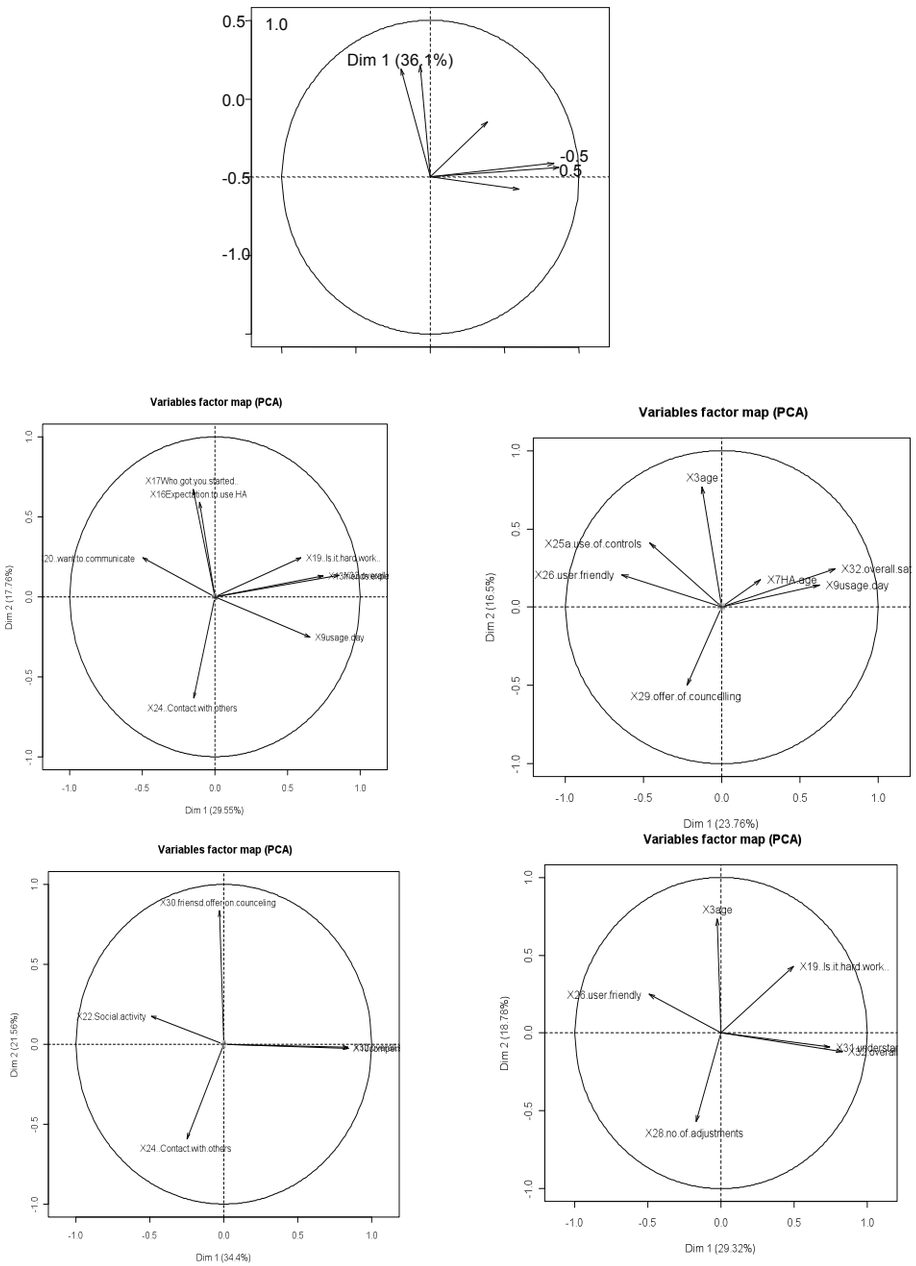

Fig. 1: Plots from Principal component analysis. "X32" refers to the question number from the questionnaire. In the text named Q32.

Correlations with primary focus on social life

The high correlation between Q12 telling others of hearing aid use and Q32 satisfaction is not very surprising as 91 % have told about their hearing problems. The scale of Q22 is reversed, showing that there is a tendency to be more socially active when the HA satisfaction increases. It is not possible to show that offering consultancy to friends and relatives (Q30) has influence on the hearing aid satisfaction, nor that the wish of social contact with others in the same situation correlates.

Correlations with primary focus on acclimatization

No correlation between Q32 overall satisfaction and Q3 age of user and Q28 how often the hearing is adjusted. High correlation between Q31 feeling understood by the fitter and Q32. The opposite direction of the arrow representing Q26 user friendliness, is due to reversed scales, so there is some indication that the easier the hearing aid is to use, the higher the overall satisfaction of the hearing aid.

Correlations with primary focus on instruction

Q32 Overall satisfaction correlates with Q9 usage a day and Q7 hearing aid age. The latter correlation might seem strange, but for the 40% first time users, the age of the hearing aid is proportional to the time they have used their hearing aid. Q32 correlates to a certain degree with Q26 user friendliness (reversed scale) and lesser degree with Q25a if user controls are used (reversed scale) and Q29 the offer of consultancy. It does not seems to correlate with the age of the user and use of controls.

SUMMARY

Generally, the PCA shows a number of expected correlations between overall satisfaction and hearing aid use, fitter empathy, expectation of improvement with hearing aid, and acknowledgement of the fact that using a hearing aid is hard work.

More interesting perhaps are the factors which do not seem to correlate, these are: Age of user, consultancy, who took initiative to the hearing aids and the question if users are looking forward to getting to use their hearing aids. Also 80% claim that commercials have no influence on their expectations. So it seems that satisfaction with hearing aids has nothing to do with age and who proposed the use of hearing aids but very much to do with the fitters skills, accepting the challenge of hearing aid use, and hoping/believing that a hearing aid will compensate the hearing loss.

Some expected correlations could not be shown in the statistical analysis such as the importance of counseling and the influence from commercials. Unfortunately it is hard to tell if these "missing correlations" are caused by the wording of the questions or a difference in the population answering the questionnaire versus the general population, or if it's because the connection simply isn't there.

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Acoustic simulation of cochlear implant hearing

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One aim in current cochlear implant (CI) research is to improve and optimize speech processing strategies. During the development of new strategies acoustic simulations of CI hearing have widely been used for evaluation. These models usually take audio signals as input and mimic the effects of CI signal processing. In the present paper a new algorithm of acoustic simulation is presented, which transforms stimulation patterns of any cochlear implant directly into an audio signal. Therefore it is independent of the CI strategy used for generating the stimulation pattern. Technical aspects like current spread and physiological aspects including loudness perception and phase locking capabilities of the simulated CI listener can be configured. The presented algorithm was used to evaluate and compare two different CI speech processing strategies in terms of speech intelligibility and pitch discrimination. The results show that acoustic simulation can help estimate the amount of useful information in a CI stimulation pattern and hence be a help in evaluating CI strategies.

INTRODUCTION

A cochlear implant (CI) is an electronic device to restore partial hearing in patients with severe to profound hearing loss. It bypasses the damaged part of the auditory system by direct electrical stimulation of the auditory nerve. Advances in the field of CI research over the last decades have resulted in good speech perception abilities of most CI users in quiet environments. However, speech recognition in noise and music perception still remain challenging.

One factor determining performance in CI users is the speech processing strategy (also called CI strategy), which translates sounds into electrical stimuli. Therefore several approaches aim to improve and optimize these CI strategies. Their evaluation is often performed with CI users in clinical studies, which can be very time-consuming and expensive. In addition, intra- and interindividual variability has to be taken into account. Consequently, a simpler way to evaluate and compare performances of CI strategies has to be found. One possible solution is the use of acoustic simulations of cochlear implant hearing. These simulations generate an acoustic sig-

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