

Deaf Disparity: How Deaf People Use Technology that Expects them to Hear

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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For members of the deaf and hard-of-hearing (DHH) community, devices and programs that require audio or speech input are frustrating, and the proliferation of remote work and learning exacerbate this problem. Zoom, Google Meet, and other tools offer no first-party support for automatic captioning (Anderson et al., 2020). DHH individuals often must interact with interfaces that expect them to hear, and try to adapt such interfaces to their needs.

The DHH community accounts for 1 in 20 Americans (Mitchell, 2005), but many online informational and entertainment videos, livestreams, and podcasts are only sometimes captioned. Closed captioning is needed more than ever, as American video consumption rose 660% from 2011 to 2012 (Maiorana and Pagliaro, 2014). Requesting accommodations, such as third-party ASL interpretation or captioning, can elicit a social stigma from coworkers and peers. ASL grammar can also be difficult with the COVID-19 pandemic, as face masks cover facial expressions, and video quality is often not good enough to clearly discern ASL signs (Katz, 2020).

Members of the DHH community vary by criteria such as degree of hearing loss, language preference, educational experience, and integration in the Deaf community. Deafness can be an attribute or an identity. For some deaf people, especially those who lost their hearing after they learned to speak and who prefer English to sign language, deafness is an attribute that may have little to do with personal identity. Some people with deafness identify with the trait; they belong to a community associated with Deaf culture (uppercase D) and generally prefer sign language.

Major participants include several classes of advocacy groups that provide education and employment solutions for the DHH community. One class focuses mainly on schooling and education (NDC, 2020), while others expand their scope to build communities (CSD Inc., 2020). Another participant are self-advocacy groups, who help deaf and hard-of-hearing people set their own goals, describe their own needs, and ask for their own assistance (Hands and Voices, 2020). Participants also include DHH persons who are frustrated with their current accessibility options, worry about their employability, and find the increase of challenging scenarios such as virtual meetings difficult (Marshall, 2016). Another important participant group are advocates for the deaf who try to close the “division” from the “hearing world” and the “deaf and hard of hearing community” by ensuring they have access to usable technology (Taylor, 2020). The final participant are software companies that value accessibility and work to provide solutions for the DHH community (Lovett, 2019). With the current global pandemic furthering the divide between abled and disabled individuals, figuring out how deaf individuals use their current technology options is essential for supporting their inclusion in society. To support their autonomy, DHH individuals require technology that serves them by default, as current accommodations are inadequate and separate assistive tools cannot keep pace with current innovation.

Review of Research

How DHH people have adapted to technology in the past can shed light on how they might operate in today’s digital world. Vaso Constantinou et al. (2020), who studied the inclusion of deaf students in mainstream schools, argues that there shouldn’t be a focus on technology built specifically for deaf people, but rather on “technology integration” that can serve the need of both DHH students and the general population (Constantinou et al., 2020).

Although Constantinou only observed K-12 schools, he argues a similar point in that accessibility should not be an afterthought. Mairoana-Basas and Pagliaro (2014) performed a national survey on the deaf community and found that new technology seems to always be “one step forward, two steps back.” With our devices an “indispensable part of daily life,” personal and professional advancement can be difficult for DHH persons when accessibility is sidelined (Maiorana and Pagliaro, 2014). Phillips and Zhao (2010) looked at technology abandonment, and how the frequent replacement of old devices for newer ones poses a threat to people with disabilities who rely on these old devices (Phillips and Zhao, 2010). Each of these research papers emphasizes the importance of accessibility being automatically provided in new devices to account for the speed of innovation.

Some researchers take the stance that separate accessibility tools are essential for deaf individuals. Glasser et al. (2020) argues that separate interfaces to interpret sign language should be used in place of conversational interfaces such as Siri and Alexa. I would instead argue that these interfaces should support DHH users by default by supporting text input and output. M. Allsop et al. (2011) adds that DHH children have an extra burden in school since they must learn to use an extra device. This would hinder their development, leave them vulnerable to social stigma from their peers, and add more developmental and financial hardship overall. Jeffrey Bigham et al. (2017) offers two solutions for conversational interfaces: creating computational workflows for understanding “deaf speech,” (how deaf people talk since they cannot hear their own voice), and using mobile interfaces that can speak on the user’s behalf (Bigham et al., 2017). Smartphones could be an intermediary between deaf users and voice-controlled devices, eliminating the need for an auxiliary device specific to DHH users.

The COVID-19 pandemic has underscored the importance of accessibility accommodation in devices. O'Brien (2020) notes how face masks make it impossible to lipread, how lockdown and isolation make social interaction difficult, and how virtual environments may stunt development in deaf children. O'Brien denounces the UK for their systemic ableism in both attitudes and policies regarding COVID-19, which speaks to the need for destigmatization and better accessibility. Separate devices used only by DHH people increases stigmatization, whereas interfaces already suited for both abled and disabled individuals alleviates negative attitudes and judgmental behavior (O'Brien, 2020). Michael McKee et al. (2020) adds that COVID-19 hospitals and clinics have restrictions that make communication hard for DHH patients. The safety procedures, though necessary, interfere with the requirements of the Americans with Disabilities Act (ADA) (McKee et al. 2020). However, McKee also points out that Automatic Speech Recognition (ASR) technology is rapidly improving due to companies creating products that make powerful captioning tools possible. The COVID-19 pandemic, while devastating, may help speed up accessibility software for navigating a virtual environment.

Previous research on how DHH individuals use and adapt to devices emphasizes the need for interfaces that can support them by default. The COVID-19 pandemic worsens these problems, where societal engagement is reliant on devices. To prove the need for devices that are accessible to everyone, I will look at how current technology options are inadequate for DHH, how separate assistive tools cause a social stigma from peers, and how specific deaf accessibility tools do not keep up with the rate of technological progress.

The Inadequacy of Current Technology Options for Deaf Users

DHH individuals struggle with the current ways to use modern technological interfaces. Their options include captioning systems in software and on the web, mobile health apps, and other apps available on a smartphone that are targeted towards everyone. I will also analyze social media apps that are severely lacking in their accessibility accommodations. Currently, all apps must comply with the Americans with Disabilities Act (ADA), which require mobile apps to be “fully accessible to people with disabilities” (NP Group, 2021). These ADA guidelines were a good step, as most applications were difficult for people with disabilities before. Even still, many apps today don’t adhere to the requirements or only provide the bare minimum for users.

Problems with internet use are very common for deaf users, even with ADA. E Foley (2019), on Level Access Blog, points out various issues with internet captioning systems, such as when they don’t clarify who is speaking, when they are missing content, or when they are not synchronized with what is on screen. More robust automated captioning through AI is helping, but is still far from perfect and sometimes “worse than no captions at all” (Foley, 2019). Steve Friess (2015), a deaf writer for TIME, wasn’t able to enjoy real-time livestreams of new Apple products or important press conferences about the 2016 presidential election online because he was forced to wait until captions were available. The FCC requires programs to be captioned within 15 days of airing, but Freiss was frustrated to not be included in such “cultural, collective moments” (Freiss, 2015). Abra Al-Heeti (2019) found that Americans with disabilities are “three times as likely” to never go online and 20% less likely to own a computer than abled individuals (Al-Heeti, 2019). Sometimes, it is simply too difficult to use inaccessible devices and services, so DHH users opt not use them at all.

Deaf and hard-of-hearing apps are also lacking for DHH users. A study by Ryan Romero looked at three categories of mobile apps: ASL translators, speech-to-text, and hard-of-hearing assistants. Evaluated using the Mobile App Rating Scale (MARS), he found that 5 of 7 ASL translators were “wholly inaccessible,” had “extremely poor design,” or were abandoned by the developer. Speech-to-text and HoH assistants were marginally better (Romero et al., 2019). Although mobile health apps are often designed by skilled developers, they still lack features that are necessary for DHH users. Deaf developers and accessibility teams would help alleviate this, since the perspective of a DHH user would give valuable information on designing with accessibility in mind. Sanjay Nasta, the founder of mobile app development company Microassist, says that mobile phones provide access to the “world’s goods and services,” including “commerce, communication, healthcare, and transportation” (Nasta and Adam, 2017). Good quality mobile apps for the DHH community are essential to have the same level of access as the hearing world. This is more than just captions and speech-to-text; haptic feedback along with noises, dynamic text size, and contrasting colors all help those with all types of disabilities. All apps must be designed with the needs of DHH people in mind.

While there is major work to be done, progress is being made in accessibility for the DHH community. Google, Apple, and Facebook have made strides in deaf accommodations through better captioning and better speech recognition. Microsoft has introduced chief accessibility officers and hired people with disabilities to “all kinds of roles” (Al-Heeti, 2019). IBM’s Watson AI and Google’s Cloud Speech-to-Text API are both powerful tools that developers can leverage to build more robust captioning services that improve with time. However, we must ensure that companies keep up with accessibility. The hugely popular short-video app TikTok has no support for automatic captioning and relies on creators to write

captions themselves, making it unusable for many DHH users. Massive social media apps are launching their own short-video-clip sharing or public chatroom capabilities through Snapchat Spotlight, Instagram Reels, and Twitter Spaces. None of these have automatic caption support. The quickly growing public audio drop-in chatroom app Clubhouse is a “great social media app” that “excluded deaf from the start” (Mellidez, 2021). For an app that was released in beta in 2021, this is a major oversight. Even long-standing apps supported by large companies, such as FaceTime and Skype, still have no automatic captioning support. If companies don’t implement captioning tools and take advantage of the huge strides made in AI, then the DHH community will continue to be marginalized.

Social Stigma Caused by Separate Deaf Accessibility Tools

Separate Deaf accessibility devices and tools elicit a social stigma by coworkers and peers. These are tools specifically used by DHH individuals, including hearing aids, special telephones, third-party ASL interpreters, and tools required by the COVID-19 pandemic. The 2007 film *Through Deaf Eyes* is a documentary that speaks about technology as a cultural force, and how deaf people are often forgotten along the way. For example, weather warnings, music, and news were inaccessible when the radio was introduced. Telephones prevented DHH users from communicating with loved ones and work. One person they interviewed, Rory Osbrink, says that when he got a cochlear implant (a device to help deaf people hear), people called him a “freak” and asked if it was “really part of [his] body” (Hott and Garey, 2007). The 2019 film *Sound of Metal* by Darius Marder explores acquired hearing loss through the lens of a musician. For a time, the main character refuses to go to a deaf community center and learn sign language because of his internalized stigma towards the disability. The movie itself is praised for its

beautiful portrayal of deafness as an identity (Glasner, 2020). Victoria L. Mousley (2018) interviewed deaf individuals to study their physical and psychological well-being, and found higher rates of control disorders, depressive symptoms, and developmental disorders. She mentions how accessibility needs “highlight their otherness,” which includes necessary devices for proper communication (Mousley, 2018). The hearing world views being deaf only as a disability, rather than an identity that brings personal growth and community. The Sound Relief Hearing Center stresses joining Deaf culture to fight this stigma and using hearing aid solutions that are invisible and in the ear canal (Prutsmann). Until the hearing world learns that deafness doesn’t mean someone is old or not smart, the Deaf community must advocate for DHH people who may feel ostracized.

The sense of difference amongst deaf people is worsened by the fully virtual settings of the COVID-19 pandemic. The National Association of the Deaf (NAD), a non-profit that promotes deaf rights, mentions how masks impede lip-reading and facial expressions required for American Sign Language. As masks became ubiquitous, people with mild hearing loss who did not need hearing aids previously, suddenly couldn’t understand speech due to the muffled sound and covered mouths (Sanchez, 2021). One solution is the FDA-approved clear mask, but these are difficult to find and the clear material muffles voices more than standard cloth (Epps, 2020). One Deaf person, Quinn West, says how the pandemic widened gaps in “communication access” through the lack of reliable technology and an underutilization of needed tools. West struggles because every new remote video call needs a new interpreter, which means adjusting to a new signing style and causing stress (Sanchez, 2021). Brianne Burger must hold her phone up to the computer speaker so that her speech-to-text app can translate her daughter’s Zoom call, and the captions are not always correct (Lefrak, 2020). Zoom, the biggest videoconferencing tool

during the pandemic, doesn't have a first-party captioning system. If there is no ASL interpreter, then there is no easy solution for DHH users. These problems add to the social stigma that the DHH community faces every day, but software and interfaces built to avoid needing special treatment can reduce it.

Deaf Technology Cannot Keep up with the Rate of Technological Innovation

Antiquated tools are widely used by the DHH community today, while abled individuals enjoy the new features of modern tools. Since DHH people cannot effectively use these interfaces, there is a technological gap between the two groups. One outdated tool is Captioned Telephone Service (CTS), where a live operator listens to the conversation and types captions that appear on a screen. The user experience of CTS is difficult; whenever a speaker is done with their sentence, they must say "Go Ahead" so that the operator knows to stop translating, and the operator's translations may not be accurate or fast (NIDCD, 2019). There have been very minor improvements to CTS in the past 20 years, but it is one of the few options for deaf users to speak on the phone. Another outdated accessibility device is an FM system, where a speaker wears a special microphone and the listener wears a receiver to hear the speaker (Berke, 2020). Both personal and room-wide FM systems are designed to improve the signal-to-noise ratio. Personal FM systems are unintuitive since the DHH user must ensure beforehand that the speaker is wearing the microphone so they can hear them. In a classroom setting, a DHH student would hear everything a teacher says throughout the entire day, even if it is not directed towards them. Room-wide FM systems worsen the quality of sound for every hearing person in the room due to it sounding like a PA speaker. If every student was connected to the system, they would overhear the teacher's messages to other students as well (Boys Town, 2021). CTS and FM systems are

outdated interfaces used by the DHH community today, and they both underscore the slow rate of innovation in accessibility tools. Technological progress for traditional devices and software speeds up “exponentially over time” due to each new generation building on the innovation of its predecessor, creating a “positive feedback loop” (Dorrier and Berman, 2016). For DHH accessibility tools, this feedback loop doesn’t exist and leaves out-of-date solutions as the only option. We must ensure that DHH people are considered in the development of new technology and are a part of exponential innovation.

Conclusion

Technology can certainly be the savior needed by the deaf and hard-of-hearing community. Intelligent captioning systems made possible by machine learning and artificial intelligence, speech recognition tools that can understand deaf speech, and conversational interfaces that support text input and output all give DHH individuals more autonomy and better means to participate in society. However, if these solutions are not properly implemented in software, the divide between DHH people and the hearing world will only widen as we become more reliant on technology. Devices or software must include these features by default, and not require any further add-ons or extra charges.

A practical application of this idea is software that can automatically caption audio from any source. This eliminates the requirement of an ASL interpreter on any virtual meeting, and users wouldn’t need to hope that the platform can provide captions. If the platform has shoddy captioning software, this tool could be used in place of it, as it would be standardized for any audio. This is possible using recent progress in Natural Language Processing and artificial intelligence from Google and IBM.

The need for better accommodations is not specific to just DHH users. All technology should be designed for everyone, and have alternate use-cases and operation modes for those who cannot use the standard interface implemented from the beginning, not as an afterthought. For example, having text-to-speech for blind users or voice control for the mobility-impaired are ways to support people with other disabilities. People with disabilities already face a magnitude more hardship than their abled counterparts every day, and technology should be the solution they need to achieve support, independence, and autonomy in our society. We need to make sure innovation is done properly, with everyone in mind.

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