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LEARNING HEARING AID PREFERENCES FROM KEY COMPLEX LISTENING SITUATIONS IN EVERYDAY LIFE

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ABSTRACT[*]

Individual hearing aid preferences can be investigated and estimated in several ways, by following comparative evaluation procedures in the lab, answering questionnaires about hearing experiences, psychoacoustic tests, real life comparisons and ratings (aka Ecological Momentary Assessment; EMA) and behavioral patterns just to name the most obvious ones in use in current fitting practice. In this study 29 experienced hearing aid users participated in a 4–6-week field trial using test hearing aids with two levels of noise reduction and two levels of high frequency amplification implemented as four programs. The participants were asked to evaluate all programs in their daily life and perform EMA at semi-regular intervals. The hearing aids also logged the acoustic context, program changes, and volume adjustments via the accompanying remote-control app. The data was logged as time stamped events to link ratings, programs, and context. At the end of the trial, all participants had the opportunity to update their ordinary hearing aids based on the experiences in the field trial. In this study we mainly focus on understanding the behavioral relationships between hearing aid settings, acoustic context, user ratings, and the individual preferences after the 4-week field trial.

Keywords: Personalized audiology, acoustic context, real world behavior, ecological momentary assessment

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1. INTRODUCTION

Precise fitting of a Hearing Aid (HA) is a key factor in achieving good outcomes with HAs. In this study we investigated if HA preferences for levels of HA technology can be explored as different programs in the HA together with data logging and EMA. We focus on two types of settting changes, those that directly impact the sound and those only change how the HA processes sounds in specific situations. Specifically, this paper focuses on personalization of two HA processes by investigating differences in Noise Reduction (NR) and differences in High Frequency (HF) gain. The two types of contrasts differ in direct audibility, e.g., a 2 dB change to HF gain changes the perceived timbre, while a 2 dB change to the NR threshold only changes the sound if the current sound was in-between the thresholds defined in the previous and current program. By allowing for individual adjustments of the NR threshold, this rule-based control of NR makes it easier to use the hearing aid, as it automatically removes noise in complex situations and automatically preserves all sounds in simple situations. However, it complicates personalization of such feature, as changing NR levels only occasionally results in a perceivable difference. This could explain why it has previously been found that HA users generally found that HF gain adjustments were more useful than NR adjustments except only in noisy situations [1]. Thus, taking general distrubution of sound environments and complexities as reported in [2] into consideration, we expect that HA users would find it easier to express preferences for HF gain settings than for NR settings.

2. PARTICIPANTS

Twenty-nine elderly experienced HA users with mild to moderate gently sloping and symmetric hearing loss took part in the study. De Videnskabsetiske Komiteer for Region Hovedstaden were consulted about the study and replied that the present study did not require notification and approval (FSP 21054594). Due to limited time, the app for collecting the data was only available for iOS, and accordingly only participants having a phone with iOS could be recruited.

3. METHODS

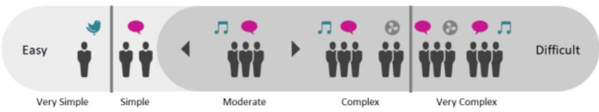

Figure 1: Adopted from Oticon’s hearing aid fitting software Genie 2, this shows the interface in which Hearing Care Professionals (HCPs) define the five levels of complexity where noise reduction kicks in. By pressing the arrows ◄ and ► the HCP moves activation of noise reduction towards easier or more complex situations. The darker shade and the arrows show where noise reduction is active.

The study investigated four standard HA settings available in Oticon More HAs through fitting with Genie 2 fitting software. Figure 1 shows the interface for adjusting NR and its relation to complexity. The adjustment of High Frequency gain was achieved by adding 4-6 dB gain in the gainmap for soft, moderate, and loud levels for frequencies above 1875 Hz.

Table 1: Overview of explored programs.

Program	**NR setting**	**High Frequency gain**
Default	Moderate	VAC+
HF+	Moderate	VAC+ with 4-6 dB HF gain
NR+	Very Simple	VAC+
NR+, HF+	Very Simple	VAC+ with 4-6 dB HF gain

The “Very Simple” NR setting means that the NR kicks in in easy environments. All participants received Oticon More HAs with amplification according to VAC+ and their audiogram with the four programs of Table 1 in random order. The default program was based on the most common NR level (Moderate) and the participants’ individual amplification according to Oticon’s fitting rational VAC+ and their audiogram. One program (HF+) differed in having 4-6 dB extra gain in high frequencies, another program (NR+) differed in having the “Very Simple” NR setting, and the last program (NR+, HF+) combined the two.
The study was a field trial (see Table 2), where Visit 1 was dedicated to fitting the HAs, and instructing the participants on how to try the different programs and report their findings using the HAs and the app. During the 4–6-week field trial period, participants had access to a special version of Oticon On remote control app on Apple TestFlight. The special version was developed internally according to internal regulatory processes for extending intended use of the HA to include the use of the special purpose app. They used the app to answer EMA questionnaires and change between the 4 programs. Participants left the study after Visit 2 which was a debriefing visit where the participants reported back on the use of the combined HA and app user interface, their experiences with the different settings and the relation to the situations they had been in. Authors LH and NP also presented individual analyses of the collected data to prompt an indepth discussion about experiences with the particpants. Because the participants expressed verbal preferences and reasoning for individual programs during Visit 2, they were given the opportunity to update the primary program of their own HAs with the preferred program from this field trial.

Table 2: Study protocol

Visit 1	Custom fitting of HAs with random order of programs from Table 1. Download of app Introduction on how to use the HA programs. Introduction to app and EMA.
Field trial	Participants used HAs for 4-6 weeks. Phone logged continuous data (SPL, SNR, program, and volume) from HAs. Participants were prompted to perform an EMA rating every 2 hours during “work hours”. Participants could initiate an EMA at own will any time.
Visit 2	Discussion between participants and about preferences based on their experiences and preliminary analysis of individual HA logging data by the authors. Participants asked if they wanted to update their hearing aid setting to one of the four programs.

4. RESULTS & DISCUSSION

After the field trial, 38% of the 29 particiants chose default as their new primary program, whereas 17% chose HF+, 17% chose NR+, and 28% chose NR+, HF+. Compared to other studies and our initial assumptions it is striking that the number of participants requesting NR+ and HF+ are remarkably equal. Based on previous research we would have expected participants to express stronger preferences for HF gain settings than for NR settings.

While EMAs were recorded together with the continuous logging data from the hearing aids, analysis has so far not revealed correlations between EMA scores and the preferred programs. The ongoing analysis of the EMA scores indicate a reflection of the complexity of the listening situations, so that easier listening situations result in a higher EMA score than complex listening situations. However, with despite recruiting 29 participants for 4-6 weeks, analysis of the data suggests that the number of EMAs for different situations and the different programs are simply too small to support this type of analysis. Especially, it seems that the key situations, e.g., the situations where HA processing really matters, are too few as has also been reported by [3].

We are therefore considering how we can instruct and encourage participants to provide increasingly more EMA ratings for key situations and how this can be achieved while also extending the coverage of the scenes in the CoSS framework [4] whilst keeping the user interface simple.

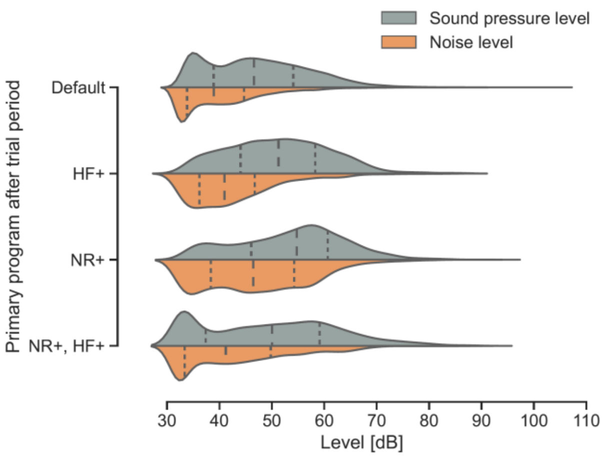

Figure 2: Statistical distribution of sound pressure and noise levels according to the primary program chosen after the trial period. The vertical bars in the violin plots indicate the 25%, 50%, and 75% percentiles.

Figure 2 shows the analysis of the sound environments that the participants have been experiencing as a function of the program they prefer after the field trial. The data indicate that the situations that participants have experienced influences their preferred program. It indicates that those preferring NR+ are in louder sound environments, with the loudest background noise; that those preferring HF+ are in less loud environments, and far less noisy environments than the those preferring NR+. Finally, the ones preferring NR+ and HF+ have a more varied sound environment.

5. CONCLUSION

While the data and analysis presented here does not represent definitive finding about personalized preferences and the interaction with key listening situations experienced in everyday life, it does suggest that there is more to be learned about the relation between HA settings, key situations, and preferences. In particular, we found an equal degree of preference for NR and HF gain adjustments, which we had not anticipated from previous literature.

While we collected EMA responses from the participants, we have not found a direct link between the contextual responses and the preferences expressed by the participants. This is statement holds for both NR or HF.

6. ACKNOWLEDGEMENTS

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