

# Survey on the Potential of Additional Modalities for Hearing Instruments

Bernd Tessorf, Daniel Roggen, Thomas Stiefmeier, Gerhard Tröster

Wearable Computing Lab., 8092 Zürich, Schweiz, Email: {lastname}@ife.ee.ethz.ch

Peter Derleth, Manuela Feilner

Phonak AG, 8712 Stäfa, Schweiz, Email: {firstname.lastname}@phonak.ch

## Introduction

Hearing instruments (HIs) analyze the acoustic environment to automatically adapt to the user's current hearing need. Recently, it has been shown that the automatic adaption can be improved by enhancing HIs with additional modalities [1, 2]. Potential additional modalities include the user's body movement, their gestures and location, or vibrotactile feedback. To this end we address in this paper the following research questions:

1. In which situations would HI users benefit from improvement by enhanced context awareness using multimodal sensors?
2. Which additional modalities would HI users accept and are, thus, available to enhance HIs?

## Questionnaire

To address the research questions stated above we conducted a survey among 80 HI users in the area of Basel and Zurich, Switzerland. We used a paper-based questionnaire of four pages and also provided the opportunity to fill out a web-based questionnaire online. Besides the closed questions we also gave the opportunities for feedback by open questions.

## Related Work

In the MarkeTrak studies [3] regularly surveys of the US hearing-loss population demography are presented. In [4] a survey among HI users to investigate the benefit and acceptance of automatic hearing program selection is given.

## General Findings

The group of study participants was balanced across both sex (51% male, 49% female) and the three age groups 45–64, 65–74, and 75+ as depicted in Table 1. A share of 86% of the respondents wears two HIs, the remaining one HI. The majority (89%) preferred the paper based questionnaire over the online variant. A share of 51% of the participants was interested in participating in follow-up studies to evaluate new technologies. This willingness to cooperate represents a potential for future user-centric HI research.

Age group [years]	20–44	45–64	65–74	75+
Share	4%	28%	35%	33%

**Table 1:** Distribution of age of the participants of the survey.

## Identification of Relevant Situations

### Traffic

Participating in traffic is not only a situation concerning comfort but also safety. Improvement in this area would support especially elderly people to freely move outside to take part in daily life. 48% would appreciate more support from the HI in traffic situations in general.

As pedestrians 45% state that they have difficulties in locating cars just by hearing. 24% cannot perceive warning signals like car horn or siren sufficiently.

A share of 81% answers that in cars they perceive well car sounds, e.g. the engine rotation speed. 42% state that they have difficulties with conversations with fellow-passengers.

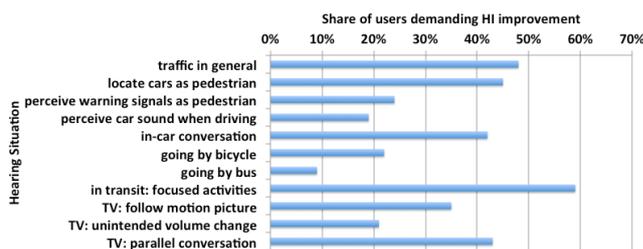
As bicycle riders 22% of the HI users experience difficulties in hearing when they go by bike. The airstream is indicated as the major disturbance here. However, 53% of the respondents, which are often elderly HI users, never go by bicycle at all.

### Transit

91% of the participants are in general satisfied with their HIs when they go by bus. When the HI users want to focus, e.g. when reading a newspaper concentratedly in a train, 59% feel disturbed by surrounding conversations, as the HI adapts to undesired speech present in the environment. This is an example for the so called ambiguity problem [2]. 24% state that they need to switch off their HI manually as a consequence.

### Watching TV

TV is a frequent activity for elderly people and given as the second important hearing activity right after conversations. People often remove the HIs and use headphones instead to follow the TV programme at a high volume. However, this approach works only for watching



**Figure 1:** Overview of hearing situations and the share of users demanding HI improvement.

TV alone, amplifying social isolation of elderly people. 43% answer, that the HI does not support them sufficiently when having a parallel conversation. 35% answer cannot follow well motion pictures, e.g. crime movies. 21% experience unintended changes in volume of the HI during watching TV.

### Miscellaneous

As a result from open questions people would appreciate more support from their HI in the theater and restaurants (cocktail party problem) and also in special situations, e.g. when playing an instrument or giving music lessons as a teacher. Fig. 1 gives an overview of hearing situations and the share of users demanding HI improvement.

## User-Acceptance of Additional Sensors

### Wristwatch

A special wrist watch could embody wireless sensors to support context recognition. However, 34% of the respondents would never wear such a device and 52% only if it results in a very strong improvement of the HI performance. Some respondents commented that they would only wear the wristwatch if it was exactly their taste and that it is also a matter of costs. Wristwatches are personal belongings that are more an accessory than a device with just a function. This explains the observed rejection of special wristwatches.

### Mobile Phone

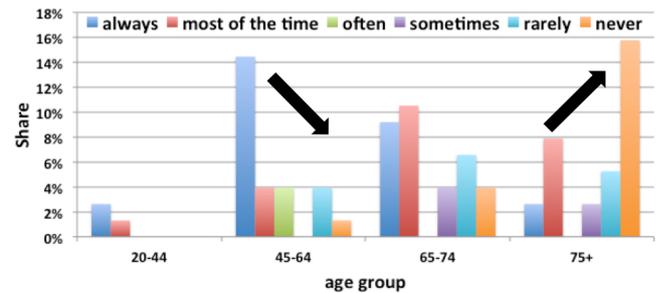
Mobile phones feature a rich set of sensors as well as wireless connectivity and are a promising novel complementing information source for hearing instruments. A share of 28% of the respondents always carry their mobile phones, 24% most of the time. Fig. 2 depicts the availability for the three age groups in detail. There is a clear trend that younger age groups carry the mobile phone more often than elderly as indicated by the black arrows in Fig. 2. 64% don't have concerns to leverage their phones for the HI, 24% are not sure and demand more information to decide, and the remaining part doesn't want the phone to communicate with the HI. Thus, mobile phones represent promising devices to enhance HIs.

### Vibrotactile Feedback

A part of the respondents demanded more support for orientation, especially for localization of sound sources. 83% stated it to be beneficial or very beneficial if the HI would indicate the direction of a sound source through vibration. 65% found it good or very good if the HI would vibrate in case of a safety-critical situation, e.g. an approaching car from behind. 48% like the idea much or very much to use vibrotactile feedback to confirm changes when operating the HI manually with the buttons; 23% rated this approach as moderately useful. Thus, enhancing HIs with vibrotactile feedback shows potential from the user side.

### Battery Run Time

Run time is critical as replacing batteries is cumbersome for HI users as confirmed by open feedback. A share of 31% don't tolerate any reduction in run time, 59%



**Figure 2:** Availability of mobile phones for different age groups in detail.

would accept a decreased run time if there was a strong improvement in HI performance. Battery run time is critical and HI user don't want to sacrifice on that.

## Conclusion

We identified activities and locations in which users demand more support from their hearing instruments. Concerning implementation aspects of enhanced HIs we found special wristwatches are not accepted by the users but mobile phones are very promising. Moreover, the integration of sensors into the HI itself is an option as long as the battery lifetime, which HI users consider as a critical factor, is not sacrificed.

For interpretation of the results we need to consider that only people who use a HI were asked. Hearing impaired who are unsatisfied and do not use a HI, were not asked as they do not visit an audiologist. Thus, our results represent an upper boundary regarding user satisfaction.

## Acknowledgements

The authors gratefully thank the collaborating acousticians for their support, namely Hörberatung Basel and Hörberatung Zürich, Switzerland. This work was part-funded by CTI project 10698.1 PFLS-LS.

## References

- [1] B. Tessorf, A. Bulling, D. Roggen, T. Stiefmeier, M. Feilner, P. Derleth, and G. Tröster, "Kontexterkennung für Hörgeräte mittels zusätzlicher Sensormodalitäten," in *37th Annual Convention for Acoustics (DAGA)*, 2011.
- [2] —, "Recognition of hearing needs from body and eye movements to improve hearing instruments," in *International Conference on Pervasive Computing*, 2011.
- [3] S. Kochkin, "MarkeTrak VIII: 25-year trends in the hearing health market," *Hear Rev*, vol. 16, no. 10, pp. 12–31, 2009.
- [4] M. Büchler, "Nützlichkeit und Akzeptanz einer automatischen Programmwahl in Hörgeräten," in *27th Annual Convention for Acoustics (DAGA)*, 2001.