
HearU: An Integrated System to Raise Awareness of Hearing Loss

Beijia Wang

University of Washington
Seattle, WA
Beijia@uw.edu

Mengxiao Song

University of Washington
Seattle, WA
Mxsong@uw.edu

Yuting Han

University of Washington
Seattle, WA
Yhan1995@uw.edu

Duo Wang

University of Washington
Seattle, WA
Victordw@uw.edu

ABSTRACT

Hearing loss is a prevalent public health crisis that often goes unnoticed in public eye due to its invisibility. People who are hard of hearing (HH) often experience social isolation caused by the lack of understanding from the hearing community. Our research revealed that there is a communication gap between the hearing and HH communities. The current state of art tends to focus on assisting HH people to participate in conversations, which places more responsibility on the HH community. There is a lack of responsibility of people in the hearing community. However, communication works in two directions; it requires both parties to take responsibilities. In this paper, we present HearU - an integrated, multichannel system that includes public interaction. Through the creation of an immersive experience that increases people's awareness of hearing loss, we aim to use HearU as a medium to weave these two communities together as a whole.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland Uk

© 2019 Copyright is held by the owner/author(s).

ACM ISBN 978-1-4503-5971-9/19/05.

<https://doi.org/10.1145/3290607.3309693>

KEYWORDS

Hearing Loss; Public Awareness; Visualization; Social Interaction; Invisible Disability; VUI; Interactive Interfaces; Communication

“Yes, hearing aids will benefit you...but you need to understand there are many situations where you might feel that they're not doing enough for you, because you're still not catching everything. You're not understanding everything.”

“What happens is, the person will often complain, I can hear, because they're hearing the lower frequency sounds of speech, but I can't understand. But normal hearing people don't know this. I mean, it's hard for them to even understand it.”

“With hearing loss, it doesn't just impact the person that has it, it impacts everyone around them...people don't necessarily know you have hearing loss, right? Hearing loss is not always visible. Even when it is visible, because a person is wearing hearing aids/ cochlear implants, it doesn't mean that you understand the degree of their hearing loss and the impact that it has on communication. it just becomes kind of a mess. Because people don't necessarily want to say, Oh, I have hearing loss.”

Figure 1: Quotes from an audiologist

1 INTRODUCTION

Hearing loss is one of the most prevalent public health crises given the significant physical and psychological repercussions on adults. Approximately 15% of adults (37.5 million) in the United States aged 18 and over reported having trouble hearing [1]. Despite its prevalence, hearing loss is often referred as an invisible disability [2], going unnoticed in the public eye. People who are hard of hearing (HH) often experience emotional frustration due to the negative impact of communication. As communication become more challenging, it could lead to social isolation [3]. The goal of this project is to increase public awareness of hearing loss through a design intervention. We hope to improve the quality of communication between communities; people who are HH and people with normal hearing range (250 – 6000 Hz).

The approach to hearing loss management mostly focuses on facilitating HH people participation in conversations. But communication works in two directions; it requires both parties to take responsibility. The emphasis on assistive tools for people who are HH and the lack of attention on raising public awareness towards hearing loss motivated us to explore the existing communication gap between the hearing and HH communities. Furthermore, we found a desire from HH community for the hearing community to better understand hearing loss and to better grasp basic tactics of communicating with HH people.

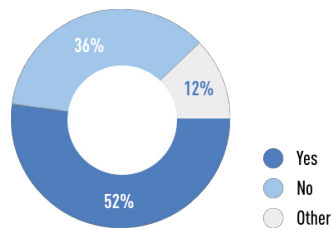
Based on our findings, we propose HearU — an integrated system that equips people with basic tactics that can improve their conversations with HH people. We envision HearU as a bridge that brings the hearing and HH communities closer together.

2 INITIAL RESEARCH

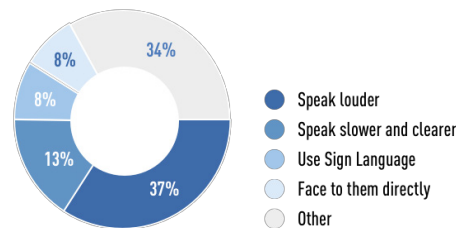
To understand the current state of hearing loss and existing solutions to communication barriers, we reviewed literature and conducted a competitive analysis. Most existing products focus on using technology to help HH people's hearing, for example, by providing hearing aids to amplify sounds [4]. However, these products are not always accurate or effective enough to give HH people expected autonomy [Fig.1](#) [5]. From our interviews with an audiologist at the University of Washington Speech and Hearing Clinic (UWSHC), HH people feel uncomfortable and frustrated when interacting with the hearing community for two main reasons: 1) a HH person's personality, especially their willingness to share information about their hearing loss; 2) the hearing community's lack of understanding about hearing loss when interacting with HH [Fig. 1](#).

Based on the initial research, we were surprised by the dearth of studies on the discomfort and the role of hearing people, especially since communication is a two-way phenomenon. To develop a better understanding of the current communication challenges and frustrations, we decided to understand this problem space from perspectives of both people who are hearing and HH.

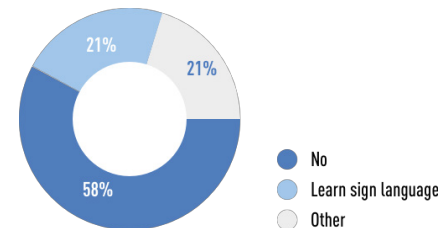
2.1 From the Hearing Community



Was your behavior changed after learning he/she has hearing loss? (58 out of 60 responses)



What would you do to better communicate with hard of hearing people? (60 out of 60 responses)



Do you know any existing resources to understand the hearing loss population? (45 out of 60 responses)

Figure 2: Survey results from Hearing community

We developed an online survey that focused on individuals' awareness of hearing loss and their interactions with the HH people. The survey was distributed in college forums and social network platforms. Sixty responses were received in total. Only half of the participants reported changing their behavior upon learning about a person's HH [Fig. 2](#). More than one-third of the participants said they would speak louder to improve communication quality [Fig. 2](#). Because speaking louder provides volume but not the clarity HH people needs [\[6\]](#), it might work counterproductively. Speaking slower and clearer, or facing people directly during the conversation are some of the proven tactics for improving the quality of communication [\[7\]](#), but only around 16% of participants specified that they used these techniques. Also, around one-third of the participants had no idea on where to find resources to learn more and better understand hearing loss [Fig. 2](#).

A focus group was held with four hearing people who are the primary communication partners of people who are HH. The major insight we discovered was that unsuccessful communication frustrates hearing people too, which aligned with our findings in the secondary research. Hearing people feel guilty for not being able to do more, but they also cannot fully understand the experience of people with HH [Fig. 3](#).

2.2 From the Hearing Loss Community

A focus group was held at the UWSHC. Five people with different levels of hearing loss (three with cochlear implants and two with hearing aids) participated in the study. All of them have been living with hearing loss for more than ten years and have been taking classes with the audiologist to improve their communication skills.

The focus group confirmed our findings from the secondary research that HH people struggle to advocate for themselves in a conversation. The top three reasons for this are 1) embarrassment about their hearing loss, 2) fatigue from informing others of their hearing loss repetitively and 3) being in denial of their hearing loss. Not advocating for themselves about their situation in a conversation usually frustrates both parties and leads to further social isolation for people who are HH. Using technology alone does not give them the autonomy they are seeking. They are still struggling in public spaces (e.g. restaurants, airports) and even when they advocate for themselves, they still experience discomfort. Overall, all participants felt frustrated and left out by the hearing community because of the public's lack of understanding about hearing loss.

In summary, people from both communities are unsure about how to communicate around hearing loss. HH tend to take more responsibility in the conversation [Fig. 4](#) while there is also room for improvement that can be rendered possible by the hearing side. Inspired by these findings, we decided to proceed in the direction of generating ideas for increasing public awareness of hearing loss to bridge the communication gap.

3 INITIAL DESIGN

A brainstorm session was held to generate ideas. Four design rules of thumb were developed from the initial research to better evaluate these ideas: 1) make the design simple to allow users to

“I have no idea what the hearing loss was... finally, at one time, I put on a pair of hearing aids, and I immediately understood when my wife would tell me I don't need to get louder, I need to be clearer.”

Figure 3: Quotes from the hearing focus group

“Communication is two ways, but I still take too much responsibility for the communication.”

Figure 4: Quotes from the HH focus group



Figure 5: Design Inspiration - Climate on the Wall, ©Peter Dalsgaard, Kim Halskov

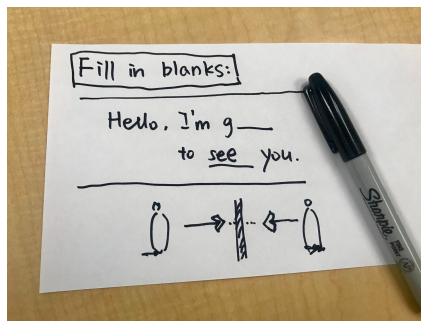


Figure 6: Design Sketch – Fill in the Blanks

grasp the meaning of the design quickly; 2) capture users' attention rapidly to provoke immediate interactions with the design; 3) make the experience immersive to have a substantial impact on users' understanding of hearing loss; 4) create a platform to effectively connect the two communities together. Based on these criteria, ideas were ranked from the best to the worst, and different idea combinations were made to form the initial design.

3.1 Design Decisions

First, we chose to use an interactive display as a part of our design solution. This is inspired by “Climate on the Wall” [Fig. 5](#), an interactive projection on a city center building wall that encouraged people's participation in forming climate statements [\[8\]](#). It is found that such displays have significant potential in promoting awareness to others outside the community and sharing content that people have in common within the community [\[9\]](#). This aligned with our project goal and motivated us to move in the direction of designing an interactive public display.

Second, we gleaned insight from people's experiences as a foundation for the interactive display. From focus groups, we found that both parties consider the best way to understand hearing loss is through actual personal experience. HH tend to experience hearing fatigue [\[10\]](#). This causes them to take in incomplete sounds, which feel like filling in the blanks in a sentence. Thus, we decided to visualize this by showing a complete sentence breaking into pieces [Fig. 6](#).

Third, to provoke an immersive and learning experience, the instructions on the display are written in the first-person view. Vocal interaction was chosen for its simplicity which aligned with our first design rule of thumb. It also helps simulate what a conversation is like with HH people.

3.2 Design Process

We designed the “fill in the blanks” tasks that first prompt the user to speak out the sentence shown on the display. The display shows the broken sentence while playing back the user's voice that has been filtered with muffled sounds to match the missing letters in the sentence. To make the task more meaningful, we also embedded tactics that can improve the conversation quality when interacting with HH people. For example, the display informs the user why speaking louder is the wrong way by prompting the user to do it first. Actual quotes and more information are shown at the end of the task to build a personal touch [Fig. 7](#).

As a tool for awareness, the public display would only capture people's attention for a short amount of time, so we decided to evolve the design from the interactive display into an integrated system. The system contains a display with a website to enable more organic interactions between the hearing and hearing loss communities. The website allows HH people to share their personal experience with the hearing community to further enhance people's awareness.

4 CONCEPT TESTING AND ITERATION

To test our design concept, we created a mid-fidelity digital prototype and conducted a Wizard of Oz study. We used a 55” TV to imitate the real size display. The test was held in a quiet studio



Figure 7: Fill in Blanks example & actual quotes

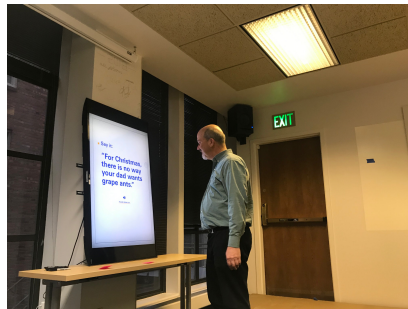


Figure 8: Concept testing in the studio

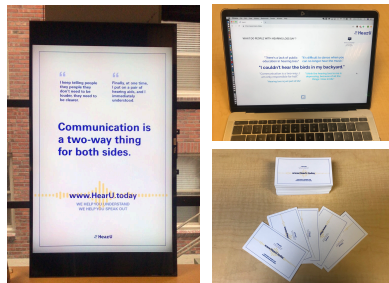


Figure 9: Final Design

on a main street near the University of Washington, so it was easier for us to invite passersby to our study [Fig. 8](#). When testing, we provided participants with a simple scenario: “You are waiting for your friend in front of the school library, and you saw the interactive display near the entrance and decide to check it out.” Participants were encouraged to apply a think aloud method to describe what they saw, the interactions they wished to have, and most importantly, their awareness of the integrated system’s purpose. We started each test by playing the “fill in the blanks” task video while observing participants’ interactions. After the participant spoke out the required sentence, we played the pre-prepared audio recording. A debrief session was held to uncover their thoughts on the design concepts and whether they became more aware of the HH community.

Intrigued by the display, all participants were able to complete the task and figure out the purpose of the design. Some participants thought the design was a pronunciation test until the final page showed up, but they didn’t consider the initial confusion to be an issue. Some participants tried to touch the screen at the beginning of the task before realizing it was not a multi-touch interaction. This might be due to the interface’s limited fidelity level. Our design also revealed that showing the website address alone at the end of the task screen cannot motivate participants to take out their phone and check out the website. More incentives are needed.

Design iterations were conducted based on the testing feedback. To emphasize the vocal aspect of the interaction, we used real-time sound wave animation instead of the circle horn icon. We also brainstormed on the incentives for motivating users to visit the website on their phone. As a result, physical information cards with the website address were added to the HearU integrated system. This added layer of the physical product experience on top of the vocal-visual interaction experience heightened/improved portability and convenience. We also enhanced the website content by adding the key feature of the “fill in the blanks” experience - the hearing loss imitator.

5 FINAL DESIGN

The final design HearU includes three parts: an interactive display, physical information cards, and a website. Further details are as follows:

Interactive display: the display will be placed in public quiet spaces, such as public libraries, and teaching buildings in universities, where people are able to have vocal interaction and are likely to pay attention to a display. Each time, the “fill in the blanks” task will randomly select from three existing modes: speak slower, speak louder, and change position. Each mode starts with a playful vocal interaction that asks people to read a funny sentence, and then processed voice feedbacks are provided together with visualized prompts. Quotes from the HH community and a website containing further information will be shown at the end of the task [Fig. 9](#).

Physical information cards: these cards are printed in standard business size and placed together with the interactive display. These cards are easy to carry, allowing people to check for more information from the website with convenience [Fig. 9](#).

Detailed Website: the website includes four main functional areas: 1) quotes from the HH

“I know when I think about say my mom who’s got hearing loss, I wonder what she’s hearing and not hearing. So, I think a lot of people know someone and would be interested in it. This (design) isn’t a lesson, here’s what how many people have hearing loss every year. This is, you know, this is what their experience is like, that kind of elements is something that I’d be curious about.”

Figure 10: Quote from concept testing

ACKNOWLEDGMENTS

We appreciate the support from University of Washington Speech and Hearing Clinic, especially Lisa L. Illich, M.C.S.O./ Senior Lecture.

The University of Washington institutional guidelines is not applicable for this study due to this is a student side project outside the degree program. However, we had obtained consents from all of our participants prior to the study and we appreciate their participations.

Thanks to Meira Chefitz, Koray Benli, Matt Bartels, Amanda Swearngin, Andrew Ko, Audrey Desjardins and Richard E. Ladner for their comments on a draft of this paper. Thanks also to Michael Smith and Jon Froehlich for their comments and suggestions on our earlier design prototypes.

community; 2) a message box that enables people from two communities to share thoughts with each other; 3) communication tactics about hearing loss to further enhance people’s awareness; 4) a hearing loss simulator that extends the interaction of the interactive display [Fig. 9](#).

6 CONCLUSION AND FUTURE WORK

HearU is an integrated system that aims to raise public awareness of hearing loss as well as create a platform for the HH community to speak out for themselves. From concept testing, all participants expressed that they began to get a sense of what experiencing hearing loss feels like after interacting with our design. They also reported their awareness towards hearing loss had been increased and it made them think about people affected by hearing loss close to them. One participant felt a little bit sad after interacting with display because it reminded him of his mom who had hearing loss. Through our design, he started to understand what his mom was experiencing. He wished he had known her feeling at that time, which would have enabled him to communicate with her mom in a different but more effective way [Fig. 10](#). Another participant found the communication tactics he learned to be helpful, because he never thought that speaking louder could work counterproductively in a communication.

Due to time limits, we only had a chance to test with the hearing community for our concept design. For future work, we will seek collaboration opportunities with organizations such as Hearing Loss Association of America. Our next steps include: 1) make a video prototype and conduct qualitative study with people from both communities, especially from the HH side; 2) we will iterate our design based on the insights from the qualitative study and construct a high-fidelity prototype; 3) we will install the prototype in a public place and conduct further study to evaluate our design impact.

REFERENCES

- [1] Blackwell, D. L., Lucas, J. W., & Clarke, T. C. (2014). Summary health statistics for US adults: national health interview survey, 2012. *Vital and health statistics. Series 10, Data from the National Health Survey*, (260), 1-161.
- [2] Davis, N. A. 2005. Invisible disability. *Ethics*, 116(1), 153-213.
- [3] Vas, V., Akeroyd, M. A., & Hall, D. A. 2017. A data-driven synthesis of research evidence for domains of hearing loss, as reported by adults with hearing loss and their communication partners. *Trends in hearing*, 21, 2331216517734088
- [4] Cox RM, Johnson JA, Xu J. 2014. Impact of advanced hearing aid technology on speech understanding for older listeners with mild-to-moderate, adult-onset, sensorineural hearing loss. *Gerontology*. 60(6):557-568. doi:10.1159/000362547.
- [5] Kochkin, S. 2000. MarkeTrak V: “Why my hearing aids are in the drawer” The consumers' perspective. *The Hearing Journal*, 53(2), 34-36.
- [6] Salorio-Corbetto, M., Baer, T., & Moore, B. C. 2017. Evaluation of a Frequency-Lowering Algorithm for Adults With High-Frequency Hearing Loss. *Trends in hearing*, 21, 2331216517734455.
- [7] Marilyn E. Demorest and Sue Ann Erdman. 1986. Scale Composition and Item Analysis of the Communication Profile for the Hearing Impaired. *Journal of Speech Language and Hearing Research* 29, 4: 515–535.
- [8] Dalsgaard, P., & Halskov, K. 2010. Designing urban media façades: cases and challenges. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2277-2286). ACM.
- [9] Taylor, N., & Cheverst, K. 2012. Supporting community awareness with interactive displays. *Computer*, 45(5), 26-32.
- [10] Rubin, H. J., & Rubin, I. S. 2011. *Qualitative interviewing: The art of hearing data*. Sage.