

Modern Communication Technology, Assistive Technology, and Hearing Impairment: How Do They Go Together?

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Abstract. This work sheds light on the experiences of hearing-impaired individuals with communication and assistive technology nowadays, primarily for the contact with public entities, including the health sector. We used an online survey and 12 in-depth interviews to collect statistics and narratives and analyzed the answers. Our findings draw a picture of technology as an enabler and lifesaver with a number of weaknesses, both technical and non-technical. Areas of improvement include the universal design of technical solutions, user journeys for users of assistive technology, technical installation and setup of public and private infrastructure, instructional and educational training, and others.

Keywords: Hearing loss, ICT, AT, public administration, barriers

1 Introduction

More and more of today's societies are to a great extent digital. Communication, be it of private nature or with public entities and administration, is often relying on online services and digital tools. This trend has increased further with the Covid-19 pandemic.

Hearing loss, while being an invisible impairment, is wide-spread in most societies. There are different definitions of "hearing loss" and different statistical approaches of how to quantify it. The estimate for Norway is that roughly 36% of the adult population are affected by hearing loss, which compounds of 20% with a mild impairment and 16% with a moderate or severe impairment [1]. The WHO state that currently more than 5% of the world's population require rehabilitation for a "disabling" hearing loss [2]. The trend is rising, as this number is expected to increase to more than 10% by 2050 [2].

In this work, we focus on the intersection of topics communication technology, assistive technology (AT), and hearing loss in the context of individuals' contact with public entities and the health sector. AT can in turn be viewed as a subset of communication technology. Questions that have guided our research are: How do individuals with hearing loss communicate by means of digital solutions? What are their technological needs, expectations, and preferences? What recent experiences do they have with various communication systems and assistive technology? What are

good solutions? What areas of improvement do exist, and what technical (and other) barriers do they encounter?

This work partly confirms previous research and partly adds new details to the overall picture. Its main contributions are novel knowledge regarding the effect of meeting and conference tools for this user group, in particular the advantages of image and video, high-quality audio, sometimes enhanced further by additional microphones, media recording and archiving, as well as of captioning. Another important contribution of this study is to view technology in a greater perspective and in the light of related areas such as AT, installation and setup, instructional training, technical support, organization and administration, as well as consequences of the Covid-19 pandemic.

The work received funding by The Norwegian Directorate for Children, Youth and Family Affairs (Bufdir). Its results were originally published as two scientific reports (both in Norwegian): One covers the in-depth interviews [3], and the other presents the survey and contains the overall discussion of results [4]. The remaining work is straightforward. After the description of the methods used, we present and discuss findings from different data sources before the work concludes.

2 Methods

In order to answer the aforementioned questions, we have used a mixed-method approach.

An online questionnaire with in total 20 questions was sent out in June 2021 to members of the Association of the Hearing Impaired in Norway (HLF). As a quantitative method, the survey's objective was to overview the area and get indications of problematic areas. The answers were subject to a plain descriptive statistical analysis [5]. Almost 380 respondents between 18 and 90 years answered our questions, with an average of 50 years and an approximated normal distribution of ages. It is underlined, however, that the number of answers for each question varies as the applicability of subsequent questions for a particular respondent depends on his / hers previous answers. The use of hearing aids prevails by far (94% occurrence), while the list of other technical solutions with a substantial usage includes hearing loop (T-coil) and Bluetooth streaming (combined 90% occurrence), various microphones (15%), cochlear implants (CI, 6%), and speech-to-text systems (6%). Additional ATs in use are smartphone apps, fire alarms, door bells, alarm clocks, sound streaming units, and a few others. Written interpreters are utilized by 11% of the respondents.

Next, we conducted 12 in-depth interviews with individuals with a hearing impairment, seven women and five men. The informants were recruited from members of the HLF. The aim of this qualitative approach was to focus on individual experiences and narratives, to collect user voices, and to supplement the picture drawn by the online questionnaire. The interviews were conducted either through phone or video call, transcribed, anonymized and then underwent a thematic analysis [6]. The population was on the average 60 years old, with the youngest being 24 and the oldest 83 years. One informant rated their technical skills as low, seven as medium, and four as high.

3 Results & discussion

Subsequently, the findings from both data sources are presented and discussed jointly.

The following communication solutions have been mentioned by the survey respondents (N=378) for contact with public entities, see Table 1. Multiple checkbox ticks were possible. In the “Other” category, the respondents bring up meeting and conference apps like Microsoft Teams and Google Meet, as well as social media. Besides the technical solutions, some have also noted that they prefer physical meetings, a result which is confirmed by a great share of interview informants.

Table 1. Answers to the question what communication technology is in use for contact with public entities.

Answer option	Share
Phone	70%
Web solution	70%
E-mail	58%
SMS	33%
Chat, including chatbot	25%
Other	4%

The bottom line is that people want to use and actually use multiple and preferably text-based solutions. The phone’s high popularity can be explained by the fact that, for many, hearing aids in combination with streaming technology / T-coil, and possibly (written) interpreter services gives a sufficient solution, particularly for shorter conversations. This result is confirmed in the interviews. The surprisingly high rating of SMS may to a great extent be due to public entities sending out confirmation and reminder text messages, but that is only a guess. It nevertheless shows that SMS as a technology is important to a significant share of respondents and should hence not be neglected.

Asked for how satisfied they are with technology in the communication with public entities in general, approximately half of the respondents (N=359) answered to be either satisfied or very satisfied, while 30% answered neutrally. See also Figure 1 (left).

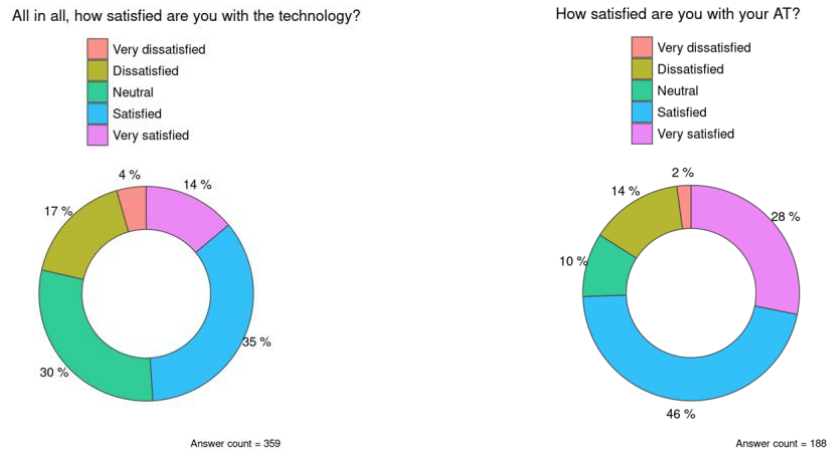


Fig. 1. Pie diagrams detailing the share of answers to the question regarding how satisfied the respondents are with technology in general (left) and assistive technology (right).

If a binary decision is enforced by splitting neutral answers equally into positive and negative sentiments, the result is a majority (64%) of those who are satisfied, while 36% are dissatisfied. Given the fact that the share of those at least satisfied (49%) is more than double of those at most dissatisfied (21%), the overall message here is that the respondents in general have mostly positive experiences with technology. This impression is further confirmed by the answers (N=188) to the question regarding the respondents' satisfaction with AT, see Figure 1 (right). Here, in total 74% said they are satisfied or very satisfied with their AT, which in the given context primarily refers to hearing aids. 16% are dissatisfied or very dissatisfied, while 10% voted for neutral.

The answers to the following two questions, combined with what the informants said in the in-depth interviews, may explain the considerable amount of dissatisfied respondents. Asked for what kind of technical problems they have experienced, a significant share ticked the checkboxes at several of the available answer alternatives, see Figure 2 (left).

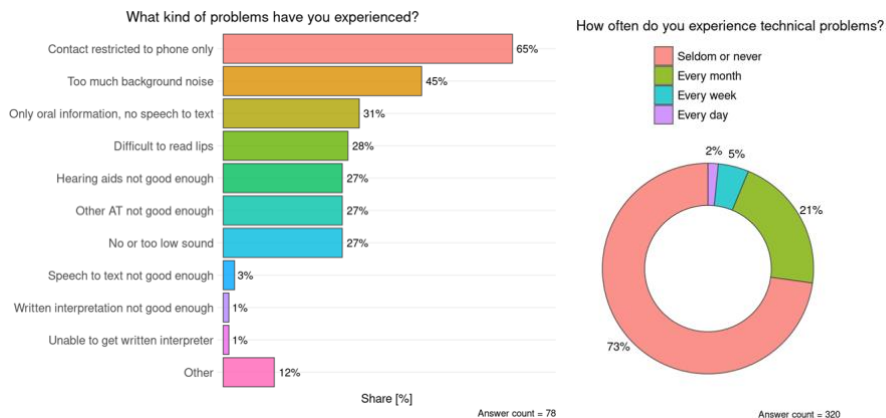


Fig. 2. Bar and pie diagrams detailing the share of answers to the question regarding what kind of problems the respondents have experienced (left) and how often they experience technical problems (right).

Considering AT and related infrastructure, many, in particular elderly, do not know how to use their devices properly, even after many years of use. This points at too complex user interfaces and operation and to a lack of universal design of these devices. Also, hearing aids may not be working optimal in a particular context, such as concerts or seminars. Particularly one-to-many conversations and sounds coming from behind were identified as problematic areas. Others complained about insufficient amplification, amplification of unwanted sounds and noise, and insufficient noise cancellation. Some hearing aids lack T-coil or Bluetooth support, which is viewed as a considerable disadvantage by the majority of informants. It also happens that users do not know whether their devices have support built in, let alone how to use it. Some manufacturers of hearing aids provide mobile apps to control them, and the user interface of these apps may be experienced as too complex, particularly by elderly users. The informants also gave various examples of T-coils not being properly installed or set up or simply not turned on, which of course renders hearing aids with T-coil support useless. The problem of a potentially wrong installation, setup, and operation also applies to fire alarm systems for the home and for hotels. The simultaneous use of many different components / devices and their inter-connection may be difficult to accomplish and cumbersome, partly due to the necessity to manage and organize all these devices with various cables, batteries, instruction manuals, and so on, and partly due to closed and proprietary vendor solutions that cannot be combined.

Also when it comes to generic communication technology, many narratives about technological challenges can be found in the experiences of the informants. The sound / audio in meeting and conferencing apps may be of poor quality due to the lack of insufficient noise cancellation, participants being too far away from the microphone, distortion due to microphone overdrive, a bad internet connection, or because of the lack of support to connect the PC or tablet PC directly to the hearing aids, to name a few. As the vast majority of people with a hearing impairment are lip readers, the

quality of visual information is of particular importance. Here, the list of potential technological obstacles includes according to the informants too small video, a poor image quality, frozen video or video which is not in sync with the audio, all of which may make lip reading challenging or impossible. Next, many informants brought up the lack of integrated captions in digital conferencing applications as an area for improvement. At the time of writing, such functionality is available in many solutions, but not all, and not always in all languages. Also, this functionality is quite new, so on the one hand the knowledge about it and how to use it appears to be limited. On the other hand its quality is often experienced as poor still, particularly in languages like Norwegian with many dialects. Recording meetings got many positive remarks, but informants suggested making it “on” by default, such that they always get the possibility to listen to the recording or parts of it later on.

A great deal of obstacles are not caused by the technology itself but rather by how it is organized and used. In many cases, the informants brought up their desire for additional communication channels as alternatives to the plain telephone, such as chat, mail, contact forms, or basically anything text-based. However, many public entities, and in particular the Norwegian health sector, do not offer other contact options besides the phone, according to our informants. Important information, like dates and times for appointments are often given only in oral form. Informants also told us about recordings that did not get properly archived, rendering them basically valueless, and they complained about meeting participants not muting their microphones when not speaking, about participants talking simultaneously with others, speaking unclearly or too fast, or about those covering their mouths. Other examples of barriers we were given are a too small face and incorrect lighting of one’s face in the video of meeting software. Not repeating speech from speakers far away from any microphone, such as in lecture and seminar settings, appears to be a frequent problem, according to the informants.

How often are technical problems encountered, and are there nowadays more technical barriers than before? In terms of the first question, an accumulated 27% of respondents (N=320) ticked the “a couple of times each month” checkbox or other alternatives with more frequent occurrence, see Figure 2 (right). This means that the remaining 73% seldom or never experience problems, which mirrors roughly the 74% share of those who are satisfied with the quality of their AT, see the discussion further above. In terms of the second question, 59% of the respondents (N=85) answered that they do not see a change in the situation, 29% said there are clearly more, whereas 12% believe there are less than before. While the large indifferent part is difficult to interpret, the overall trend is that there are more barriers now. However, for a not insignificant share of informants, the Covid-19 pandemic has had a positive impact on their communication. Even though most prefer physical meetings over digital ones, many acknowledge that nowadays there are more and better solutions for video meetings, such as Teams, Skype, Messenger, and similar, which eases lip reading and for many results in better speech audio and less noise, which may partly be due to more disciplined participants. However, while visual communication is received well without exception, there are a few voices that complain about bad audio and bad acoustics in the home, which is due to many being in their home office.

All technical difficulties may have a range of consequences: Many respondents (N=84) said they need more time to solve their problems (67%), while others call help (19%) or simply let those helping solve their tasks (32%). A share of 29% state that they may just give up, which means their problem(s) remains unsolved. It is stressed that multiple alternatives were possible with this survey question. Regarding asking for help, it was striking in the interviews that all informants said they wanted to be as autonomous as possible and tried to solve potential technical issues themselves. Yet, almost all informants admitted to being in need of help from time to the other. This picture is confirmed in the survey. Here, we found that 81% of the respondents (N=16) need sometimes, often, or very often help to communicate, across all ages. This finding is in contrast to the high satisfaction with communication technology and AT as discussed before.

There are two more interesting results from the survey regarding getting instructions for AT and educational training. First, there are many different actors in this field in Norway: Audiologists, audio educators, audio engineers (all of which are related to the health sector), The AT Center of the Norwegian Labour and Welfare Administration (NAV), AT manufacturers, the municipality's hearing contact point, the municipality's adult education, and a few others. This high number of actors makes these waters difficult to navigate for the AT users. Second, as many as 20% of the respondents (N=187) claim that they have not received any instruction at all, and at least 34% think the technology instructing part and training was insufficient. The importance of this demand is raised even further in the interviews, where almost all informants agree that there is a high demand for both better information, better instruction, and repeated training.

When it comes to the list of actors a person with a hearing impairment may have to relate to during their lifetime, the above list of educational actors has to be extended by personal physicians, ear-nose-throat specialists, health nurses, civil society organizations and their hearing peers, interpreting services, and others. Several informants experience it to be challenging to navigate in this jungle of responsibilities, which raises the question of whether there are too many actors. In addition, some of the technical support is organized on a municipality level, and - according to many informants - both service level and competence in Norwegian municipalities regarding hearing loss vary a lot. A superior entity with expert competence and a nation-wide service offer could be a remedy here.

Finally, several informants raised critical voices considering the suppliers of hearing aids. They question the power these suppliers have in the (Norwegian) market, and that the authorities seem to have accepted the lack of interoperability among hearing aids and other assistive devices, such as streaming devices and microphones. As a result, in most cases one cannot combine the solutions of different suppliers with each other. To solve this, it has been suggested to commit the suppliers to the use of joint technical recommendations and protocols, such that interoperability is maintained.

4 Limitations

The validity of this work's results is limited by the following considerations. Both respondents and informants were recruited through HLF's member registry and are thus not representative for the entire population of persons with hearing impairments. An initial N=380 respondents and inter-question dependencies gave (a few) subsets with as low as N=15 for particular survey questions. A larger number of respondents would have been beneficial but was limited by the available project budget. It has also to be kept in mind that the effect of distributing and conducting the survey in a digital manner, and of carrying out the interviews either on the phone or digital meeting tools, may be to give a too positive view of any digital barriers, as both methods of recruiting favor the tech savvy.

5 Conclusion & outlook

To conclude, we found that our population of people with hearing loss was quite heterogeneous, but they all had in common that communication technology is very important to them. Many informants stated that they are "totally dependent on their hearing aids and AT", and it is not rare even to hear statements that technology "has saved their life". The tremendous recent technical advances targeting hearing impairment have considerably increased the quality of life for a wide range of the population. The survey has shown a number of good technical solutions for many situations and a wide-spread satisfaction with their quality. However, we also have uncovered a number of areas where the technology and related areas can be improved, including installation and instruction, as well as a low degree of universal design of AT.

This picture of technology as an enabler with weaknesses for people with hearing impairments has been confirmed by our interviews. In the opinion of several informants, hearing loss - as compared to other impairments - is once more confirmed as the invisible impairments which - in many cases - does not get the proper attention by the authorities and lawmakers as other impairments do.

Many countries have or are about to incorporate CRPD / the Convention on the Rights of People with Disabilities [7] into national law. In Norway, the current government has expressed their intention to do so in the near future. Incorporation of the CRPD means, among other aspects, to develop universally designed goods, services, equipment and facilities. As the UN's definition of *universal design* particularly includes assistive devices, any system which cannot be combined with AT such as hearing aids is not universally designed. Also, the CRPD applies to basically all aspects of society. This is in contrast to Norwegian legislation, which at the time of writing only requires universal design of ICT for Web, apps, and self-service machines [8], while Norway's Equality and Anti-Discrimination Act [9] mandates the facilitation and adaptation on an individual level. More equality of opportunities and more inclusion could be achieved in Norway and other countries by extending the requirement for universal design of ICT to areas such as working life, the

communication with public and private electronic services, and others, and by making facilitation and adaptation the responsibility of the society, not the individual.

Regarding future research, one possibility is to include the experiences, needs and preferences of relatives and caregivers of individuals with a hearing impairment. This was outside the scope of this work but would give additional valuable knowledge about technology. Another possibility is to gain more knowledge about the experiences of hearing-impaired individuals with technology in education- and work-related contexts, as technology and its proper use is crucial in both settings.

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